BS 2021 1-3 SEPT BRUGES

INTERNATIONAL BUILDING PERFORMANCE SIMULATION ASSOCIATION

Distribution of potential savings from urban-scale energy modeling of a utility

Speaker:

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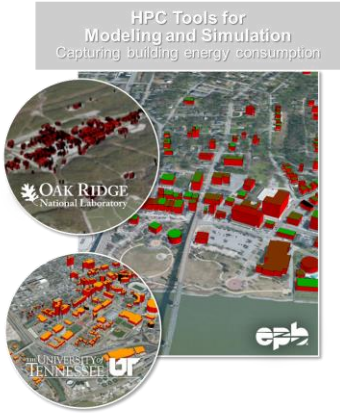
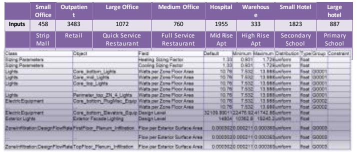
Motivation

- Utility+ - Urban-scale energy modeling is now scalable to utility-sized or larger geographic regions
- BEM for utilities - How can BEM inform utility energy efficiency programs and use cases?
- Distribution of savings - What are ranges of savings across every building in city-sized areas?
- Best practices - Develop case studies that can validate and inform best practices for urban-scale building energy modeling

Beyond Urban-scale Modeling



1. Quantitatively rank most important building inputs

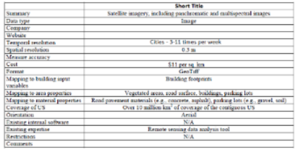


Sensitivity Analysis

2. Time on world's #1 fastest high-performance machines

Supercomputers

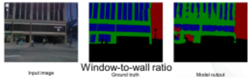
3. Identify and compare data sources for important inputs



Comparison Matrix

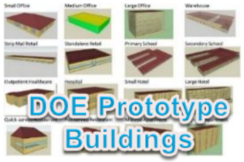
4. Establish partnerships and APIs for scalable data retrieval

5. Algorithms to extract building properties

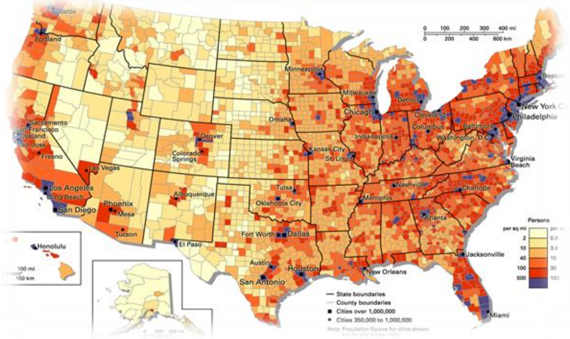


Computer Vision

6. Create OpenStudio & EnergyPlus models



DOE Prototype Buildings



Demonstrate and stimulate opportunities toward a sustainable built environment

7. Make models freely available

Download BEM via street address

Use cases:

- Utility-scale energy and program impacts
- City-scale emissions reductions
- Simulation-informed analysis during siting & design
- Resilience and Adaptation to Climate Change
- Sales/marketing leads
- Automated financing
- Business model evaluation

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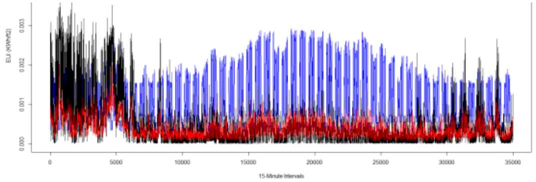
Key Innovations

- AutoBEM (Automatic Building Energy Modeling; bit.ly/AutoBEM) software suite developed to synthesize multiple data sources, generate building energy models, simulate, and statistically summarize simulation results for large geographical regions.
- High Performance Computing - Theta, world's 39th most powerful supercomputer, used to perform over 2 million annual simulations.
- Distribution of energy efficiency (EE, kWh) of 4 technologies for all buildings in a utility’s service area.
- Distribution of demand flexibility (DF, kW) of 4 technologies for all buildings in a utility’s service area.

Virtual EPB – utility serving Chattanooga, TN, USA

- 178k building, 8-county, 1400 km^2 service area at boundary of TN, GA, and AL
- 15-minute whole-building electricity use from each building
- Building type assigned by: utility rate class, tax assessor data, and 15-min energy use intensity for a year (EUI_{15}) of actual vs type+vintage combinations
- 8 technologies

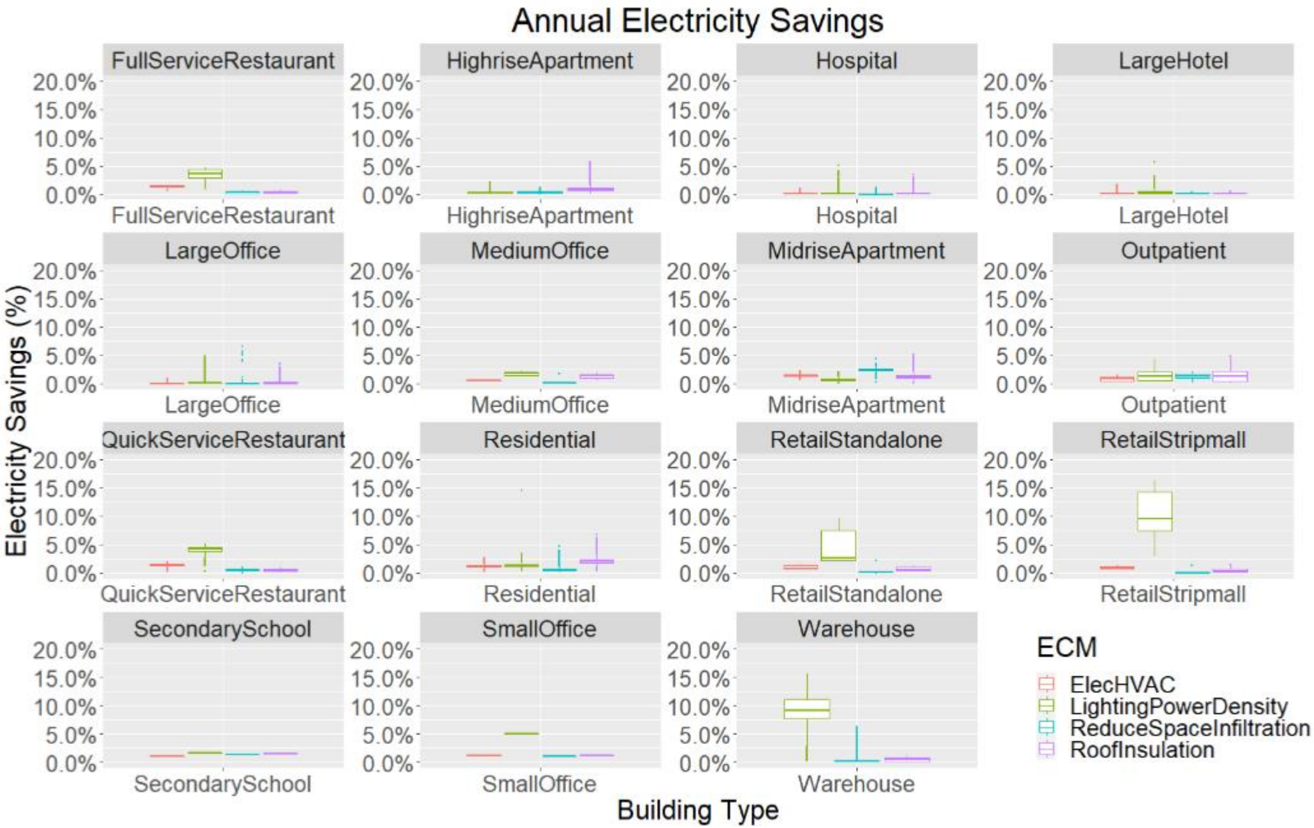
Black – actual kWh/ft^2
Red – Residential EUI_{15}
Blue – Small office EUI_{15}



#	Description	Category	Value	Source
1	Insulate Roof	Envelope	R-16.12 to R-28.57	IECC-2012
2	Reduce Space Infiltration	Envelope	Reduce 25% from vintage	EnergyStar
3	Smart Thermostat (2.2°C)	HVAC	2.2°C 2 hours prior to peak	EPB
4	Smart Thermostat (4.4°C)	HVAC	4.4°C 4 hours prior to peak	EPB
5	Change Electric HVAC COP	HVAC	COP to 3.55 (heating) 3.2 (cooling)	IECC-2012
6	Change Lighting Power Density	Lighting	LPD 0.85 W/ft^2	IECC-2012
7	Change to Gas Water Heater	Water	Efficiency 80% (assumes electric)	IECC-2012
8	Change to Gas HVAC	HVAC	Efficiency 80% (assumes electric)	IECC-2012

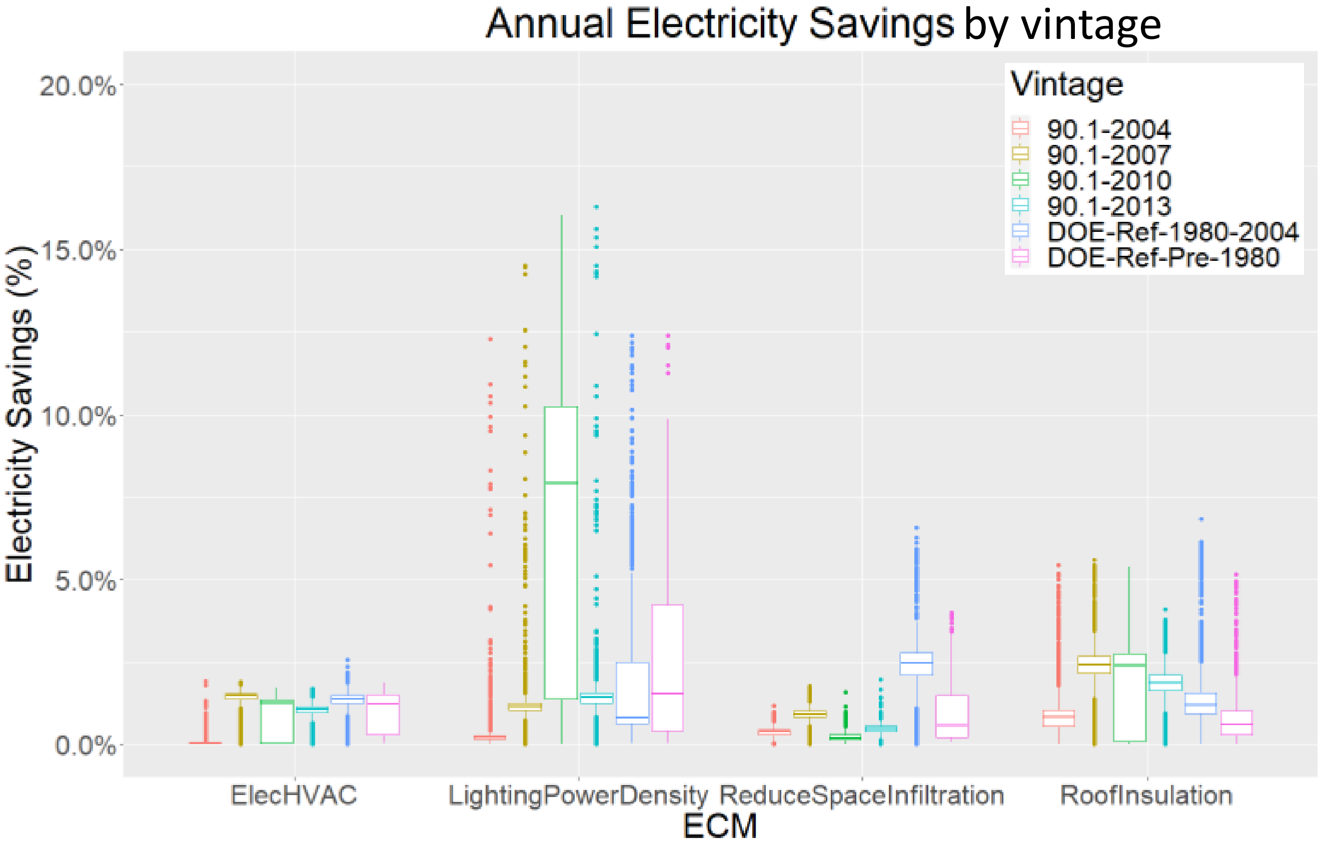
Results (kWh)

- Greatest savings: lighting in warehouses, strip malls, and retail



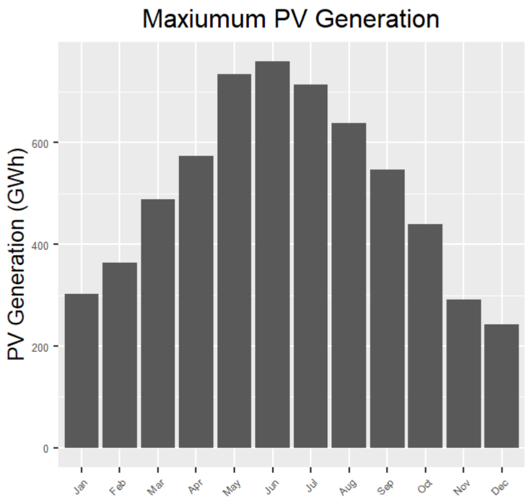
Results (kWh)

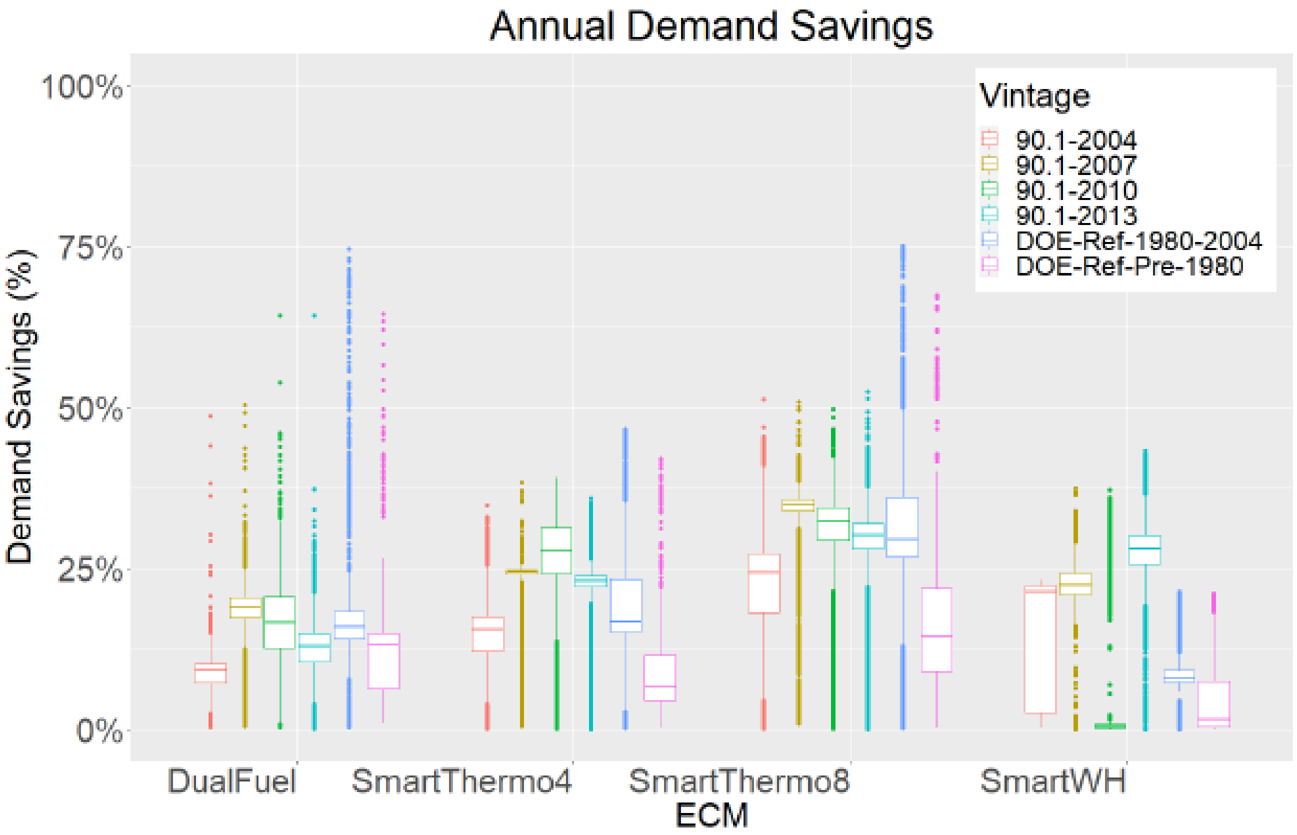
- Old buildings save more
- HVAC is most consistent



Results (kW)

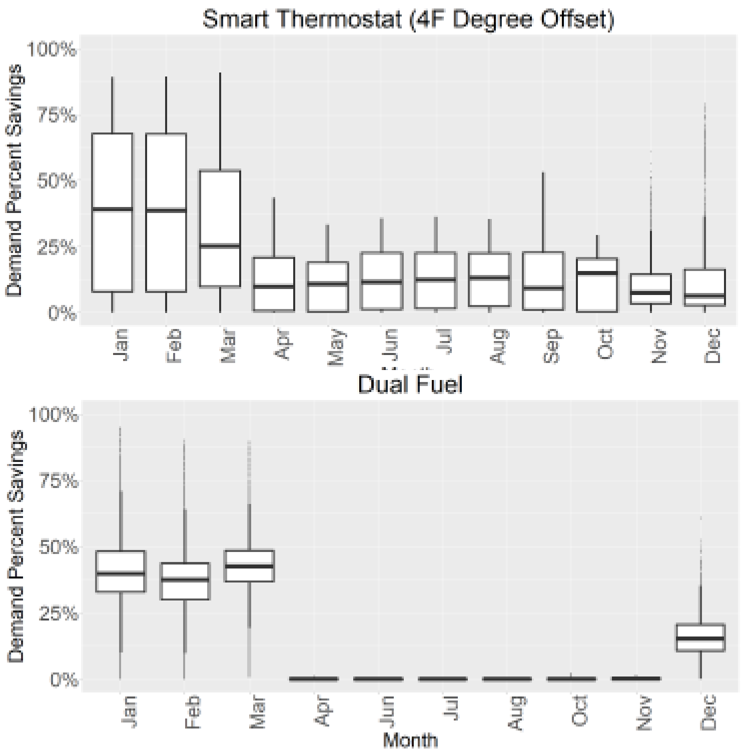
- 0-75% DF
- PV: 300-750 GWh/month





Results (kW)

- 2.2°C pre-conditioning avg 22% kW savings but varies 0-93% per month by building
- Fuel-switching to natural gas for heating shows significant electric demand savings during winter months

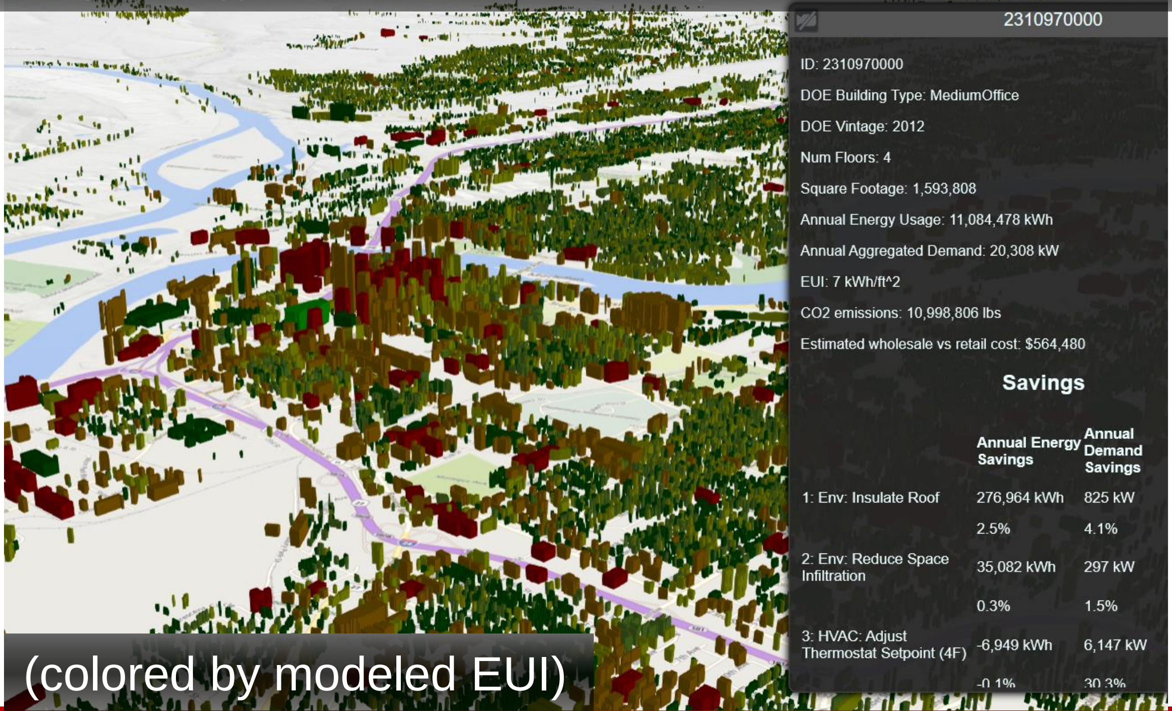


Energy, Demand, Emissions, and $avings at building-level

Virtual EPB: 178,368 building energy models; validated against 15-minute electricity

- Results
  - Energy (kWh)
  - Demand (kW)
  - Emissions ($CO_{2\text{-eq}}$)
  - Cost ($USD)
- Publicly available:

bit.ly/virtual_epb



(colored by modeled EUI)

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Questions and Comments

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