BUILDING ENERGY MODELS USING GENERATIVE LEARNING FOR GRID-EDGE APPLICATIONS

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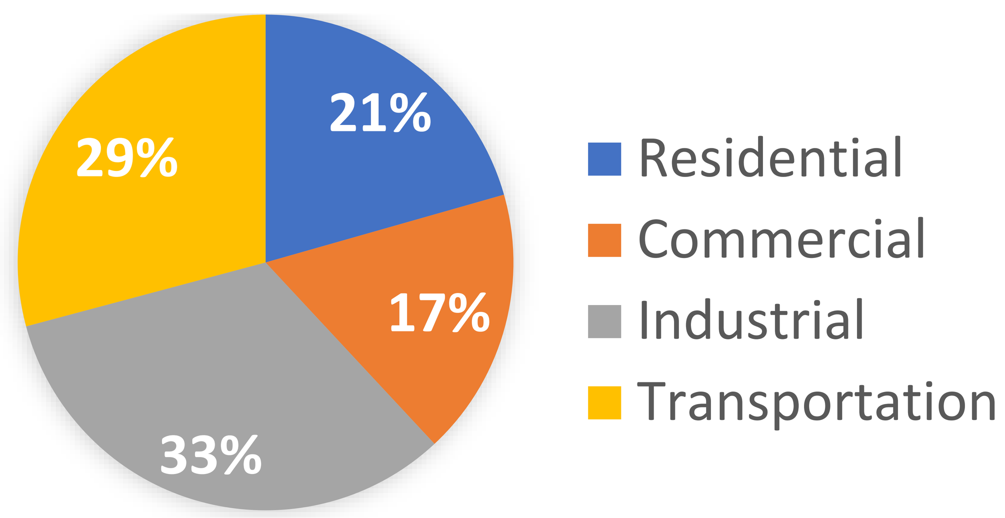
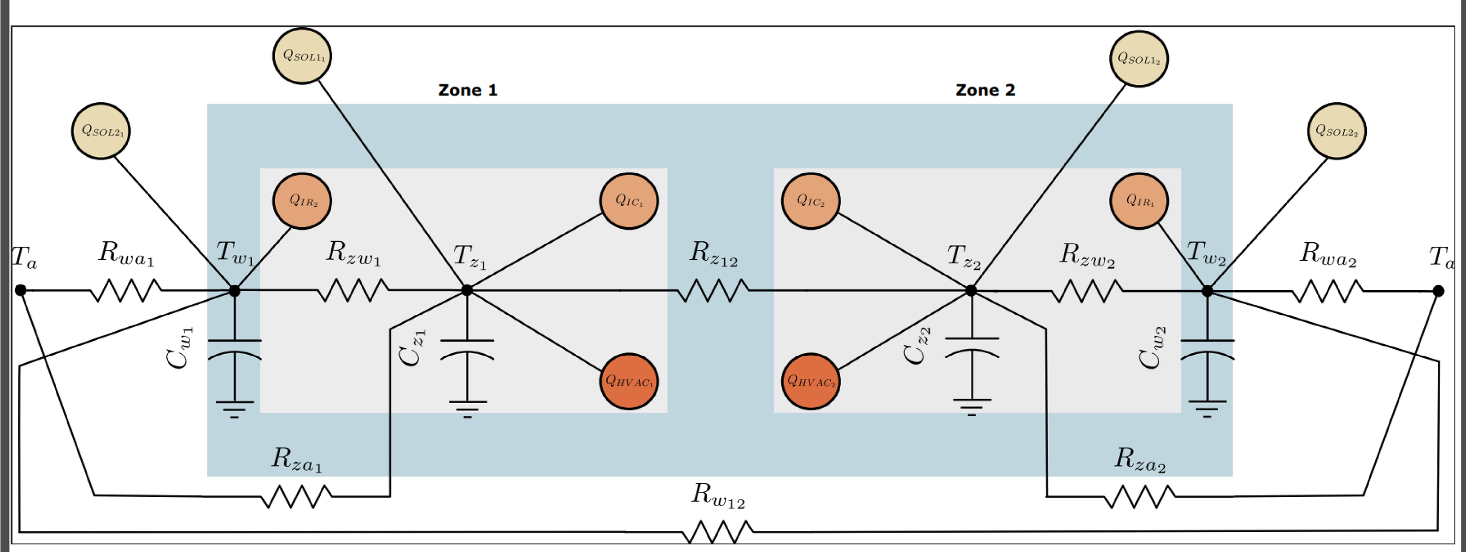
1. BACKGROUND AND MOTIVATION

- Commercial and residential buildings account for 38% of energy consumption in the US.
- Buildings have the potential to help stabilize the electric power grid by reducing or shifting energy usage during peak demand times.
- Building energy consumption models are needed to predict the effects of demand-response signals.

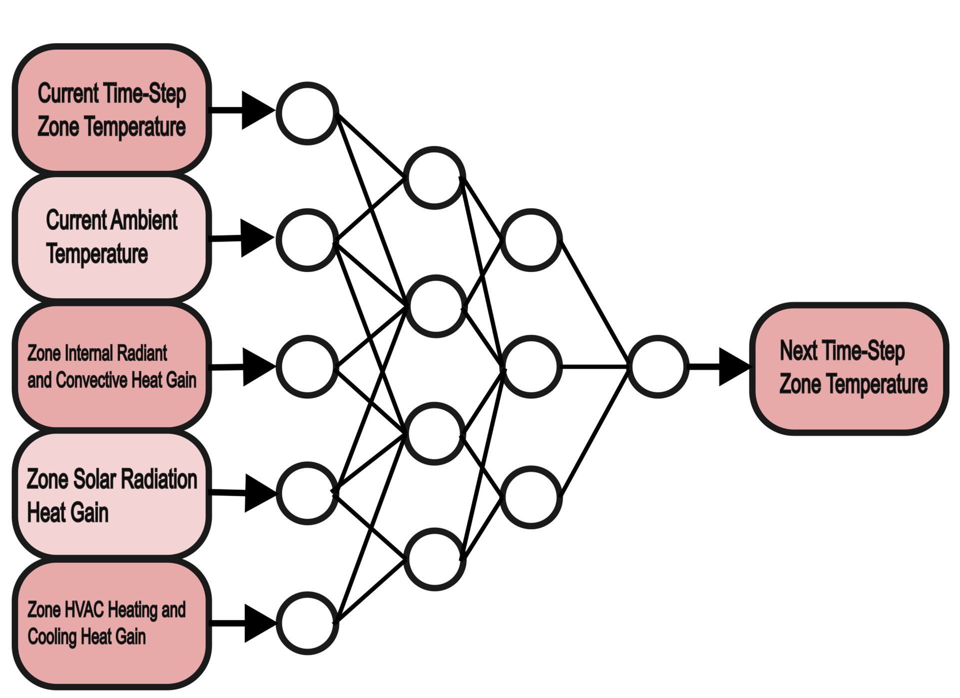


2. BLACKBOX AND GREYBOX PROCEDURES



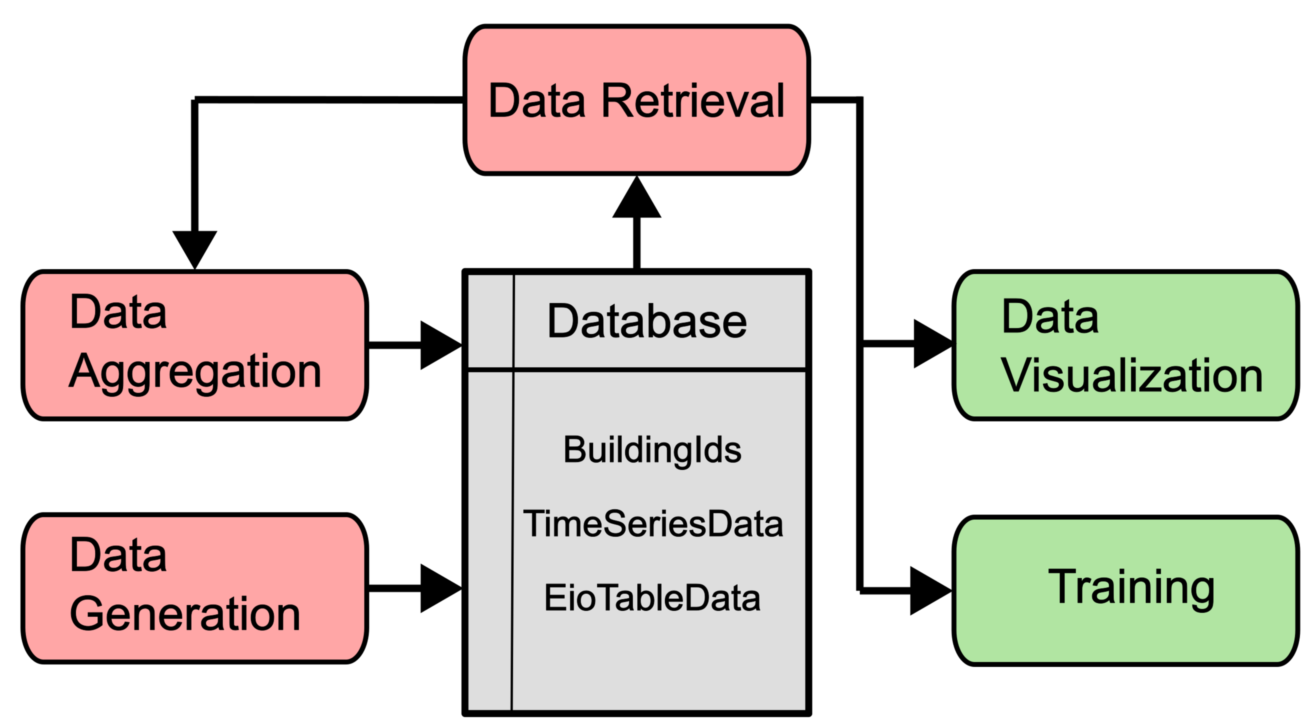
$$P_{HVAC_i}(k) = \frac{P_{HVAC}(k)}{n} = f_{HVAC_i}(Q_{HVAC_i}(k)),$$

$$Q_{HVAC_i}(k) = C_a \dot{m}_i(k)(T_{z_i}(k) - T_{s_i}(k)).$$



3. EP DATA MANAGEMENT APPLICATION

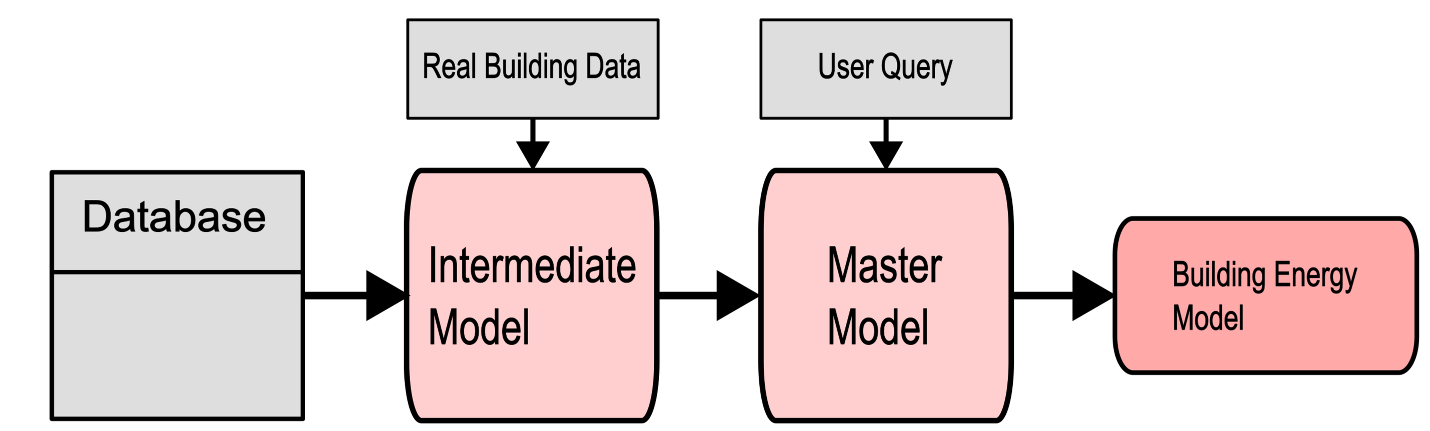
- Current energy simulation tools are limited by complexity, and traditional white-box models are too computationally expensive to use in a simulation of many buildings at once.
- Our tool is built on top of Energy Plus, a high-fidelity physics-based simulation software.
- **Data Generation:** We perform automated runs of Energy Plus to obtain time series data for specified variables.
- **Data Aggregation:** We collapse a building model composed of many thermal zones into a single zone to create a reduced-order, lightweight model.
- **Data Visualization:** The user may generate time-series plots, scatter plots, and compute basic statistics for any variable.



4. MULTI-BUILDING GENERATIVE MODEL

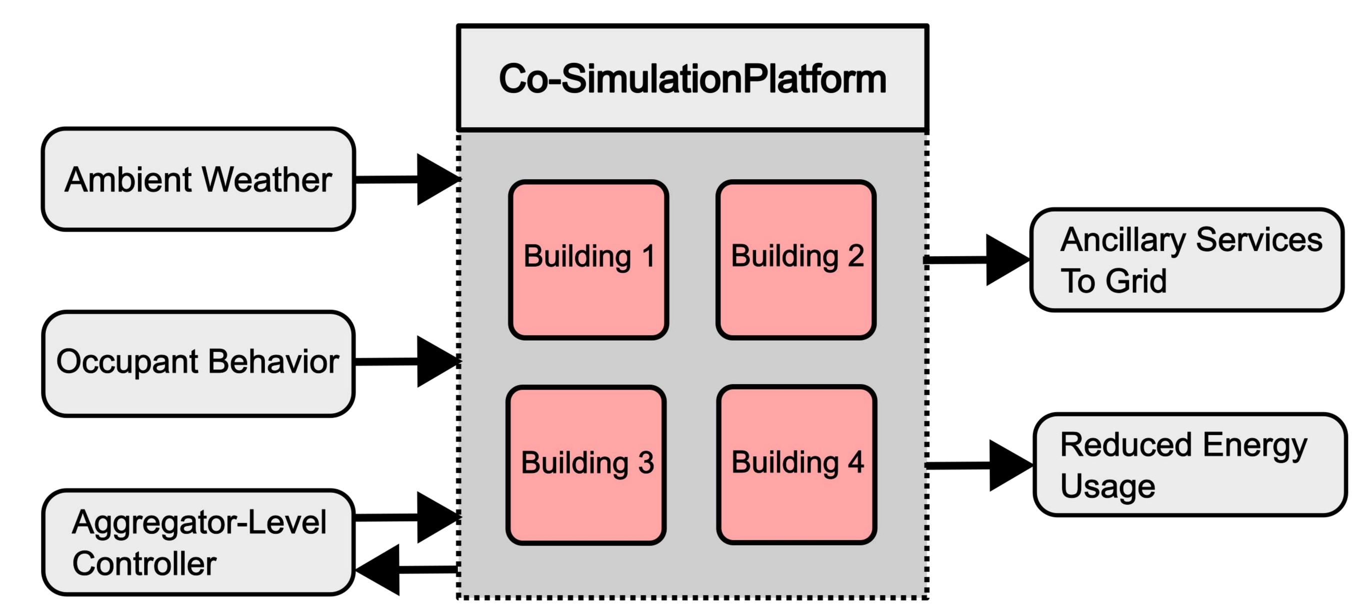
- Previous Models have only trained on one building at a time. Using a large dataset, we can train a model on many buildings at once.
- **Intermediate Model:** ANN trained on combined dataset from all buildings. Learns general patterns and relationships between inputs and outputs across a wide array of buildings.
- **Master Model:** Conditioned on real-building data using a reinforcement learning approach. Given inputs of building parameters, the model must deliver a black-box representation that accurately describes the building.
- **Building-specific Energy Model:** We obtain a building model by prompting the master model with building parameters such as geometry, construction, and heating and cooling type.

4. MULTI-BUILDING GENERATIVE MODEL



5. Future Applications

- Co-simulation platform: Integrate n-number of buildings into a distribution power flow solver.
- Develop a scalable control algorithm for providing grid services.



6. CONCLUSION

- We've developed a large dataset of synthetic data created using EnergyPlus. A model trained on data from many buildings may be queried to obtain a lightweight energy consumption model for any specific building.
- Potential applications include distribution modelling, automated demand response systems, and aggregator-level control systems, allowing buildings to provide ancillary services to the grid.
- By leveraging the grid-edge capabilities of buildings, we can accelerate the transition to a decentralized power system.

Thank you to NSF CPS for supporting this work.