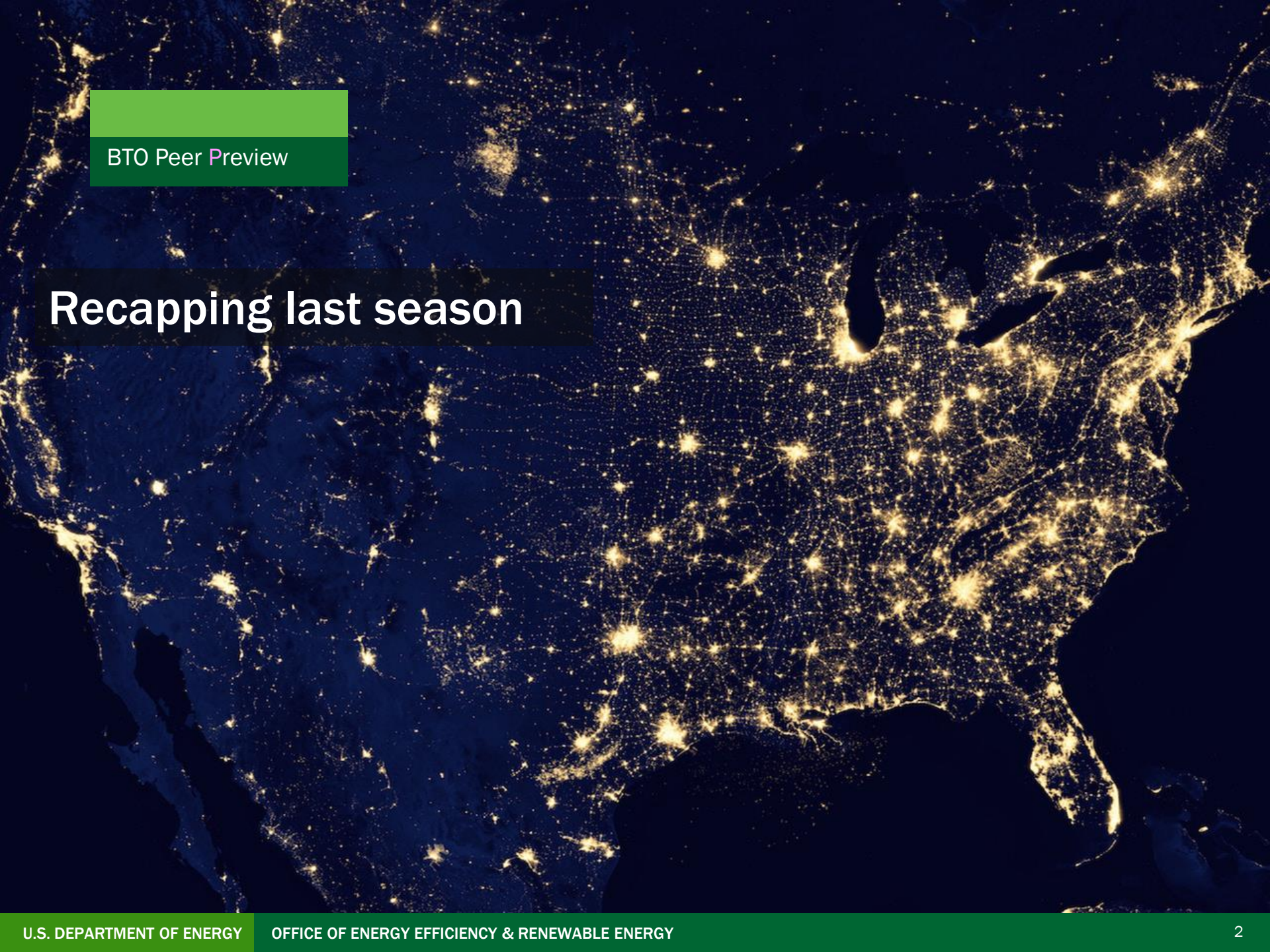


Building technologies and BTO: 2019 Peer Review

David Nemptzow, BTO Director

April 15, 2019



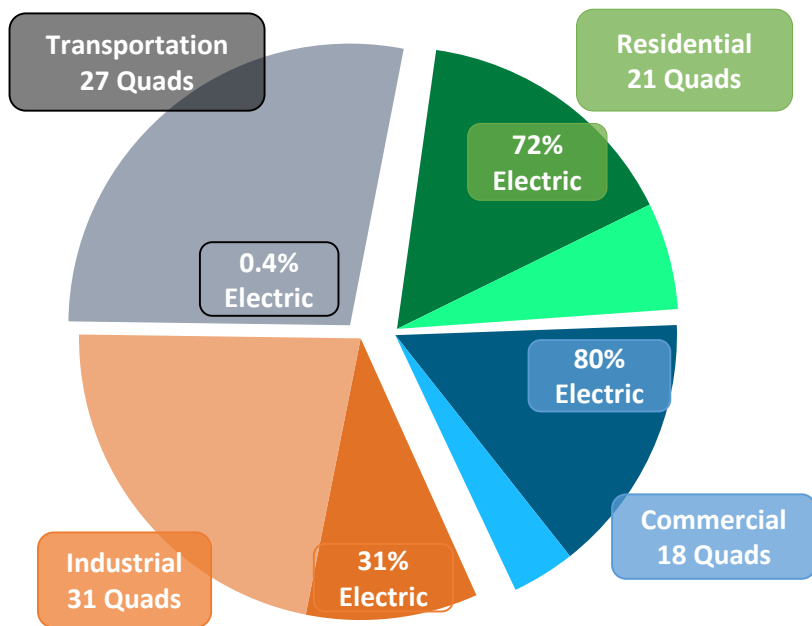


BTO Peer Preview

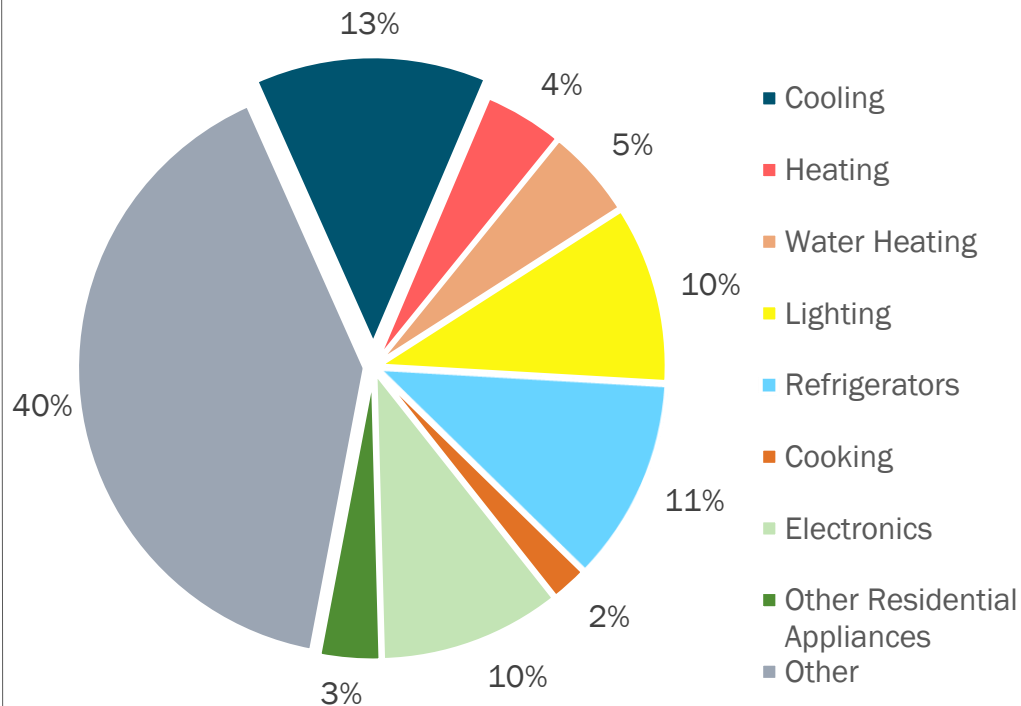
Recapping last season

Energy use in the U.S. building sector

Energy Use



Building Electricity Use



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

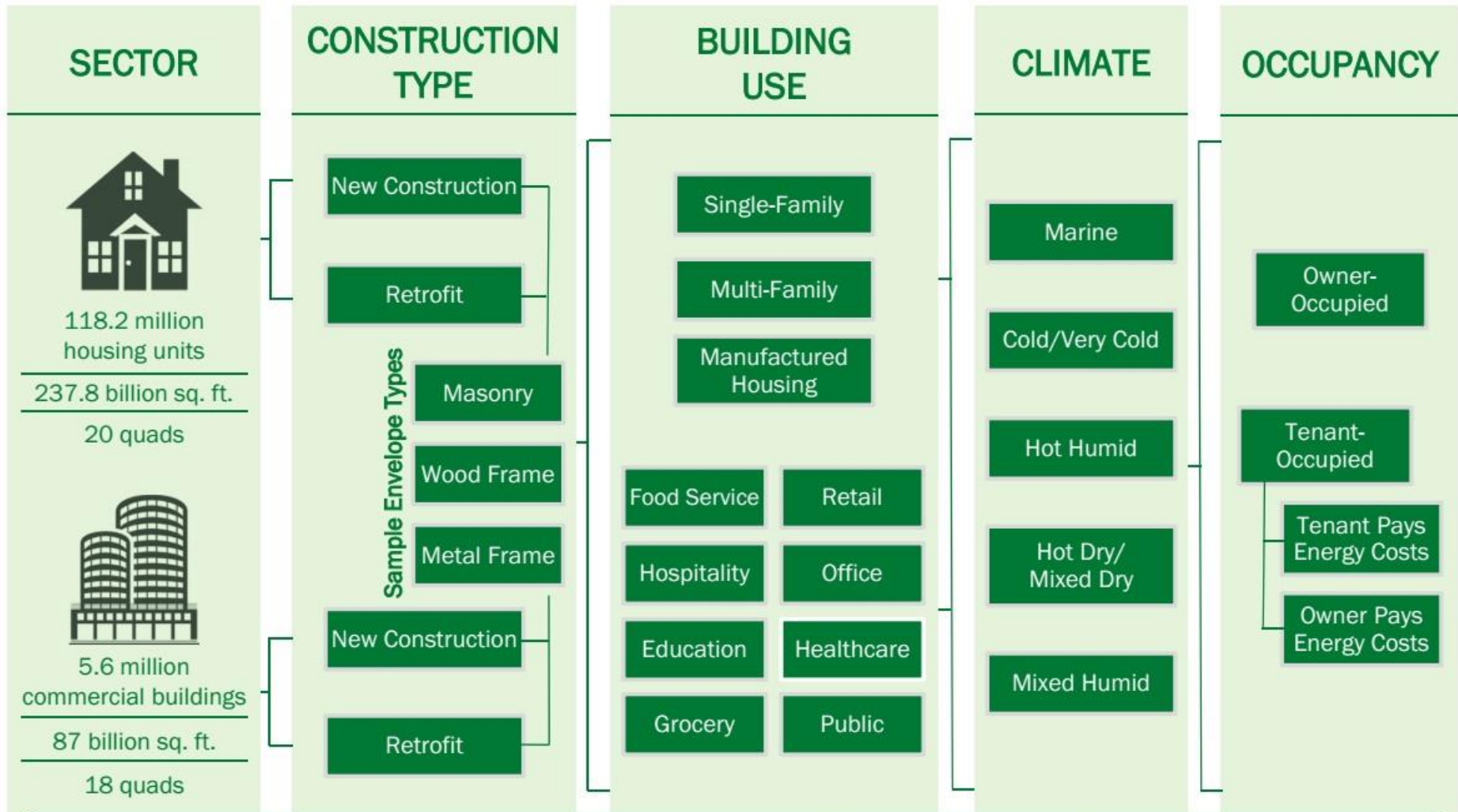
Buildings Electricity Consumption: 75% of U.S. total

Buildings Peak Electricity Demand: ~80% of regional total

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

Source: EIA 2017 Annual Energy Outlook

Complexity of Energy Use in the Buildings Market



Sample Technology Areas (Gas and Electric)



BT Research How to Save Energy

Past



- \$1,200 purchase
- \$200/year to operate
- 18 cubic feet



- \$8/year
- 60 Watts
- 1,000 hour life



- Single-pane
- High heat loss

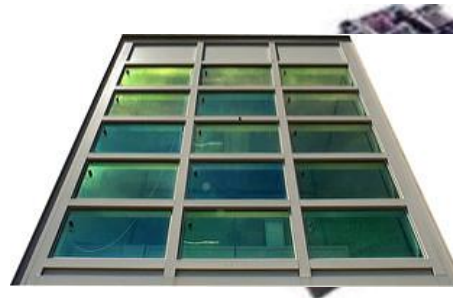
Future



- Quieter operation
- \$550 purchase
- Larger storage capacity
- \$50/year to operate
- Reduced frost accumulation for more efficient cooling
- 22 cubic feet



- Flexible \$20/year
- Tunable color/brightness
- 15 Watts (or less)
- Connectivity and automated control
- Up to 25,000 hours

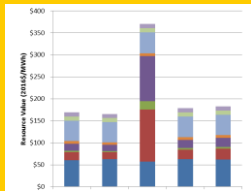


- Daylighting maximized automatically
- Double-pane & low-e
- Less uncontrolled heat loss/gain
- Low heat loss
- 3x more efficient
- Greater energy savings

Due to appliance standards alone, a typical household saves about **\$320** per year off their energy bills today, and as people replace their appliances with newer models, they can expect to save about **\$530 annually** by 2030.

Building energy efficiency R&D across the U.S.

Time-Sensitive Valuation of Energy Efficiency



Transactive Campus



Wireless Sensors



SonicLQ



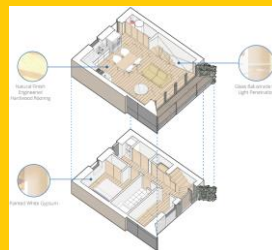
LED Thermal Performance



Cold-Climate Heat Pump



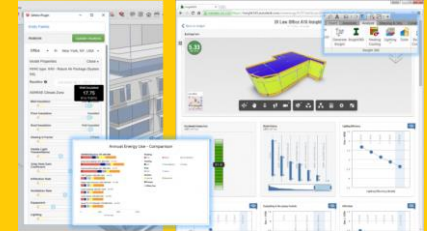
Zero Energy Ready Buildings



Ultrasonic Clothes Dryer



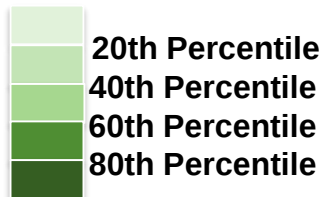
Building Energy Modeling



Connected Neighborhoods

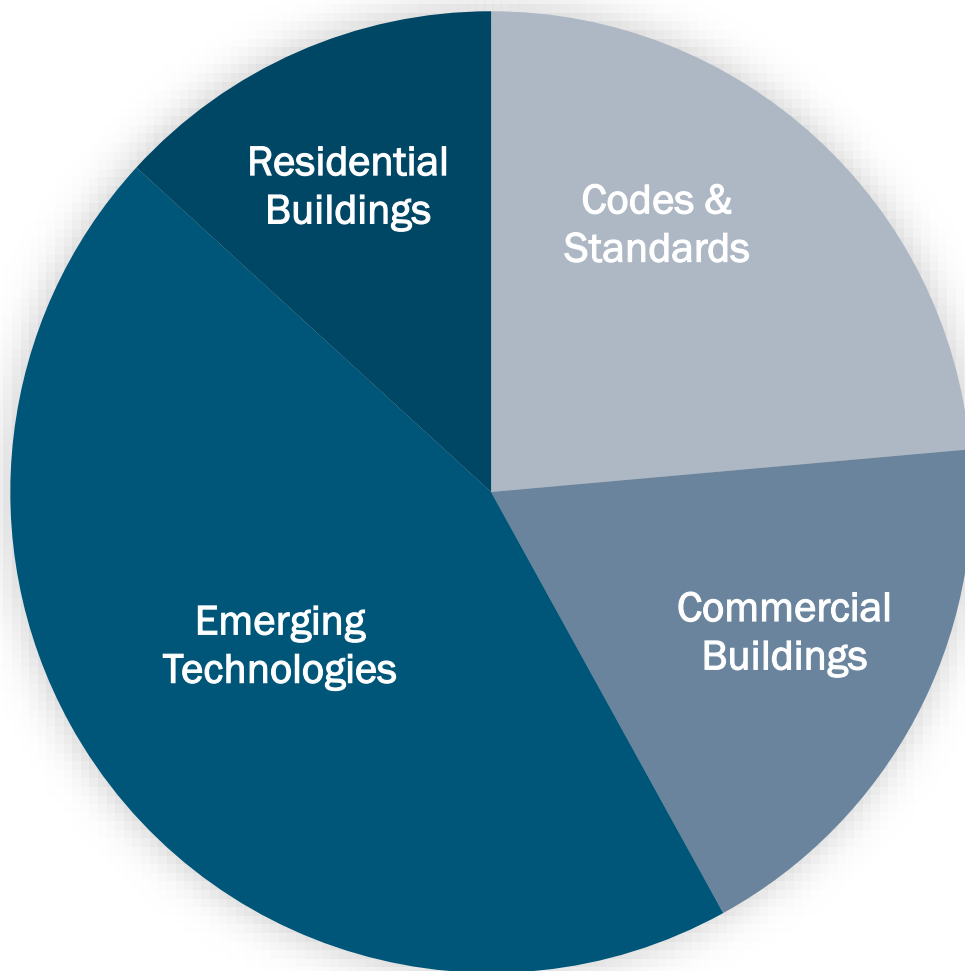


Overall
Employment in
Energy
Efficiency
Sector



Sources: U.S. Energy and Employment Report, 2017, U.S. Department of Energy;
<https://www.energy.gov/eere/buildings/articles/bto-year-review-looking-back-progress-and-looking-forward-innovation>

BTO Budget for FY2019: \$226M



- ✓ Focus on:
 - Early-stage R&D
 - Systems integration & validation
 - Statutory requirements
- ✓ Grid Mod, Transactive, S&C, Adv. Energy Storage Initiative
- ✓ Advanced Bldg. Construction
- ✓ Grid-interactive Efficient Buildings
- ✓ Solid-State Lighting
- ✓ Modeling
- ✓ Decision Tools
- ✓ And more!

Advanced Building Construction with Energy Efficient Technology and Practices

Challenges hindering reaching our energy, affordability, building goals include:

- ✓ **Slow pace** of efficiency-oriented retrofits; very few achieving deep savings
- ✓ **Underinvestment** in innovation by new building construction and remodeling industry
 - Fragmented products & service delivery
 - Little automation, digitalization
 - Inconsistent performance
 - Workforce challenges
- ✓ **Lack** of integrated, energy efficiency technology solutions that are affordable and minimally disruptive (esp. for retrofits)



Available technologies can cut bldg. energy use 50%* but...

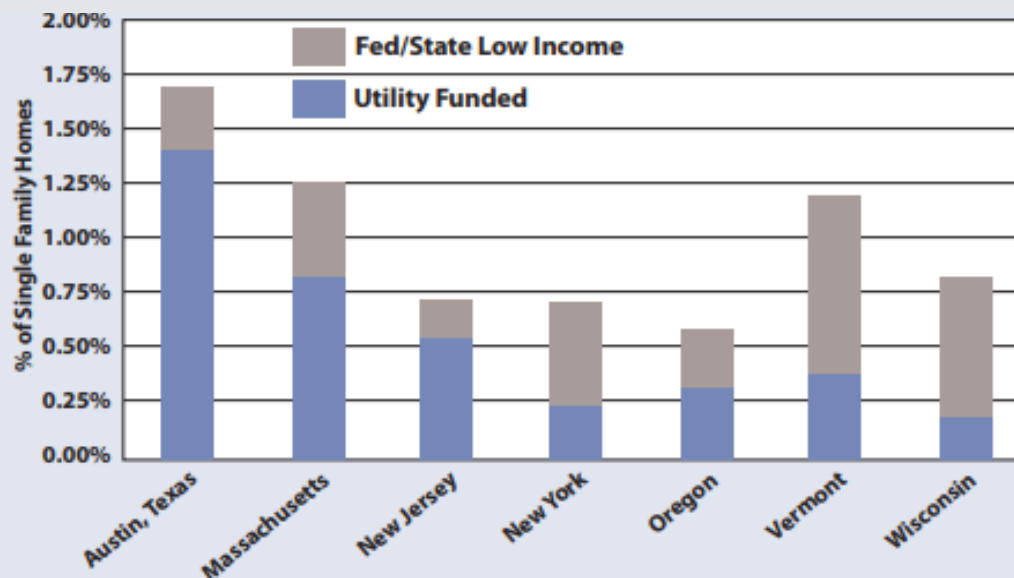
Commercial Buildings

- ✓ Estimated 2.2% of floor space are retrofit each year, with median energy savings of roughly 11% per building relative to average building EUI (ACEEE 2017)

Residential Buildings

- ✓ 2015: Nearly 4 million homeowners reported replacing their HVAC system; nearly 1.8 million reported adding insulation to their homes

Even leading jurisdictions retrofit 0.5%-1.75% of homes each year with 20-35% overall energy savings.

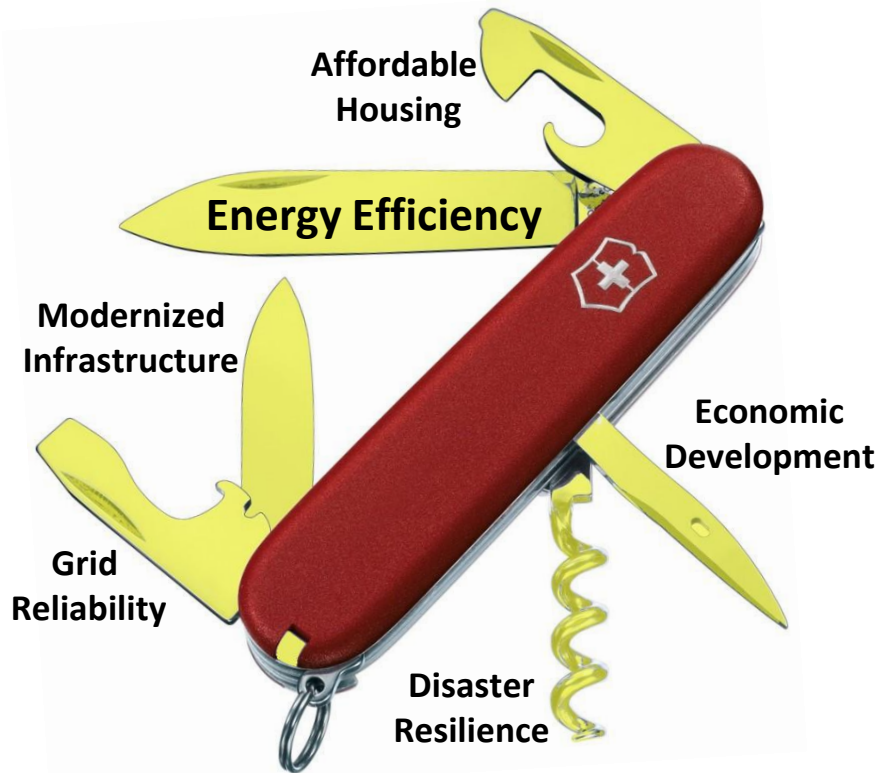


Source: Regulatory Assistance Project 2011

* Source: U.S. DOE
Quadrennial Technology
Review 2015

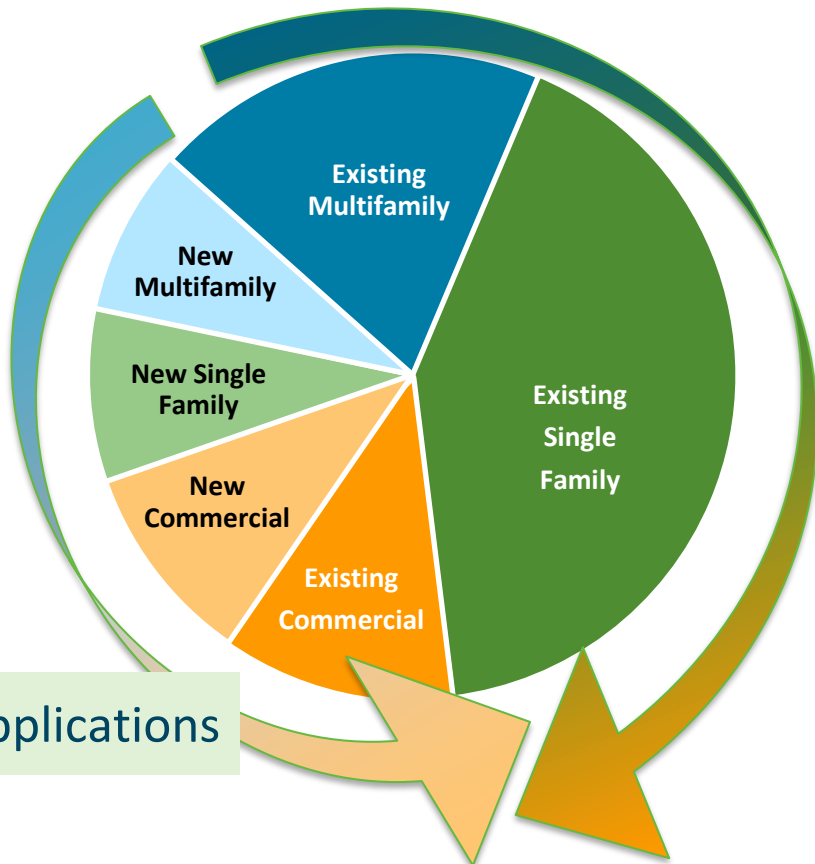
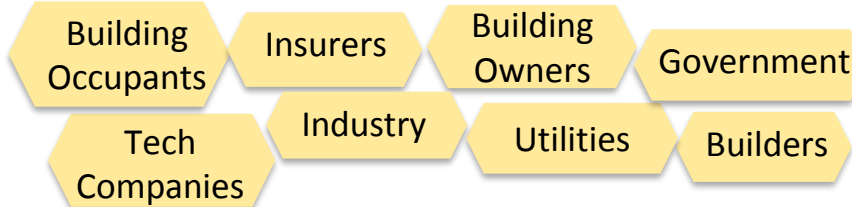
So “all” we need is something that:

Develops integrated technologies that deliver multiple benefits



...and widespread applications

...for multiple stakeholders



Advanced Building Construction

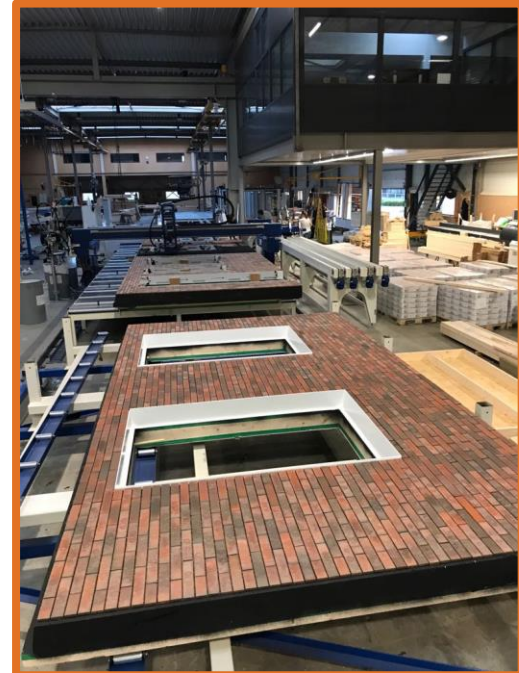
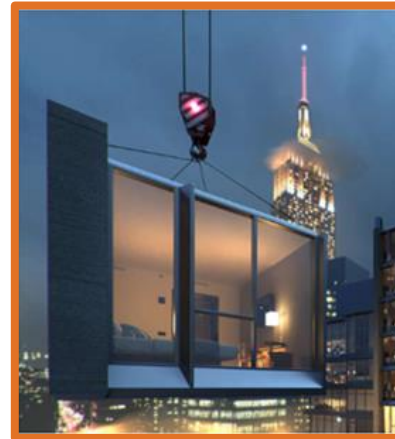
Next-gen technologies and practices that improve building energy performance without increasing costs of building construction, including innovations in design, component fabrication, onsite assembly, and construction process integration

- ✓ New Construction & Retrofit applications
- ✓ Residential & Commercial
- ✓ Lean Construction & Remodeling processes:
 - Shorter construction schedules
 - Less production uncertainty
 - Construction cost savings through component standardization & automation
 - Improved labor productivity
 - Fewer installation errors
- ✓ Off-site production technologies



ABC initiative @ BTO

- An integrated strategy across BTO (RBI ET, CBI, Codes) programs
- Early-stage R&D focused on whole building savings, with requisite advancements in building envelope, HVAC, DHW
- Seeks transformative technology packages, not incremental improvements; and reduce risk and accelerate tech to market
- Seeks regional/local solutions that account for differences in building stock, workforce, and other factors
- “Not a project, but an approach”



ABC's focus on thermal loads

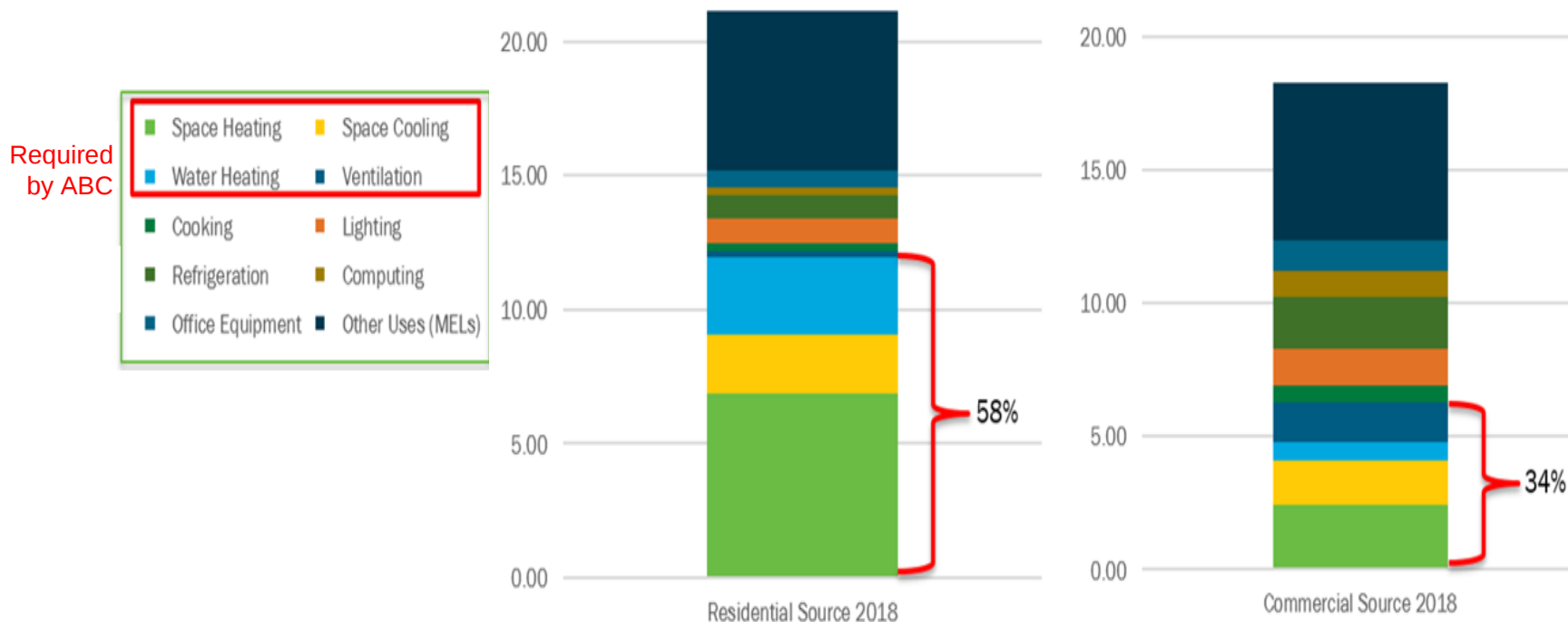
ABC Goal

Reduce energy use in existing U.S. buildings by 50%



Required to address thermal loads

Focus on envelope and high-performance equipment

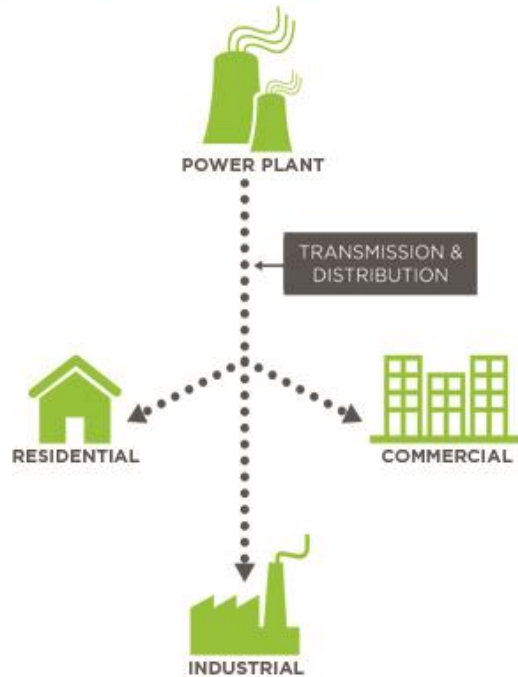


Grid-interactive Efficient Buildings

Moving toward the grid of the future

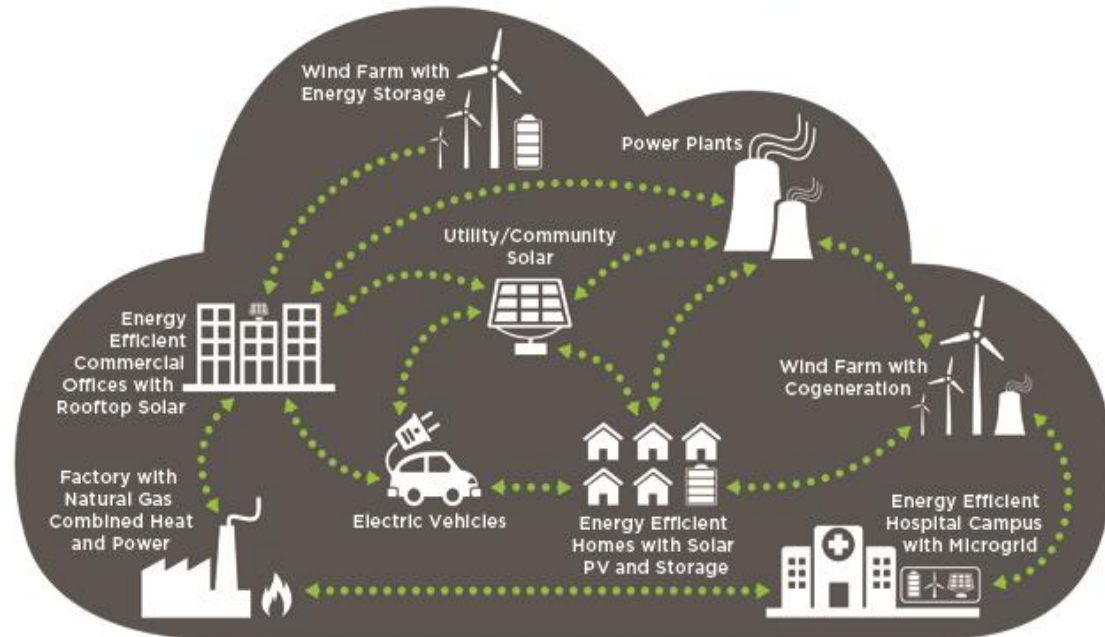
TODAY: ONE-WAY POWER SYSTEM

Central, One-Way Power Systems



EMERGING: THE ENERGY CLOUD

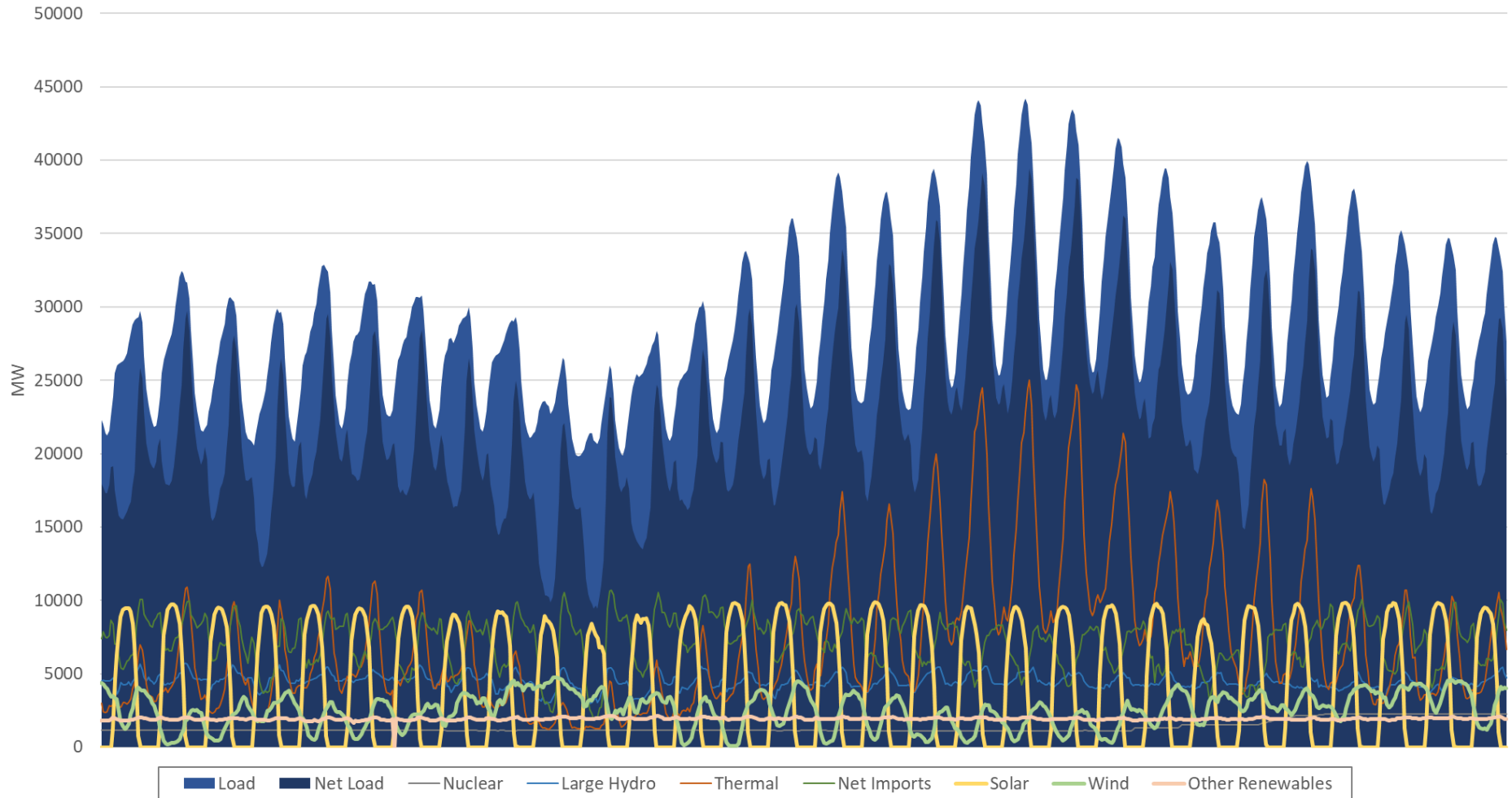
Distributed, Two-Way Power Flows



(Source: Navigant)

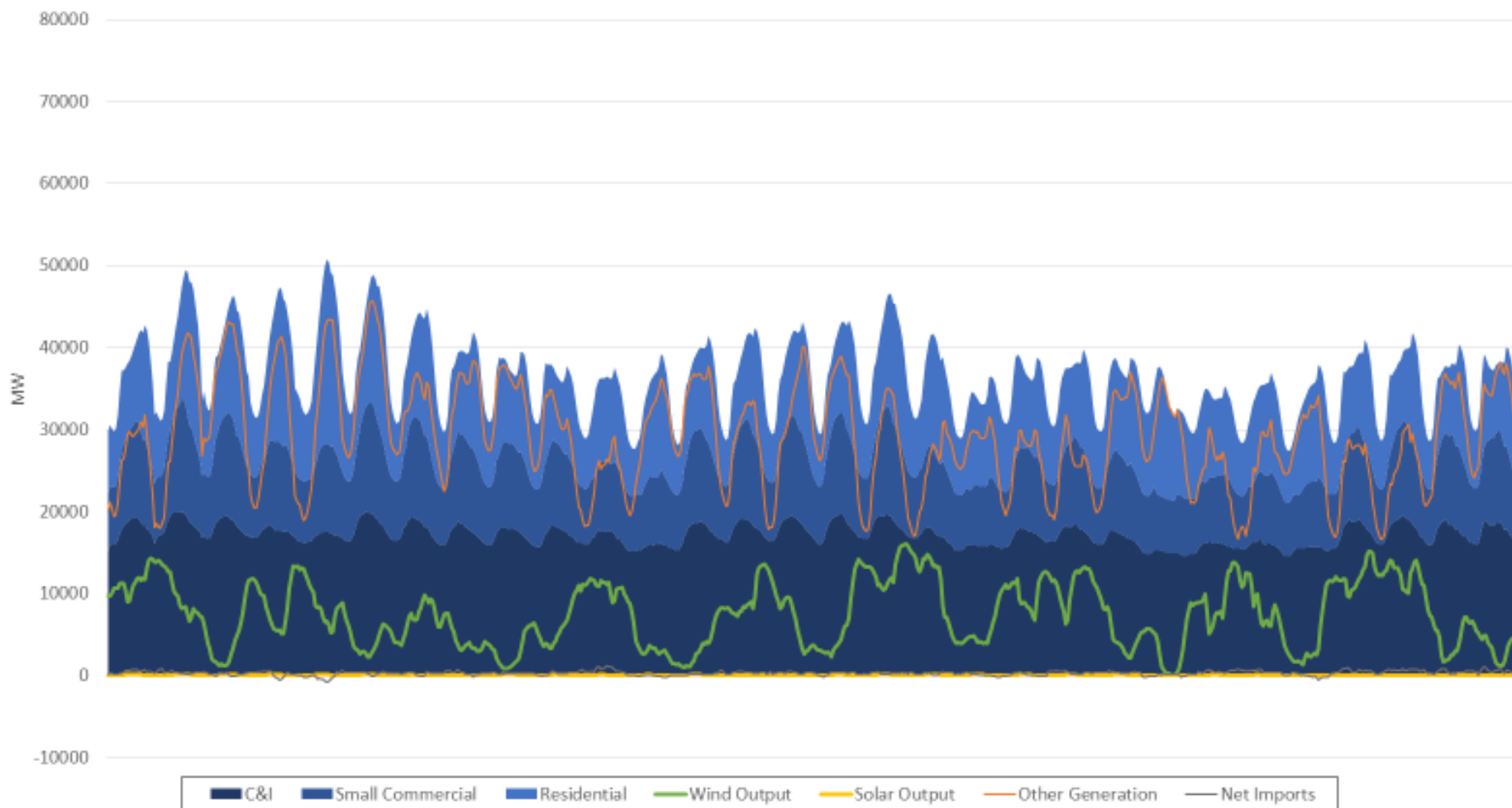
One month for California

CAISO - 2017 - June

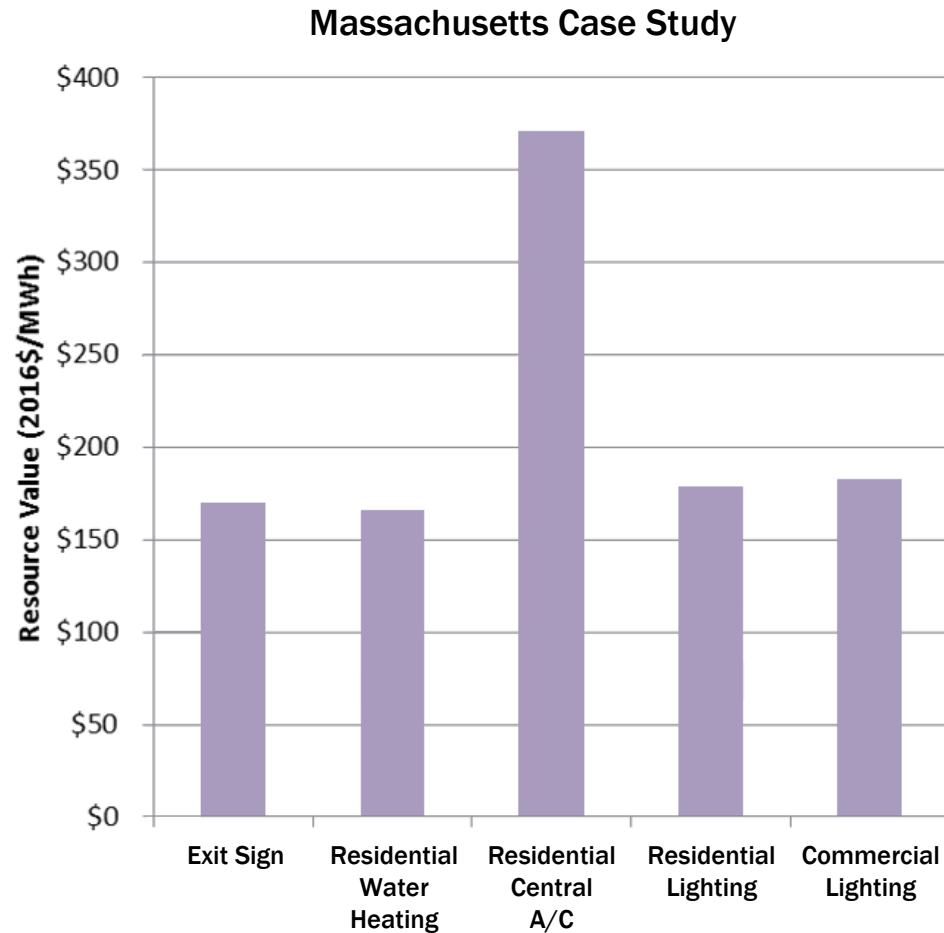


And one for Texas

ERCOT - 2017 - November



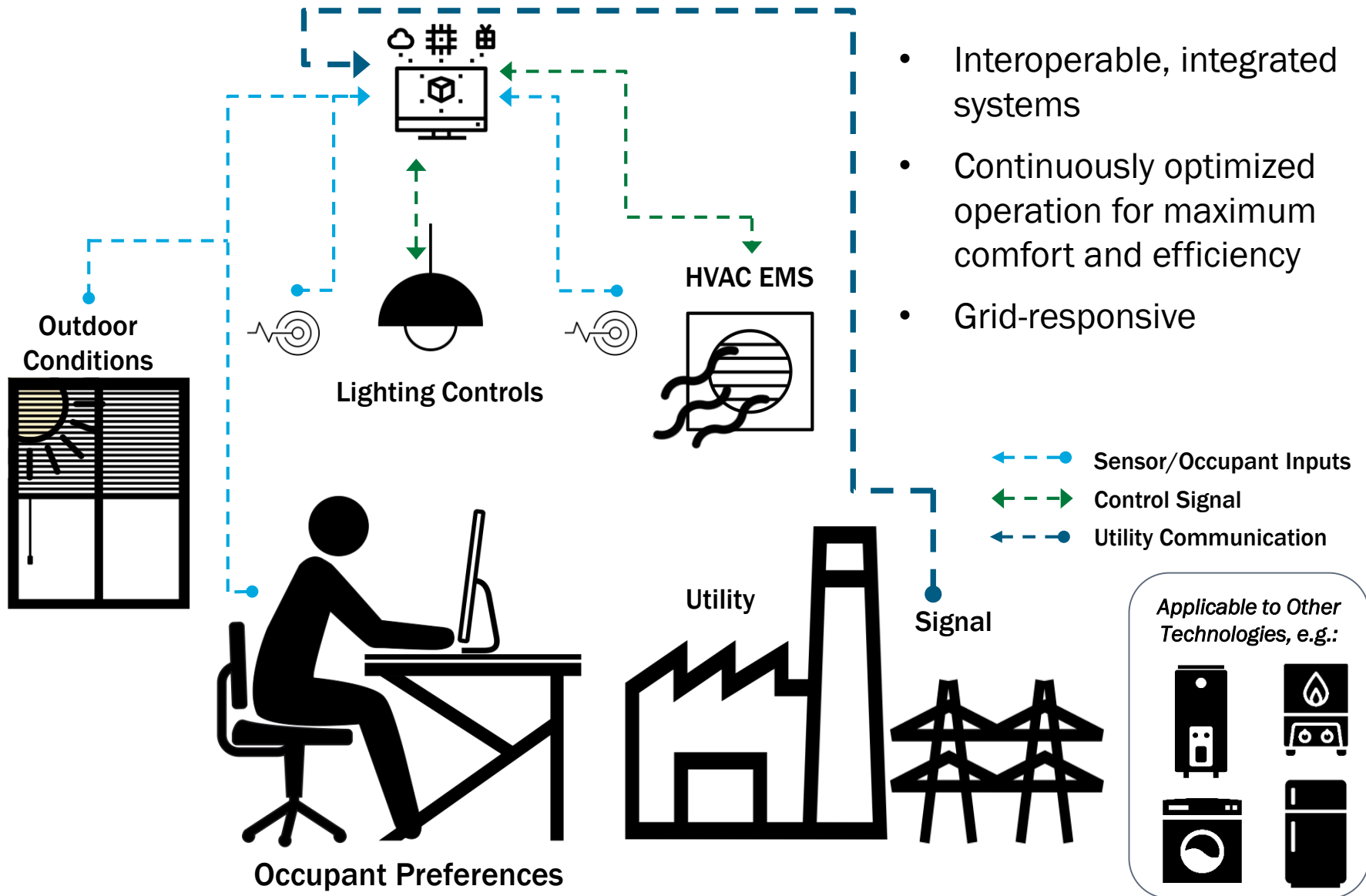
Not all saved kWh are equal



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

Building occupants come first



Characteristics of Grid-interactive Efficient Bldgs.



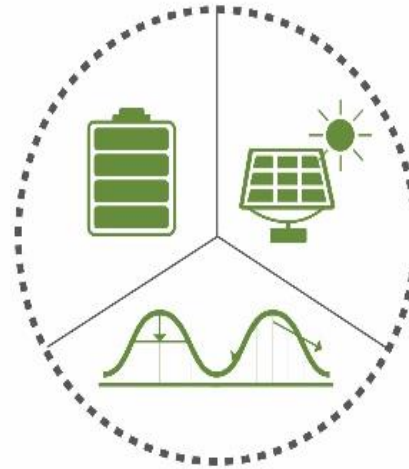
EFFICIENT

Persistent low energy use minimizes demand on grid resources and infrastructure



CONNECTED

Two-way communication with flexible technologies, the grid, and occupants



FLEXIBLE

Flexible loads and distributed generation/storage can be used to reduce, shift, or modulate energy use

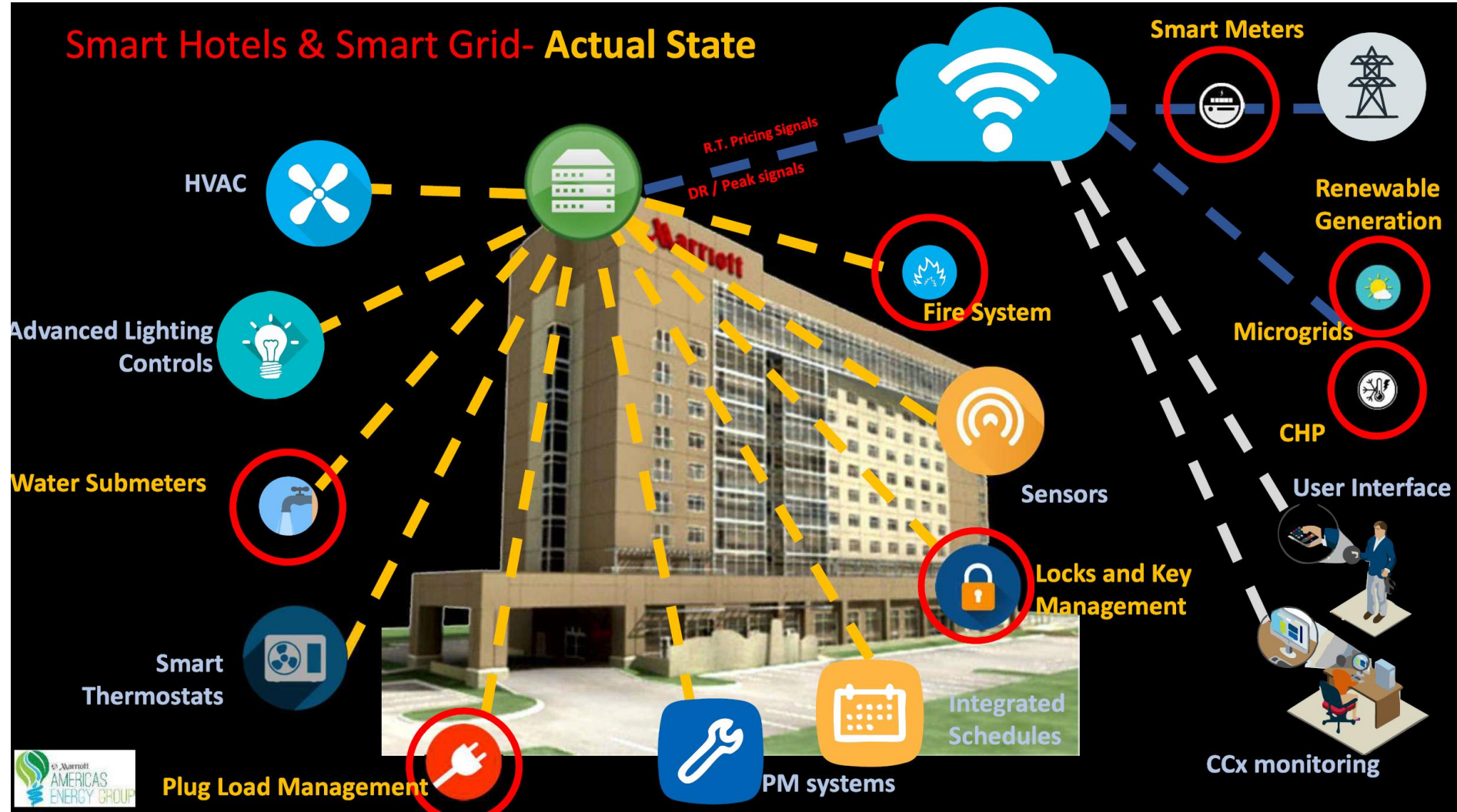


SMART

Computing, data analytics, and machine learning supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences

But life is more complicated –

Smart Hotels & Smart Grid- Actual State

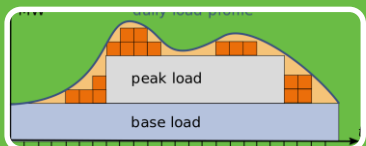


Source: Douglas Rath, Marriott International

Benefits of GEB/flexible building loads



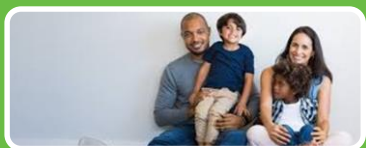
✓ Energy Affordability



✓ Improved reliability



✓ Reduced grid congestion



✓ Enhanced integration & services



✓ Environmental benefits



✓ Customer choice

What's in it for the grid? (Teaser slide)

Grid Services	Potential Market Size Addressable by Demand Flexibility in Buildings
Generation Services	
Generation: Energy	Large
Generation: Capacity	Large
Ancillary Services	
Contingency Reserves	Moderate
Frequency Regulation	Small
Ramping	Small
Delivery Services	
Non-wires Alternatives	Moderate
Voltage Support	Small

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.*

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.*

TECHNOLOGY OPTIONS

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



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

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.*

2019 GEB planned activities and projects

✓ Continued Feedback on Concept

- Flexible Building Loads RFI
- IEA *Modernising Energy Efficiency through Digitalisation*
- NASEO/NARUC regulatory working group with states and utilities (February start)
- Time-sensitive Valuation working group and webinars (Ongoing)
- BTO Peer Review (“You are here”)
 - 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

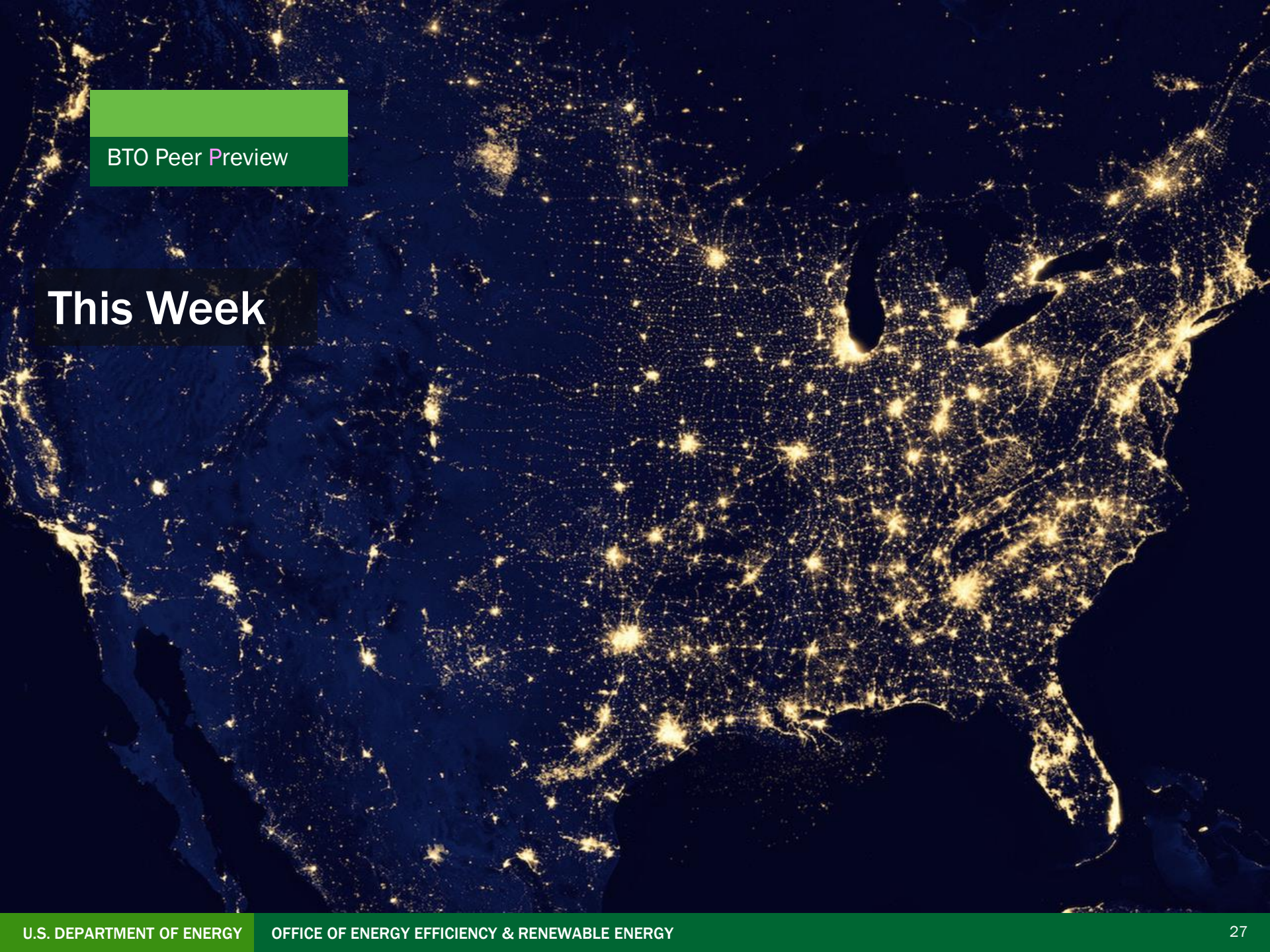
- GEB Technical Report Series (Drafts complete for BTO Peer Review in April)
 - If interested in reviewing drafts, contact: monica.neukomm@ee.doe.gov
- GEB Resource Potential (Fall)

✓ Upcoming Competitive Funding

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

✓ More to come!

“Not a project, but an attitude”



BTO Peer Preview

This Week

FY 2019 Peer Review Objectives (Project-Level)

Objectives

1. Objectively evaluate BTO projects and portfolios.
2. Communicate BTO program activities and their connections, highlighting: what we do; transparency; progress being made with taxpayer dollars.
3. Provide a forum that promotes the creation of more collaboration and partnerships.
4. Demonstrate DOE's role in energy efficiency.

Evaluation Criteria Weighting



FY 2019 Peer Review Objectives (Portfolio-Level)

Objectives

1. Objectively evaluate BTO projects and portfolios.
2. Communicate BTO program activities and their connections, highlighting: what we do; transparency; progress being made with taxpayer dollars.
3. Provide a forum that promotes the creation of more collaboration and partnerships.
4. Demonstrate DOE's role in energy efficiency.

Evaluation Criteria Weighting

Portfolio (Partnerships)

- Scope (30%)
- Impact (40%)
- Collaboration, Coordination, and Integration (30%)

Portfolio (Data, Modeling, and Controls)

- Scope (30%)
- Impact (30%)
- Collaboration, Coordination, and Integration (20%)
- Communication and Stakeholder Engagement (10%)
- Metrics (10%)

Overview of the BTO Peer Review

PLENARIES

Monday, April 15	Introductory Video Remarks Daniel Simmons, Assistant Secretary, EERE
	Industry-Changing Developments in Building Technologies R&D Steven Chalk, Acting Deputy Assistant Secretary, EERE
	Building Technologies and DOE's Role: A Vision for 2030
	Metrics: Then, Now and the Future
	Practitioners' Perspectives on Grid-Interactive Efficient Buildings
	Integrating Building Technologies with Renewables and Energy Storage
Tuesday, April 16	Early to Mid-Career Fast Pitches
	Advanced Building Construction Panel

POSTER SESSION

Monday, April 15
6:00 – 7:30 PM

PORTFOLIO REVIEW TRACKS

Grid-Interactive Efficient Buildings
Building Energy Data
Building Energy Modeling
Sensors and Controls
Commercial and Residential Buildings Partnerships

PROJECT REVIEW TRACKS

Commercial Buildings Integration	Integrated Technology Packages
	Systems Approaches
Emerging Technologies	HVAC, Water Heating, and Appliances
	Solid-State Lighting
	Windows/Envelope
Residential Buildings Integration	Building America

Overview of the BTO Peer Review – GEB Track

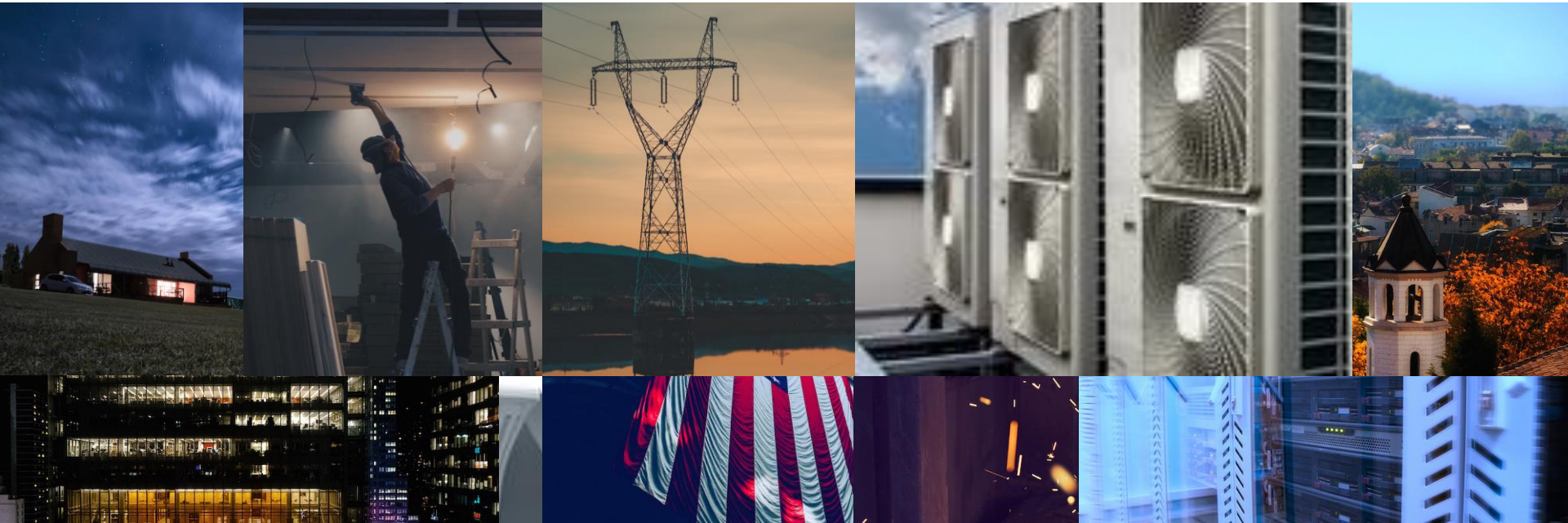
Grid-Interactive Efficient Buildings (GEB)	
Monday, April 15	Grid-Interactive Efficient Buildings Overview
	Grid-Interactive Efficient Buildings Project Review
	Grid-Interactive Efficient Buildings Strategy Discussion
	Grid-Interactive Efficient Buildings Validation
	Grid-Interactive Efficient Buildings Lighting Technical Report
Tuesday, April 16	Grid-Interactive Efficient Buildings Windows and Opaque Envelope Technologies Technical Report
	Grid-Interactive Efficient Buildings Heating, Ventilation, Air Conditioning (HVAC), Water Heating, Appliances, and Commercial Refrigeration Technical Report
Wednesday, April 17	Overview of Grid-Compatible Controls
	Grid-Compatible Controls Portfolio Review
	Grid-Interactive Efficient Buildings Sensors, Controls, Modeling and Data Analytics Technical Report

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Thanks for your
time, attention, commitment, candor & brainpower
from the entire BTO Team

www.energy.gov/eere/buildings/building-technologies-office



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BTO's National Lab Family

