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Grid-Interactive Efficient Buildings (GEB)

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BUILDING TECHNOLOGIES OFFICE
NREL NATIONAL RENEWABLE ENERGY LABORATORY

What Are Grid-Interactive Efficient Buildings?

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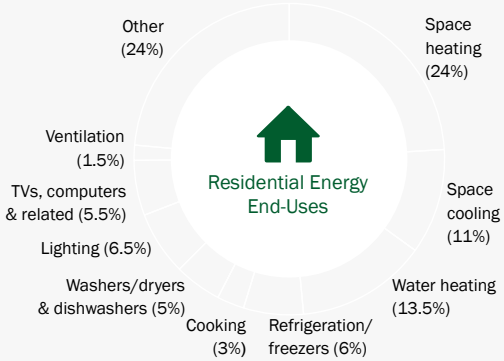
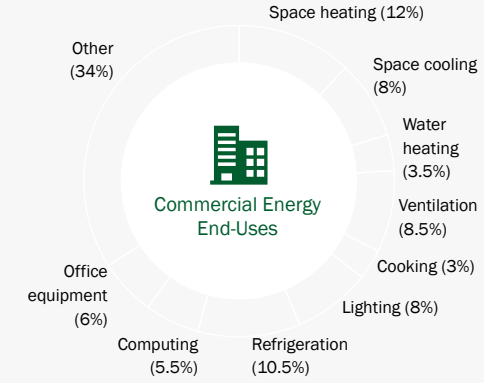
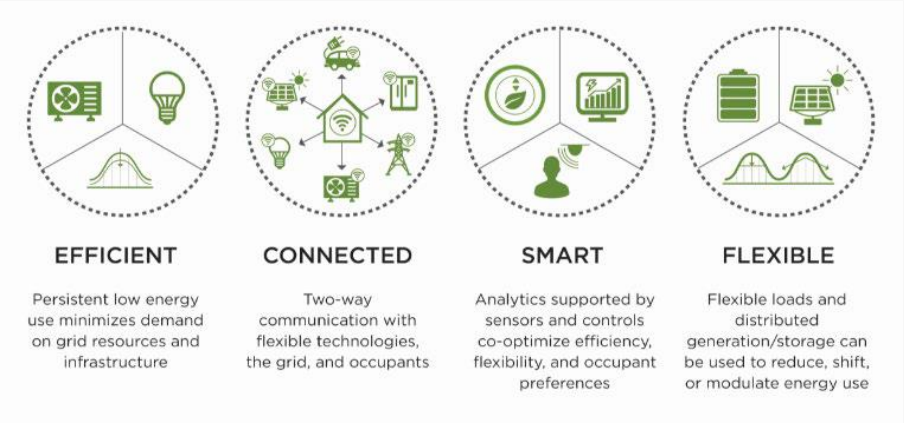
GEBs are buildings that integrate and optimize DERs in conjunction with the electric grid to provide benefits to building owners and occupants as well as to the operation of the electricity system





Four Key GEB Features

- **Energy Efficiency** – high-performance equipment and building envelopes
- **Connectivity** – **u**biquitous sensing and optimized controls with two-way communications
- **Smart** – manage behind-the-meter DERs to benefit grid, building owners/occupants
- **Flexible** – dynamic load shaping and optimization of resources



GEB uses integrated smart technologies to provide flexibility while co-optimizing energy cost, grid services, occupant needs and preferences

Improving Efficiency and Flexibility

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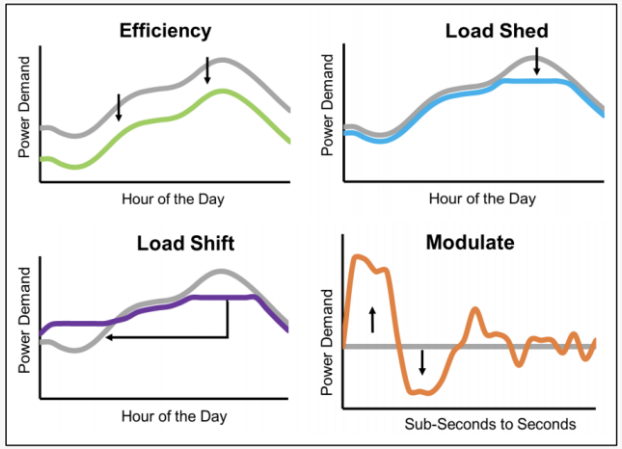
Efficiency is the ongoing reduction in energy use while providing the same or improved level of building function.

Load Shed is the ability to reduce electricity use for a short time period and typically on short notice. Shedding is typically dispatched during peak demand periods and during emergencies.

Load Shift is the ability to change the timing of electricity use for minimizing demand during peak periods, taking advantage of the cheapest electricity prices, or reducing the need for renewable curtailment.



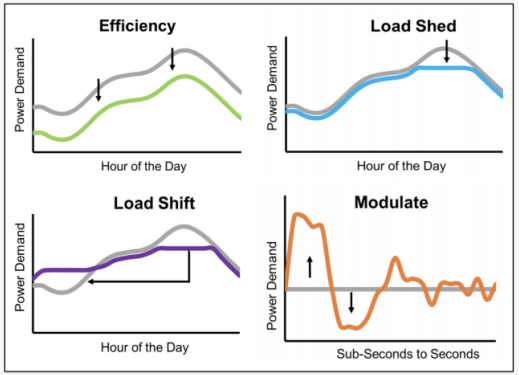
Building flexibility load curves

Source: Grid-interactive Efficient Buildings Technical Report Series: Overview of research challenges and gaps

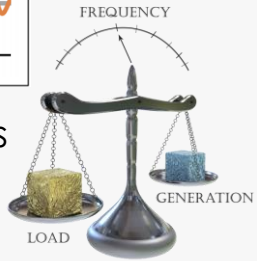
Improving Efficiency and Flexibility (cont'd)

Modulate is the ability to balance power supply/demand or reactive power draw/supply autonomously (within seconds to sub-seconds) in response to a signal from the grid operator during the dispatch period.

Generate is the ability to generate electricity for on-site consumption and even dispatch electricity to the grid in response to a signal from the grid. Batteries are often included in this discussion, as they improve the process of dispatching such generated power.



Building flexibility load curves



Source:Grid-interactive Efficient Buildings Technical Report Series: Overview of research challenges and gaps

Background
Demand Response Programs

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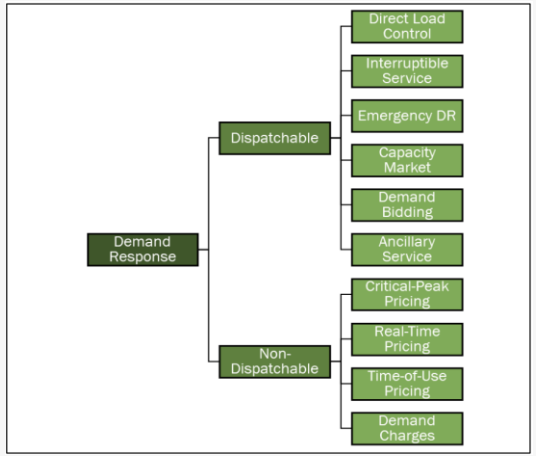
Demand Response Programs (DR)

- Management programs can reduce or shift electricity usage during peak periods in response to time-based rates or other forms of incentives.
- However, existing programs are limited in scope both in number of buildings loads engaged as well as the amount of demand flexibility engaged in specific utilities.

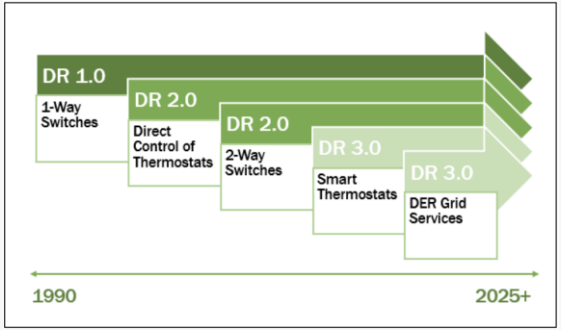


Demand Response Classifications

Source: Grid-interactive Efficient Buildings Technical Report Series: Overview of research challenges and gaps

Background
Demand Response Programs

- By engaging this demand flexibility to provide grid services, there is room for significant impact
  - For example, like peak demand reduction
- On-site distributed energy resources (DERs) can be co-optimized with building loads to expand demand options
  - such as rooftop photo voltaic (PV)
  - electric vehicle charging
  - batteries

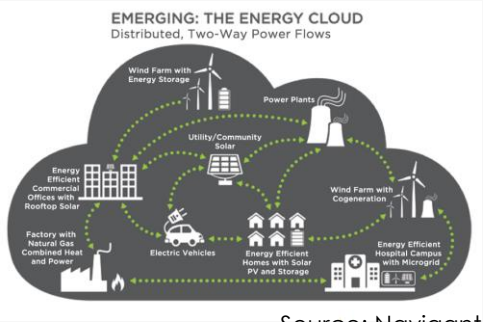


Demand Response Evolution

Source:Grid-interactive Efficient Buildings Technical Report Series: Overview of research challenges and gaps

Benefits of GEBs

- Demand must be met through matching services provided by supply-side entities: integrated utilities, grid operators, generators, and/or distributed generation resources
- Building owners or occupants that use demand-side management strategies may do so for various motivations, including compensation through lower utility bills, lower rates, or negotiated payments



Source: Navigant

- $ Reduced energy bills
- Improved reliability
- Reduced grid congestion
- Market price reductions
- Environmental benefits
- Customer choice and improved services

The challenge

Grid Interactive Energy Efficient Buildings Challenge

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- A conceptual designs
  - intelligent algorithms that optimize the operation of building's active and passive systems to maximize energy efficiency
  - whole-building-level interoperable automation systems that enable communication between building equipment and appliance to optimize operation to provide grid services.

► **Challenge !!**

The challenge
Potential GEB Solution

Teams can explore solutions appropriate to any and all building uses and building types, including residential buildings, commercial buildings, and campuses and may choose to, but not limited to, work on some of the following research items and strategies:

- **Interoperability.** Innovative approaches to establish two-way connectivity and communications with the building equipment and appliances as well as the grid
- **Control Algorithm Development.** Intelligent algorithms for optimal scheduling of devices that can maintain user comfort while minimizing energy cost. This may include data-driven and machine learning approaches
- **Building Load Shaping to Match Renewable Generation.** Control and coordination concepts that enable innovative load shapes to maximize utilization of renewable generation for optimizing occupant energy usage and changing conditions over multiple timescales
- **Ensuring Occupant Comfort.** User-friendly methods to obtain feedback on comfort from occupants while the building is providing grid services

The challenge
Requirements

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- Problem statement. Identify stakeholder(s)
- Description of the proposed solution. What problem or need does it address? How does the solution address that problem?
- Details about how the proposed solution will be integrated with and improve upon the existing approach of the building
- How the proposed solution will benefit both end-users and the grid (e.g., quantified potential energy and nonenergy benefits realized through increased automation and user interaction)

Additional Resources

Grid-Interactive Efficient Buildings

- https://www.energy.gov/eere/buildings/grid-interactive-efficient-buildings

Grid-interactive Efficient Buildings Technical Report Series: Overview of research challenges and gaps

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

Grid-interactive Efficient Buildings Technical Report Series: Windows and opaque envelope

- https://www1.eere.energy.gov/buildings/pdfs/75387.pdf

Buildings-to-grid integration

- https://www.energy.gov/eere/buildings/about-buildings-grid-integration

State of the Market: Grid-Interactive Efficient Building Utility Programs

- https://www.aceee.org/white-paper/gebs-103019

Grid-interactive efficient buildings: Assessing the potential for energy flexibility alongside energy efficiency

- https://www.energy.gov/sites/prod/files/2020/06/f76/bto-geb-potential-062520.pdf

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Questions or Comments?

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Thank You!