

Modeling building energy self-sufficiency of using rooftop photovoltaics on an urban scale



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Building Energy Models (UBEMs): Essential Tools for Carbon Neutrality

- **Citywide Energy Insights:**
UBEMs simulate the *energy use of entire building stocks*, revealing high-impact areas for improvement.
- **Scenario-Based Planning:**
Enable testing of various *retrofit/decarbonization strategies* (e.g., rooftop PV, insulation, electrification).
- **Scalable and Adaptable:**
Applicable from *neighborhood to city scales* with integration of local building data and outdoor climate inputs.
- **Demand-Responsive Grid-Integration:**
Enable coordination with smart grid systems and *demand-response strategies* for sustainable urban energy management.
- **Support for Policy & Decision-Making:**
Provide *regional-specific* data for city planners and policymakers to design effective *carbon reduction policies*.
- **Monitoring Progress Toward Goals:**
Facilitate *tracking of GHG emissions* reduction over time to ensure alignment with *carbon neutrality targets*.



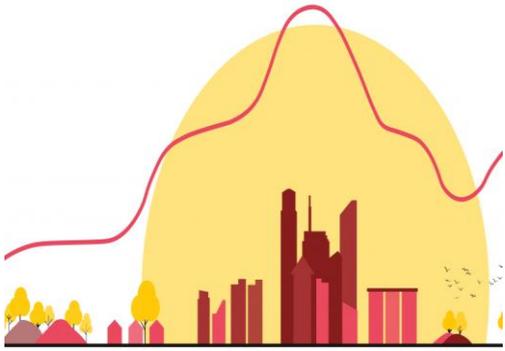
CityBEM: An In-House, Bottom-Up Physics-Based Urban Building Energy Model



Urban rooftop PV retrofitting



Bottom-up building energy prediction



Data exchange with microclimate models



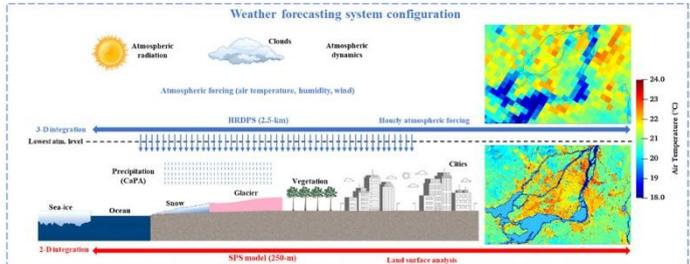
Urban green roof retrofitting



Developed in 



Inter-building shading impacts

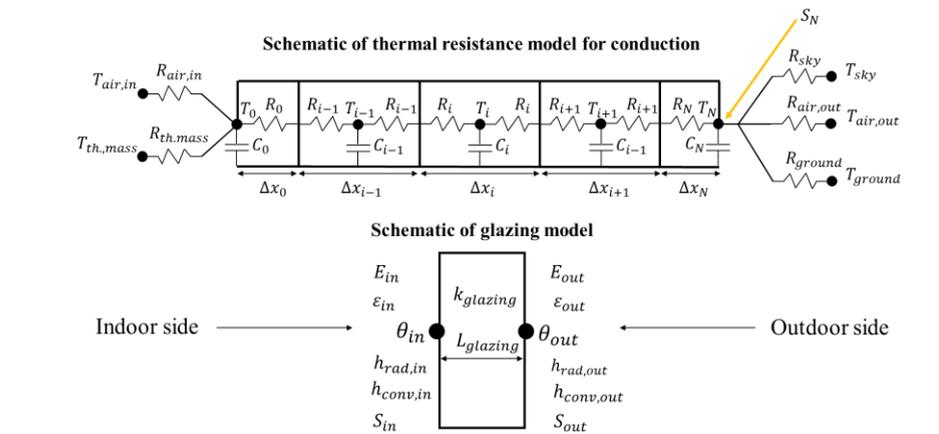
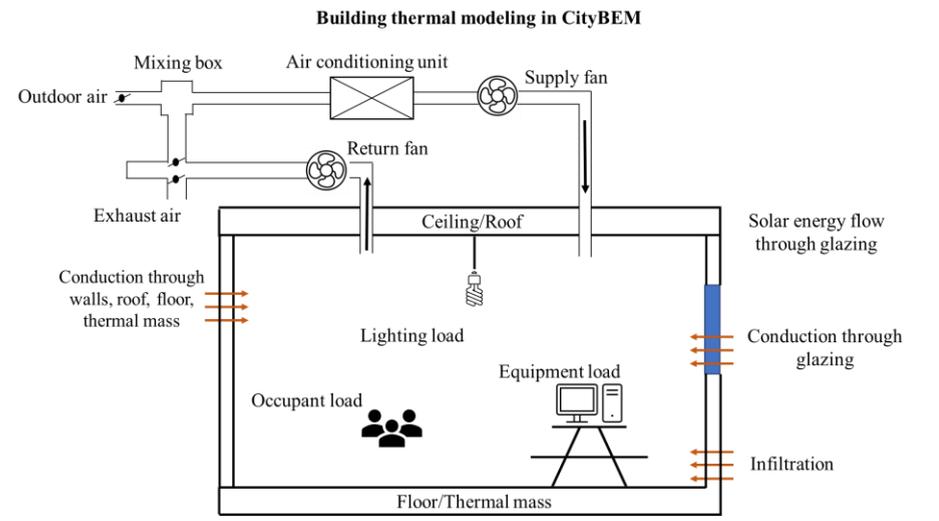
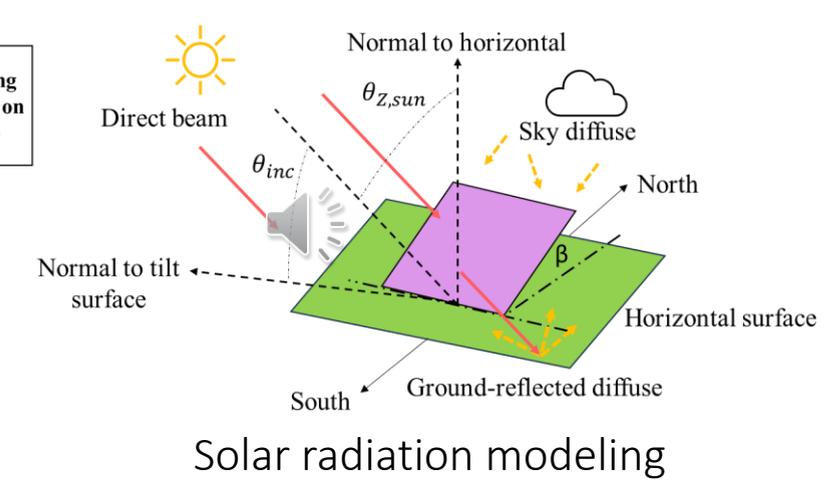
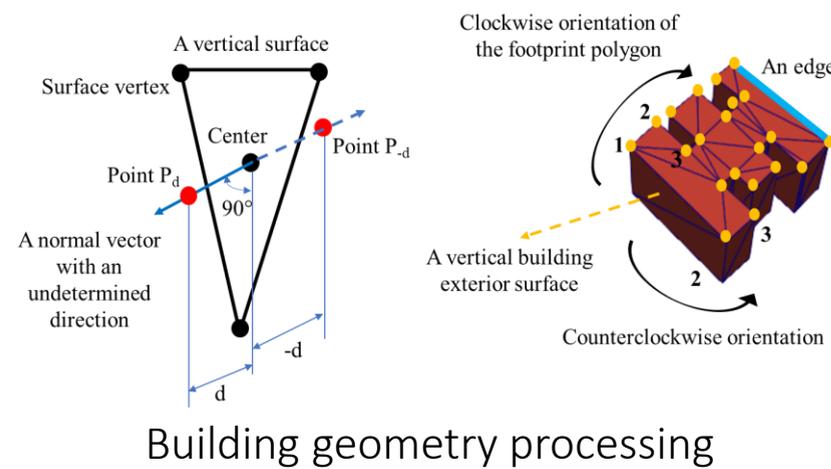
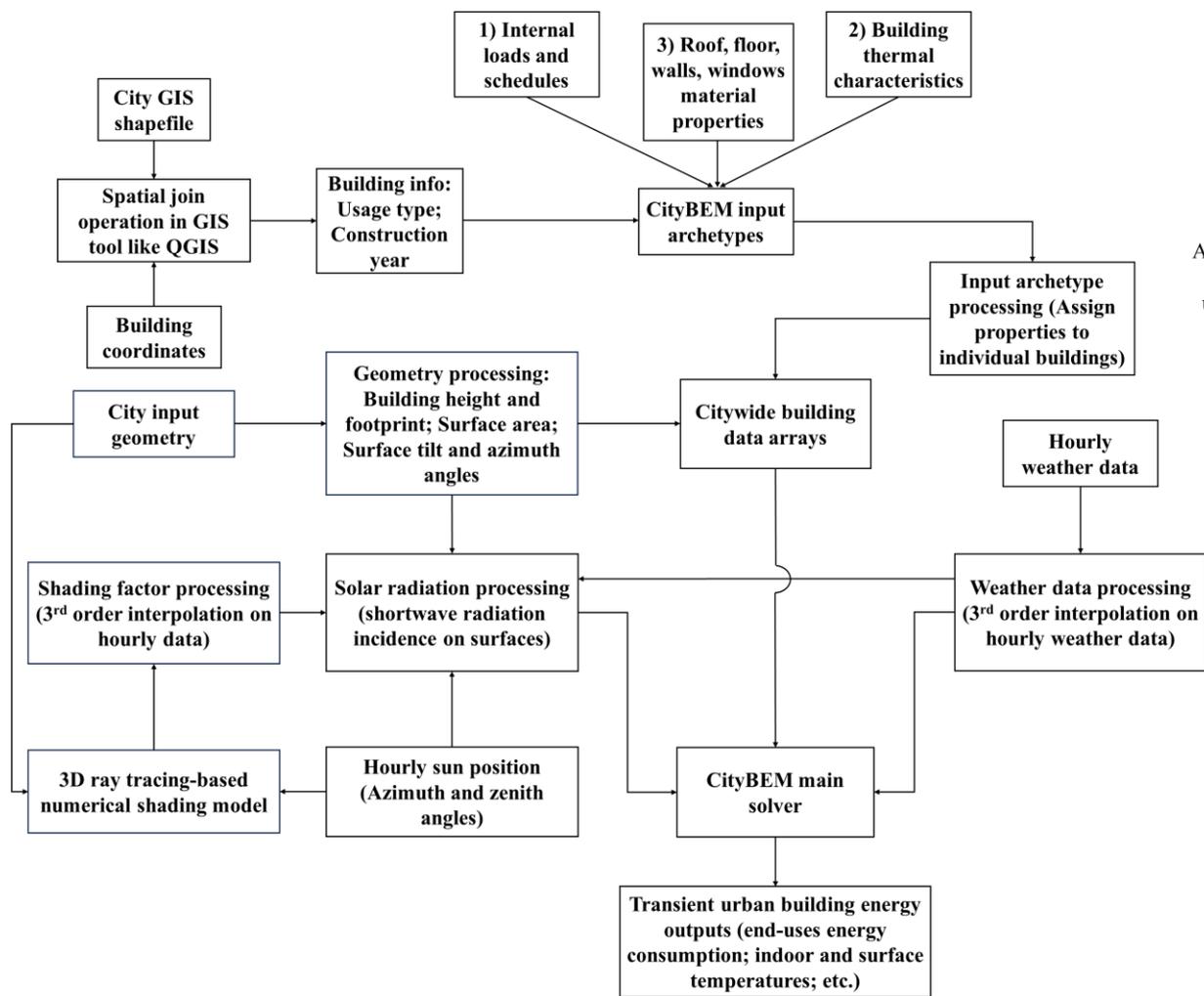


Data exchange with weather forecasting models

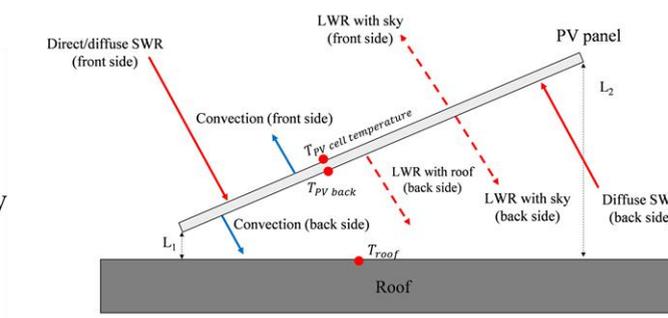
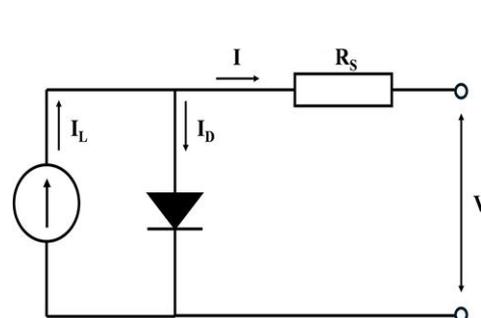
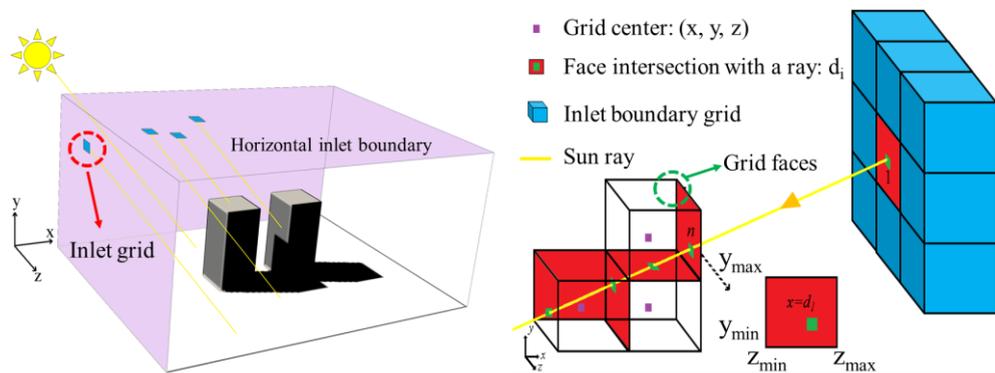


Integrated with other UBEs like tools4cities

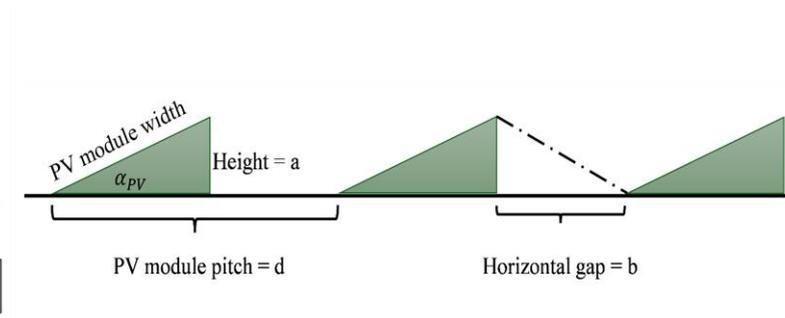
CityBEM Theoretical Foundation



Major steps in CityBEM



Building energy modeling approach

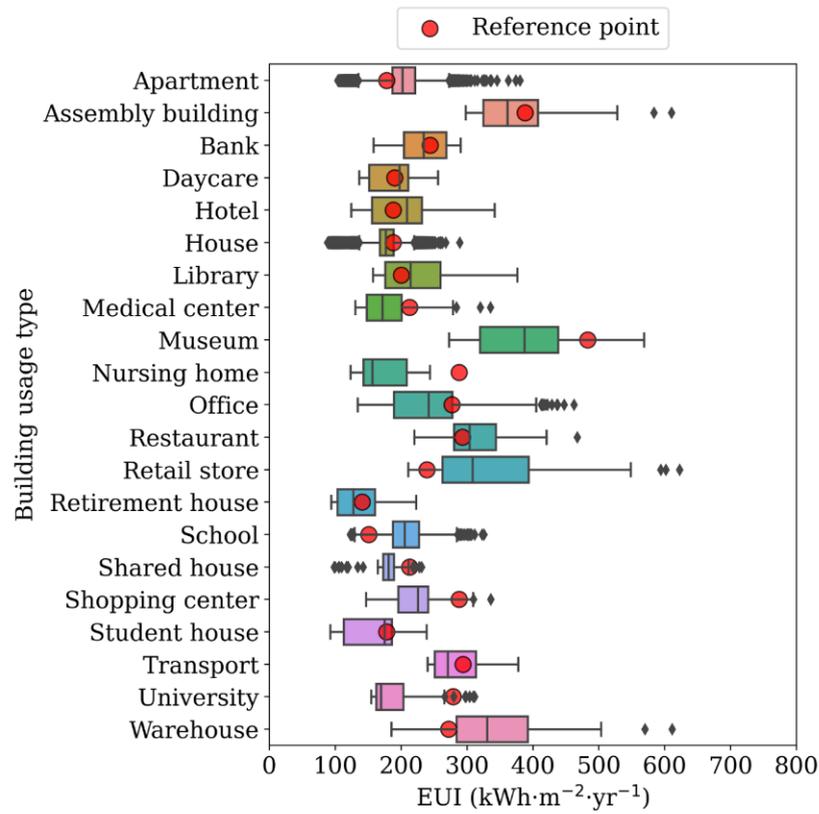


Abbreviations:
SWR: Shortwave radiation LWR: Longwave radiation

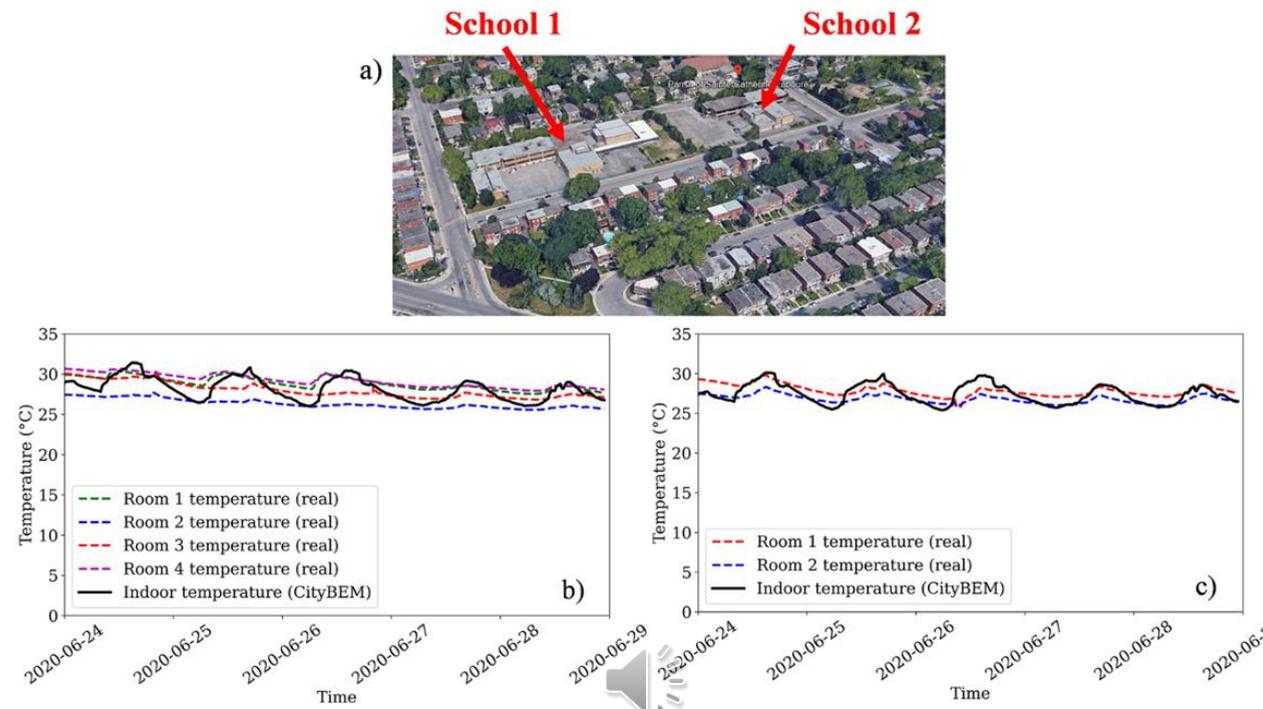
Rooftop PV modeling (Crystalline PVs)



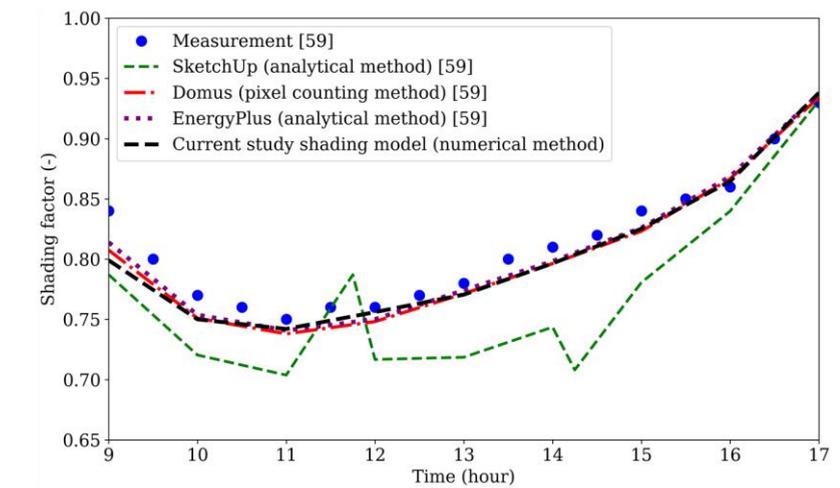
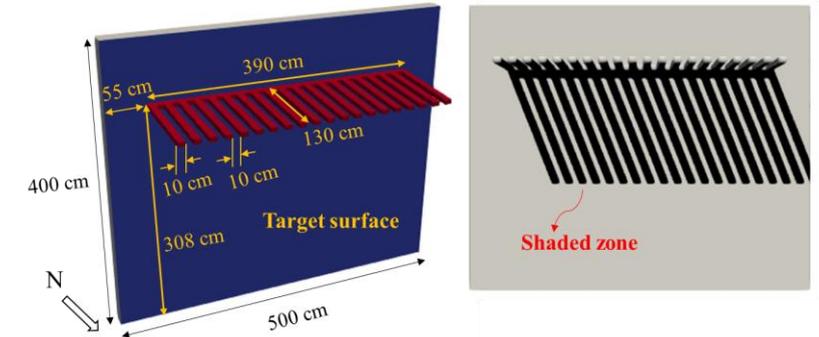
Model Validation and Verification



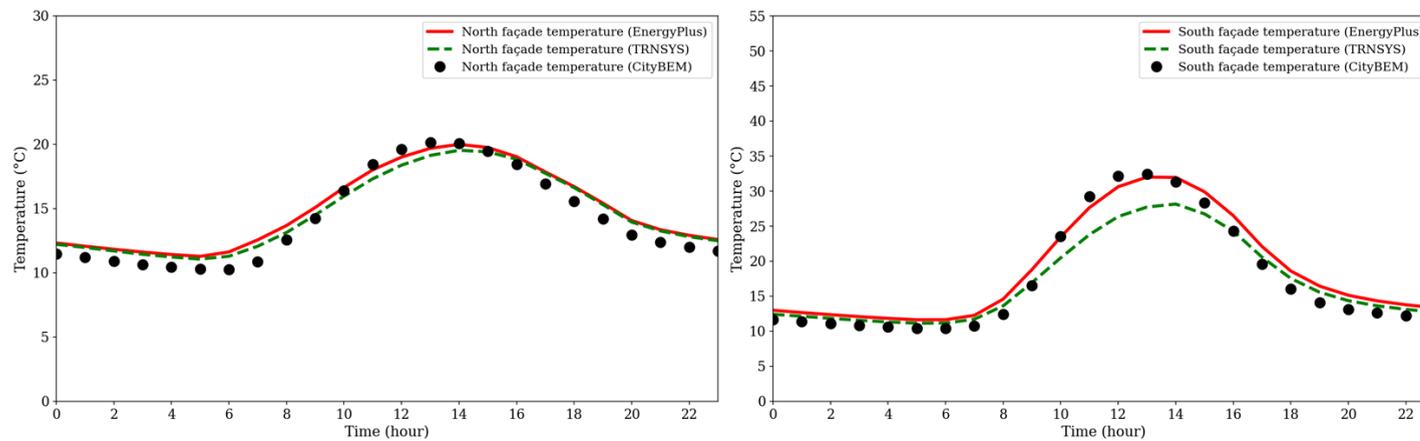
Annual EUI results



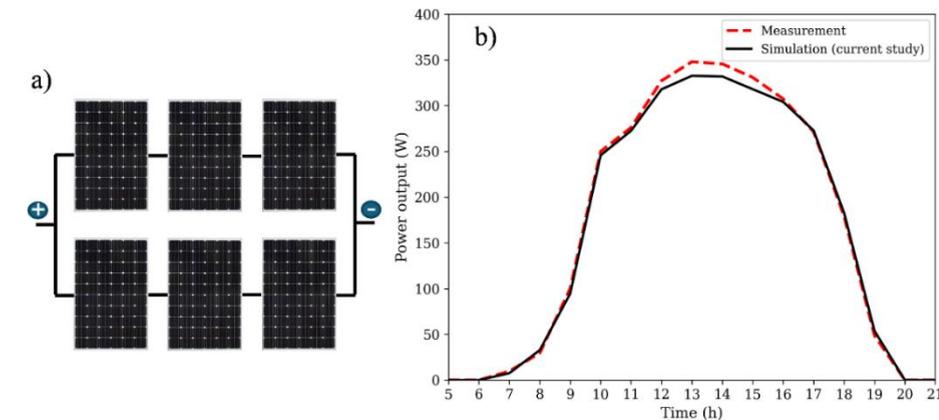
Average indoor air predictions



Shading model predictions



Building surface temperature annual trend

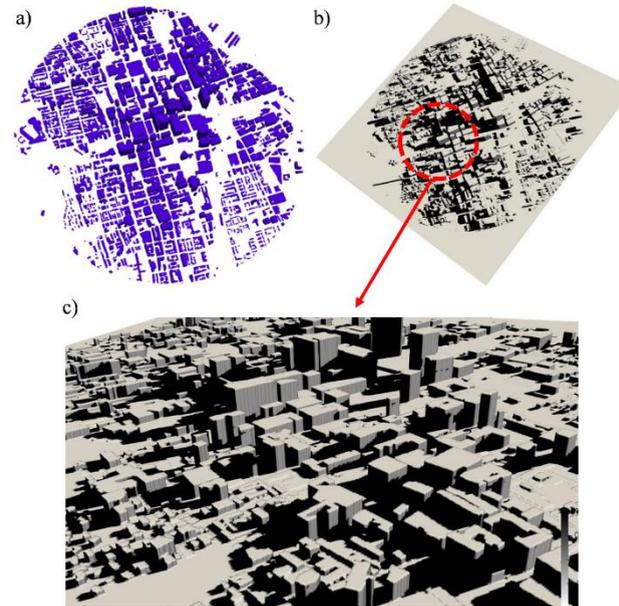


PV network output power simulation

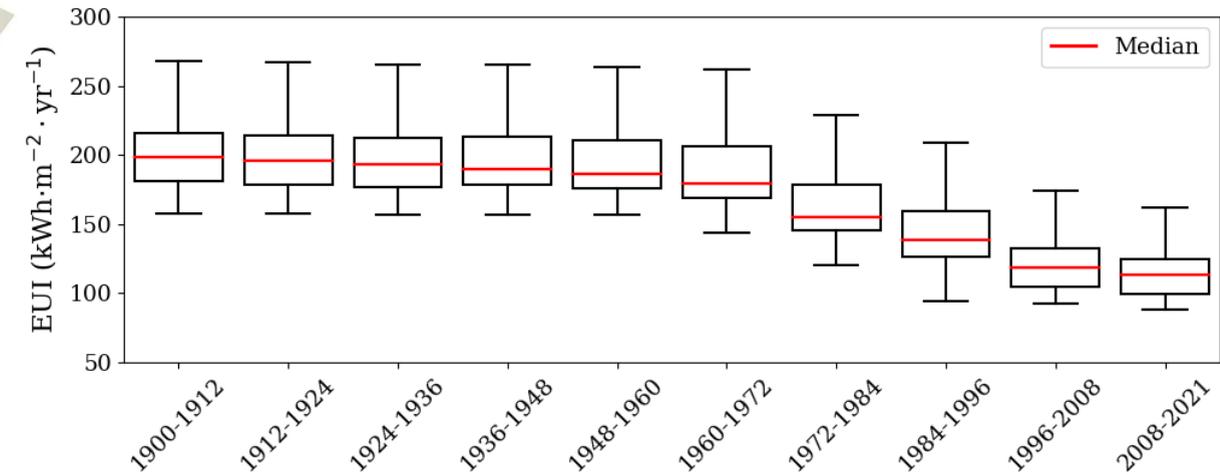
Simulation Results for the City of Montreal



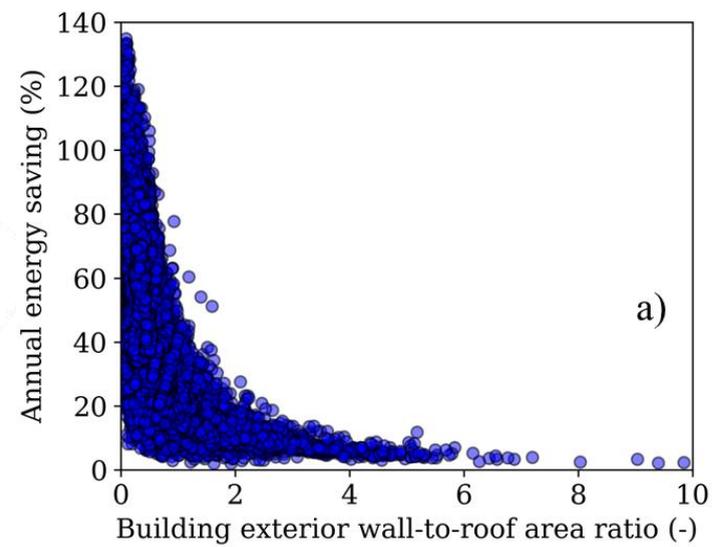
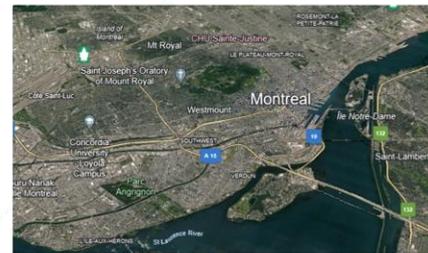
Building info extraction (usage type, age, etc.)



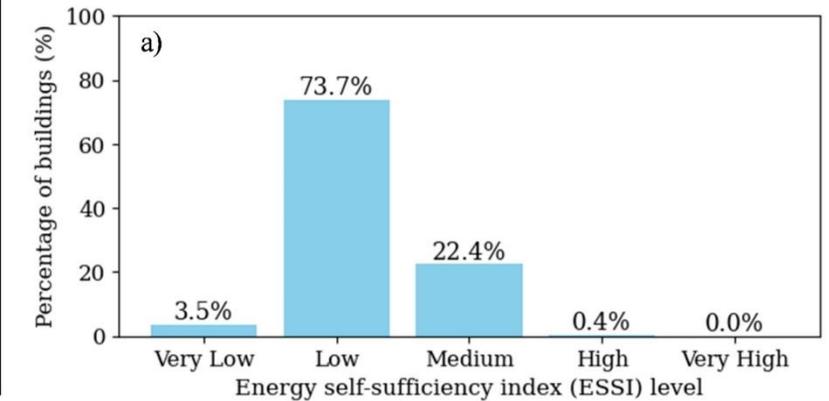
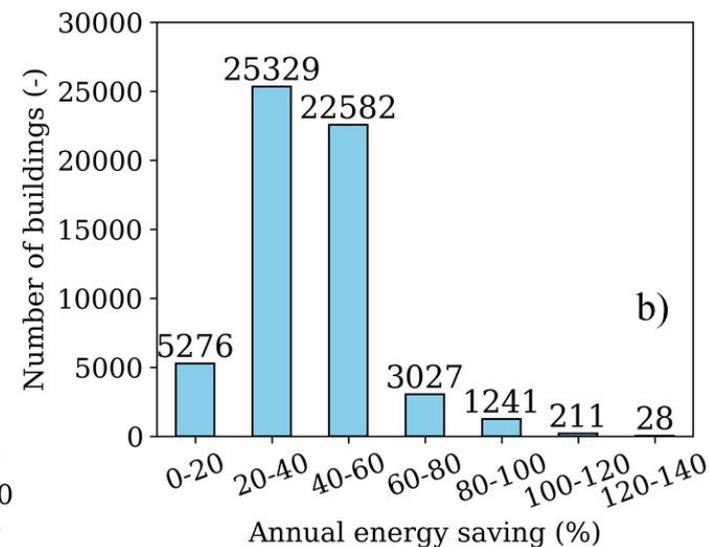
Urban shading modeling



EUI of Montreal buildings



Energy saving of PV retrofitting



Labeling Montreal buildings for energy self-sufficiency level



3D geometry processing