U.S. DEPARTMENT OF ENERGY

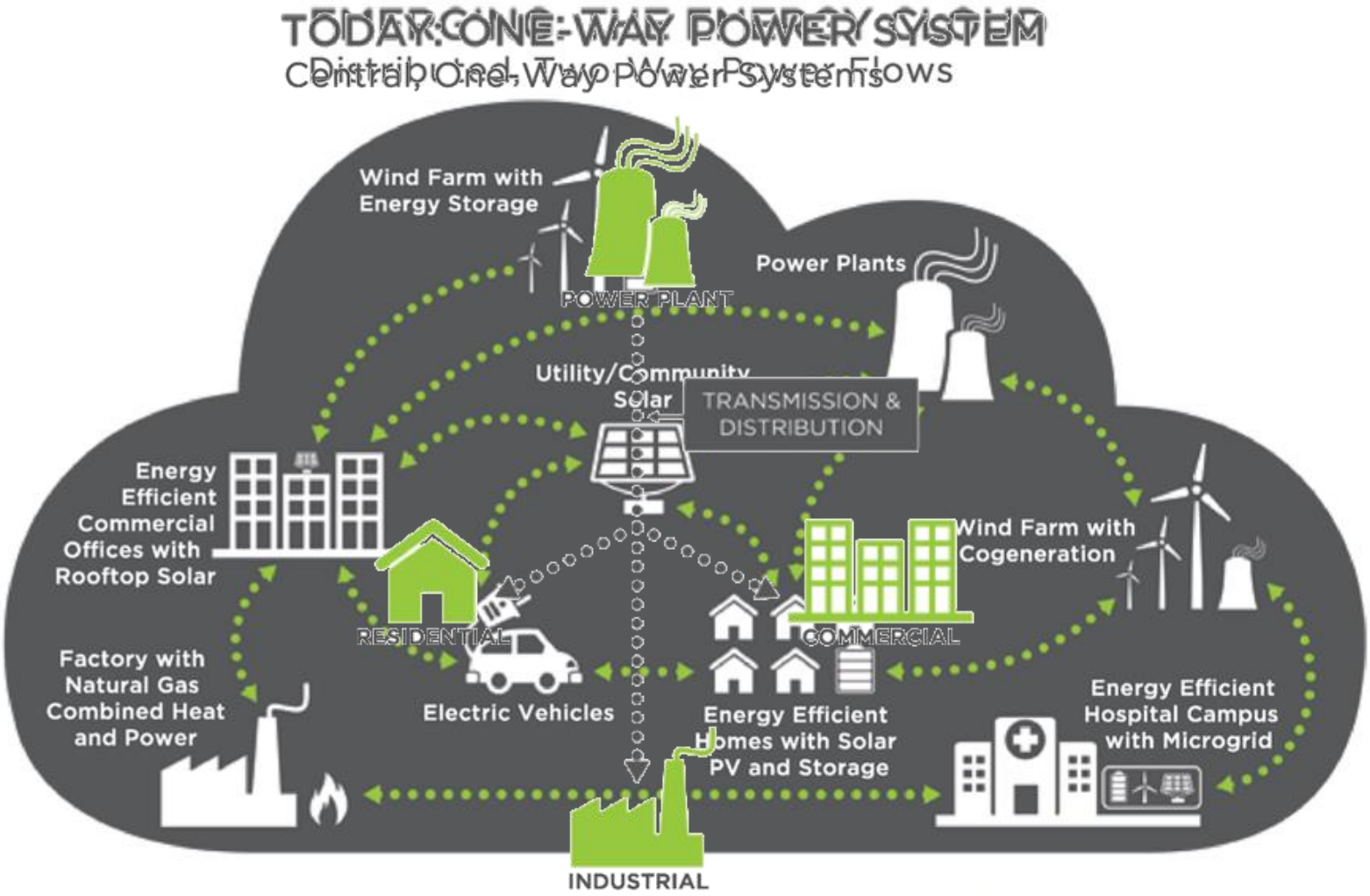
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Grid-Interactive Efficiency Buildings Overview

Building Technologies Office

July 12, 2018

Moving Towards the Grid of the Future

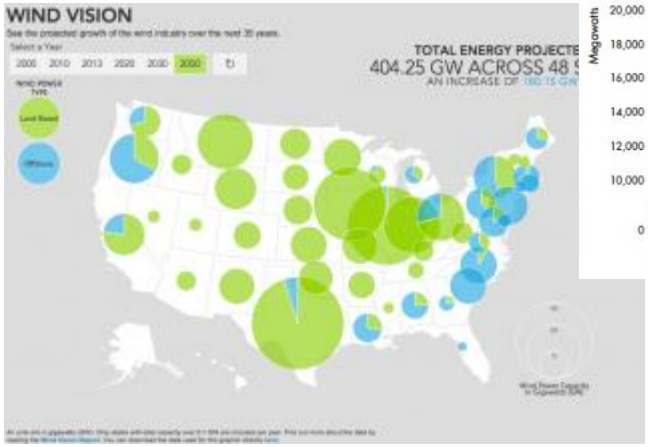


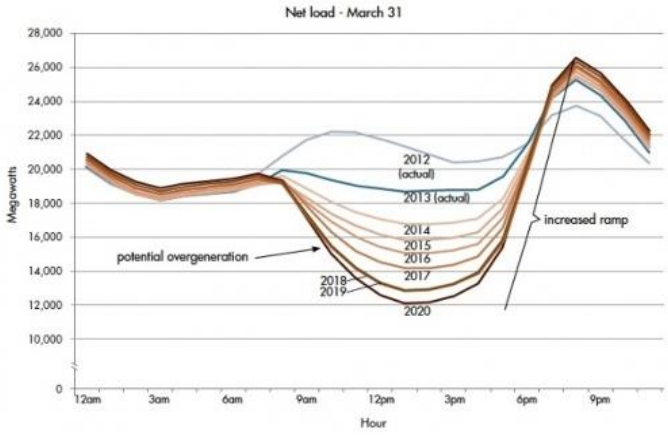
Source: Navigant

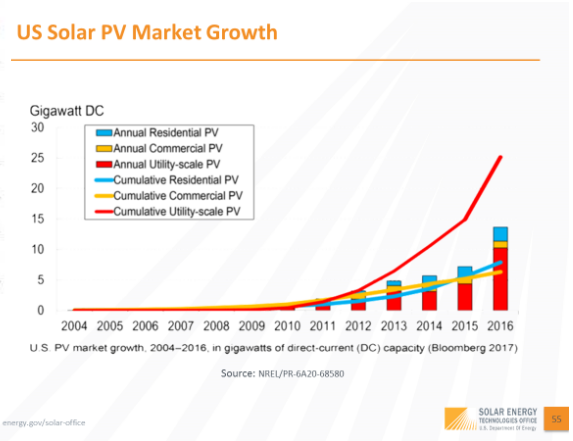
Changing Electricity System

A changing energy system is creating an opportunity for buildings to serve as flexible, responsive demand side resources:

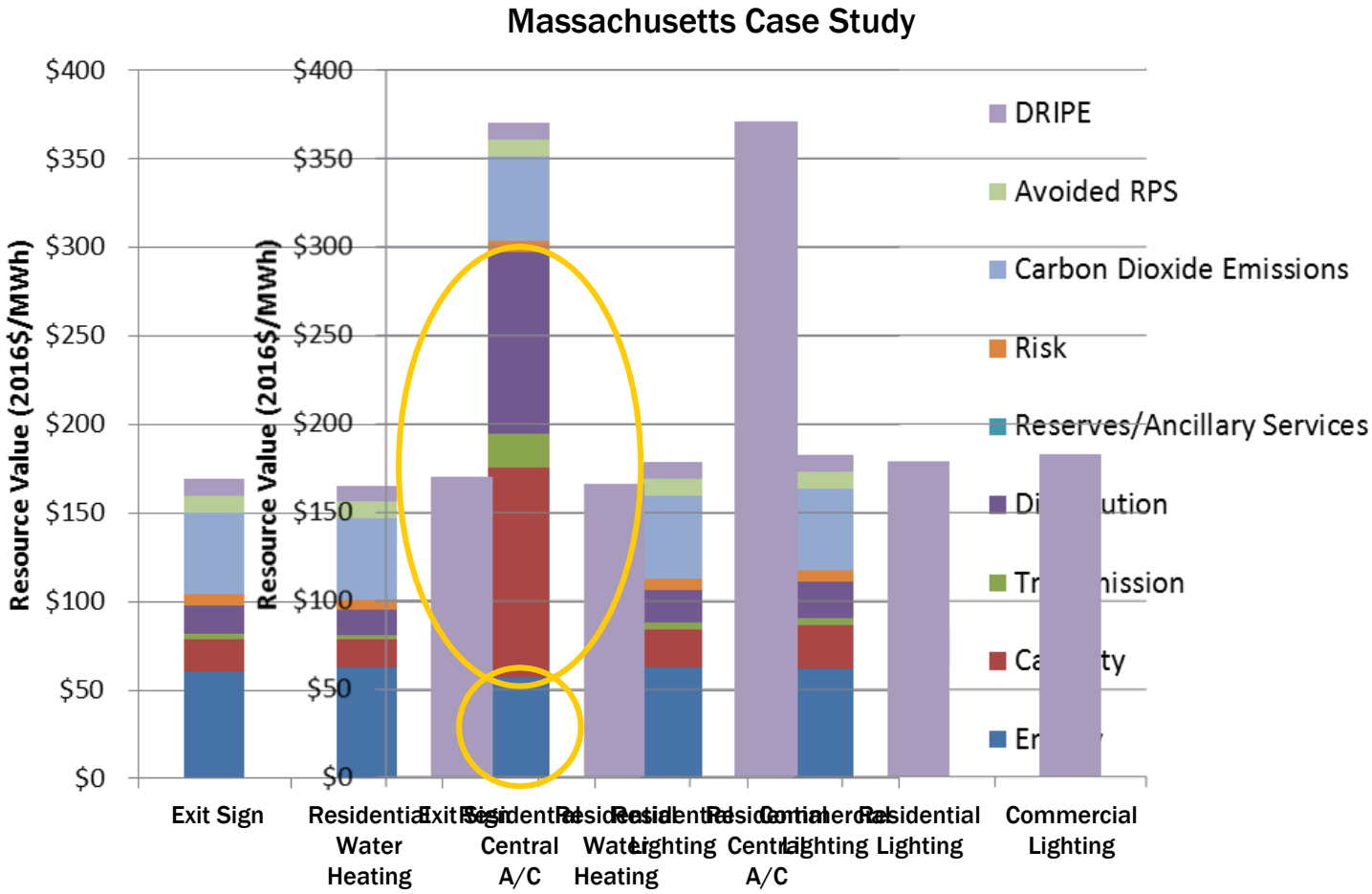
- **Solar** – Since 2013 has represented at least 25% of all new capacity – and now represents 53 giga-watts of total capacity
- **Wind** – Expected to account for over 250 billion kWh MAKE GWH of production in 2018 – and over 400 billion kWh by 2022







Not All Energy Efficiency is Equally Valuable



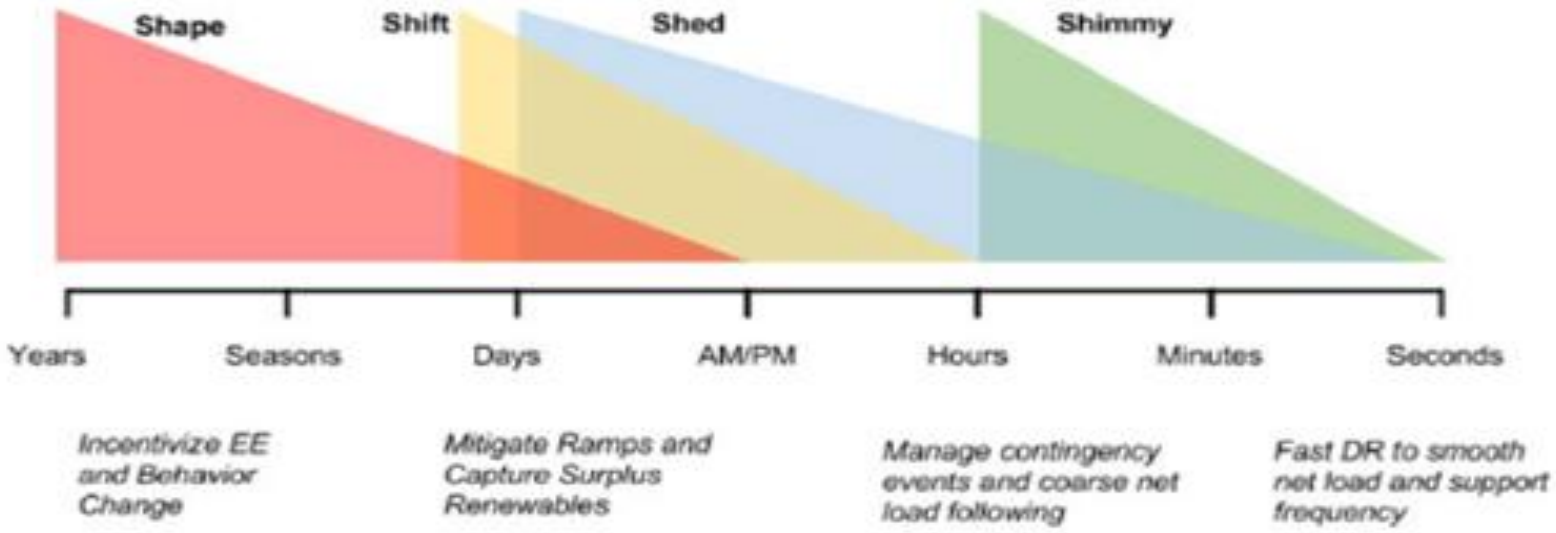
Time-varying value of energy efficiency savings by load shape

(reflects publicly available data only)

Source: ***Time-Varying Value of Electric Energy Efficiency*** *June 2017* N.Mims, T.Eckman & C.Goldman, LBNL, for BTO

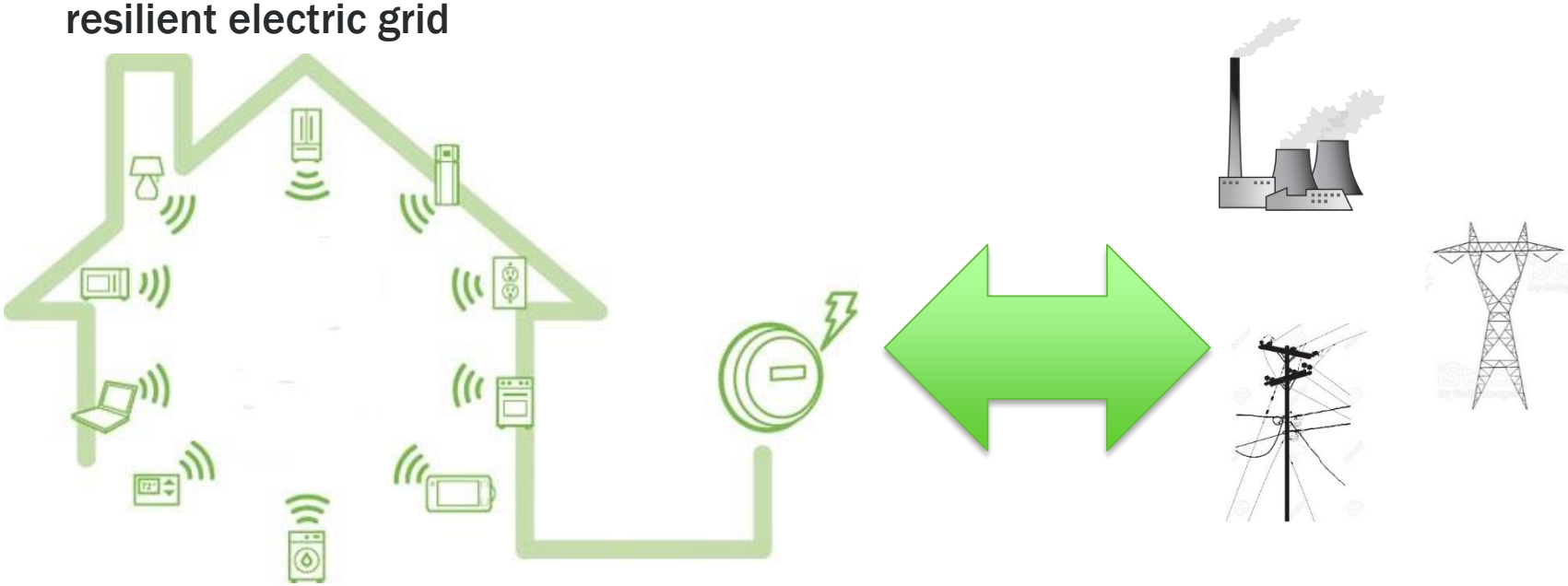
EE/DSM Services Buildings can Provide

Buildings *are* ***underutilized*** as a flexible electric system resource



BTO R&D is Improving Building-to-Grid Interactions

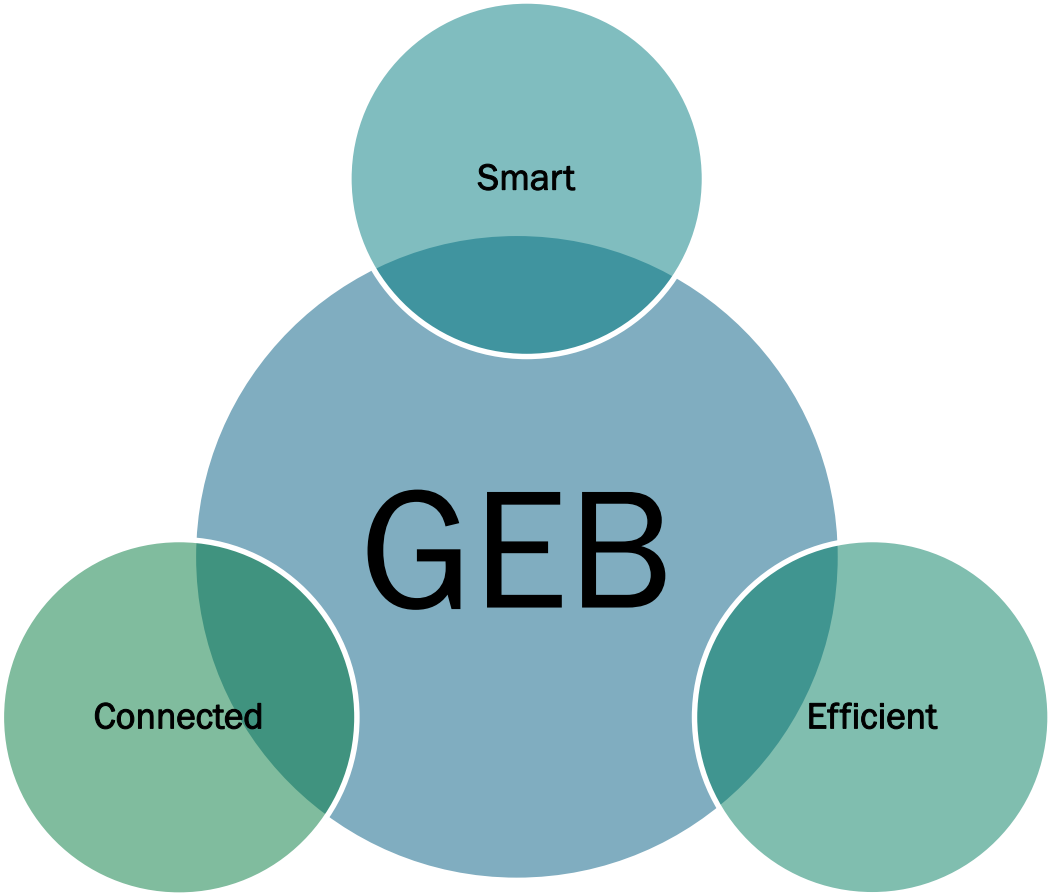
- BTO is identifying key concepts of grid-interactive efficient buildings (GEB) that outline specific technical challenges and opportunities related to building-grid interaction
- Defining GEB concepts will help better integrate the significant portion of BTO's current activities that contribute to a more interactive, efficient, affordable and resilient electric grid



BTO Mission

To develop, demonstrate, and accelerate the adoption of technologies, techniques, tools, and services that are ***affordable***, as well as to enable ***high-performing***, ***energy-efficient*** residential and commercial buildings in both the new and existing buildings markets.

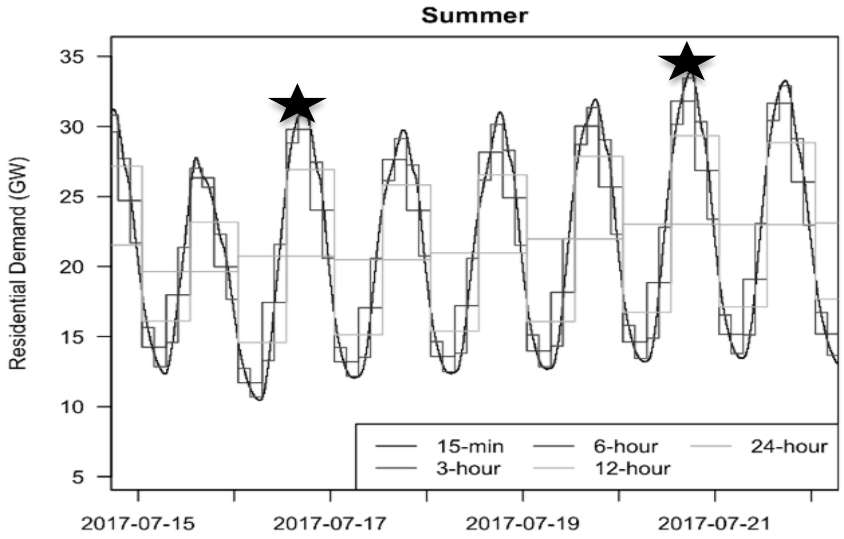
Grid-interactive Efficient Buildings (GEBs)

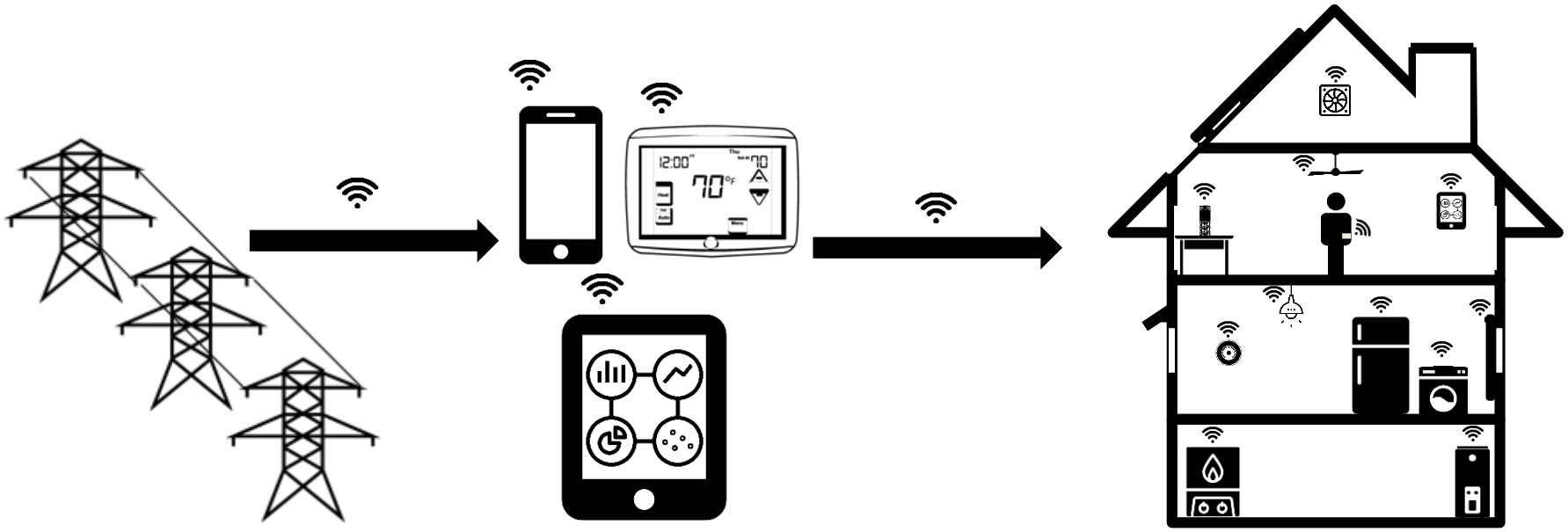


- **GEB**: an efficient, connected and smart building with a portfolio of interoperable technologies that can adjust demand up or down and shift, store, or dispatch electric load in response to grid and building needs.
- GEB technologies include smart thermostats, wireless sensors and controls, building automation systems, distributed energy storage, smart meters, and efficient, connected air conditioning, lighting & appliances.
- GEBs can help American families and businesses affordably reduce their utility bills, access new sources of revenue, increase comfort and convenience, and gain greater control over energy use.

Grid-interactive Efficient Building Concept

1. Lowers total electricity demand
2. Flattens peak demand
3. Aligns with variable renewable energy generation (considers load net of renewables)

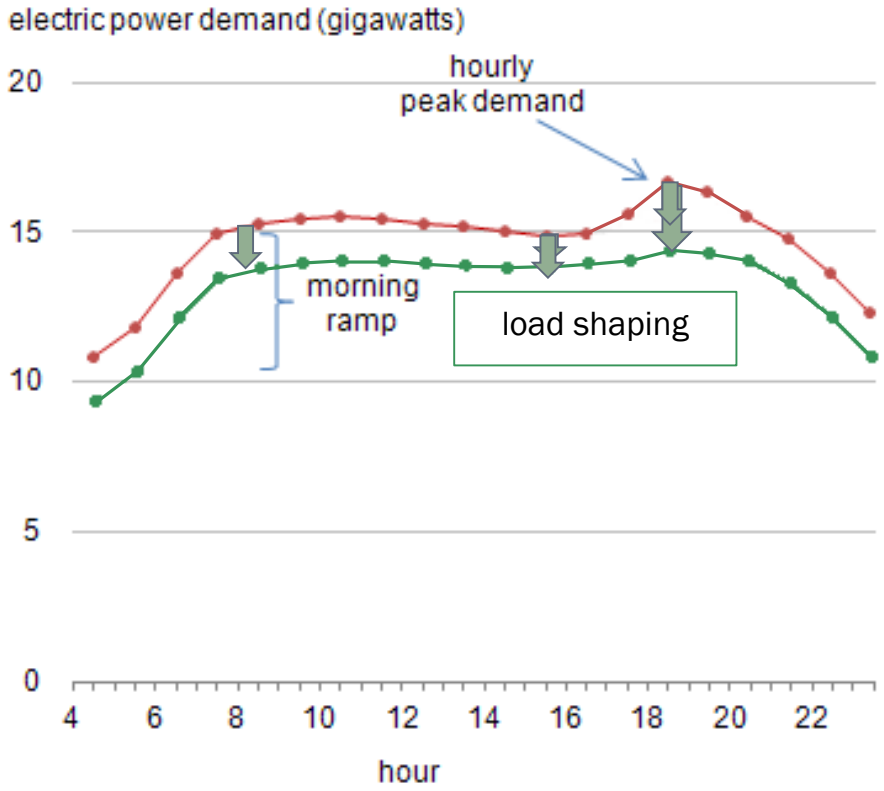




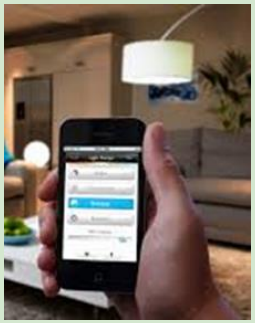
Energy Efficiency can be Key Responsive Grid Resource

Energy efficiency projects remove energy loads from the grid, reducing the energy supply required.

- Defers or eliminate investments in new electric generation capacity or the T&D system; and
- Reduces peak demand and the strain placed on existing T&D infrastructure.

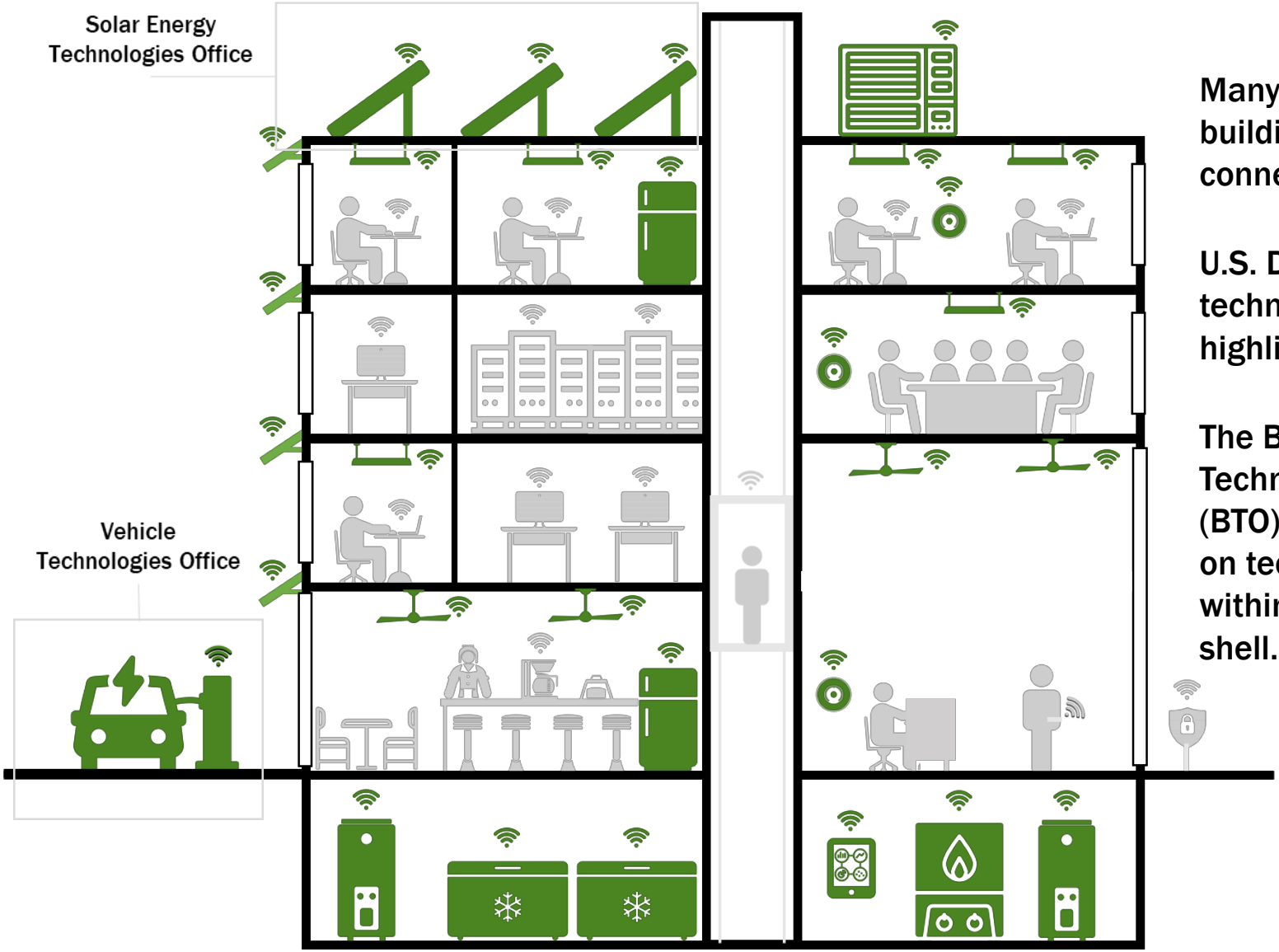


Examples of GEB technologies

	Passive	Active	Connected
Non-Storage	Daylighting 	LED Lighting 	Lighting Controls 
Storage	Phase Change Materials 	H_2O-Based Thermal Storage 	Controllable Multi-Speed HVAC 

EE+DR Additionality
Optimized Lighting: • Minimized Energy Consumption • High Occupant Comfort • Low Ability to Provide Grid Services
Optimized Comfort: • Minimized Energy Consumption • High Occupant Comfort • High Ability to Provide Grid Services

Cybersecurity for Connected Devices in Buildings



Many technologies in buildings can be connected.

U.S. DOE works on technologies highlighted in green.

The Building Technologies Office (BTO) leads research on technologies within the building shell.

GEB in Action: Connected Neighborhoods

Image courtesy of Alabama Power

Smart Neighborhood

- Outside Birmingham, AL
- 62 homes connected to community microgrid (solar, battery storage, natural gas)
- 35% more efficient homes (compared to standard AL new home)

This first of-its-kind transactive residential microgrid in the Southeastern United States is a partnership between Southern Company (Alabama Power, Georgia Power), DOE, Oak Ridge National Laboratory, Electric Power Research Institute, Vivint, Carrier, and Rheem.

The neighborhood's intelligent technology communicates with each home's heating, air conditioning, and water-heating system to determine the best way to provide energy.

How can GEB Support the Grid?

- Reducing peak electric demand: smart technologies can help reduce peak electric demand by communicating with the grid and determining the best time to cycle off and on high energy-intensive equipment (e.g. HVAC, pool pumps, refrigerators);

- Helping integrate variable renewables: the flexibility offered by smart technologies can help integrate variable renewables like solar and wind by enabling the precise control of electricity use – so that when the wind isn't blowing or a cloud blocks the sun, energy demand can be managed to maintain the balance of energy sources and loads;

- Providing de facto storage capability: smart building technology can offer "virtual storage" which, like traditional batteries but without the same upfront cost, allows building owners, homeowners and tenants to shift their energy use from peak to off-peak times, providing additional resilience and stability to the electric grid; and

- Helping balance power flows: behind-the-meter assets such as home energy management systems or smart inverters can help manage and balance power flows for buildings that have distributed renewables installed on-site – by shifting energy consumption on the building's side of the meter, these systems reduce any need for distributed resources to "back feed" onto the grid.

BTO Early Stage GEB R&D Focus Areas

- Building energy management **Cyber-Physical Systems** to enhance the provision of grid services, including advanced building controls, sensing, metering, and data analytics
- Energy efficient **Component-Based Technologies** that interact with the grid
- Advancement of **Building Energy Modeling** to support design, planning, and valuation
- **Systems Integration** to validate GEB technologies and verify benefits

Questions for STEAB

- What state and local priorities should DOE consider as it advances GEB?
- What actions are occurring at the state level that could inform DOE research on GEB?
- What are key LMI considerations for GEB?
- How can states partner with DOE to analyze and demonstrate the value of GEB?