U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

Emerging Demand Flexibility Options for Reducing Energy Costs and Increasing Resilience

T04-S01, August 5th, 2025

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

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Agenda

- Session Learning Objectives
- Demand Response Overview
- Unlocking Grid Support and Sustainability
- Demand Flex Examples from Connected Communities
- Conclusion and Q&A

Session Learning Outcomes

1. Identify key technologies and strategies for load flexibility, including for HVAC and lighting controls, battery storage, and smart electric vehicle charging
2. Recognize the benefits of demand flexibility in reducing energy costs and enhancing grid resilience
3. Compare emerging technologies and determine their potential applicability to specific building scenarios
4. Select appropriate load management solutions based on building type, operational needs, and utility rate structures

Demand Flexibility Elements

Demand Response

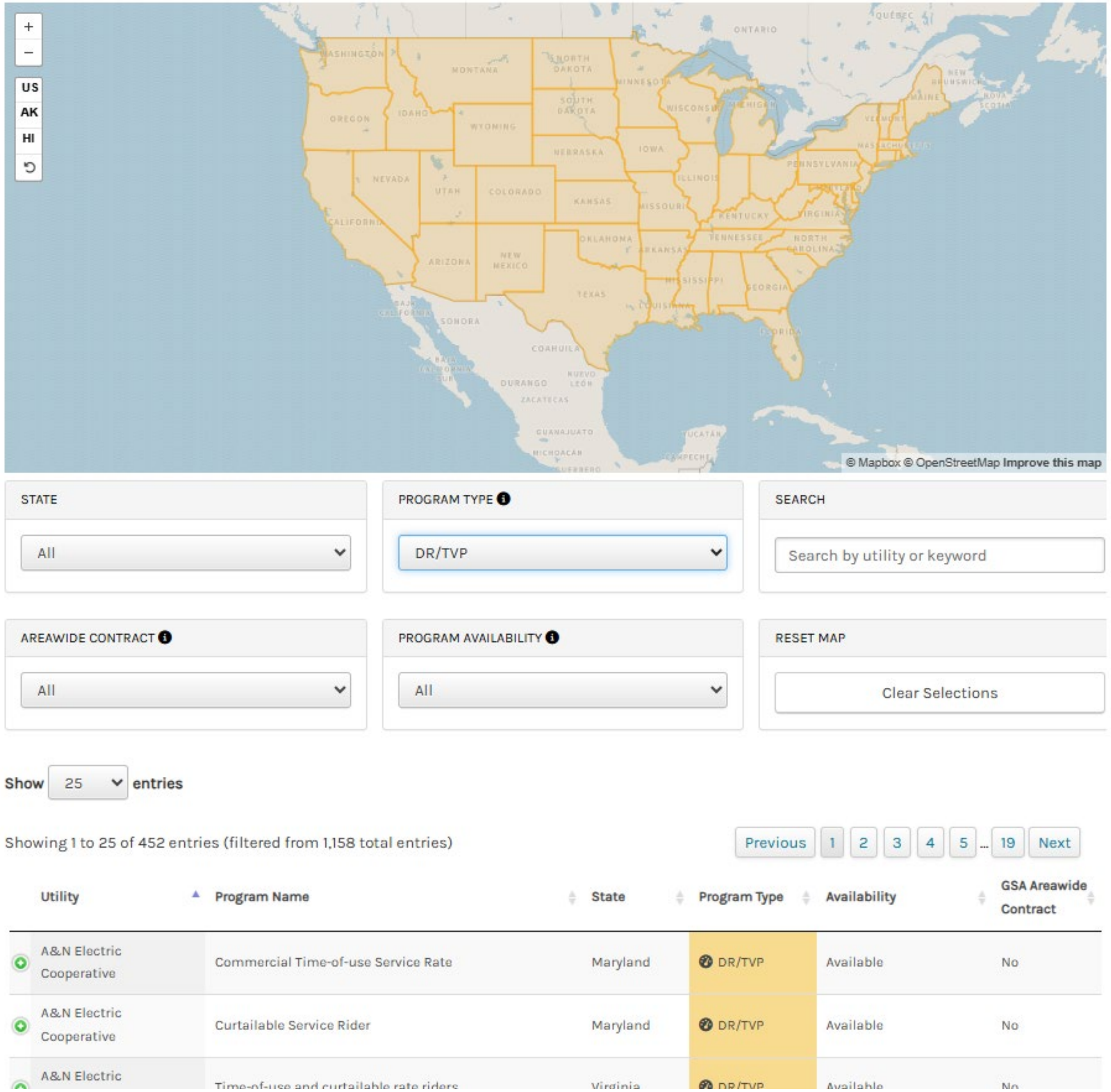
- Shifting or reducing demand for short time period
- Infrequent
- Time period varies based on region (e.g., summer afternoon/evening, or winter morning)
- Potential incentives for enrollment, <u>and</u> for events

Utility Bill Reduction Through Load Shift / Load Reduction

- Utility ‘time-of-use’ tariffs allow for bill savings if consumption is shifted
- Daily shifting of load (can vary by season depending on tariff)

FEMP Utility Program Navigator

Check out the Navigator for more information on time-of-use tariffs and DR programs!



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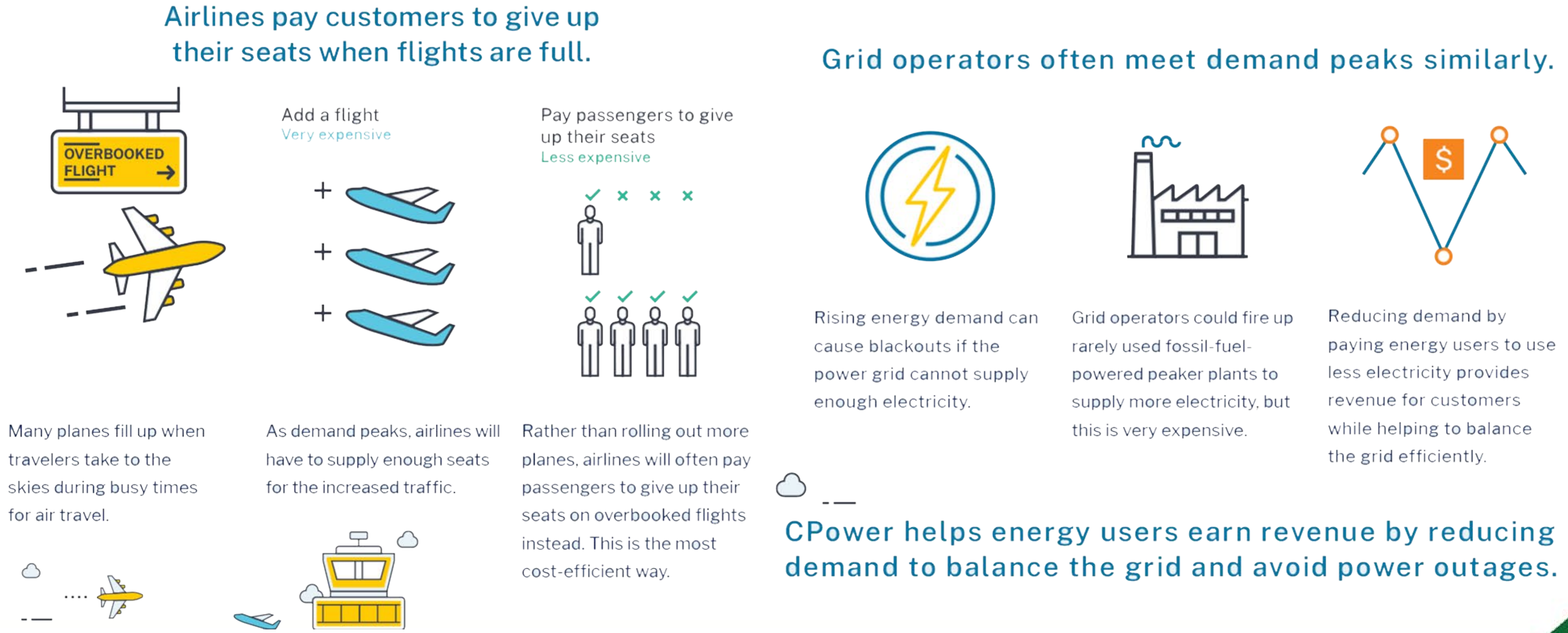
What Is Demand Response?

- Umbrella term for strategies to balance electric supply and demand
- Short-term adjustment in electricity use where customers voluntarily reduce or shift consumption or switch to behind-the-meter generation to support grid stability
- “Grid events” can be triggered by:
    - Compromised grid reliability
    - High wholesale market prices
    - Supply and demand imbalances

Air Travel and Virtual Power Plants: An Analogy

Decreasing demand can be more efficient than increasing supply during peak periods in the air or on the power grid



Demand Response Benefits

Dollar Revenues for Government Facilities

More Reliable and Resilient Grid

Strong Relationship with Local Community

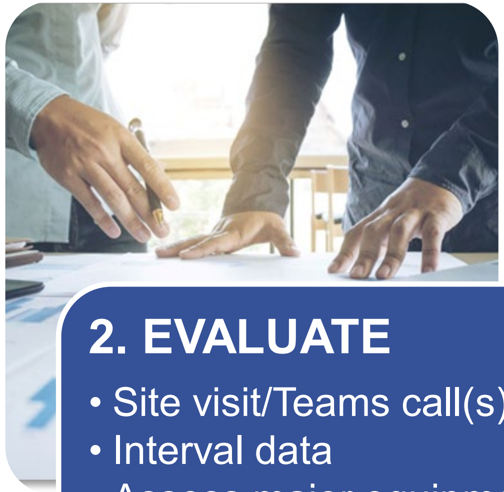
Stakeholder Overview

PARTICIPANT ROLES				
1	2	3	4	5
Power Generators	**Utility Grid**	**Independent System Operator**	**Curtailment Service Provider (CSP)**	**Federal Facility: Electric Customer**
Supply grid with electricity and meet demand for power most of the time.	Transmits electricity from generators to customers, can be stressed by severe weather and other events.	Ensures electric grid supply / demand always balanced, pays revenues to customers for enrolling and shedding load if and when needed.	Facilitates and makes demand response easy for electric customers by providing turnkey and programmatic solutions for customers.	Military facility receives revenues for participating in demand response and thereby supporting a reliable and resilient grid.
		$	$	$ $ $
		Supply Demand		

How CSP Supports the Demand Response Needs of Federal Agencies

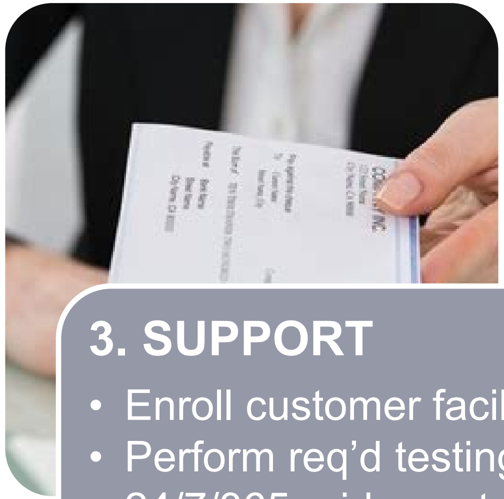
1. ENGAGE

- Educate and consult through meetings with customer
- Explain programs and opportunities
- Match ISO program(s) to customer needs
- Answer all stakeholder questions



2. EVALUATE

- Site visit/Teams call(s)
- Interval data
- Assess major equipment
- Engineer-to-Engineer consultation
- Customized Demand Response Plan
- Complete all ISO documentation



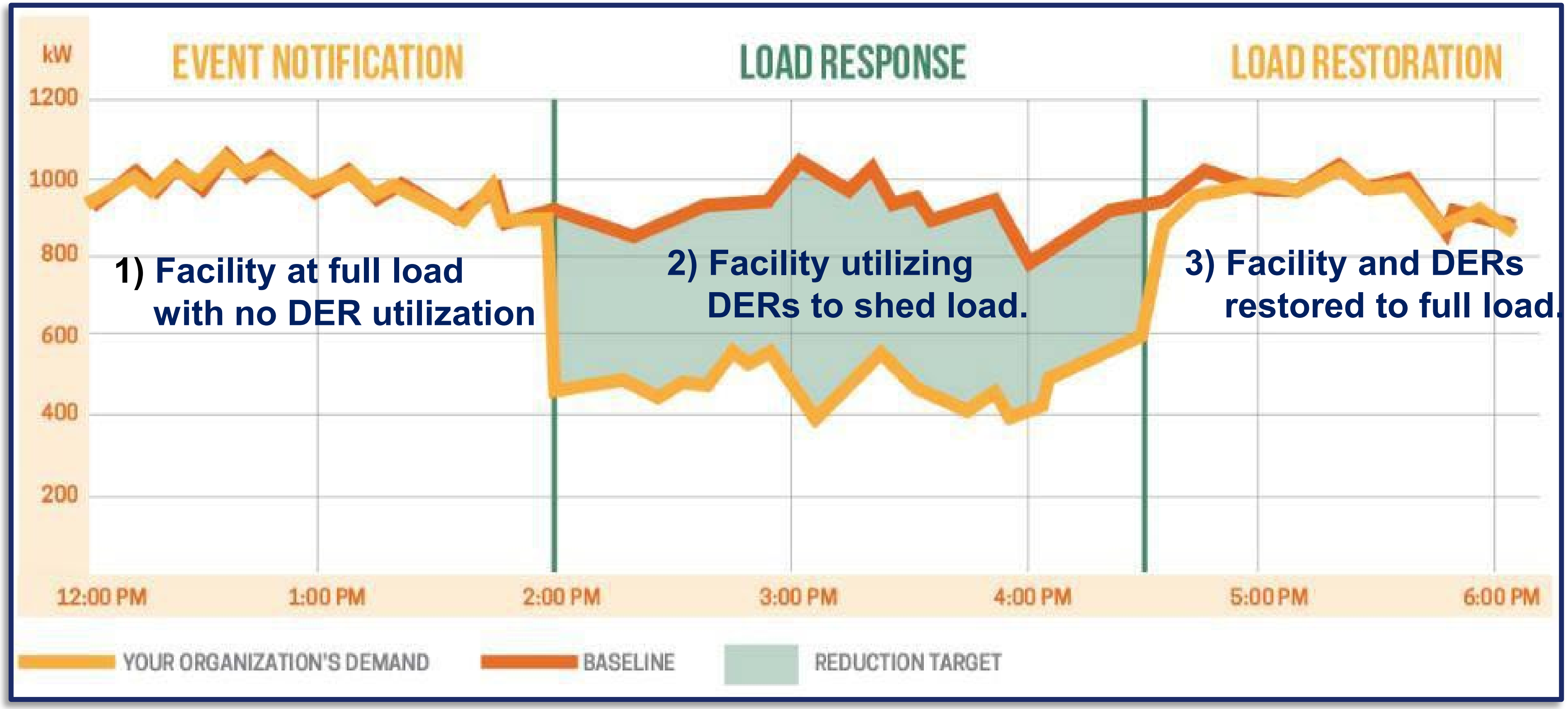
3. SUPPORT

- Enroll customer facility
- Perform req'd testing
- 24/7/365 grid event dispatch
- Ensure ISO compliance
- Continuous customer contact
- Pay quarterly revenues

Factors for Evaluating CSPs

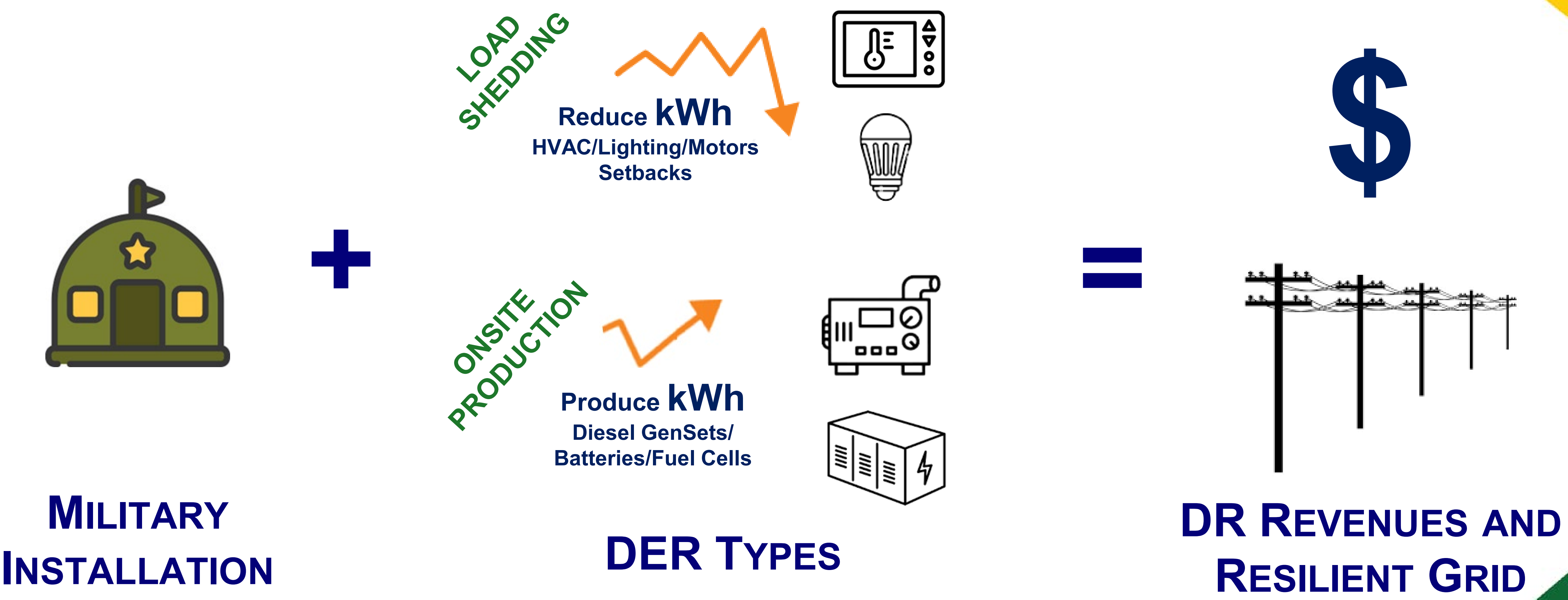
	FACTOR	WHY IT MATTERS
1.	**Revenue Split**	A CSP does not charge for its service. CSP receives revenues from ISO, keeps a small percentage for its work, and send your facility the bulk of the payment. A “higher split” can (but does not always) provide more revenue for a facility.
2.	**Customer Service**	Demand response participation is easy when a CSP provides turnkey service allowing your agency to benefit from demand response revenues while focusing on its mission.
3.	**Adequate Capacity**	A CSP must obtain capacity (MWs) in advance of providing capacity to your facility. If the CSP has inadequate capacity, your facility may be excluded from demand response participation
4.	**Technical Expertise**	A CSP’s in-house engineering capabilities allow a facility to enroll more load/assets (e.g., air permitting and interconnection for diesel gens) to obtain greater demand response revenues.
5.	**Program Breadth**	A CSP offering the fullest range of ISO programs possible (not all do) enables your facility to “stack” and further maximize revenues.

Grid Event Example



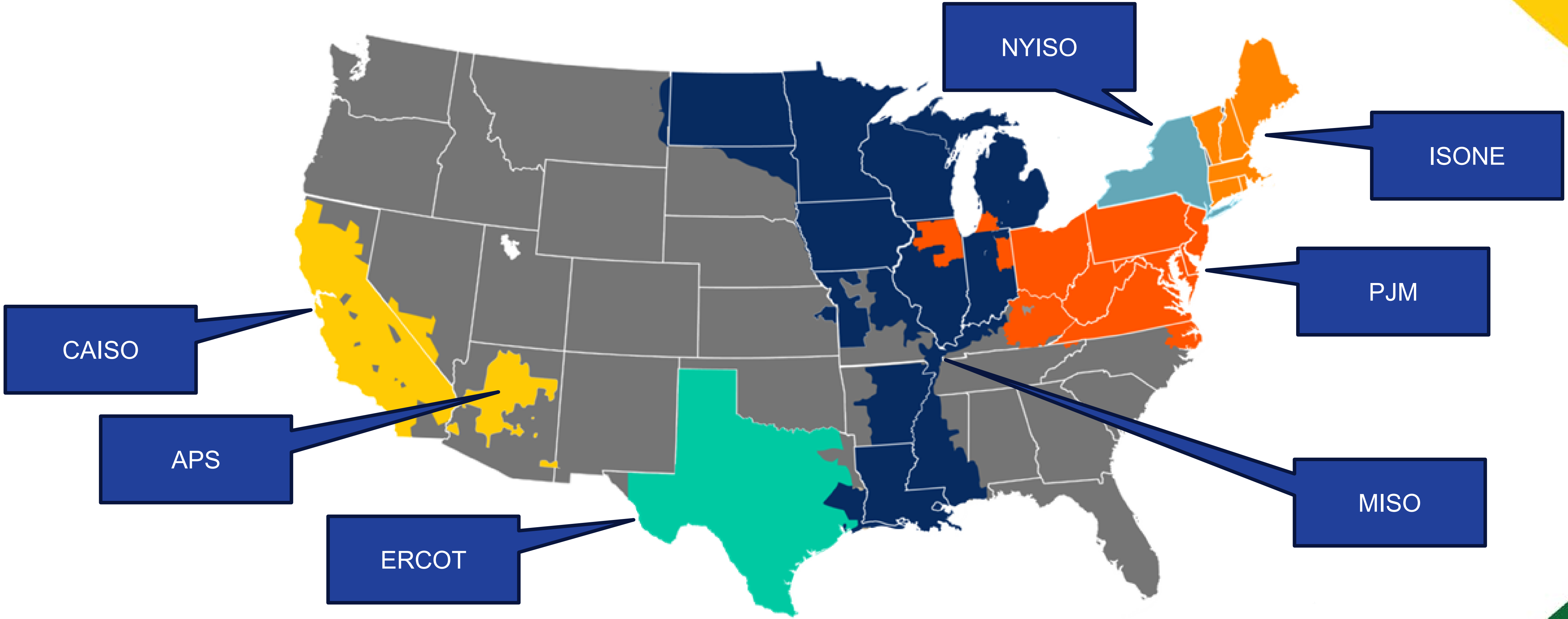
- Facility commits to participating in demand response program during enrollment period
- A “grid event” is time limited and often due to extreme weather
- ISO pays incentives to customer whether or not there is an event

Distributed Energy Resources*



* Load Shedding or Onsite Production covering facility load has the same beneficial effect for the grid.

Independent System Operator (ISO) Regions

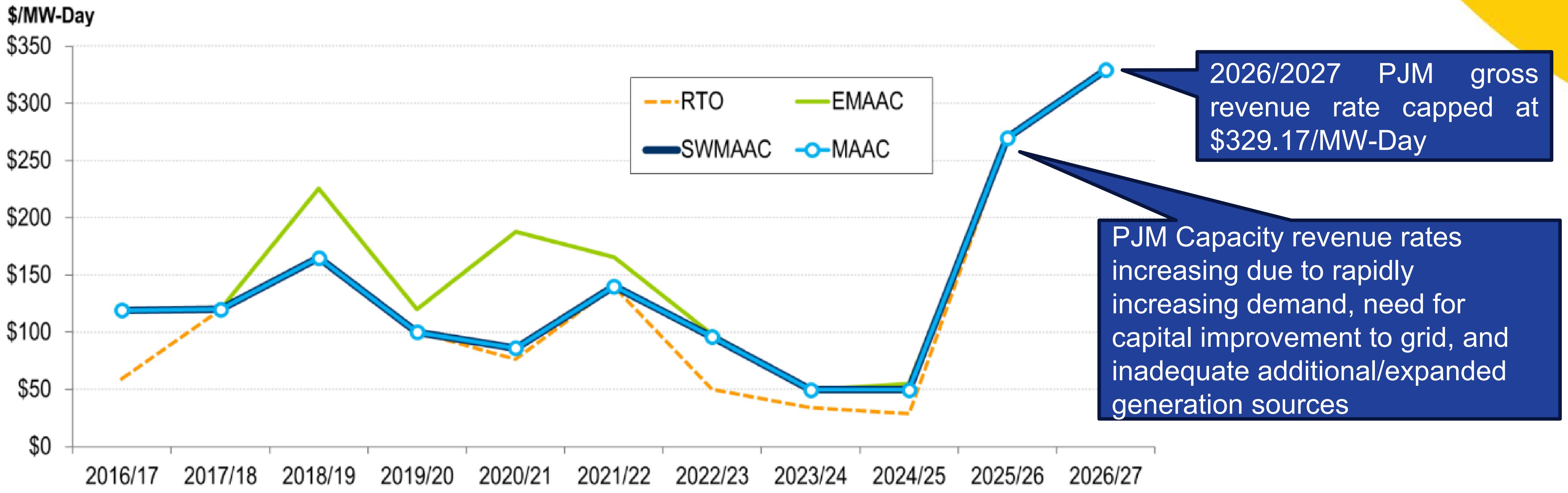


Note: Demand response available from ISOs in colored regions – other areas may have demand response programs facilitated by the serving electric utility.

Overview PJM ISO DR Programs

Emergency Capacity	Synchronized Reserves	Economic	Frequency
Simplest and most widely used demand response program assures systemwide grid reliability.	*Short duration and high revenue demand response program addresses local power imbalances. Typically only 3-hrs dispatch per year lasting no longer than 30-min each*	*Hourly arbitrage program that pays revenues, offsets high power prices, and keeps electricity affordable. Choose hours and participate only when compensation outweighs cost.*	*Pays highest levels of revenues to maintain all-important 60 Hz AC frequency in the grid. A "must" for facilities with batteries. Opt out when batteries needed for another purpose.*

PJM Capacity Program: Clearing Price Trends



- These are “gross” revenue rates – for 2026/2027 program year, a “cap” of $329.17/MW-Day is in place.
- This daily rate translates into gross of $120,147/year for each MW enrolled.
- The $120,147 annual incentive is lowered by a .69 ELCC rate and a designated “split” (e.g., 70% participant/30% CSP) for ***(approximately) $58,031/MW-year paid to participant.***

Source for chart: *PJM 2026/2027 Base Residual Auction Report (July 22, 2025)*

Federal Procurement and Contracting for Demand Response

- Certain CSPs have Master Service Agreement (MSA) with U.S. Defense Logistics Agency (DLA) to provide demand response to military and civilian agencies and their facilities

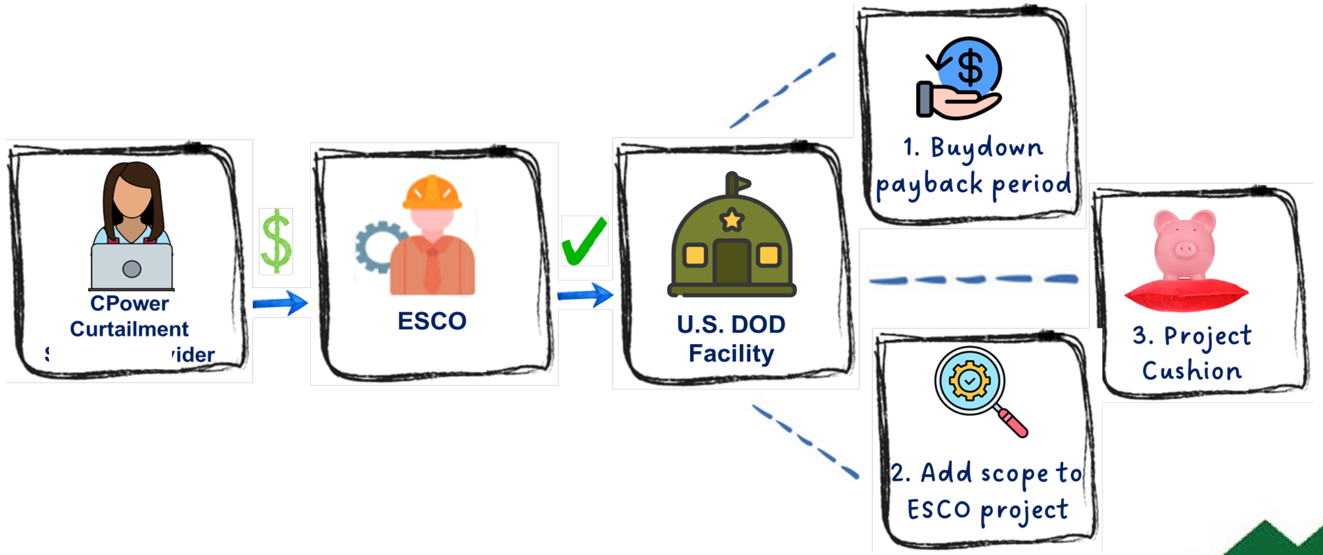
- Proven and easy means for feds to procure demand response

- An excellent resource for fed agencies is Mr. Jacob Sigler, Contract Specialist, DLA, (571) 359-8421, **Jacob.Sigler@dla.mil**

Demand Response Revenue Restrictions - 10 USC 2919 Cannot Directly Pay Agency/Facility

Option #1: Offset electric bills by sending directly to utility company

Option #2: Utilize in connection with an ESCO performance contracting project at the site



Case Study: U.S. DOD Installation

Facility Description:	**Historic Installation. Joint Army/Navy Base on Atlantic Seaboard.**
Demand Response Program Type(s):	PJM Emergency Capacity, Synchronous Reserves, and (recently) Economic programs. Seven (7) diesel generators involved that produce “stacked” and multiple demand response revenues.
Participation Record:	Consistent participation, excellent performance during annual PJM demand response testing and (infrequent) local grid events.
Maximum Curtailment To-Date:	6 MW
Participation Length with CSP To-Date:	> 8 years
Notes:	Demand response revenues provided through site’s awarded ESCO “Option 2”). More than sixty (60) diesel generators onsite, many with potential to be included in demand response activity.

Foroud Arsanjani

President
NEWR Energy

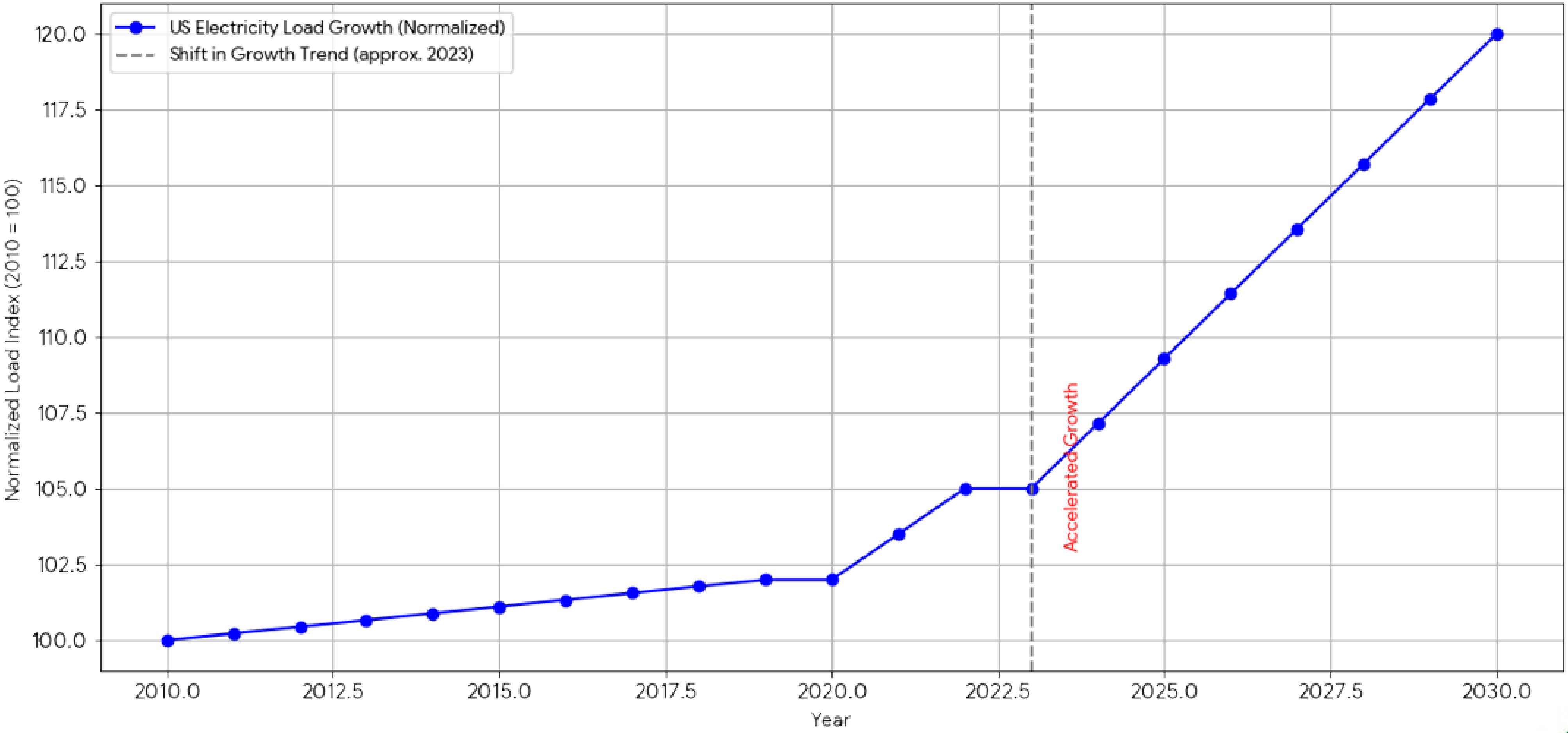
Agenda

- The Evolving Energy Landscape
- Decentralized Energy Resources & the Rise of Virtual Power Plants (VPPs)
- Why Buildings Matter in the Energy Transition
- BVPP: Concepts and Key Benefits
- From Passive Consumers to Active Prosumers and Grid Participants

The Evolving U.S. Energy Landscape

1. **Accelerated Electricity Load Growth:** Demand is surging due to data centers, electrification, and industrial expansion, marking a shift from decades of flat growth
2. **Evolving Electricity Supply Mix:** Coal is declining as renewables, natural gas, and emerging technologies reshape electricity generation
3. **Why Buildings Matter:** Buildings are major power users and offer key opportunities for efficiency and flexible demand
4. **Grid Preparedness & Market Pressure:** Technology shifts and market demands are pushing the grid toward faster modernization
5. **Electricity as a National Priority:** Powering AI, data, and clean industry, electricity is central to U.S. strategic goals
6. **The Changing Customer Role:** Consumers are becoming active players, generating, managing, and optimizing their own energy use

Conceptual US Electricity Load Growth (2010-2030)



Electricity: A National Strategic Imperative

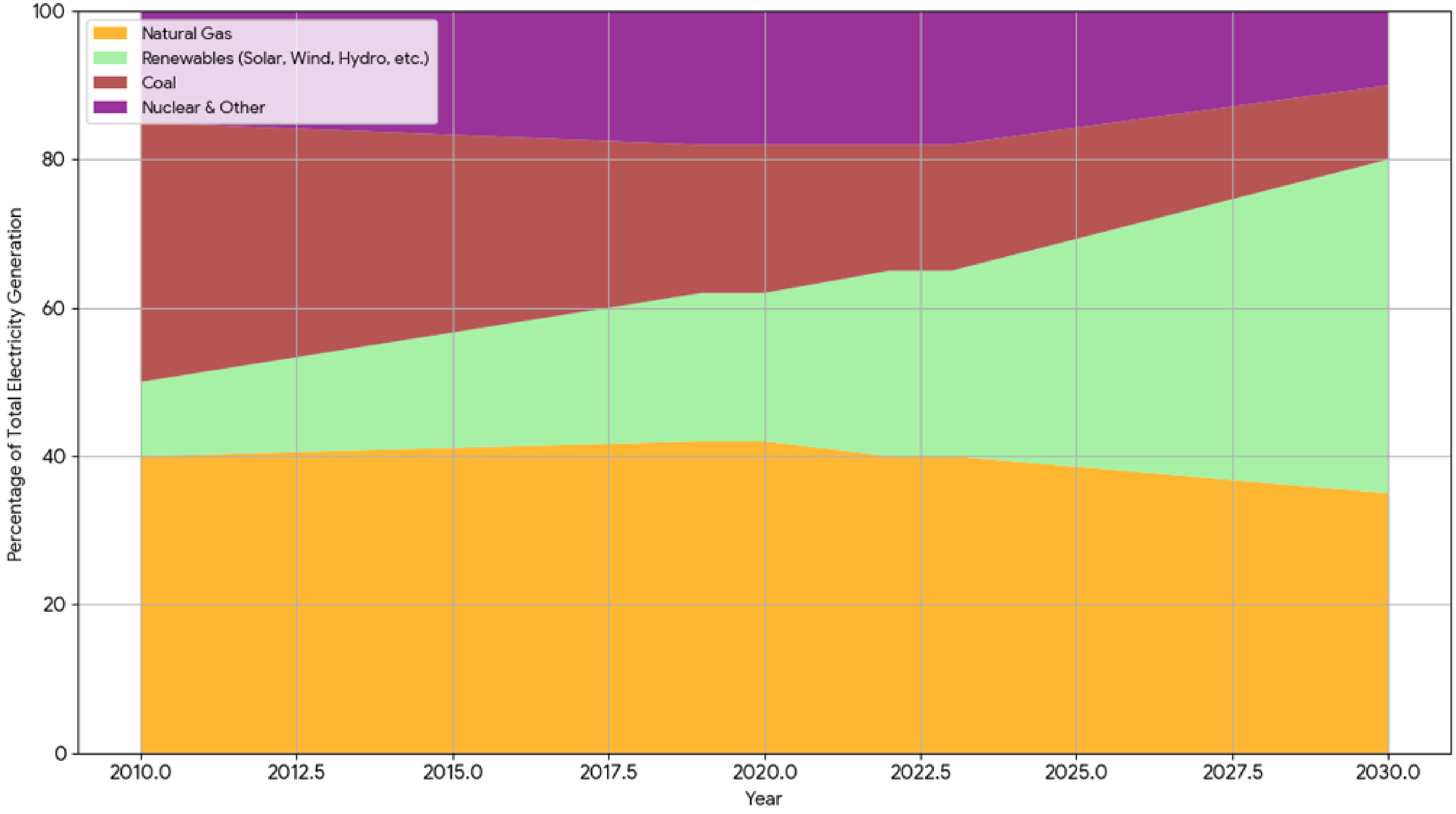
China: Strong and Consistent Growth

- Electricity Demand Growth: 6% annually
- Key Drivers:
  - Broad-based electrification across industry, buildings, and transport
  - Rapid industrial expansion, especially in:
    - **New energy manufacturing** (e.g., solar PV modules, EVs, batteries)

US: From Stagnation to Acceleration

- Electricity Demand Growth: 2% annually
- Key Drivers:
  - Surge in **AI-driven data centers**
  - Reshoring and expansion of **domestic manufacturing**
  - Growing **electrification** of transport and heating systems

Conceptual US Electricity Supply Composition (2010-2030)



Why Buildings?

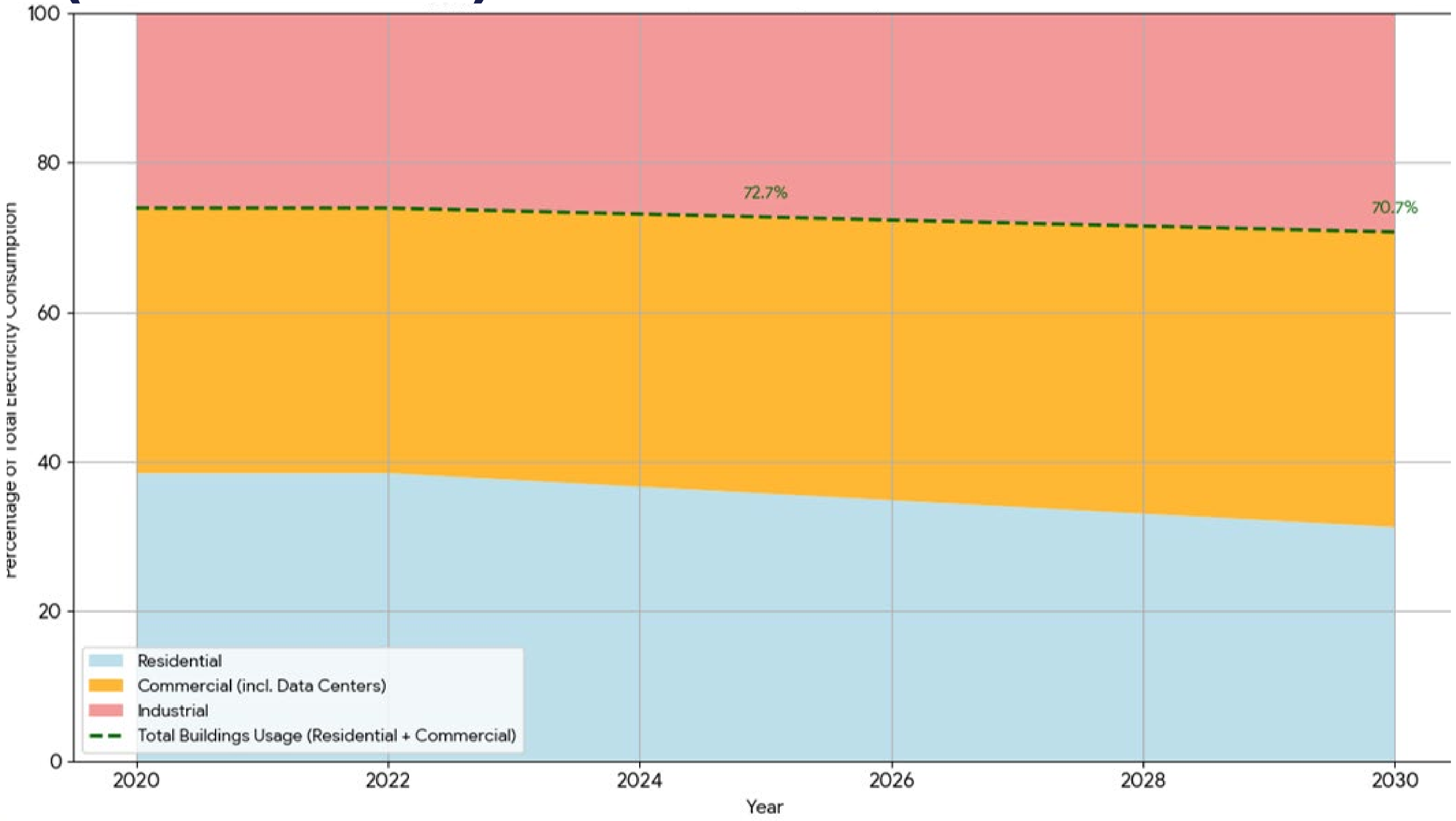
- Massive energy consumption and emissions footprint
- Untapped potential for energy efficiency (demand reduction)
- Emergence of buildings as Distributed Energy Resources (DERs)
- Source of demand flexibility and grid services
- Enhanced grid resilience and reliability
- Enabling electrification and decarbonization goal

U.S. Electricity Consumption: Buildings Sector Overview

Based on EIA's Short-Term Energy Outlook (May 2025) and other sources

- The **Residential and Commercial sectors combined,** often referred to as "buildings usage", typically account for **approximately two-thirds to three-quarters** of total U.S. electricity consumption
- In **2022**, the breakdown was:
  - **Residential:** 38.4%
  - **Commercial:** 35.4%
  - **Total Buildings Usage: 73.8%**
- This combined share is expected to **remain substantial**, generally in the **65–75% range** of total U.S. electricity consumption
- A **gradual shift toward commercial consumption** is anticipated, driven primarily by **data center expansion**
- Year-to-year fluctuations may occur due to **weather patterns and economic conditions**

Conceptual US Electricity Consumption by Sector (2020-2030)



Buildings as Virtual Power Plants (VPPs)

Definition

A **Building Virtual Power Plant (BVPP)** aggregates and centrally manages **distributed energy resources (DERs)** and **flexible loads** within residential, commercial, and industrial buildings using advanced software platforms.

Key Features:

- Operates as a **single, coordinated entity**
- Optimizes energy consumption and production
- Participates in **energy markets** and provides **grid services**
- Part of the broader **Virtual Power Plant (VPP)** shift from centralized to **decentralized** energy systems

Benefits of BVPPs

For Buildings and Owners:

- New **revenue streams** through energy market participation
- **Economic savings** via optimized energy use
- Lower **infrastructure costs** by reducing peak demand

For the Grid and Environment:

- Enhanced **grid reliability and resilience**
- Supports **distributed resilience** (localized backup power)
- Reduces **carbon footprint** by integrating clean DERs
- Contributes to a **more sustainable energy future**

Technologies Enabling Next-Gen Performance

The latest enabling technologies for smart operations and energy efficiency in buildings are centered around enhanced data collection, advanced analytics, automation, and seamless integration.

Key Enabling Technologies:

1. Advanced IoT Integration
2. Artificial Intelligence (AI) & Machine Learning (ML)
3. Advanced Building Automation Systems (BAS) / Building Management Systems (BMS)
4. Digital Twins
5. Occupant-Centric Technologies
6. Grid Integration / Virtual Power Plants (VPPs)

NEW Technologies – Implementation

Implementation Focus Areas:

- Proven and simulated operational models
- Use of market-proven smart technologies
- Integrated and seamless installation
- Testing, training, and maintenance design
- Introducing AI – carefully
- Cybersecurity challenges – IT vs OT objectives and domains
- Regulatory and data privacy concerns – occupant and building owner concerns
- Business models / revenues designed for each project to address all stakeholder needs, including:
  - Regulated incentive models – DR, load management programs
  - Structured agreements within the regulatory framework – BVPPs, utility interchange

Smart Building Maturity Model

TIER	TECHNOLOGY	OPERATIONAL DISCIPLINE	KEY CHARACTERISTICS
TIER 1: **Basic Foundational Disconnected**	Legacy systems, minimal sensors, manual controls, siloed data	Reactive or scheduled maintenance, minimal data use	Focus on basic functionality, limited visibility
TIER 2: **Connected Automated**	Basic BMS, some networked sensors, automated HVAC/lighting	Proactive maintenance, basic analytics, rule-based control	Efficiency gains, partial integration, basic insights
TIER 3: **Integrated Optimized Intelligent**	Integrated BAS/BMS, extensive sensors, analytics, AI/ML, early DERs	Predictive maintenance, data-driven optimization, cross-system coordination	Strong efficiency, occupant comfort, grid interaction starts
TIER 4: **Cognitive Adaptive Prosumer**	Advanced AI/ML, IoT platform, full DERs, EV charging, VPPs, digital twins	Self-learning, automated optimization, energy market participation	Maximum performance, resilience, revenue generation, deep decarbonization

Challenges and Future Outlook

- Regulatory Concerns
- Operational Complexity
- Consent, Transparency & Data Management
- Training and Education for DER Operators
- Growth and Maturity of Energy Markets & DERs
- Prosumer Evolution

Looking Ahead

The national imperative for the efficient use of electricity will drive new incentives to transform our homes and buildings into smart-enabled facilities. This shift will help alleviate congestion in distribution and sub-transmission grids, supporting a more resilient and sustainable energy future.

Call to Action: What Are the Key Next Steps?

360° Review

Align owner/building management goals and resources

→

Audit & Planning

Perform energy/ops audit

Update technology transformation plan

→

Data & Digitization

Digitize systems

Collect & analyze building data

↓

Systems & Maintenance

Test & commission systems

Define maintenance strategy

→

Training & Emergency Prep

Train staff & management

Plan for grid & utility readiness

→

VPP Enablement

Integrate with grid

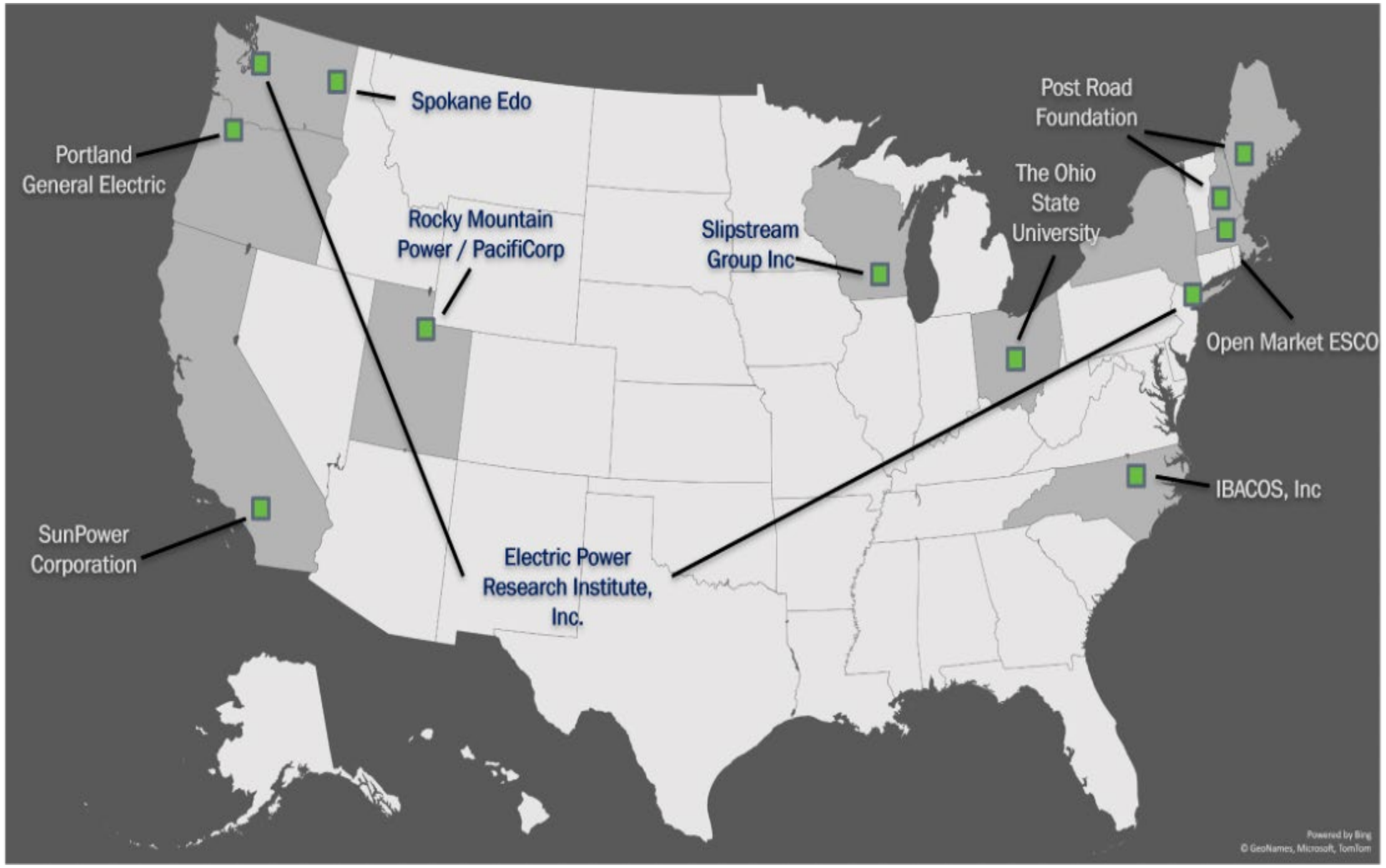
Explore revenue opportunities

Cindy Zhu

Technology Researcher
Lawrence Berkeley National Laboratory

Ten Connected Communities Pilots

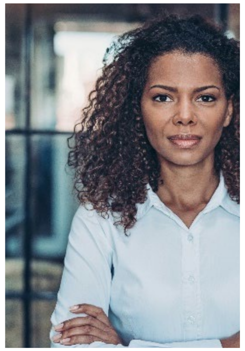
- $61M grid-interactive buildings and DER community demonstrations
- Demonstrates how **coordinated demand flexibility and grid services** at scale **can support emerging grid issues,** and support variable renewable energy supply
- Residential, commercial, new construction and retrofits
- 10s to 1000s of buildings each



What Are the Results We’re After?

Documented Performance

Collecting data on highest impact programs, technologies, and engagement strategies. What worked in different contexts?



Value Propositions

Better understanding of motivations by stakeholder, from grid to end user; what incentives and messaging resonates?

Business Model Innovation

Learning how to scale. Who paid for upfront costs, how were costs recouped, how were benefits shared?

Technology Innovation

Understand research needs. What are technology performance and pricing needs across efficiency, flexibility and DER integration?

Coordination Across a Diverse Cohort of Pilots

National Coordinator (LBNL) will work with BTO/DOE to:

- Provide **technical assistance** to awardees, particularly around M&V
- Work with BTO to **facilitate shared learning** across both awardees and key stakeholders during project implementation stages and provide technical assistance to awardees with common challenges.
- **Synthesize** information across many projects to replicate and scale innovation.
- Cultivate a **broader community of learning and innovation** among non-awardees who could benefit from project insights.

Teams by Building Type

	Multifamily Residential	Single Family Residential	Commercial	Light Manufacturing	Campus
OME	✔				
EPRI	✔				
Pacificorp	✔		✔	✔	✔
Edo		✔	✔		✔
UC Irvine		✔			
IBACOS, Inc		✔			
Post Road		✔			
Slipstream			✔		
OSU			✔		✔
PGE	✔	✔	✔		

Utility-led or high Utility involvement

Affordable Housing

New Construction

Retrofit

Demo Teams & DER Packages

	Solar PV	Battery Energy Storage	EV Charging	Smart Electrical Panel	Weatherization Upgrades	Centralized HVAC controls	Smart Thermostats	Heat Pumps (HP)	HP Water Heaters
OME	✔	✔	✔			✔	✔		
EPRI	✔		✔		✔	✔		✔	✔
PacifiCorp	✔	✔	✔				✔	✔	✔
Edo	✔	✔	✔		✔	✔	✔		
UC Irvine	✔	✔	✔	✔			✔	✔	✔
IBACOS, Inc		✔	✔	✔	✔		✔	✔	✔
Post Road		✔	✔				✔	✔	
Slipstream	✔	✔	✔			✔			
OSU	✔		✔			✔			
PGE	✔	✔	✔		✔		✔	✔	✔

Most Common:

1. EV Charging
2. Batteries, Solar PV
3. Smart Thermostats
4. Heat Pumps
5. Centralized HVAC controls, HPWH

Multifamily

Single Family

Commercial

Mixed Portfolio

Key Takeaways - Packages & Building Type

1. **Residential** buildings are prioritizing **energy efficiency** and **cost-saving** technologies such as weatherization upgrades and smart thermostats
   a. **Multifamily** benefits from centralized HVAC upgrades and supervisory controls (Edo, EPRI), and solar PV and batteries to reduce common area usage (OME, EPRI)
   b. **Single-family** is well-suited for individualized technologies like solar, storage, and smart home energy monitors (UCI, IBACOS, Post Road) that can be enrolled in **VPP-style programs**
2. **Commercial** spaces emphasize **reliability** and **consistent operational schedules**
   a. Commercial and campus settings prioritize **EMIS integration** and **load optimization via centralized controls** (Slipstream, OSU)
3. **New construction** enables cost-effective integration of **DER-ready infrastructure** (UCI, IBACOS)
4. **Retrofits** require deployments aligned with **owner and tenant value streams** (OME, EPRI)

Grid Service Provisions

	Energy Markets				Transmission Services						Distribution Services			Customer Bill Management	
	Day Ahead Energy	Imbalance (Real TIme)	Capacity	Ancillary Services	Economic Energy Dispatch	Forward Capacity	Voltage Support	Frequency Regulation	Frequency Response	Contingency Reserves	Emergency Load Transfer	Voltage Mgmt	Capacity Relief	Peak Load Mgmt	Tariff Optimization (TOU Rates)
OME	✔				✔	✔							✔	✔	✔
EPRI		✔	✔		*exploring all bulk system services*							✔	✔	✔	✔
PacifiCorp									✔	✔			✔	✔	
Edo													✔		✔
UC Irvine	✔			✔			✔	✔			✔		✔	✔	✔
IBACOS, Inc				✔			✔		✔				✔	✔	✔
Post Road				✔		✔							✔	✔	✔
Slipstream					✔							✔	✔	✔	✔
OSU	✔			✔						✔			✔	✔	
PGE	✔	✔			*exploring all bulk system services*							✔	✔	✔	✔

Most Common:

Distribution Services

1. Capacity Relief

Customer Bill Management

1. Peak Load Management
2. Tariff Optimization

Energy Markets

1. Ancillary Services
2. Day Ahead Energy Markets

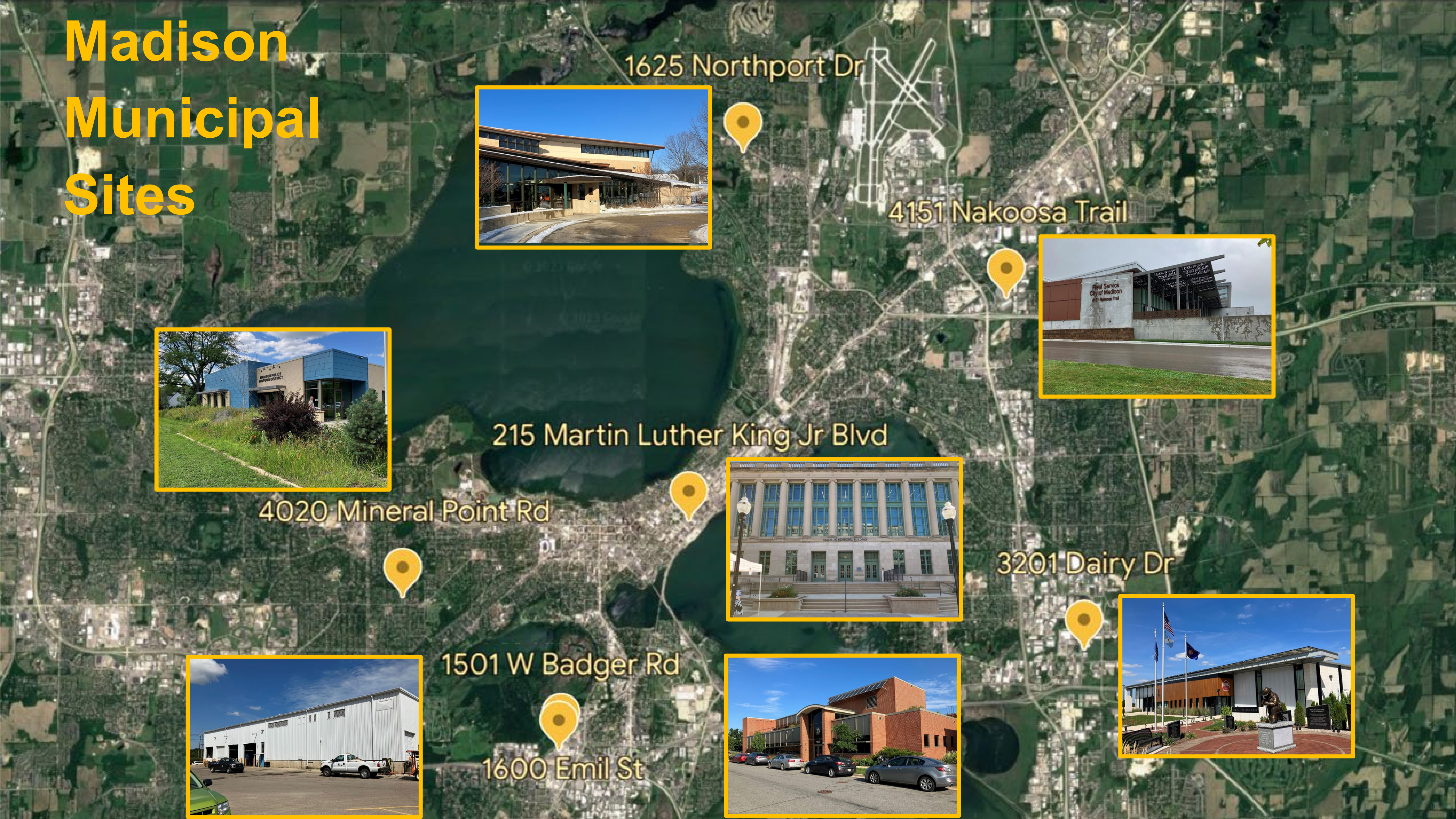
- Multifamily
- Single Family
- Commercial
- Mixed Portfolio

Key Takeaways - Grid Services

1. Grid service(s) are influenced by the technology packages being deployed
2. **BESS** projects are exploring bulk system services like f**requency regulation and response** (UCI, PacifiCorp), reflecting capabilities of batteries to respond in real time
3. **Smart electric panels** can enable **dynamic load adjustments**, providing customer bill management and TOU optimization (UCI, IBACOS)
4. **Centralized EMIS systems** with **HVAC controls** are providing **peak load management** (Slipstream, OSU)

Case Study: Slipstream, City of Madison, Madison Gas & Electric

Madison Municipal Sites

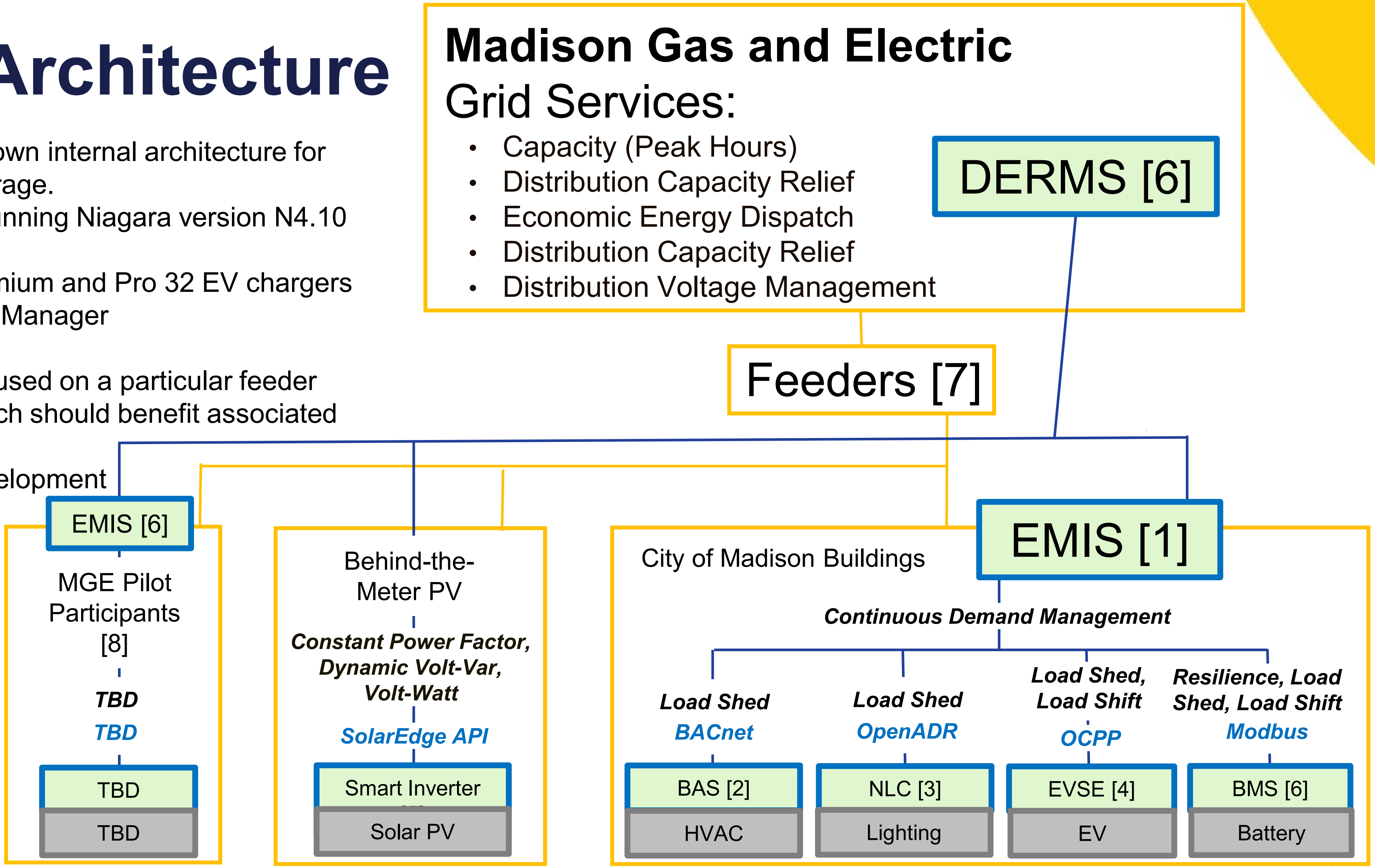


Distributed Energy Resources

Site	HVAC Controls	Networked Lighting Controls	EV Managed Charging	Battery	EMIS	Smart Inverter
Fleet Headquarters			●		●	●
Madison Municipal Building	●	●	●		●	●
Fire Station 14				●	●	●
Midtown Police District	●		●		●	●
Engineering Operations	●	●	●		●	●
Streets West			●	●	●	●
Warner Park Rec Center	●				●	●

System Architecture

[1] ACE IoT using their own internal architecture for control and data storage.
[2] Honeywell Tridium running Niagara version N4.10
[3] Lutron Vive
[4] EnelX JuiceBox Premium and Pro 32 EV chargers
[5] Solar Edge C&I One Manager
[6] TBD
[7] Buildings are not focused on a particular feeder though GEB approach should benefit associated feeders
[8] MGE pilot under development



Questions?

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How to obtain your CEUs:

1. Log in to https://edu.wbdg.org/ using your WBDG credentials
   - The assessment and evaluation will be made available to attendees at 8:00am ET on Monday, August 11th
   - The assessment and evaluation will close on September 22nd
2. In the list of trainings you attended, click on the Visit link by the course you wish to complete
   - If the course you're looking for is not listed, click on My Account in the top right menu
   - If you still can't find your course, contact the WBDG support team to check your eligibility
3. Complete the assessment with a score of 80% or above
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5. Complete and submit the evaluation
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