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<th>Docket Number:</th>
<th>21-IEPR-06</th>
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<tbody>
<tr>
<td>Project Title:</td>
<td>Building Decarbonization and Energy Efficiency</td>
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<td>239951</td>
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<tr>
<td>Document Title:</td>
<td>Presentation - A National (and California) Roadmap for GEBs</td>
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<tr>
<td>Description:</td>
<td>S1.1 David Nemtzow</td>
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<tr>
<td>Filer:</td>
<td>Raquel Kravitz</td>
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<td>U.S. Department of Energy (DOE)</td>
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<td>10/4/2021</td>
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A National (and California?) Roadmap for GEBs
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
- Changing Load Shapes
- Tighter envelope
- Advanced Building Energy Systems

### Managing Behind-the-Meter Assets
- Energy Use Optimization
- Buildings as a resource
- Create load shapes

### Identifying Revenue & Rate Design Impacts
- Informed Load Forecasting
- New building codes & standards
- How to price energy in IoT future

### Understanding Renewable Energy Grid Integration
- Help meet 2050 Low-to-No Carbon Goal
- New infrastructure needs
- Balance grid & customer benefits
Results from DOE’s First Connected Communities (aka Smart Neighborhoods)

Reynolds Landing (Hoover, AL)  
- 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 CO₂ avoided per home

Average Home Energy Use

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Reynolds Landing</th>
<th>Altus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity used</td>
<td>100%</td>
<td>56%</td>
<td>58%</td>
</tr>
<tr>
<td>Electricity bought</td>
<td>100%</td>
<td>58%</td>
<td>42%</td>
</tr>
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</table>

Altus at the Quarter (Atlanta, GA)  
- 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 CO₂ 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
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).

A National Roadmap for Grid-Interactive Efficient Buildings
## RECOMMENDATIONS FOR ACCELERATING GEB ADOPTION

### Pillar 1: Advancing GEBs through research and development

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Example Action</th>
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<tbody>
<tr>
<td>Research, Develop and Accelerate Deployment of GEB Technologies</td>
<td>Support development and field testing of user-friendly, affordable integrated whole-building control and grid service delivery</td>
</tr>
<tr>
<td>Accelerate Technology Interoperability to Optimize Efficiency and Demand Flexibility Performance</td>
<td>Accelerate adoption of existing open standards, particularly at the application layer</td>
</tr>
<tr>
<td>Collect and Provide Data and Develop Methods for Benchmarking and Evaluating Demand Flexibility Technology &amp; Whole Building Performance</td>
<td>Expand EE benchmark dataset and benchmarking tools to incorporate demand flexibility</td>
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### Pillar 2: Enhancing the Value of GEBs to Consumers and Utilities

<table>
<thead>
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<tbody>
<tr>
<td>Improve and Expand Innovative Customer Demand Flexibility Program Offerings</td>
<td>Design and market demand flexibility programs with a focus on consumer preferences</td>
</tr>
<tr>
<td>Expand Consumer Knowledge and Consideration of Price-based Programs</td>
<td>Plan for full scale deployment</td>
</tr>
<tr>
<td>Introduce Incentives for Utilities to Deploy Demand Flexibility Resources</td>
<td>Identify and evaluate the appropriate incentive mechanisms to encourage investment in demand-side programs</td>
</tr>
<tr>
<td>Comprehensively Incorporate Demand Flexibility into Utility Resource Planning</td>
<td>Ensure that a comprehensive list of demand-side measures are considered in the analysis, and account for all applicable value streams</td>
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## Pillar 3: Empowering GEB Users and Operations

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

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

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Lead by Example</strong></td>
<td>Government building participation in demand response and energy efficiency programs and markets</td>
</tr>
<tr>
<td><strong>Expand Funding and Financing Options for GEB Technologies</strong></td>
<td>Identify how requirements of existing financing and funding mechanisms for EE can be modified to include demand flexibility</td>
</tr>
<tr>
<td><strong>Expand Codes and Standards to Incorporate Demand Flexibility</strong></td>
<td>Combine grid-interactive requirements and open standards for automated communication with energy efficiency requirements</td>
</tr>
<tr>
<td><strong>Consider Implementing Demand Flexibility in State Targets or Mandates</strong></td>
<td>Consider establishing statewide or utility-specific demand flexibility procurement requirements</td>
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</table>
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 CO₂ 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