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10-9-2019

### Renewable Energy Decisions

Adam Warren, PhD

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# Renewable Energy Decisions

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*National Lab Day  
Montana Technological University  
Butte, Montana*

# NREL at a Glance



Golden, CO

# NREL at a Glance

2,050

**Employees,**  
plus more than

**500**

early-career researchers  
and visiting scientists

\$480M

**Budget**

with support from  
DOE, other federal  
agencies, & industry

nearly  
820

**Partnerships**

with industry,  
academia, and  
government



**Campus**

operates as a  
living laboratory

# NREL's Science Drives Innovation



## Renewable Power

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Solar  
Wind  
Water  
Geothermal



## Sustainable Transportation

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Bioenergy  
Vehicle Technologies  
Hydrogen



## Energy Efficiency

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Buildings  
Advanced Manufacturing  
Government Energy  
Management



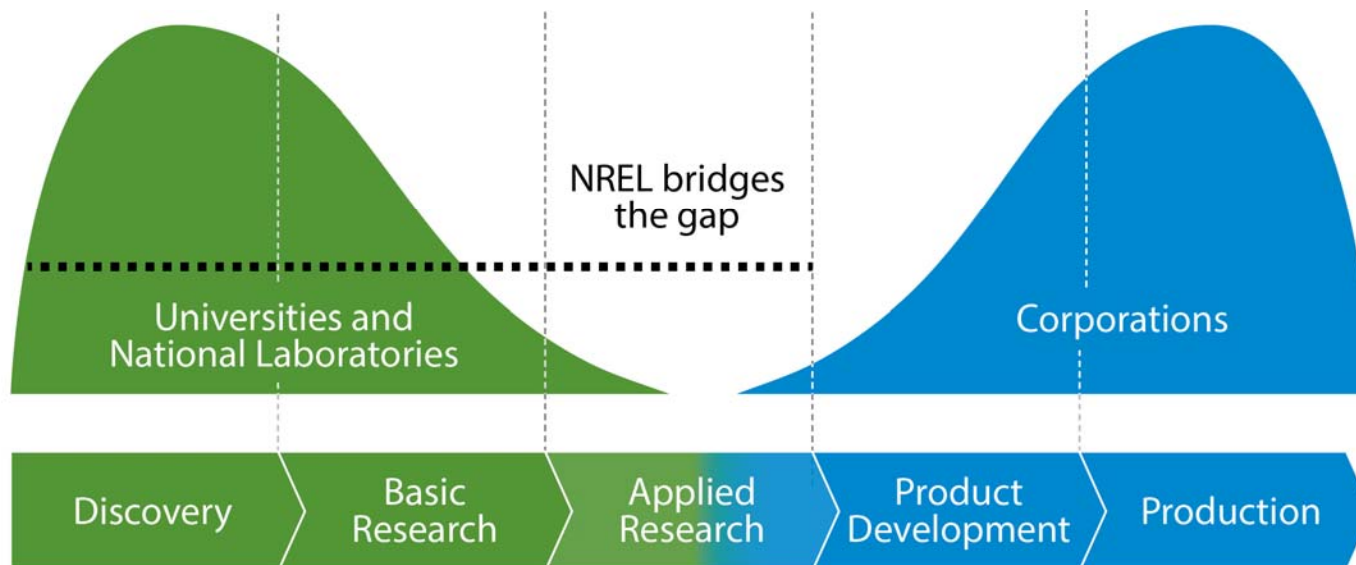
## Energy Systems Integration

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High-Performance  
Computing  
Data and  
Visualizations

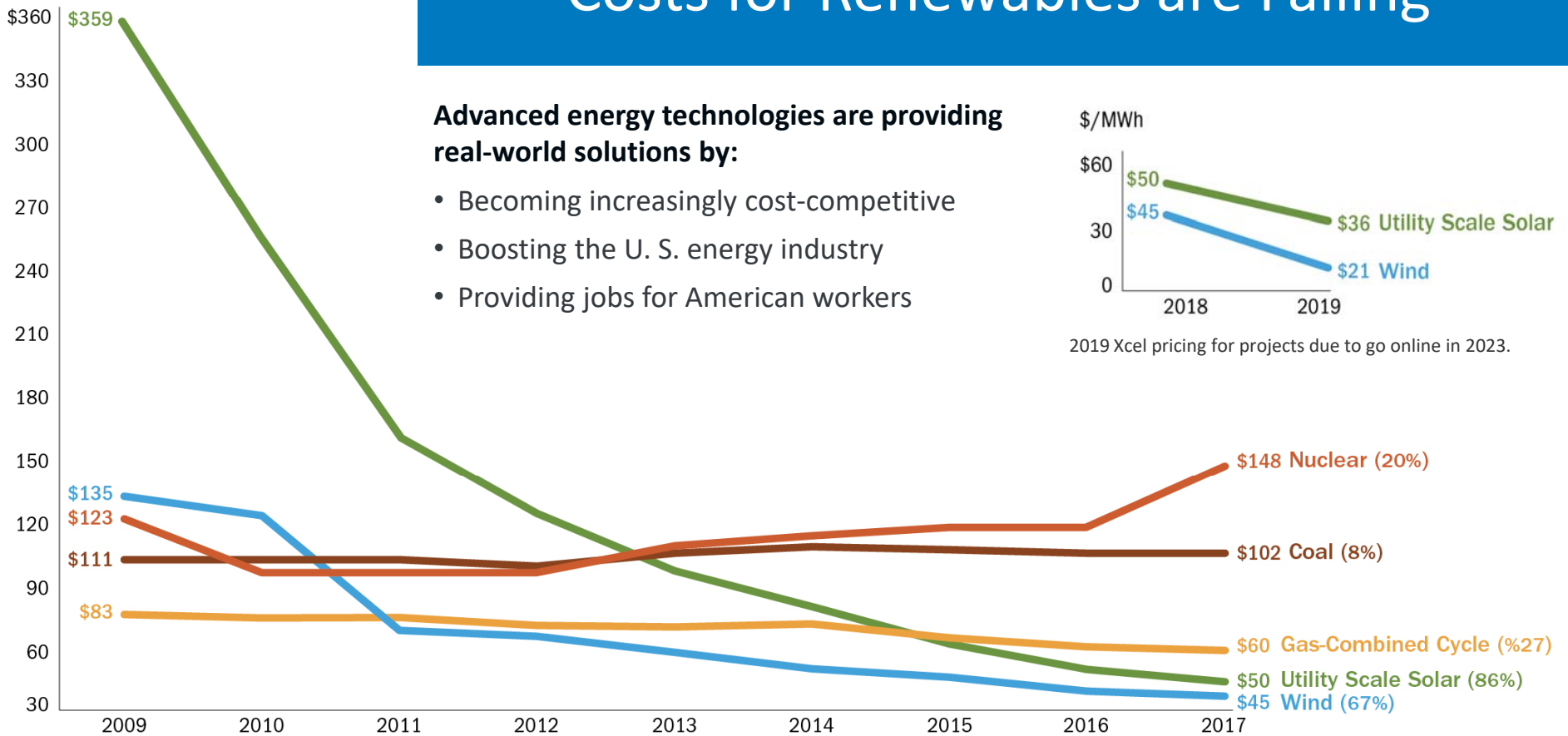
# We Reduce Risk in Bringing Innovations to Market

- NREL helps bridge the gap from basic science to commercial application
- Accelerated time to market delivers advantages to American businesses and consumers



# Costs for Renewables are Falling

Mean LCOE  
\$/MWh



**Advanced energy technologies are providing real-world solutions by:**

- Becoming increasingly cost-competitive
- Boosting the U. S. energy industry
- Providing jobs for American workers

Source: Lazard's 2017 Levelized Cost of Energy Analysis, Version 11, 2 November 2017

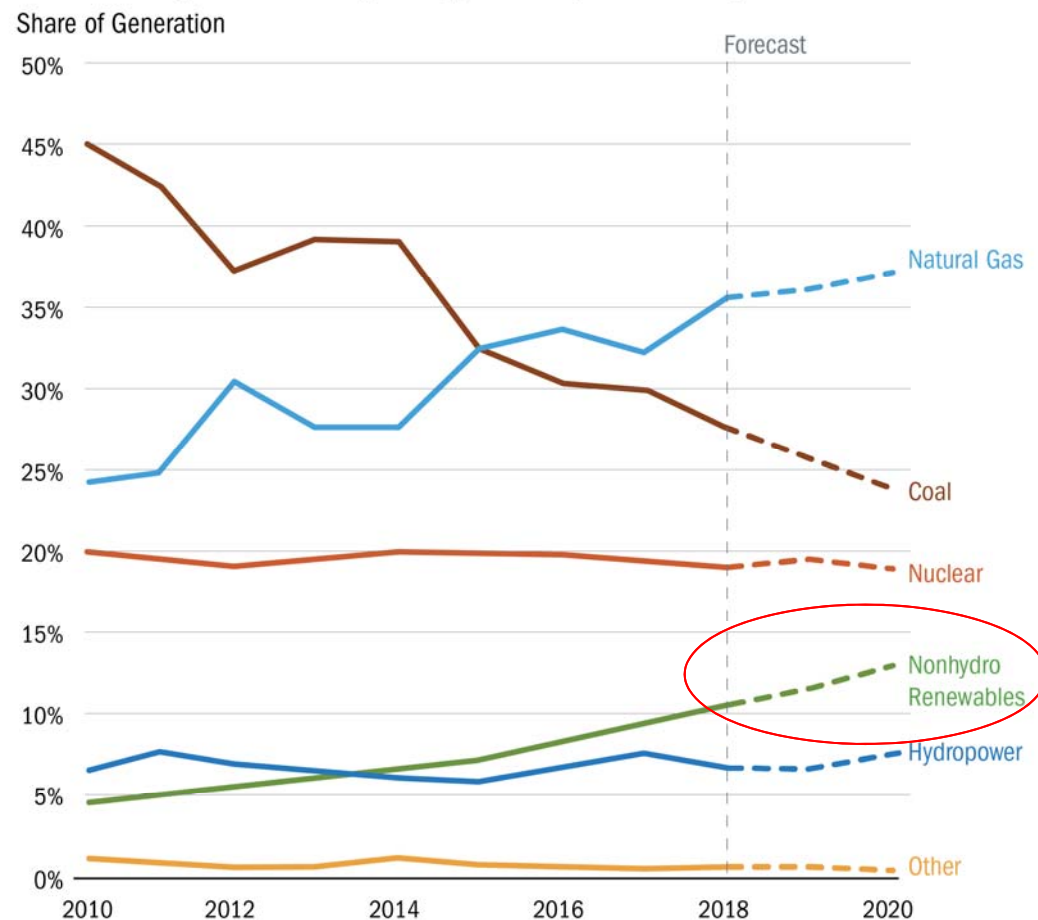
# U.S. Energy Supply is Shifting

Non-hydro RE currently produces 10% of the total U.S. electricity generation. Within the next two years, this is expected to grow to 13%.

Generation will be increasingly distributed, with 31% of new capacity behind-the-meter.

Achieving this transformation will require increasingly integrated and complex solutions, and the tools to

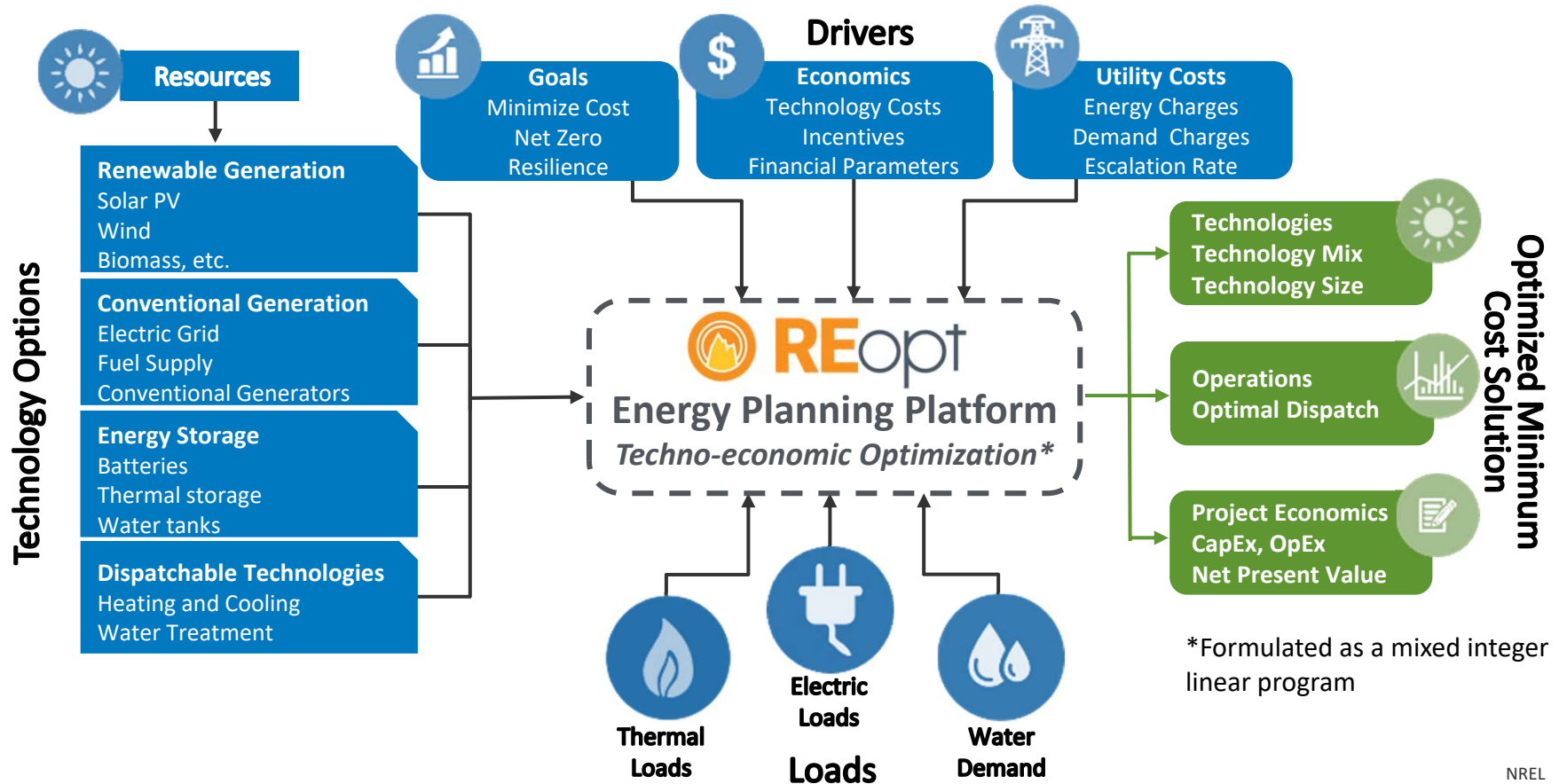
U.S. Electricity Generation by Energy Source (2010-2020)



Source: United States Energy Information Agency, *Today in Energy*, 18 January 2019



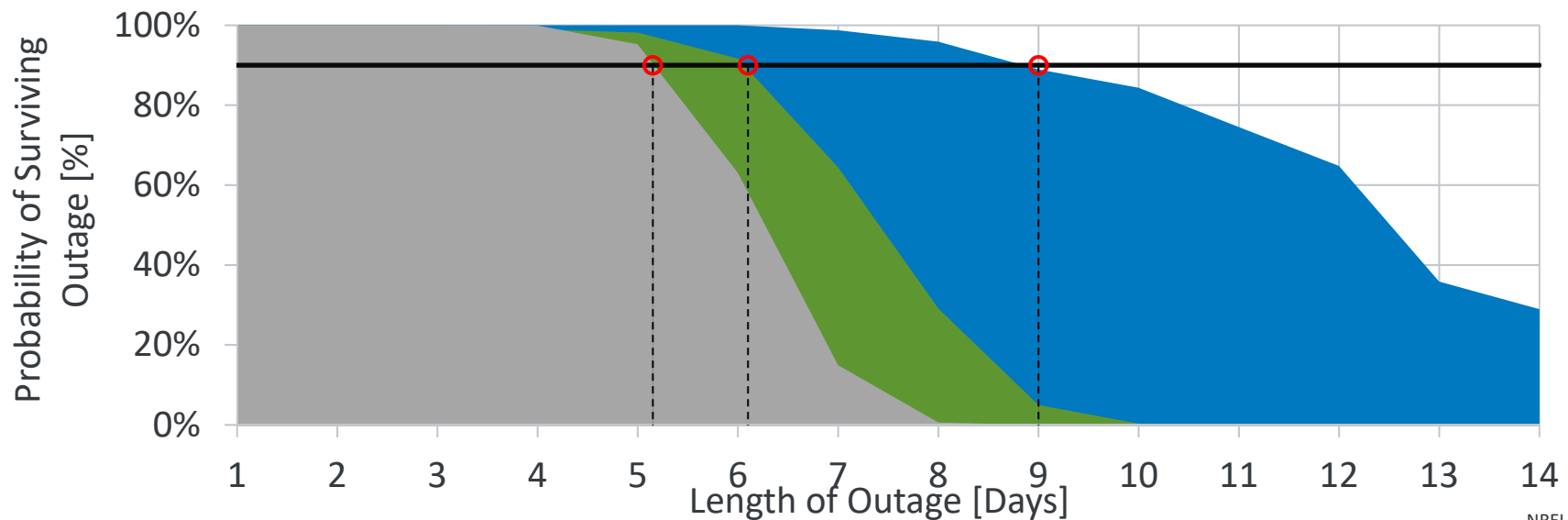
# REopt Platform Inputs and Output



# Increasing Resilience



	<u>Generator</u>	<u>Solar PV</u>	<u>Storage</u>	<u>Lifecycle Cost</u>	<u>Outage</u>
1. Base case	2.5 MW	-	-	\$20 million	5 days
2. Lowest cost	2.5 MW	625 kW	175 kWh	\$19.5 million	6 days
3. Proposed system	2.5 MW	2 MW	500 kWh	\$20.1 million	9 days



# REopt Lite Web Tool

- **REopt Lite** web tool provides access through a web interface that is easy to use
- **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 storage systems along with existing back-up generators to sustain critical load during grid outages

## Step 1: Choose Your Focus

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

Financial  Resilience



## Step 2: Enter Your Data

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

**Site and Utility** (required) ⊖

\* Site location  ⓘ Ⓧ Use sample site

\* Electricity rate  ⓘ

Custom electricity rate ⓘ

Net metering system size limit (kW)  ⓘ  
Enter 0 if net metering is not available

Wholesale rate (\$/kWh)  ⓘ

**Load Profile** (required) ⊕

Financial ⊕

## Step 3: Select Your Technologies

Which technologies do you wish to evaluate?

PV  Battery  Wind

PV ⊕

Battery ⊕

Wind (Beta Version) ⊕

<https://reopt.nrel.gov/tool>

# Impact of E-Buses in Missoula, MT



- In this analysis, NREL used the [REopt model](#) to evaluate the economics of charging six electric buses purchased by the City of Missoula, Montana
- Evaluates potential of adding solar PV and lithium-ion battery storage to mitigate the costs of charging the electric bus fleet



Solar Energy Innovation Network: <https://www.nrel.gov/solar/solar-energy-innovation-network.html>

Montana Solar Powered Community Transportation Initiative: [https://www.nrel.gov/solar/solar-energy-innovation-network-round-1.html#panel10e178\\_3](https://www.nrel.gov/solar/solar-energy-innovation-network-round-1.html#panel10e178_3)

Thank you!

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[www.nrel.gov](http://www.nrel.gov)



# SEIN Overview



- This analysis was conducted under the first round of the [Solar Energy Innovation Network](#) (SEIN), a program led by the [National Renewable Energy Laboratory](#) (NREL) that assembles diverse teams of stakeholders to research solutions to real-world challenges associated with solar energy adoption.
  - Through SEIN, NREL researchers work with multi-stakeholder teams over the course of 15-18 months on novel applications of solar
  - Teams receive a) direct funding, b) analytical support, and c) coaching and workshop facilitation support, including several in-person working sessions at NREL.
  - Funded by DOE SETO
- This analysis supported the efforts of the [Montana Solar Powered Community Transportation Initiative](#), a team consisting of:
  - The Montana Renewable Energy Association
  - Montana Energy Office at the Department of Environmental Quality
  - Climate Smart Missoula
  - City of Missoula, City of Bozeman, City of Whitefish
- The team is investigating the synergies between solar generation and electric vehicle (EV) charging, including the potential opportunities and challenges related to co-locating solar energy and charging infrastructure to reduce costs and enhance co-benefits of the electrification of transportation.
- The City of Missoula's transit agency has purchased six electric buses. This analysis supports the team's efforts to understand the potential costs and specific options for using solar and storage to reduce EV bus charging costs.

Solar Energy Innovation Network: <https://www.nrel.gov/solar/solar-energy-innovation-network.html>

Montana Solar Powered Community Transportation Initiative: [https://www.nrel.gov/solar/solar-energy-innovation-network-round-1.html#paneld10e178\\_3](https://www.nrel.gov/solar/solar-energy-innovation-network-round-1.html#paneld10e178_3)

# How does REopt Work?

- REopt considers trade-off between capital costs and cost savings across multiple value streams to recommend optimal size and dispatch
- Results show 12.4 MW PV system with 2.4 MW/3.7 MWh battery storage can provide \$19.3 million net present value
  - A smaller system would be cheaper, but provide less value
  - A larger system would provide more savings, but be more expensive
- Battery is only economical when paired with PV at this site due to wide peaks

