



Industrial Decarbonization Peer Exchange

Feb 21st, 2024

Better Buildings, Better Plants Summit



REGISTRATION IS OPEN FOR THE 2024 SUMMIT!

• **2024 Agenda-at-a-Glance**

• **Hotel Room Block** (Secure your room before space runs out- closes March 11)

Better Plants Bootcamps

Decarbonization Bootcamp

Crash course in carbon accounting fundamentals, renewable energy, and decarbonizing manufacturing facilities

The next Decarbonization Bootcamp is **February 27- March 1** at Oak Ridge National Laboratory

Energy Bootcamp

Crash course in industrial energy system fundamentals, energy management, and industrial decarbonization

The next Energy Bootcamp is **May 13 - 17** at Oak Ridge National Laboratory



If you are interested in participating please contact the following individuals:

- Jennifer Travis (travisjm@ornl.gov)
- Wei Guo (guow@ornl.gov)
- Thomas Wenning (wenningtj@ornl.gov)

In-Plant Trainings (INPLTs)

Host Plant Name / City, State	Energy System Type	Date
Textron, Inc / Hurst, TX	Treasure Hunt	March 5-7, 2024
PepsiCo / Charlotte, NC	Treasure Hunt Exchange	April 23-25, 2024
Leggett & Platt / High Point, NC	Treasure Hunt Exchange	April 28-30, 2024
Legrand North & Central America / Kenosha, WI	Process Heating	May 7-9, 2024
Owens Corning / Newark, OH	Water Efficiency	May 7-9, 2024
Leggett & Platt / Tupelo, MS	Treasure Hunt Exchange	May 19-21, 2024
Lockheed Martin / Owego, NY	Compressed Air	May 21-23, 2024
PepsiCo / Lynchburg, VA	Treasure Hunt Exchange	June 11-13, 2024
Entegris / Burnet, TX	Treasure Hunt	TBD
Lear Corporation / Southfield, MI	50001 Ready	TBD
Quanex Custom Components / St. Cloud, MN	Treasure Hunt	TBD
Saint-Gobain Corporation / Shreveport, LA	Process Heating	TBD
Stryker / Mahwah, NJ	Treasure Hunt	TBD
Weatherford US, LP / Huntsville, TX	Treasure Hunt	TBD



Selected applicants has been announced.

- INPLTs teach plant workers how to conduct assessments, use DOE tools, and implement projects.
- **140+** In-Plants, **2400** participants since 2011

Virtual In-Plant Training

50001 Ready

Mar 28, 2024 to May 16, 2024

- Learn the basics of 50001 Ready energy management system that is structured using ISO 50001 standard.
- Learn to utilize the DOE 50001 Ready Navigator and several software tools such as, EnPI Lite, Energy Footprint and Automated Register of Implemented Projects (Project Register) with real data and case study to enhance the learning.



If you or your colleagues are interested in participating in the training, please [register here](#).

Questions? Contact Wei Guo (guow@ornl.gov)

Onsite Renewable Energy and Storage: Overview, Opportunities, and Challenges

Speakers



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Agenda

- Onsite Renewable Energy and Storage: Overview, Opportunities, and Challenges
- Onsite Energy Technical Assistance Partnerships (TAPs)
- Exploring Onsite Energy Technologies
 - Site Screening Methodology
 - Case Study Example
- Wrap-Up

Poll Question #1

Onsite Renewable Energy and Storage and Decarbonization

Why pursue onsite renewable energy and storage?

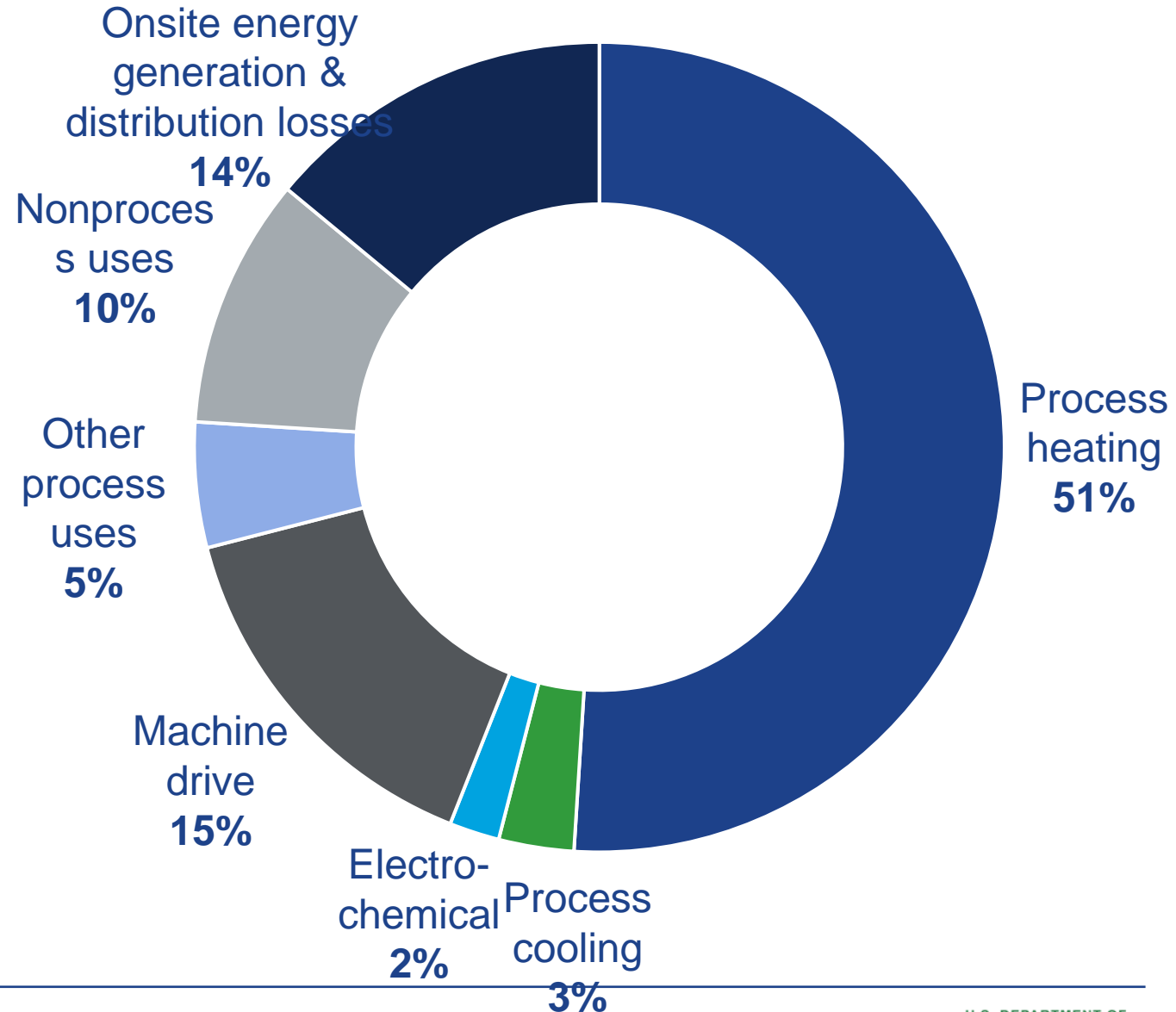
- Leveraging advancements in low-carbon electricity from onsite renewable generation sources will reduce both direct (scope 1) and indirect (scope 2) emissions by:
 - Replacing utility-purchased electricity with onsite renewable sources (scope 2)
 - Serve heating load with renewable thermal or low/no-carbon fuels (scope 1)
 - Electrify heating load (reduces scope 1, increases scope 2), and then use onsite (or offsite) renewables to serve additional electric load (reduces scope 2)

Pros	Cons
Visible, demonstrates commitment	Logistics, consumes time and space
Direct supply, reduced losses	Interconnection delay, costs
Direct ownership, financial benefits	Upfront capital
Property owned already	Limited roof or land

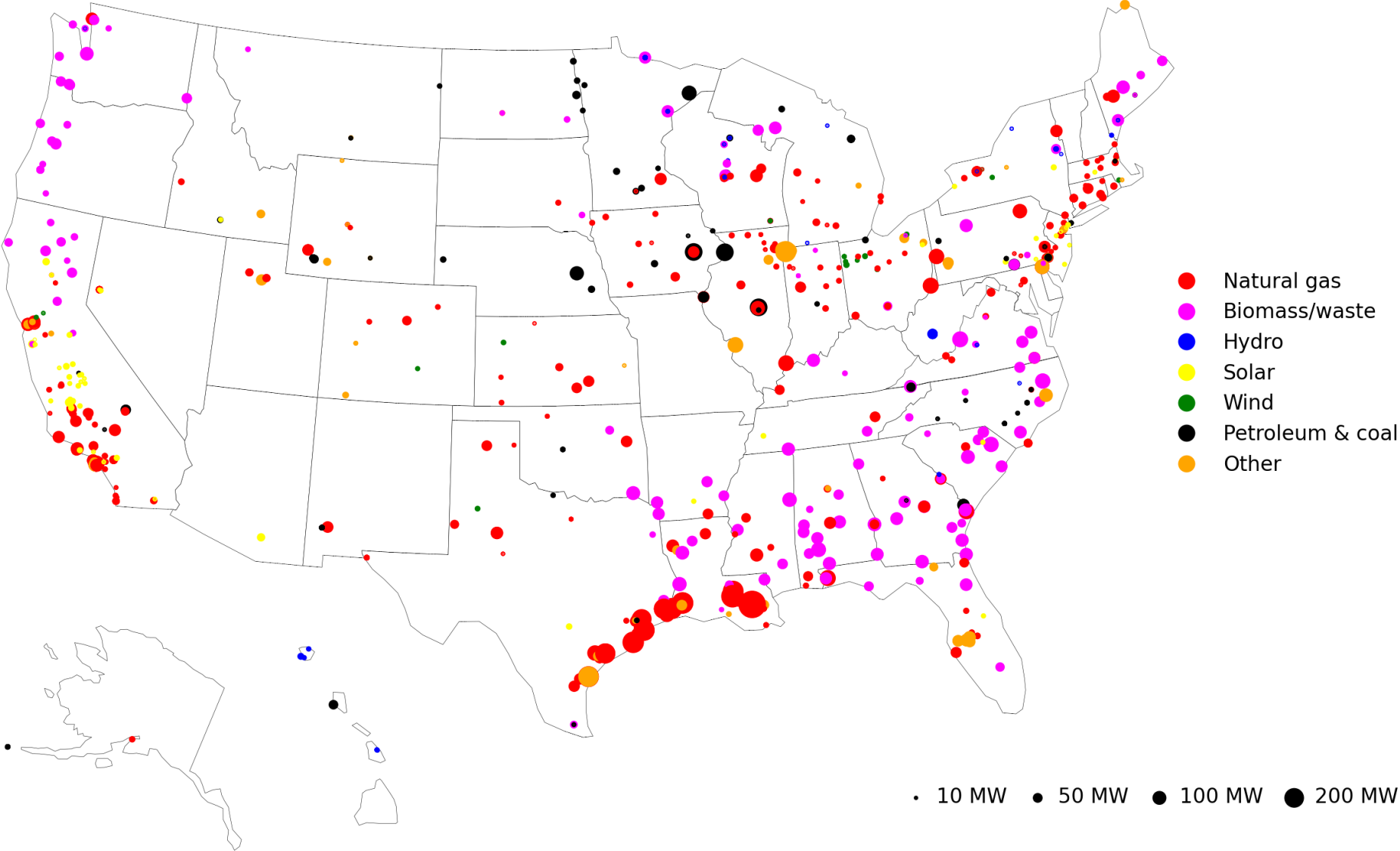
Opportunity: Decarbonize with Onsite Clean Generation

- Achieving net-zero greenhouse gas emissions will require fully decarbonizing the grid **and** producing low-carbon electricity and heat near industrial facilities.
- Onsite clean energy technology can be a solution to decarbonize soon and significantly reduce direct (scope 1) and indirect (scope 2) emissions.

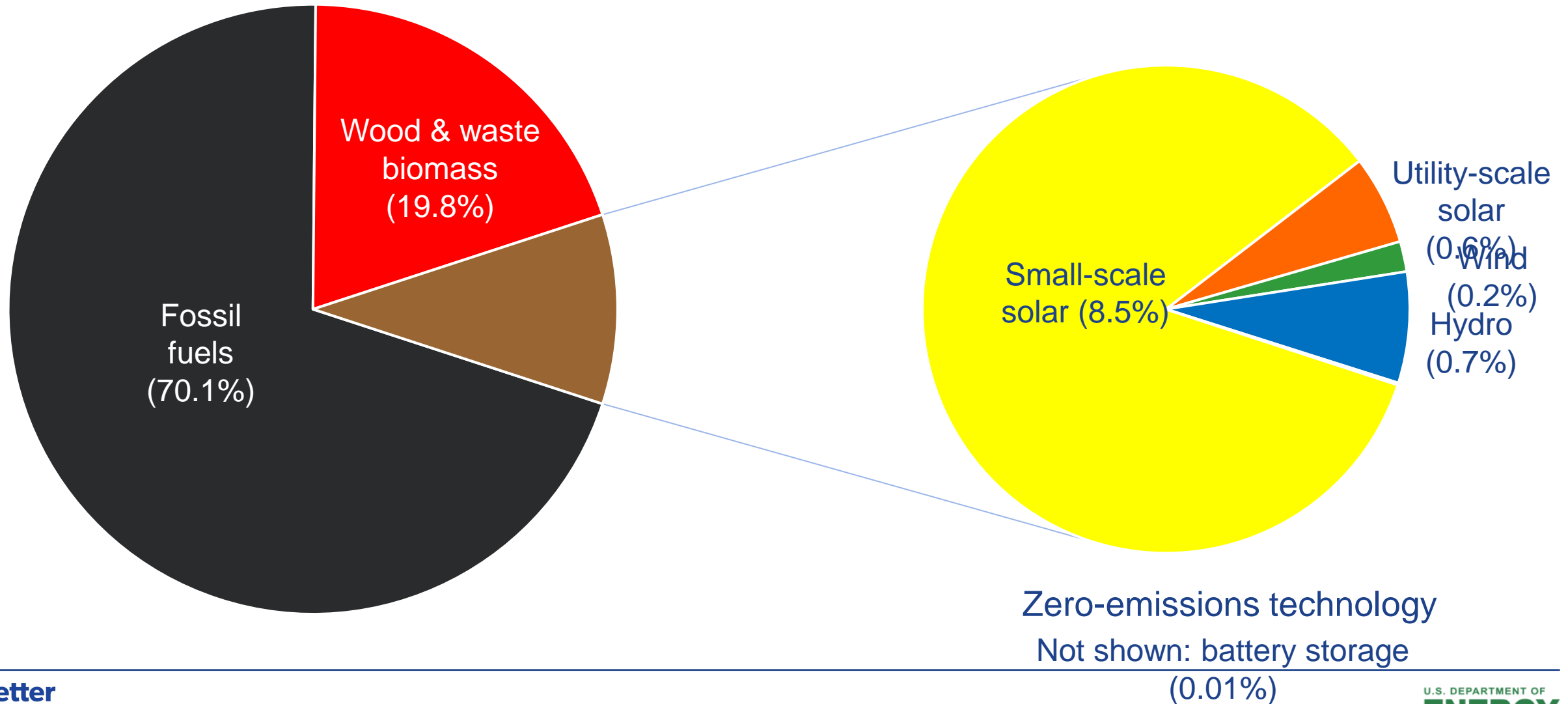
battery storage | combined heat and power | fuel cells| geothermal | industrial heat pumps | renewable fuels | solar PV | solar thermal | thermal storage | wind



Onsite Energy Systems at Industrial Facilities Today



Current Onsite Industrial Power Generation



Barriers: Onsite Renewable Energy and Storage

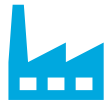
Industrial facilities face significant challenges and barriers to using onsite clean energy technologies:



Cost of new / retrofitted equipment



High-temperature & energy-intensive processes & equipment



Space limitations



Workforce issues



Regulatory constraints (interconnection, permitting)

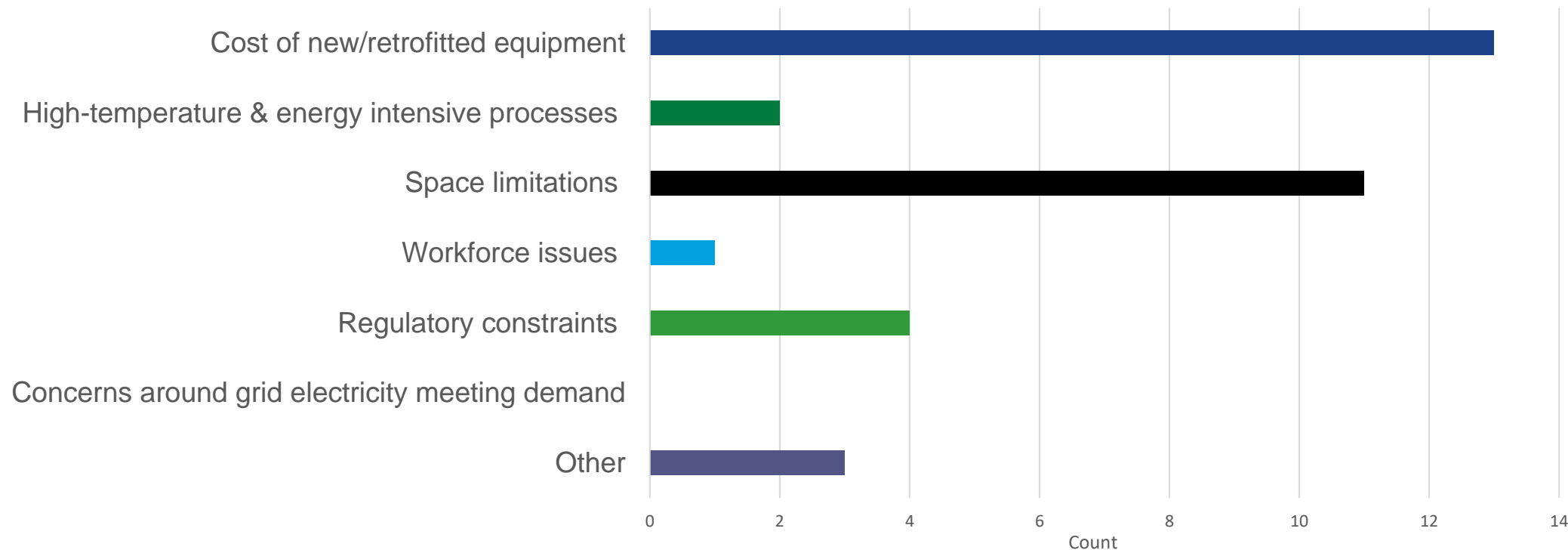


Grid electricity meeting increased demands*

*For those who prefer to electrify and rely on grid

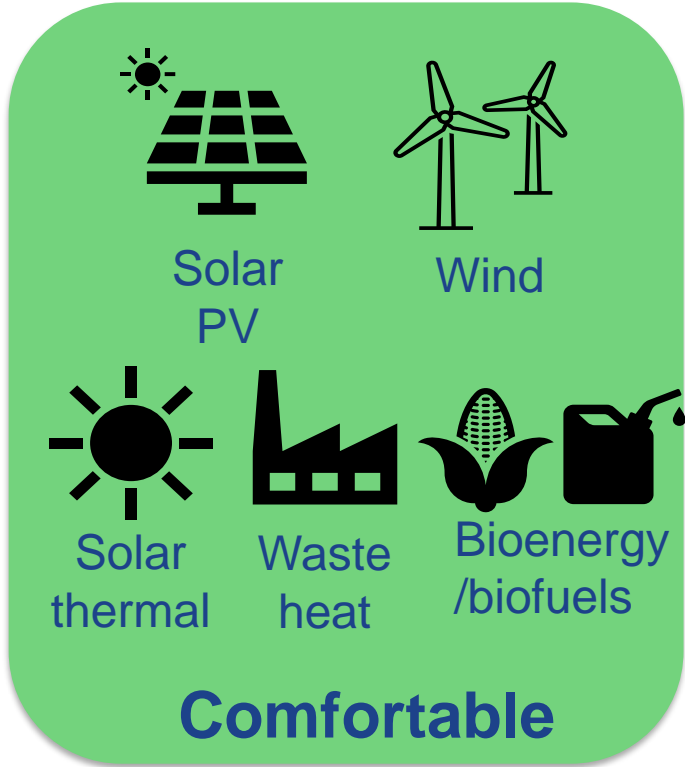
Onsite Renewable Energy and Storage Working Group Responses

What are your biggest barriers to pursuing onsite energy technologies at your U.S. facilities?



“Other” barriers included: pursuing onsite energy projects at leased sites, understanding the different financing structures, and uncertainty about how the GHG protocol will be applied

Opportunities and Interest



Solar PV

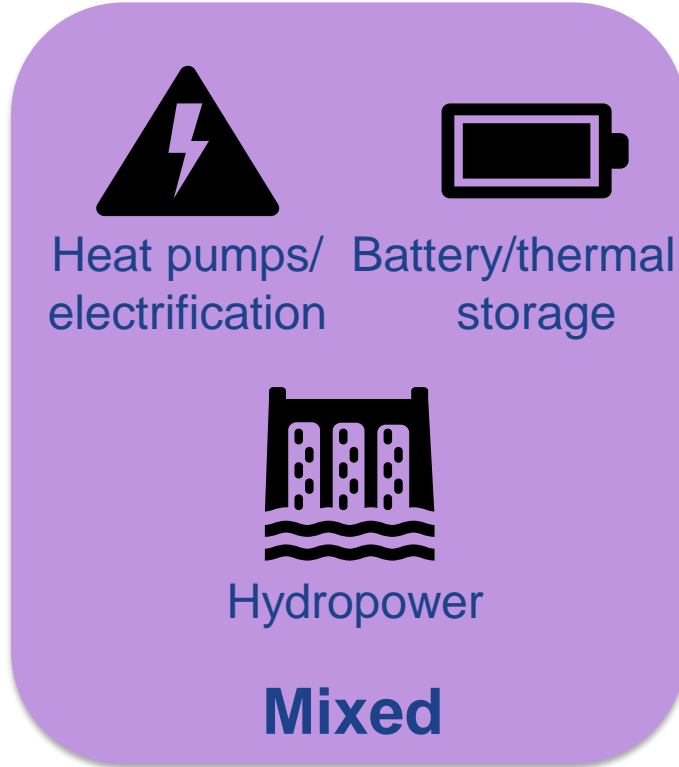
Wind

Solar thermal

Waste heat

Bioenergy /biofuels

Comfortable

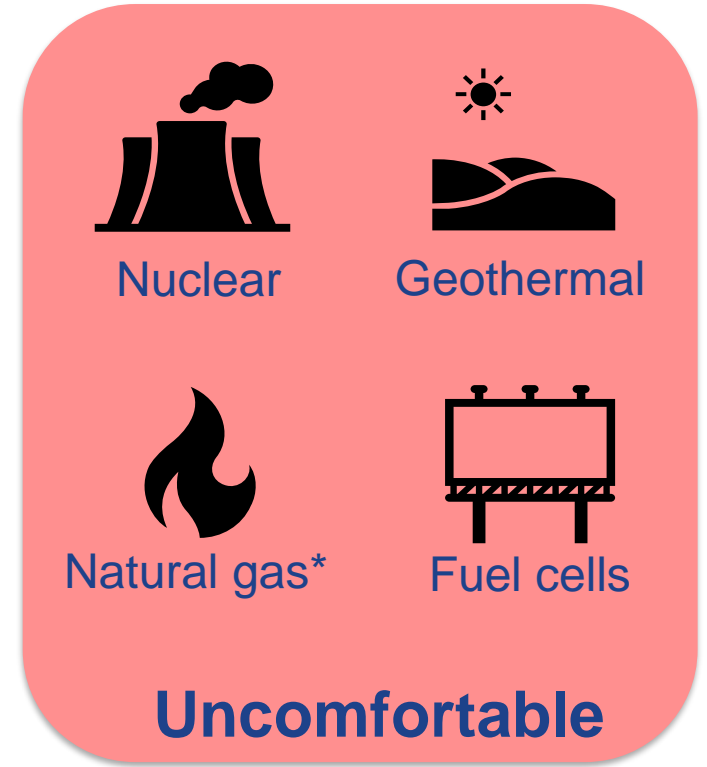


Heat pumps/ electrification

Battery/thermal storage

Hydropower

Mixed



Nuclear

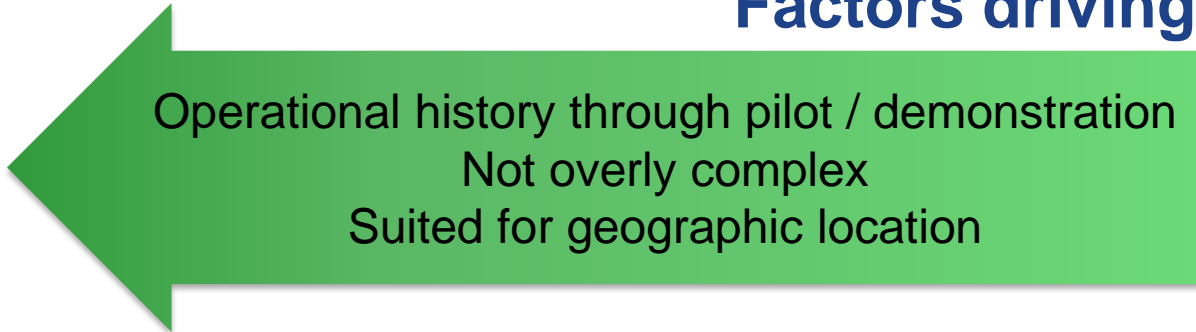
Geothermal

Natural gas*

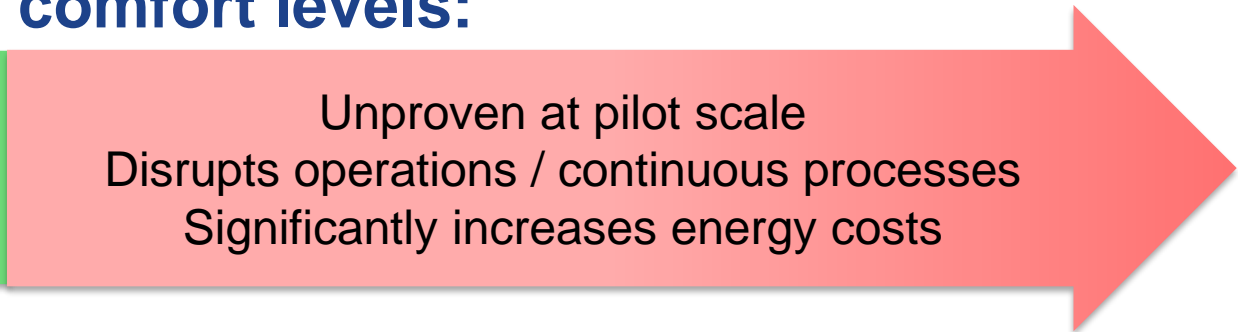
Fuel cells

Uncomfortable

Factors driving comfort levels:



Operational history through pilot / demonstration
Not overly complex
Suited for geographic location



Unproven at pilot scale
Disrupts operations / continuous processes
Significantly increases energy costs

Onsite Energy Technical Assistance Partnerships (TAPs)

Poll Question 2

Onsite Energy Program

The U.S. Department of Energy's (DOE) Onsite Energy Program provides technical assistance, market analysis, and best practices to help industrial facilities and other large energy users increase the adoption of onsite clean energy technologies.

battery storage | combined heat and power | district energy | geothermal | industrial
heat pumps | renewable fuels | solar PV | solar thermal | thermal storage | wind



Onsite Energy Technical Assistance Partnerships



Onsite Energy Technical Assistance Partnerships (TAPs)

DOE's 10 regional Onsite Energy TAPs provide technical assistance to end users and other stakeholders about technology options for achieving clean energy objectives. Key services include:



Technical Assistance: Screen sites for opportunities to implement onsite energy technologies and provide advanced services to maximize economic impact and reduce risk from initial screening to installation to operation and maintenance.



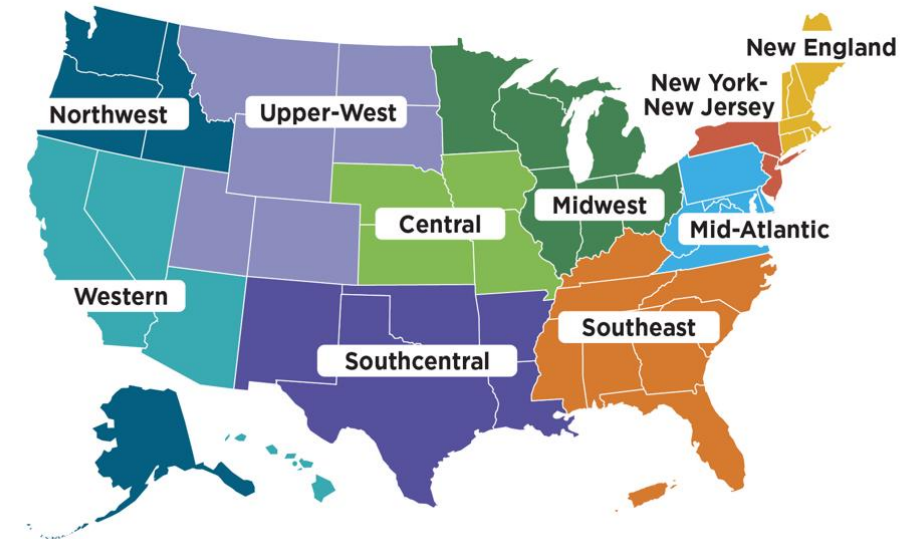
End-User Engagement: Partner with organizations representing industrial and other large energy users to advance onsite energy as a cost-effective way to transition to a clean energy economy.



Stakeholder Engagement: Engage with strategic stakeholders, including utilities and policymakers, to identify and reduce barriers to onsite energy through fact-based, unbiased education.



Onsite Energy Technical Assistance Partnerships
U.S. DEPARTMENT OF ENERGY



<https://betterbuildingsolutioncenter.energy.gov/onsite-energy/taps>

Getting Started: How to Work with Your Onsite Energy TAP

Contact Your Regional TAP



End-user reaches out to regional Onsite Energy TAP to start exploring onsite energy opportunities.

Discuss Site Characteristics, Goals, Objectives



End-user meets with regional TAP to discuss preliminary interest in onsite energy and learn about the facility's needs and energy-related goals.

Collect Site Data



Onsite Energy TAP works with end-user to collect data needed to perform technical assistance (e.g., facility size, operations, electric and gas usage, etc.).

Conduct Analysis



Onsite Energy TAP works with Technical Analysis Team to perform initial screenings for multi-technology options or advanced analysis to support project installations.

Review Results

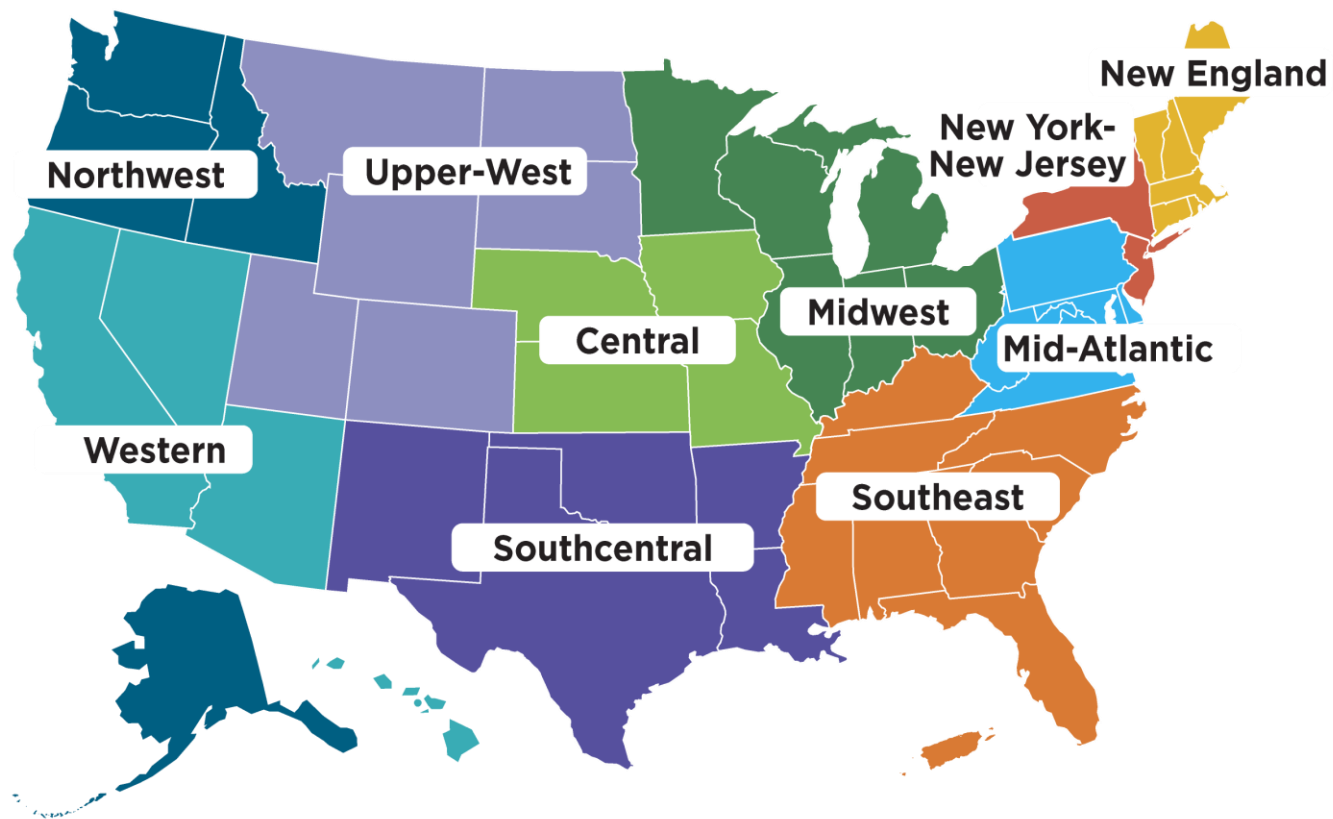


Meets with the end-user to review results and discuss next steps (e.g., options worth further analysis or additional support available)



Onsite Energy Technical Assistance Partnerships

U.S. DEPARTMENT OF ENERGY



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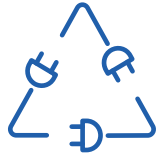
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IAC Implementation Grants: overview

Bipartisan Infrastructure Law Provision 40521.b1



\$80M in funding available through FY 2026
(Additional funding available in the next couple years depending on demand)



Grants awards of up to **\$300,000 per manufacturer**, at a 50% cost share¹;
Criteria: 50% impact/feasibility; 25% financial need + cost share; 25% community benefits



Eligibility exclusively for **small- and medium-sized manufacturing firms**,² water treatment facilities, and Controlled Environment Agriculture (CEA) facilities



To **address energy assessment recommendations** by IACs, **DOE Combined Heat and Power/Onsite Energy Technical Assistance Partnerships**, or other third-party assessors deemed equivalent by DOE

1. 50% cost share means that the applicant must cover at least 50% of the project cost. So, for instance, if an implementation project or projects costs \$100k, DOE can make a \$50k grant. Because \$300k is the maximum grant size per entity, applicants will need to cover 100% of costs over \$600k.

2. Small and medium-sized manufacturer (an entity that engages in the mechanical, physical, or chemical transformation of materials, substances, or components; or a water or wastewater treatment facility) is a firm with: gross annual sales of less than \$100M, fewer than 500 employees at the plant site, and annual energy bills of \$100,000 - \$3,500,000. **If the manufacturer/facility is an individual LLC that pays separate taxes from the parent company, then eligibility is based on the LLC.**

IAC Implementation Grants: Funding purpose

Provide federal funding to eligible SMMs to implement recommendations made in:

- **No-cost IAC or CHP/Onsite Energy TAP assessments** starting in 2018, or
- **Qualified third-party assessments¹** starting in 2021

Covered projects include energy assessment report recommendations that:



Improve site energy and/or material efficiency



Improve site cybersecurity infrastructure



Improve site productivity



Reduce site waste production



Reduce site greenhouse gas emissions and/or non-greenhouse gas pollution

1. Ten energy assessment providers have been selected for qualification as “IAC-equivalent” so far; see the list at the bottom of the page [here](#).



For More Information

Visit the Webpages



<https://www.energy.gov/eere/iedo/onsite-energy-program>

<https://betterbuildingsolutioncenter.energy.gov/onsite-energy>

Read the Fact Sheet



<https://www.energy.gov/eere/iedo/onsite-energy-fact-sheet>

Watch the Video



https://www.youtube.com/watch?v=CZa_riZPLRw&t=4s

DOE Onsite Energy Program Contacts

<https://betterbuildingsolutioncenter.energy.gov/onsite-energy/taps>

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Patti Garland

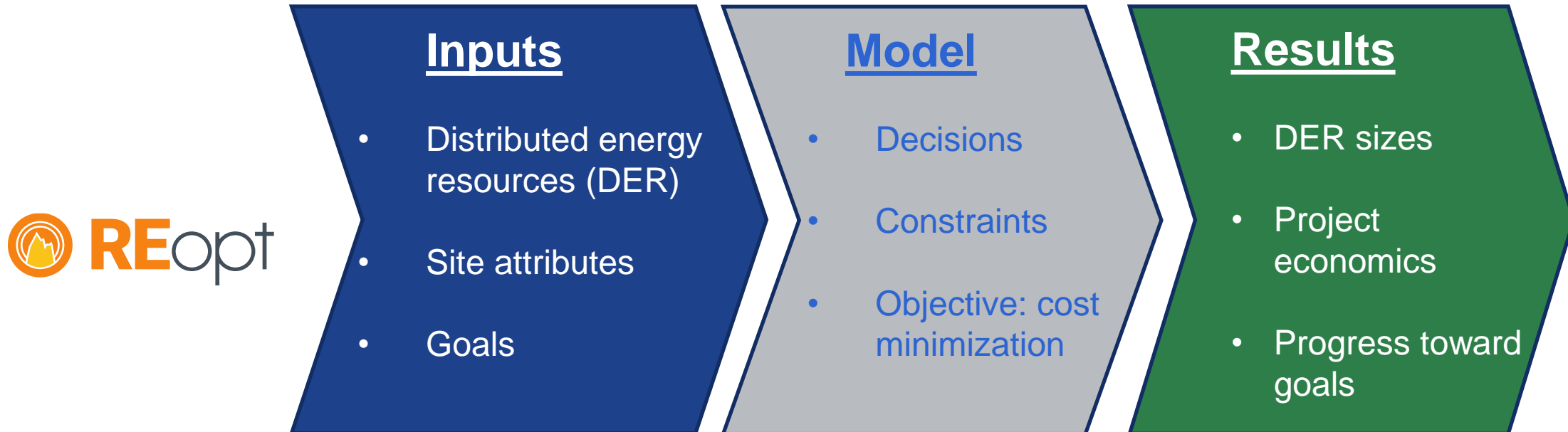
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Exploring Onsite Energy Technologies: Site Screening Methodology

Poll Question 3

Screening Process and Tools

- Technology screening tools can be a first step in identifying the economic value and emissions impact at a site.
- A crucial step in the screening process is engaging with the company and site personnel to identify site attributes and goals
- Some example screening tools are REopt® and the System Advisor Model (SAM) which are both publicly available, open source, and developed and maintained by NREL



Goals could include target emissions reduction or resilience requirement to sustain a certain outage length

Example Site Level Data to Perform Onsite Energy Screening Analysis

- Location
 - Solar/wind resource, grid emissions factors
- Electric load profile
 - Hourly or 15-minute interval, ideally
- Heating fuel consumption
 - Typically, monthly gas usage is available
- Electricity cost structure
 - Typically, can be determined by electric bills
 - And natural gas costs, if evaluating heating technologies
- Rooftop area for PV, land for PV or Wind, space for other technologies like battery storage
- Any previous quotes for technologies, in place of using defaults
- Net metering or other state incentives, interconnection limit
- Resiliency requirements – sustain grid outages

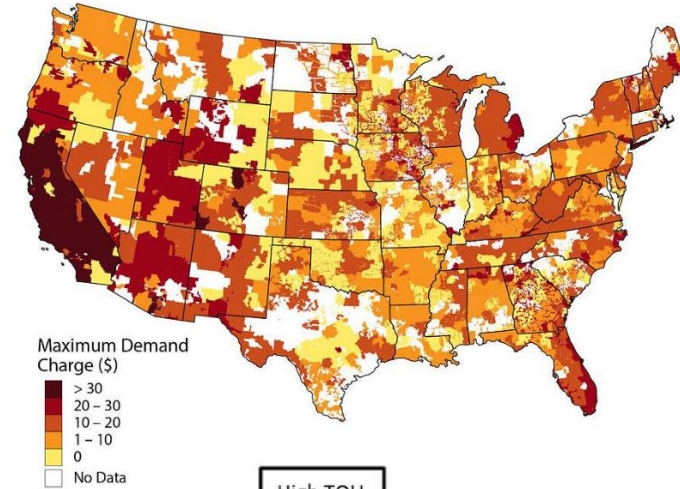
Battery Storage and Solar + Storage

- **Economics:** standalone battery storage charges up when electricity is cheaper or when the site load is low, and it discharges when electricity is expensive or when the site load is high
- **Resilience:** if a reserved amount of energy is maintained in the battery, it can be discharged during an unexpected grid outage to serve the site load
- **With solar PV,** battery storage can leverage onsite renewable electricity production to achieve greater economics and resilience benefits
 - Charge with renewable energy
 - Discharge during peak load
 - Sustain longer grid outages during the day



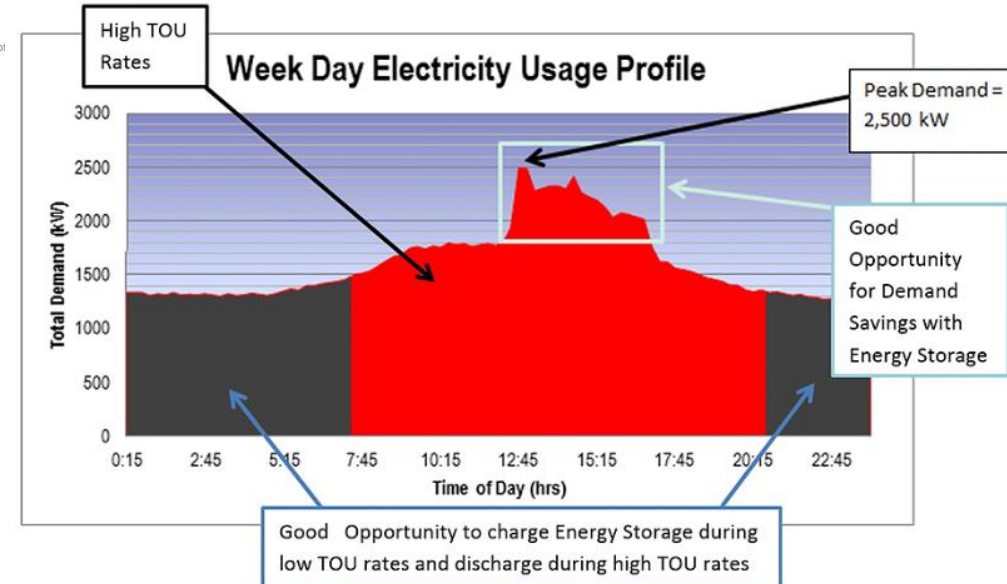
Battery Storage Site-Suitability

- High demand charges (*peak shaving*)
- Big difference between off-peak and on-peak energy charges (*energy arbitrage*)
- Demand response program for load reduction <4 hours
- “Peaky” loads – enables peak shaving with shorter duration battery. Peaky loads could come from EV charging in the future. (*avoid/defer electrical upgrades*)
- With solar, it can capture excess PV if net-metering is not available and credit for exported energy is not valuable (*self-consumption*)
- Battery storage can be used as uninterruptible power supply (UPS), limited duration back-up power for resilience, and with solar it can sustain longer outages during the day (*backup power*)



Peak Demand Charges Across the U.S.

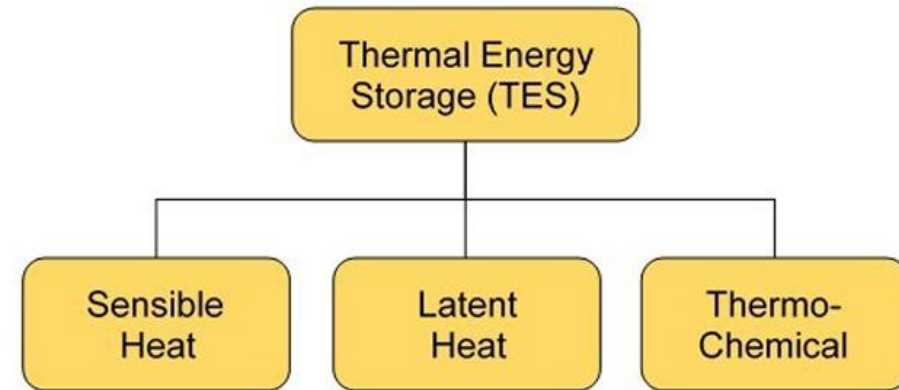
Figure 3: Geographical Representation of



<https://www.nrel.gov/state-local-tribal/blog/posts/when-does-energy-storage-make-sense-it-depends.html>

Thermal Energy Storage (TES) and Solar Thermal

- **Cold water storage** (sensible) or **ice storage** (latent) effectively acts as electric storage by enabling electric chillers to run more off-peak (charge tank) and less on-peak (discharge tank)
 - Energy arbitrage
 - Peak shaving for demand charge reduction
- **Hot water storage**, less common than cold TES, is mainly applicable to assist combined heat and power (CHP)
 - Utilize all of the heat that CHP creates, decoupling the heat supply from the demand
- **Solar + High temperature TES for process heating**
 - Solar PV could charge resistive elements to provide heat directly or store the high temperature heat in a material such as concrete or graphite for later use
 - Concentrated solar power (CSP) or other direct thermal capture of solar can be a heat source or store the heat for later use



- Chilled water
- Hot water
- Ice
- Phase-change material
- Materials which react exothermically (for heat) or endothermically (for cold)



This 8.8-million-gallon chilled-water TES tank provides 75,000 ton-hours of cooling, integrated with 45 MW CHP at Texas Medical Center in Houston.² Photo courtesy of TECO

Options to Decarbonize of Process Heat with Onsite Energy

- **Electrify**

- And serve electric load with onsite renewable electric technology like PV and wind
- **Challenge:** requires complex design and technology to convert gas to electric supply

- **Renewable fuels**

- And feed onsite CHP or boilers
- **Challenge:** resource availability and a distribution of renewable fuels or H2 blends into existing NG pipeline

- **Solar thermal**

- Integrate with thermal storage to serve the heating load outside of direct solar producing hours
- Low temperature solar collectors for pre-heating or low temperature process,
- High temperature solar collectors for higher temperature process
- **Challenge:** high “levelized cost of heat” compared to natural gas

Case Study: Screening for Onsite Energy

BorgWarner Office Park Analysis Overview

Engineers from the National Renewable Energy Laboratory (NREL) supported Borg Warner in evaluating the techno-economic potential of **solar photovoltaics (PV) + battery storage** at their Propulsion Technical Center.

The analysis evaluated three scenarios for DER analysis:

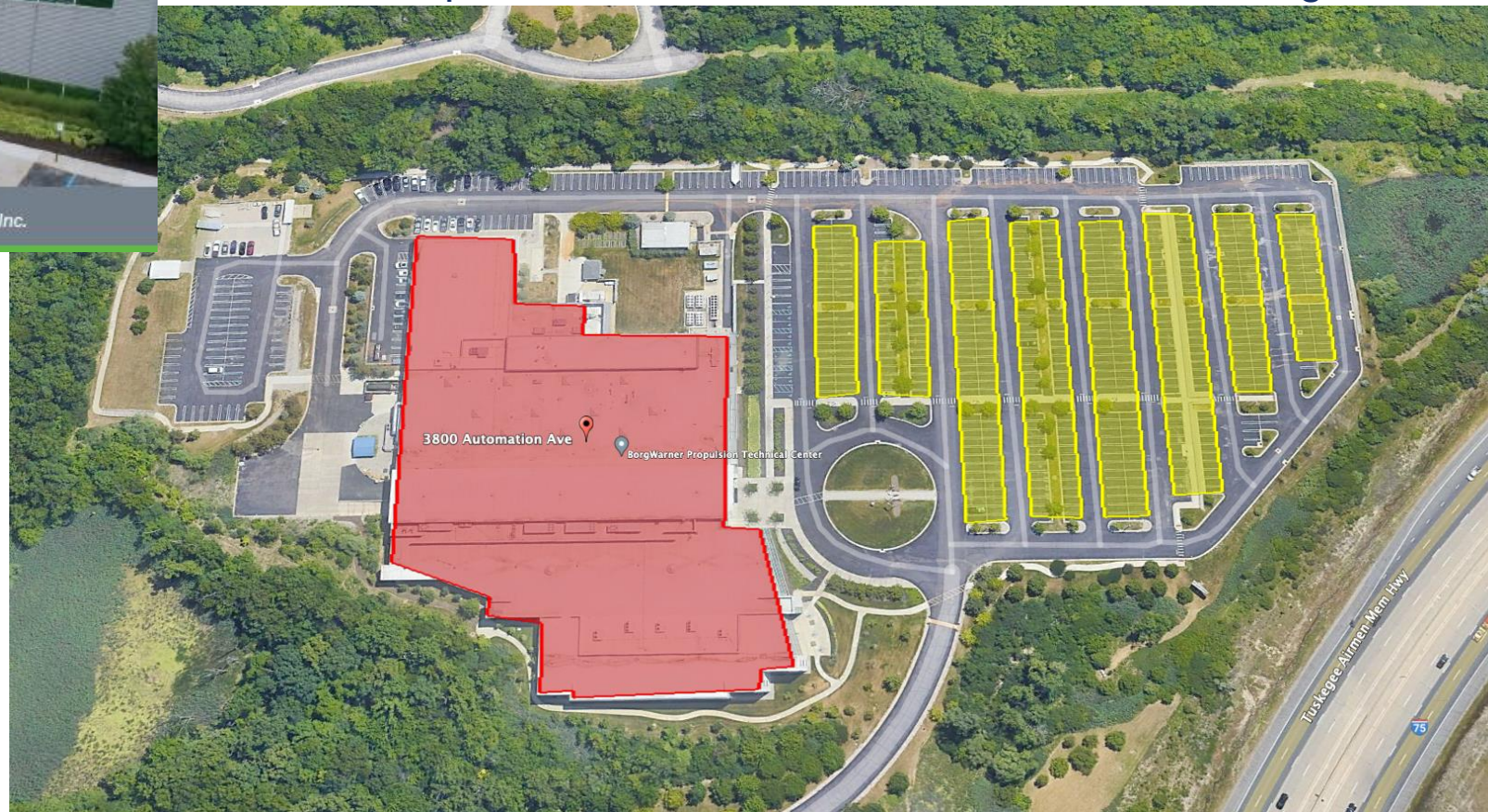
- **Cost-optimal** technology sizing to minimize lifecycle energy costs
- **Resilience** evaluation to quantify how solar/storage can help extend the probability of surviving a simulated grid outage
- Specified **Emission Reduction** targets to reduce the number of CO2 emissions with solar/storage.

Additionally, we include an electrification screening of space heating. This screening considers the additional energy required to **convert the heating load to electric** through the use of heat pumps.


Estimates of Area Available for PV



With assistance from Borg Warner and analysis using Google Earth, NREL estimates approximately **128,000 square feet (sq.ft.)** of rooftop space and **91,814 square feet (sq.ft.)** of carport space that could host up to a total of **2,198 kW-DC of PV**, assuming **10 W-**



 = rooftop

 = carport

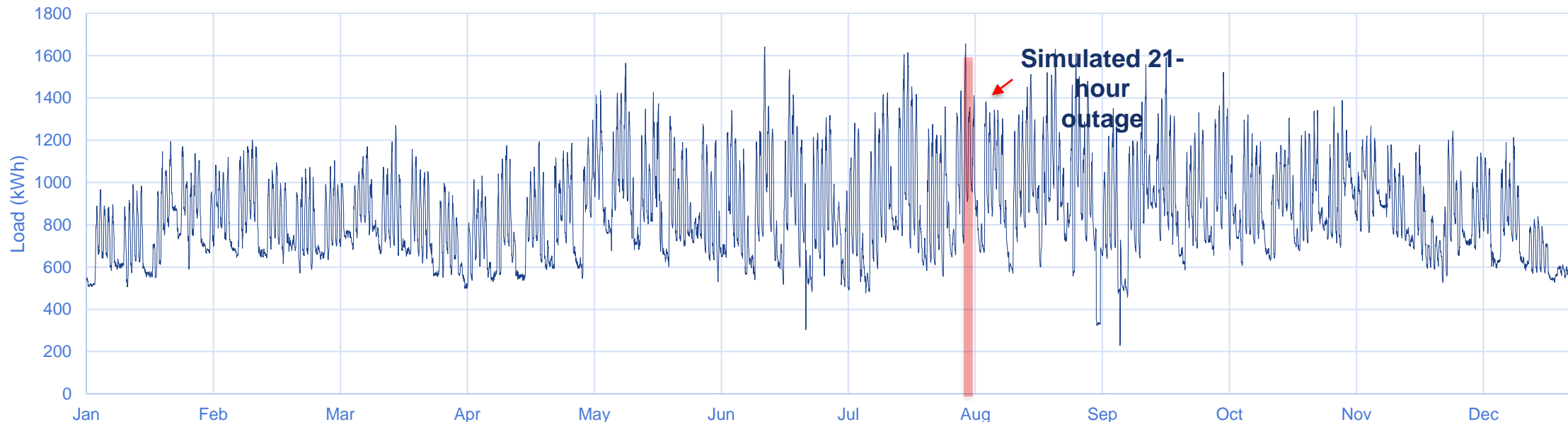
Electric Utility Rate Analysis

- The structure of the site's electricity charges was determined by reviewing utility bills and diving into details of the electric rate tariff of the distribution utility and energy supplier
 - Energy Charges
 - Time-of-use
 - Demand Charges
 - Ratchet/look-back time period

- The electricity rate and electric load were then used to **validate** the model against the monthly electricity bills

Outage Modeling with Onsite Energy for Resilience

BorgWarner Hourly Load Profile (12/1/2021-11/30/2022)



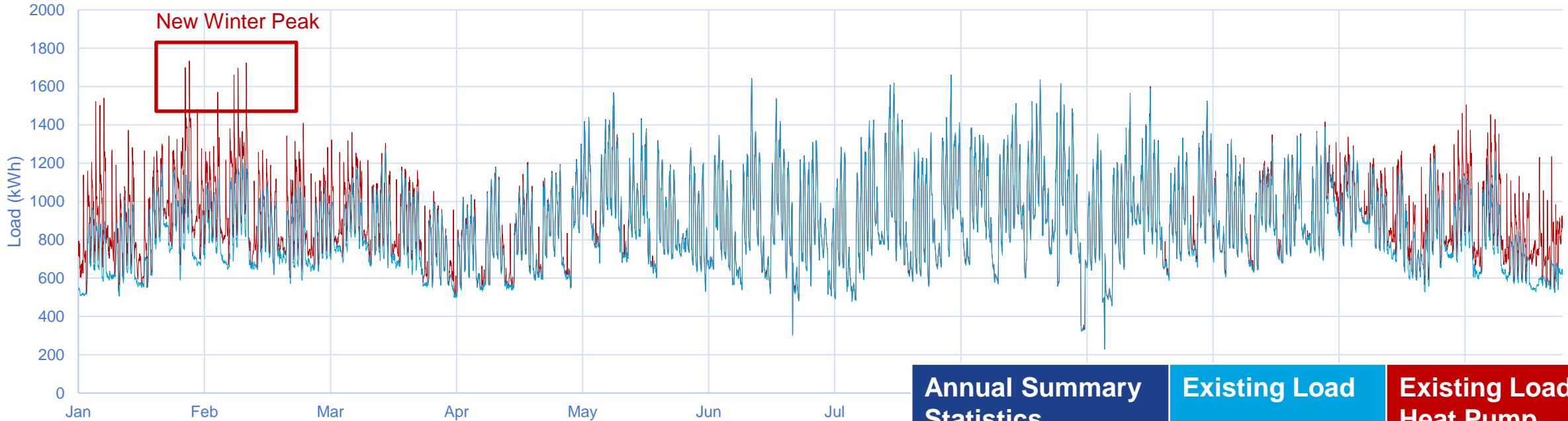
For resilience scenarios, **PV + battery** for evaluated to support a **critical load** equal to **100%** of the site’s full/typical load for a **21-hour outage duration**. The timing of this simulated outage was selected based on the site’s annual peak demand.

- Simulated 21-hour outage:
08/03 3 PM – 08/04 12 PM

Generator Inputs	Assumptions
System Type	Existing backup diesel generators (only operate in case of grid outage)
Rated Capacity	500 kW total per Borg Warner
Fuel Cost	\$3.00/gal (diesel) - EIA
Fuel Cost Escalation Rate	2.7% (EIA)
Fuel Availability	1,000
Fuel Burn Rate	0.076 gallons/kWh

Electrification of Heat Load: Hourly Analysis

BorgWarner Hourly Load Profile + Electrification on Heat (12/1/2021-11/30/2022)



- Electrification of heat load data was obtained by normalizing a typical gas usage load profile and scaling based on the electricity required to power the heat pumps assuming a COP of 5. This load data was then added to the aggregated interval data.
- The additional electrification of heat load increases the total electric consumption in the winter months.
- **The additional electrification of heat load does increase the annual peak load and will increase the minimum monthly demand charge set by the 100% lookback charge.**

Annual Summary Statistics	Existing Load	Existing Load + Heat Pump Elec. Consumption
Minimum (kW)	228	228
Maximum (kW)	1,656	1,733
Average (kW)	854	907
Annual Consumption – (MWh)	7,482	7,942

Analysis Results

- **Cost Savings Only:** Small solar PV, serving just 3% of site electricity
- **Resilience:** Large/max-site PV and large 11 hour battery to serve the load during the outage
- **Emissions Reduction:** Large, almost-max sized PV with a moderate battery to achieve 25%+ emissions reduction
- **Heat electrification (not on chart):** Electrification of the site's space heating and domestic hot water loads through air-source heat pumps eliminates the site's Scope 1 emissions, but it only reduces the total emissions (Scope 1 and Scope 2) 2 by 1%. However, this enables total site emissions reduction in the future with accelerated greening of the grid or other PPA of RE off site.

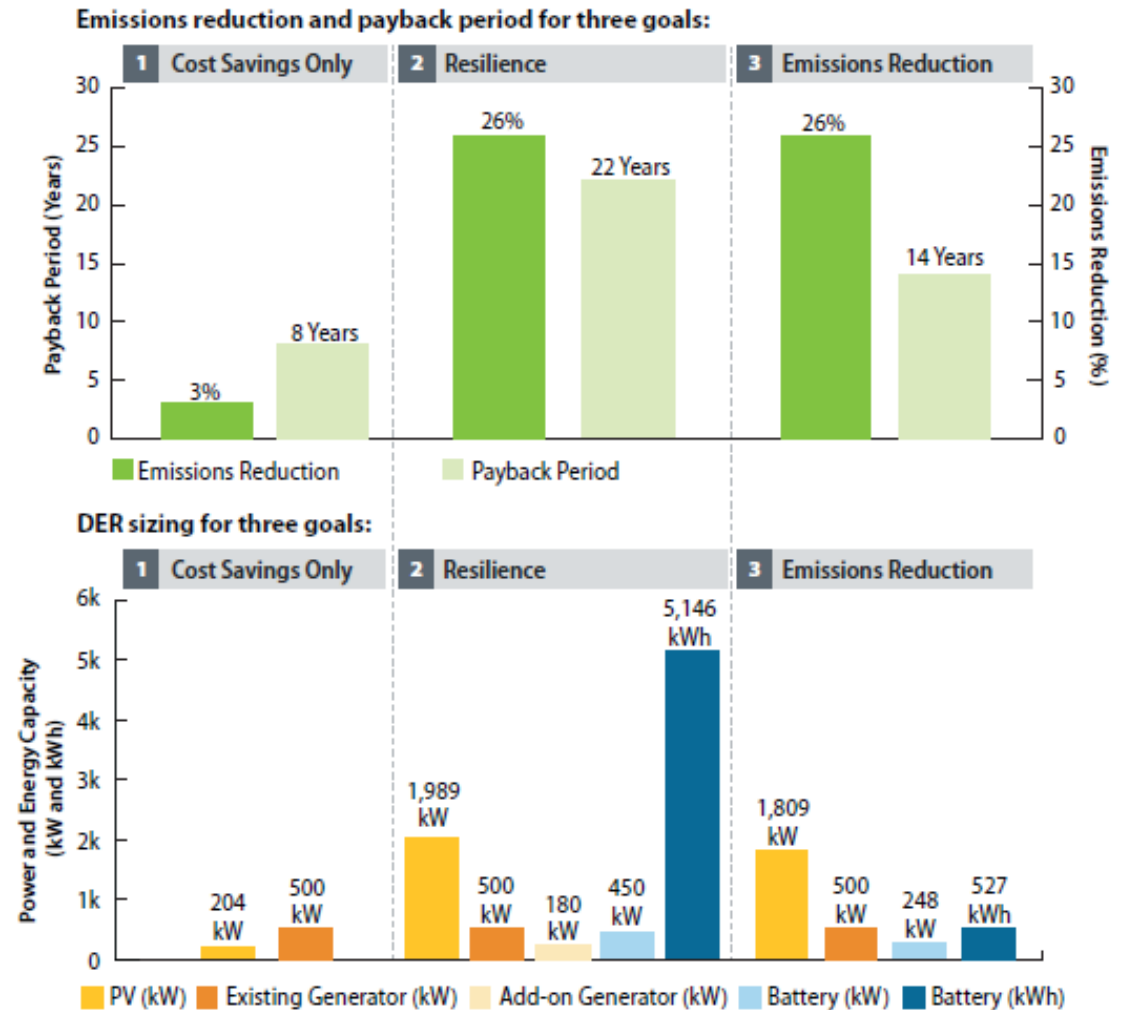


Figure 1. Analysis results of different scenarios

Better Buildings, Better Plants Summit

- The U.S. Department of Energy's Better Buildings, Better Plants Summit will be April 2-4, 2024 at the Capital Hilton in Washington, D.C.
- Join us for engaging and interactive sessions, as well as opportunities to network with your fellow industry peers and experts.
 - Space is limited. Register now to reserve your spot: <https://betterbuildingsolutioncenter.energy.gov/summit>
- “Insight into Onsite Energy: Onsite Renewable Energy and Storage for Industry”
 - **Thursday April 4, 10:30am – 12:00pm**
 - Hear from participants of the Onsite Renewable Energy and Storage Working Group about onsite energy projects at their facilities along with key takeaways on topics including technology options, cost estimation and financing opportunities, engaging with utilities, among others. Regional TAP directors will also speak about the launch of the new Onsite Energy Technical Assistance Partnerships (TAPs) and how they can support end users when deploying onsite renewable energy and storage technologies.



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Thank you!