U.S. DEPARTMENT OF
ENERGY

Federal Environmental Symposium
Flexibility is the Future: GSA's Roadmap to Grid Interactive Efficient Buildings (GEBs)

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March 12, 2024

FEMP
Federal Energy Management Program

What are GEBs?

GEBs incorporate energy efficiency, renewables, energy storage, and load flexibility

GEBs employ these capabilities to flexibly **reduce, shed, shift, modulate, or generate** electric load as needed

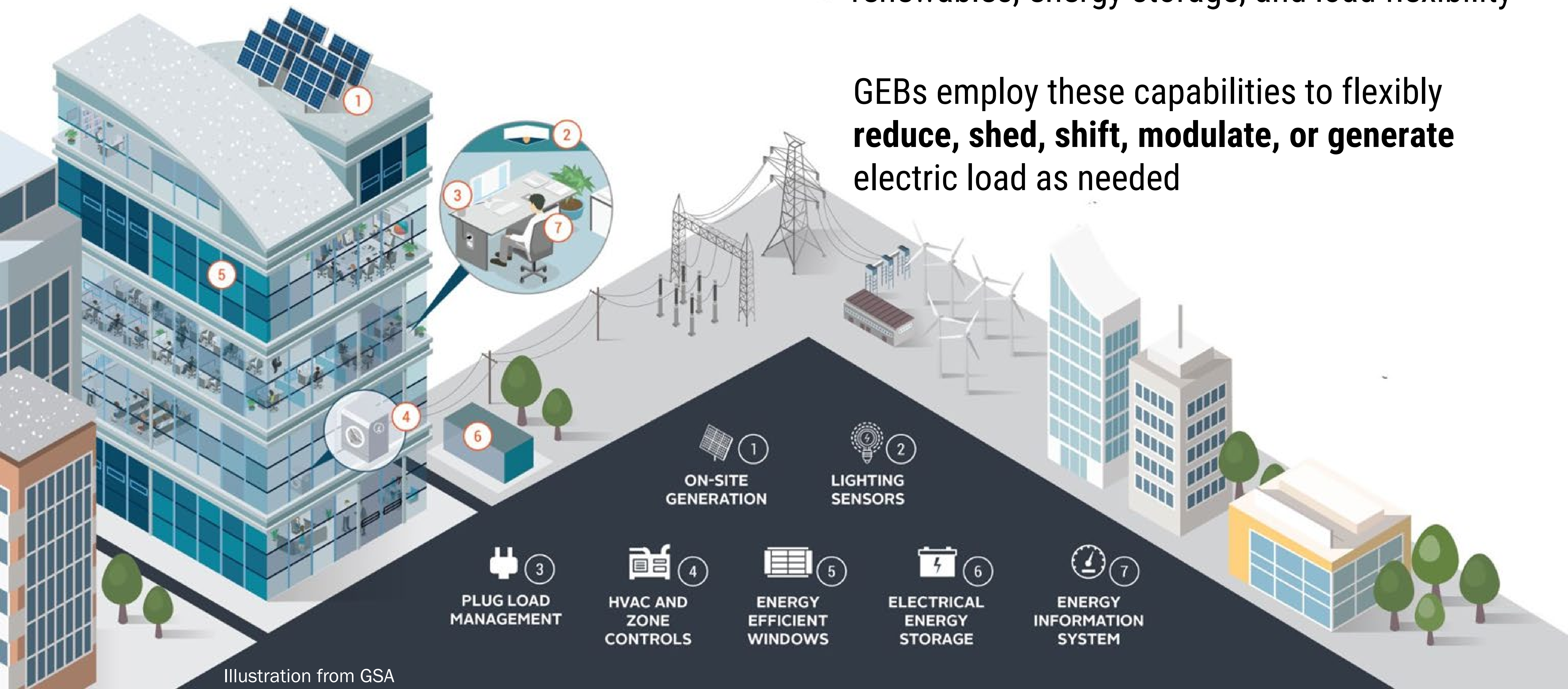


Illustration from GSA

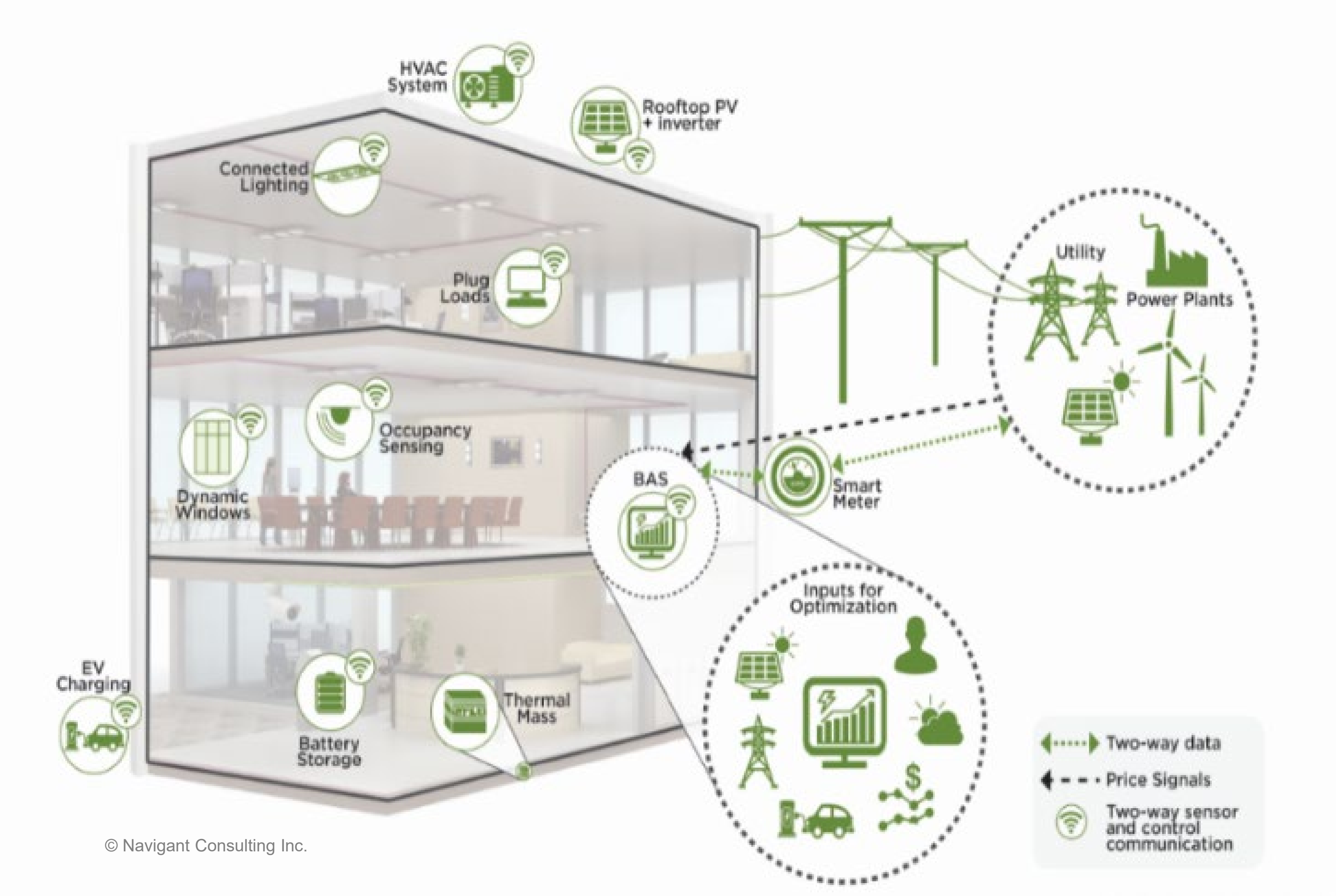
Key Characteristics of GEBs

A GEB is an energy-efficient building that uses smart technologies and on-site DERs to provide demand flexibility while co-optimizing for energy cost, grid services, and occupant needs and preferences, in a continuous and integrated way.

EFFICIENT	CONNECTED	SMART	FLEXIBLE
Persistent low energy use minimizes demand on grid resources and infrastructure	Two-way communication with flexible technologies, the grid, and occupants	Analytics supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences	Flexible loads and distributed generation/storage can be used to reduce, shift, or modulate energy use

https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/bto-geb-factsheet-41119.pdf

How Can Buildings Provide Flexibility?

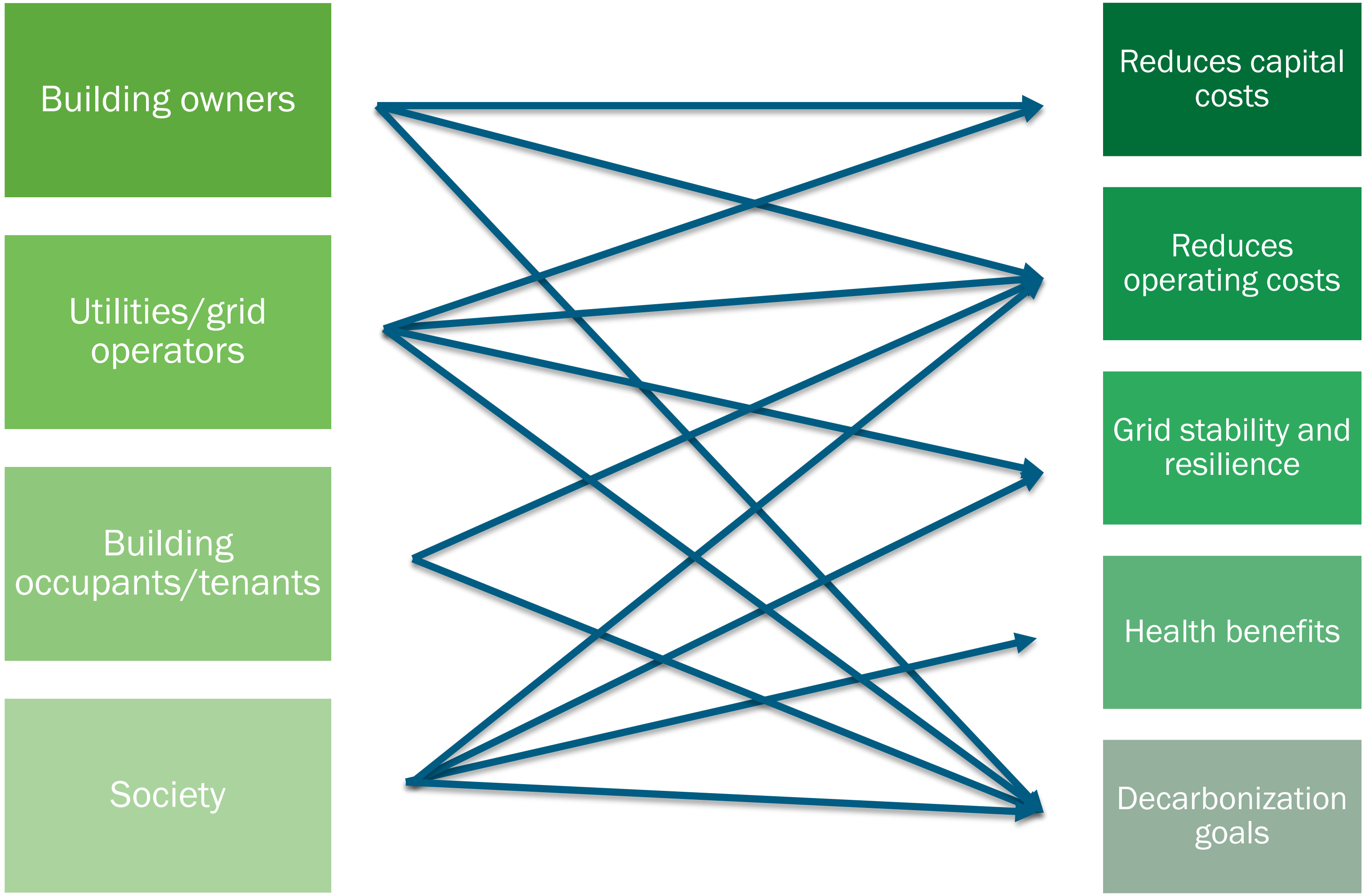


https://connectedcommunities.lbl.gov/sites/default/files/2021-08/GEB%20Technical%20Report%20Series%20-%20An%20Overview%20of%20Research%20Challenges%20and%20Gaps%2075470_2.pdf

Why are GEBs important?

- Buildings can provide flexibility by reducing wasted energy, helping balance energy use during times of peak demand and/or plentiful renewable generation, and reducing the risk of frequency deviations.
- As the grid becomes increasingly complex, demand flexibility can play an important role in helping maintain grid reliability, improving energy affordability, and integrating a variety of generation sources.

Multiple Stakeholders, Multiple Sources of Value



https://newbuildings.org/wp-content/uploads/2021/04/GTZ-GridIntegratedBuildings_4-29-21presentations.pdf

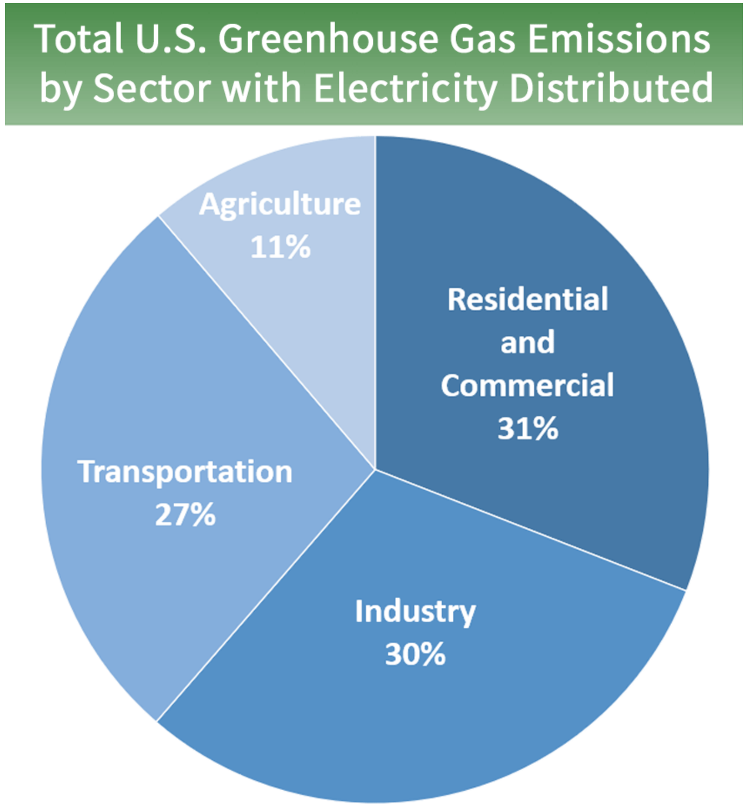
Legislative Drivers

- **EISA 2007**
  - Numerous mentions (114 to be exact!) of "smart" (e.g., smart grid technologies, smart consumer devices and appliances, smart services and practices)
- **EA 2020**
  - Smart building acceleration
    - The section requires the Secretary of Energy, as a part of the Better Building Challenge, to develop smart building accelerators to demonstrate innovative policies and approaches to accelerate the transition to smart buildings.
    - The section also establishes an R&D program focused on building-to-grid integration.
- **EO 14057 (Catalyzing America's Clean Energy Industries and Jobs through Federal Sustainability)**
  - Guidance for both existing facilities (energy efficiency and deep energy retrofits) and new construction and modernization to implement GEB

Why GEB?
Greenhouse Gases (GHGs) and Buildings

- **31% of GHG emissions by electricity end-use due to residential and commercial buildings**

- **Commercial and Residential Sector Emissions:**
  - **Direct emissions:** include fossil fuel combustion for heating and cooking needs, management of waste and wastewater, and leaks from refrigerants
  - **Indirect emissions:** occur offsite but are associated with use of electricity consumed by homes and businesses



U.S. Environmental Protection Agency (2022). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020

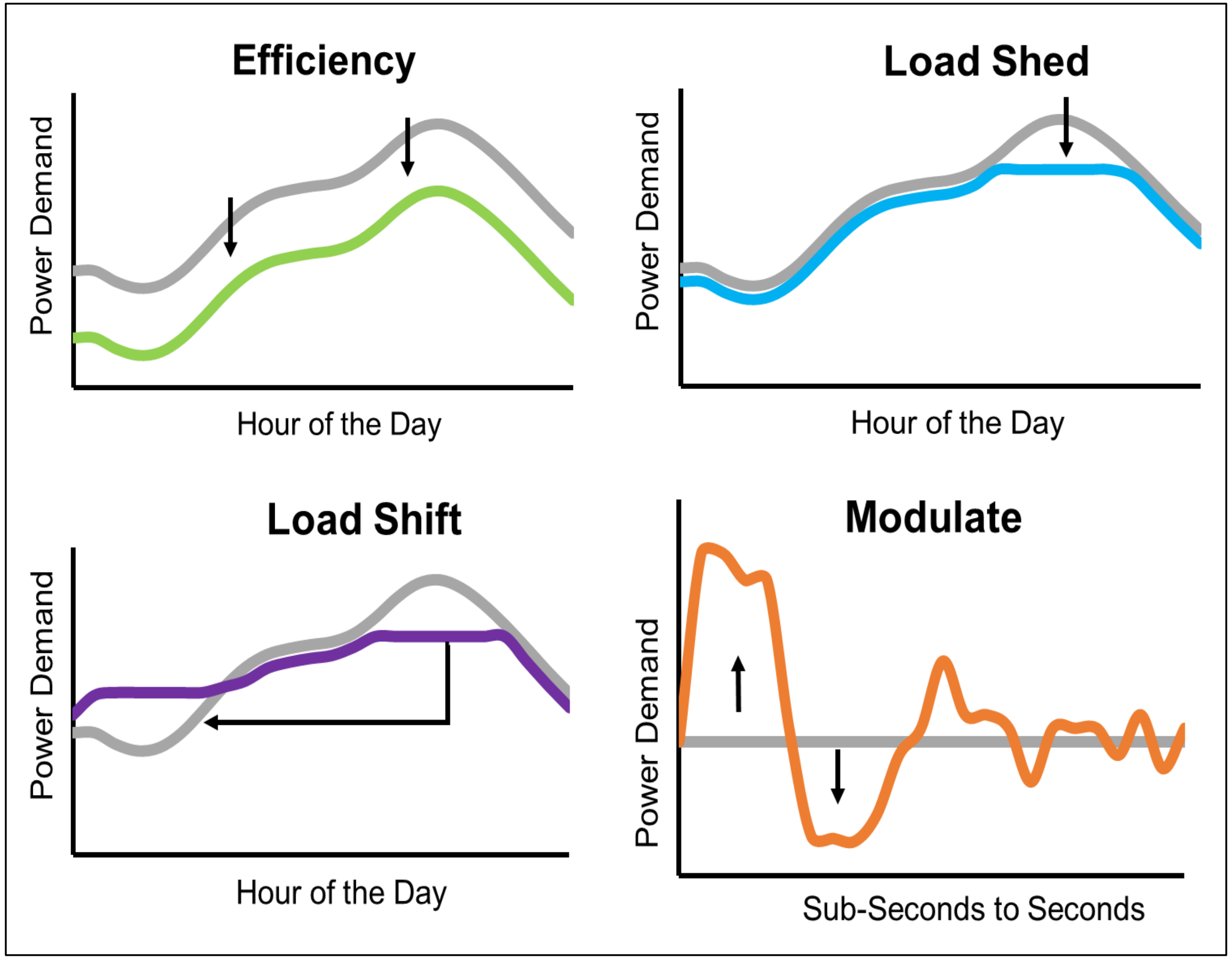
https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

GEBs and Decarbonization

GEBs decarbonize the building stock by utilizing:

1. Energy efficient equipment to ***reduce*** energy usage
2. Tight building envelopes to ***reduce*** heating/cooling energy use
3. Renewable energy generation (e.g., PV panels, etc.) and energy storage to ***replace*** carbon heavy energy sources and ***enable*** fleet decarbonization
4. Grid connected smart technology and energy storage help integrate variable renewable energy sources on the grid to further ***replace*** carbon heavy sources

Demand Flexibility Provided by GEB



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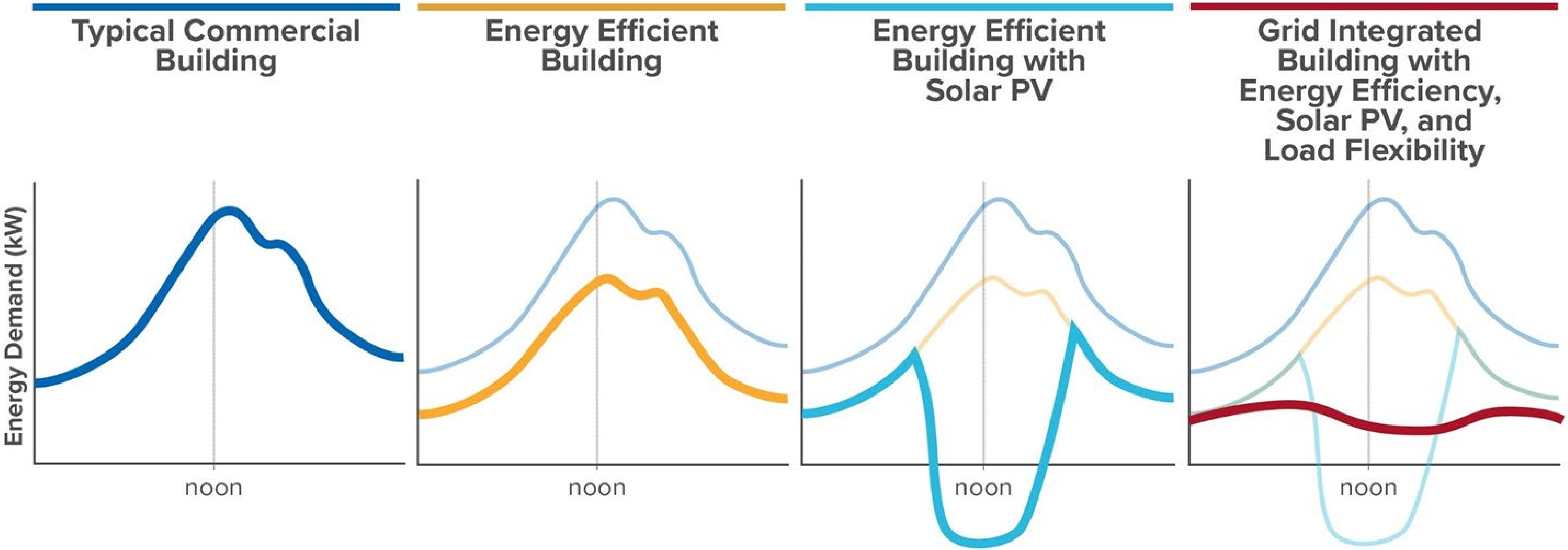
GEB Load Profile Potential



Efficiency reduces demand and energy costs

Solar reduces demand and energy charges but causes steep ramping of loads and utility challenges

Grid-interactive efficient buildings optimize energy use and demand costs and increase resilience by providing a lower, flatter, more flexible load shape

https://rmi.org/insight/value-potential-for-grid-interactive-efficient-buildings-in-the-gsa-portfolio-a-cost-benefit-analysis/

GEB Technologies and Solutions

- Can leverage existing equipment
- Technologies may or may not be “smart”
- Building managers can control individual equipment or leverage software solutions to optimize multiple end-use systems
- Flexibility can be provided through:
  - Continuous demand management
  - Response to specific demand response (DR) events
- Dynamic utility signals can and should be leveraged where possible

Sampling of GEB Enabling Technologies

- Building Automation
  - Grid-Connected BAS/EMIS
  - Chiller Temperature Setpoint Reset
  - Air Handling Unit (AHU) Pressure and Temperature Reset
  - Supervisory Control and Automation

- Connected Technologies and Controls
  - Automated Window Attachments
  - Modulating/Advanced Clothes Dryers
  - Advanced BAS/Energy Management Information Systems (EMIS)
  - Advanced Controls for Commercial Refrigeration
  - Advanced Lighting Sensors and Controls
  - Advanced Plug Load Controllers (including Smart Power Strips)
  - Advanced/Smart Water Heater
  - Basic Building Automation Systems (BAS)
  - Electronic/Computing Energy Management
  - Rooftop Unit Advanced Control
  - Smart Thermostats

Distributed Energy Resources and Storage

- Battery Energy Storage System (BESS)
- Electric Vehicles and Chargers
- Thermal Energy Storage
- Small Wind Turbines
- Solar Photovoltaic (PV) Panels
- Building Scale Combined Heat and Power (CHP)

GEB Software Solutions

- Connect to building automation systems (BAS) or home energy management systems (HEMS)
- Can control multiple building end-use systems
- May offer 1- or 2-way communication with the grid
- Provide analytics for flexible control
- Trend load data
- Should capture dynamic signals:
  - Weather
  - Time-Of-Use (TOU) utility rates
  - Carbon emissions
  - Utility demand response

Photo by Werner Slocum, NREL 65538

Utility Rates Considerations

- Demand response programs
- Coincident peak demand charges
- Virtual power plant/aggregator laws
- Minimum billing demand clauses
- Time Variable Pricing
  - Real-time pricing (RTP)
  - Day-ahead hourly pricing
  - Block-and-index pricing (sometimes called block-and swing pricing)

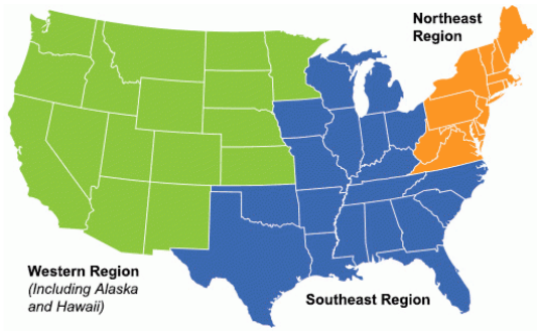
Demand Response and Time-Variable Pricing Programs

Federal Energy Management Program

Federal Energy Management Program » Demand Response and Time-Variable Pricing Programs

The Federal Energy Management Program developed profiles of demand response and time-variable pricing programs throughout the United States. These profiles are grouped regionally by state.

- Western States
- Northeastern States
- Southeastern and Midwestern States



Demand response (DR) is a short-term, voluntary decrease in electrical consumption by end-use customers that is generally triggered by compromised grid reliability or high wholesale market prices. In exchange for conducting (and sometimes just committing) to curtail their load, customers are remunerated.

https://www.energy.gov/eere/femp/demand-response-and-time-variable-pricing-programs

Utility Offerings and Incentives

Favorable utility rates

- High peak demand rates;
- Large differences between peak and non-peak energy and demand charges; or
- TOU rates available with high on-peak charges

Incentives: prescriptive and customized offerings for efficient building equipment and distributed energy technologies (e.g., lighting, refrigeration equipment, HVAC equipment, smart thermostats, PV, batteries).

Table 6. Illustrative Utility Rate Favorability for GEB

Rate Type	GEB Favorability	Total Energy Charges	Total Demand Charges
Low energy and demand rates	Less	$0.05–0.10/kWh	$5–$10/kW
High demand rate (low energy rate)	More	$0.05–0.10/kWh	$10–$20/kW
High demand rate (high energy rate)	Most	$0.10–$0.20/kWh	$10–$20/kW

https://www.nrel.gov/docs/fy21osti/78190.pdf

Cybersecurity Considerations

Figure 2. Managing cybersecurity risks using NIST's RMF. *Image by Anuj Sanghvi and Fred Zietz, NREL*

https://csrc.nist.gov/projects/risk-management/about-rmf

Deployment Considerations

- **How do you currently approach energy efficiency (EE)/Demand Response (DR)/load management and interconnectivity efforts?**
  - Do you have an integrated approach to control and ongoing management of plug loads, lighting, and HVAC?
  - Would better analytics support decisions for optimal balance of grid resources, EE/DR, renewables, and energy storage?
  - Do you wait for the utility signal to reduce demand, or do you continually manage demand?
- **What are key barriers to adoption of advanced controls that enable the ability to provide grid services?**
  - Concerns about impact on productivity
  - Making the business/investment case
  - Complexity of advanced controls and potential of obsolescence
  - Cybersecurity concerns
- **What utility offerings can help support technology adoption?**

Selection/Screening Process

	Screening Phase	Description	Data Needs/Considerations
1	**Market Screening**	Market-based screening utilizing existing datasets	• Site locations • Site consumption • Blended electricity rate • Presence of utility incentive programs
2	**High-Level DER Screening**	High-level DER screening incorporating site-specific utility rate	• Type of existing electric rate • Annual electricity consumption (hourly consumptions will be simulated and scaled)
3	**Detailed GEB Analysis**	In-depth energy modeling analysis at top sites; will require additional data from sites.	• 15-minute electrical meter interval data from site • Custom modeled utility rate • Additional building data and existing BAS and control system data, LED lighting, and plug load data

https://www.nrel.gov/docs/fy21osti/78190.pdf

Cost Effective GEB Measures and Strategies

Measures

Cost-effective in almost every location	Cost-effective in some locations

• **LED lighting upgrades,** including tube retrofits, fixture retrofits
• **Staging to reduce peak demand:**
  • Laptop battery charging
  • AHU fans
  • Electric resistance heaters (all-electric only)
• **Temperature setback to reduce peak demand**
	• **Advanced lighting controls,** which enable peak shaving and DR
	• **Battery energy storage system**
	• **Solar PV** energy generation
	• **A solar + storage "bundle" —** bundling enhances the value beyond investing in solar and storage individually

Cost-effective GEBs measures have high net present value and short paybacks.

Strategies

- The best returns are in locations with high demand charges, time of use rates, and seasonal variation.
- Consistent demand management and peak shaving delivers greater value than demand response in most scenarios.

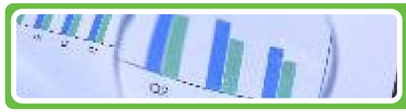
Metrics

Quantitative Objectives for Demand Flexibility	Metrics
Energy Efficiency Savings (from GEB solution)	Energy savings: kWh/year and % savings Energy intensity savings: $kWh/ft^2/year$
Continuous Demand Management	Monthly peak demand reduction: kW and % Summer and winter average peak kW reduction
Peak Load Shed	Demonstrated load shed based on a utility signal: • Demand shed per event: Average kW reduction (for shed) over a specified time window • Average % demand reduction • Demand shed intensity: W/ft^2
Load Shift	Average demand increase or decrease over shift days during the summer and winter: kW, W/ft^2, % Net building consumption change in 24 hours over shift days during the summer and winter: %
Carbon Reduction	$CO_2/ft^2/year$

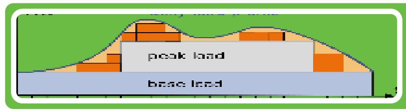
In Closing

GEBs are an efficient, connected, smart, and flexible solution to decarbonizing our building stock, with numerous additional benefits.

✓ Energy affordability



✓ Operational cost reduction



✓ Improved reliability and resiliency

✓ Reduced grid congestion

✓ Enhanced services

✓ Environmental benefits

✓ Customer choice

https://newbuildings.org/wp-content/uploads/2021/04/GTZ-GridIntegratedBuildings_4-29-21presentations.pdf

Resources – Websites and Reports

- DOE's "GEB-site": https://www.energy.gov/eere/buildings/grid-interactive-efficient-buildings
- Blueprint for Integrating Grid-Interactive Efficient Building (GEB) Technologies into U.S. General Services Administration Performance Contracts: https://www.nrel.gov/docs/fy21osti/78190.pdf
- A National Roadmap for Grid-Interactive Efficient Buildings: https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf
- Demand Response and Time-Variable Pricing Programs: https://www.energy.gov/eere/femp/demand-response-and-time-variable-pricing-programs
- Incentive Mechanisms for Leveraging Demand Flexibility as a Grid Asset: https://www.energy.gov/sites/default/files/2021-06/GEB_Implementation_Guide_May_2021.pdf

Connect with FEMP:
GEB and Smart Facilities:
Jason Koman
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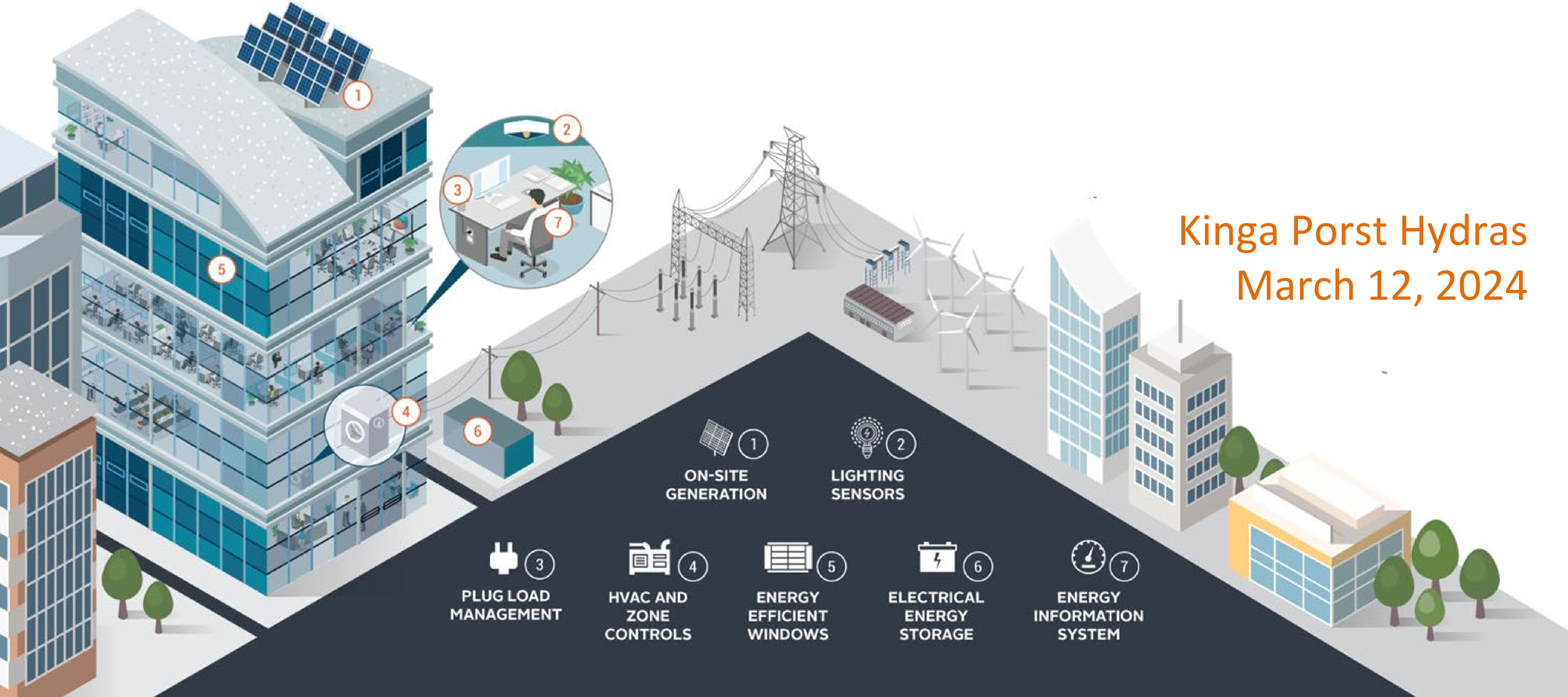
FEMP's Cybersecurity Resources:

- Distributed Energy Resources Cybersecurity Framework: https://dercf.nrel.gov/
- Distributed Energy Resources Risk Manager: https://www.nrel.gov/docs/fy22osti/83237.pdf
- EMIS Cybersecurity Best Practices: https://www.energy.gov/sites/default/files/2022-07/emis-cybersecurity-best-practices.pdf
- Facility Cybersecurity Framework: https://facilitycyber.labworks.org/

Grid-Interactive Efficient Buildings (GEBs)

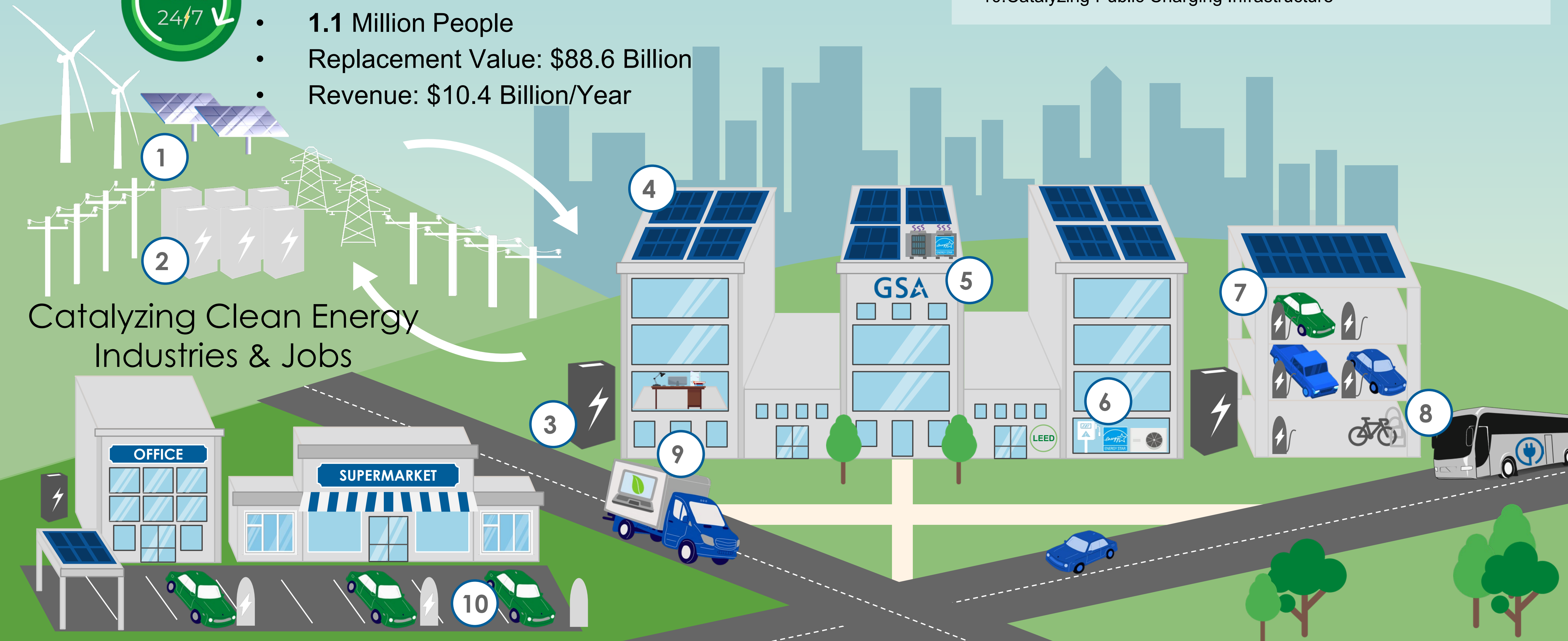
Kinga Porst Hydras
March 12, 2024



Buildings are a Critical Focus

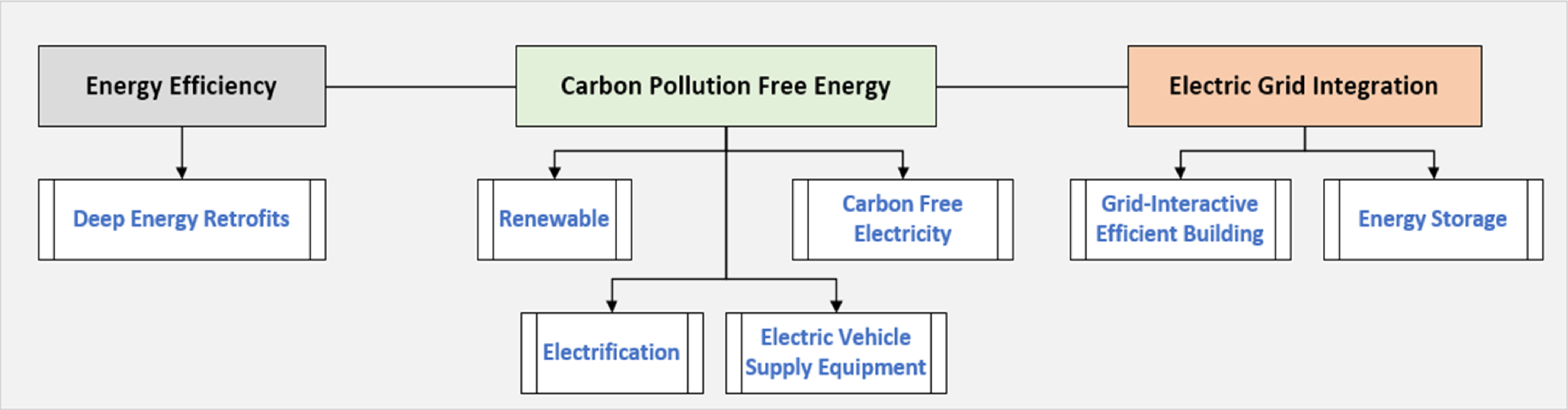
- **8,842** Owned or Leased Assets
  - 186.5 Million Square Feet Owned
  - 184.5 Million Square Feet Leased
- **1.1** Million People
- Replacement Value: $88.6 Billion
- Revenue: $10.4 Billion/Year

1. Carbon Pollution Free Energy Procurement
2. Utility Scale Energy Storage
3. Onsite Energy Storage
4. Onsite Energy Generation Potential
5. Heat Pumps
6. Grid-interactive Efficient Building
7. Workplace Charging
8. Federal Zero Emission Vehicle Fleet
9. Sustainable Procurement
10. Catalyzing Public Charging Infrastructure

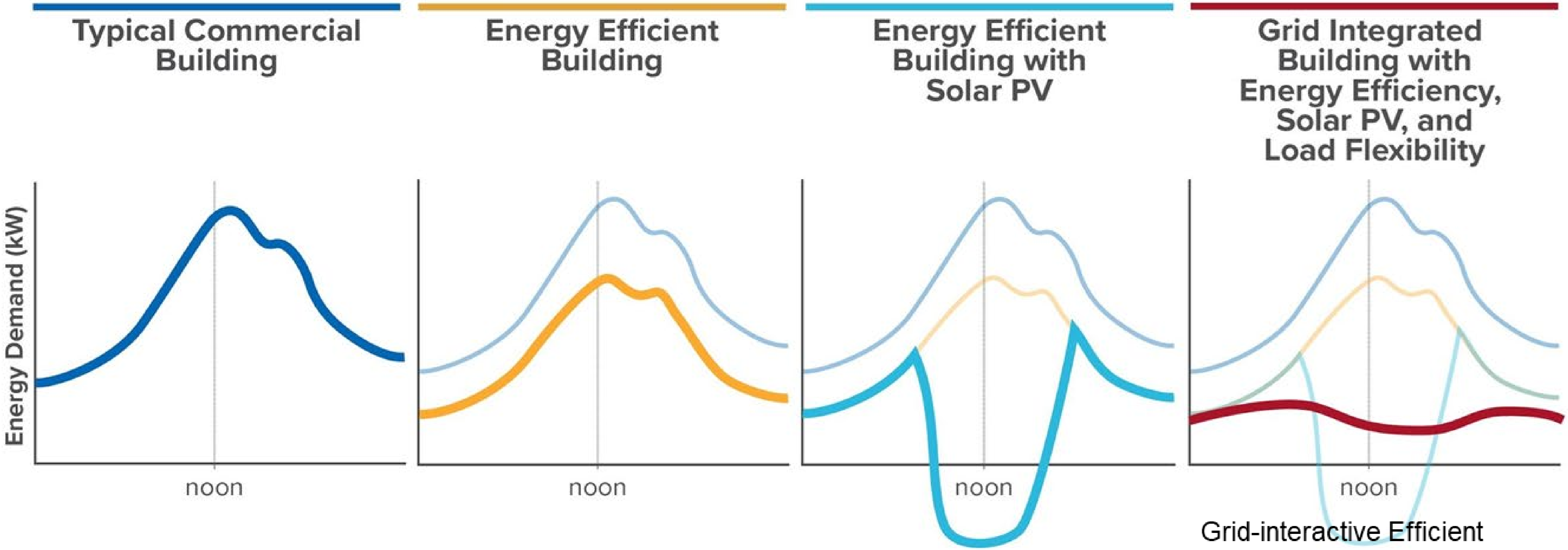


Catalyzing Clean Energy Industries & Jobs

Pathway to Decarbonization



GEBs illustrative load profiles



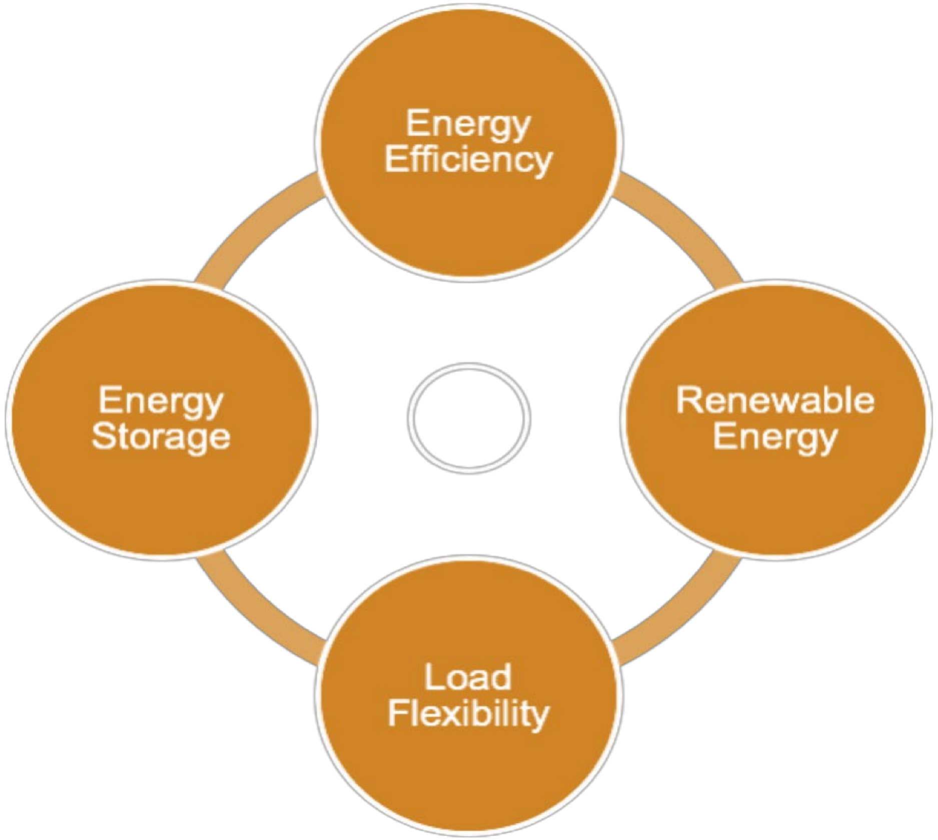
Efficiency reduces demand and energy costs

Solar reduces demand and energy charges but causes steep ramping of loads and utility challenges

Grid-interactive Efficient Buildings optimize energy use and demand costs and increases resilience by providing a lower, flatter, more flexible load shape.

What are Grid-Interactive Efficient Buildings (GEBs)?

- A GEB strategy enables achievement of ambitious climate & resilience goals by bringing buildings & the grid together
- GEBs draw from a toolbox that includes energy efficiency, renewables, energy storage and load flexibility
- GEBs employ these capabilities to flexibly **reduce, shed, shift, modulate or generate** electric load as needed
- In response to utility price signals, a GEB can reduce costs and enhance resilience for both building and utility



How GSA Got to This Point

- **Identified opportunity**
  - DOE BTO GEB Initiative, NBI Grid Optimal program
- **Consulted outside experts to develop recommendations**
  - GSA Green Building Advisory Committee - two Advice Letters
    - Findings & Recommendations (2-21-19)
    - Proposed Federal Roadmap (12-9-19)
- **Developed internal analyses of feasibility, costs & benefits**
  - GSA-Rocky Mountain Institute (RMI) Value Potential Report
- **Initiated pilot projects to test and demonstrate the concept**
  - Region 7 pilot and GPG pilots
- **Conducted outreach to target audiences**
  - Blueprint for Integrating GEB into GSA Performance Contracts
  - Smart Facilities Accelerator with FEMP
  - SFTool.gov GEB page

Findings: The Value of GEBs to GSA

Direct Benefits to GSA

- $50 MM in annual cost savings
- $206MM in NPV
- Project-level payback under 4 years
- Futureproof: Accommodates future rate structure changes and helps manage costs

Grid and Societal Value

- Reduce grid-level T&D and generation costs up to $70MM/yr
- These savings ultimately benefit the government and taxpayers
- Future grid economic models will value savings (e.g. NWA's)

Indirect Value to GSA

- Demonstrates federal and real estate industry leadership
- Enables deeper savings in ESPCs and UESCs
- Better building control can improve comfort, health, and productivity
- CO_2 savings

Assumes GEBs are applied across the GSA portfolio of owned office buildings; Based on bundle of measures modeled by RMI.

Key Differentiators of Grid-Interactive Efficient Buildings

Attribute	Potential	Improved from
Two-way communication between building and grid	Ability to receive a utility signals (price or carbon); ability to communicate load flex potential to grid	Manual, widget-based demand response programs
Interoperability and intelligence across building systems	Single, overarching integrator to monitor and control all loads, including plug and storage loads; ability to optimize for cost, carbon, resilience, etc.	Limited EMIS controls; isolated lighting, storage controls
Load flexibility and demand-focused building optimization	Building level intelligence to track and map demand, shift or shed rapidly based on inputs such as price, weather, carbon, peak grid demand, etc.	Isolated applications of thermal energy storage; battery storage

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GEB Blueprint

Key to the success of a GEB project is:

- Site selection with utility rates and incentives favorable to GEBs;
- Identification of GEB measures early;
- Stakeholder engagement;
- Integration of GEB measures within major building renovations; and
- Careful consideration of GEB measurement and verification methodologies.

Load Flexibility Category	GEB Measure	GEB Control Capability	Load Shed	Load Shift	Demand Response	Generation	Modulation	Efficiency
Load Shed	**Building Envelope – Automated Window Shades**	Automated window shades can be closed during peak cooling periods to reduce demand..	X		X			X
	Plug Loads – Advanced Controls	Advanced plug load controls can be used to cycle off nonessential plug loads during peak periods, or to stage or shift the charging time of certain devices with batteries.	X	X	X			X
Load Shift	**Battery Electrical Storage**	Batteries (e.g., Li-ion, lead acid, flow) can be used to store electrical energy during times of excess generation or off-peak periods and discharge during peak periods to reduce demand.	X	X	X		X	
	Whole Building – Energy Management Information Systems	Whole building energy management information systems (EMIS) can be used to integrate all end uses (HVAC, lighting, plugs) and DER.	X	X	X	X	X	X

Findings: Example GEB Enabling Technologies

- Building Automation
  - Grid-Connected BAS/EMIS
  - Chiller Temperature Setpoint Reset
  - Air Handling Unit (AHU) Pressure and Temperature Reset
  - Supervisory Control and Automation
- Distributed Energy Resources and Storage
  - Battery Energy Storage System (BESS)
  - Electric Vehicles and Chargers
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- Connected Technologies and Controls
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  - Advanced/Smart Water Heater
  - Basic Building Automation Systems (BAS)
  - Electronic/Computing Energy Management
  - Rooftop Unit Advanced Control
  - Smart Thermostats

GEB Test Beds

TECHNOLOGY	VALUE PROPOSITION
Occupancy-based GEB Platform *Prescriptive Data/ Slipstream*	● Facility operation optimized for real time occupancy. ● Connect and/or control building systems regardless of make / manufacturer. ● Reporting - demand management savings roll up to portfolio level queries.
Gamified GEB Platform *Logical Buildings/Comcast MachineQ*	● Scalable across a broad range of building types. ● Easily integrates with existing BAS and IoT devices. ● Seamless consistency across mobile/desktop applications.
Open Source GEB Platform *Kinetic/Intellimation/Xcel Energy/Slipstream*	● Easy configuration - software automates “point mapping” of equipment. ● Machine learning improves accuracy of predictive demand management. ● Real time automated fault detection and diagnostics (AFDD).

Federal GEB Examples

Philadelphia U.S. Custom House

- Automated programming to pre-cool
- Sequencing chillers to reduce peak demand by approximately 20%
- Structural mass provides good insulation for this programmed pre-cooling

Fort Carson

- 80 LEED buildings
- SPIDERS microgrid :
- two diesel generators (3 MW)
- one solar farm (1 MW)
- Central control system with extensive metering
- Battery storage to flatten the energy consumption profile
- Planned occupancy-based HVAC control system

White Oak FDA Campus

- 55 MW central utility plant micro-grid capable
- Combined heat and power plant
- Utility demand management 30kW Photovoltaic installation

GSA GEB Readiness Levels

Complete GEB System

Oklahoma City Federal Bldg

- Networked BAS
- Renewables
- Energy Storage
- Microgrid Controller
- Dynamic Energy Management
- Load Shifting, Automated Demand Response, Tariff Adjustments, Peak Shaving

Advanced GEB Software

Foley Federal Building – Las Vegas, NV

- Networked BAS
- GSA Green Proving Ground Advanced Software
- Automated Demand Response, Peak Shaving, Utility Engagement

GEB Utility Participation

Ted Weiss Federal Building – New York, NY

- Networked BAS
- Demand Response and/or Automated Demand Response, Utility Engagement

GEB Ready

Cabell Federal Building – Dallas, TX

- Networked BAS
- Minor, Non-holistic Demand Reduction Strategies
- No Active GEB Strategies Deployed
- Majority of GSA Facilities

Project Overview - Oklahoma City FB

<u>Goal</u>: Improve overall **building efficiency, power reliability** and **resiliency**, and **lower energy consumption**

<u>Location</u>: Downtown **Oklahoma City**, Oklahoma occupying **178,342 square feet**

- GSA engaged in a **Utility Energy Service Contract** (UESC) with **Oklahoma Gas and Electric** (OG&E)
- Part of a five-building retrofit that is projected to save **$13.5 million dollars** over the course of the contract and account for a **41% reduction** in total energy use and **3,100 metric tons of carbon** reduction annually

Roles and Responsibilities

Building Owner

- Key decision maker and project managers/leaders
- Helped to develop project team
- Provided recommendations on technologies early in the project and provided insight on feasibility of technologies
- Acquisition team helped manage the contract and purchasing processes

Utility (OG&E)

- Contract owner for the UESC
- Reviewed and approved final designs, oversaw the overall project execution, and served as liaison between the ESCO and GSA

ESCO (Ameresco)

- Responsible for project development, engineering & design, contract deliverables, hiring and managing subcontractors, preparing the interconnect agreement, commissioning systems, and providing performance guarantees laid out in the UESC

SMEs

- Reviewed technical aspects of technology recommendations

Tenants

- Provided feedback on comfort for technologies

Oklahoma City Federal Building GEB Strategy

APPROACH TO BUILDING RESILIENT ENERGY SYSTEMS

ENERGY EFFICIENCY

- Reduce annual loads through conservation measures
- Minimize capital investment requirement

ON-SITE GENERATION

- CHP
- Renewables
- Back-Up Generation

CONTROLS

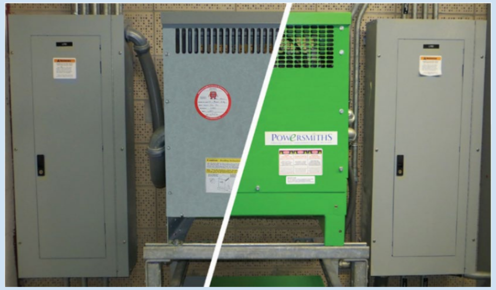
- Safely disconnect during LOU
- Fast Load Shed
- Demand Response Dispatch
- Manage generator assets in island mode

ENERGY STORAGE

- Support microgrid during LOU
- Self fund via savings/revenue
  (Utility Bill Management)
  (Demand Response)
  (Self Consumption of PV)

Oklahoma City Federal Building GEB Strategy

Energy Efficiency

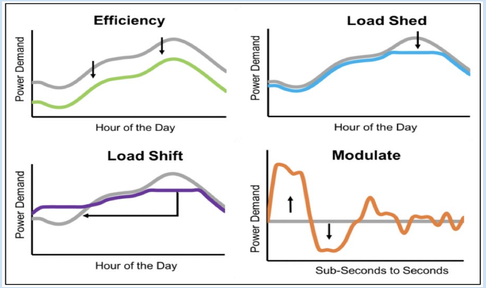


- LED Lighting
- Lighting Controls
- HVAC Controls
- Transformer Upgrades
- Advanced Power Strips
- Building Insulation

Renewable Energy

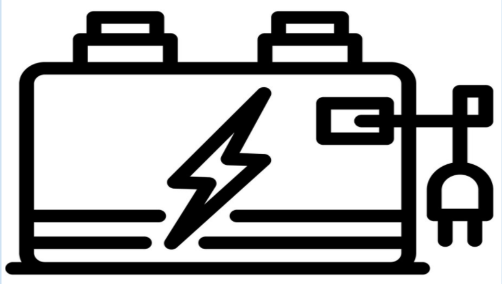
- 300 Kw Solar Rooftop PV
- Utility billing rate changes

Load Flexibility/Controls



- Microgrid Controller
  - Lighting Controls
  - HVAC Fans
  - PV Production
- Load Shedding
- Net Energy Exporting

Energy Storage/Resiliency



- 250 kw / 500 kWh BESS
- 250 kW Emergency Generator (existing)
- Island Mode Operational Capability

Fed Flex Forum - October 2023

GSA brought together GEB leaders in the federal government. RMI facilitated a workshop focused on implementing GEBs across the federal portfolio.

The nearly 50 attendees included: staff from DoD, GSA Green Proving Ground, national labs, DOE, GSA facilities management, along with a variety of private and public entities

The forum's agenda included presentations and working sessions to consider a federal GEB strategy

Presentations included:

- Grid-Interactive Efficient Buildings (GEBs) by GSA Office of High Performance Buildings
- GSA Experience and Case Studies by GSA Facilities Management
- Field Validation of a Grid-Interactive Efficient Building (GEB) Software Solution by NREL
- Grid Interactive Efficient Buildings (GEBs) & Associated Opportunities and Challenges by FEMP
- Smart Building Pathway to Grid-Interactive Efficient Buildings (GEB) by GSA Facilities Management
- Implementing and Scaling GEB by LBNL
- Operator-in-the loop GEB technology evaluated in a GSA facility by PNNL

In the afternoon, RMI facilitated working groups to coalesce on next steps in particular topic areas. Those topics included: economics and delivery models, technology, utility engagement and education

The working sessions identified further GEB R&D that is needed:

GRID NEEDS – More research and analysis needed to understand grid needs across the US, now and in the future, such that large portfolio owners can make educated decisions about how to upgrade their buildings.

RELIABILITY – More studies need to be conducted in real buildings to confirm the reliability and even understand the margin of error in the flexibility. Utilities are still hesitant to rely on demand flexibility in buildings, with little understanding (and potentially control) of when and how much demand can be shifted.

SYSTEM INTEGRATION – Smart technologies need to (a) integrate different HVAC, lighting, EVs, etc. and (b) provide two-way communication between buildings/EVs and grid.

Beyond tech R&D, GEB has implementation hurdles to overcome also:

BUSINESS CASE FOR GEB TECH – The financial case for GEB integration needs to be improved. Rate structures and programs that access and maximize all of the financial streams that GEBs benefit (T&D, infrastructure investment deferral, etc.) are few and far between.

STANDARDIZATION –

- GEB technology needs standard communication protocols that can meet government cybersecurity requirement to more smoothly enable two-way communication between buildings and grid
- The market, particularly building owners, need standardized metrics and functionality to set expectations in codes, contracts, project requirements, etc.
- Utilities need a standard approach to program design. There are very few one-size-fits-all solutions for utility programs that encourage GEB.