

# CityBES: A Data and Computing Platform for City Buildings

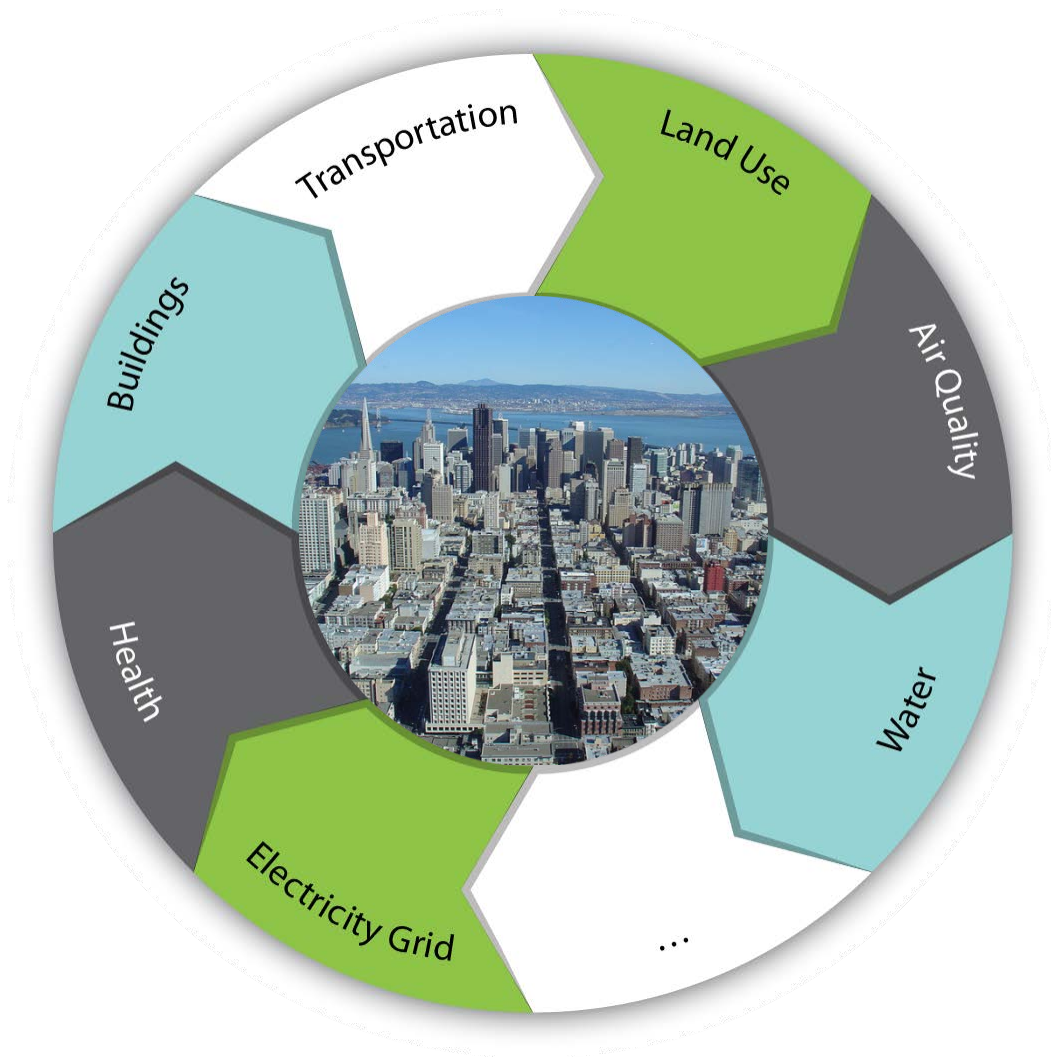
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Building Technology and Urban Systems Division



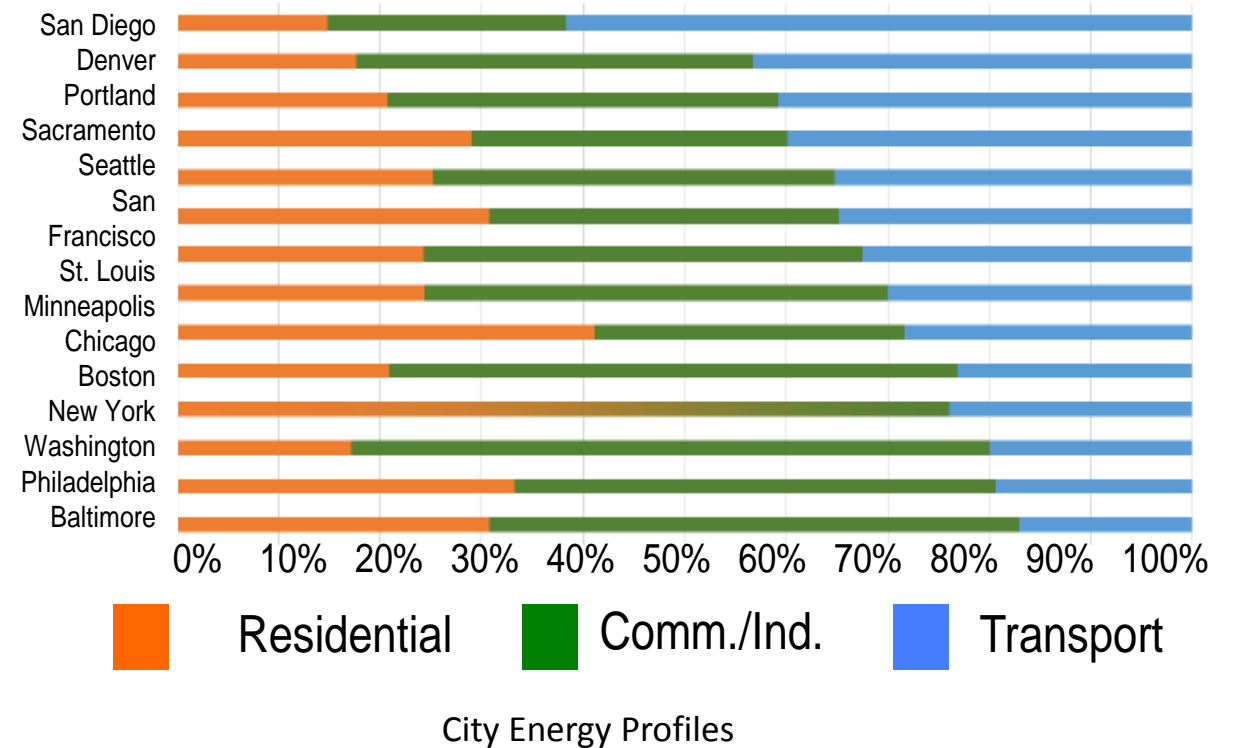
Lawrence Berkeley  
National Laboratory

**Urban Infrastructures NSF Workshop  
New York Institute of Technology  
December 1<sup>st</sup>, 2017**

# How to reduce 50% energy use in city building stock?



- Buildings in cities consume 30-70% of the primary energy
- Cities have different building energy use profiles
- The building sector has the most potential to save energy



# City Building Energy Saver (CityBES.lbl.gov)



Filtering Buildings

3D + GIS + Color Coding

Result Visualization Options

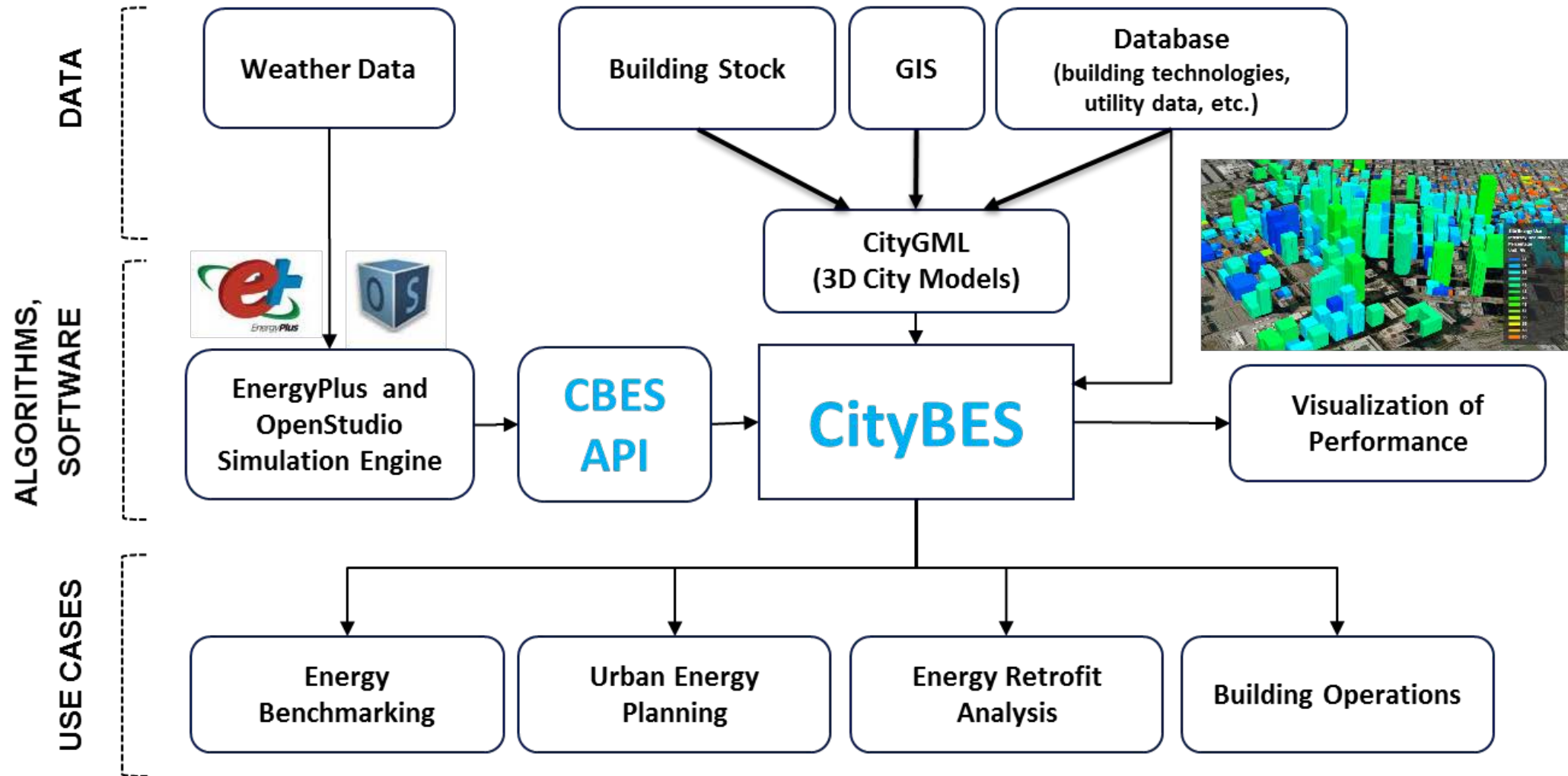
Aggregated Retrofit Results

Building Highlight

# Overview of CityBES

1. An open-access web-based platform to support city and district scale building energy efficiency programs.
2. Creation and evaluation of energy retrofit scenarios for city buildings.
3. Visualization (3D + GIS) of existing buildings' performance data.
4. Detailed energy modeling and simulation, considering inter-building effect and interactions with urban climate
5. Builds upon open standards

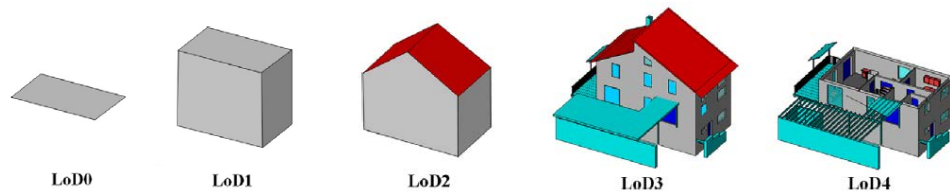
# Workflow and Use Cases





# CityGML

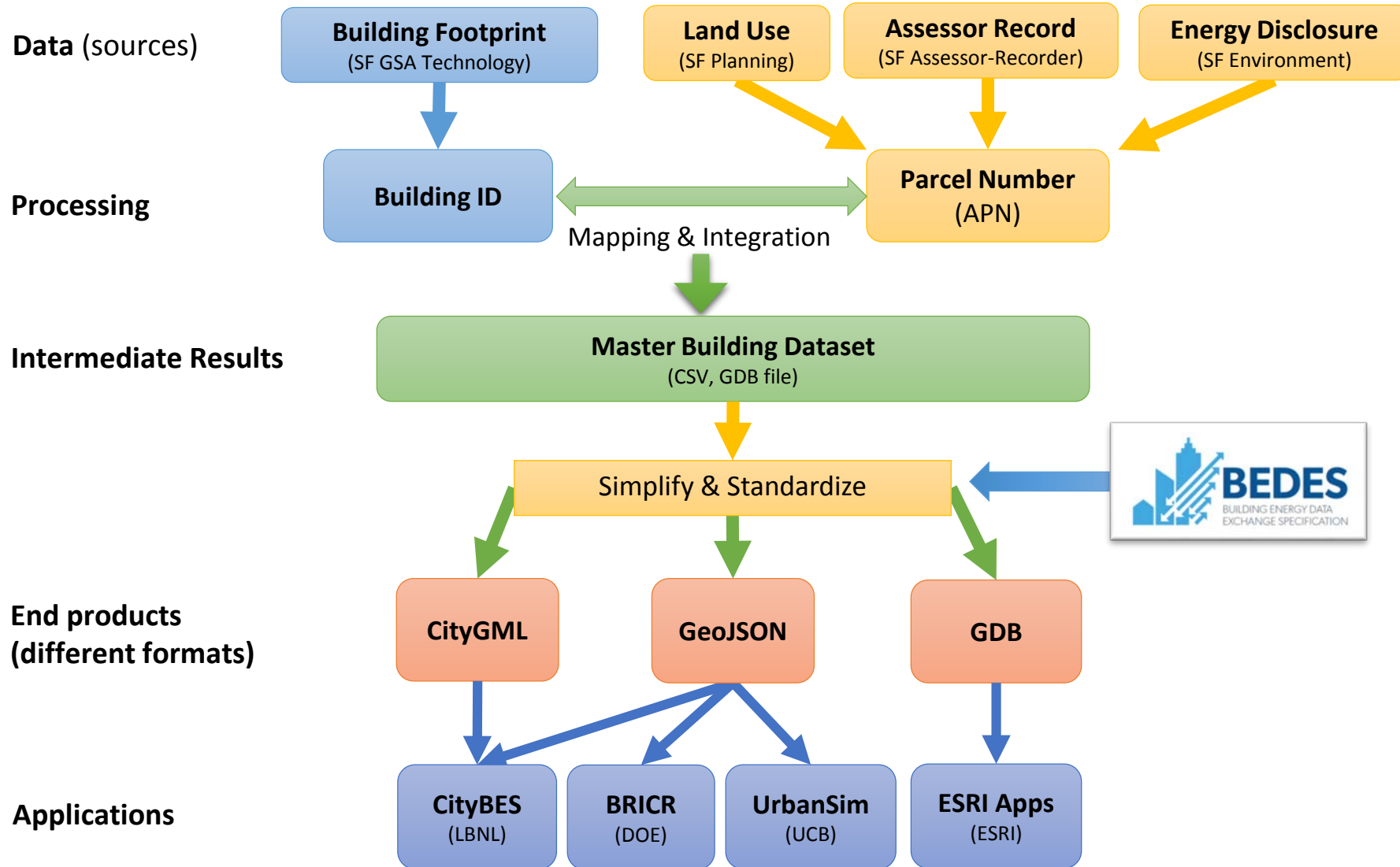
- International OGC standard for representation and exchange of 3D city models.
- Started in 2002, v.2.0 in 2012
- Multi-resolution model
- Customization and extensibility



## Examples of CityGML objects

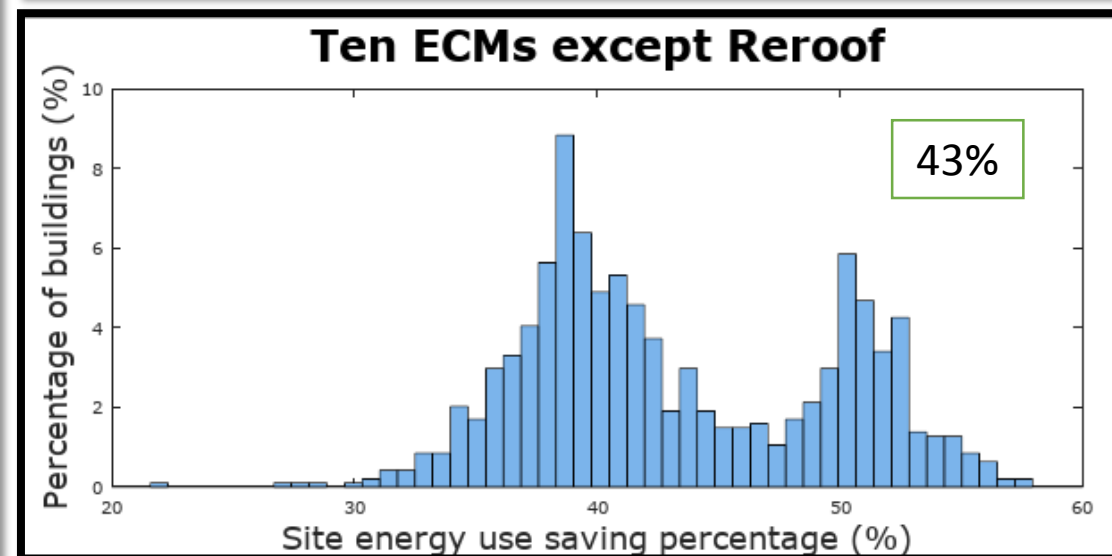
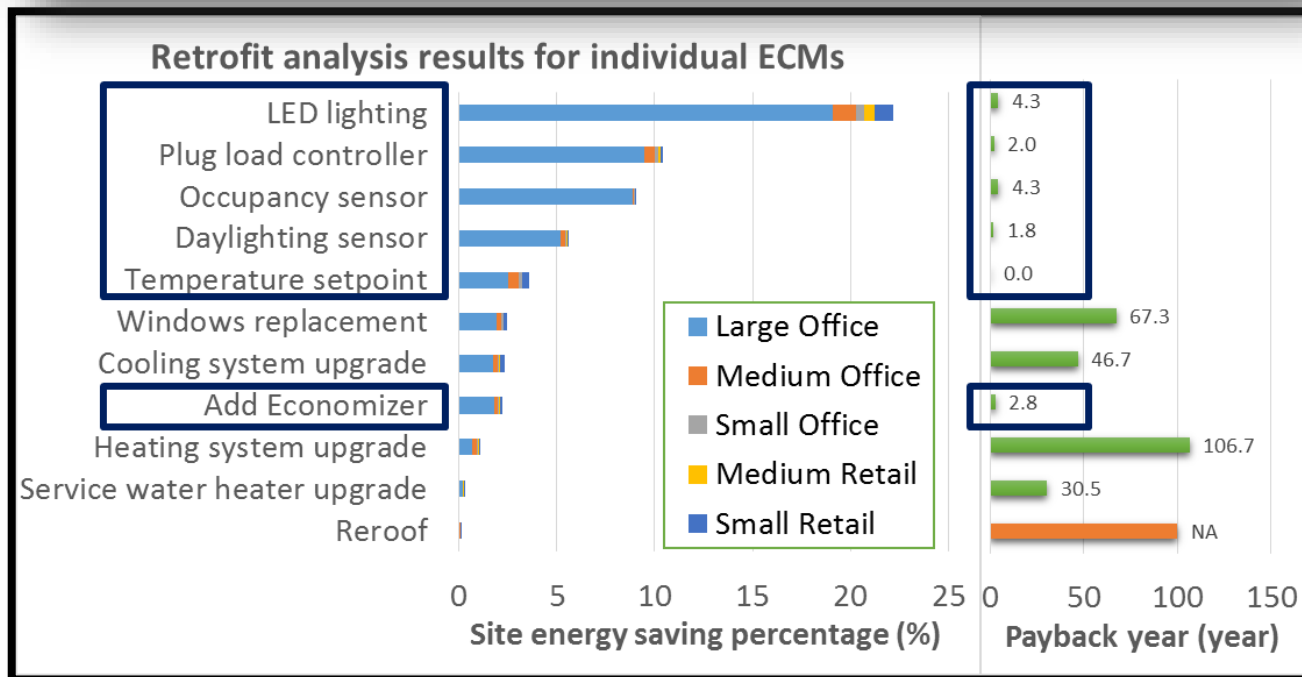
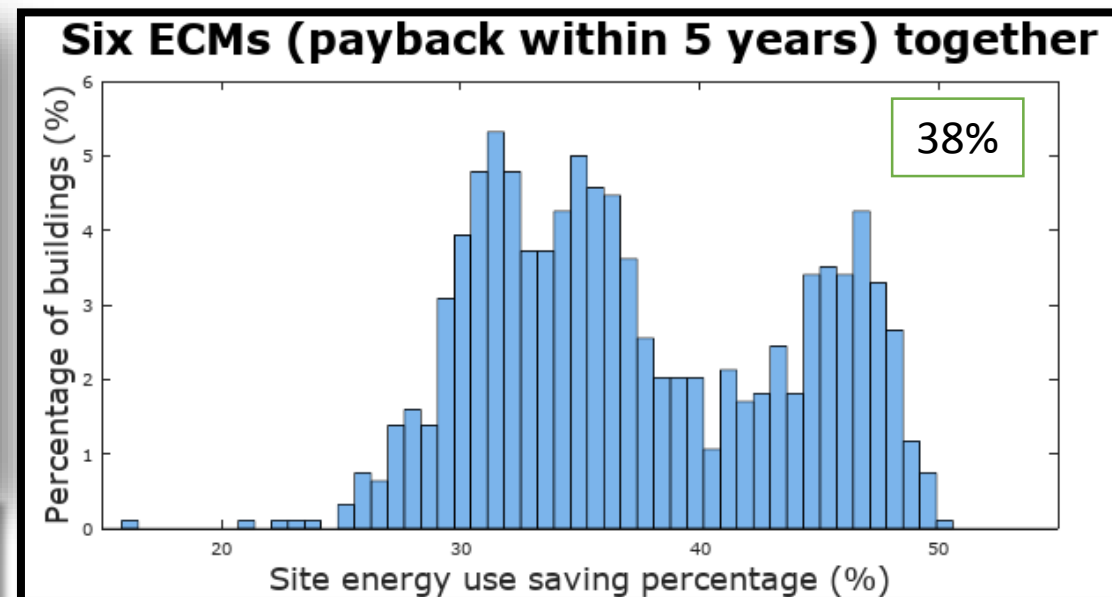
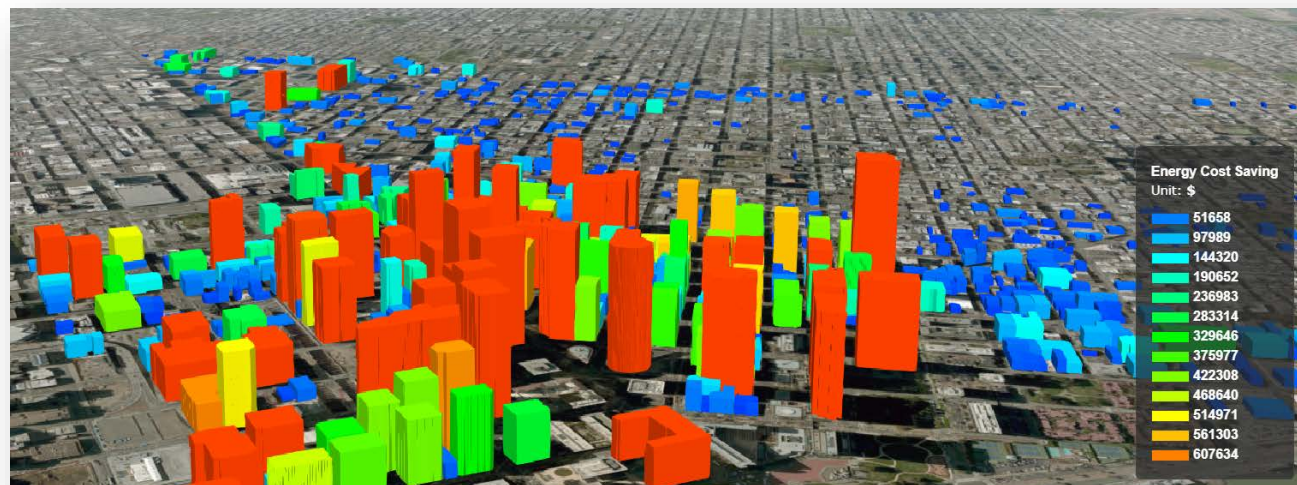


# Open City Buildings Datasets



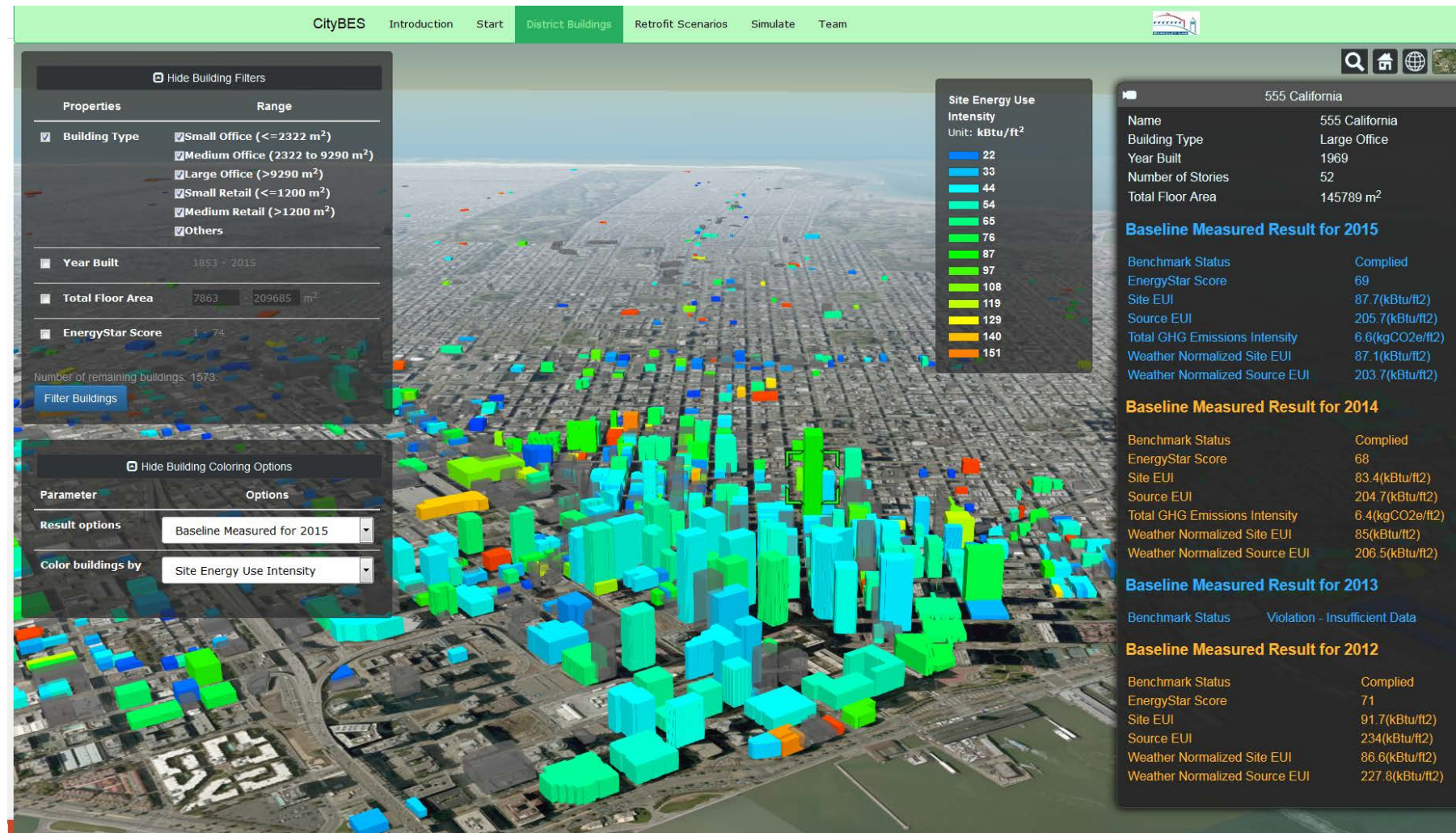
Translate diverse city datasets into inter-operable, standardized format

# Case Study – Retrofit Analysis (940 bldgs, 11 ECMs, SF)



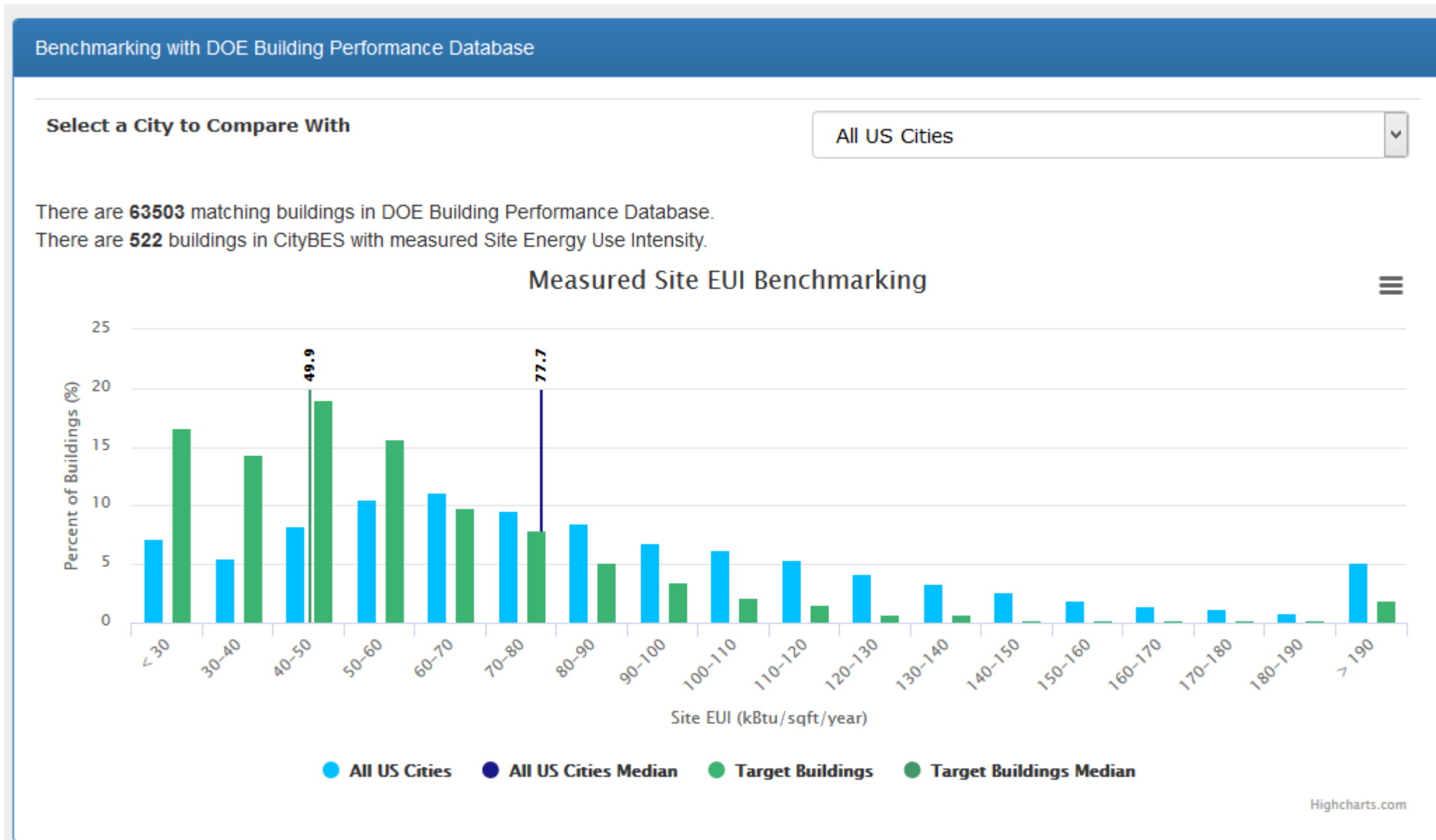


# Visualizing Performance of City Buildings



Visualizing the San Francisco energy ordinance dataset with 1,573 buildings: (1) filtering buildings by type, size, vintage, and (2) color-coding by EUI, CO<sub>2</sub> emission, ENERGY STAR score, compliance status.

# Benchmarking Performance of City Buildings



Comparing site EUI of 522 office buildings in San Francisco with 63503 office buildings in the BPD.



# Identify and evaluate strategies to mitigate GHG emissions



## Hunters Point Shipyard

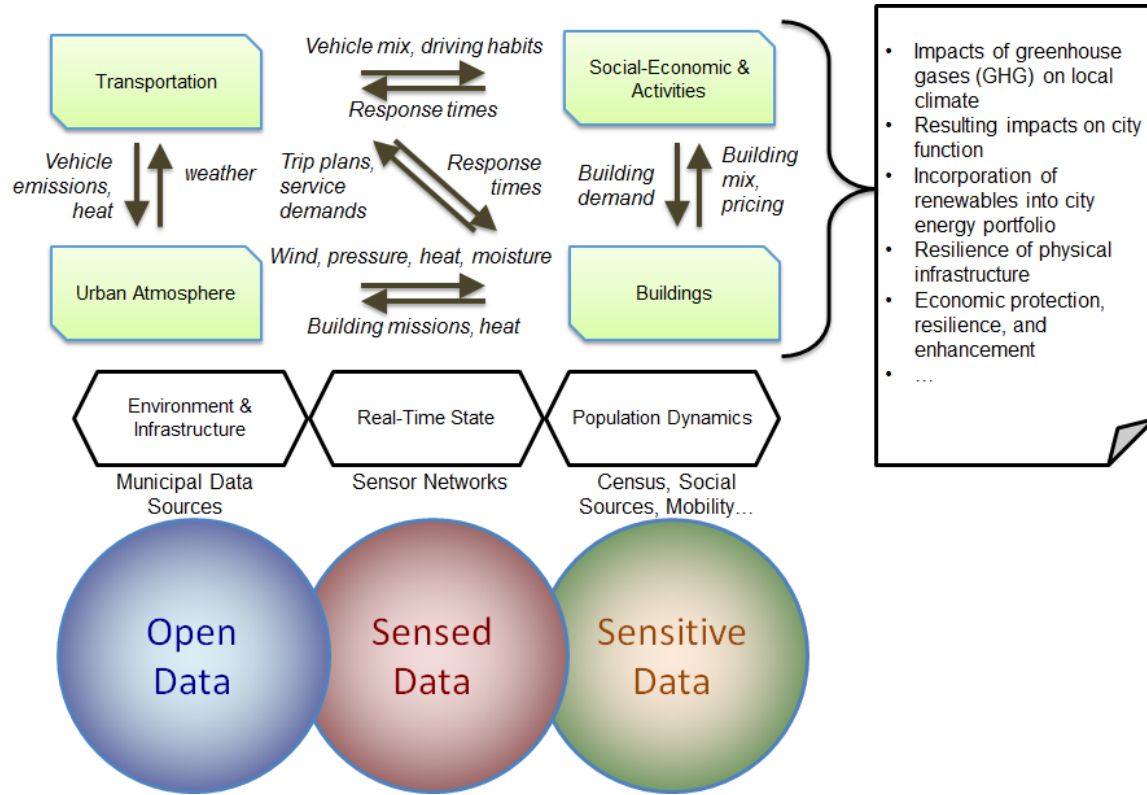
- Leverage and activate a massive number of existing resources, priorities, and opportunities all at once
- Dramatically increase the economic multiplier of HPS and other projects already in development
- Cement San Francisco's role as a global center of innovation and the crossroads for the Bay Area cluster



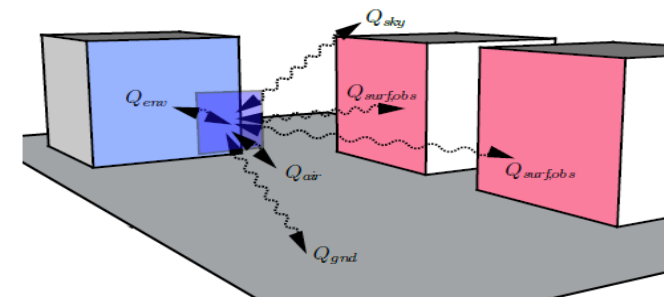
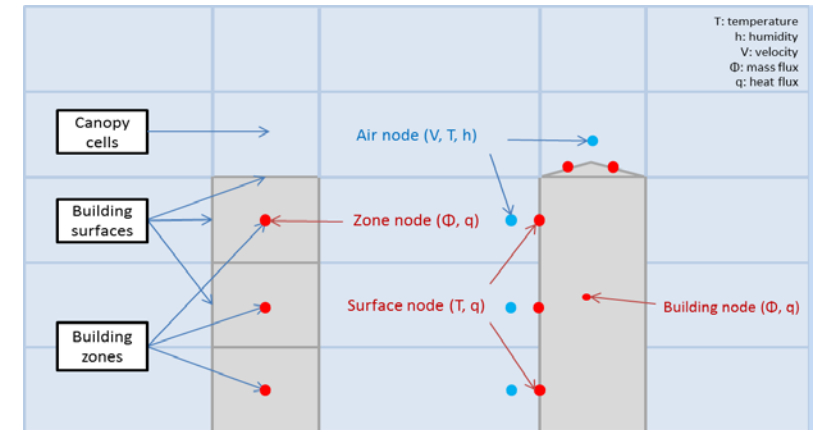
## Concord Naval Base

- The 2,200-acre former naval base could eventually hold 6M ft<sup>2</sup> commercial real estate, as well as 12,000 units of housing.
- The development contract could be as much as \$6 billion.

# Multiscale Coupled Urban Systems: An Exascale Computing Project



- **Application Area:** *Coupled computational models integrating urban systems such as atmosphere, buildings, transportation, and social/economics.*
- **Challenge Problem:** *Support urban design and operations, at multiple scales (district, building, vehicles) through coupled models capturing interdependencies between urban systems and activities.*



- USDOE Office of Science
- Five national labs: ANL, LBNL, ORNL, NREL, PNNL



# Challenges

## 1. Data

A big data problem integrating diverse sources with different temporal and spatial resolutions, quality, and structure/format.

## 2. Modeling

Integration of multiple domain models with different scales and resolutions.

## 3. Simulation

An exascale computing problem.

# Publications

1. T. Hong, Y. Chen, M.A. Piette. [CityBES: A Web-based Platform to Support City-Scale Building Energy Efficiency](#). International Urban Computing Conference, 2016.
2. Y. Chen, T. Hong, M.A. Piette. [City-Scale Building Retrofit Analysis: A Case Study using CityBES](#). IBPSA Building Simulation Conference, 2017.
3. Y. Chen, T. Hong, M.A. Piette. [Automatic Generation and Simulation of Urban Building Energy Models Based on City Datasets for City-Scale Building Retrofit Analysis](#). Applied Energy, 2017.
4. T. Hong, M.A. Piette, Y. Chen, et al. [Commercial Building Energy Saver: An energy retrofit analysis toolkit](#), Applied Energy, 159: 298-309, 2015.
5. M. Wetter, M. Bonvini and T.S. Noudui. [Equation-based languages – A new paradigm for building energy modeling, simulation and optimization](#). Energy and Buildings, 117:290–300, 2016.
6. R.Z. Pass, M. Wetter, M.A. Piette. [A Tale of Three District Energy Systems: Metrics and Future Opportunities](#). Proc. of ACEEE Summer Study on Energy Efficiency in Buildings, Asilomar, CA, August 2016.
7. R.Z. Pass, M. Wetter, and M.A. Piette. [A Thermodynamic Analysis of a Novel Bidirectional District Heating and Cooling Network](#). Energy and Buildings, 2017, under review

Thank You!

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