Wisconsin Office of Energy Innovation

Critical Infrastructure Microgrids For Resilience

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WI Office of Energy Innovation

December 10, 2021

A Brief History of the Office of Energy Innovation: Home of Wisconsin's State Energy Office

- 56 Energy Office (50 states 6 territories)
- Energy Policy & Conservation Act of 1975
- Each state is required, under 42 U.S.C. § 6323(e)(1), to submit an energy emergency plan that it will utilize in the case of an energy supply disruption.
- Moved in 2015 to PSCW, (ch. 16.955 Department of Administration, State Planning and Energy has been updated to Ch. 196.025(7) as of January 2018.

Chapter 196.025(7) Information.

"**(7)** State energy office.

(a) The commission shall do all of the following:

1. In cooperation with the other state agencies, collect, analyze, interpret, and maintain the comprehensive data needed for effective state agency energy planning and effective review of those plans by the governor and the legislature.

2. Administer federal energy grants, when so designated by the governor pursuant to s. 16.54.

3. Prepare and maintain contingency plans for responding to critical energy shortages so that when the shortages occur they can be dealt with quickly and effectively.

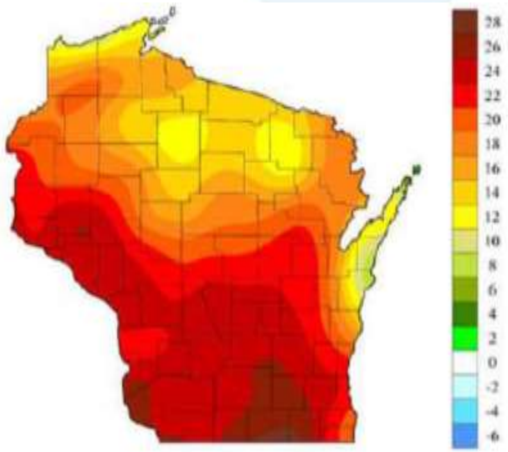
(b) The commission may provide technical assistance to units of government other than the state to assist in the planning and implementation of energy efficiency and renewable resources and may charge for those services. The commission may request technical and staff assistance from other state agencies in providing technical assistance to those units of government.

Wisconsin Office of Energy Innovation

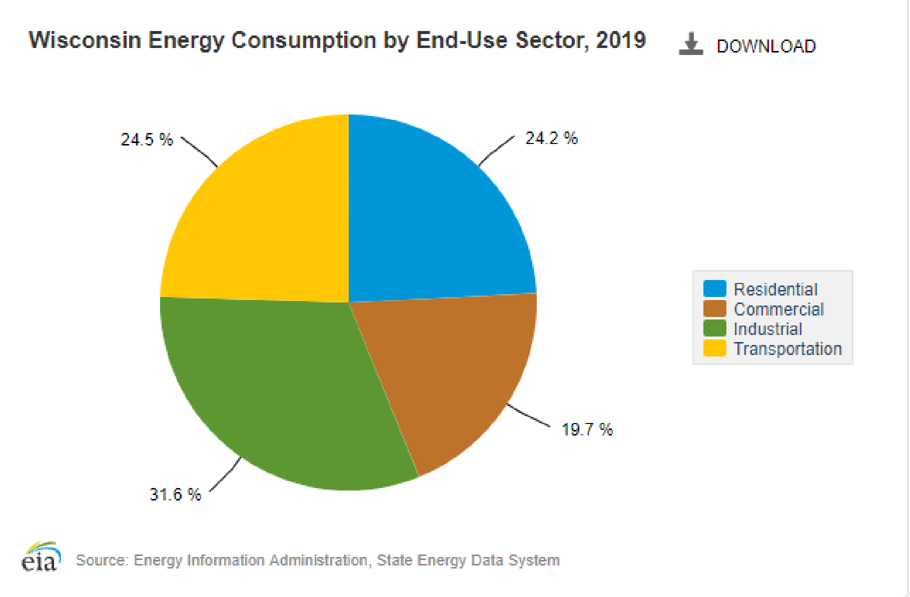
The $14 Billion Problem

- ❑ *Wisconsin consumes 6 times more energy than it produces.*

- ❑ *Despite a warming climate on the whole, Wisconsin will have thermal needs that are difficult to satisfy as well as more cooling load in the summer.*



Projected Change in the Frequency of 90°F Days Per Year from 1980 to 2055



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A Brief History of OEI Programs Leading to Microgrids for Resilience

ENERGY INDEPENDENT COMMUNITIES PROGRAM

"Generate 25% of Wisconsin power and transportation fuels from renewable resources locally by 2025"

- 150 Energy Independent Communities
- 50 Communities received grant funding for creating sustainable energy plans for government operations in 2009 and 2010. More have since.
- Encompasses 3.41 million people
- 58.7% of Wisconsin's population

Municipal Energy Efficiency Technical Assistance Program-MEETAP

Petroleum Shortage Contingency Planning

Energy Security Planning and Response

Statewide Assistance For Energy Resilience and Reliability SAFER2

- Recruit Tribes and Communities to update emergency plans and participate in "deep-dive analysis"
- Deep-dive components (customized to participants' needs and goals):
- Wisconsin Clean Cities Alternative Fuel fleet assessment
- *Micro-grid feasibility study of critical infrastructure*

OEI

Wisconsin Office of Energy Innovation

Critical Infrastructure Microgrid & Community Resilience Center Pilot Grant Program

- ► **The Pilot Grant Program (CIMCRC)** design details were established by the Public Service Commission in an open meeting on April 15, 2021

- ► **Federally Funded** through U.S. Department of Energy by the State Energy Program

- Program Design Memorandum staff researched programs in:
- New York (NY Prize)
- Connecticut
- New Jersey
- Rhode Island
- Maryland
- Massachusetts

Strategic Objectives

► **Energy Security:** Foster critical infrastructure security and resilience, improving the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.

► Prioritize reliability and resilience benefits (during outages not caused by events beyond a utility's control) and benefits of avoiding major power outages (i.e. outages caused by major storms or other events beyond a utility's control).

► **Clean Energy Equity:** Help provide equitable access to the benefits of clean energy, efficiency, and preparedness by reaching broad applicant types. This includes applicants who may traditionally face barriers to adopting clean energy solutions and the benefits they provide, or whose communities may be disproportionately impacted by the negative effects of traditional fossil fuel and inefficient energy systems.

Definitions

- **Critical Infrastructure:** Those facilities, systems, and other assets deemed vital to the public confidence and to Wisconsin. Loss or incapacity of critical infrastructure would have a debilitating impact on the state's security, public health, economy, safety, or well-being.
- **Microgrid:** A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island- mode.
- **Lifelines:** A lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security. Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function.

Definitions Continued

- **Level 1 or single customer:** a single Distributed Energy Resource (DER) or multiple DERs serving one customer through one meter. Example: a single facility (such as a hospital) using an on-site microgrid to provide backup power.
- **Level 2 or single customer or campus setting (partial feeder microgrid):** a single DER or multiple DERs serving multiple facilities, controlled by one meter at the interconnection point (also known as Point of Common Coupling or PCC). Example: a microgrid sited on a University campus connected to multiple buildings.
- **Level 3 or multiple customers (advanced or full feeder microgrid):** a single DER or multiple DERs serving multiple facilities or customers on multiple meters. The DER(s) may be located on a different site from the facilities or customers. While the advanced microgrid has one PCC, the individual facilities or customers within the advanced microgrid may have their own individual connections to the distribution grid.
- **Community Resilience Centers (CRC):** Facilities designed to provide emergency heating and cooling capability; refrigeration of temperature-sensitive medications, vaccines and milk from nursing mothers; plug power for durable medical equipment (to include dialysis equipment and continuous positive airway pressure machines); plug power for charging of cell phone and computer batteries; and/or emergency lighting. A CRC may also be a designated location (by the city, county, or State of Wisconsin) for the distribution of emergency services during extended grid outages. This center would not necessarily be a replacement for an emergency shelter, and should not be required to have food service capabilities, showers, or locker rooms; however, an emergency shelter that does provide these services would still be eligible to apply. A CRC can be a Level 1, 2, or 3 Microgrid (see definition of Microgrid above).

Eligible Applicants

► Municipalities, Universities, Schools, Hospitals, and Like Entities (MUSH Market): cities, villages, towns, counties, K-12 school districts, tribes, municipal water and wastewater utilities, municipal electric utilities, municipal natural gas utilities, University of Wisconsin System campuses and facilities, Wisconsin Technical College System, public or nonprofit hospitals. 501(c)(3) nonprofits

► The Commission approves the staff identified option to establish a partnership approach for eligible applicants, wherein a Lead Applicant engages Target Partners. The Commission establishes the MUSH Market as "Lead Applicant" eligible entities; responsible for partnering with "Target Partners" described as appropriate public, private, and non-profit entities, or their subunits, with unique oversight or expertise in sectors appropriate to the project such as housing authorities, municipal utilities, and engineering firms.

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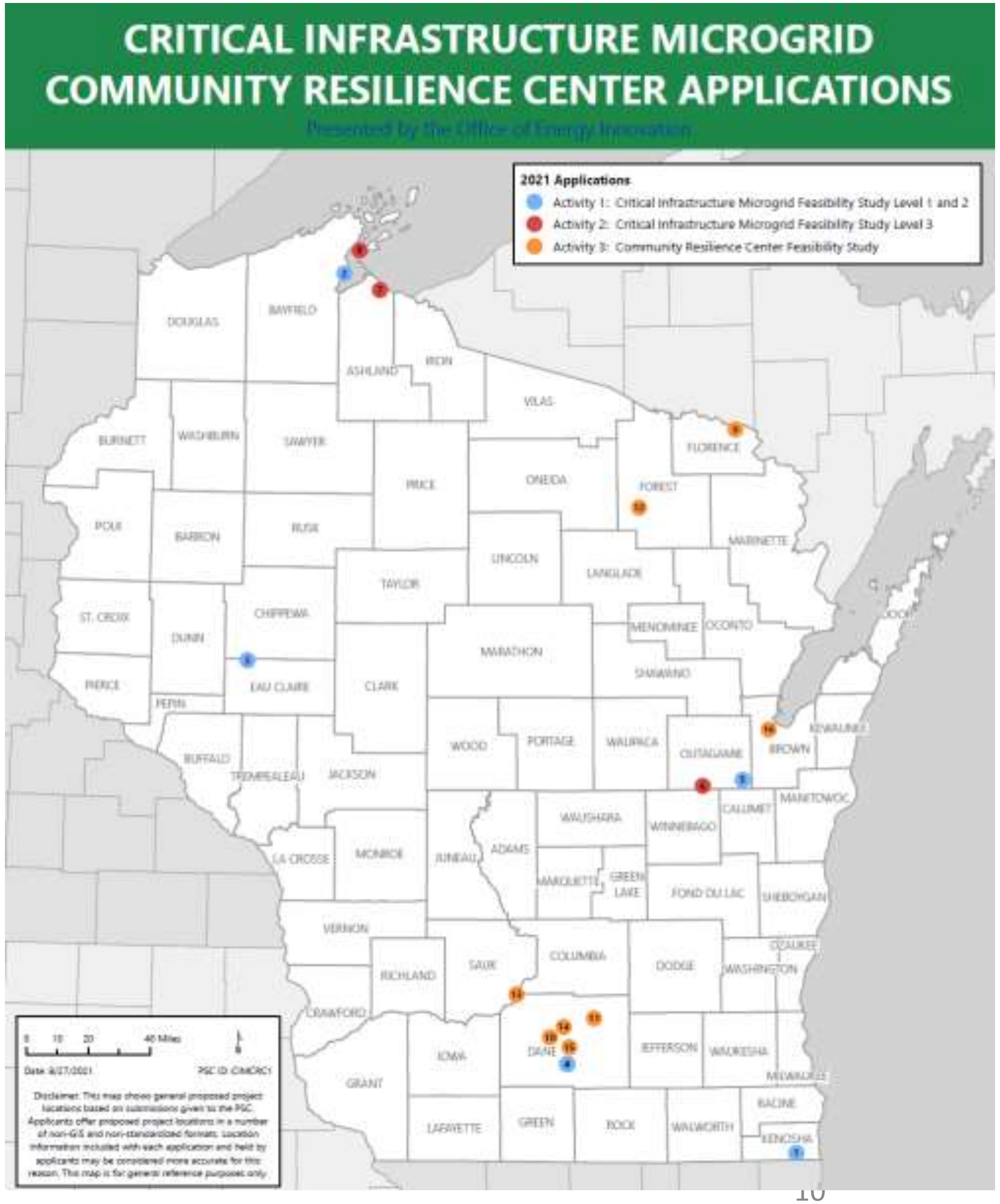
Critical Infrastructure Microgrid & Community Resilience Center Grant Program



15 projects funded to study the feasibility of Microgrids for resilience across Wisconsin:

Projects include:

Hospital, Airport, Police Operations Center, Business Park, Mobile Microgrid, Mini-grid (combination of 3 microgrids), Water Treatment Facility, Wastewater Treatment Facility, and more!

$915,000 awarded

Docket# [9705-FG-2020]

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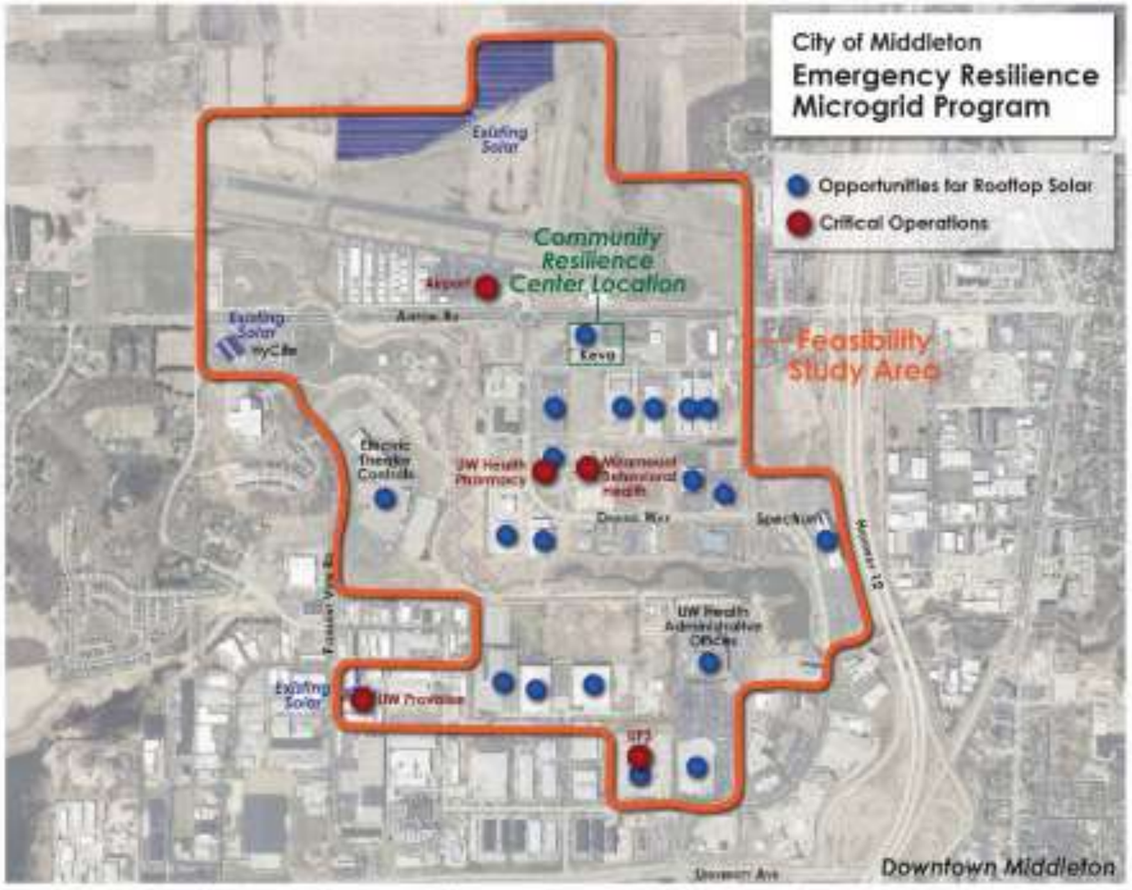
City of Middleton Emergency Resilience Microgrid Study

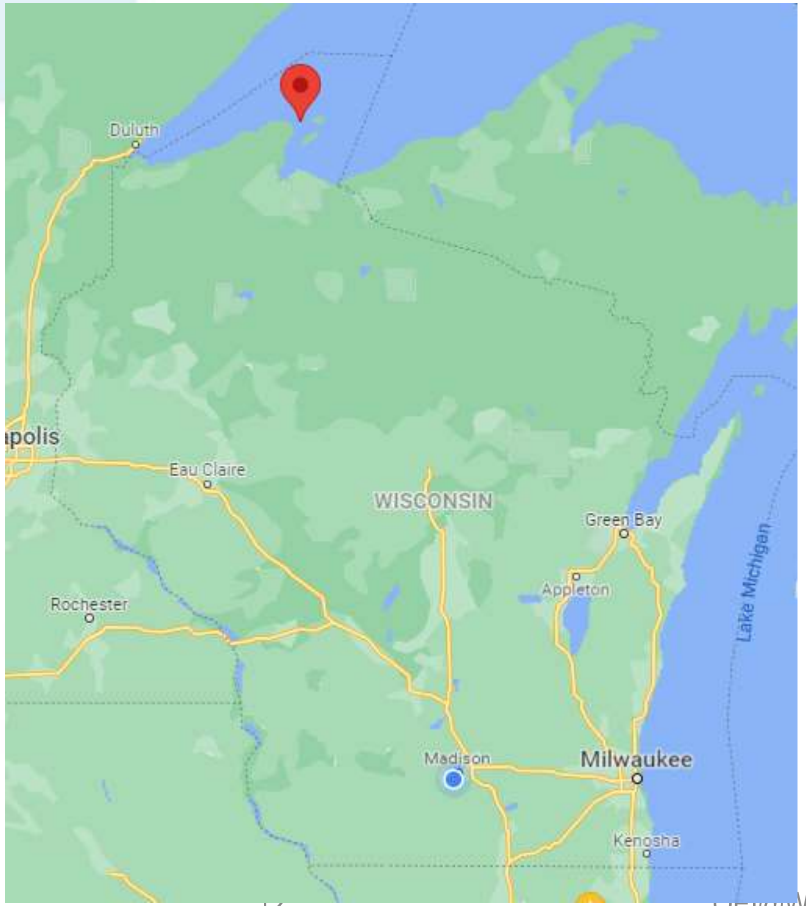
- Energy Independent Communities (EICs) are advancing!
- 2018- OEI funded a clean energy plan study for 7 communities- Middleton was the lead.
- This installation will build on existing solar at the Police department (which also received another grant for a battery and expanded solar array in 2020).
- Concept includes installation of 5 MW of solar and utilization of 35 acres of rooftop space distributed throughout the project area.
- Extreme rainfall event in August of 2018 (12 inches in 24 hours) flooded the project area and crippled emergency services.
- Feasibility study will consider service to more than 60 businesses.



Town of La Pointe Microgrid Feasibility Study

Level 3 Critical Infrastructure Study:

Remote community located on Madeline Island, part of Apostle Islands National Lakeshore



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Town of La Pointe Microgrid Feasibility Study

Level 3 Critical Infrastructure Study:

Key to the project- existing DERs and propane generators- considering lithium-ion battery storage, controls, solar.

Questions?

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FERC Order 2222: Policy & Regulatory Approaches

PREPARED FOR THE
Microgrids and Energy Storage for Emergency Grid Resilience Webinar Series

Will McNamara

DECEMBER 10, 2021

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND2021-15653 O

The research included in this presentation has been funded by the Department of Energy, Office of Electricity, under the sponsorship of Dr. Imre Gyuk.

Energy storage policy is the focus of this presentation.

- We will be covering the following topics:

  - Setting the Context for Order 2222
  - Microgrids 101
  - Summary of the Order
  - RTO Responses
  - Need for Federal / State Coordination
  - Q&A Session

Context
for
FERC Order 2222

Federal vs. State Responsibilities

FEDERAL

FERC, Congress, potential for federal agencies to act (e.g., EPA)

- Rules governing wholesale markets / RTOs (FERC)
- Rules governing transmission lines (FERC)
- Tax credit for solar + storage (Congress)

STATES

PUCs,
state legislatures,
executive directives from governors

- Retail markets
- Operations of distribution networks
- Utility rates
- Other enabling policies

FERC is the agency that regulates wholesale markets.

- FERC regulates the transmission and wholesale sales of electricity across interstate lines.
- Comprised of five commissioners appointed by the president.
- Commissioners serve five year terms and have an equal vote on regulatory decisions.
- The current commissioners are:
  - Chairman Richard Glick
  - Commissioner James Danly
  - Commissioner Allison Clements
  - Commissioner Mark C. Christie
  - Commissioner Willie L. Phillips

The U.S. market is not homogenous.

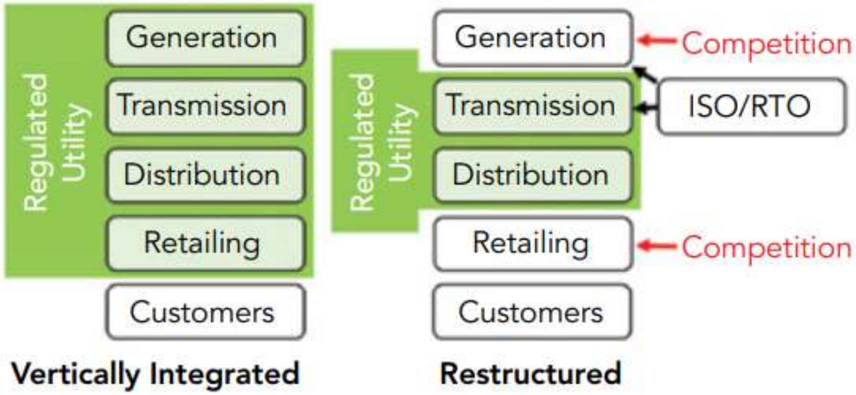
Regulated Markets

"Vertically integrated" utility **owns or controls** generation, transmission, and distribution

Regulated by states (public utility commissions)
Cost recovery via rates charged to customers

ES needs to solve grid problem and be reliable, low-risk

Status of Electric Restructuring by State



Restructured Markets

Market is **competitive**

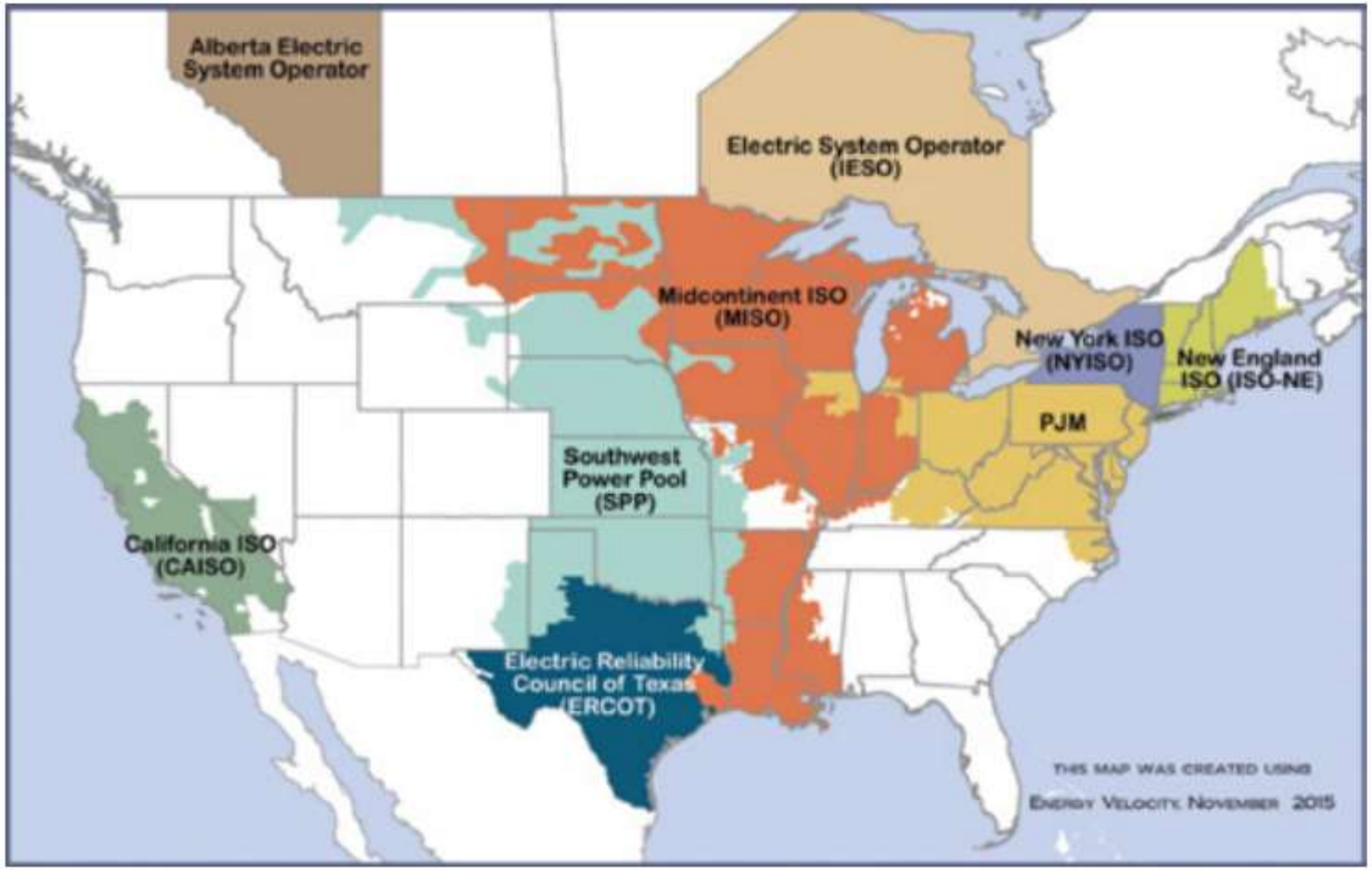
Utilities usually prohibited from owning G&T assets.

RTOS/ISOs responsible for inter-/intra-state T, D and O&M with oversight from FERC

Role of PUC varies state to state

ES needs to make money

In the late 1990s, electric restructuring included the formation of ISOs/RTOs.



Source: FERC

Some regions remain resistant to federal oversight.

- Texas is perhaps the most obvious example. Also the Southeastern U.S. and large portions of the Western U.S. are not part of an RTO.
- While some former FERC commissioners and others have called on FERC to require utilities to join RTOs, Chairman Glick questioned whether the it has the authority to do so.
  - "In some cases, I think we give utilities an excuse or reason not to join RTOs if they can say, 'Well, if I join an RTO, I have to be subject to order 2222 and 841 and all the other orders they have." (FERC Chairman Glick).
- Distributed energy resources (DERs) highlight the gray areas between federal and state jurisdiction when they are considered for wholesale transactions.
- In an area of policy debate that is directly germane, FERC has said for decades that sales by DERs at wholesale are FERC-jurisdictional.

DERs have struggled to find a place in wholesale markets.

- "Distributed energy resources (DERs)" is a broad term that covers small, flexible resources, often sited at end-user locations, including batteries, electric vehicles, rooftop solar, and smart thermostats.

- DERs have proliferated across the U.S. in the last decade—primarily driven by customer demand, technology improvements, and falling prices.

- DERs have been associated with Demand Response resources (i.e., dispatched infrequently in times of severe grid stress).

- However, certain DERs have characteristics that enable them to be used more strategically (e.g., immediate dispatch).

- Microgrids are considered one form of DERs.

Theoretically DERs can contribute to both wholesale and retail operations.

Retail	Wholesale

• Primarily used for reliability & resilience
• Transportation/vehicle charging
• Distribution-level demand response
• Peak shaving
• Load reduction
• Non-wires solutions for distribution utility needs.
	• Energy, capacity, and ancillary services, such as:
	  • Reliability and resilience
	  • Frequency regulation
	  • Voltage support / reactive power used to maintain constant voltage levels.
	  • Arbitrage?

The challenge (for grid operators and regulators) has been to develop a "continuous" participation model that gives DERs credit for their full capacity value.

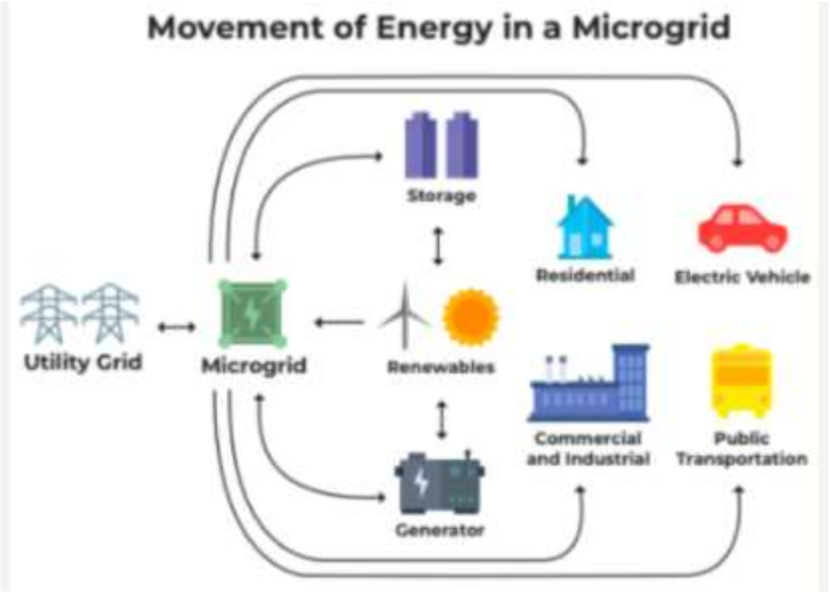
Market gaps set the stage for Order 2222.

- The "square-peg-into-round-hole" problem: DERs don't fit legacy operational, planning, regulatory and business models.
- High volumes of "unmanaged" DERs can export variability and extreme production profiles to the bulk system (e.g., California's "duck" profile).
- Bulk system operators have no visibility into distribution, and utilities may have very little visibility into DER activities.
- DERs reduce grid infrastructure needs, the basis of utility profits.
- It's been difficult for DERs to monetize values because the industry has not yet agreed on methods for valuing them .
- Main driver may be revenue creation: Put simply, participation in both markets increases the financial viability of DERs.

Microgrids
101

Microgrid basics

- Microgrids are one kind of a distributed energy resource (DERs).
- Microgrids are unique in that they are localized energy grid with their own control capabilities, which means they an disconnect from the traditional grid and operate autonomously.



- A microgrid can be powered by distributed generators, batteries, and/or renewable resources like solar panels.
- Depending on how it's fueled and how its requirements are managed, a microgrid might run indefinitely.
- Most microgrids are set up to run 24/7.

What is a microgrid?

- A much smaller version of an energy utility's mega-grid: a network that connects a few buildings, a campus or a neighborhood.
- Microgrids can connect to mega-grid or through a switch can automatically or manually separate from the mega-grid and function as an island.
- Historically fossil-fuel sources, but can be powered by batteries and/or renewables; not uncommon to have a mix of power sources.
- Forecasters expect solar, wind and hydropower to drive 35% of new microgrid capacity by 2025.
- Can be utility- or third party-owned.

- A record number of microgrids (546) were installed in the United States in 2019, (Wood McKenzie). The pandemic slowed growth of microgrids in 2020 and 2021.
- However FERC Order 2222 will be a major post-pandemic accelerant for microgrids.
- Third-party ownership is also a market driver.

Microgrids are unique when compared to other DERs?

- They are typically comprised of different (heterogenous) resources--solar, energy storage, wind, diesel, natural gas, hydro, and others.

- This creates an inherent challenge of putting one, two, or more additional energy sources on the grid at the same point.

- Microgrids are viewed differently by different entities:

  - To utilities, they are a less-valuable subset of DERs to a grid-serving entity.

  - To customers, they are a more valuable form of DER because they are flexible and have the ability to island.

- From a financial perspective, should they be valued less than other DERs?

Why are we seeing more microgrids?

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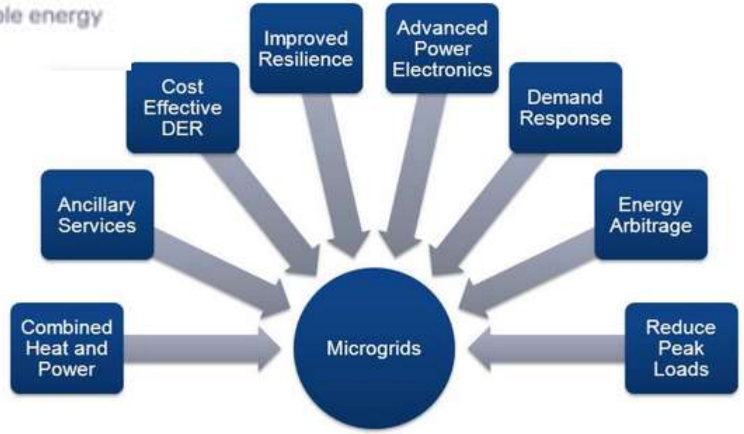
- They offer a core benefit of resilience, which has become increasingly important in extreme weather conditions.
- Wildfires, hurricanes and floods often threaten the grid. Microgrid enable independence to “live off the grid.”
- Can be used by one entity or serve a larger community—e.g., distributing solar power within a neighborhood.
- They can relieve pressure on the main grid during peak demand.
- The have less emissions and are less expensive than centralized power stations.
- The cost of renewables is decreasing, which supports the projection that most future microgrids will be fueled by renewables + storage.

Why are we seeing more microgrids?

In summary,
microgrids produce multiple benefits.

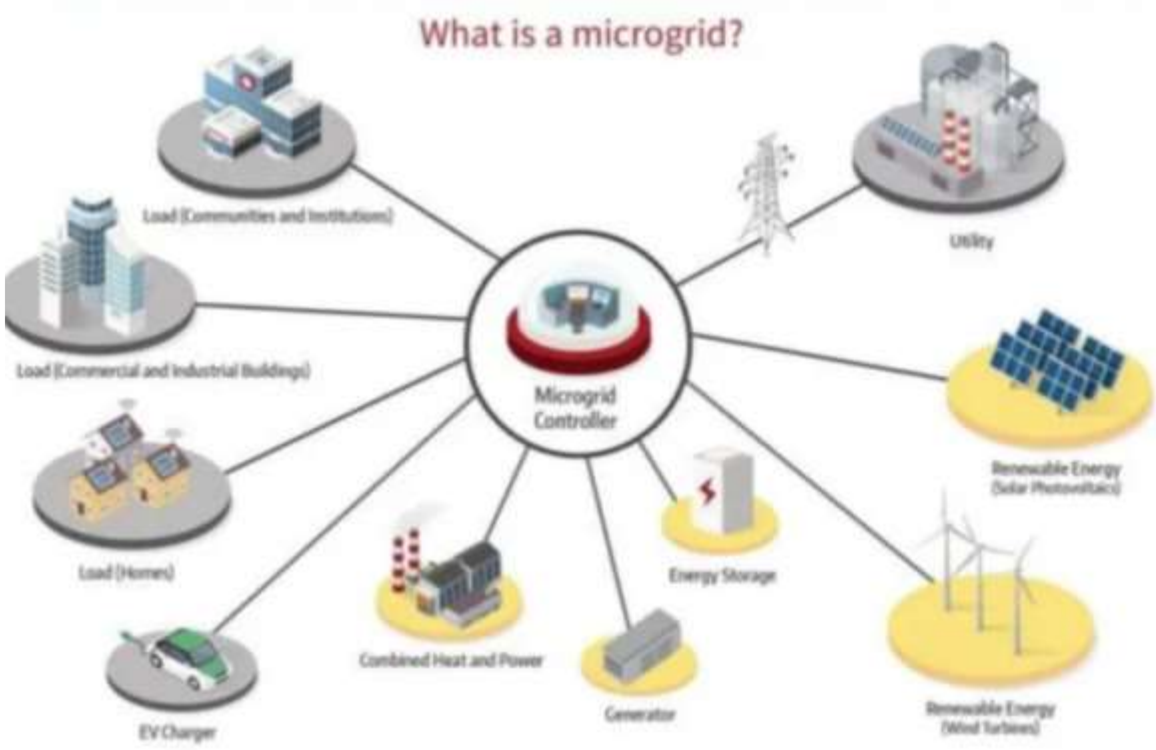
UTILITIES	CUSTOMER	SOCIETY
Reduced cost of operations	Energy bills are reduced due to energy-efficient equipment.	Greenhouse gasses reduction because fossil fuel power plant constructions aren't needed
Reduced expenses on building power plants, costs of transmission and distribution	Power cuts are reduced, and the power supply is more reliable and stable.	Power distribution is equitable due to less disruption of power
Operations run efficiently	Customer satisfaction and reduced maintenance costs for energy-efficient appliances	The promotion and development of sustainable energy and efficiency in the conversion of renewable energy sources

A caveat to utility benefits is that utilities have historically been resistant to DERs as they eat into profits driven by electricity sales and cost recovery for baseload power plants.



How a microgrid is structured impacts how it is regulated.

- On-site generators, energy storage, electric vehicles, energy efficiency and other energy systems are commonly integrated within a microgrid.



The likelihood that a microgrid is interconnected to other DERs such as an EV charger, energy storage (e.g., battery) becomes a defining characteristic as FERC Order 2222 unfolds.

Why are we seeing more microgrids?

Regulatory rules are being developed that open up the market for microgrids—

State level rules allowing third-party ownership.

And perhaps most significantly

FERC's Order 2222

Summary of
FERC Order 2222

Prior to Order 841, FERC policies on DR laid the groundwork.

Order	Date
Order 719	October 17, 2008
Order 745	March 15, 2011

Established that Demand Response Resources need to be treated comparably to other resources.

Required each RTO/ISO to pay a Demand Response Resource the market price for energy (locational marginal price) when the DR resource can balance supply and demand as an alternative to a generation resource.

How is a Demand Response Resource defined?

Can vary slightly depending on RTO , but generally Demand Response Resources must verifiably reduce end-use demand for electricity from the power system.

FERC's Order 841 was a pre-cursor to 2222.

FERC Order 841 (2018)

- Directed RTOs to remove barriers to the participation of electric storage in wholesale markets
- RTOs must establish rules that open capacity, energy, and ancillary services markets to energy storage
- Answers the question that ES can be both generation and load
- Does not apply to vertically integrated, non-RTO markets (e.g., Texas)

841 Compliance Status:

- MISO: Has until June 6, 2022, to implement tariff provisions and comply with Order 841.
    - Received approval for SATOA filing, which enables ES assets to be valued similarly to a wires solution.
- Preliminary approval was given to PJM and SPP plans
- 10-hour duration requirement set by PJM was controversial; PJM has now has requested an extension until October 1, 2022.

Order 2222 was issued in September 2020.

<u>Key components of Order 2222</u>

- Based on the premise that FERC has jurisdiction over DER activities to the extent they involve injection and sale of energy for resale in the wholesale energy markets (still the subject of debate and challenges).
- Requires RTOs to ensure DERs can participate alongside traditional resources in RTOs through aggregation.
- DERs are broadly defined—"any resource located on the distribution system, any subsystem thereof or behind a customer meter above 100 kW."
- RTOs/ISOs are required to change tariffs to accommodate DERs aggregations in energy, ancillary services, and capacity markets.
- RTOs/ISOs can limit maximum DER and/or aggregation size.

Demand response opt-out "clarification."

- Order No. 2222-A (3/18/2021) removed opt-out rights for "heterogeneous" DER aggregations.
- Order No. 2222-B (6/17/2021) then deferred the opt-out examination to a Notice of Inquiry proceeding for Order No. 719.
- Current understanding:
  - DERs aggregations that contain DR in addition to other technology types (e.g., rooftop solar or energy storage) will be treated as mixed asset virtual power plants (VPPs) because of the use of supply and demand side resources.
  - If a DERs aggregation contains any DR resource + another kind of DERs (i.e., a VPP), a state cannot opt out of Order 2222.
  - If a DERs aggregation is composed solely of DR resources, then a state could attempt to opt out of Order 2222.

Consider the impact of aggregated DERs on a massive scale.

- Batteries at residential and commercial buildings.
- Municipal fleet vehicles being replaced with electric models.
- Enabling wholesale market participation for smart thermostats alone has the potential to contribute 40 GW of flexible and responsive load reductions from residential customers in jurisdictions
- Batteries in electric school buses (there are more than 480,000 school buses serving more than 25 million students across the U.S.)

What impact does Order 2222 have on microgrids specifically?

- By definition, any microgrid can provide asset-based demand response and therefore be considered a Demand Response Resource
- Once Order 2222 is formally adopted, it will allow microgrids to aggregate with other DERs and participating in wholesale markets.
- It’s also possible that a community microgrid might be able to bid into a wholesale market on its own.
- If a microgrid is aggregated with another DERs there is no opt out option from participating in Order 2222, and its services are eligible for wholesale transactions.
- If a microgrid does not aggregate with another DERs, then it could opt not to participate in wholesale transactions and opt out from Order 2222 regulation. (unlikely because microgrids are usually paired with other DERs).

As of now, RTOs/ISOs have the action item.

- All RTOs/ISOs must amend their existing participation models or create new ones to enable participation by DER aggregations.
- Order 2222 allows grid operators to set up participation rules designed to avoid market distortions that could arise from DERs participating in both the retail programs and the wholesale markets (i.e., “dual participation” of the same service that could lead to double compensation).
- FERC recommends that each RTO/ISO create a “coordination framework” to clarify the communication and other responsibilities of the RTO/ISO, Distribution Company, Relevant Electric Retail Rate Authority (RERRA), and DERs Aggregator (DERA).
- The DERA is ultimately responsible to attest it has met all the requirements for registration.

RTO filings must define market rules.

- Define “DER Aggregator” as RTO/ISO market participant.
- Create market ”participation models” for DERA ≥ 100 kW capacity.
- Establish coordination with Distribution Utilities & Aggregators & enable voluntary engagement with state regulators.
- Order is optional for utilities with < 4 million MWh annual energy delivered.
- Address metering and telemetry hardware and software requirements for DERs aggregation.
- Address coordination between the RTO/ISO, the DER aggregator, the distribution utility, and the relevant electric retail regulatory authorities .
- Create a standard market participation agreement for DER aggregations

Spring 2022 will be the next milestone.

Compliance filings due July 2021: CAISO & NYISO filed on time; multi-state (PJM, MISO, SPP, ISO-NE) got extensions to Spring 2022.

Implementation dates to be proposed by each RTO/ISO

Need for Federal / State Coordination

Order 2222 requires active coordination of wholesale and retail operations.

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Federal (FERC/ RTOs)	State (Regulatory Commissions)
RTOs/ISOs will propose and FERC will either approve or reject: • Which aggregated DERs can participate in wholesale transactions. • Rates for wholesale sales from aggregated DERs and any other conditions of wholesale services provided by DERs.	State regulators will retail significant authority to address: • Reliability and safety of DERs • Cost impacts on distribution systems • DERs aggregations are subject to state interconnection rules • Rates and terms of conditions of retail DERs programs • States cannot regulate which DERs can participate in wholesale markets or how., but regulate the retail market.

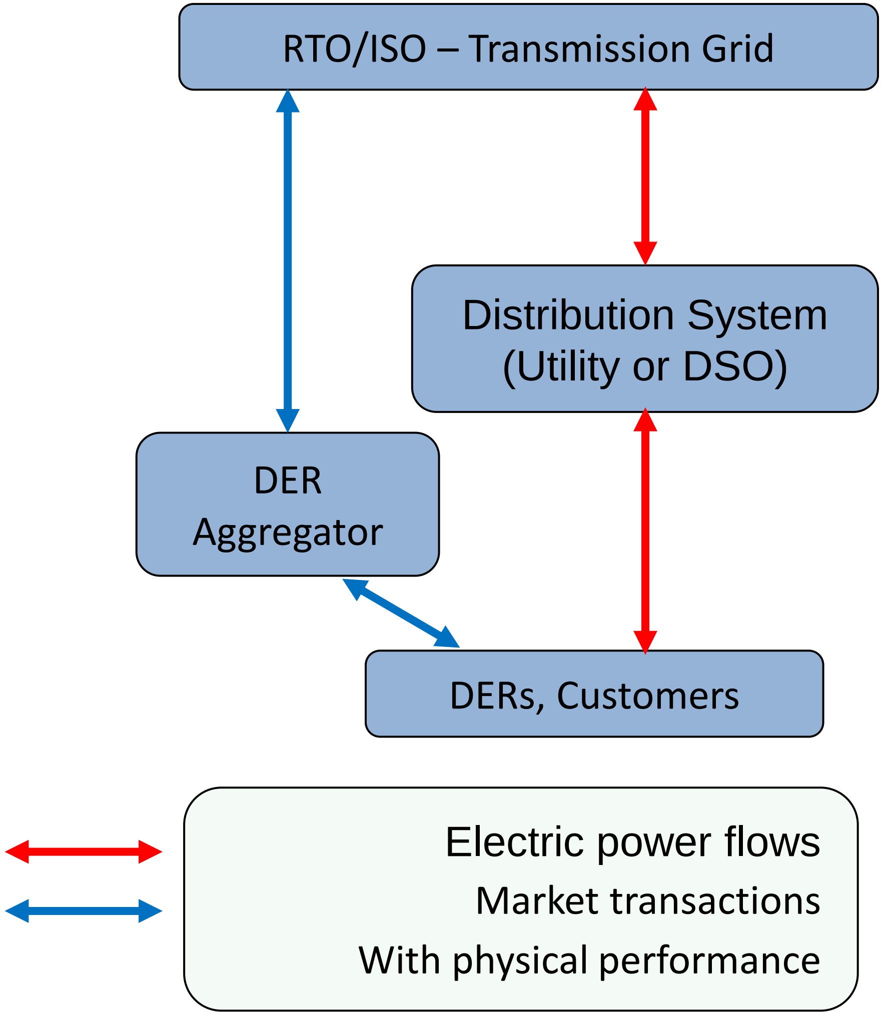
Order 2222 will also create a number of new challenges (1):

- **For utilities:**
  - They will be tasked with managing all the privately owned DERs connected to the grid. From rooftop solar to on-site batteries, many DER’s are BTM and outside each utility operator’s direct control.
  - As increasing amounts of BTM DERs become connected to the grid, utilities may be increasingly overwhelmed by the sheer amount of real-time data they must manage when optimizing network-wide energy delivery.
  - New operational and data analysis tools will be needed.

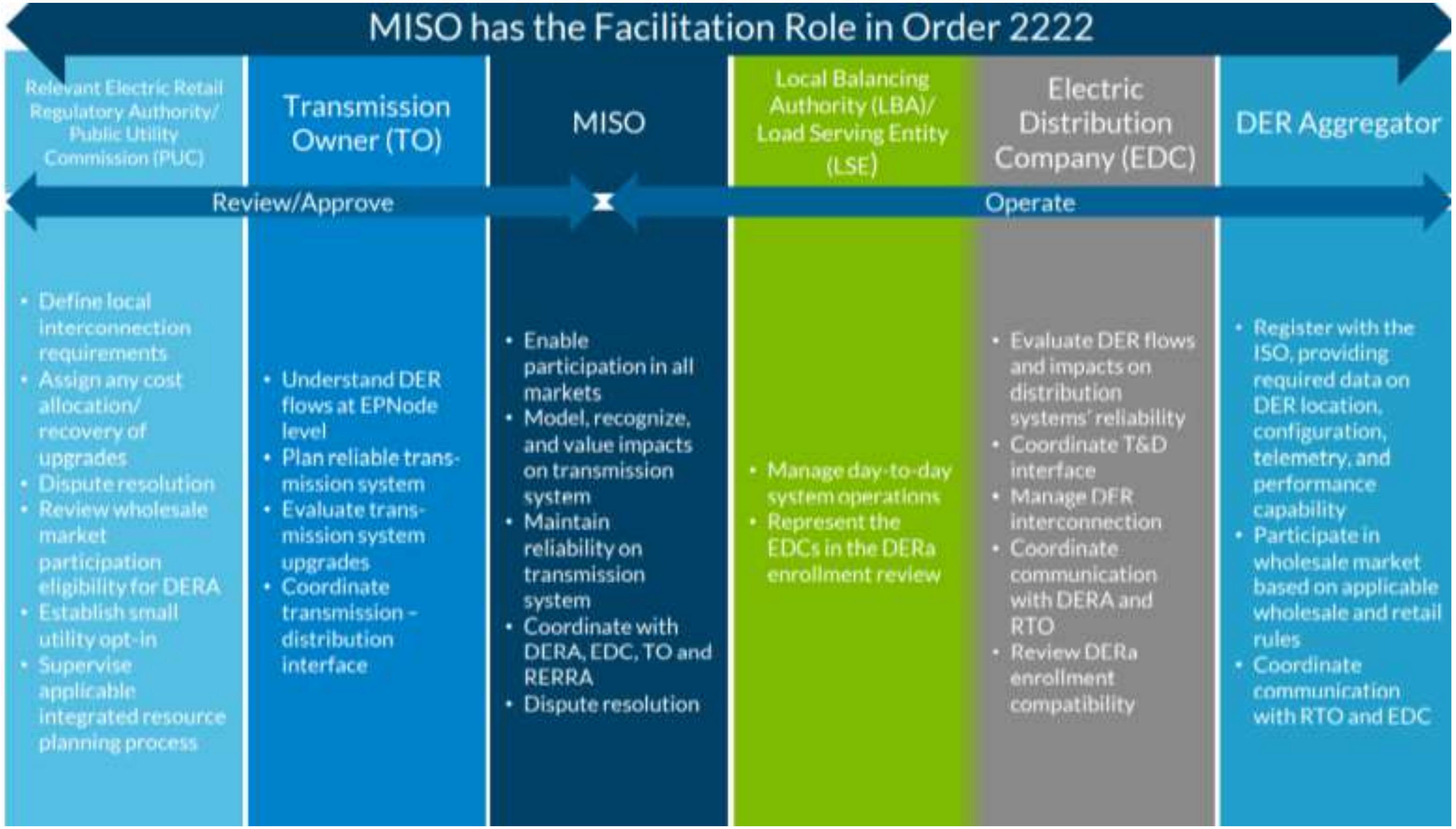
Order 2222 will also create a number of new challenges (2):

- **For grid operators and market participants:**
  - Even pre-Order 2222 an additional 65GW of DERs capacity by 2025 was projected to come on to the grid. The allowance of aggregated DERs will place even greater strain on an already burdened system.
  - The Order provides RTOs/ISOs with significant flexibility in designing market rules. Such flexibility may result in considerable variations in the rules that each RTO/ISO proposes for DER aggregators in its markets.
  - As a result, market participants that are active in multiple RTOs/ISOs will need to be aware of the differences among the various organized markets and plan and coordinate their participation accordingly.
  - RTO will not have jurisdiction of the interconnection of DER resources, but rather oversight over the DER aggregation participating in wholesale markets.

Grid operations will become more complicated.



Role clarification (illustrated by the MISO filing).



Observations on RTO filings.

- **ISO New England: I**ISO-NE is arguably the farthest along in refining its compliance plan among the four RTOs that did not already have a DER participation model in place.
- **PJM:** Compliance filing due in February 2022. PJM plans to use this time to iterate on the design for DER aggregations and is gathering input from stakeholders.
- **MISO:** April deadline for compliance filing. Has expressed concerns about software capabilities. After criticism about limits on DERs aggregation is following PJM's lead and engaging stakeholders presently.
- **SPP:** April 2022 deadline. Has said publicly that it will addressing compliance on an issue-by-issue basis.
- **NYISO and CAISO** already have DER participation models that were approved by FERC prior to Order No. 2222.

The energy storage policy landscape continues to evolve.

Sandia National Labs monitors and analyzes activity at the federal and state levels and publishes information in the Global Energy Storage Database, available at this link:

https://www.sandia.gov/ess-ssl/global-energy-storage-database/

Q&A Session

Thank you!

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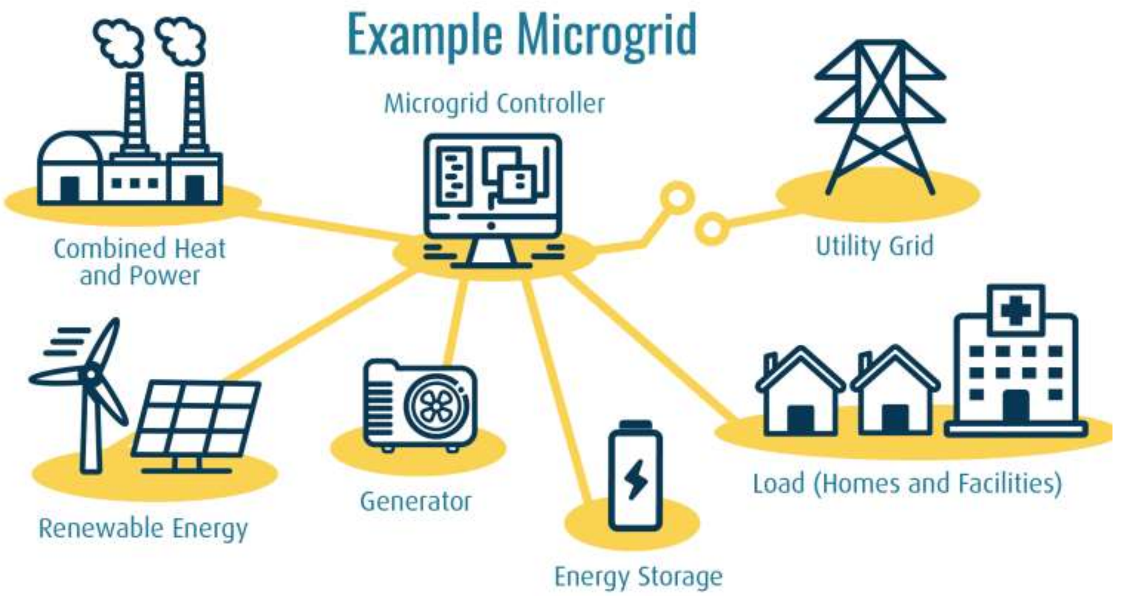
505-206-7156

Sandia Microgrids and Energy Storage for Emergency Grid Resilience Webinar NASEO NARUC Presentation



Kirsten Verclas, NASEO, and Kiera Zitelman, NARUC

About NASEO

- The only national non-profit association for the governor-designated energy officials from each of the 56 states and territories
- Serves as a resource for and about the State Energy Offices through topical committees, regional dialogues, and informational events that facilitate peer learning, best practice sharing, and consensus building
- Advances the interests of the State and Territory Energy Offices before Congress and the Administration
- Learn more at www.naseo.org

NASEO Programs and Priorities

Buildings

Electricity

Climate

Financing

Workforce

Resilience

Equity

Planning

Innovation

Transportation

Solar

Policy

About NARUC

- National non-profit membership association for state utility regulators (public utility/service/commerce commissions) from all 50 states, DC, and territories
- Serves as a resource for and about state utility regulators through topical committees, regional dialogues, and informational events that facilitate peer learning, best practice sharing, and consensus building
- Advances the interests of state utility regulators before Congress and the Administration
- Learn more at www.naruc.org

NARUC Board of Directors

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Regional Organizations:
Western
MARC (Mid-America)
MACRUC (Mid-Atlantic)
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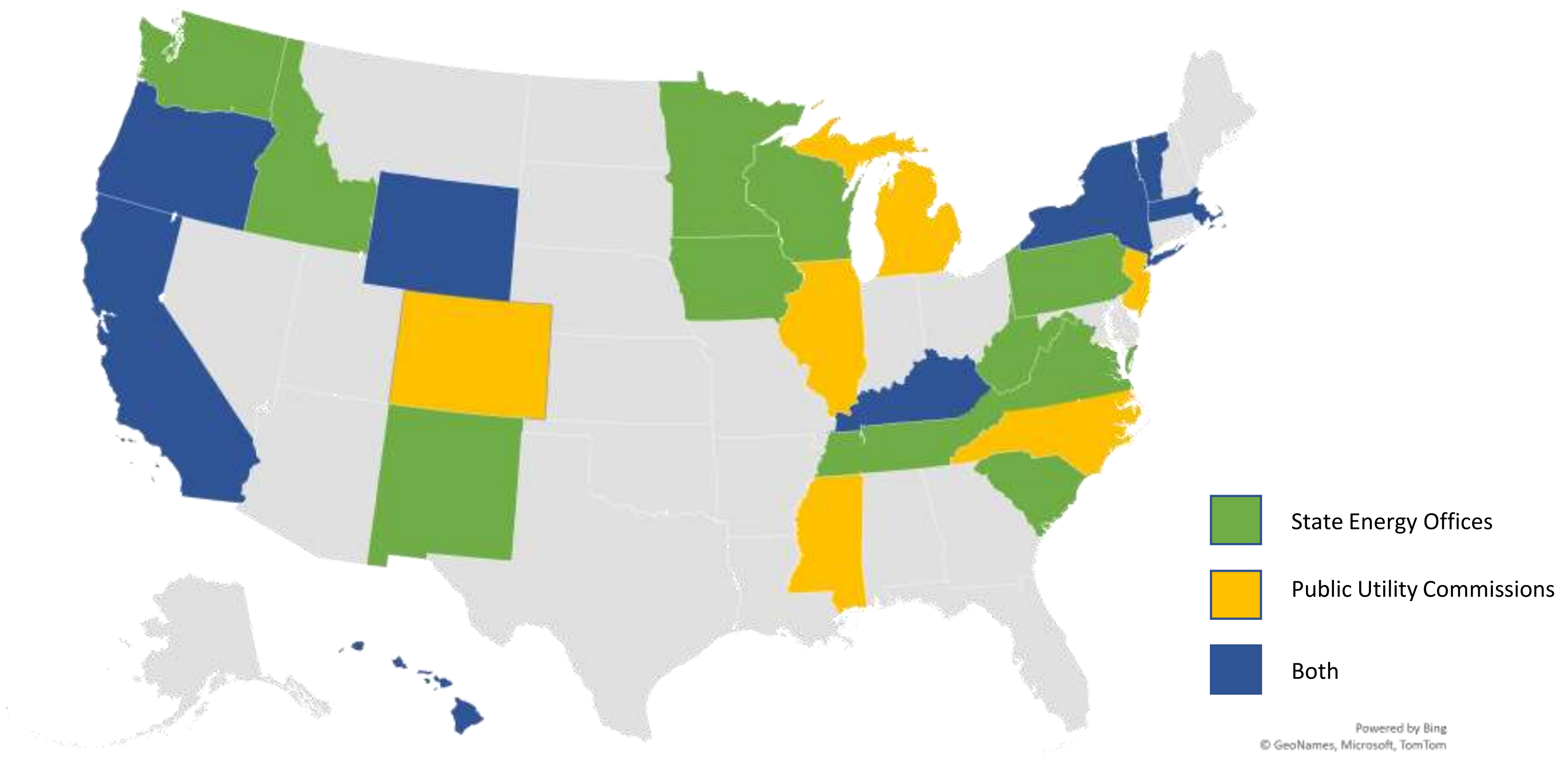
SEARUC (Southeast)

About NARUC

- Eight topical committees: Gas, Electricity, Energy Resources and the Environment, Critical Infrastructure, International Relations, Consumers and the Public Interest, Telecommunications, Water
- Subcommittees and staff subcommittees on more granular topics
- Center for Partnerships & Innovation serves as grant-funded technical assistance office with active programs on cybersecurity, electricity regulation, natural gas, nuclear energy, coal, microgrids, and more

NASEO NARUC Microgrids State Working Group



Resources from NASEO and NARUC

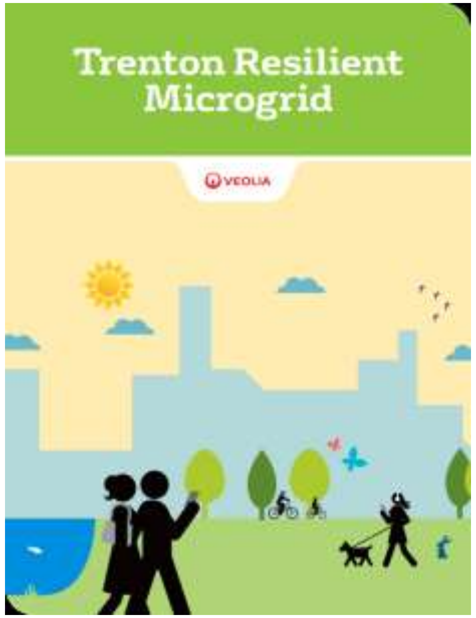
- Webinar Recordings
- Publications
- Complication of Models and Other Technical Resources

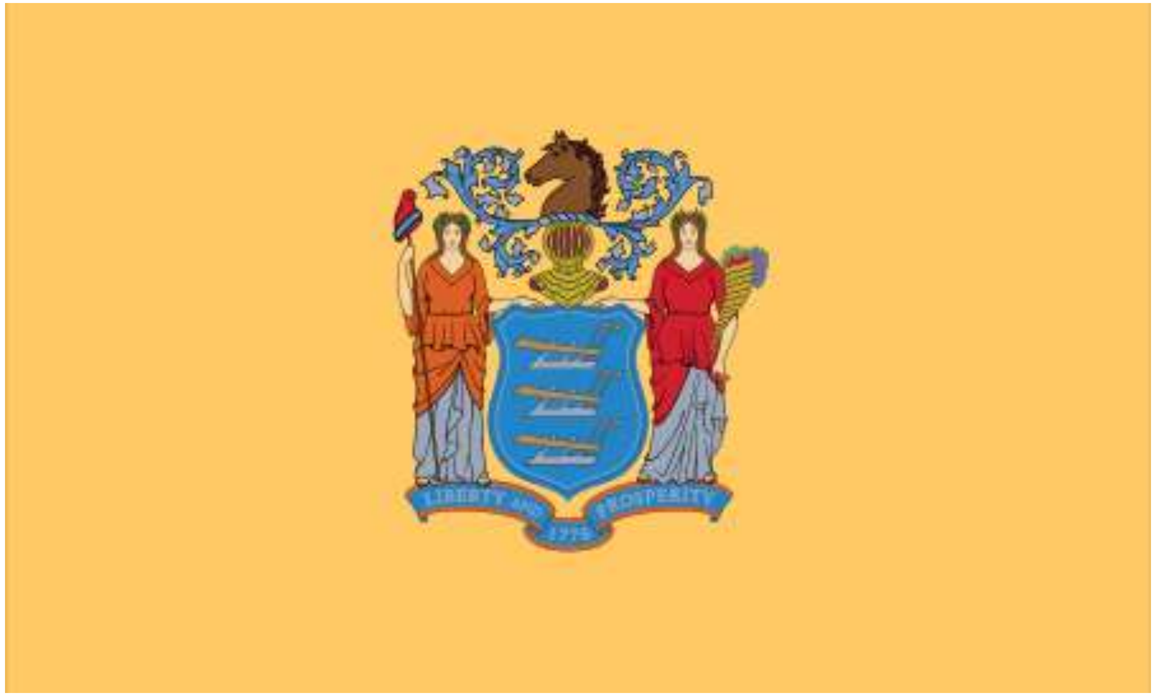
Resilient Maryland Program

Microgrid installed at Montgomery County Public Safety Headquarters Photo Credit: Montgomery County, MD

New Jersey: Microgrid Town Centers and NJ Transit

Microgrid Type	DERs	Facilities	Meters	Facility Owners
Level 1 single facility	1 - 2+	1	1	1
Level 2 campus	1 - 2+	2+	1 - 2+	1
Level 3 multi-user community	1 - 2+	2+	2+	2+





http://blog.veolianorthamerica.com/veolia-and-trenton-new-jersey-resilient-microgrid

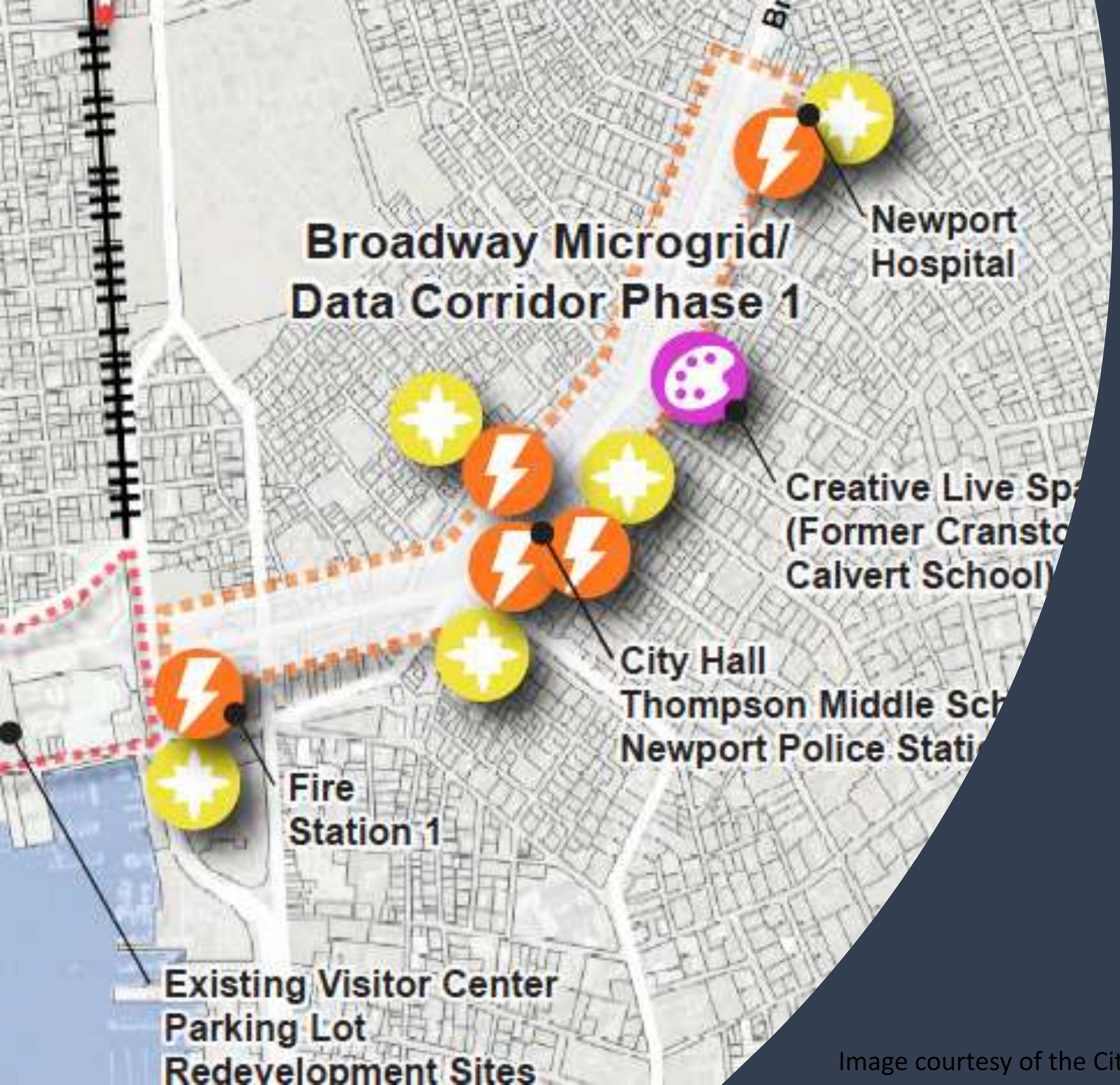


Image courtesy of the City of Newport

Rhode Island: Resilient Microgrids for Critical Services

Role of PUCs in Resilience

- Core role of PUCs is to consider utility investments made with ratepayer dollars and ensure ratepayers are benefiting in a manner that is proportional to their electricity costs
- Unlike State Energy Offices, PUCs do not disburse grants or develop policy
- PUCs set objectives or performance standards for utilities and approve prudent costs / just and reasonable rates to achieve expectations

Role of PUCs in Resilience

- Some examples of utility-proposed resilient community microgrids have come before commissions
- Response from regulators has generally been skeptical: if resilience benefits to ratepayers are not quantified, it is not something ratepayers should pay for. Costs can instead by borne by individual customers or utility.
- Estimating the value of resilience for ratepayers – i.e., how much customers will pay to maintain some level of energy service during an outage – is a key step for regulators to consider approving these types of projects

Valuing Resilience

- Resilience for multiple customers/society at large is difficult to quantify: no universally accepted valuation method. Challenges measuring impacts of long-duration outages (>24 hours), costs of outages to society, and costs where more services (e.g., water treatment, transportation, natural gas service, communications) rely on electricity
- Some methods have been recently developed or are in progress for PUCs and State Energy Offices to use to better guide investments in resilience, whether from ratepayers or taxpayers, and ensure benefit-cost analysis justifies investments

Valuing Resilience

Method / Tool	Advantages / New Additions	Available
Interruption Cost Estimator 2.0 Tool	• Updated calculations of power interruption costs. • New willingness-to-pay surveys that will populate the tool with more recent data and more geographic specificity for power interruption cost estimates. • New data on customer responses to longer-duration power interruptions	2023
Customer Damage Function Calculator Tool	• Helps individual facilities (or groups of similar facilities) calculate power interruption costs, based on the specific losses that they project will occur. • Guided questions lead facilities through their own assessments.	2021
Social Burden Method	• Provides a metric for the social burden of power outages that emphasizes the needs of communities during power outages, rather than protecting critical infrastructure for its own sake. • Adopts a more neutral treatment of the ability to pay for resilience, rather than willingness to pay.	Pilot 2021-2022
FEMA Benefit-Cost Analysis Tool	• Provides quantitative values for lost emergency services, such as police, fire, and emergency medical response. • New pre-calculated values specifically for hospitals published in 2021. • The use of FEMA values aligns with the application requirements of FEMA grant programs.	2021
Power Outage Economics Tool (POET)	• Estimates the economic impacts of longer-duration power outages. • Accounts for how utility customers adapt their behavior during long-duration power interruptions. • Uses surveys of utility customers to collect data on how they would behave during a power outage.	Pilot 2021-2022

Next Steps

- PUCs and State Energy Offices can:
  - Use an existing method, recognizing shortcomings
  - Wait for new approaches to emerge
  - Gather input from utilities on strengths/weaknesses of current approaches
  - Gather data from existing microgrids and other resilience investments
  - Gather input from stakeholders on defining, measuring, and investing in resilience

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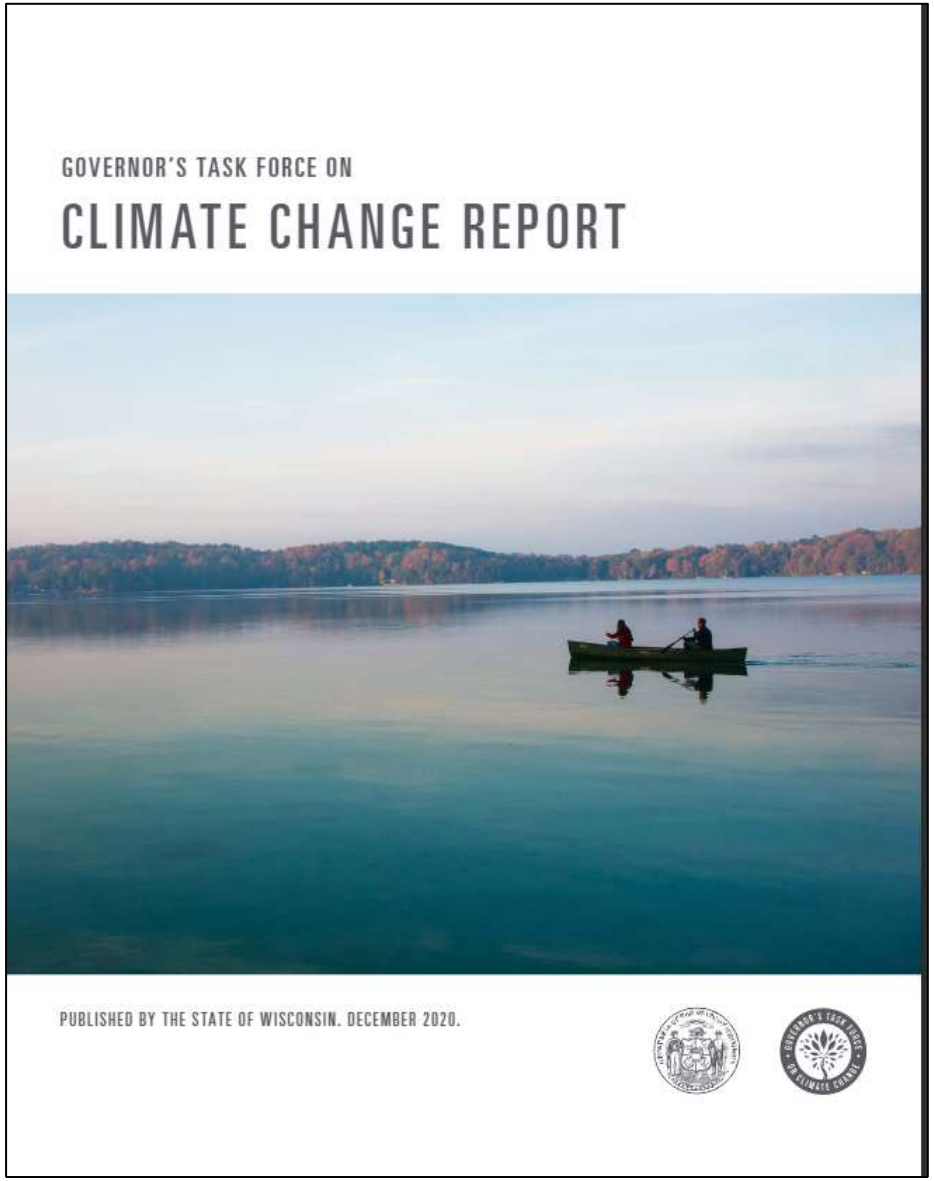
Wisconsin: Critical Infrastructure Microgrid and Community Resilience Center Pilot Grant Program



Mobile Microgrid for Disaster Recovery

Microgrids and ES for Emergency Grid Resilience
DOE/Sandia/ISU Webinar December 10, 2021

Anne Kimber, EPRC Director,

Team: Nicholas David, EPRC Engineer**, Dolf Ivener**, SunCrate, **Dan Stieler**, PowerFilm

Col. John Perkins and **Ken Thornton**, Iowa Army National Guard

https://www.ece.iastate.edu/eprc/

IOWA STATE UNIVERSITY
Electric Power Research Center

IOWA economic development

PowerFilm SOLAR MADE IN THE USA

IOWA NATIONAL GUARD

SunCrate

Background: IEDA project: mobile microgrid for disaster recovery

Iowa Economic Development Authority funding

SunCrate solar/storage crate to Puerto Rico (w/ Black & Veatch)

PowerFilm Inc. flexible solar materials, military applications.

Iowa Army National Guard provide design requirements for crate performance, contribute expertise on applications

ISU Architecture, Electrical Engineering, Mechanical Engineering profs and students: solar house design/build, battery modeling and testing, microgrid design

Advisory Committee: IA ANG, Alliant, City of Ames, Cedar Falls Utilities, MidAmerican Energy

Earlier microgrid: Solar crate in Puerto Rico, August 2018

Phase 1 Tasks:

- **Design, build, deliver:** mobile microgrid for disaster recovery, to IA ANG requirements
- Provide plans for a *second* crate to serve for human use as office, or housing, based on ISU solar decathlon experience

Phase 2 Tasks: Demonstrate, collaborate and improve the microgrid based on feedback from microgrid advisory committee, Iowa Dept. Homeland Security, County Emergency Managers

Background: EPRC: Started in 1963 as Power Affiliates Program

"Advance research and graduate education in electric power systems; strengthen industry ties"

Industry Members:
Alliant Energy
City of Ames
Cedar Falls Utilities
Central Iowa Power Cooperative
Corn Belt Power Cooperative
International Transmission Company
MidAmerican Energy
MidContinent Independent System Operator
Northwest Iowa Power Cooperative

EPRC: Catalyst for collaboration in ISU-industry-National Laboratories power systems R&D and technology transfer, to strengthen undergraduate and graduate education in energy infrastructure.

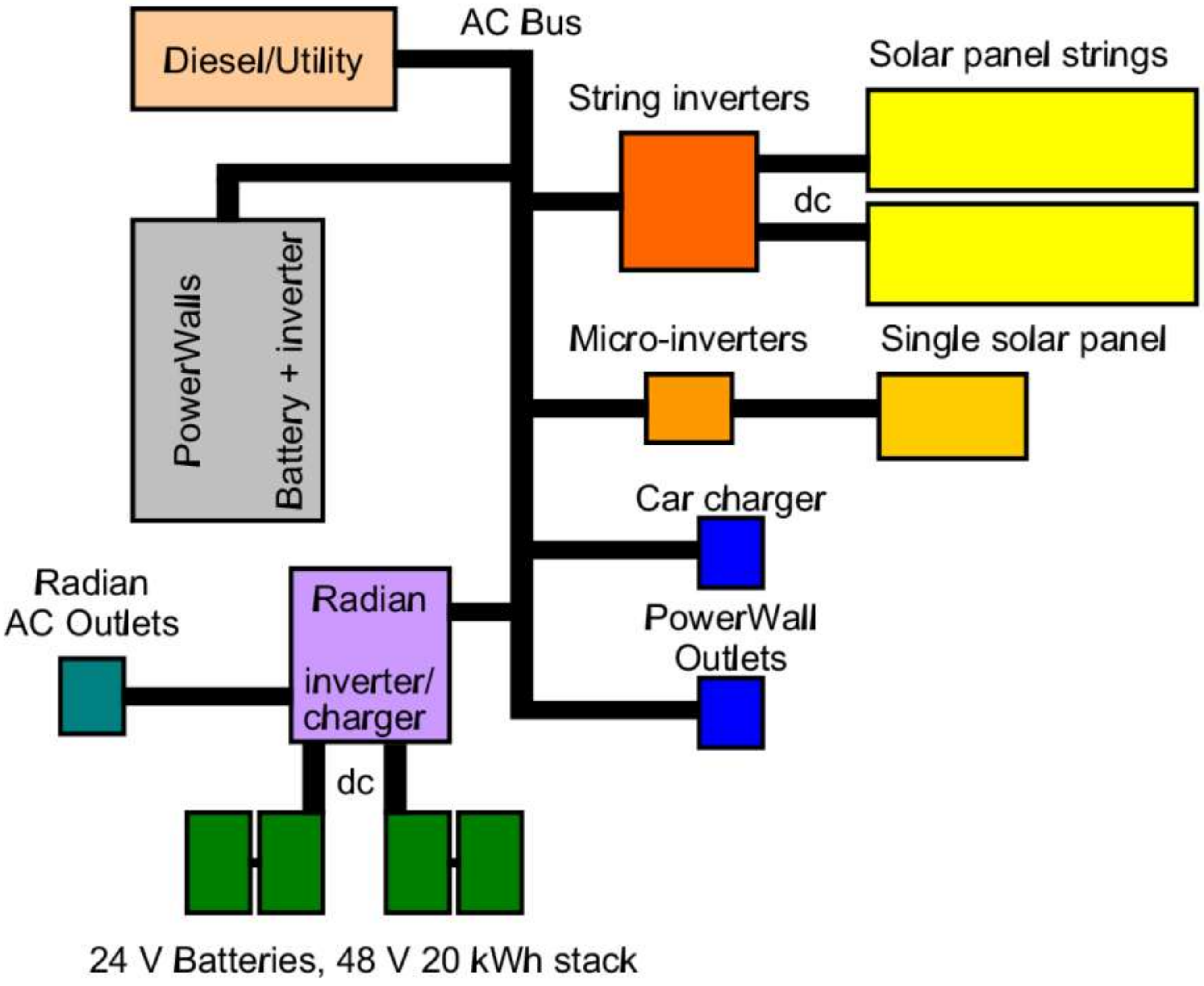
We study power systems from large interconnected transmission grids to microgrid-scale- with strength in fundamental and applied work in transmission and distribution planning and operation, and cybersecurity.

Research and education driven to improve reliability and security of the grid as more variable and distributed generation resources are connected, and as loads also become more variable.

Other Collaborators: Algona Municipal Utilities, Maquoketa Valley Electric Cooperative, Iowa Lakes Electric Cooperative, Iowa Army National Guard, National Labs, American Public Power Association, SunCrate, PowerFilm

Power Systems Engineering Faculty:

- **Venkataramana Ajjarapu**, Whitney Professor, IEEE Fellow, vajjarap@iastate.edu; voltage stability, T&D co-modeling
- **Chao Hu, Mechanical Engineering;** battery testing, battery state estimation, battery life prediction, chaohu@iastate.edu
- **Ian Dobson**, Sandbulte Professor, IEEE Fellow, Dobson@iastate.edu; voltage collapse, cascading outage
- **Manimaran Govindarasu**, Marston, Harpole Professor, IEEE Fellow, gmani@iastate.edu; cyber security of power systems
- **Jim McCalley**- Marston, London Professor, IEEE Fellow, jdm@iastate.edu; SEAMS project, co-optimization of generation and transmission planning, wind energy integration
- **Hugo Villegas-Pico**, Harpole-Pentair Assistant Professor, Power Systems, Power Electronics and Controls, hvillega@iastate.edu
- **Zhaoyu Wang**, Northrop Grumman Associate Professor, wzy@iastate.edu; Distribution Systems, renewable energy integration



IEDA microgrid is *primarily* "off-grid": it can accept power from utility grid to charge batteries, but in current configuration does not feed back into grid. Can modify controls to allow power to feed back, at the discretion of the local utility and specific use case.

Current configuration includes:

1. Rigid PV panels (14.4 kW) and DC to AC inverters
2. Flexible PV panels (from PowerFilm)- 3 types, total 960 W, with DC to AC inverters
3. 6 Tesla power walls (total 78 kWh, 30 kW)
4. A diesel generator (6.5 kW)
5. A local network and Tesla Gateway controller (the brain)
6. A communications network
7. Three, single phase outlets (2 at 120 V, one 240 V) *and one 3-phase, 230 V*
8. *NEW in July: 8 kW Outback Radian inverter and 20.8 kWh of Hawk Big Battery Lithium Iron Phosphate*

Moving SunCrate to Camp Dodge

Transports:

Flatbed, tow truck
Enhanced Container Handling Unit (ECHU) on Heavy Expanded Mobile Tactical Truck (HEMTT)

Challenges:

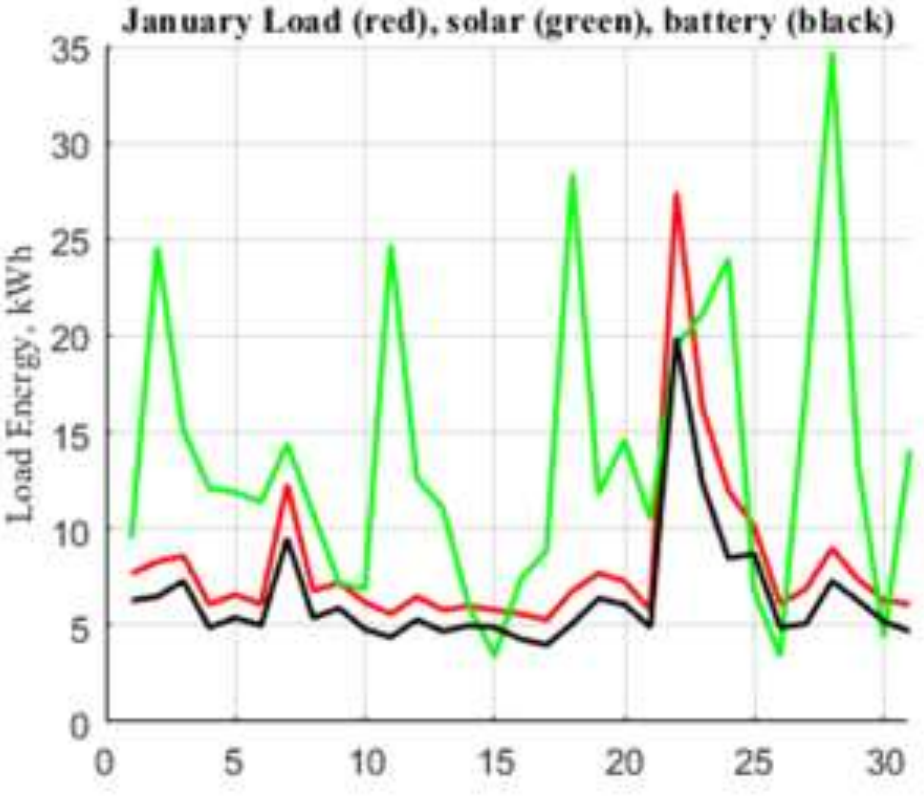
Soil variability, Ergonomics, PV cable management, Secure mounts

January, February 2021

- Solar replenishes night heat load

One-month data:

January

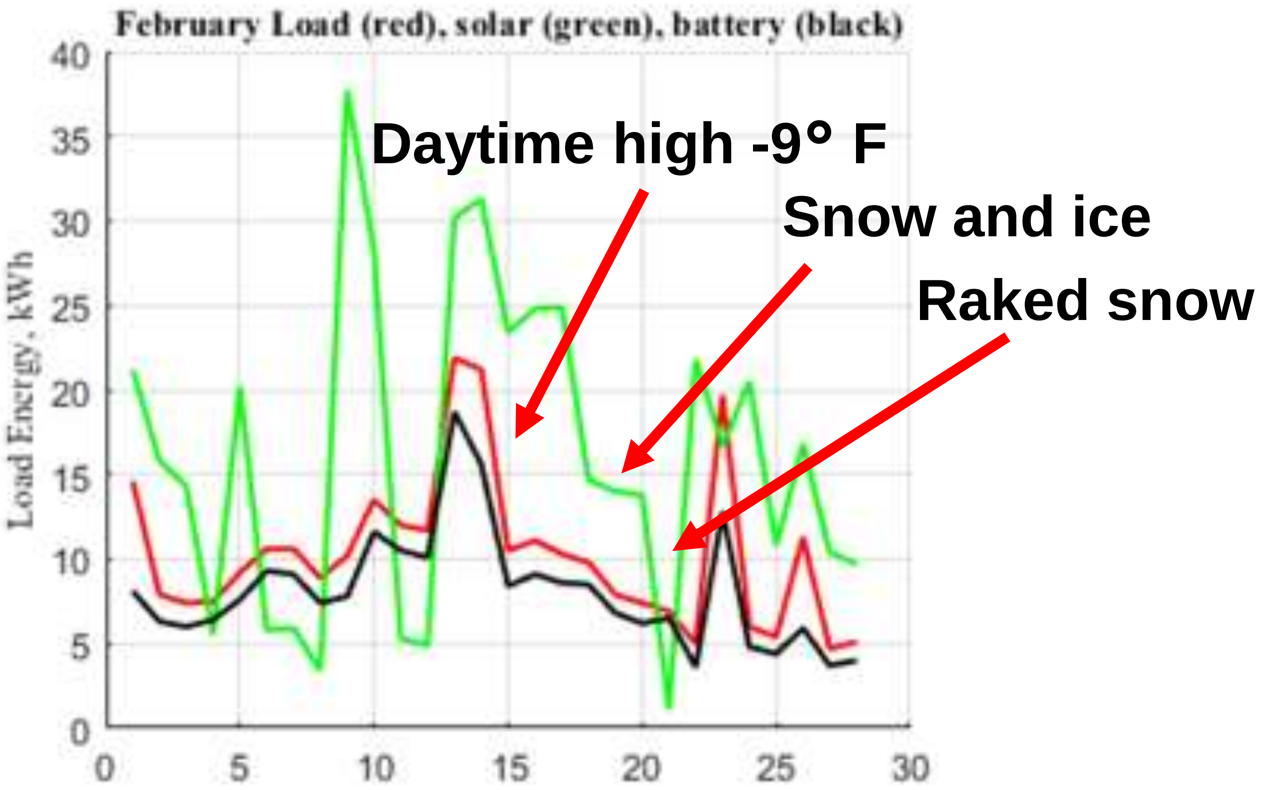


Car charging... Snow... Cold...

One-week polar vortex

- Load increases from added heating

February



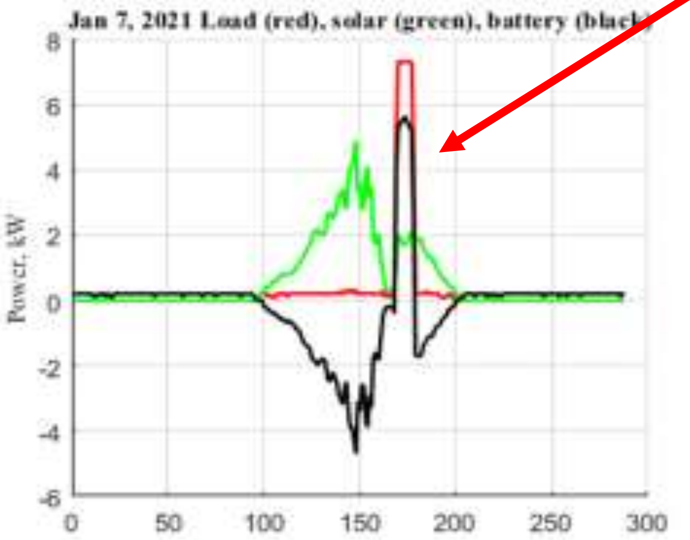
Winter car charging

One-day data:

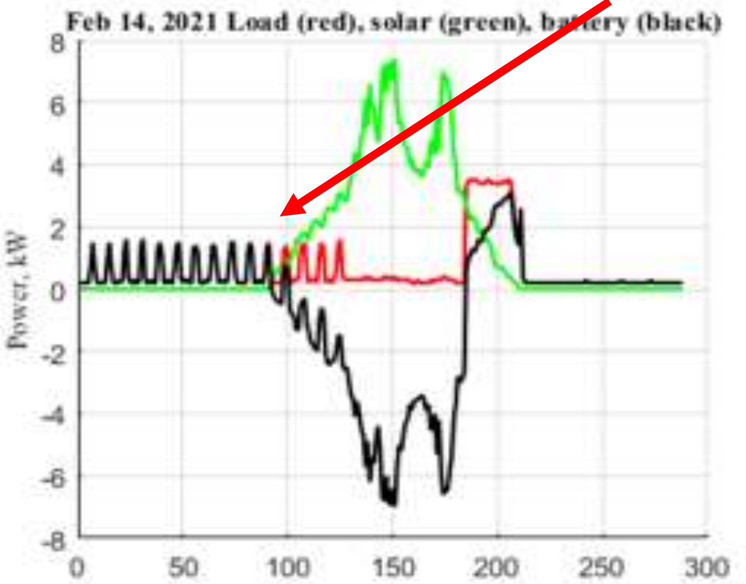
Ogden veterinarian – Tesla car

City of Ames – Chevy Bolt

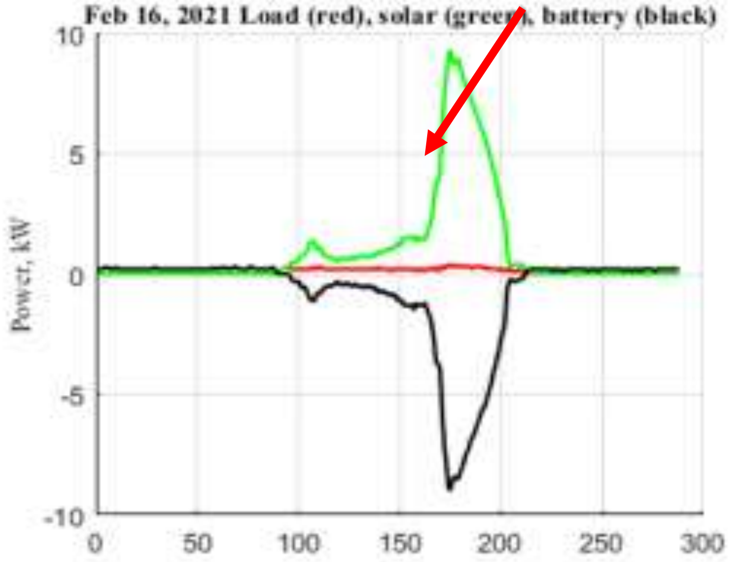
Heaters keeping up
Low: -21° F
High: -5° F



Snow/Hazy morning,
level 2 car charge



Car Trickle and refill,
Solar and Battery "load sharing"



Cells warmed mid-day

Keep the snow cleared,
First snow, then sun melts ice

Different cars have different profiles

In -20° F, internal and
external heaters barely enough

Idea of rapid deployment of mobile microgrids for community resiliency hubs

Idea: Mobile microgrids as “Grid Resilience Assets”

-gas stations
-city hall or community center, red cross shelters, daycares
-critical circuits in grocery stores
-cell towers and communication infrastructure,
-nursing home or health care facilities,
-food trucks, mobile kitchens,
-mobile command center
-water treatment and distribution pumping
-wastewater collection, treatment, discharge:

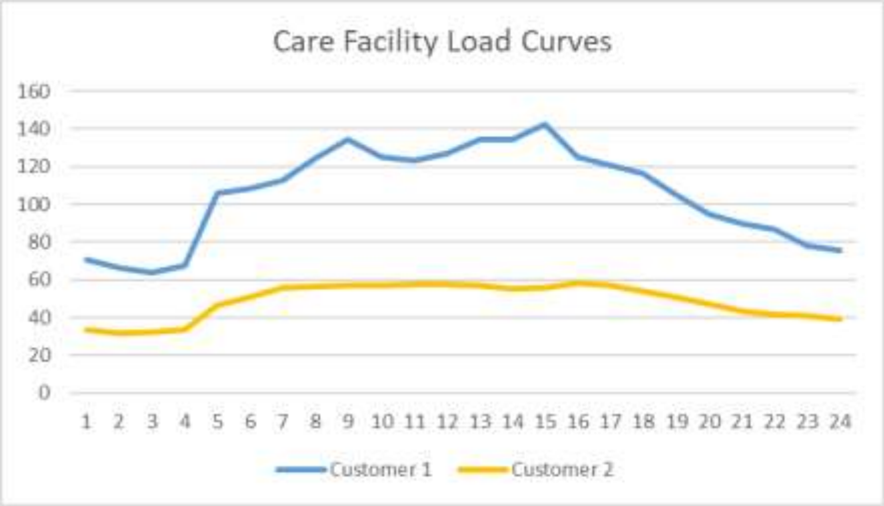
Dow City NH4 removal demonstration with BES and U. Iowa December 2021

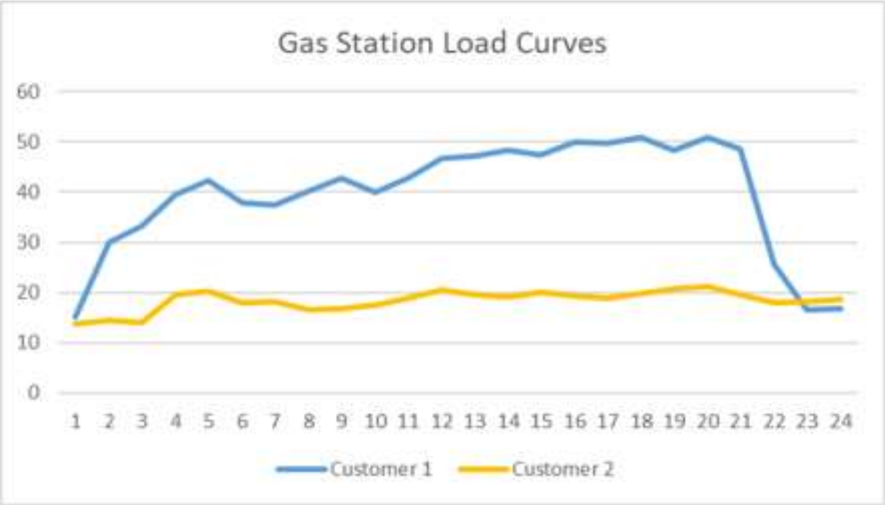
“daisy-chained” plug and play systems: pallet designs

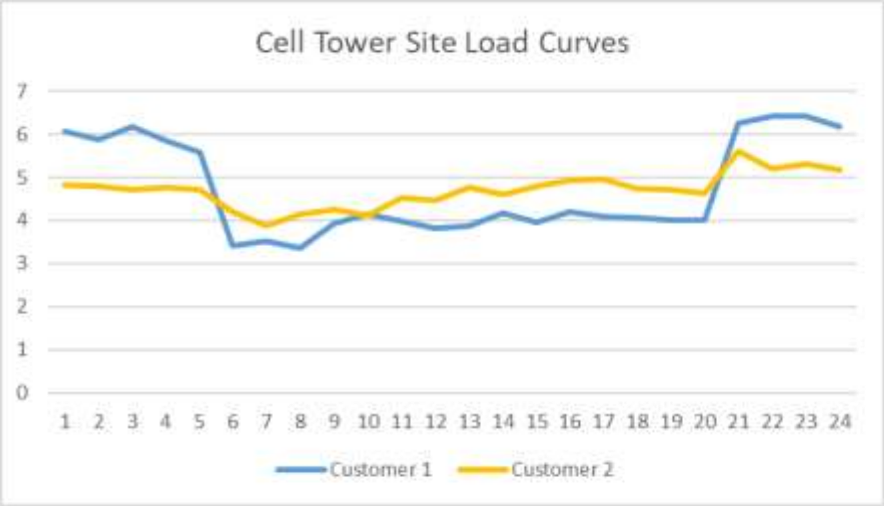
Delivered fully charged: immediate power supply for utility and community resource

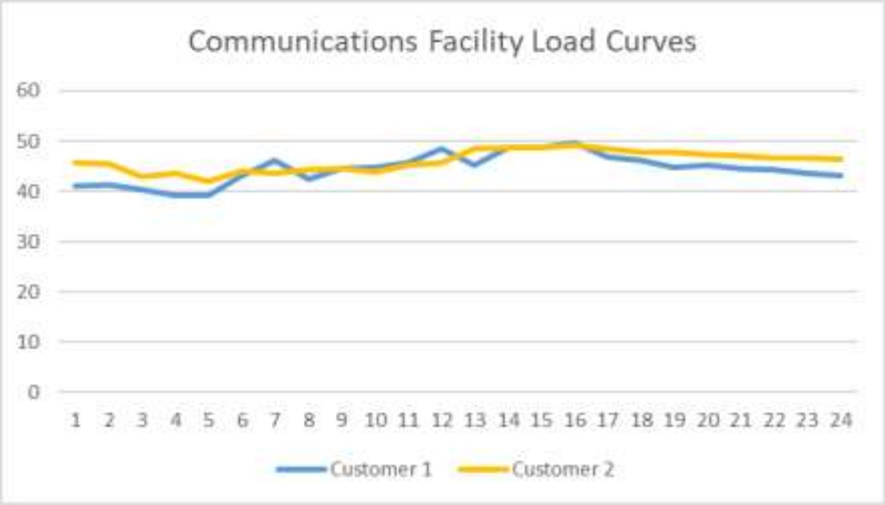
Derecho damage Aug 8 2020
photo by Kayley Lain, City of Ames

Use cases: Summer peak day demand profiles for critical customer loads

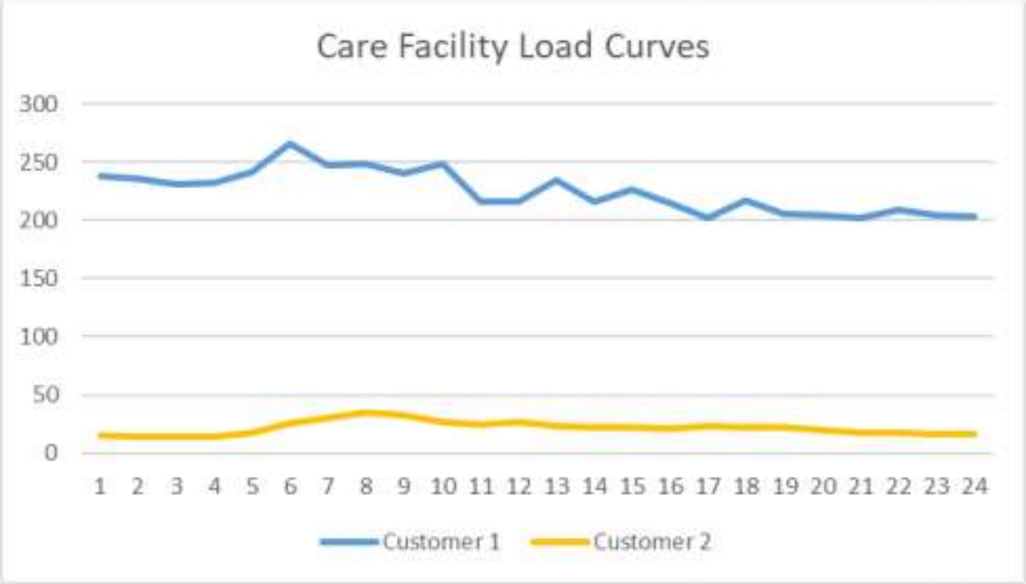


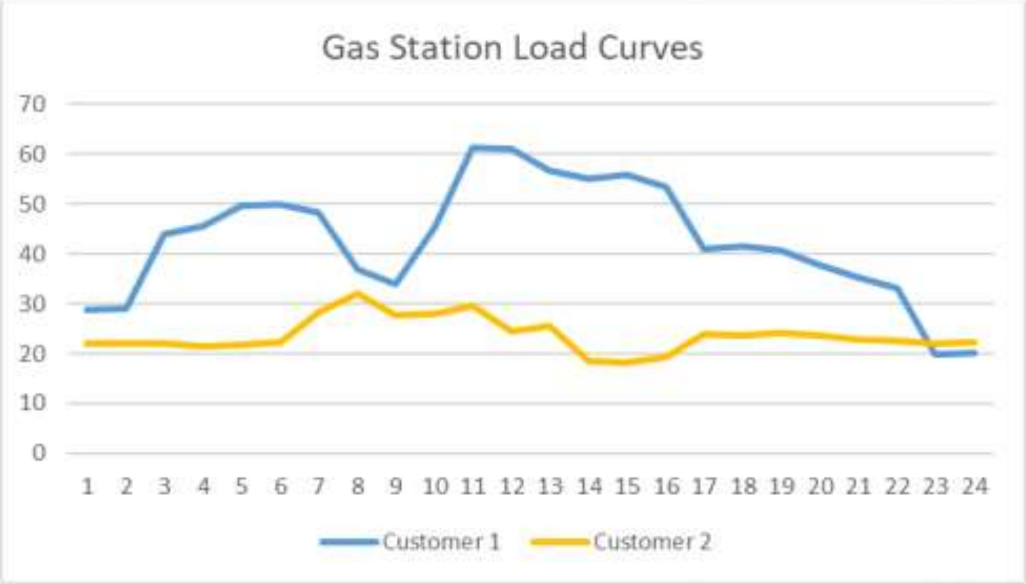


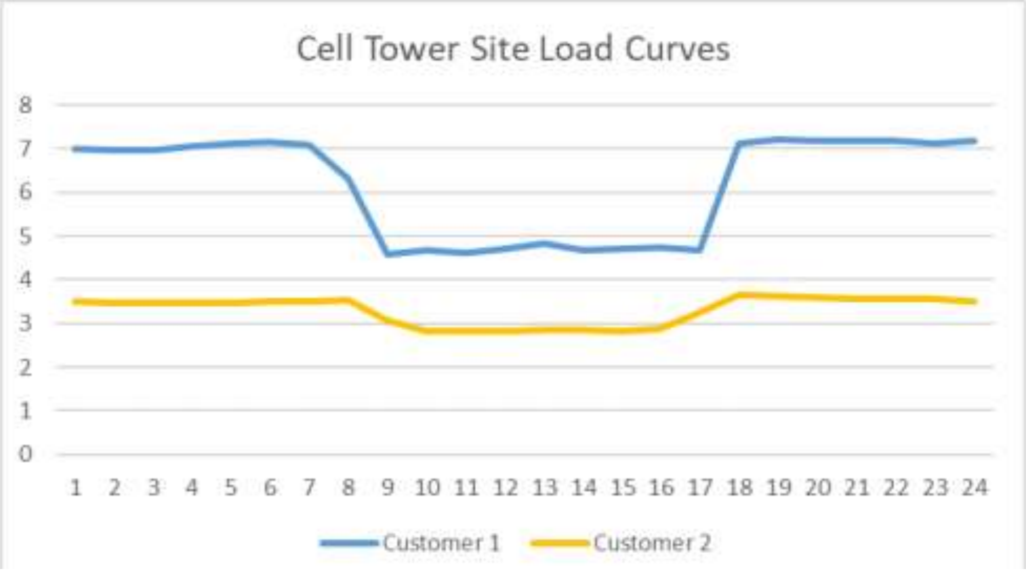


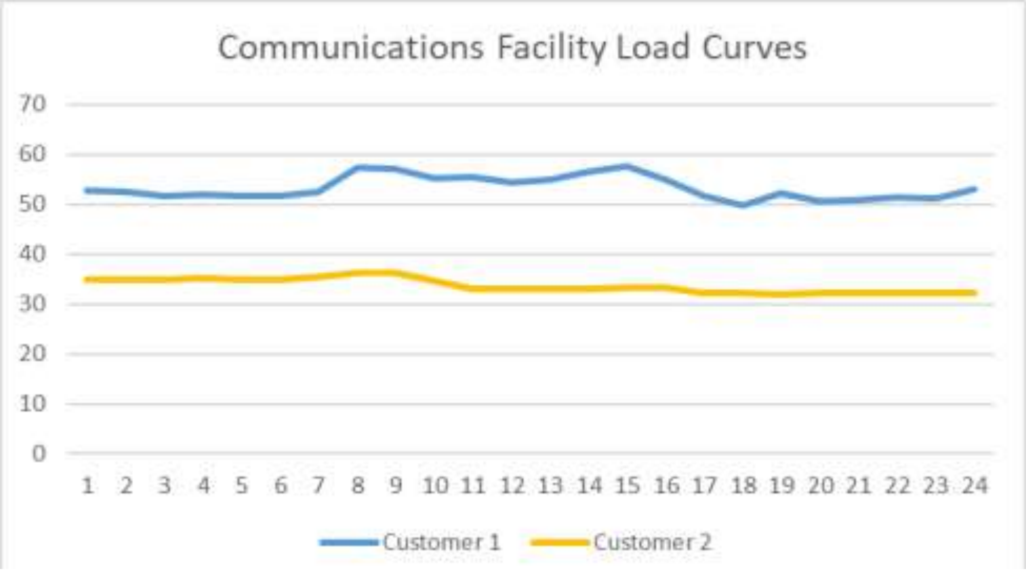


Winter peak day demand profiles for critical customer loads







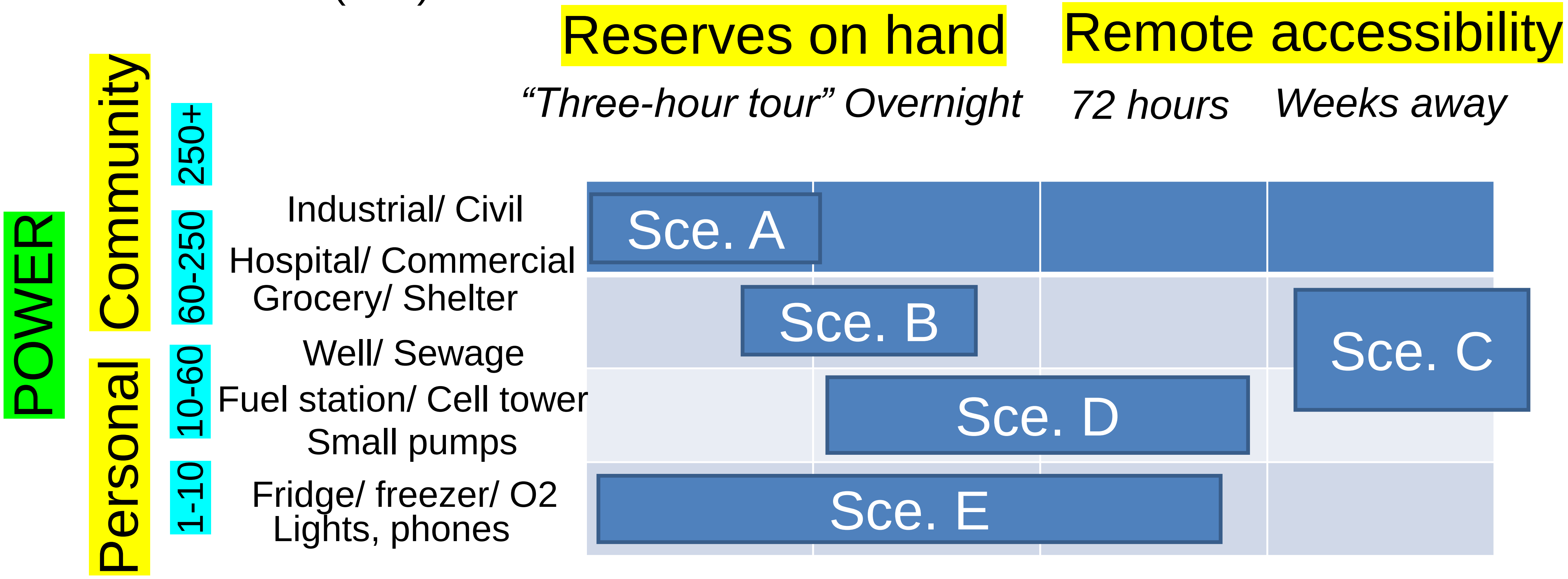


Recommendation

- Design for a “Class of applications”
  - Application-specific is too precise and tedious
  - Modular market-ready products
  - Plan for a scenario (Sce)

- Application (power) with Risks (duration)

DURATION



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