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CEC IEPR Commissioner Workshop on Grid-Interactive Efficient Buildings

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

A National (and California?) Roadmap for GEBs

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Why GEBs?

Integrate the growing share of variable renewable energy

Reduce costs to replacing aging electricity system infrastructure and improve system reliability

Assist in achieving decarbonization goals through reduced fossil fuel generation and increased heating electrification

Optimize energy use based on customer preferences

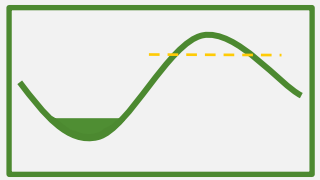
FLEXIBLE BUILDING LOADS CAN BENEFIT OWNERS, OCCUPANTS, AND THE ELECTRIC GRID

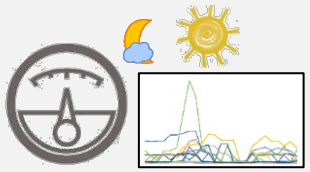
www.energy.gov/eere/buildings/GEB

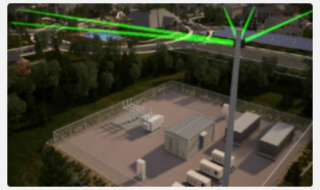
Groups of GEBs can provide added value: *Connected Communities*

Connected Community: Group of GEBs with diverse, flexible end use equipment that collectively work to maximize building and grid efficiency without compromising occupant needs and comfort.

Research to Utility Testbed: Alabama Power Neighborhood







High Performance Homes	Managing Behind-the-Meter Assets	Identifying Revenue & Rate Design Impacts	Understanding Renewable Energy Grid Integration
Changing Load Shapes	Energy Use Optimization	Informed Load Forecasting	Help meet 2050 Low-to-No Carbon Goal
Tighter envelope	Buildings as a resource	New building codes & standards	New infrastructure needs
Advanced Building Energy Systems	Create load shapes	How to price energy in IoT future	Balance grid & customer benefits

Results from DOE's First *Connected Communities (aka Smart Neighborhoods)*

Reynolds Landing *(Hoover, AL)*

Alabama Power Smart Neighborhood® Idea Home. Image courtesy: Alabama Power.

- ✓ **7,167 kWh annual savings** per home on an equivalent sq. ft. basis
- ✓ **$931 annual savings** per home on an equivalent square foot basis
- ✓ **5.6 tons of CO_2 avoided per home**

Average Home Energy Use

Altus at the Quarter *(Atlanta, GA)*

Altus rooftop solar and batteries. Images courtesy: Georgia Power.

- ✓ **Homes sold an average 873 kWh** back to Georgia Power annually
- ✓ **In winter, 30% lower max hourly kW demand** than baseline
- ✓ **In summer, 62% lower max hourly kW demand** than baseline
- ✓ **9.3 tons of CO_2 avoided per home**

Smart Neighborhoods: Lessons Learned (so far)

- **Significant load flexibility is available from residential loads**
  - A coordinated control framework and customer education key to success
  - Reduce computational footprint for seamless deployment
- **Standardizing data frameworks, communication protocols, and control modes/ranges** can
  - facilitate easier data collection and set point optimization
  - reduce development and implementation costs
- **To improve GEB value proposition:**
  - Clearly communicate the value of connected communities to customers—in energy savings and co-benefits (e.g., improved comfort)
  - Scale demonstrations up to larger building types and community sizes

Water heater CTA-2045 module

Altus Home Smart Receptacles


Hybrid Heat Pump Water Heater

Home electric car charger

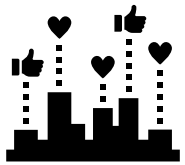

High-efficiency heat pump.

Connected Communities: Increasing GEB impact

Beneficial electrification of home loads

Deploying Advanced Metering Infrastructure

Implementing time-of-use tariffs



Shared value
- Manufacturers
- Customers
- Utility

Policy/ rulemaking to identify
- Performance criteria
- Reference standards
- Testing and certifications

R&D
- Communications
- Data management
- Load optimization models

New DOE *Connected Communities* Projects to Take Many Forms

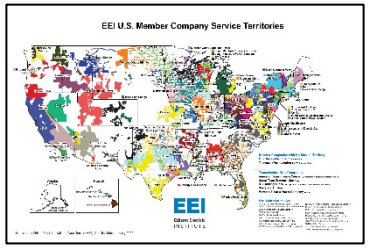
Residential neighborhoods

Mixed-use development

Commercial and multi-family buildings

University, or corporate campus

Geographically-dispersed building portfolio



Different geographies with varied utility and regulatory practices

New construction and existing building retrofits

DER integration: PV, battery storage, EV charging, CHP & district systems

DOE *Connected Communities* FOA Research Wish List

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

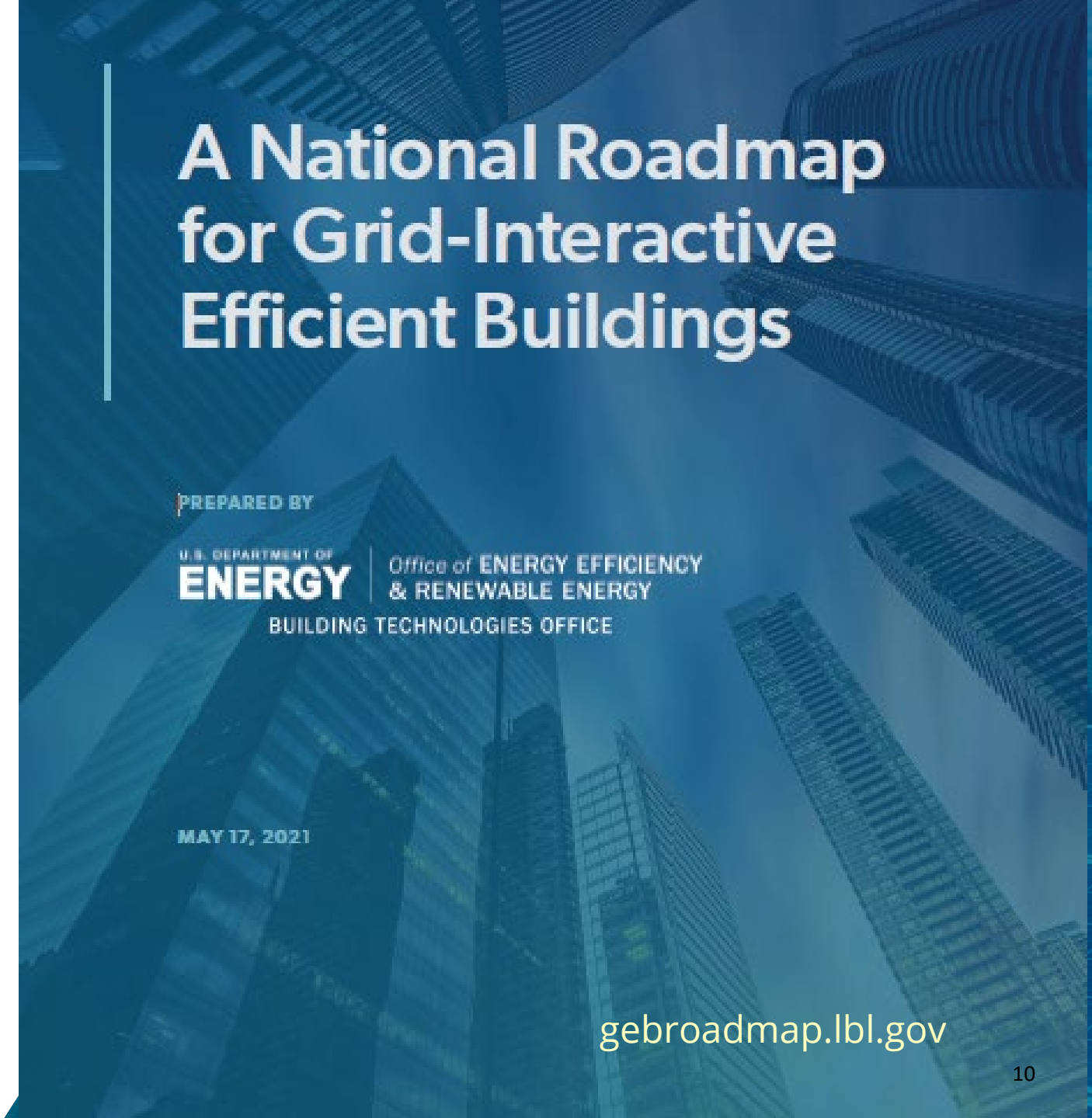
Seeking insights on research needs. What technology performance and pricing needs work across efficiency, flexibility and DER integration?

Activities Beyond R&D

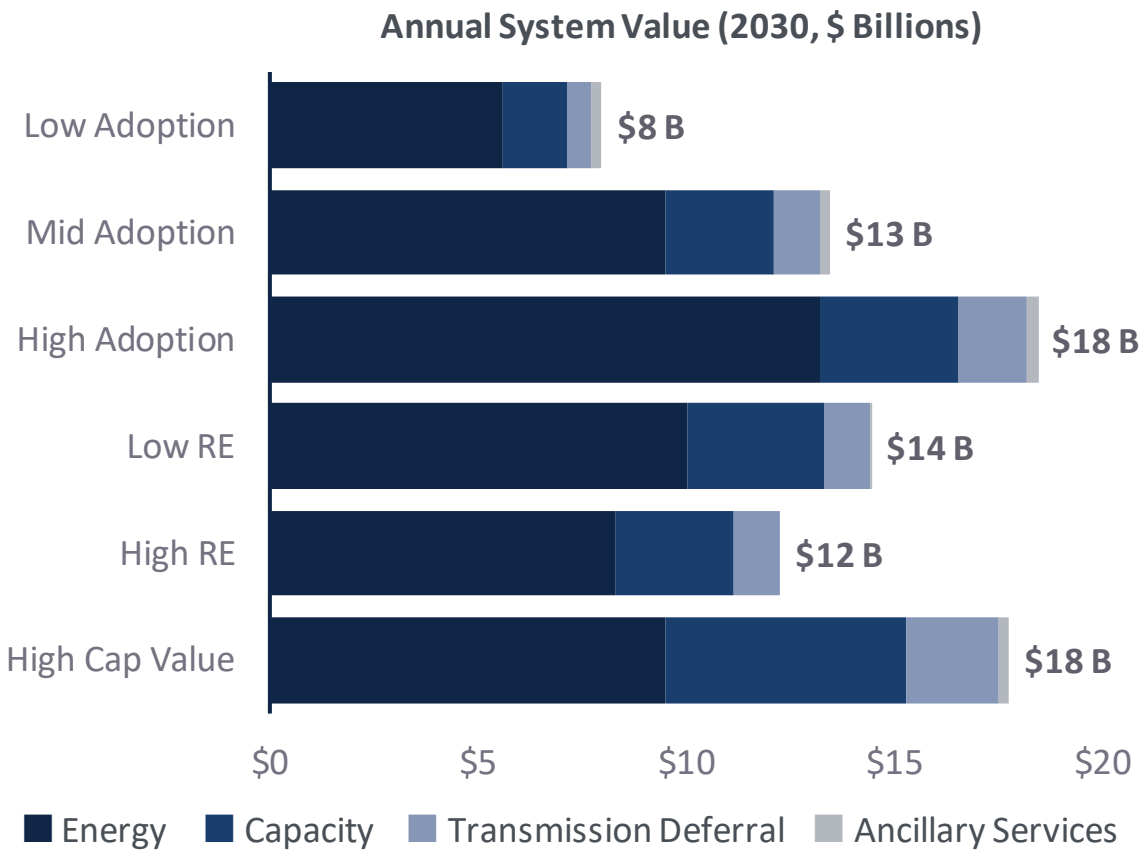
- ✓ **Building Energy Codes**
  - Code values EE measures based on when savings occur
  - Compliance paths provide credit for DF measures
  - Code includes grid-interactive requirements and open standards for communication and automated load management
- ✓ **Appliance and Equipment Standards**
  - Equipment capable of automated load management in response to a signal
- ✓ **Resource Standards**
  - EE resource standards (EERS) include peak demand targets
  - States account for time-sensitive value of EE
  - DR included in EERS or eligible to meet clean energy standards
- ✓ **Utility Programs**
  - EE program goals include peak demand reduction
  - Cost-effectiveness assessments of EE programs consider time-sensitive value of savings**
  - EE program metrics include carbon emissions
  - Requirements for DR programs include potential studies
  - DR goals include significant increases in peak demand savings over time
  - Programs for utility customers address equity
  - Pay for performance programs
  - Locational value informs incentive rates for EE and DR
  - Programs address multiple DERs to achieve DF
- ✓ **What else?**

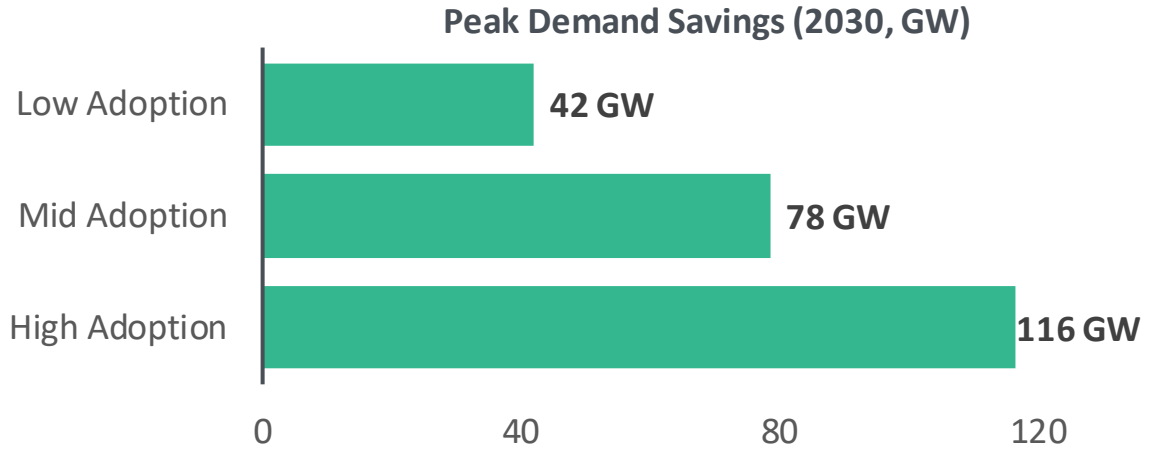
A National Roadmap for Grid-Interactive Efficient Buildings

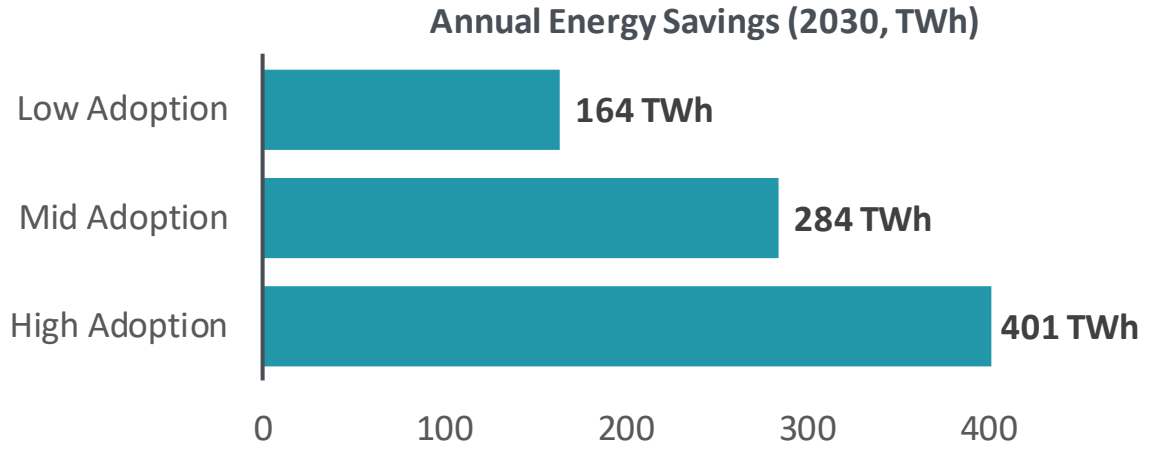
a/k/a **the $100-$200 Billion Opportunity**



GEBs could save up to $18 billion per year in power system costs by 2030, or roughly **$100 to $200 billion** between 2020 and 2040







Notes: All in 2019 dollars. Peak demand savings are computed as the sum of impacts during each region's coincident peak hour. $100 - $200 billion reflects the NPV at a social discount rate of 4% nominal (2% real).

Pillar 1: Advancing GEBs through research and development

Recommendation	Example Action
Research, Develop and Accelerate Deployment of GEB Technologies	Support development and field testing of user-friendly, affordable integrated whole-building control and grid service delivery
Accelerate Technology Interoperability to Optimize Efficiency and Demand Flexibility Performance	Accelerate adoption of existing open standards, particularly at the application layer
Collect and Provide Data and Develop Methods for Benchmarking and Evaluating Demand Flexibility Technology & Whole Building Performance	Expand EE benchmark dataset and benchmarking tools to incorporate demand flexibility

Pillar 2: Enhancing the Value of GEBs to Consumers and Utilities

Recommendation	Example Action
Improve and Expand Innovative Customer Demand Flexibility Program Offerings	Design and market demand flexibility programs with a focus on consumer preferences
Expand Consumer Knowledge and Consideration of Price-based Programs	Plan for full scale deployment
Introduce Incentives for Utilities to Deploy Demand Flexibility Resources	Identify and evaluate the appropriate incentive mechanisms to encourage investment in demand-side programs
Comprehensively Incorporate Demand Flexibility into Utility Resource Planning	Ensure that a comprehensive list of demand-side measures are considered in the analysis, and account for all applicable value streams

Pillar 3: Empowering GEB Users and Operations

Recommendation	Example Action
Understand How Users Interact with GEBs and the Role of Technology	Evaluate the relationship between prices, incentives, technology and load flexibility
Develop Tools to Support Decision Making on Design and Operation of GEBs	Enhance capabilities of existing building performance tools to include demand flexibility and GHG emissions information
Leverage Existing Building-Related Workforce Programs to Integrate Advanced Building Technology and Operations Education and Training	Establish building training and assessment centers

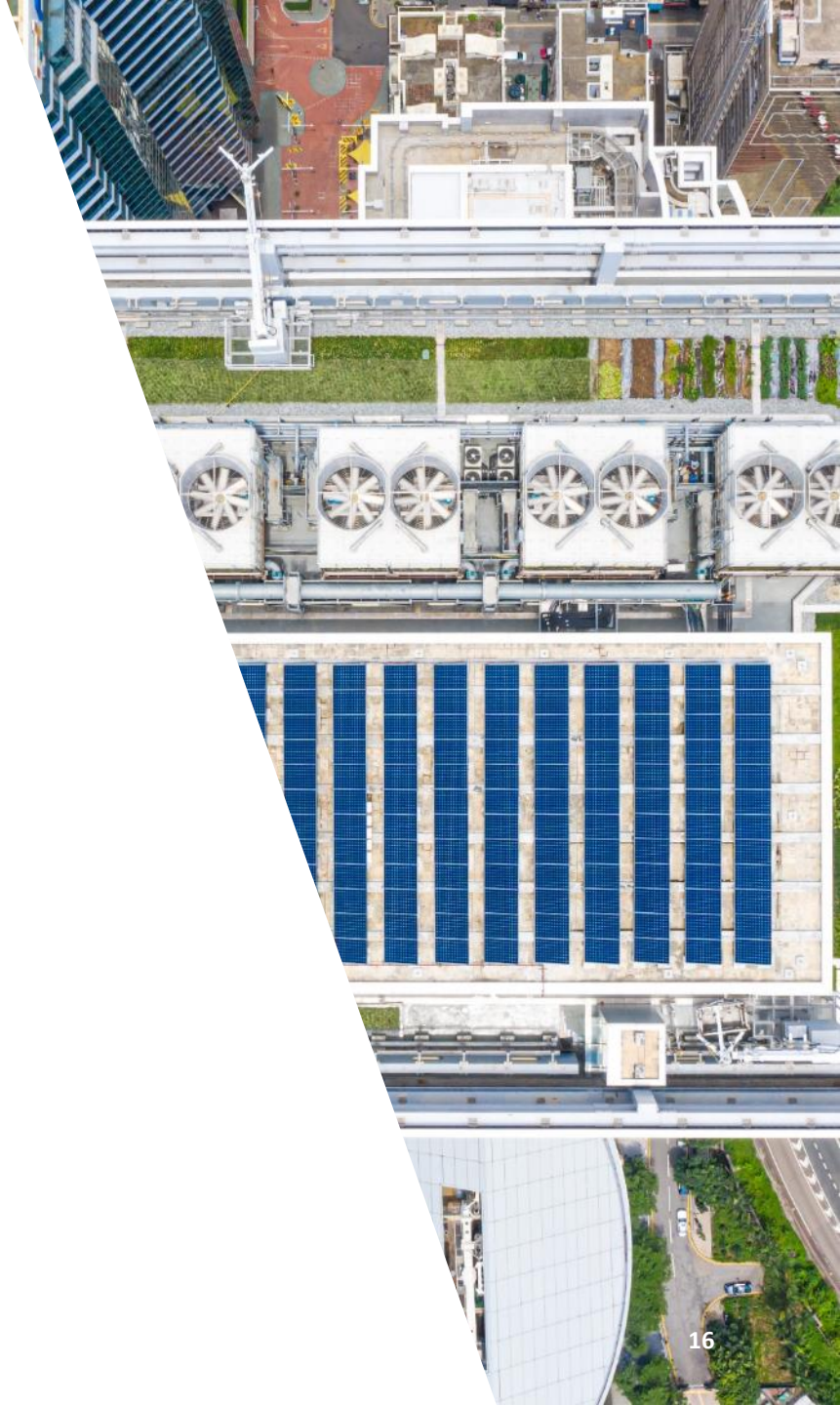
Pillar 4: Supporting GEB Deployment through State and Federal Enabling Programs and Policies

Recommendation	Example Action
Lead by Example	Government building participation in demand response and energy efficiency programs and markets
Expand Funding and Financing Options for GEB Technologies	Identify how requirements of existing financing and funding mechanisms for EE can be modified to include demand flexibility
Expand Codes and Standards to Incorporate Demand Flexibility	Combine grid-interactive requirements and open standards for automated communication with energy efficiency requirements
Consider Implementing Demand Flexibility in State Targets or Mandates	Consider establishing statewide or utility-specific demand flexibility procurement requirements

Putting the recommendations into action

DOE has established a goal of tripling energy efficiency and demand flexibility in residential and commercial buildings by 2030, relative to 2020 levels

- All stakeholders play an important role in successfully implementing the Roadmap recommendations and achieving this ambitious goal
- Strong leadership that works effectively across all key market actors, policy and program actors, and other stakeholder groups is necessary to successfully realize this enormous opportunity
- Given its national scope, resources, legal authorities, convening power, and new commitment to forceful measures to mitigate CO_2 emissions, DOE will play a central role in advancing GEBs as a resource for the future U.S. clean energy economy and modern electric grid, and to make the nation's homes and buildings more affordable and sustainable.



Thank You

Let's work together

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BTO: www.energy.gov/eere/buildings

GEBsite: www.energy.gov/eere/buildings/GEB

GEB Roadmap: gebroadmap.lbl.gov