

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Grid-interactive Efficient Buildings

NASEO EPO Conference *Kick-Off Meeting*

David Nemptzow, Director

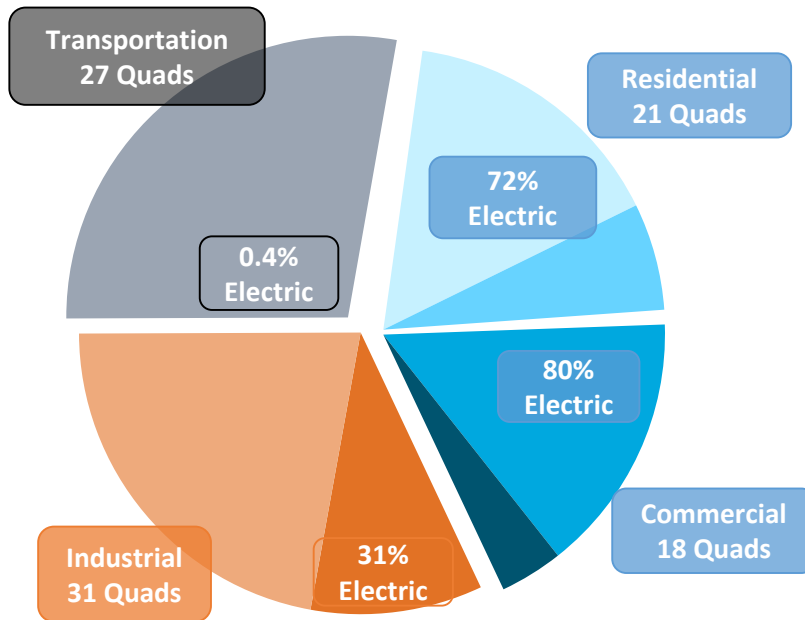
Director, U.S. Building Technologies Office

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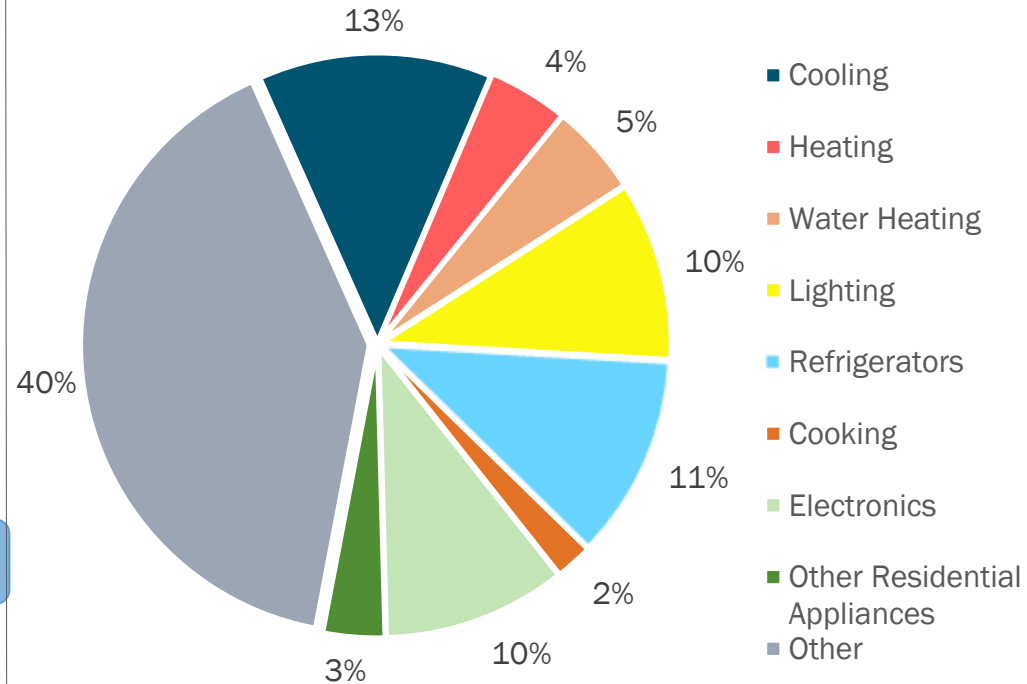


Energy use in the U.S. building sector

Energy Use



Building Electricity Use



Buildings Energy Use: 40% of U.S. total

Buildings Electricity Consumption: 75% of U.S. total

Buildings Peak Electricity Demand: ~80% of regional total

U.S. Building Energy Bill: US\$380 billion per year

Source: EIA 2017 Annual Energy Outlook

Flexible building loads



Provide options to increase electricity system reliability & energy affordability



Support renewables & all generation options resulting from grid modernization



Optimize energy use based on customer preferences

Respond to innovations in the energy economy

Key Aspects of a Grid-Interactive Efficient Building



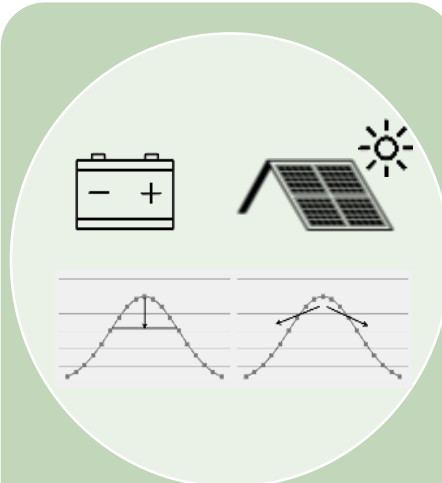
Smart

Sensing, control, analytics co-optimize efficiency, flexibility and occupant needs



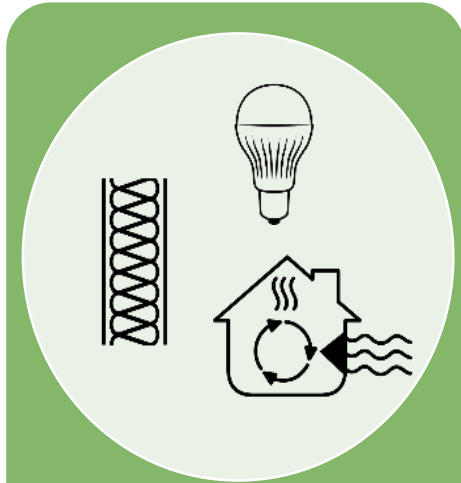
Connected

Two-way communication with flexible technologies, grid, occupants



Flexible

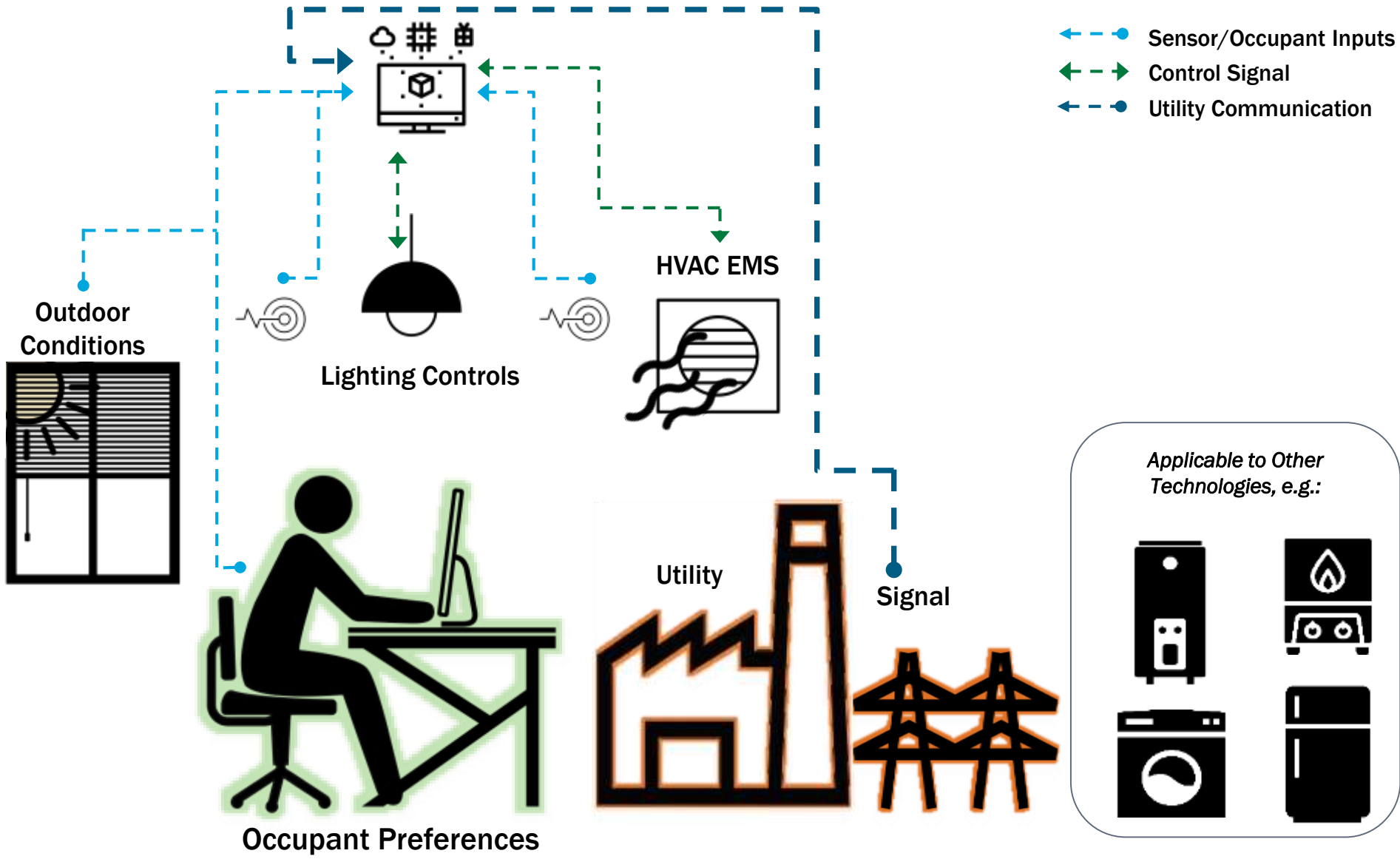
Flexible loads, DG/DERs/storage can reduce, shift, modulate grid-level energy use



Efficient

Persistent low energy use minimizes demand on grid resources and infrastructure, save energy & money!

Interactions with Building Occupants



Flexible Building Services Provided by GEB

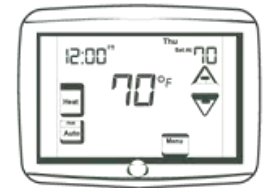
Efficiency

- Reduced overall demand, including during high-cost periods
- Efficient appliances, insulated envelope
- **Grid Service: Reduce generation and T&D upgrade**



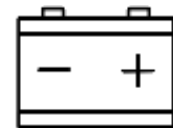
Shed Load

- Reduced demand during generation balancing annual peak demand
- Thermostat setpoints; IT equipment
- **Grid Service: Reduce generation capacity, T&D upgrade**



Shift Load

- Changes energy use to a different time
- Batteries, thermal mass and storage, smart appliances
- **Grid Service: Improve utilization of low-cost generation**



Modulate Load

- Modulates demand in response to a signal from grid
- SSLs, IT equipment, VFD equipment, batteries
- **Grid Service: Support frequency regulation**



BTO's grid-interactive efficient buildings portfolio

VALUATION

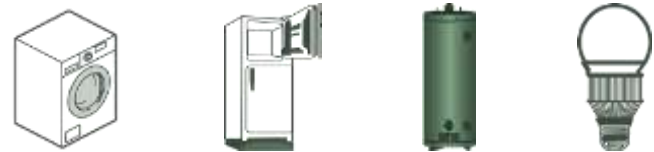
How do time & the interaction of flexibility options impact value?



Identify values to stakeholders, quantification of national value.

TECHNOLOGY OPTIONS

Which end use technologies provide solutions to specific grid needs?



Prioritize technologies / solutions based on grid services.

OPTIMIZATION

How to maintain or improve building services while optimizing for flexibility in building operations?



Solutions that meet grid operator & building occupant needs.

VALIDATION

Do technologies perform as predicted and meet grid & occupant needs?



Verification of technologies / strategies, increasing confidence in the value of energy flexibility.

Select BTO GEB projects & analyses (1)



BTO and US National Laboratories are conducting R&D and field testing to advance key concepts that will shape grid-interactive buildings, including:

- ✓ Developing analytical frameworks that fully **value** buildings as flexible grid resources, including valuing efficiency on a time-sensitive basis
- ✓ Quantifying flexible building **load potential** to provide grid services and maximize demand response capacity
- ✓ Developing open source, scalable, cybersecure transactive **control systems** that enable buildings to provide grid services without decreasing performance
- ✓ Conducting end-use **load profile modeling** across the US building stock to inform energy efficiency and demand response savings profiles for buildings & technologies

Select projects (2) www.energy.gov/eere/buildings/geb

- ***End Use Load Shapes*** (FY19-21; NREL/LBNL): This project will result in: 1) end-use load profiles for U.S. building stock at both aggregate and individual building scales; 2) calibrated building stock end use models with ability to estimate EE/DR savings profiles for existing and emerging technologies. These datasets will be made publicly available via the EPRI load shape database and the methods used to develop these end use load shapes will be documented in a research paper.
- ***Characterization of Connected Lighting Systems (CLS) Potential to Provide Grid Services*** (FY19-21; PNNL): The ability of CLS to deliver potential grid services while simultaneously delivering sufficient lighting service and occupant satisfaction has not yet been proven or quantified. This project will evaluate and advance the ability of CLS to provide grid services through modeling and simulation, laboratory testing, and field testing.
- ***Adaptive and autonomous controls:*** Suite of projects (FY16-19) at both universities and national laboratories aim to develop adaptive and predictive control algorithms through a combination of physics-based and data-driven modeling techniques along with machine learning by accounting for the trade-offs between model and computational complexity versus enabled energy savings. Occupant inputs (presence, movement, etc.) through advanced monitoring approaches are being incorporated to better match building operations with occupant comfort requirements.

2019 Planned activities

✓ Continued Feedback on Concept

- Flexible Building Loads Request for Information
 - <https://eere-exchange.energy.gov/Default.aspx#Foaldd5fd318d-0a38-44fc-b1ab-aa54579c6177>
- IEA *Modernising Energy Efficiency through Digitalisation* (Jan., >40 countries)
- U.S. State/regulatory working group with states and utilities (starting right now)
- Time-sensitive Valuation working group and webinars (ongoing)
- BTO Peer Review (April, Washington, DC)
 - www.energy.gov/eere/buildings/building-technologies-office-2019-peer-review
- Multiple Technical Advisory Groups on GEB projects (ongoing)
 - If interested in joining any project TAG, contact: monica.neukomm@ee.doe.gov

✓ Refined Determination of Opportunity

- GEB Technical Report Series (Drafts complete for BTO Peer Review in April)
 - If interested in reviewing drafts, contact: monica.neukomm@ee.doe.gov
- GEB Resource Potential (fall)

✓ Upcoming Competitive Funding

- Grid Modernization Lab Consortium – 2nd round of focus areas and projects (January)
- Inclusion in non-governmental and national lab competitive funding RFPs (spring/summer)

✓ More to come!

- Greater coordination with REEOs, SEEAAction Report series, NASEO

Questions?

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Flexible Building Loads RFI – Accepting all Feedback!

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