# Better Buildings Webinar Series

We'll be starting in just a few minutes….

**Tell us…**

**What topics are you interested in for future webinars?**

Please send your response to the webinar organizers via the question box.

# Save Money and Build Resilience With Distributed Energy Technologies

February 4, 2020

3:00 – 4:00 pm EDT


# John Agan

U.S. Department of Energy

# Today's Presenters

**Emma Elgqvist**
National Renewable Energy Laboratory

**Nicholas DeForest**
Lawrence Berkeley National Laboratory

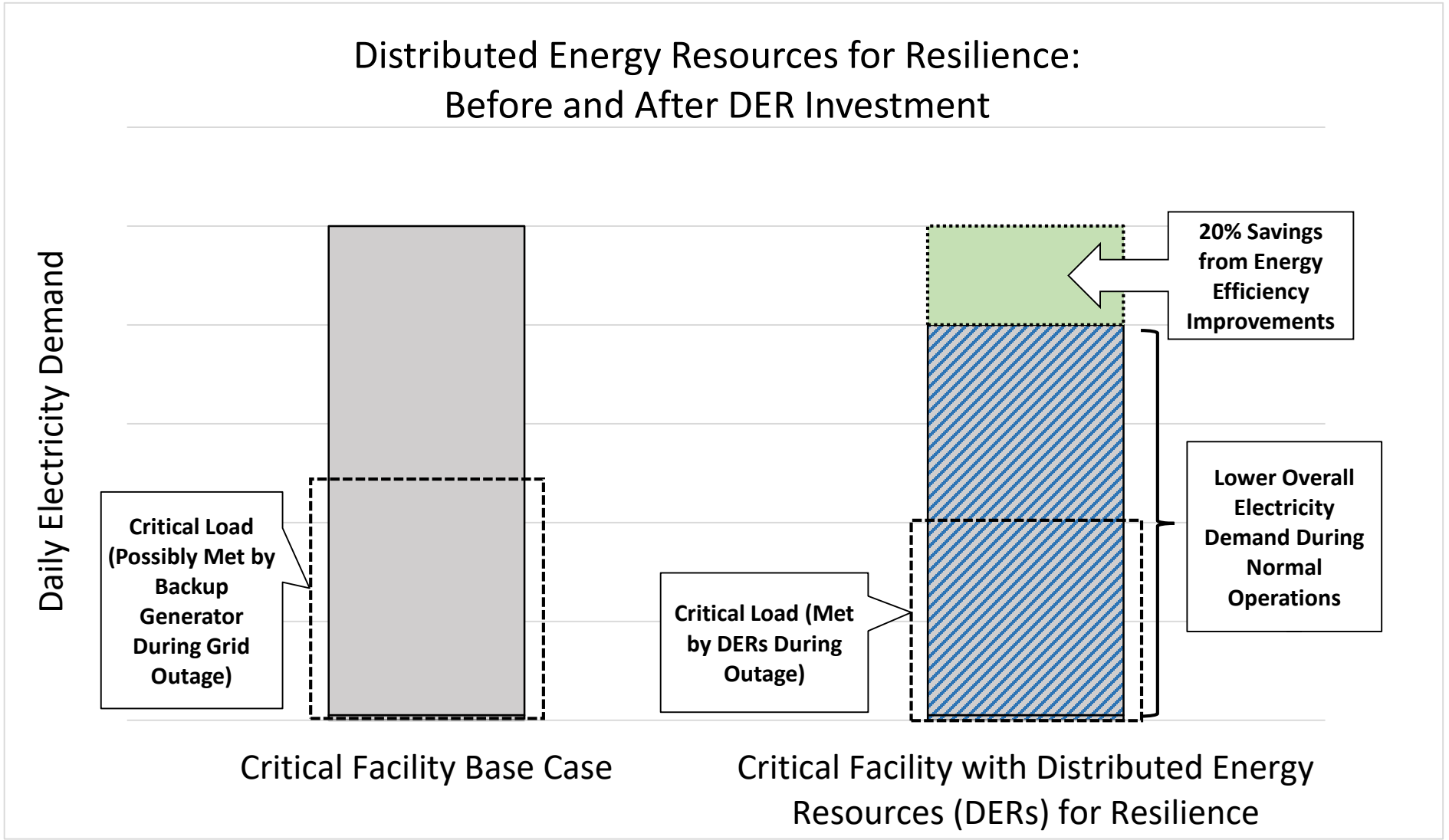
# Polls

# Resilience

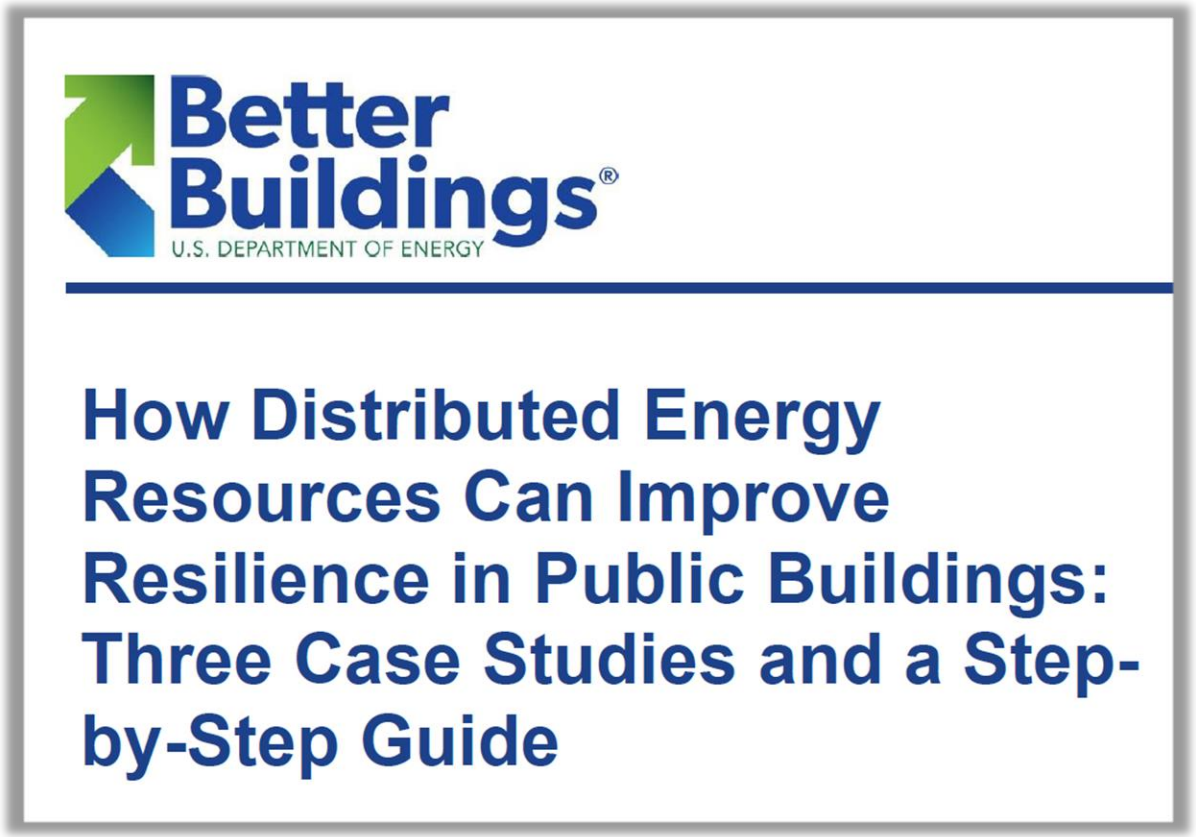
In 2017, the U.S. experienced natural disasters* that cost more than $300 billion in damages and led to **longer and more frequent disruptions in power**

*Droughts, floods, freezes, hurricanes, and wildfires
Source: National Oceanic and Atmospheric Administration

# With EE, critical load is lower and DG investment needed is cheaper



# New DOE Resilience Resource




- Introduces readers to the benefits of integrating energy efficiency with other DERs to achieve resilience objectives
- Describes two tools to analyze DER options at critical facilities, presenting case studies with completed analysis for three partners in DOE's Better Buildings Challenge
- Provides step-by-step guidance for conducting new analysis

# Analysis: BBC Partners

Better Buildings Challenge (BBC) partners commit to:

- Reduce energy intensity of building portfolio by at least 20% over ten years
- Share successful strategies and results.

Better Buildings® CHALLENGE U.S. DEPARTMENT OF ENERGY

| Partner | Improvement Since Baseline | New Analysis: Identified Buildings | Simulated Outage Details |
|---|---|---|---|
| North Carolina | 16% | 8 critical facilities, including some used as shelters | Hurricane Season – 48-96 hours 50% of building load |
| Hillsboro, OR | 26%*<br><br>*Goal Achiever - Set a new goal in 2018 | 8 community facilities, including potential shelters | Four seasonal outages, 24 hours each |
| Alachua County Public Schools (FL) | 7% | 11 schools used as emergency shelters | Hurricane Season – 120 hours 30% of normal load |

# North Carolina

*Background:* Executive Order 80: Reduce energy intensity in state-owned buildings by 40% by 2025

*Analysis:* Six sites assessed for solar PV and battery storage, two for CHP

*Outcomes:*

- Ample savings opportunities exist when energy efficiency is integrated
- Modeled solar PV arrays provide 20-28% of each of the six sites' annual electric consumption

| *Modeled Results for Meeting 50% of Building Load During a 2-day (48-hour) Grid Outage* | | | | | |
|---|---|---|---|---|---|
| NC Facility and Electricity Usage Scenario | Battery Storage Size (kWh) | PV System Size (kW) | Annual PV Production (kWh) | Solar PV Production As % of Electricity Consumption | Installed Cost |
| NC Facility #6 - Business as Usual (BAU) | 361 | 191 | 233,475 | 22% | $491,550 |
| NC Facility #6 - 10% More Efficient | 325 | 172 | 210,128 | 22% | $442,395 (~$49,000 less than BAU) |
| NC Facility #6 - 20% More Efficient | 289 | 152 | 186,780 | 22% | $393,240 (~$98,000 less than BAU) |
| NC Facility #6 - 40% More Efficient | 217 | 114 | 140,085 | 22% | $294,959 (~$197,000 less than BAU) |

# Additional DOE Resources

- Resilience Resources
  - How Distributed Energy Resources Can Improve Resilience in Public Buildings: Three Case Studies and a Step-by-Step Guide
  - Energy Efficiency and Distributed Generation for Resilience: Withstanding Grid Outages for Less
  - Distributed Generation for Resilience Planning Guide
  - Efficiency-Resilience Nexus Fact Sheet

- **EE Financing Resources**
  - Better Buildings Financing Navigator
  - Commercial Property Assessed Clean Energy (C-PACE) for Resiliency Toolkit
  - Energy Savings Performance Contracting (ESPC) Toolkit

# Stay Connected

- **State and Local Solution Center:**

  http://energy.gov/eere/slsc

  - More than **500** tools, resources, and best practices

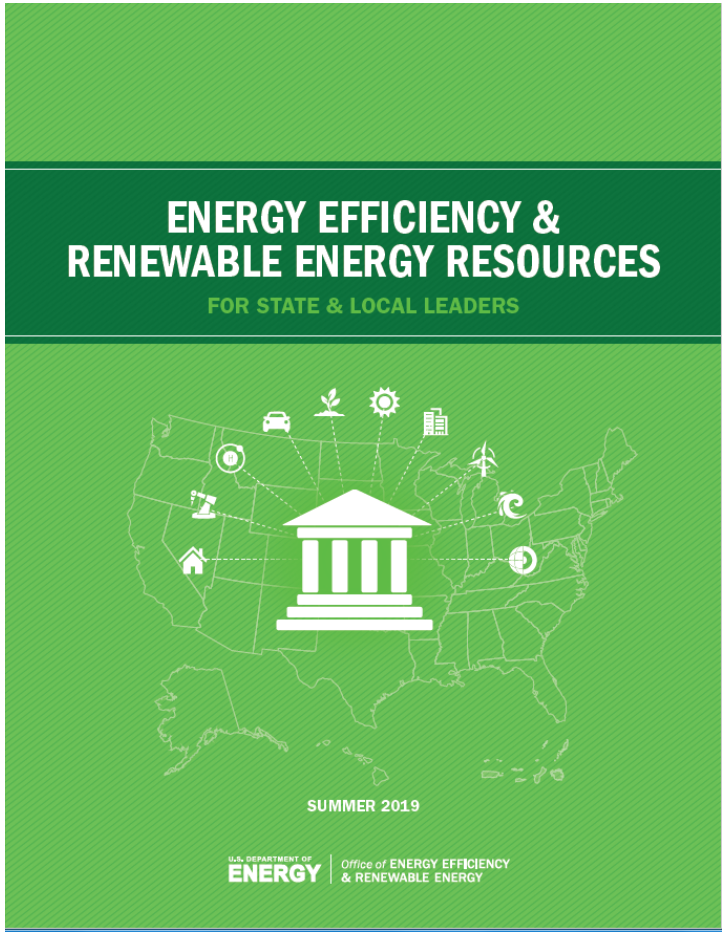
- **State and Local Spotlight:**

  http://energy.gov/slsc/subscribe

  - Monthly newsletter with **~33,000** subscribers


John Agan
John.Agan@ee.doe.gov

State and Local Inbox
stateandlocal@ee.doe.gov


Energy Efficiency and Renewable Energy Resources for State and Local Leaders


# Emma Elgqvist

National Renewable Energy Laboratory


U.S. DEPARTMENT OF ENERGY

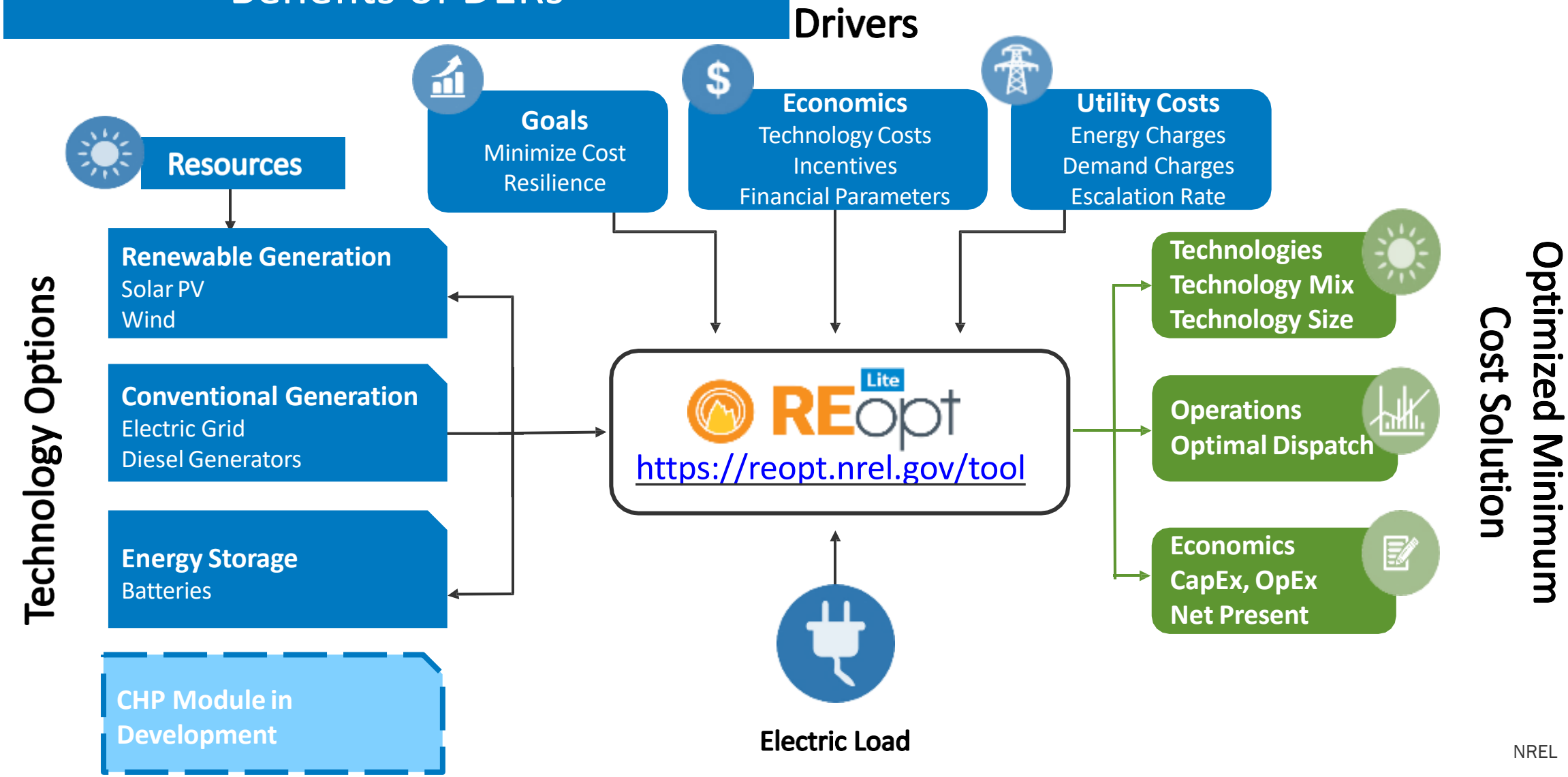
# Assessing PV + Storage Project Feasibility using NREL's REopt Lite Tool

Emma Elgqvist, Engineer, National Renewable Energy Laboratory

Better Buildings Webinar Series: Save Money and Build Resilience with Distributed Energy Technologies

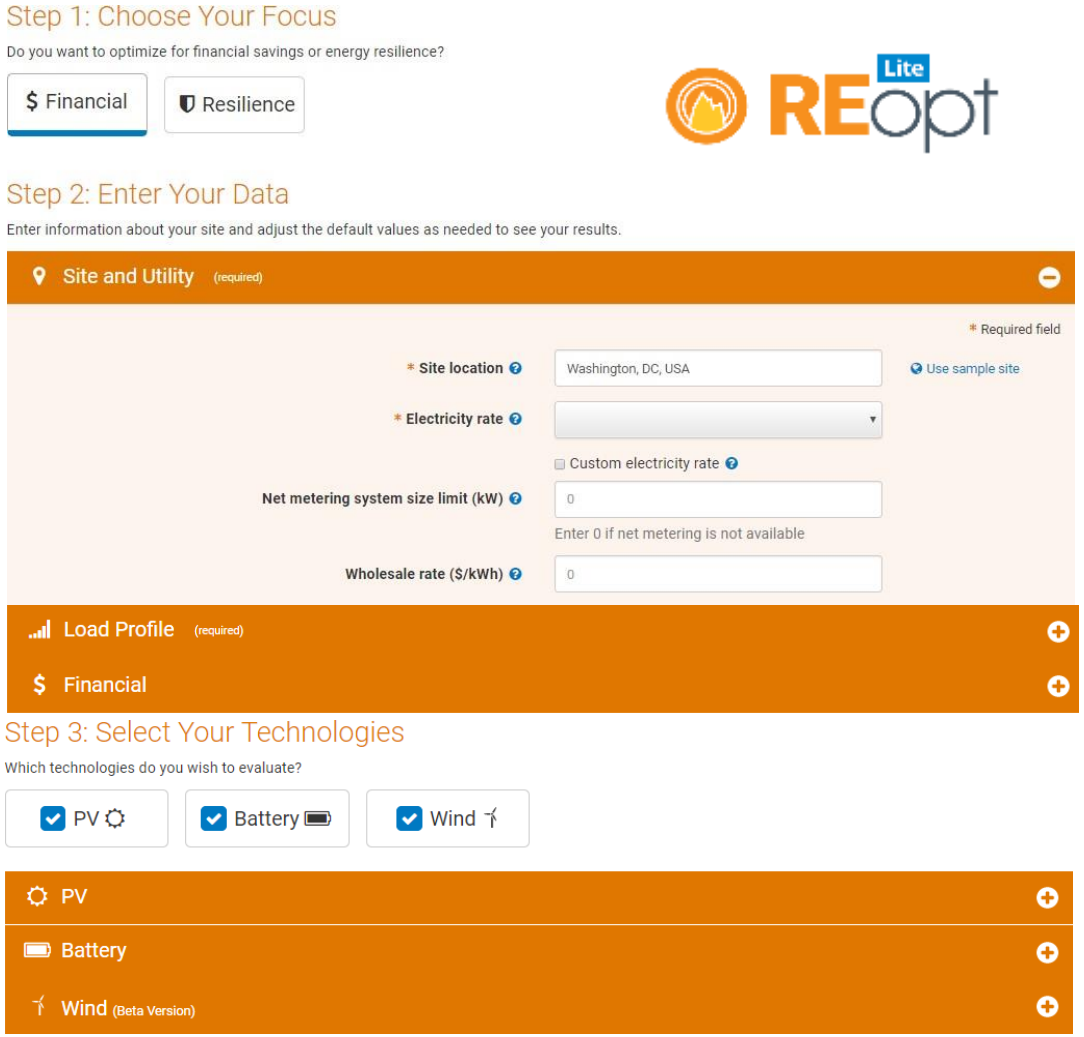
February 4, 2020

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



# REopt Lite Web Tool

- **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
- **Resilience mode** optimizes PV, wind, and battery systems, along with back-up generators to sustain critical load during grid outages
- To access REopt Lite: https://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

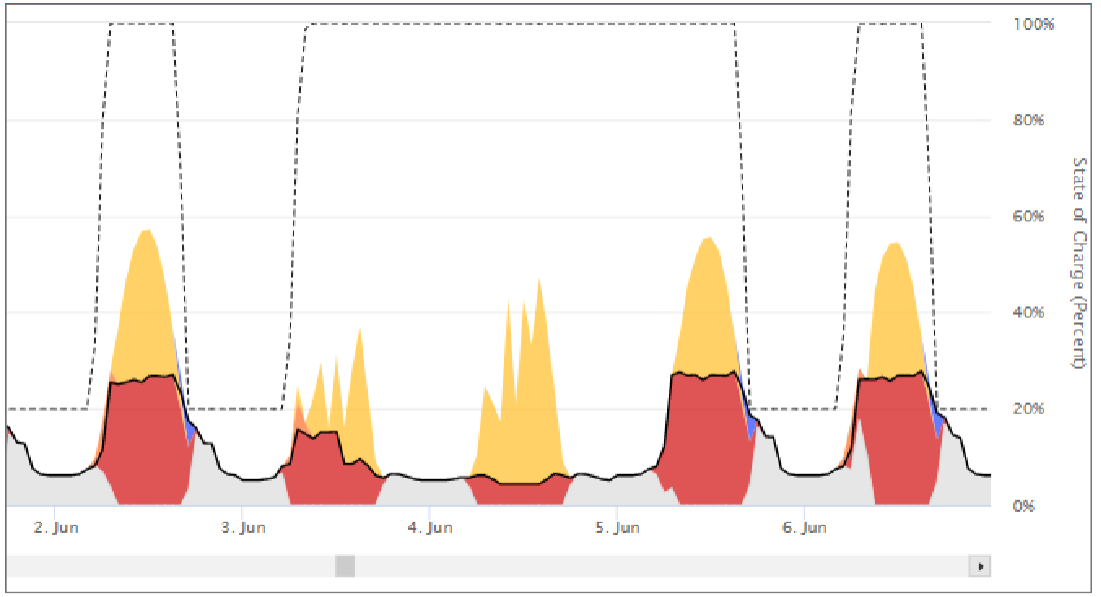
This system size minimizes the life cycle cost of energy at your site. The battery power and capacity are optimized for economic performance.

**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***

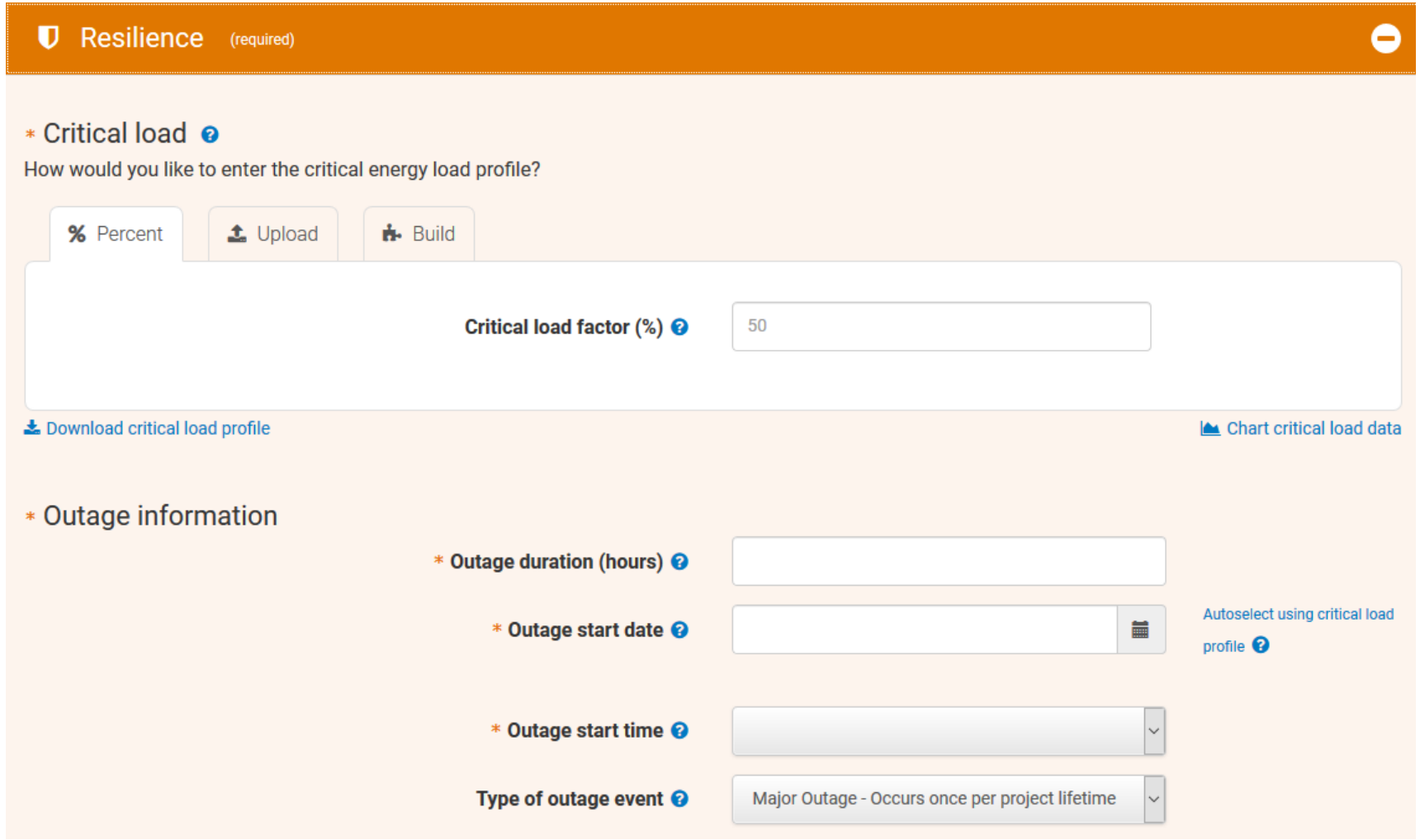
# Recent Resilience Update

- **October 2019:** Resilience Modeling, Diesel Generator Sizing, Load Profile Dashboard, Utility Rate Help, International Guidelines, and Updated Cost Assumptions

- **April 2019:** PVWatts and Solar Resource Data Set Upgrade
- **March 2019:** Custom Hourly Rate Tariffs and Integrated Critical Load Builder
- **November 2018:** Wind Module, Custom Monthly Rate Tariffs, Critical Load Builder, and User Dashboard
- **June 2018:** Enhanced Resilience Features
- **March 2018:** Application Programming Interface
- **September 2017:** REopt Lite's Initial Release

REopt update history: https://reopt.nrel.gov/software-update-history.html

# Resilience Inputs

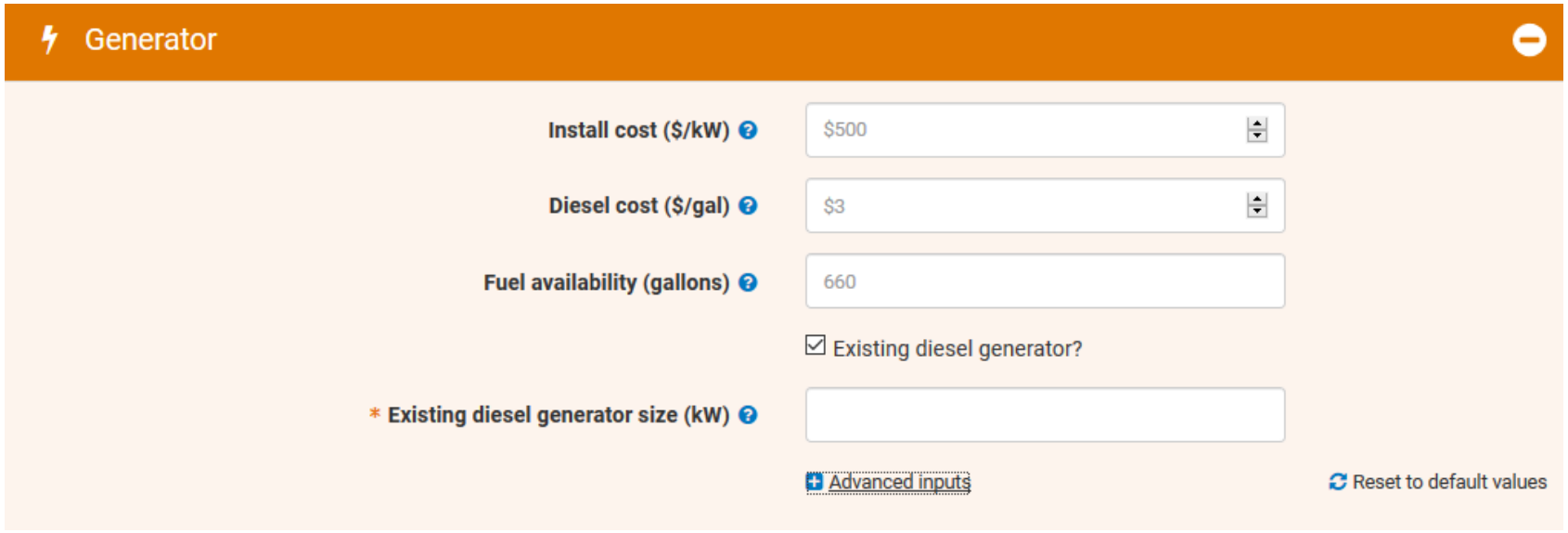



What load needs to be met during the outage?

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

# Generator Modeling


Generator option for resilience evaluation




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

Defaults are for diesel generator but can be modified

# Resilience Outputs

## 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.

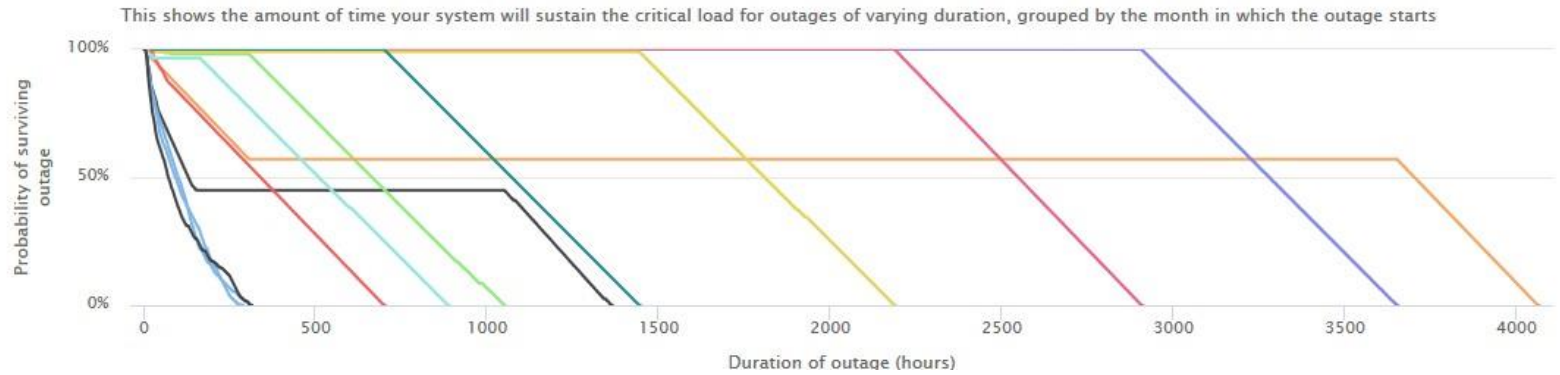
72% System survives 72% of 168-hour outages

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

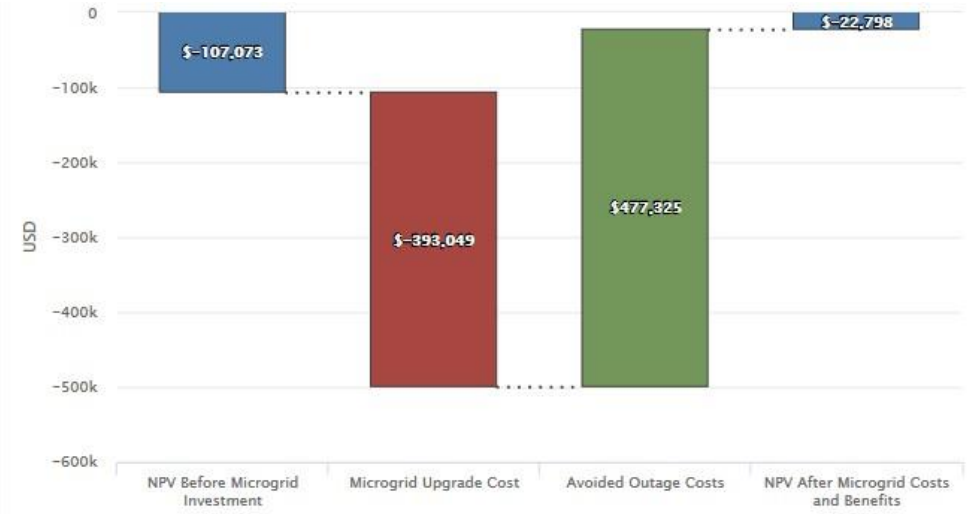


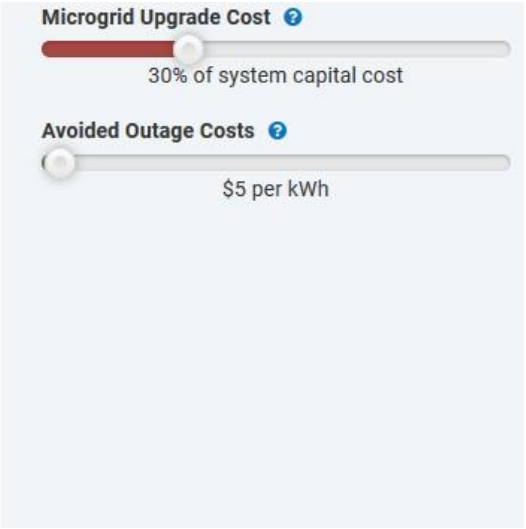

REopt Lite simulates outages of varying length throughout the year

# Resilience Outputs

| | 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

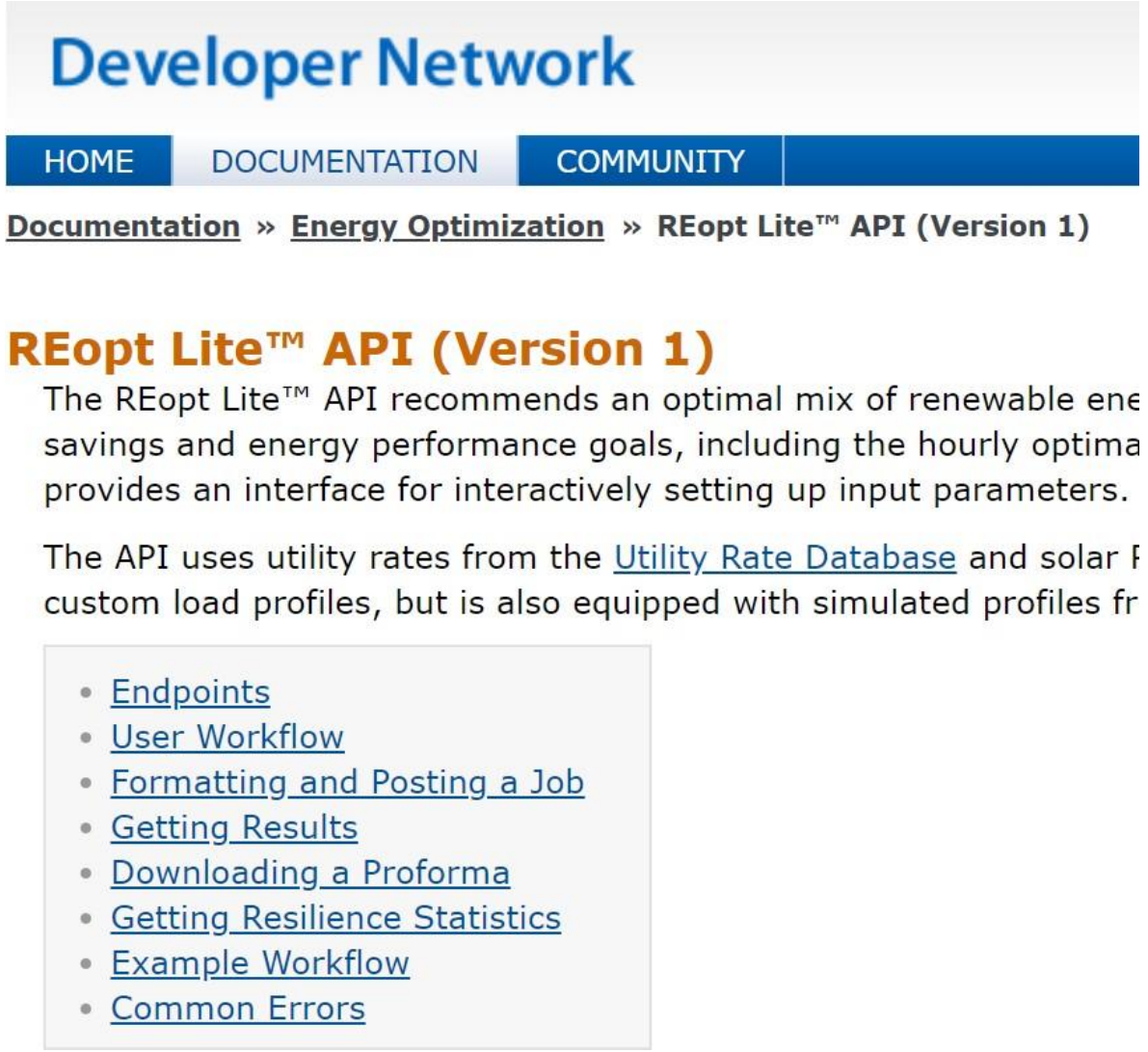



Explore impact of microgrid upgrade costs and value of avoiding an outage

# REopt Lite API

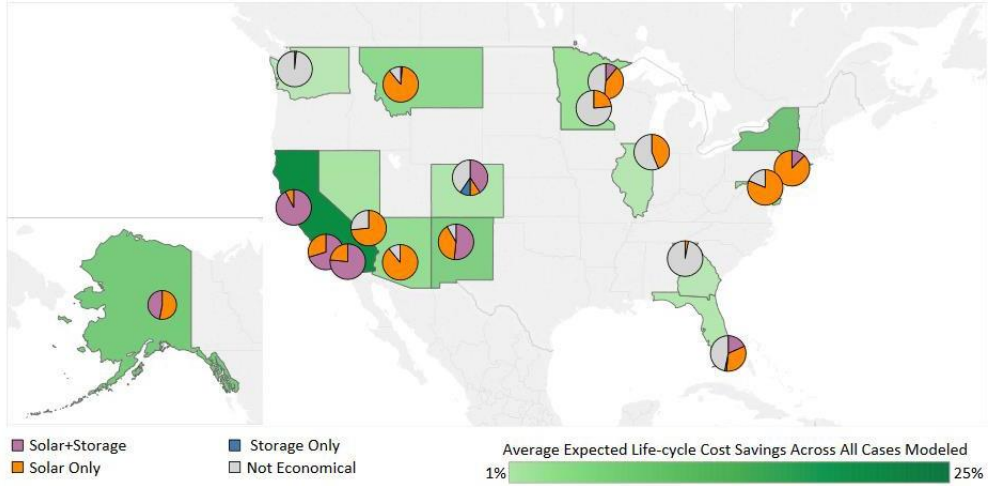
- What is an API?
  - Application Programming Interface.
  - Programmatic way of accessing REopt Lite (sending and receiving data from a server)
  - File format used for sending and receiving the data: JSON
- Advantages:
  - Multiple simulations for different sites can be run programmatically
  - Scenario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



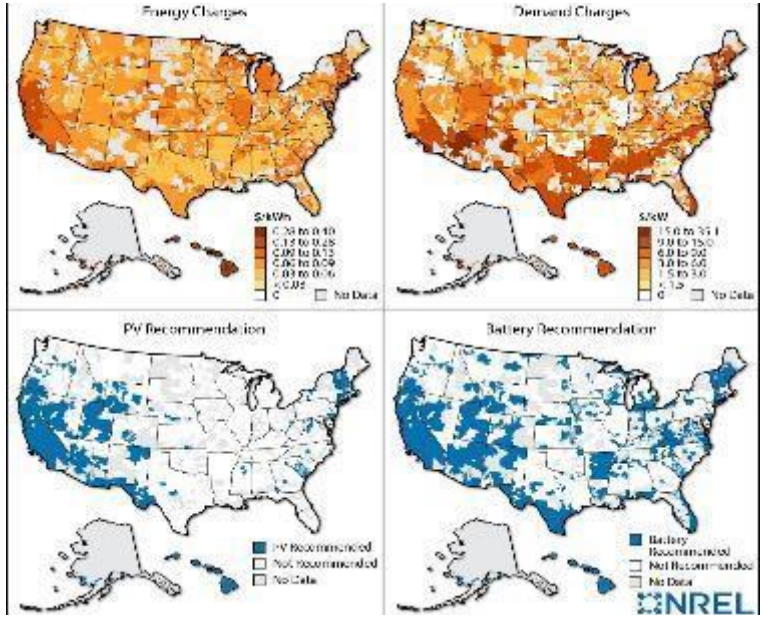

https://developer.nrel.gov/docs/energy-optimization/reopt-v1/

# 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 US?
  - 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 Development Plans

- **Third-party financing:** Develop a financial model for third-party ownership of photovoltaic, wind, or battery systems.
- **Federal scenarios:** Create analysis assumptions and results for federal users.
- **Run comparison:** Compare results from different REopt Lite scenarios.
- **Utility rates:** Add features such as ratchets and peak load contribution.
- **Constraints:** Add ability to constrain solution based on budget, emissions, and renewable energy goals.
- **Combined heat and power:** Integrate a combined heat and power technology option.
- **Online user forum:** Allow users to ask and respond to questions, and share insights and successes.
- **Electric vehicles:** Add option to include electric vehicle loads in optimizations.
- **Open source:** Release REopt Lite open source software.
- **Additional resources:** Add new REopt Lite case studies and tutorials.

Thank You

Emma Elgqvist

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www.nrel.gov


- REopt Lite (tool and help manual): https://reopt.nrel.gov/tool
- REopt Website (analysis services and case studies): https://reopt.nrel.gov/tool
- Send tool feedback & ask a question: reopt@nrel.gov


# Nicholas DeForest

Lawrence Berkeley National Laboratory

DER-CAM

DECISION SUPPORT TOOL FOR
DECENTRALIZED ENERGY SYSTEMS

ANALYTICS | PLANNING | OPERATIONS

# Introduction to DER-CAM

## Better Buildings Webinar Series: Save Money and Build Resilience with Distributed Energy Technologies

Feb 4, 2020

Nicholas DeForest
Grid Integration Group, Berkeley Lab

BERKELEY LAB

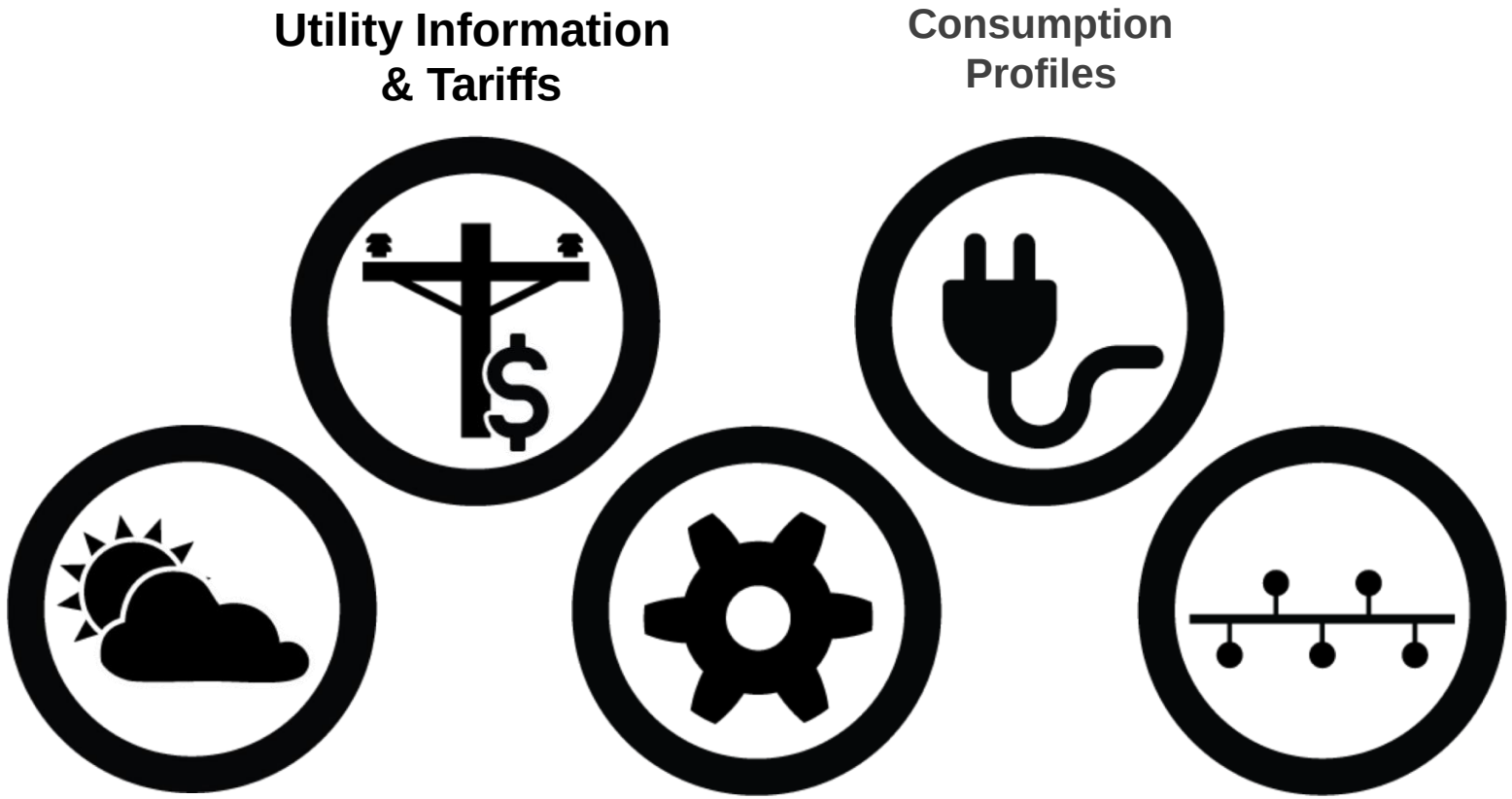
# Why DER & Microgrids?

**Reduce Total Energy Costs**

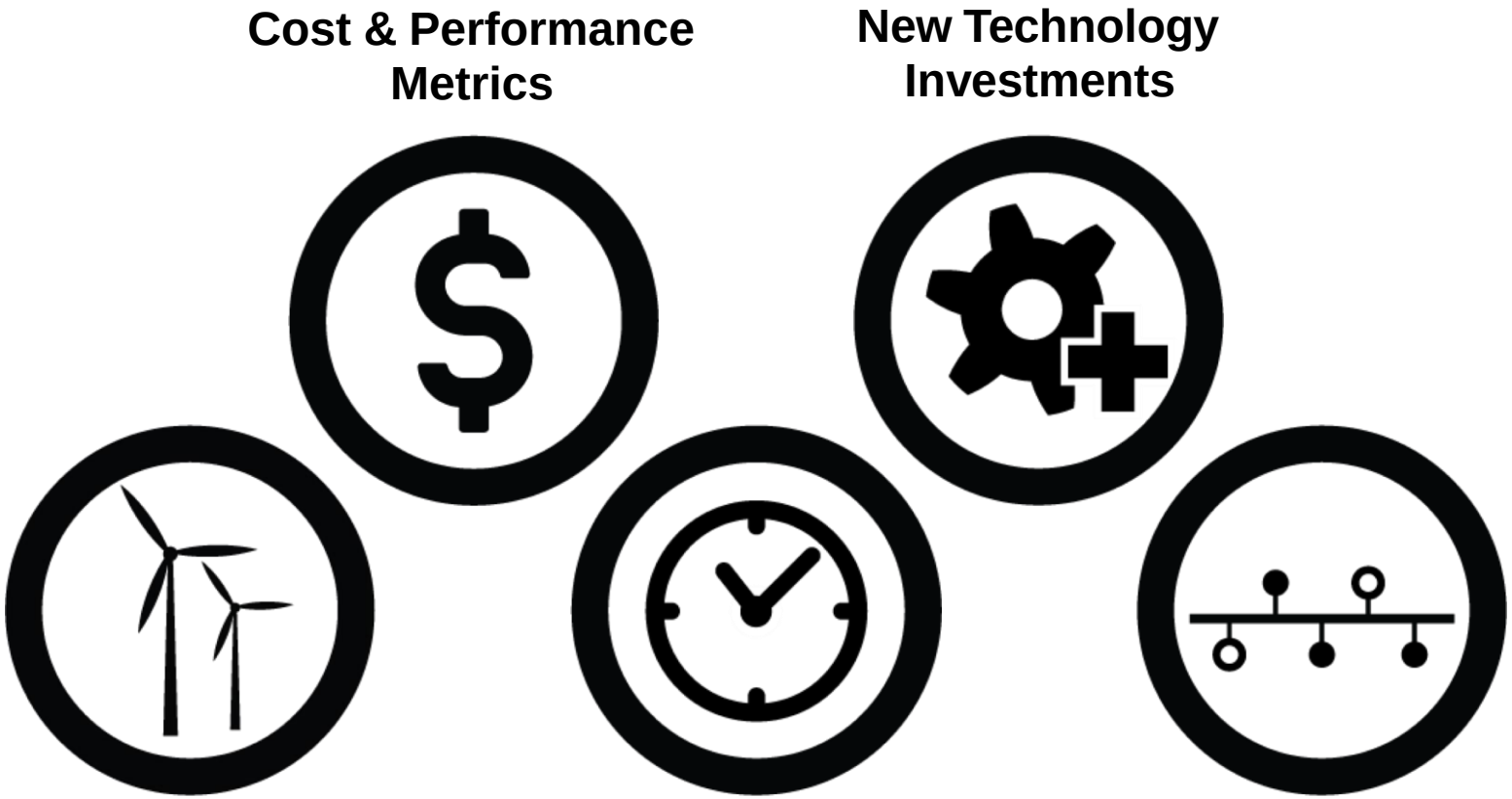
**Reduce Total $CO_2$ Emissions**

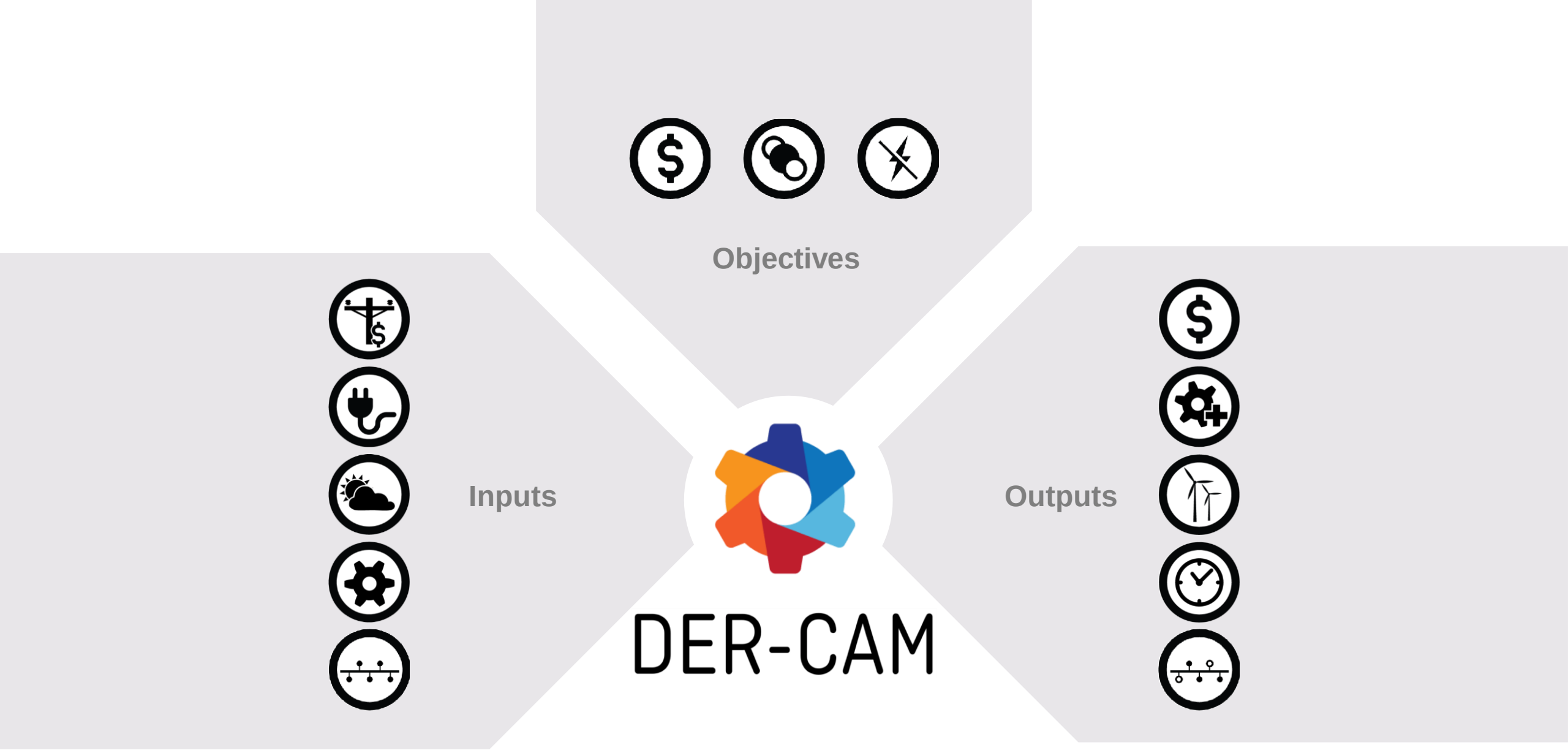
**Reduce Outages & Ensure Energy Security**

# What Impacts a System's Potential?



# What Guidance is Needed?




Objectives
Inputs
Outputs
DER-CAM


# DER Technologies & Investments

**Generation**
- Solar PV
- Combined Heat & Power
  - Combustion Engines
  - Fuel Cells
  - Micro-turbines,
- Solar Thermal Panels
- Wind And Hydro Power

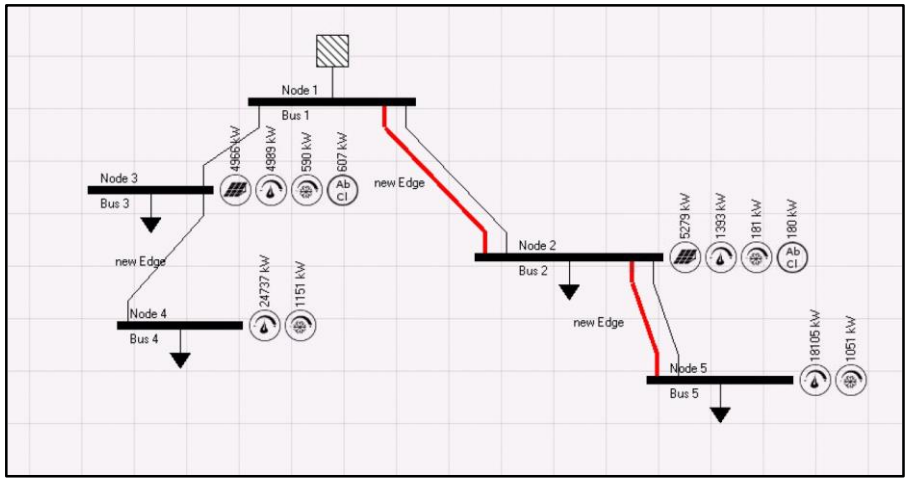
**Energy Storage**
- Battery Storage
- Heat Storage
- Chilled Water And Ice Storage
- Electric Vehicles

**Load Management**
- Demand Response
- Load Shifting
- Load Curtailment

**Energy Efficiency Measures**


# DER Value Streams

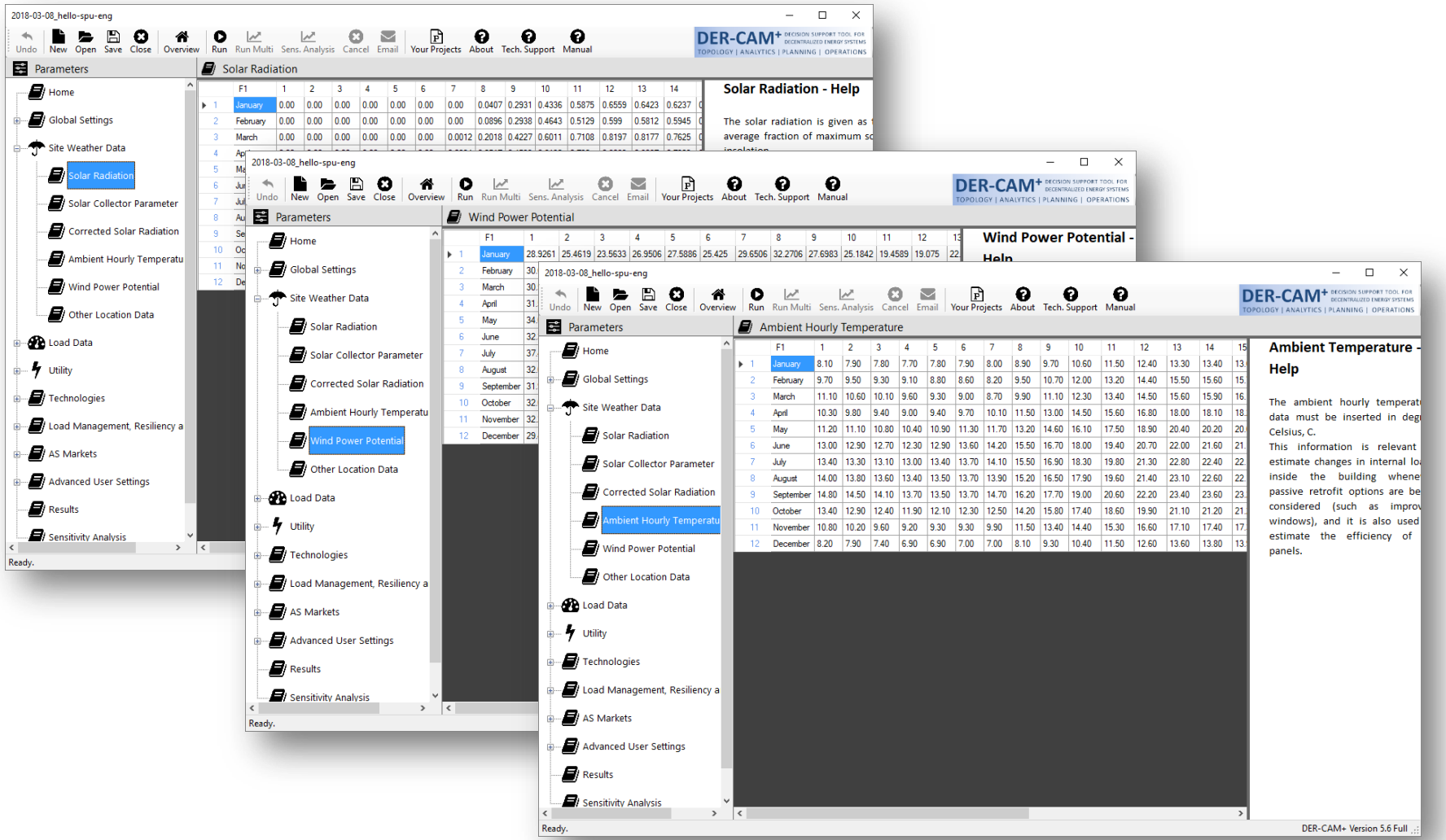
- Volumetric electricity purchases
- Monthly demand charges
- Electricity exports
- Demand response
- Ancillary services
- Reduced energy consumption
- Improved service efficiencies




- Multi-building networked microgrids
- Heat and power flow modeling
- Multi-energy microgrids
- AC & DC microgrids
- N-1 security constrained designs

# Advanced Features

# DER-CAM Desktop UI



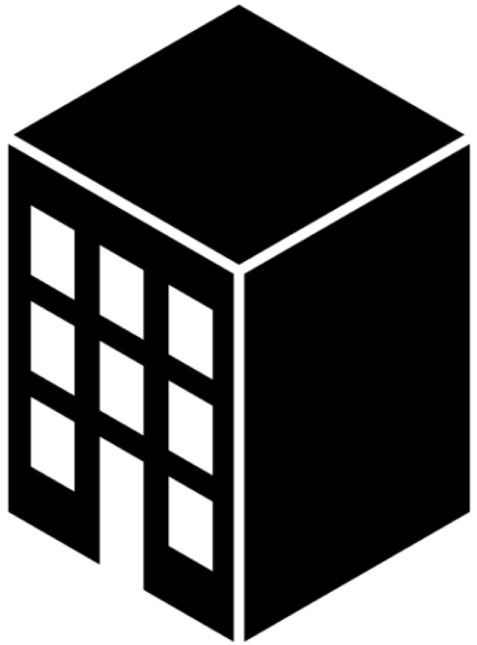
# DER-CAM Data Resources

Reference building load profiles

Electricity tariff database

Typical insolation profiles

DER technology libraries



# Quick Feasibility Studies

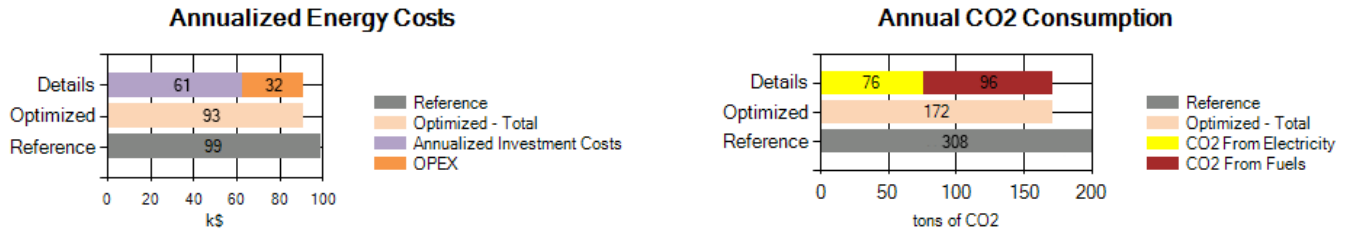
• Results

Summary | Electricity Dispatch | Heat Dispatch | Cooling Dispatch | Investment Decisions | Economic Results | Energy & Fuel Supply | Environmental Results | Detailed

Summary Table

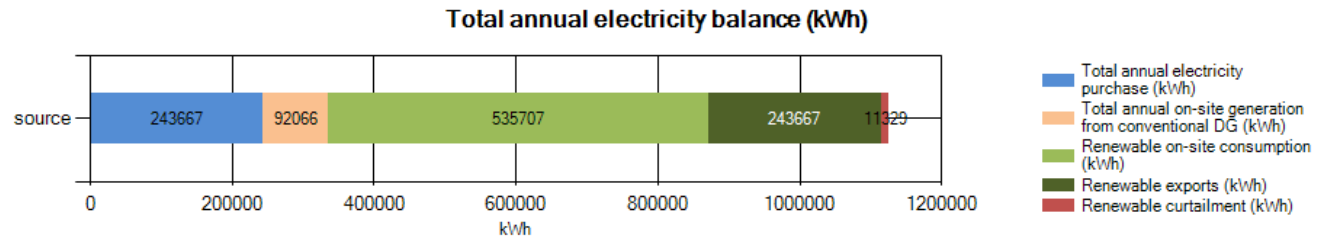
| | DER Solution | Reference | Total Savings (%) |
|---|---|---|---|
| **Total Annual Energy Costs (k$)** | 93 | 99 | 6.1 |
| **Total Annual CO2 emissions (metric tons)** | 172 | 308 | 44 |

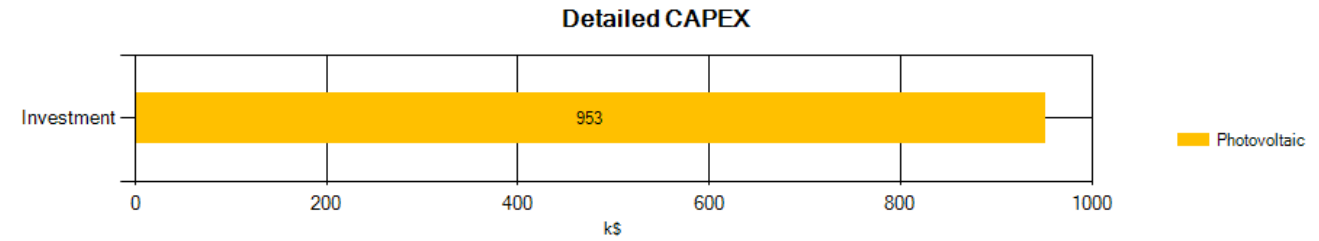
Charts Summary







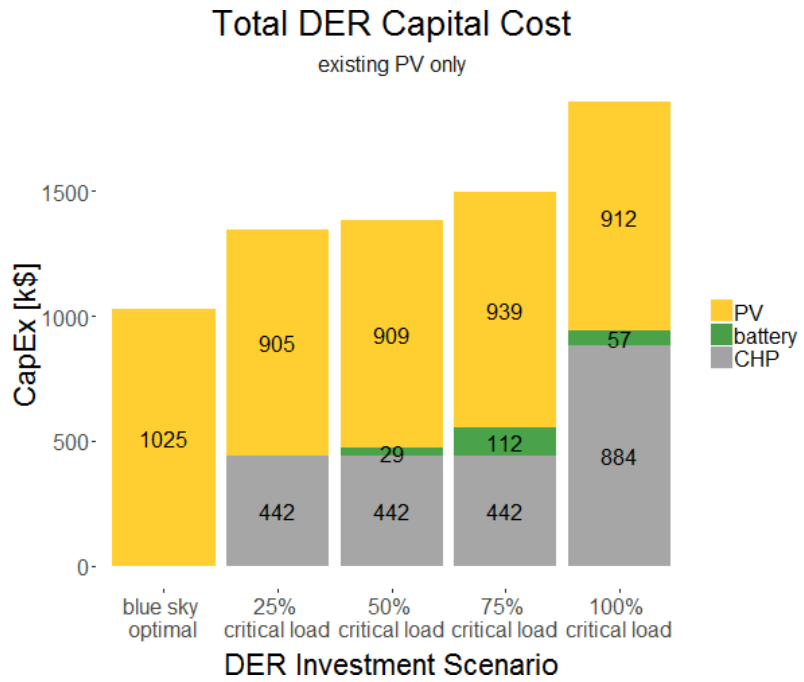


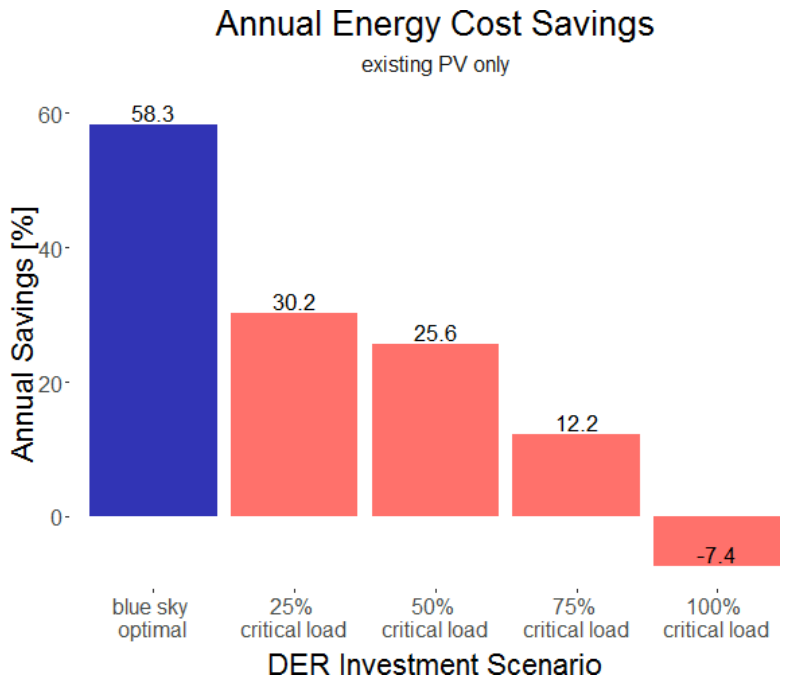




# Scenario & Parametric Analysis

- DER Technologies & Costs
- Tariffs & Energy Rates
- Load Profiles
- Etc.

# Resilience Modeling Scenario Analysis

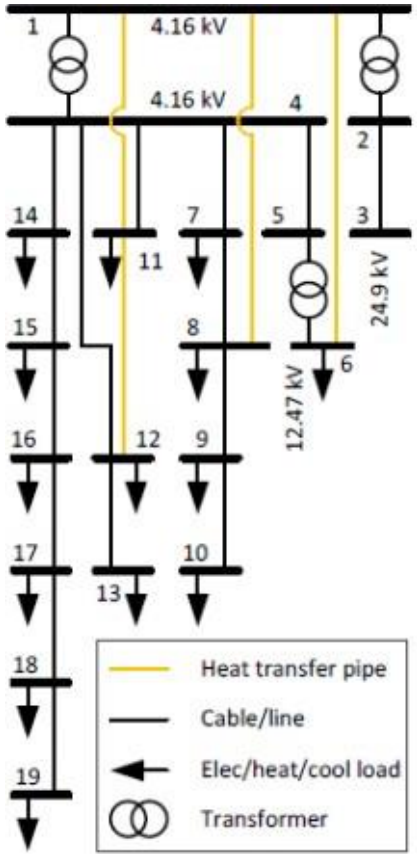


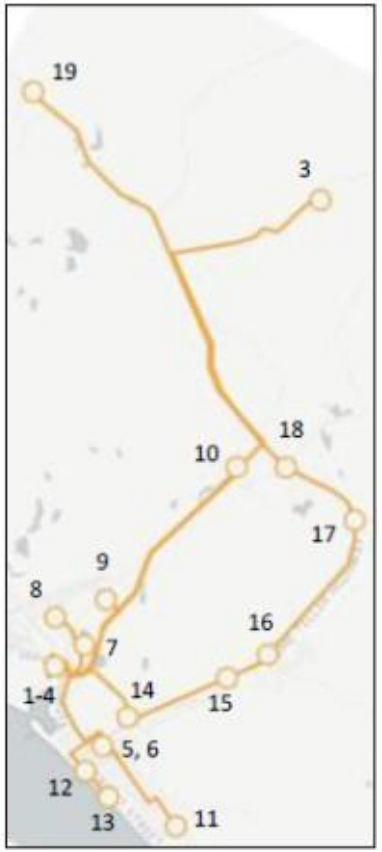



# Networked Microgrids & Remote Systems

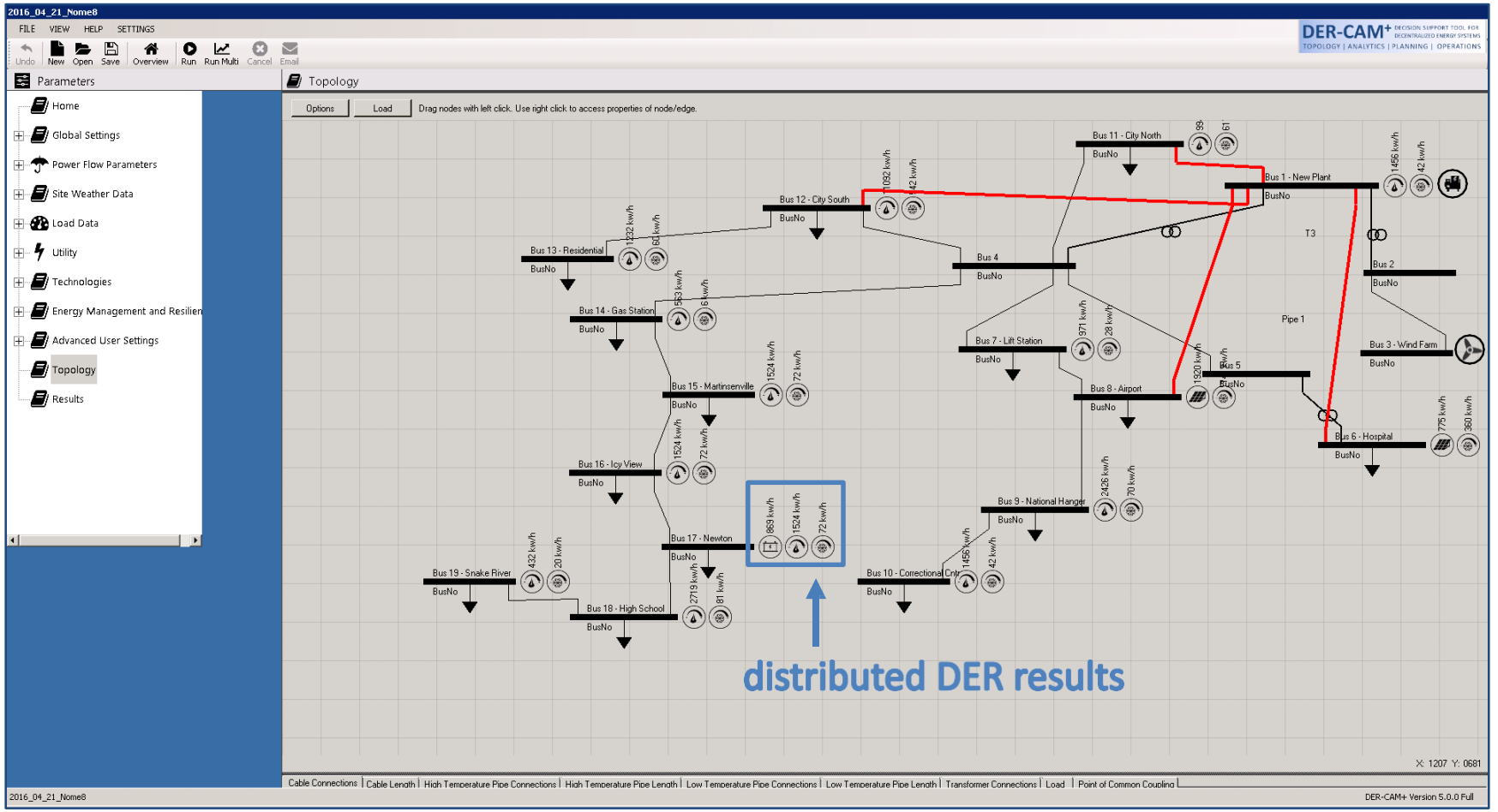
**Case Study**

- City of Nome in Alaska
- Isolated grid
- Radial 4.16 kV dist. network
- 19 nodes (in our model)



# Networked Microgrids & Remote Systems




- Simple DER-CAM API
- Data support for Energy Efficiency
- Automate scenario-based resiliency analysis
- Expanded ancillary service options

# Upcoming Developments

DER-CAM

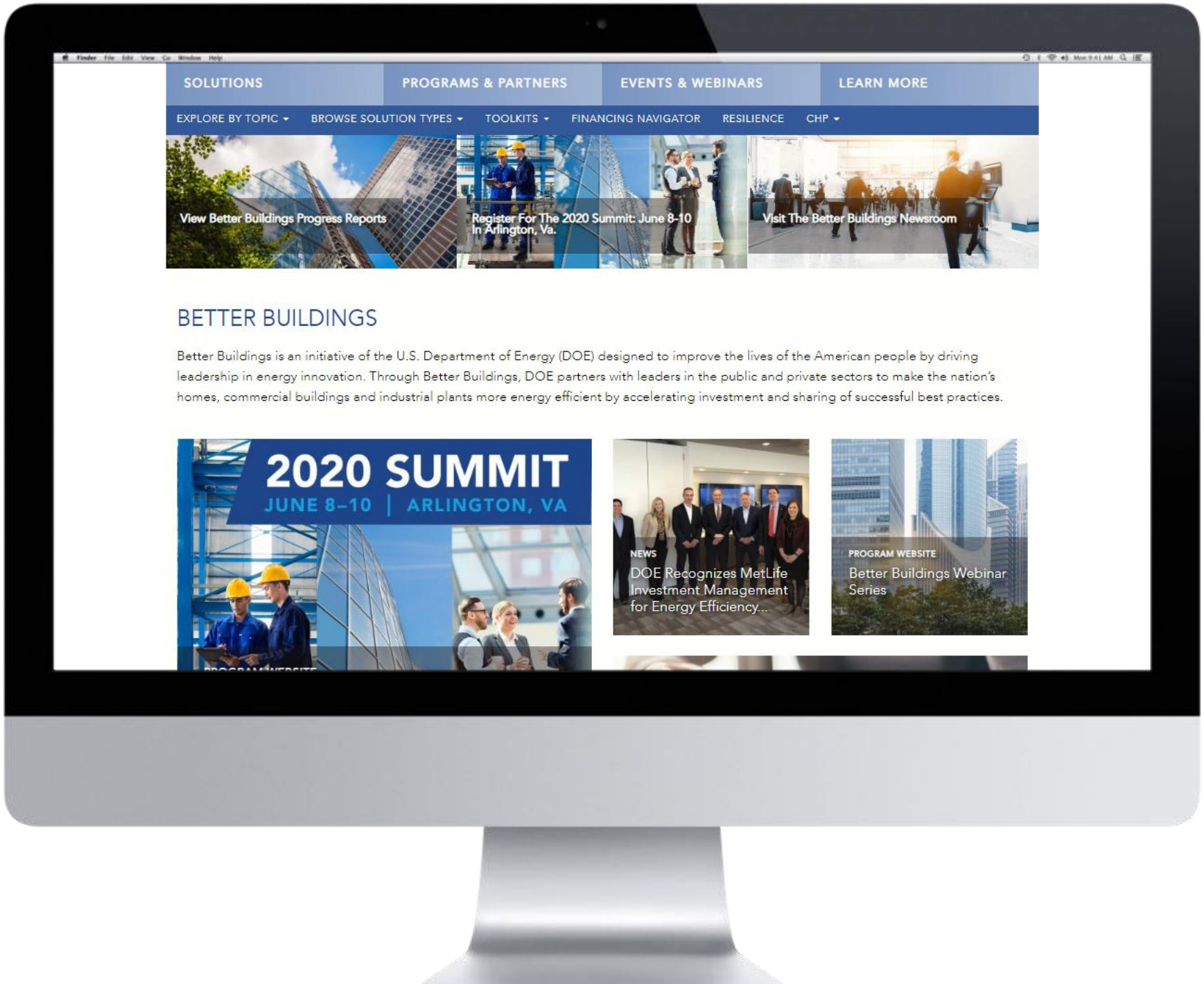
BERKELEY LAB

learn more at:

dercam.lbl.gov

contact us at:

dercam@lbl.gov




Better Buildings
U.S. DEPARTMENT OF ENERGY

# Q & A

# 2019-2020 Better Buildings Webinar Series

## BACK BY POPULAR DEMAND:
THE BEST OF THE 2019
BETTER BUILDINGS SUMMIT

Tue, Sep 17, 2019 | 3:00 - 4:00 PM ET

## HOW BUILDINGS OF ALL SHAPES AND SIZES ARE BECOMING ZERO ENERGY USERS

Tue, Dec 3, 2019 | 3:00 - 4:00 PM ET

## FINANCE + RESILIENCE: a two-part miniseries

### PART 1: BUILDING THE FINANCIAL BUSINESS CASE FOR RESILIENCE

Tue, Apr 21, 2020 | 3:00 - 4:00 PM ET

REGISTER TODAY

## GETTING TO 100%:
OVERCOMING BARRIERS TO
TENANT DATA COLLECTION

Tue, Oct 1, 2019 | 3:00 - 4:00 PM ET

## BEST OF THE BETTERS:
THE 2019 BETTER PROJECT AND
BETTER PRACTICE PRESENTATIONS

Tue, Jan 7, 2020 | 3:00 - 4:00 PM ET

### PART 2: TAKING ACTION TO IMPROVE RESILIENCE & DISCLOSE PERFORMANCE

Tue, Apr 28, 2020 | 3:00 - 4:00 PM ET

REGISTER TODAY

## ENERGY EFFICIENCY AND RENEWABLE ENERGY IN SMALL AND RURAL K-12 SCHOOLS

Tue, Oct 22, 2019 | 3:00 - 4:00 PM ET

## SAVE MONEY AND BUILD RESILIENCE WITH DISTRIBUTED ENERGY TECHNOLOGIES

Tue, Feb 4, 2020 | 3:00 - 4:00 PM ET

## GET SMART (LABS):
RESULTS FROM THE
SMART LABS ACCELERATOR

Tue, May 12, 2020 | 3:00 - 4:00 PM ET

REGISTER TODAY

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# Additional Resources

- Better Buildings Solution Center - Local Government Home Page
- Better Buildings Solution Center – State Government Home Page
- Efficiency-Resilience Nexus

# Questions or Feedback Specific to the Tools Discussed Today?

## Please Reach Out Directly

reopt@nrel.gov
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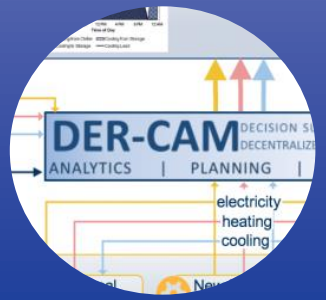


dercam@lbl.gov
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# Additional Questions?

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