A hybrid modelling approach to characterize the impact of urban context on building energy retrofits

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Built Environment and Infrastructure

https://youtu.be/4X8bHGvinLM

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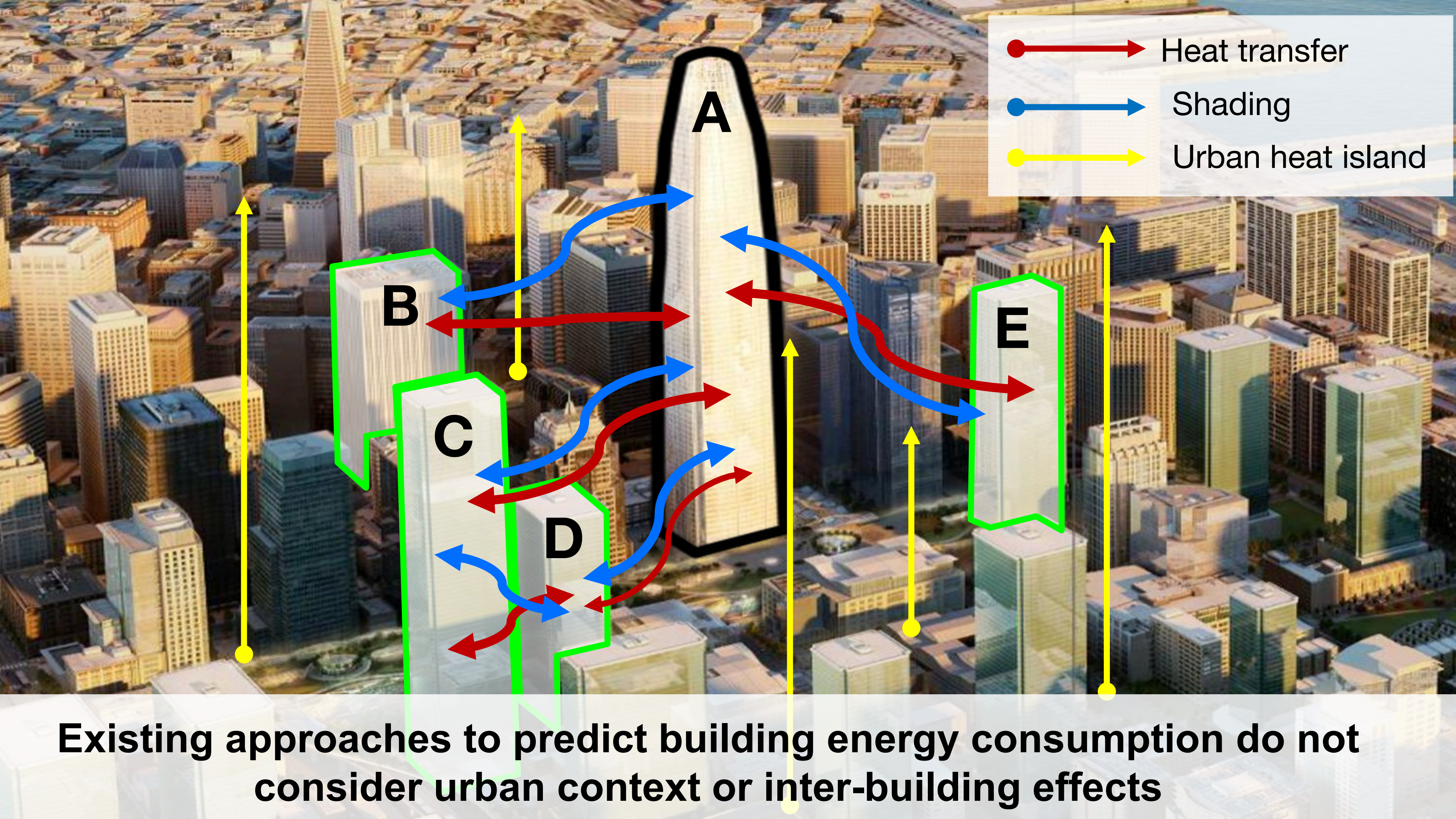
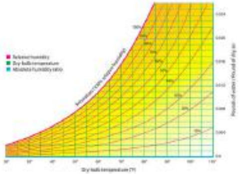
Clean Energy Education & Empowerment (C3E)



Existing approaches to predict building energy consumption do not consider urban context or inter-building effects

“Knowledge from data”

Building characteristics

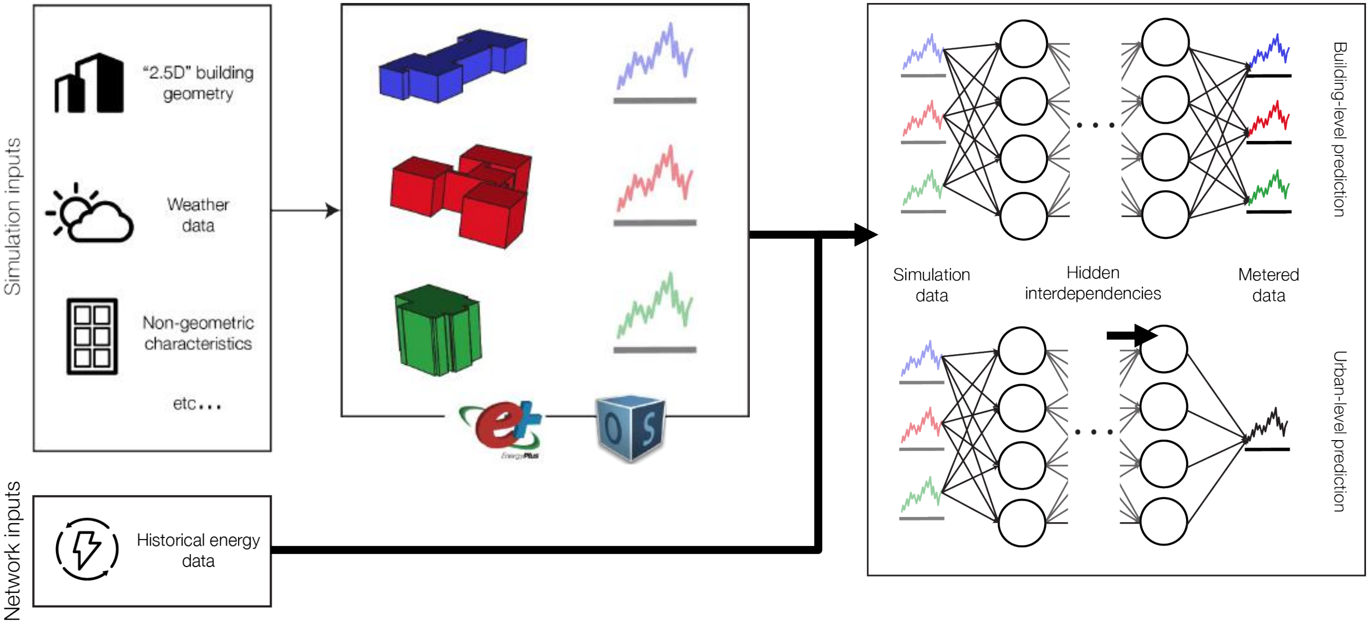


Weather data

Smart meters (Energy use)

“Knowledge from building physics”

Data-driven Urban Energy Simulation (DUE-S): Integrating physical and data-driven modelling tools to enhance spatiotemporal predictions of urban building energy use



1 Create baseline energy simulations

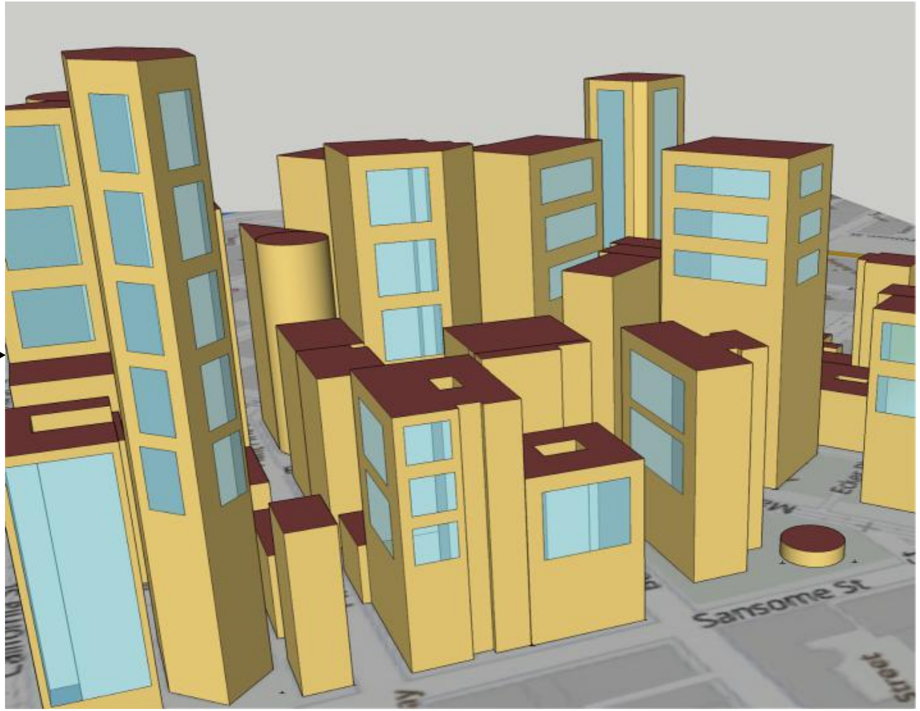
2 Use deep learning model for multi-scale analysis

Step 1: Baseline energy simulation model

"2.5D"
Building Geometries
(GIS, LiDAR)

Historical weather
data
(NOAA)

DOE Commercial
Reference Building
inputs

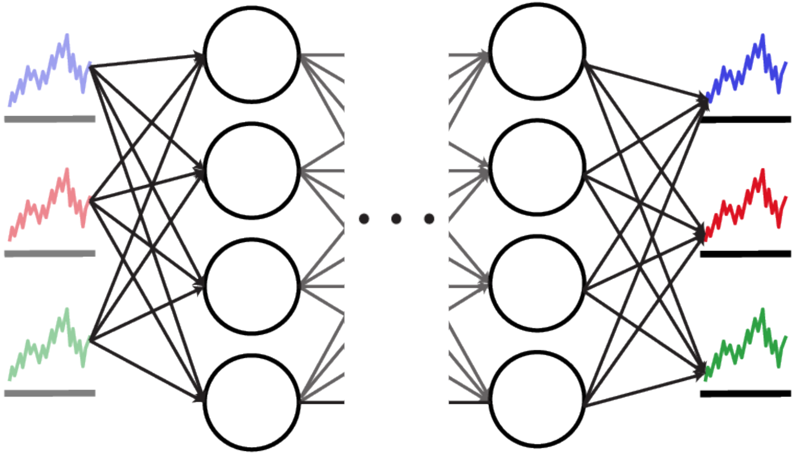


① Create baseline energy simulations

② Use deep learning model for multi-scale analysis

Step 2: Deep learning model

Simulated energy use predictions



Actual metered energy consumption

"hidden uncertainties"

Goal: develop a model to map simulated energy predictions to actual energy data

→

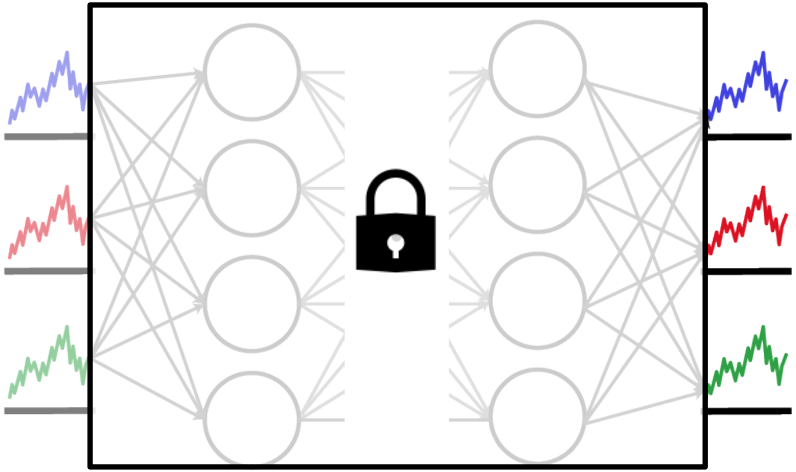
Long short-term memory network (LSTM)

① Create baseline energy simulations

② Use deep learning model for multi-scale analysis

Bonus Step: DUE-S model for retrofit analysis

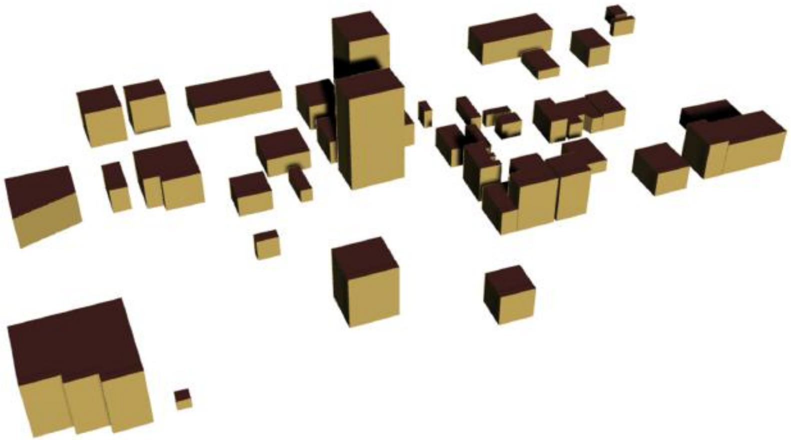
Simulated energy use predictions



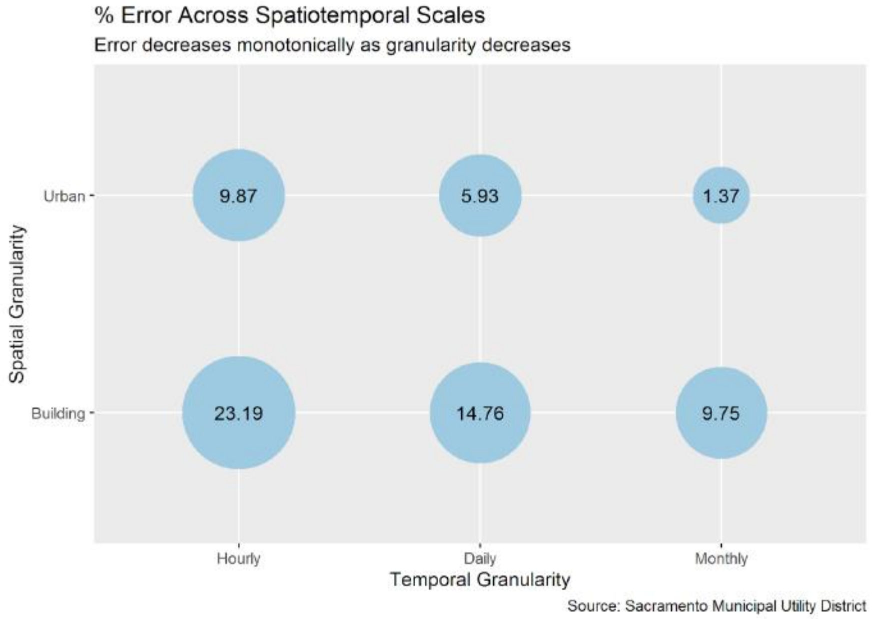
Actual metered energy consumption

1. Build baseline prediction model (already completed)
2. Model retrofits in EnergyPlus, creating *new* simulated predictions
3. Use new simulation data to predict change in metered energy consumption

Prediction accuracy improves at larger scales

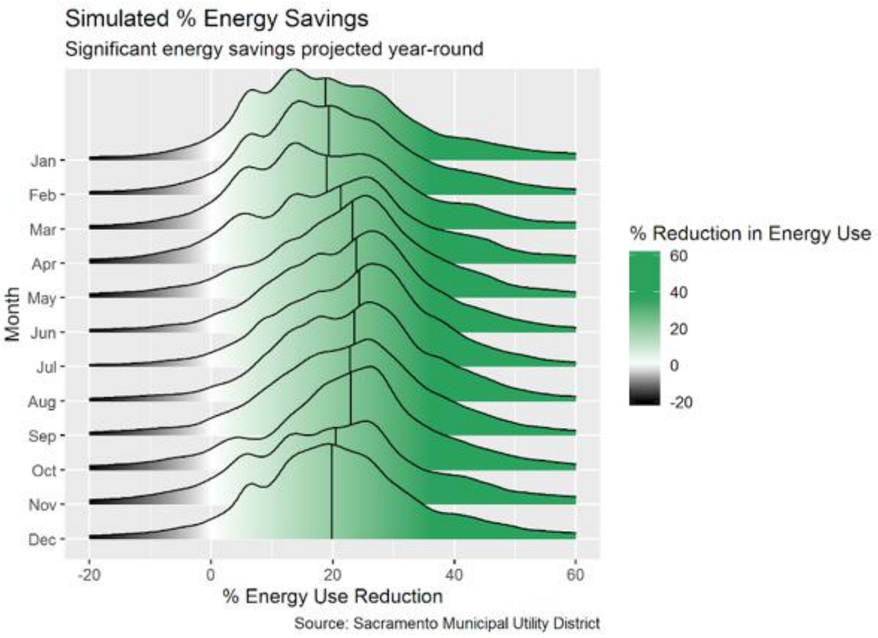


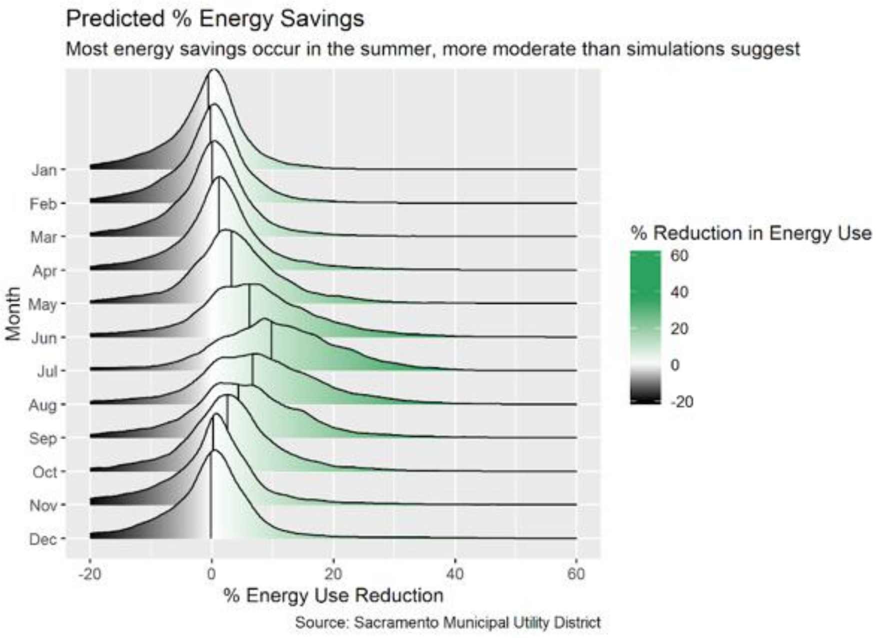
29 buildings in
downtown Sacramento



Aggregation reduces variability
in overall electricity consumption

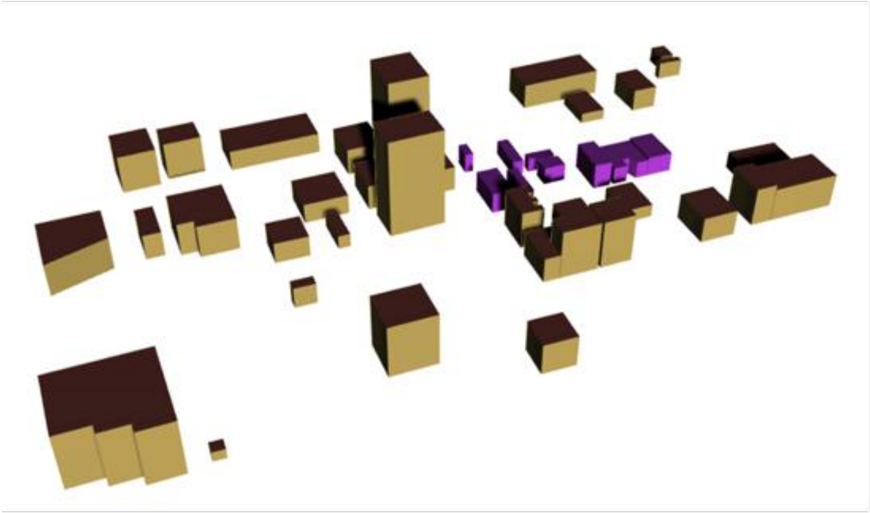
DUE-S retrofit model provides more conservative estimates of future retrofit performance vs. simulation-based approach

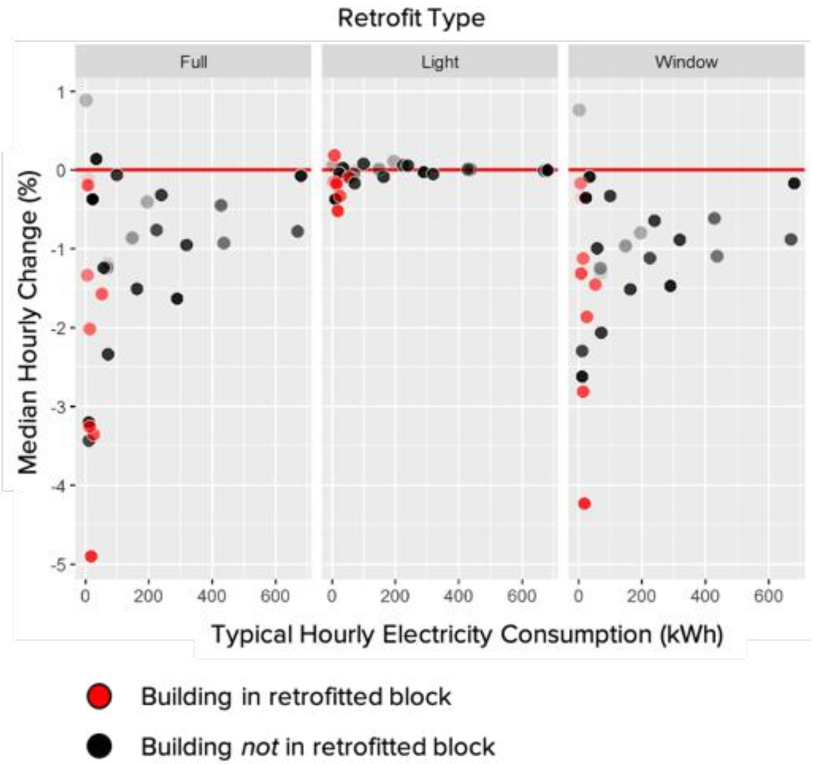




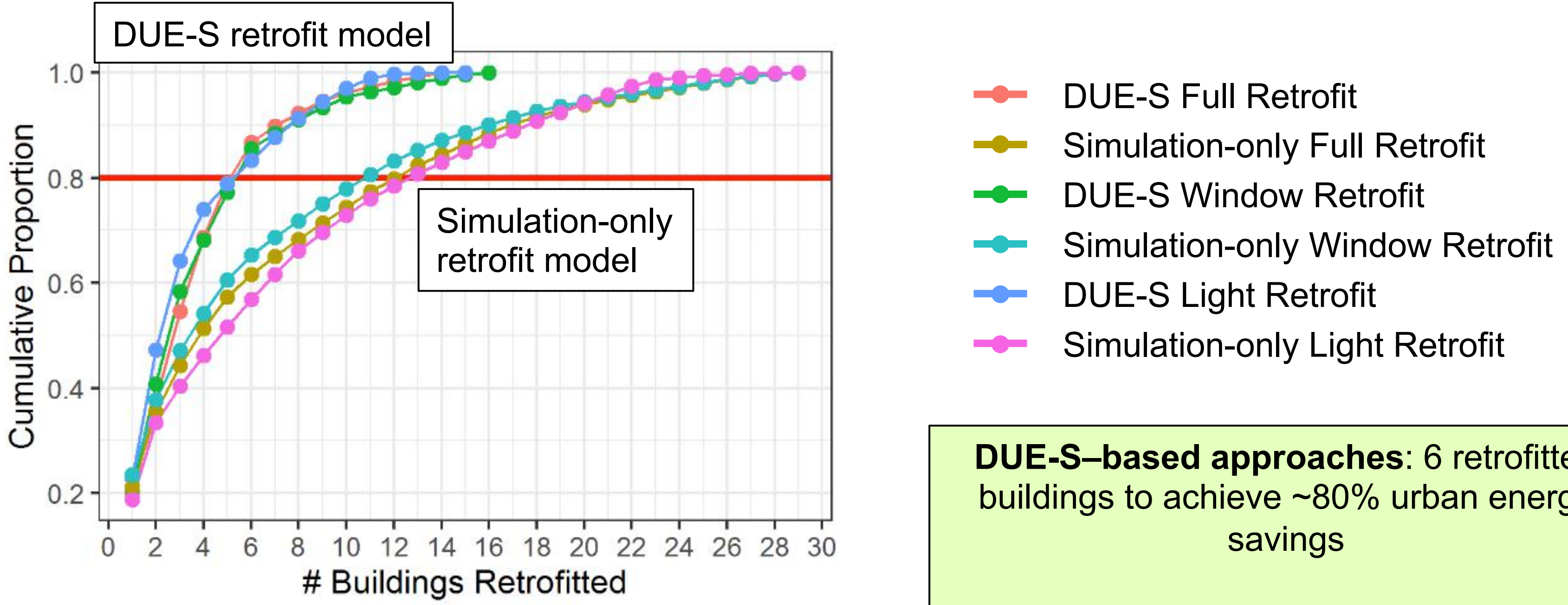
Clean Energy Education & Empowerment (C3E)

Buildings that undergo retrofits impact energy performance of surrounding buildings





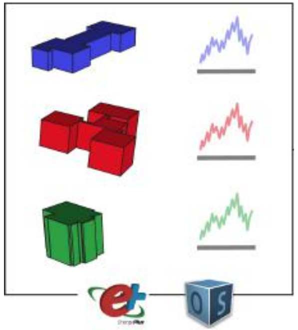
Optimizing for maximum urban energy savings, DUE-S predicts fewer buildings require retrofits vs. naïve approaches

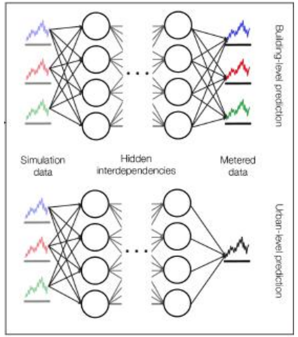


DUE-S–based approaches: 6 retrofitted buildings to achieve ~80% urban energy savings

Naïve, simulation-only approaches: 12-14

Conclusion and Next Steps





Conclusions	Future Work

Hybrid modelling approach can assess the influence of urban context on retrofit performance

DUE-S can help inform urban energy decision making for variety of stakeholders

- Explore methods to better quantify the influence of specific inter-building effects
- Integrate renewable energy generation (e.g., solar) into DUE-S modelling framework

Acknowledgments

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