# Potential Demand Reduction from Buildings in a Simulated Utility

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### Motivation: BEM for every U.S. Building by 12/31/2020

Methodology: Scalable compute, data, simulation, and empirical validation

1. Quantitatively rank most important building inputs

	Small Office	Outpatien t 3483		Large Office	Medium Office		Hospital	Wai	ehous e	Small Hotel			Large hotel	
Inputs	458			1072	760	1955	333		1823			887		
Strip Mall		Re	tail	Quick Servic Restauran			Mid Rise Apt		n Rise Apt	Secondary School			Primary School	
Class		_	Object		Field		Default	Minimum	Maximum	Distribution	Type	Group	Constraint	
Sizing Para			1000		Heating	Sizing Factor	1.33			minorim	float		1077000000	
Sizing Parameters					Cooling Sizing Factor		1.33			uniform	float			
Lights			Core bottom Lights		Watte :	er Zone Floor Area	10.76	7.532	13.988	Ministern	Ficet	G0001		
Lights			Core mid Lights		Watta	per Zone Floor Area	10.76	7.532	13.988	Buniform	Tigat	G0001		
Lights		Core top Lights			per Zone Floor Area	10.76			Suniform		G0001	_		
					Watts:	per Zone Floor Area	10.76	7.532	13.988	duniform	float	G0001		
Lights			Perimete			per Zone Floor Area	10.76			Dunitorm		G0001	_	
Electric Equipment		Core_bottom_PlugMist_Equip			per Zone Floor Area	10.76			Sunitorm		G00002			
					Watts I	per Zone Floor Area	10.76	7.532	13.988	Suniform	float	G0002	-	
ElectricEqu	ipment.		Core ba	tom Elevators Equip	Design	Lovel	32109.89011	22476.92	41742.80	Suniform	float.			
Exterior Lights		Exterior Facade Lighting		Dasign	Cavel	14804	10362.8	19245.2	unitorm	Float		_		
Zoneinfiltrat	ton DesignF	lowRate	FirstFloo	_Plenum_infitration	Flowp	er Exterior Surface Area	0.000302	0.000211	0.000393	Suniform	float	G0003		
					Powp	er Exterior Surface Area	0.000302	0.000211	0.000393	uniform	float	G0003		

**Sensitivity Analysis** 

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



3. Identify and compare data sources for important inputs

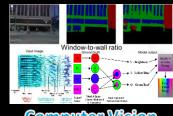
	Short Title
Summary	Satellite imagery, including panchromatic and multispectral images
Data type	Image
Company	
Website	
Temporal resolution	Cities - 3-11 times per week
Spatial resolution	0.3 m
Measure accuracy	
Cost	S11 per sq. km
Format	GeoTiff
Mapping to building input variables	Building footprints
Mapping to area properties	Vegetated areas, road surface, buildings, parking lots
Mapping to material properties	Road pavement materials (e.g., concrete, asphalt), parking lots (e.g., gravel, soil)
Coverage of US	Over 10 million km <sup>2</sup> of coverage of the contiguous US
Orientation	Aerial
Existing internal software	N/A
Existing expertise	Remote sensing data analysis tool
Restrictions	N/A
Comments	

**Comparison Matrix** 

4. Establish partnerships and APIs for scalable data retrieval

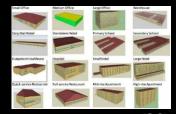


5. Algorithms to extract building properties



Computer Vision

6. Create OpenStudio and EnergyPlus models



**DOE Prototype Buildings** 

Goal: Stimulate private sector activity and academic research for a sustainable built environment



7. Make models freely available online



Download BEM via street address

#### IGA:

- · Walkthrough Audit
- Calibration to measured data

#### Use cases:

- Simulation-informed analysis
- Sales/market leads
- Utility program formulation
- Automated financing



**ACM BuildSys 2019** 

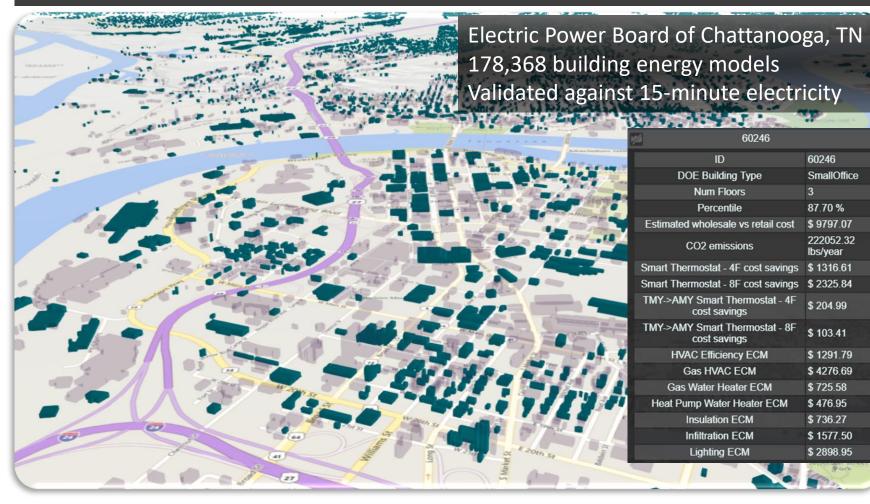


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B. Bass and J. New

### Results: Digital Twin of Campuses and Virtual Utility





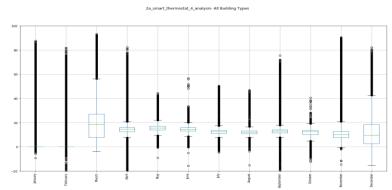


**ACM BuildSys 2019** 

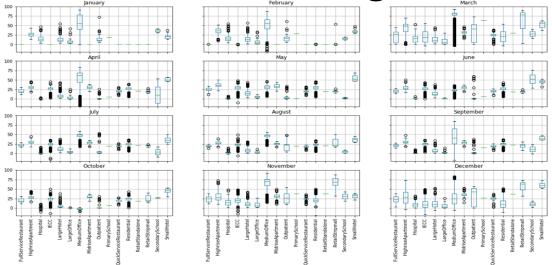


Potential Demand Reduction from Buildings in a Simulated Utility

#### B. Bass and J. New



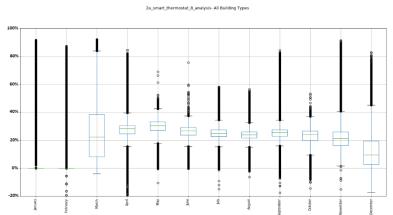
**4°F** pre-conditioning shows an average **13%** peak demand reduction across 178,368 residential and commercial buildings.



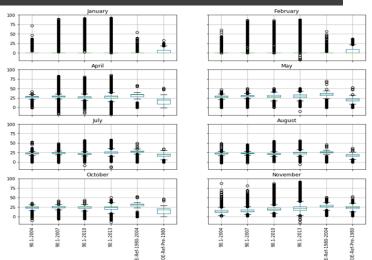
**8°F** breakdown of quartiles by **building type** for each calendar month with medium offices and strip malls as high, but timesensitive, value deployments.

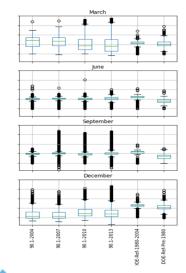
# Analysis: Demand Reduction Breakdowns

8°F shows an average 22%, significant spread.



**8°F** breakdown of quartiles by **vintage** (age) for each calendar month shows slight increases with newer vintages.







**ACM BuildSys 2019** 

