Considerations and Approaches for Grid-interactive Efficient Building (GEB) Pilots

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Presentation Overview

- Project origin
- Purpose of technical briefs
- Current status of Washington and Hawaii technical briefs
- General approach
  - Defining GEB
  - Specific GEB benefits and illustrations through a current pilot
  - Energy priorities and potential drivers of GEB features
  - Washington specific energy characteristics and pilot implications
  - Metrics and data needs for pilots
- Other pilot considerations
- What's different for Hawaii
- Next steps

Project Origin

- U.S. Department of Energy Grid Modernization Laboratory Consortium
- GMLC 4.2.5 – Grid-interactive Efficient Buildings Technical Assistance
- Working together with Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory
- NASEO-NARUC GEB Working Group
- Working with Washington and Hawaii. Have had preliminary conversations with Michigan and Minnesota as well.
- Task goal: Assist utilities, states, and regulatory staff with the creation of GEB pilots and tailor a technical brief specific to their needs

Purpose

GEBs are potentially very beneficial!
But they're new and complex

- Create clarity and common language on what GEBs are and services they can provide
- Clarify challenges and barriers to GEBs
- Illuminate how GEBs ties to specific state energy goals
    - Energy goals tied to specific GEB metrics to be tested through a pilot
- Highlight state-specific policies that can leverage GEB pilot development
- Provide general considerations for GEB pilots

Current Status of Projects

- Washington State – Working with staff from the Washington Utilities and Transportation Commission and Department of Commerce
  - After a few iterations, finalizing draft
  - Emphasis on GEB definition and potential benefits; various GEB resources and technological challenges; address various state energy goals, such as those through the Clean Energy Fund
- Hawaii State – PNNL participating in Hawaii's monthly GEB Working Group (PUC, State Energy Office, Hawaiian Electric, Hawai'i Energy, Kauai Island Utility Cooperative)
  - First draft delivered – collaboratively updating this draft with the Working Group
  - Emphasize opportunities through Hawaii's existing dockets/policies that could potentially support GEB development

Washington Technical Brief Overview

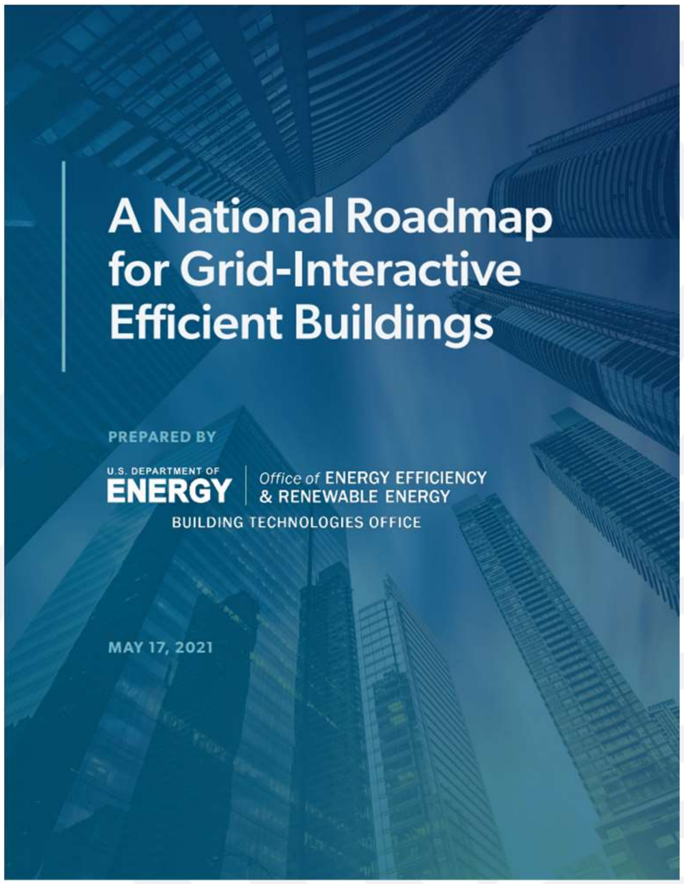
Establish GEB basics

Define grid-useable benefits from GEBs

Identify utility/state energy mandates and utility priorities potentially addressed through GEBs

Summarize goals, metrics, data, and considerations for GEB pilots

GEB resources available from DOE


A National Roadmap for Grid-Interactive Efficient Buildings

PREPARED BY

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

BUILDING TECHNOLOGIES OFFICE

MAY 17, 2021

https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs-20210712.pdf


U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Grid-interactive Efficient Buildings Technical Report Series

Overview of Research Challenges and Gaps

December 2019

https://www1.eere.energy.gov/buildings/pdfs/75470.pdf

GEB Basics - Overview

GEB Basics – overall definition of GEBs, common language

GEB's energy efficient and energy/load flexing resources and technologies

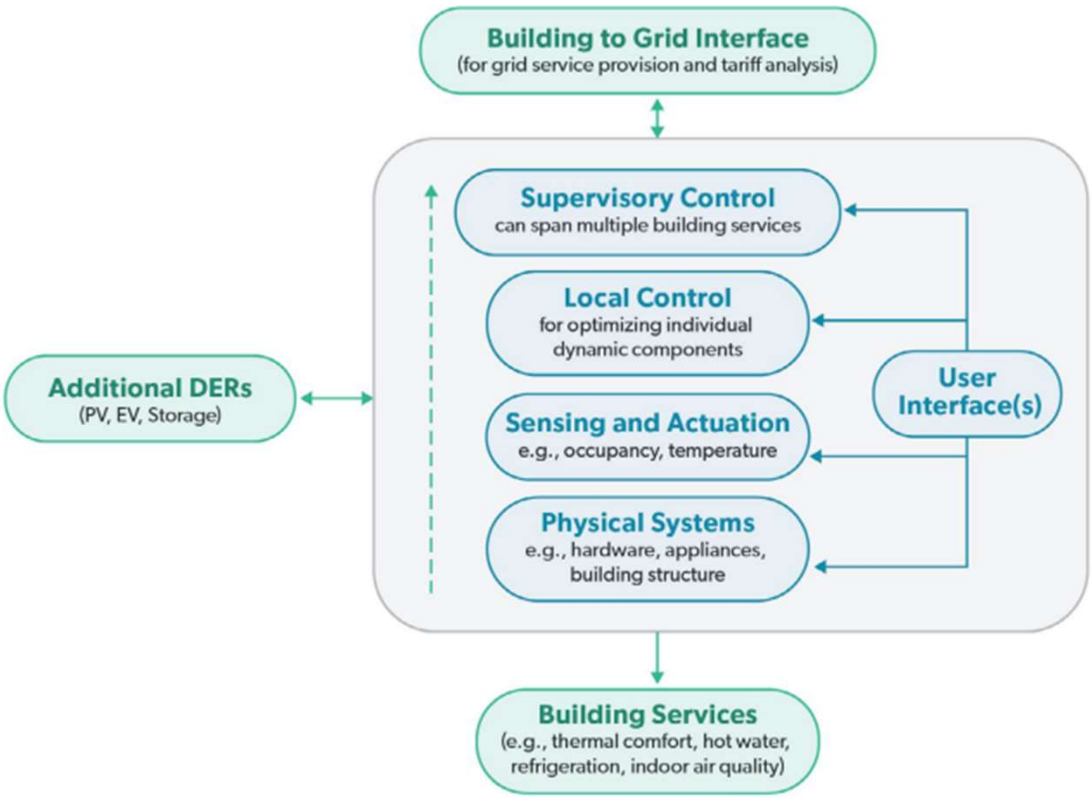
- Demand response (DR) and demand flexibility (DF)
- Energy efficiency (EE)
- Photovoltaics (PV)
- Electric vehicles (EV)
- Battery energy storage systems (BESS)

GEB systems - How all the GEB pieces fit together

- Building systems and DERs such as PV, EV, and storage
- Smart technologies and communications
- Building to grid interface
- Optimized energy use for grid services, building occupants comfort and performance with greater affordability

GEBs are new and important because they use buildings or campuses of buildings as grid resources.

GEB Technology Layers



From DOE National GEB Roadmap

GEB Basics – Takeaway

Key Takeaway – There are a lot of potential benefits of GEB, but enabling technologies and interoperability are required and can impact cost-effectiveness.

Poll: Question #1 – What is your familiarity with GEB technologies?

1. **Non-existent** – I have no familiarity with GEB technologies

2. **Very little** - Only familiar with energy efficiency and basic demand response.

3. **Some** – I've heard of some of the technologies (AMI, home energy management systems, cloud-based energy management platforms that connect to in-home smart devices) but am not aware of any of these technologies collectively being used in my state.

2. **Moderate** – I'm familiar with efforts that used at least one grid-interactive technology for buildings to provide grid services and I generally understand how the costs and benefits are determined.

3. **High** – I'm familiar with efforts that used 2 or more GEB technologies simultaneously and have a good understanding of grid interactions, data collection and analysis, and costs and benefits.

GEB Basics - Overview

GEB illustrative example

Illustrative Example – Basalt Vista, CO

- Project developed by the local energy cooperative and NREL
- Low-income
- Microgrid potential
- Grid resource potential
- More info on NREL support of Basalt Vista

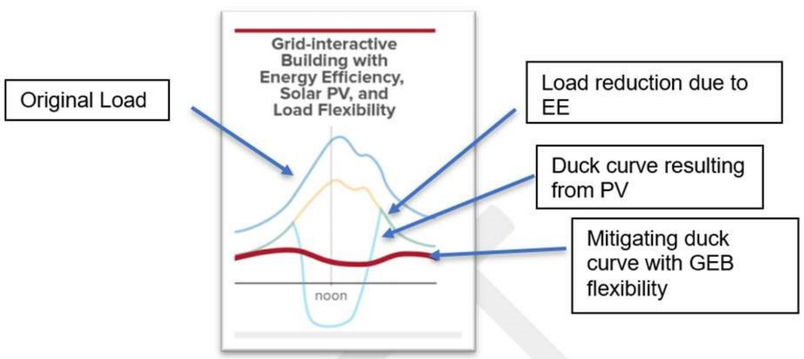
Photo by Dennis Schroder, NREL

GEB Benefits - Overview

GEB Benefits – GEB resources provide various and quantifiable benefits

<u>Different ways GEBs can provide value to the grid</u> (see Roadmap) :
- Efficiency – (Ex: building insulation, efficient equipment)
- Shed Load – (Ex: dim lighting)
- Shift Load – (Ex: pre-heat water during off-peak periods)
- Modulate – (Ex: batteries and inverters automatically modulate to maintain grid frequency)
- Generate – (Ex: rooftop solar or behind-the-meter wind)

<u>Benefits</u>:
- Reduced energy use, emissions, and cost
- Peak demand reduction
- Load smoothing, renewables integration, ancillary services, avoided generation, transmission, and distribution expansion, resilience



Adapted from Carmichael et al. 2019

By 2030, potential national annual energy savings between 164 and 401 TWh and peak demand savings between 42 and 116 GW (between $8 billion and $18 billion) depending on adoption. See Roadmap

GEB Benefits – Takeaway

Takeaway - There are potentially many applications of GEB, but technologies are complex and grid signals are needed. A pilot could bring clarity to complexities and support realizing benefits to local grid systems.

Key Drivers – Washington Overview

Utility Goals/Key Drivers - to inform GEB pilot content (what is to be studied?)

Key Drivers – Based on Clean Energy Fund, Washington State Energy Strategy, legislative mandates, and state dockets:

- Reliability
- Clean Energy Standard – 100% clean electricity by 2045
- Greenhouse gas (GHG) targets
- Resource adequacy
- Lowest reasonable cost
- All cost-effective EE, DR
- Transportation electrification
- Electrifying and decarbonizing buildings
- Resilience for customers
- Equity
- Work force deployment

Poll: Question #2 – What are the top two GEB applications you see for your state? (pick 2)

1. **Peak demand and capacity need reduction** – reduce peak demand and avoided need for generating resources and transmission and distribution expansion
2. **Energy cost savings** - reduce energy demand and energy costs generally
3. **Reduced greenhouse gas emissions**
4. **Flexibility for renewables integration**
5. **Reliability** – use demand flexibility for smoothing or ancillary services
6. **Resilience** – use GEB measures to provide resilience to climate change & extreme events etc.

Technical Brief – Key Drivers

Takeaway – Washington utilities and policymakers can design pilots to test aspects of GEBs that will help achieve state policy goals and to understand costs and benefits of GEB development and usage.

Metrics and Data - Overview

Metrics and Data – to be included, measured, and evaluated in pilots

Grid Metrics

- Energy savings
- Capacity contributions
- Renewable energy and BTM generation
- Grid carbon alignment
- Short-term/long-term demand flexibility
- Resilience

Goal	Potential Metrics	Data (units)
Grid objectives		
Energy savings	Energy saving over a year – as compared with an established building energy consumption baseline	kWh/year
	Energy intensity saving over a year – pre and post program	kWh/ft^2/yr
	Total energy consumption reduction	kWh
	Total annual energy cost savings	$/year
	Persistence of savings/performance over time	Measure the persistence of savings and performance over time
Capacity contributions	Coincident peak load reduction	kW
	Non-coincident peak load reduction	kW
	Reduced investment in generation, transmission, and distribution capacity as a result of GEBs	$
Renewable energy and behind-the-meter generation	Total renewable energy generation	kWh/year
	Renewable energy consumed onsite	Hourly consumption (kWh)
	Renewable energy exported to the grid	Hourly export (kWh)
	Avoided bulk or local renewable energy curtailment	kWh

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

Goal	Potential Metrics	Data (units)
Grid objectives		
Grid carbon alignment	Reduced carbon emissions	Avoided carbon per/kWh, per year
Short term/long term demand flexibility	Shed - Building's ability to reduce demand for 15 min, 1 hour, 4 hours	kW reduced over specified timeframes
	Shift – Building's ability to shift load from peak to off-peak periods	kW, kWh
	Ability to modulate power draw up for the purpose of frequency and voltage support	kW and response time
	Ability to modulate power draw down for the purpose of frequency and voltage support	kW and response time
	Ramp rate	kW/min
	Demand change intensity	W/sqft
Resiliency	Building ability to island for 4-24 hours	Islandable time
	Contribution to local microgrid	% capacity and energy contribution to local microgrid
	Ability to support critical functions during outage	Critical function and time sustained
	Ability to support black start following a power outage with motor soft start	Black start capability (kW)

Poll: Question #3 – What kind of participation will you have with a GEB pilot? (select all that apply)

1. **Creator** – My organizations has the resources and authority to create and run a GEB pilot.

2. **Regulator** – My organization will approve pilots and address cost recovery and/or direct utilities or other entities to conduct pilots.

3. **Feedback on creation** – My organization will be part of a working group that provides feedback on and help inform potential pilots and pilot design.

4. **Funding** – My organization may provide funding that will support pilots.

5. **Public buildings** – My organization could help inform or implement pilots for public buildings.

Metrics and Data - Overview

Metrics and Data – to be included, measured, and evaluated in pilots

Metrics Impacting Customer Participation

- Customer retention
- Customer satisfaction
- GEB performance relative to comfort/productivity
- Bill impacts
- GEB technology – first costs, operational costs
- Overall cost-effectiveness
- Messaging impacts

Metric	Analysis Method
Customer retention	Measure customer retention (%) in different program and rate designs, including opt-in versus opt-out programs.
Customer satisfaction	Survey participant satisfaction.
GEB performance relative to comfort settings	Track performance of measures relative to established comfort settings.
Bill and revenue impacts associated with: • Energy savings • Demand/peak savings • Revenues from exporting energy • Revenues from providing grid services • Utility incentives for participation in DR programs • Non-utility incentives • REC revenues • Other	Track overall impact to customer bills and revenues.
Technology investment costs including measure costs, IT/communication system costs, and O&M costs ($)	Track costs to participants. Conduct surveys to understand customer thresholds for costs relative to different potential short/long-term savings through GEB measures.
Customer and building-owner overall cost-effectiveness	Calculate simple payback in years and net present value.
Messaging impacts	Survey customers to understand marketing potential and the most effective messaging. Determine what messaging is most appropriate for each consumer group?

Metrics and Data – Takeaway

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

Takeaway - Pilot component options are numerous. Pilot developers will need to choose which metrics to include and consider all the ways in which the data will be collected, analyzed, and evaluated.

GEB pilots – other considerations

- **Equity** – Consider how disadvantaged communities can participate and benefit
- **Key enablers** – Advanced metering and time-of-use rates are important GEB enablers
- **Interoperability** – Address interoperability and how devices/buildings communicate and interact
- **Cybersecurity** - Interconnectivity associated with GEB will require extra protocols to ensure customer data security
- **Utility alignment and preparedness** – GEBs require utilities to integrate across departments
- **Policy and regulatory aspects to pilots** – Address utility ownership and control, utility compensation models, shared savings options, and rate-basing issues.
- **Role of third-party service providers** – Consider role of third-party service providers and contractual arrangements in pilot design
- **Building owner vs. utility control** – Consider who controls interactive features
- **Review and vetting of pilot design** – Consider third-party review and vetting of pilot design <u>before</u> implementation
- **Evaluation, measurement, and verification (EM&V)** - Clear EM&V plan is needed
- **Sharing results** – Plan ahead for appropriate results sharing for broader benefit

Hawaii GEB Pilot

- Differing energy needs and starting points
- More than just utilities have the potential to create pilots (Hawai'i Energy and HNEI)
- Key drivers - potential for GEB pilots to support:
  - Integrated grid planning and grid-modernization dockets
  - Distributed energy resources dockets
  - Energy efficiency and renewable portfolio standards (EEPS and RPS)
  - Transportation electrification
  - Equity
  - Microgrid

Next Steps

- Finalize briefs for Washington and Hawaii
- Share briefs with NASEO/NARUC working group
- Continue to work with other states if time and budget allow

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