Urban Systems Research

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Building Technology and Urban Systems Division

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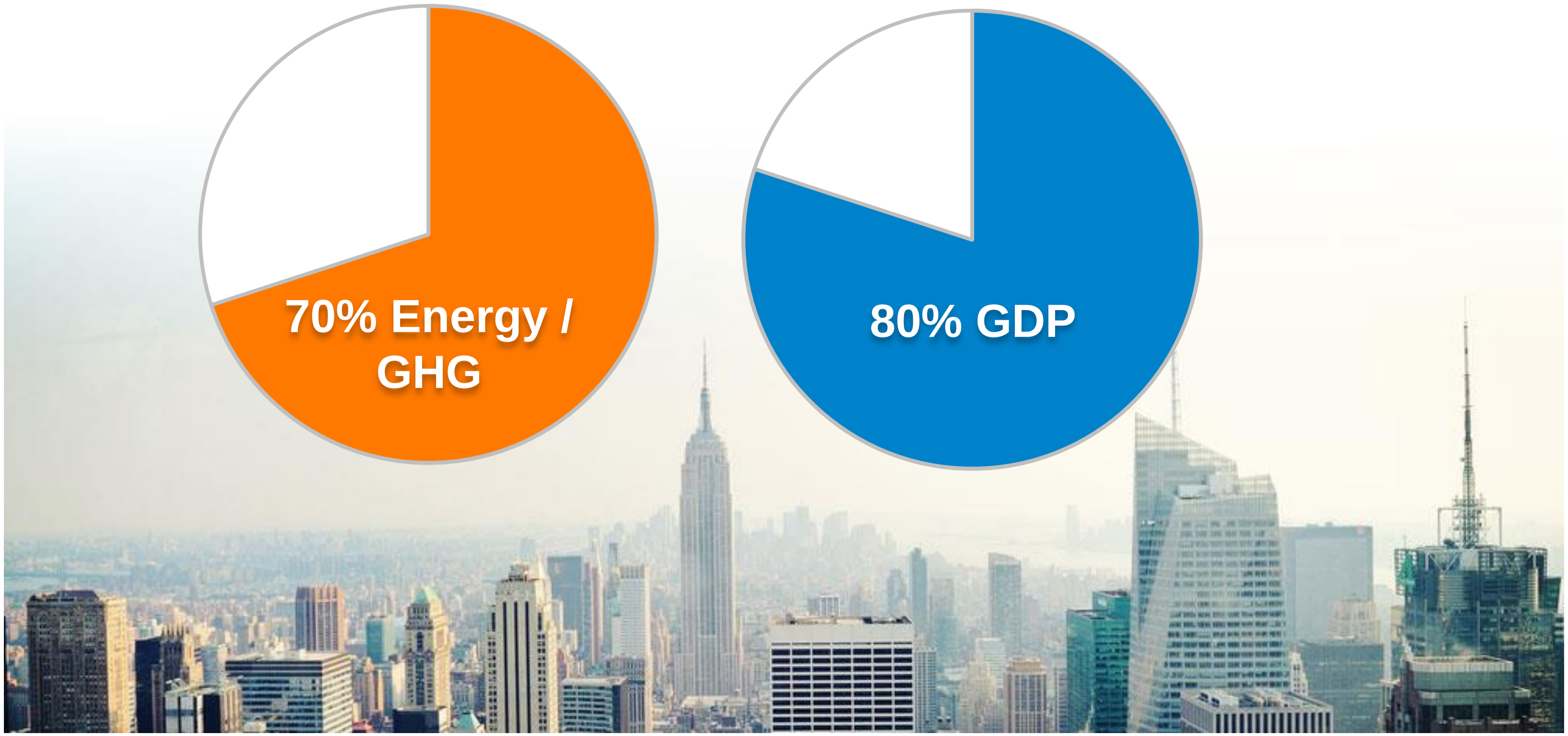
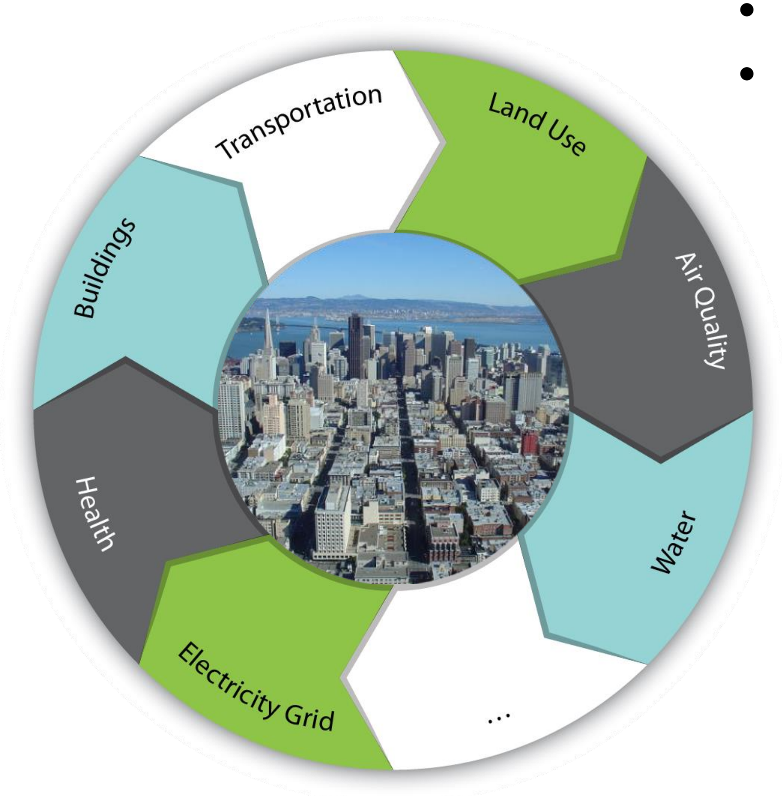
Transforming Cities

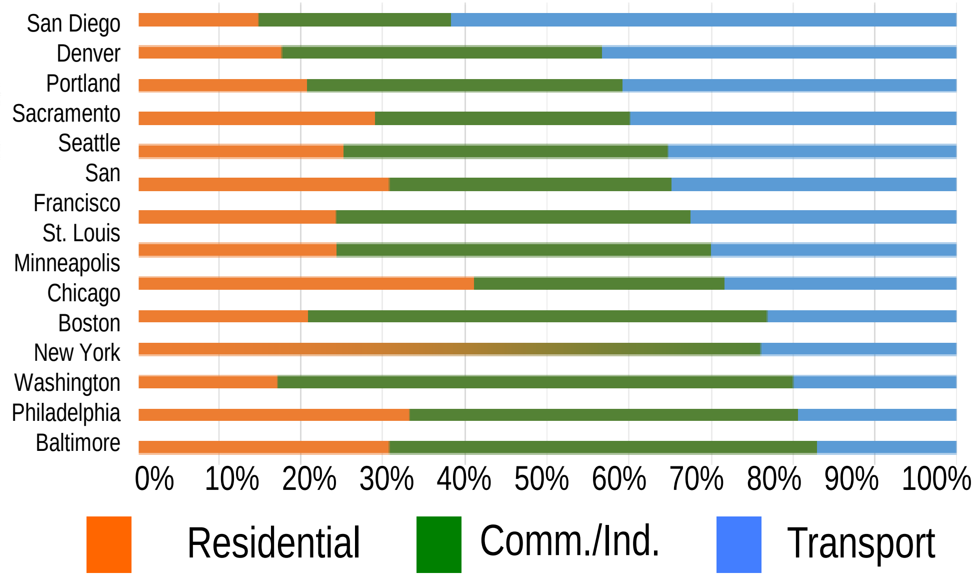
Cities drive our economy and dominate energy and environmental challenges



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



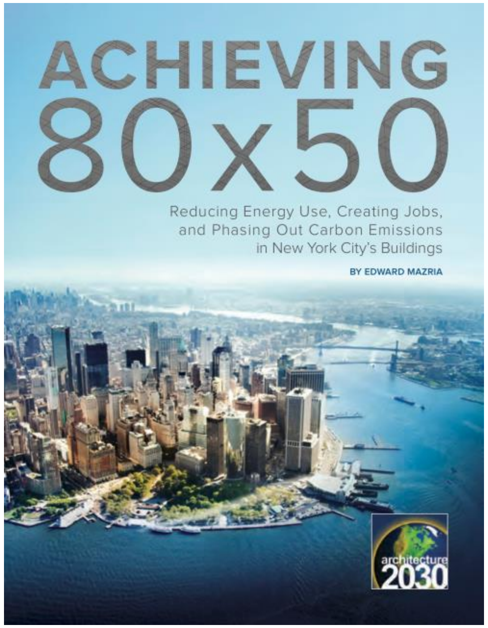
City Energy Profiles

Imagine a City…

…that consumes 50% less total energy per person while improving economic vitality and quality of life and increasing resilience and sustainability

Support cities on decision making for meeting the 80 X 50 goal

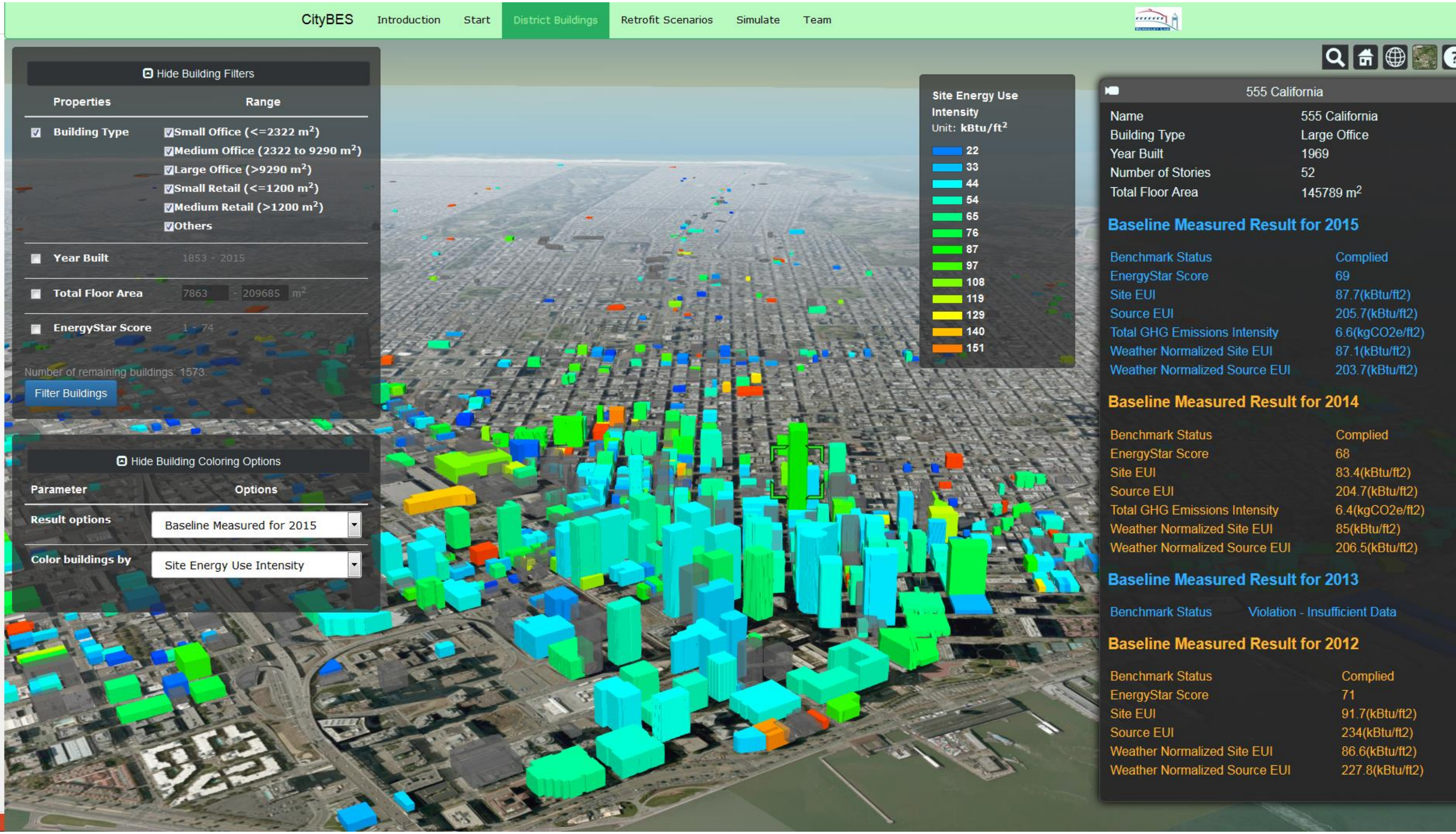
- Support building energy disclosure ordinance: building energy visualization and benchmarking
- Prioritize building retrofit investment: quantitative modeling and analysis
- Track and report building performance (energy use and GHG emissions)
- Inform policy and evaluation: incentives/rebates, climate change, heat waves
- Guide urban energy planning: ZNE communities, smart energy districts



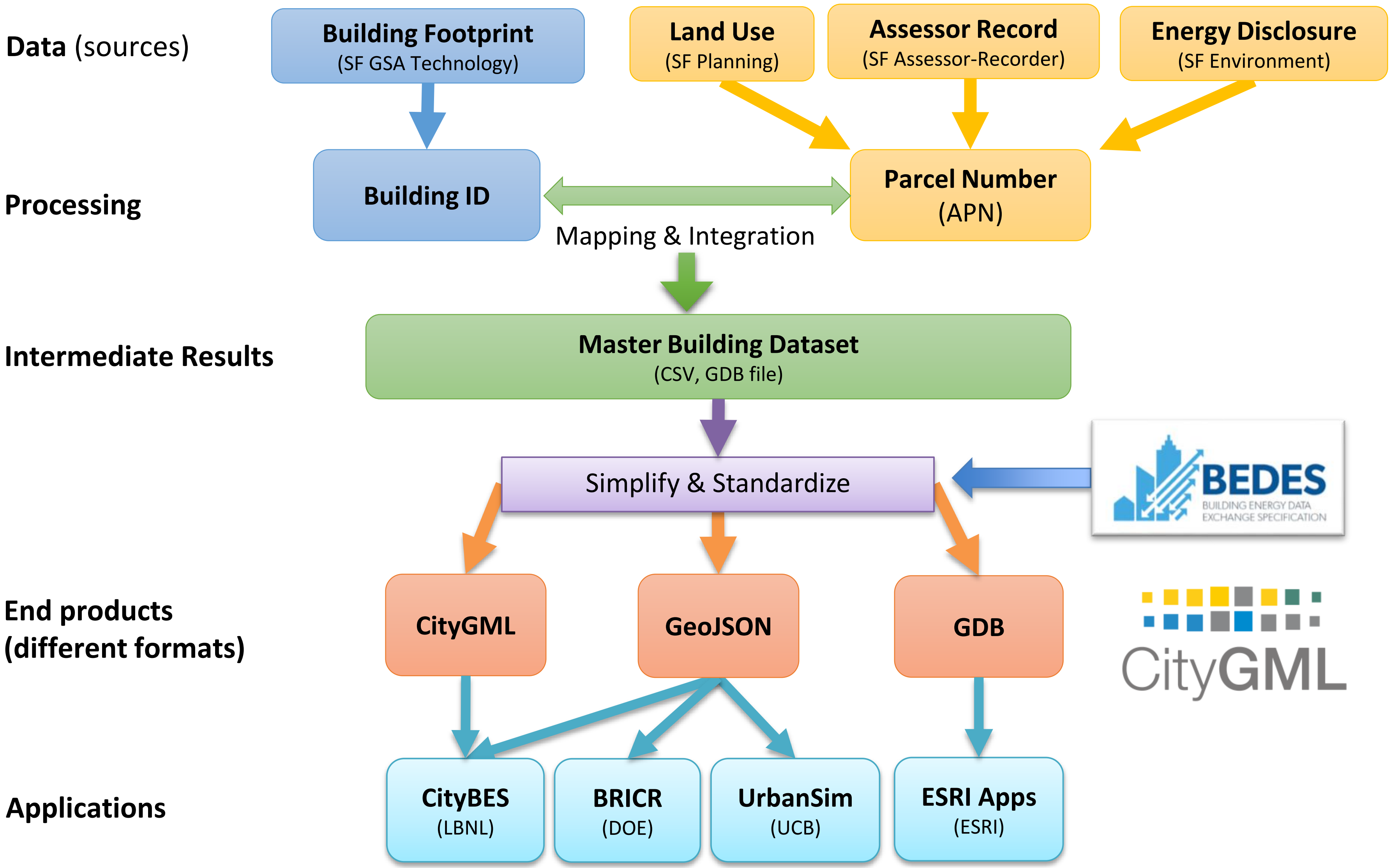
Our Partners / Collaborators

- **Cities**: San Francisco, Oakland, San Jose, Los Angeles
- **Developers**: FivePoint
- **DOE labs**: ANL, NREL, ORNL, PNNL
- **NIST** Global City Teams Challenge
- **Organizations**: NYSERDA, RTA, C40, USDN, Smart Cities Council, IEA EBC
- **Universities**: UCB, EPFL, Darmstadt, Tsinghua,
- **Companies**: SideWalk Labs, Autodesk, MEP Associates, Integral Group

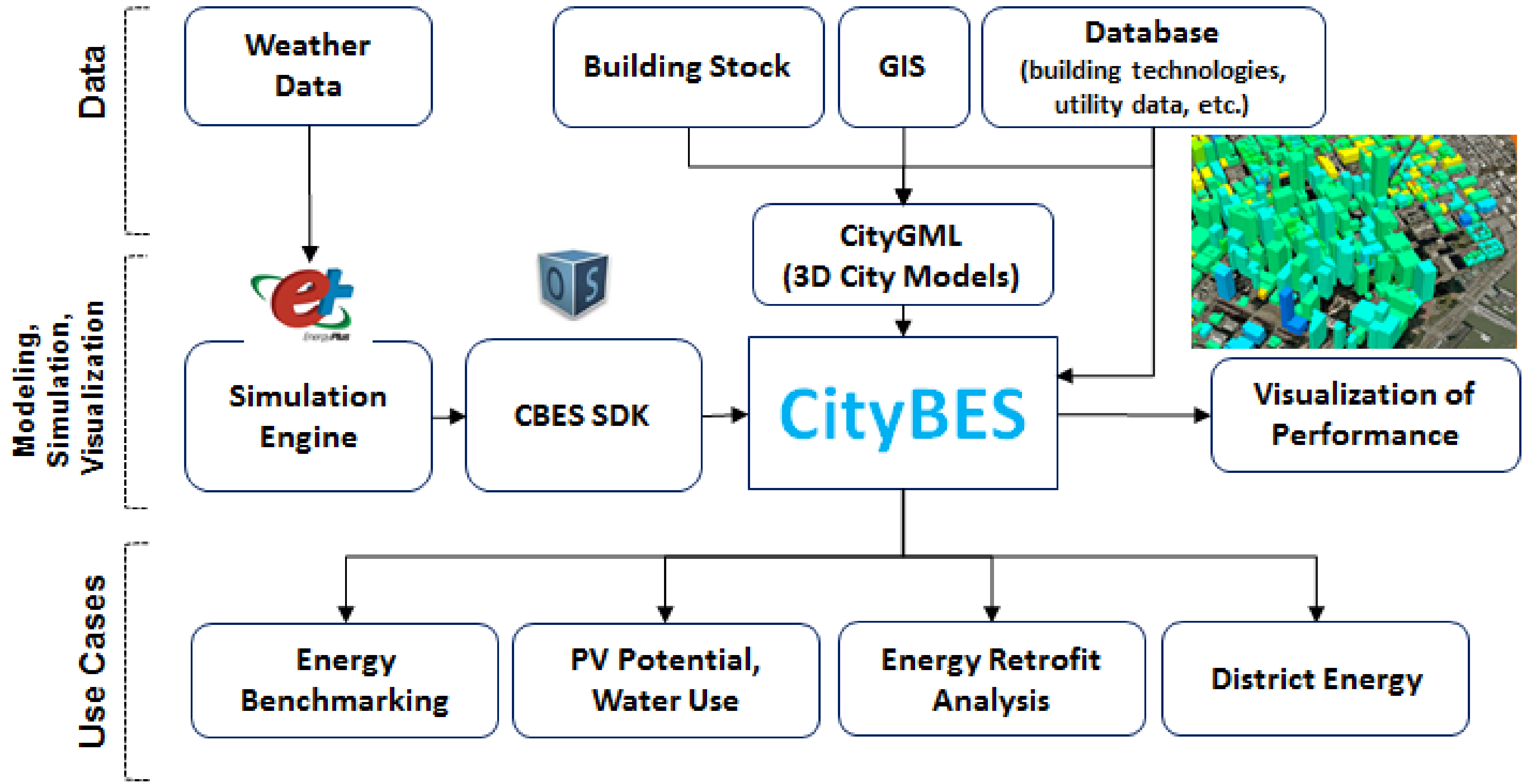
CityBES.LBL.gov
(A Platform for City Buildings)



Integrating City Data in Open Standards

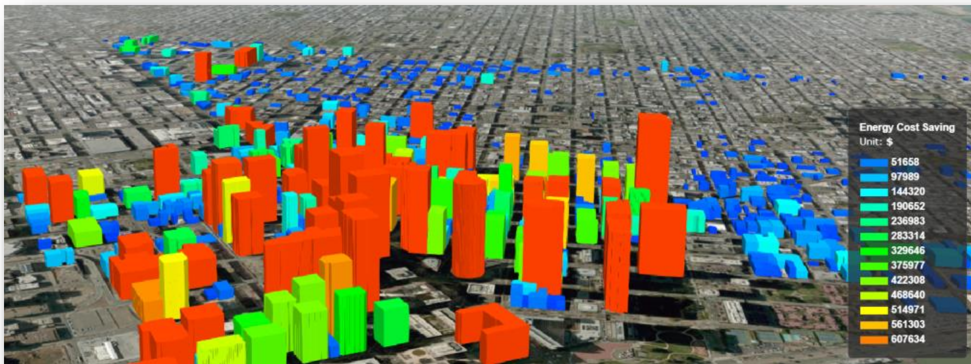


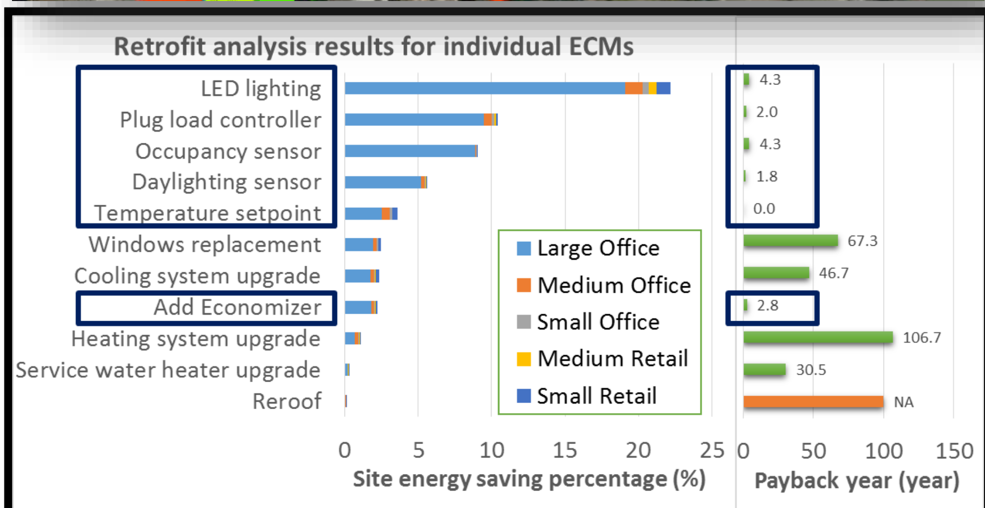
CityBES Workflow and Use Cases

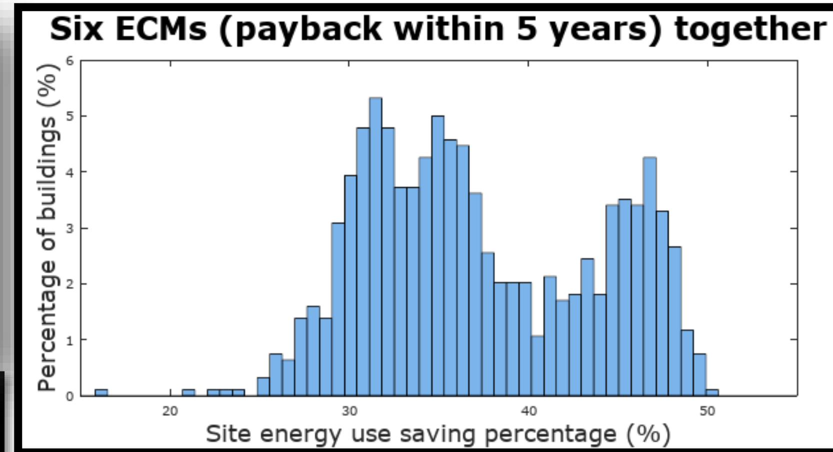


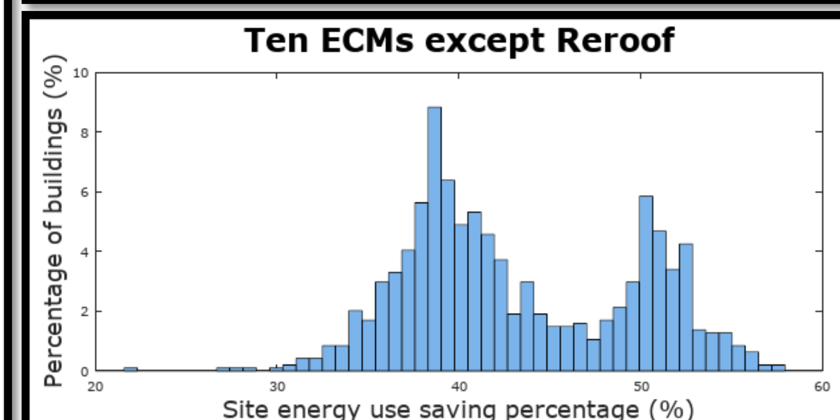
Evaluate building retrofits at large scale:

940 office and retail buildings in Northeast San Francisco

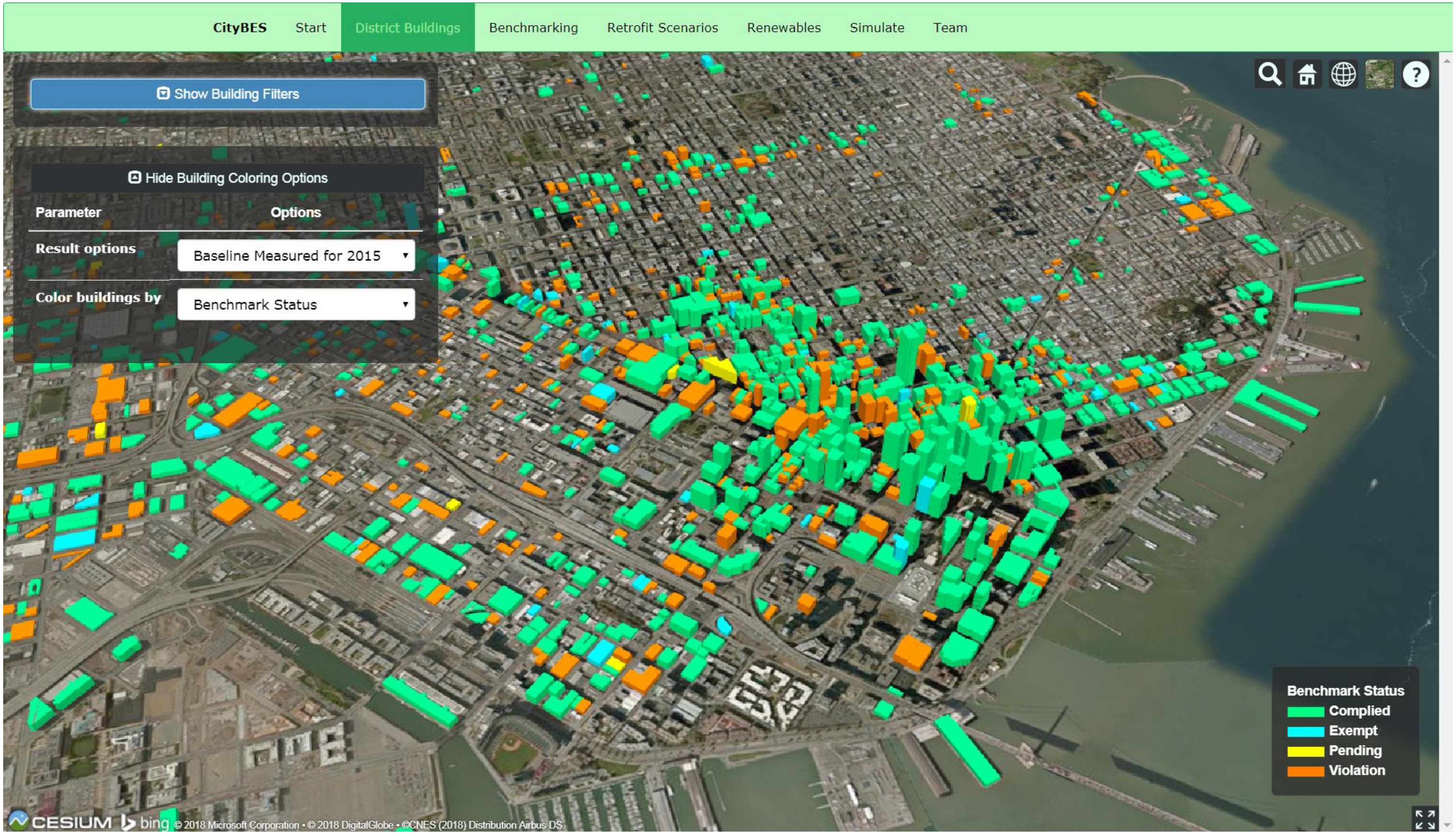








SF building energy ordinance



https://citybes.lbl.gov/?sf_ecbo=1

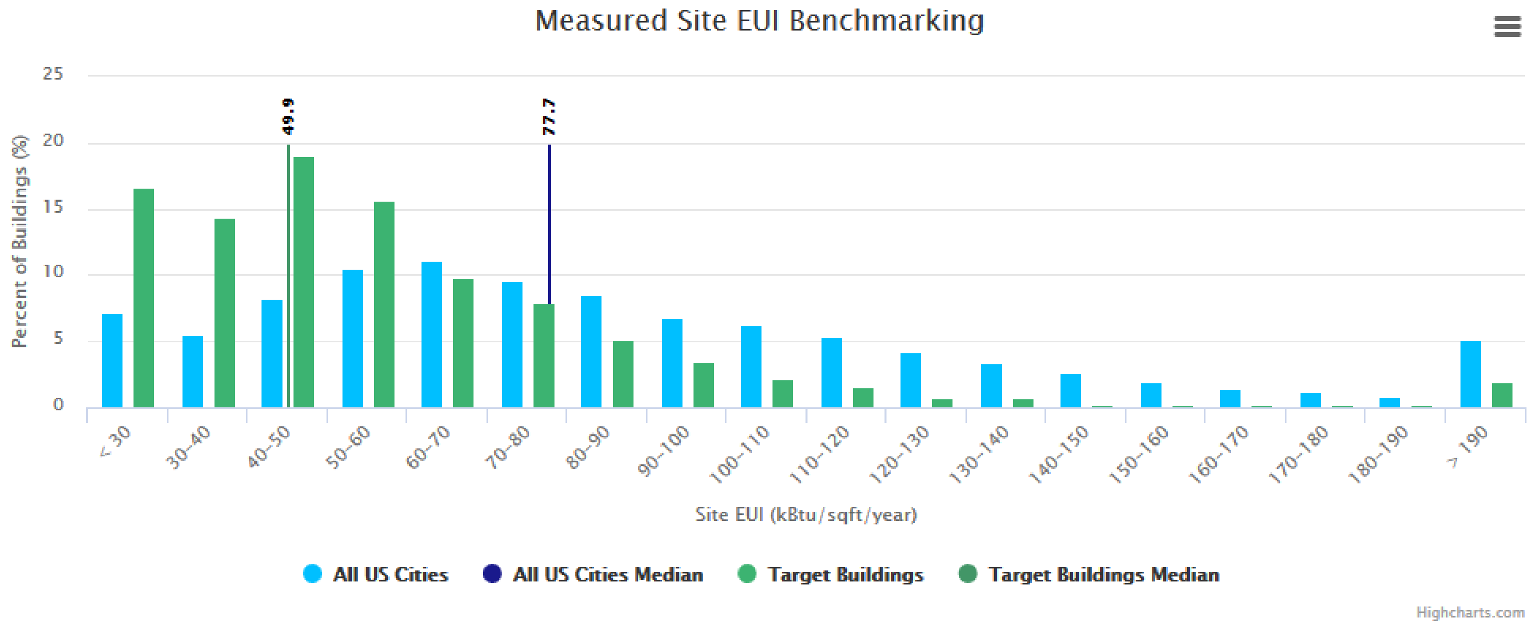
Benchmarking Performance of City Buildings

Benchmarking with DOE Building Performance Database

Select a City to Compare With

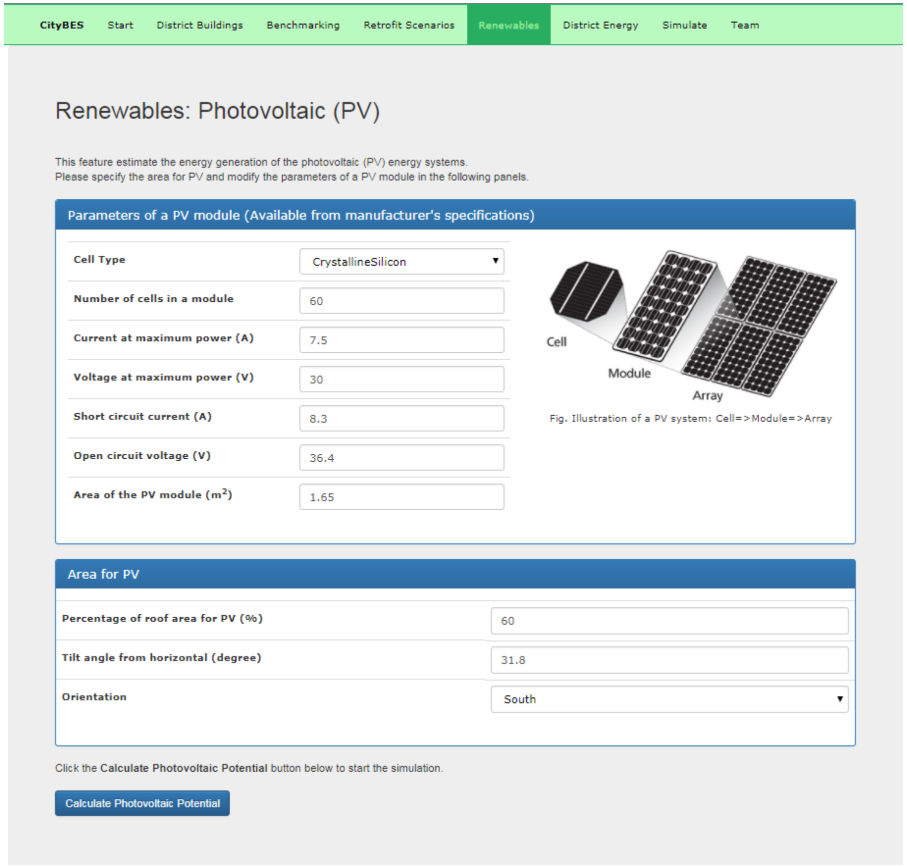
All US Cities

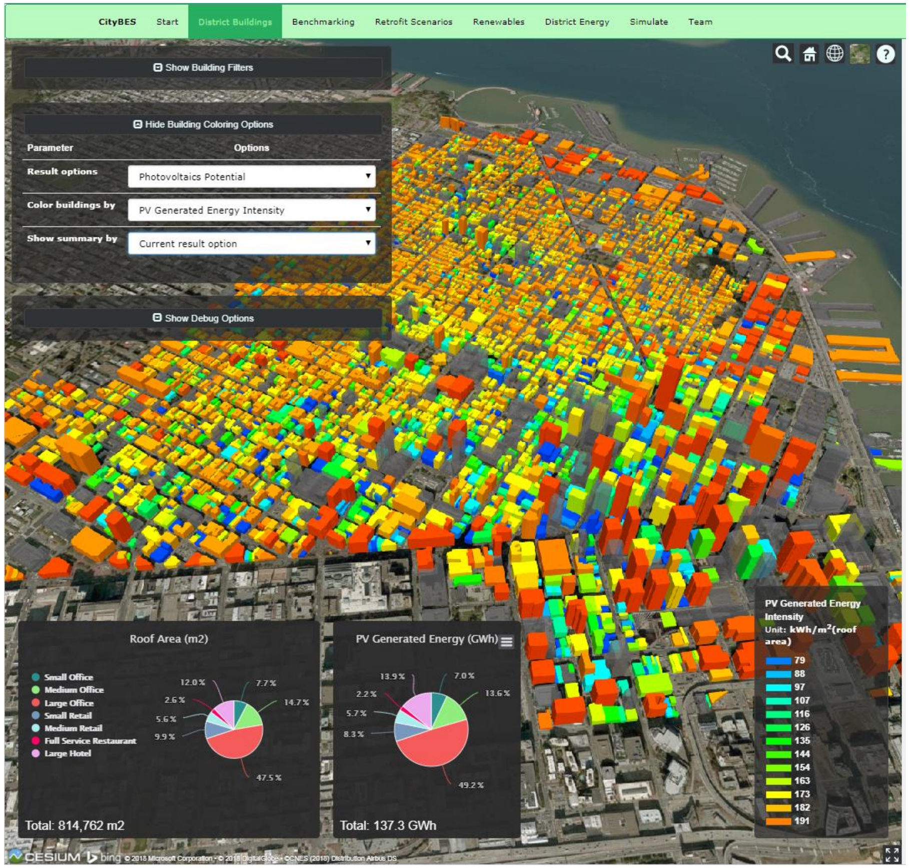
There are **63503** matching buildings in DOE Building Performance Database.
There are **522** buildings in CityBES with measured Site Energy Use Intensity.



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

Evaluate Rooftop PV Potential





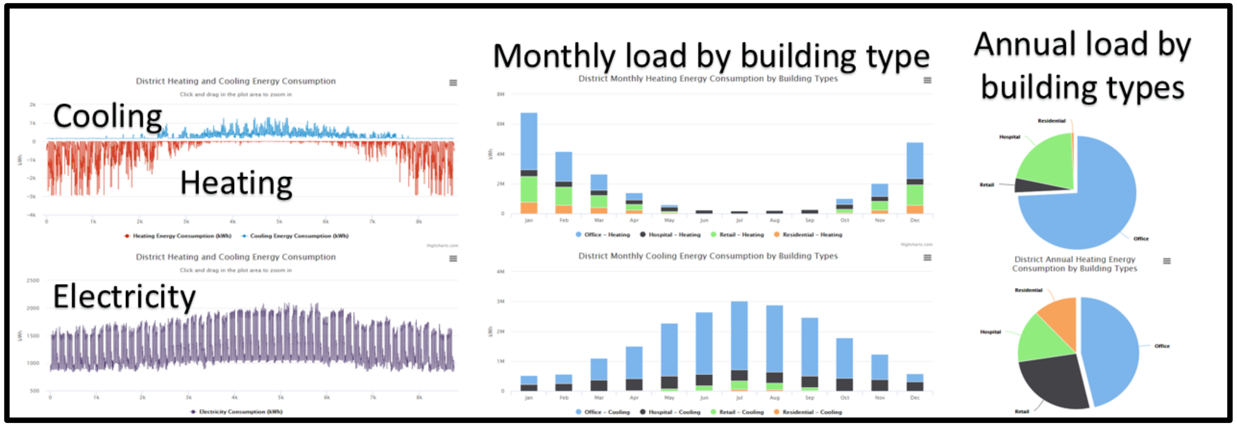
Evaluate the photovoltaic potential of 8,665 buildings in Northeast San Francisco

District Energy
(A feature in development)

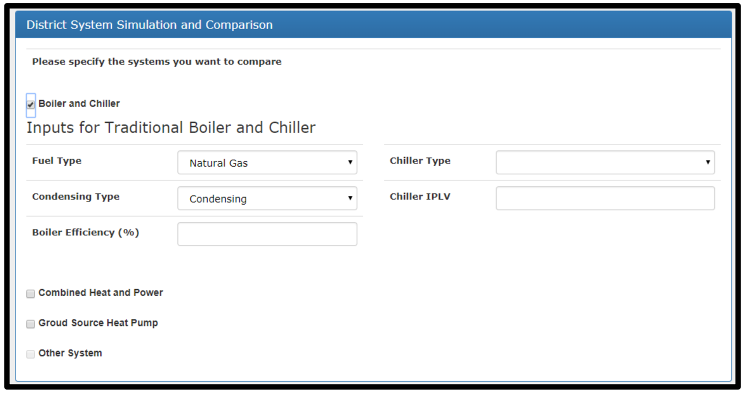
Load profile inputs

Load profiles (simulation or user upload)

Load profile & heat recovery potential visualization



District systems assumptions

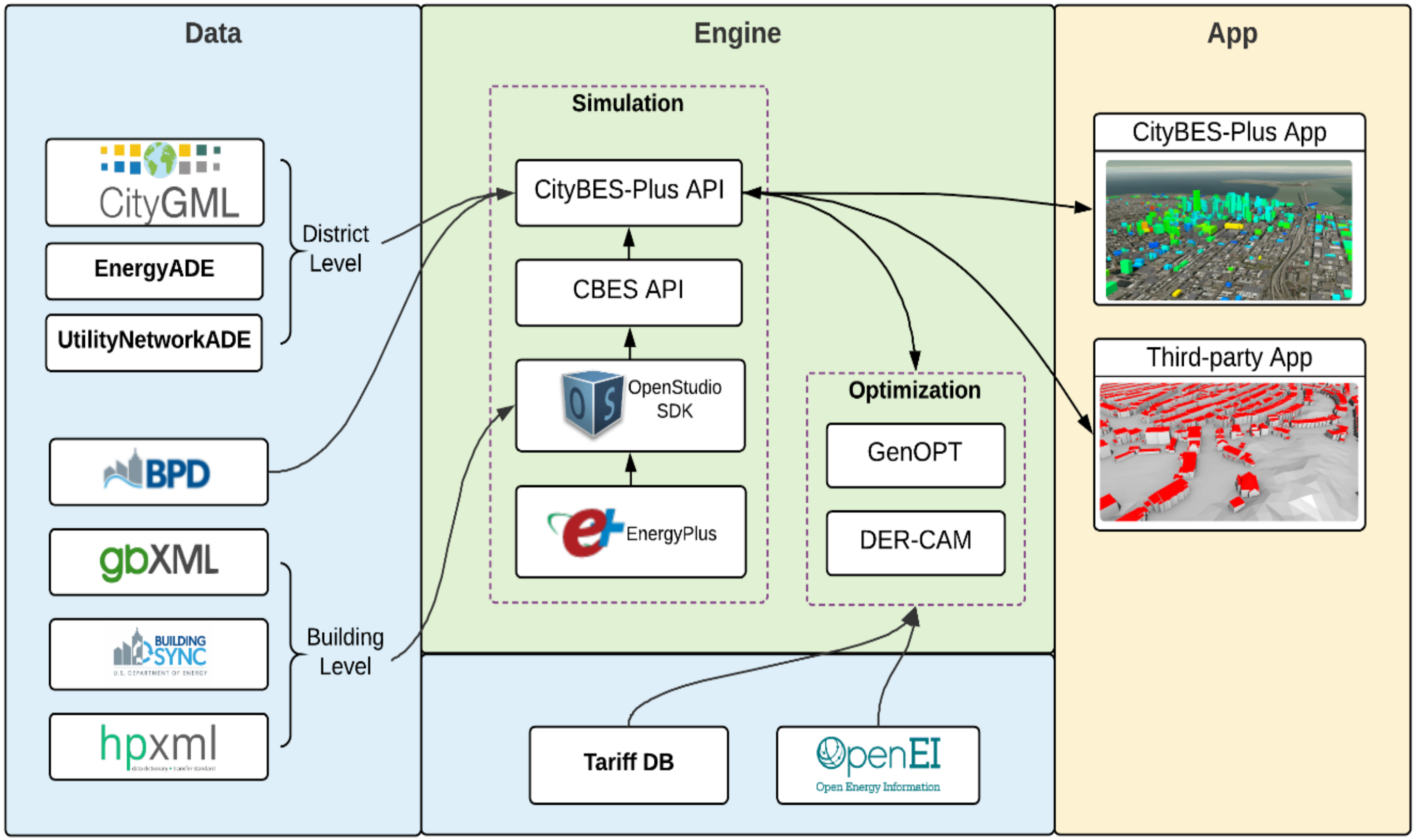


District system performance comparison

	Boiler + Chiller	CHP	GSHP	...
Capital Cost	...	...	...	...
Operation Cost	...	...	...	...
NPV	...	...	...	...
Energy Consumption	...	...	...	...
GHG Emission	...	...	...	...
...	...	...	...	...

Future of CityBES

(A submitted DOE proposal)



Publications

1. 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.
2. R.Z. Pass, M. Wetter, M.A. Piette. A thermodynamic analysis of a novel bidirectional district heating and cooling network, **Energy**, 2017.
3. C. Weissmann, T. Hong, C.A. Graubner. Analysis of heating load diversity in German residential districts and implications for the applications in district heating systems. **Energy and Buildings**, 2017.
4. J. An, D. Yan, T. Hong, K. Sun. A novel stochastic modeling method to simulate cooling loads in residential districts. **Applied Energy**, 2017.
5. B. van der Heijde, M. Fuchs, C.R. Tugores, G. Schweiger, K. Sartor, D. Basciotti, D. Müller, C. Nytsch-Geusen, M Wetter and L. Helsen. Dynamic equation-based thermo-hydraulic pipe model for district heating and cooling systems. **Energy Conversion and Management**, 151:158-169, 2017.
6. F. Buenning, M. Wetter, M. Fuchs, D. Mueller. Bidirectional low temperature district energy systems with agent-based control: Performance comparison and operation optimization. **Applied Energy**. 2017.
7. Y. Chen, T. Hong. Impacts of Building Geometry Modeling Methods on the Simulation Results of Urban Building Energy Models. **Applied Energy**, 2018.
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9. T. Hong, Y. Chen, S.H. Lee, M.A. Piette. CityBES: A Web-based platform to support city-scale building energy efficiency. Urban Computing, August 2016, San Francisco.
10. R.Z. Pass, M. Wetter, M.A. Piette. A Tale of Three District Energy Systems: Metrics and Future Opportunities, ACEEE Summer Study Conference, 2016.

Acknowledgments

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- Research team: Mary Ann Piette, Xuan Luo, Han Li

Thank You

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