U.S. DEPARTMENT OF ENERGY

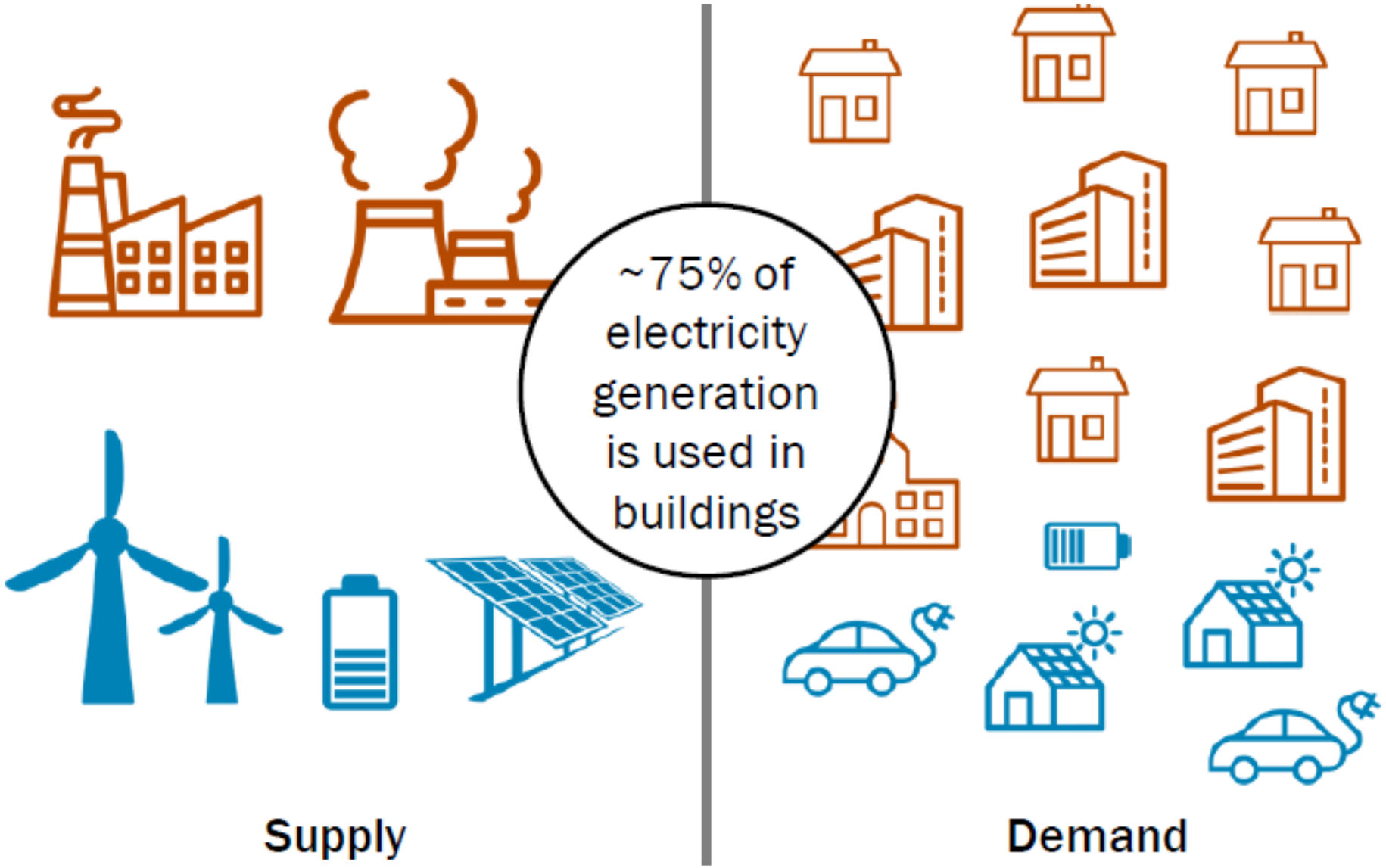
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

U.S. Department of Energy:
Grid-interactive Efficient Buildings

Jack Mayernik, Sr. Energy Analyst

9 June 2020

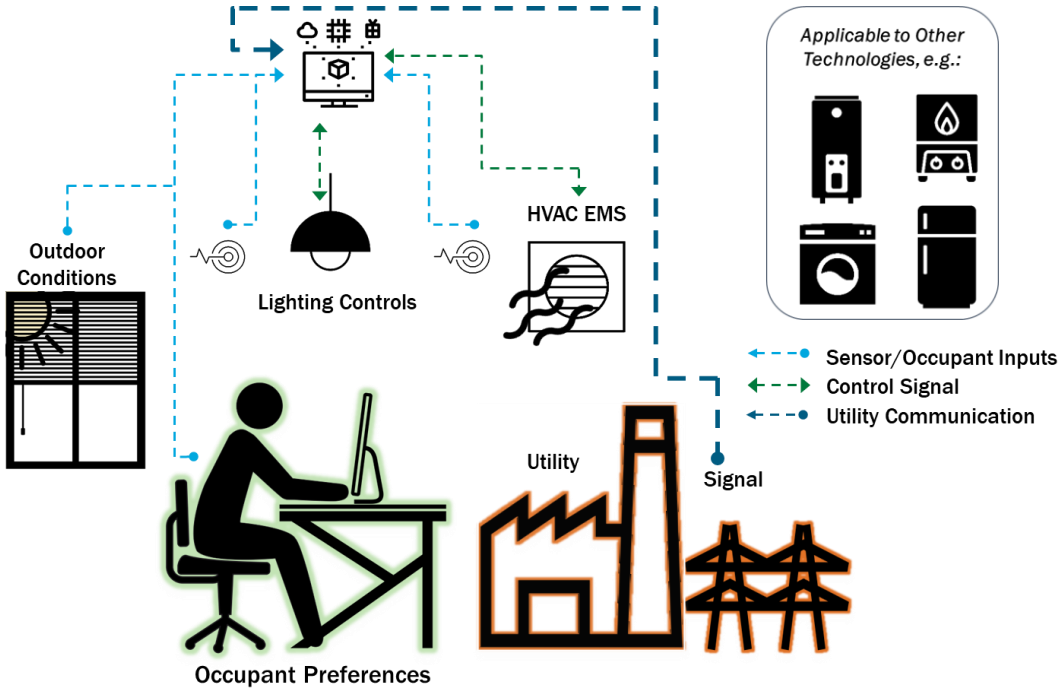
Our Evolving Energy System



BTO's Grid-interactive Efficient Buildings (GEB) initiative will develop the technologies and solutions necessary for buildings to provide energy flexibility and other grid-services

Characteristics of Grid-interactive Efficient Buildings (GEB)

Buildings can play an important role in providing services to the grid by changing how and when they use energy



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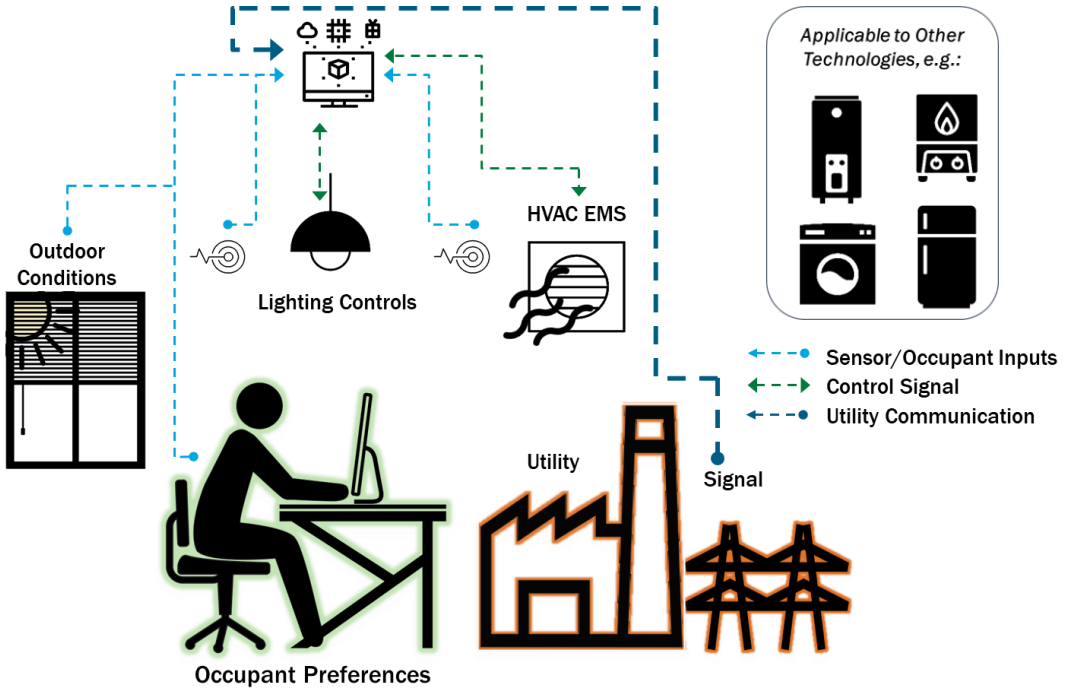
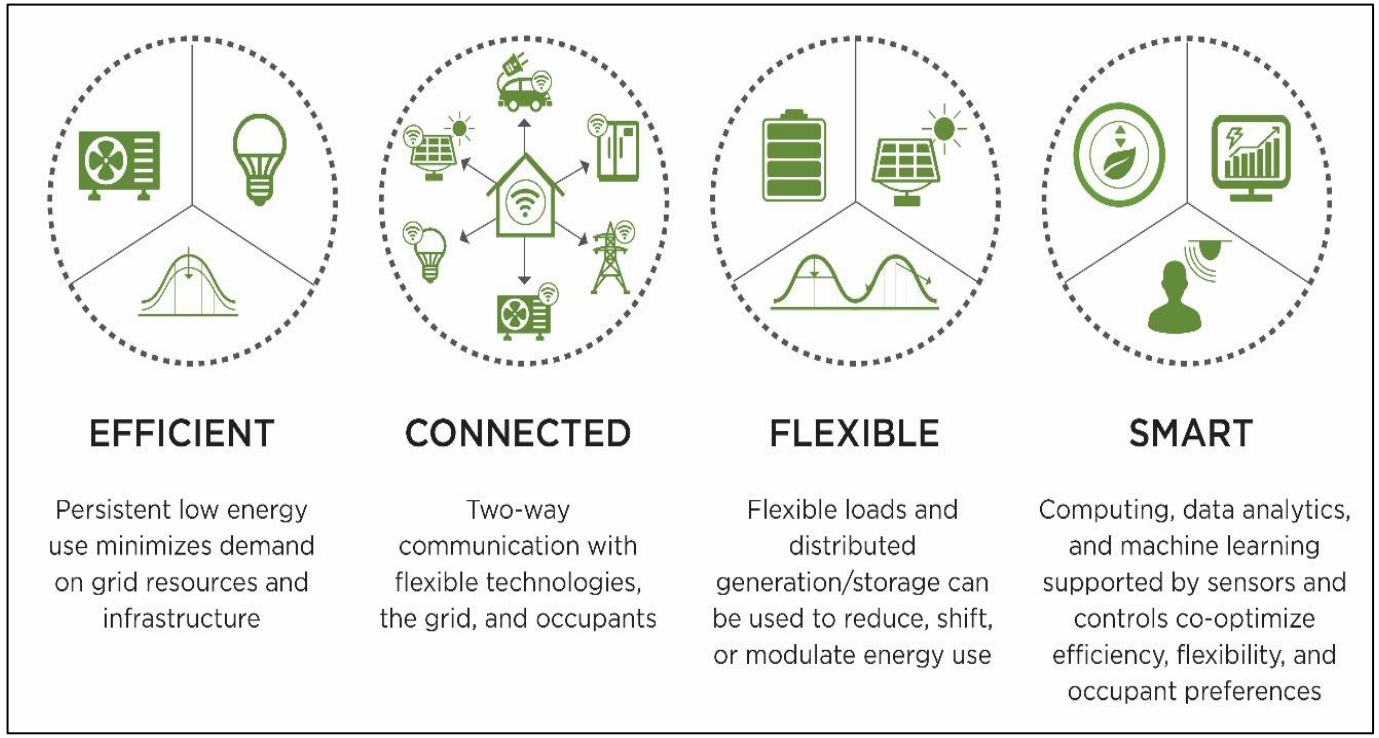
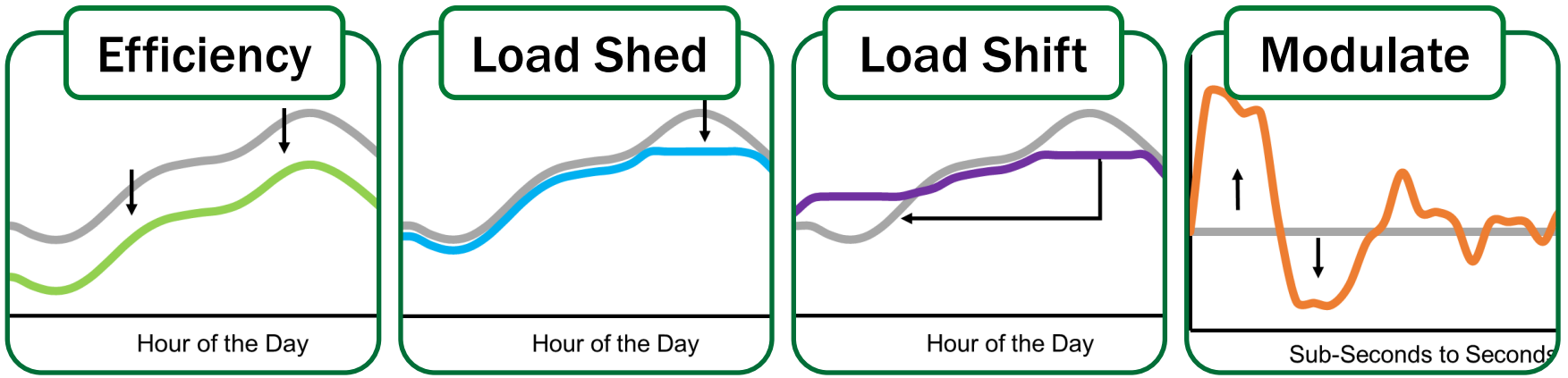




BTO's GEB Vision - The integration and continuous optimization of distributed energy resources for the benefit of the buildings' owners, occupants, and the electric grid

Demand Management Provided by GEB

Buildings can provide grid services through 4 demand management modes.



Grid Services Provided

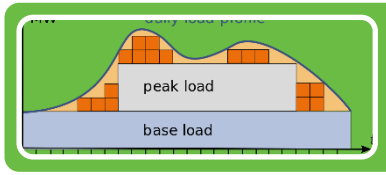
• Generation: Energy & Capacity • T&D: Non-Wires Solutions	• Con. Reserves • Generation: Energy & Capacity • T&D: Non-Wires Solutions	• Generation: Capacity • T&D: Non-Wires Solutions	• Frequency Regulation • Ramping

Examples

• Daylighting with sensors & controls	• Reduce plug loads	• Precool with T-stat; preheat water heater	• Rapid dimming of lighting

Potential Benefits of Flexible Building Loads

✓ Energy affordability



✓ Improved reliability & resiliency

✓ Reduced grid congestion

✓ Enhanced services

✓ Environmental benefits

✓ Customer choice

BTO Grid-interactive Efficient Buildings (GEB) Portfolio

VALUATION ANALYSIS

Key Question: *How do time & the interaction of flexibility options impact value / improve affordability?*

Outcome: *Identify values to stakeholders, quantification of national value.*

TECHNOLOGY OPTIONS

Key Question: *Which end use technologies provide solutions to specific grid needs?*

Outcome: *Prioritize technologies / solutions based on grid services.*

OPTIMIZATION

Key Question: *How to optimize for flexibility while maintaining or improving building operation /occupant comfort / productivity?*

Outcome: *Solutions that meet grid operator & building occupant needs.*

VALIDATION

Key Question: *Do technologies perform as predicted / meet grid operator & building occupant needs?*

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

Valuation Analysis

scout
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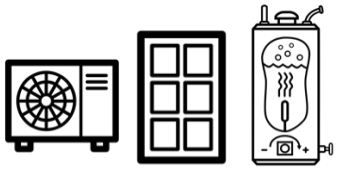
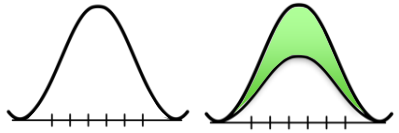
1. Define energy efficiency (EE), demand flexibility (DF), and EE + DF measure portfolios



2. Develop 8760 load baselines for Scout by climate region and building type



3. Develop bottom-up EnergyPlus measure simulations and 8760 savings shapes

OpenStudio

4. Translate measures into Scout ECMs

5. Assess national portfolio potential in Scout

Valuation Analysis

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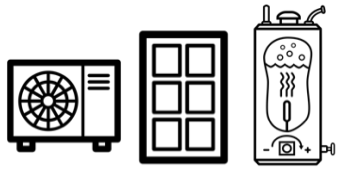

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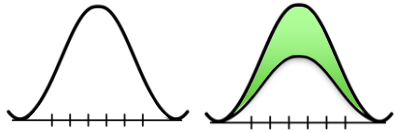

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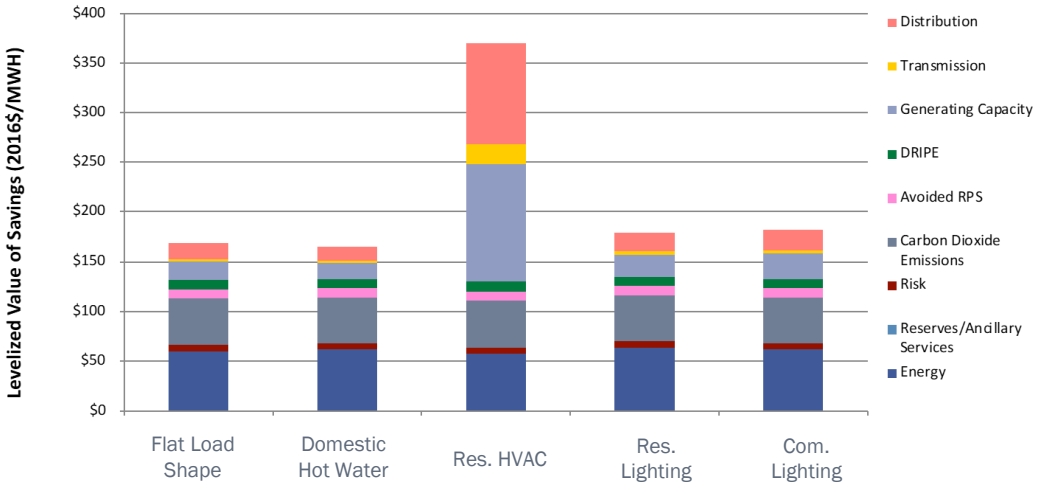
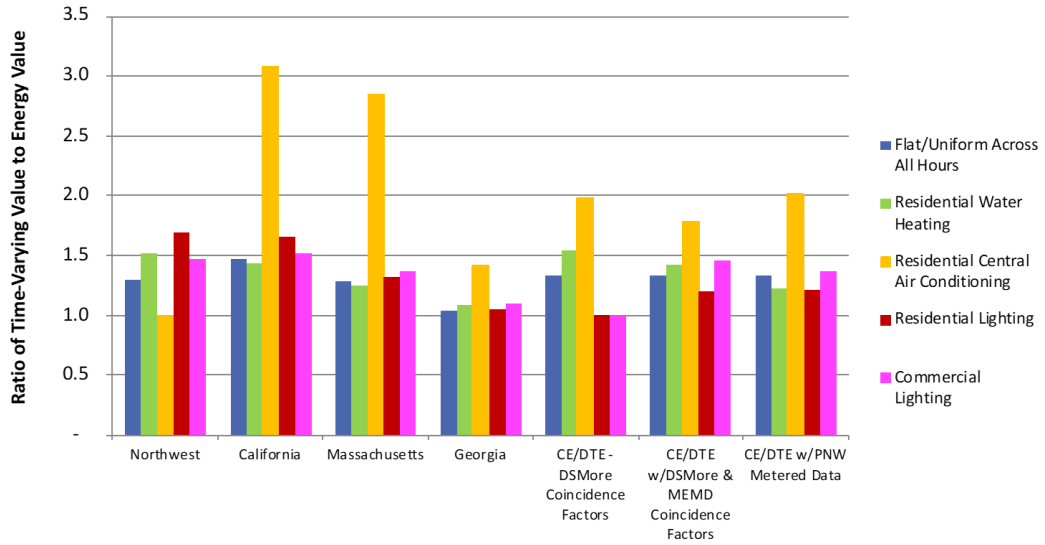
Time-Sensitive Value of Energy Efficiency

(reflects publicly available data only)





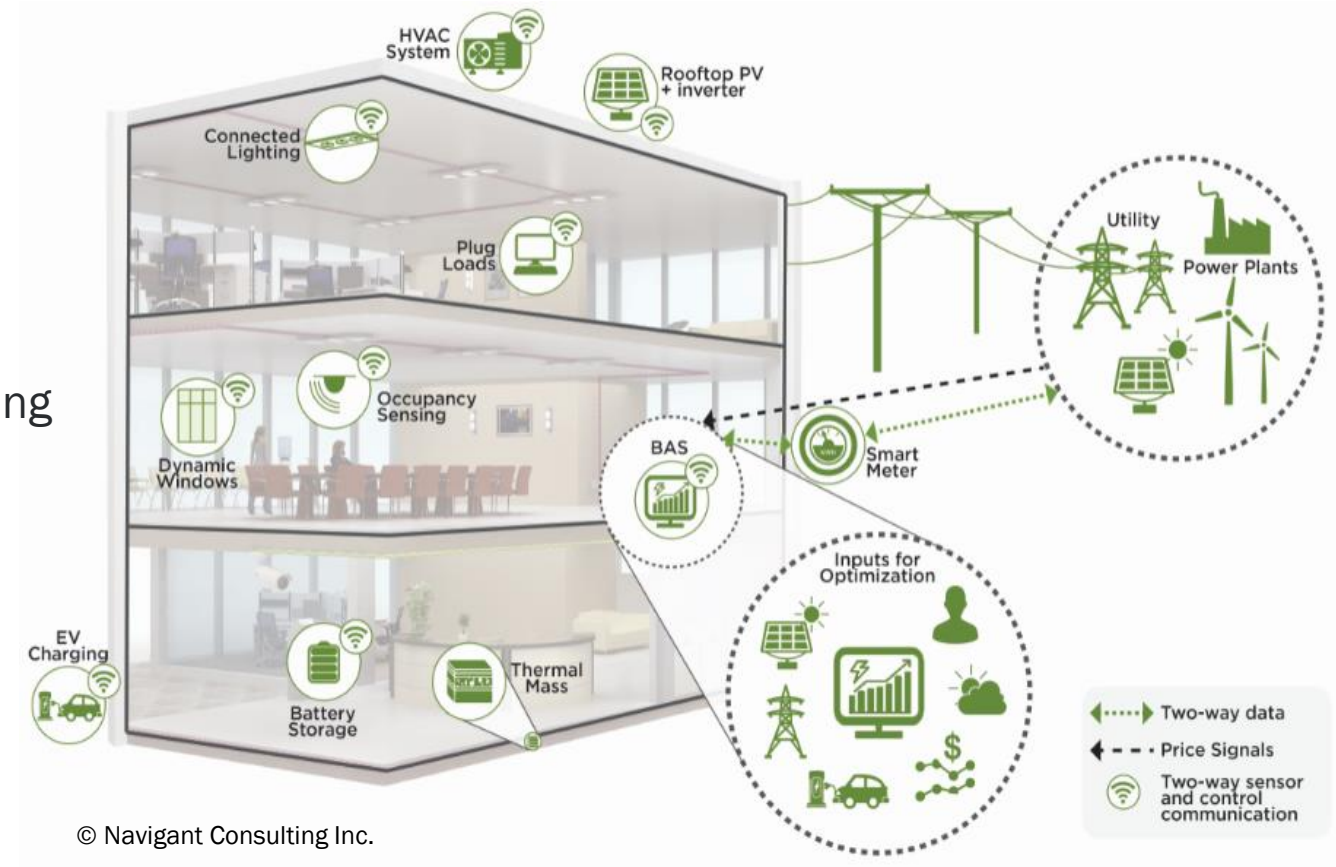
Technology Development

The GEB Technical Report Series outlines key demand flexibility opportunities across BTO's R&D portfolio: http://energy.gov/eere/buildings/grid-interactive-efficient-buildings

Technical Report Series:

- Overview
- Heating, Ventilation, & Air Conditioning (HVAC); Water Heating; and Appliances
- Lighting
- Building Envelope & Windows
- Sensors & Controls, Data Analytics, and Modeling

Individual devices, appliances, and equipment within the building must be able to monitor and communicate their operating conditions and respond to control commands to provide demand flexibility ***and*** building must have the ability to manage these actions across loads in a coordinated way.



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Validation

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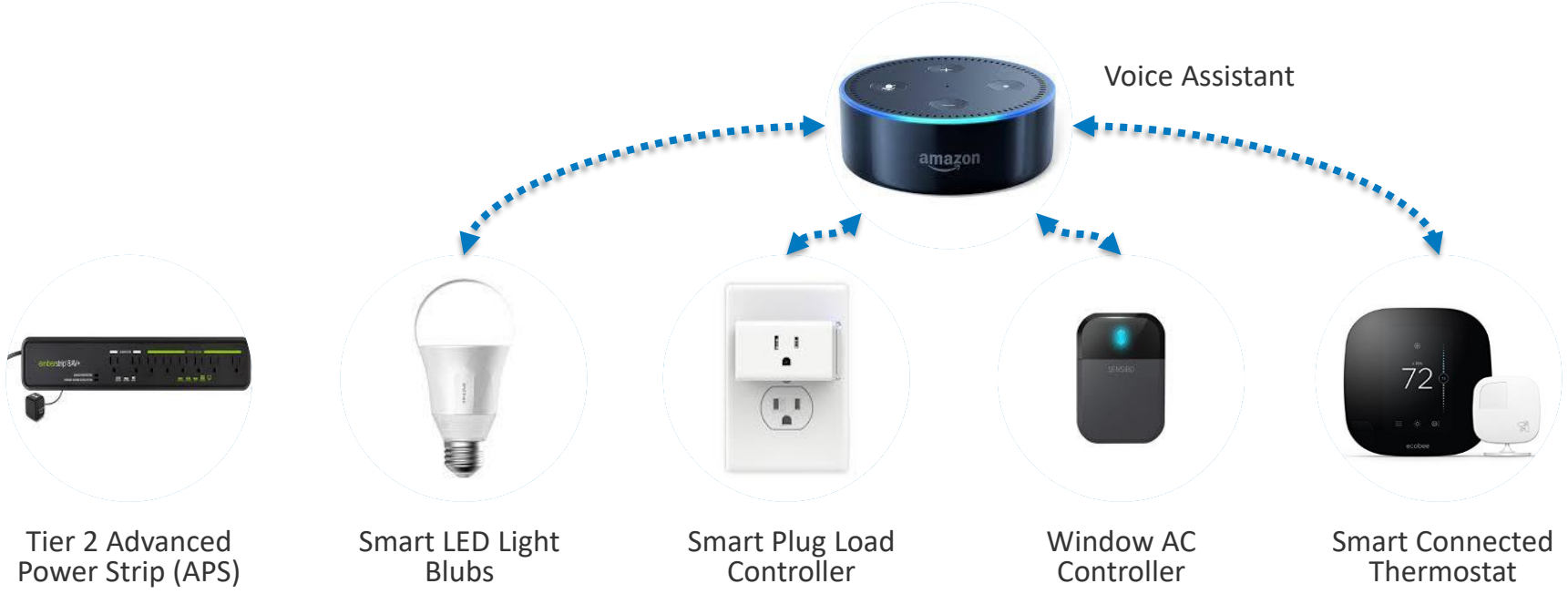


Tier 2 Advanced Power Strip (APS)

Smart LED Light Blubs

Smart Plug Load Controller

Window AC Controller

Smart Connected Thermostat

Real world ***validation provided valuable feedback*** that will help utilities design Home Energy Management System (HEMS) incentive programs

Lessons Learned:

Not a "do it yourself" project:

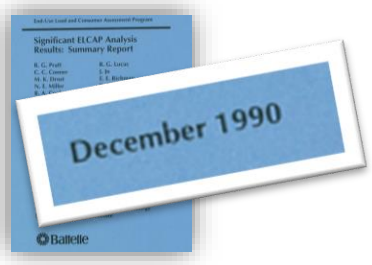
- Most single-family homes had separate thermostats for heating and cooling
- Many AC systems were incompatible with smart thermostat

Product compatibility is still a challenge:

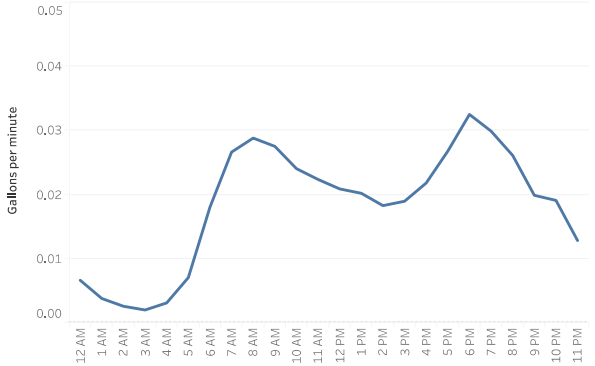
- Window AC controller requires remote control, but many units do not have remote control features.

Optimization

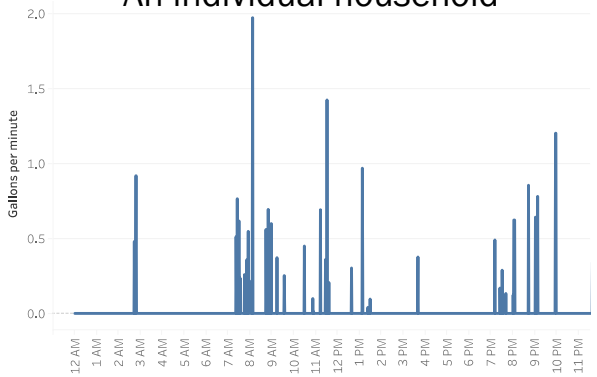
Existing profiles are often **outdated, regionally limited, based on small sample size, and limited to a subset of the building stock** because of the high cost of the historical sub-metering approach.



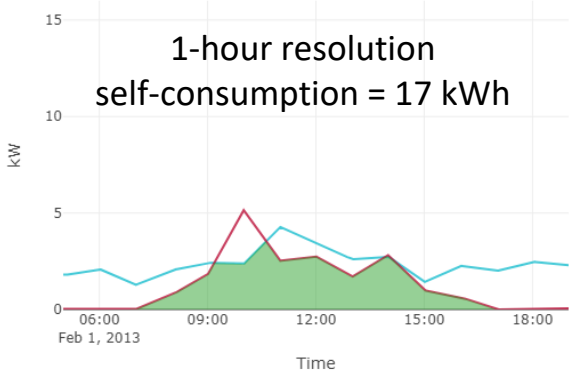
Blended average of all households



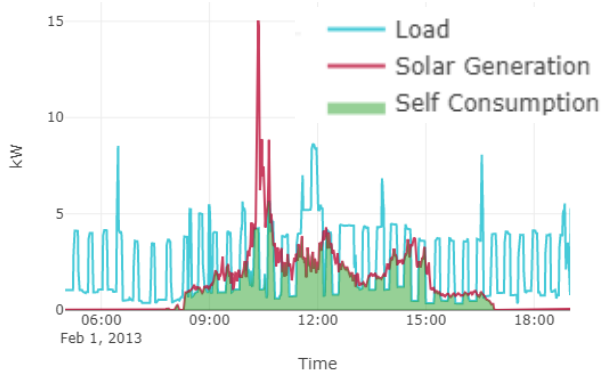
An individual household



1-hour resolution
self-consumption = 17 kWh



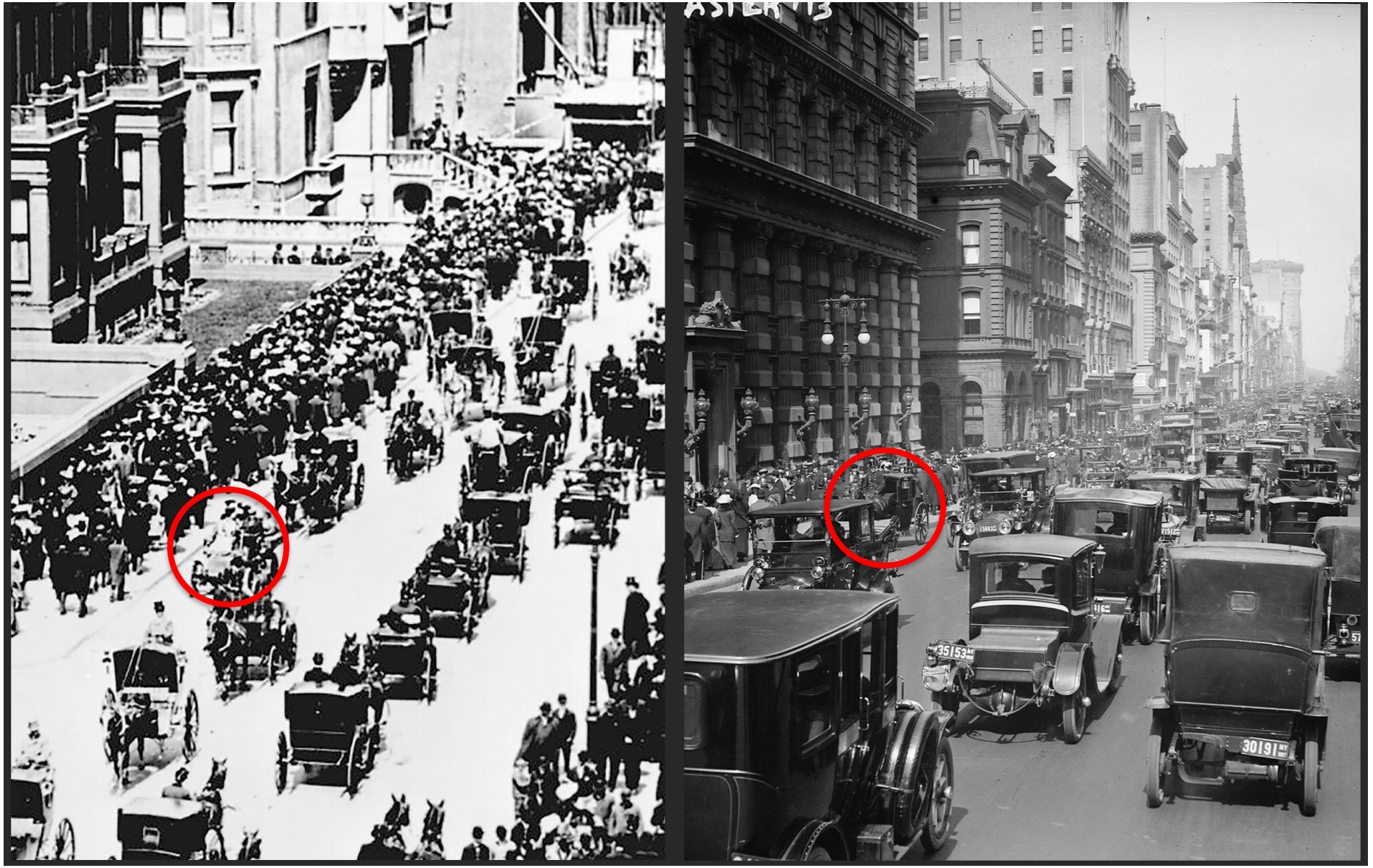
1-minute resolution
self-consumption = 13 kWh

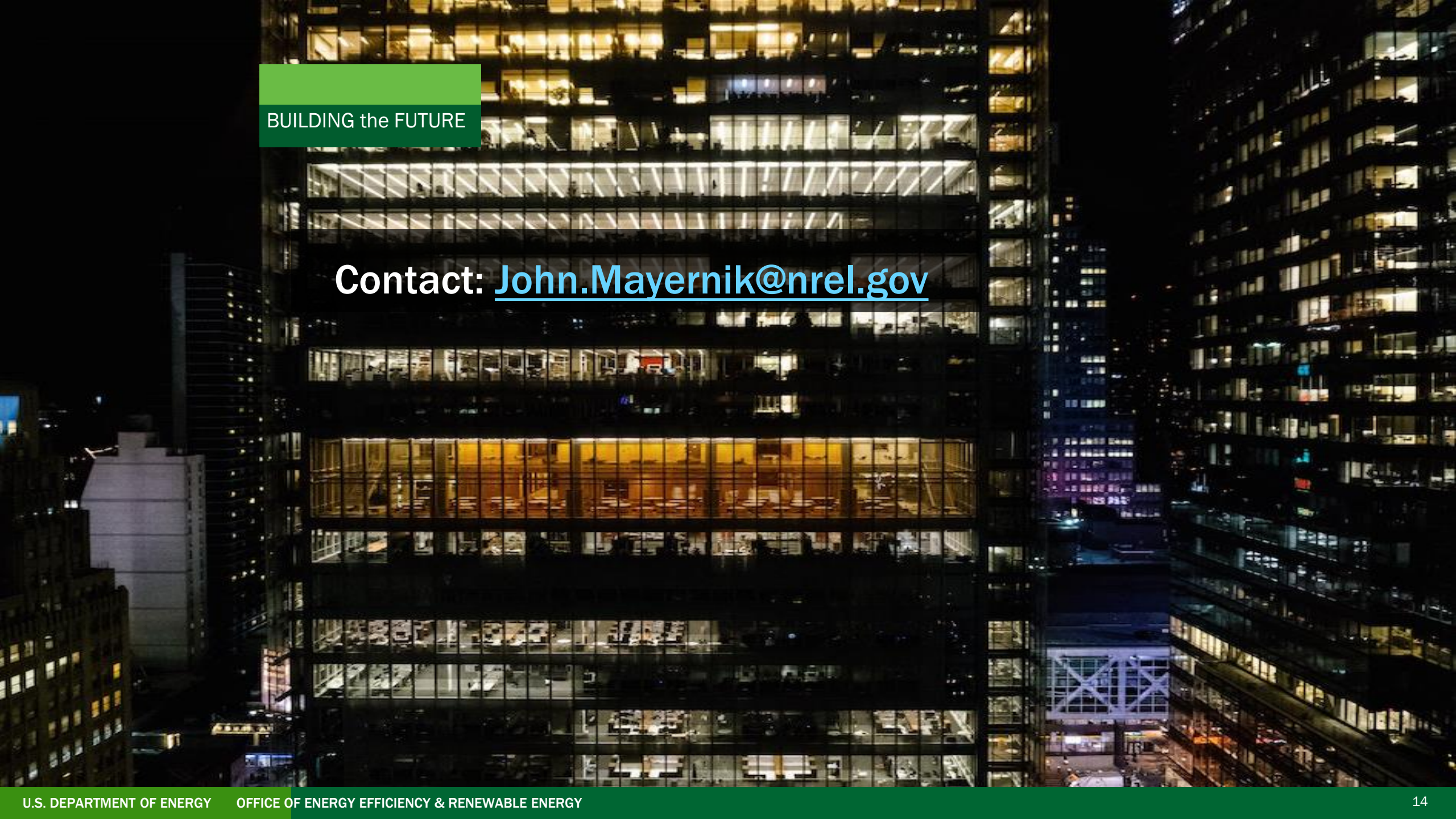


End-use load/savings profiles are…

- The **most essential** data resource currently missing for Time-Sensitive Valuation of Energy Efficiency (TSV-EE)
- Needed for **R&D prioritization, utility resource and distribution system planning, state and local energy planning and regulation**
- Critical for **widespread adoption** of grid-interactive and efficient buildings

Easter in New York in 1900: 1 car. 1913: 1 horse.





BUILDING the FUTURE

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