Machine learning to simulate interactions between buildings and their outdoor conditions

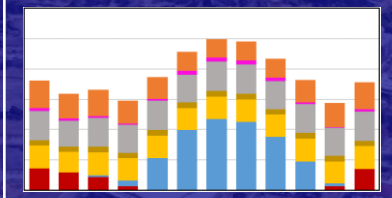
Miguel Martin, Mario Berges, Jantien Stoter, Clara Garcia-Sanchez

Now — 2030 — 2050

100 cities in Europe

All cities in Europe

Building energy use



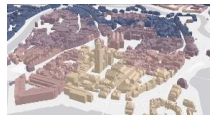
Outdoor conditions

Physics

Machine Learning

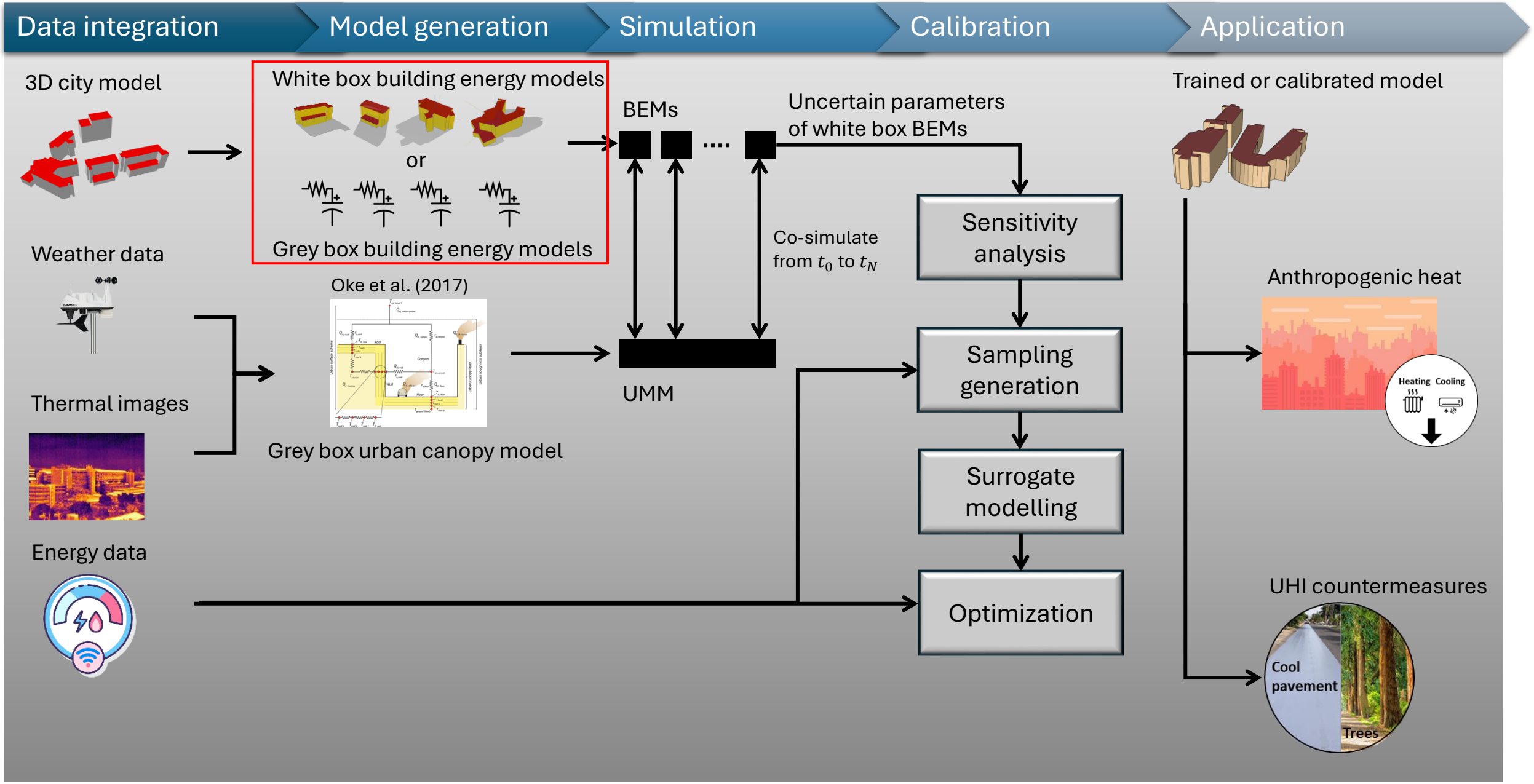
Modelling

Data extraction



Static

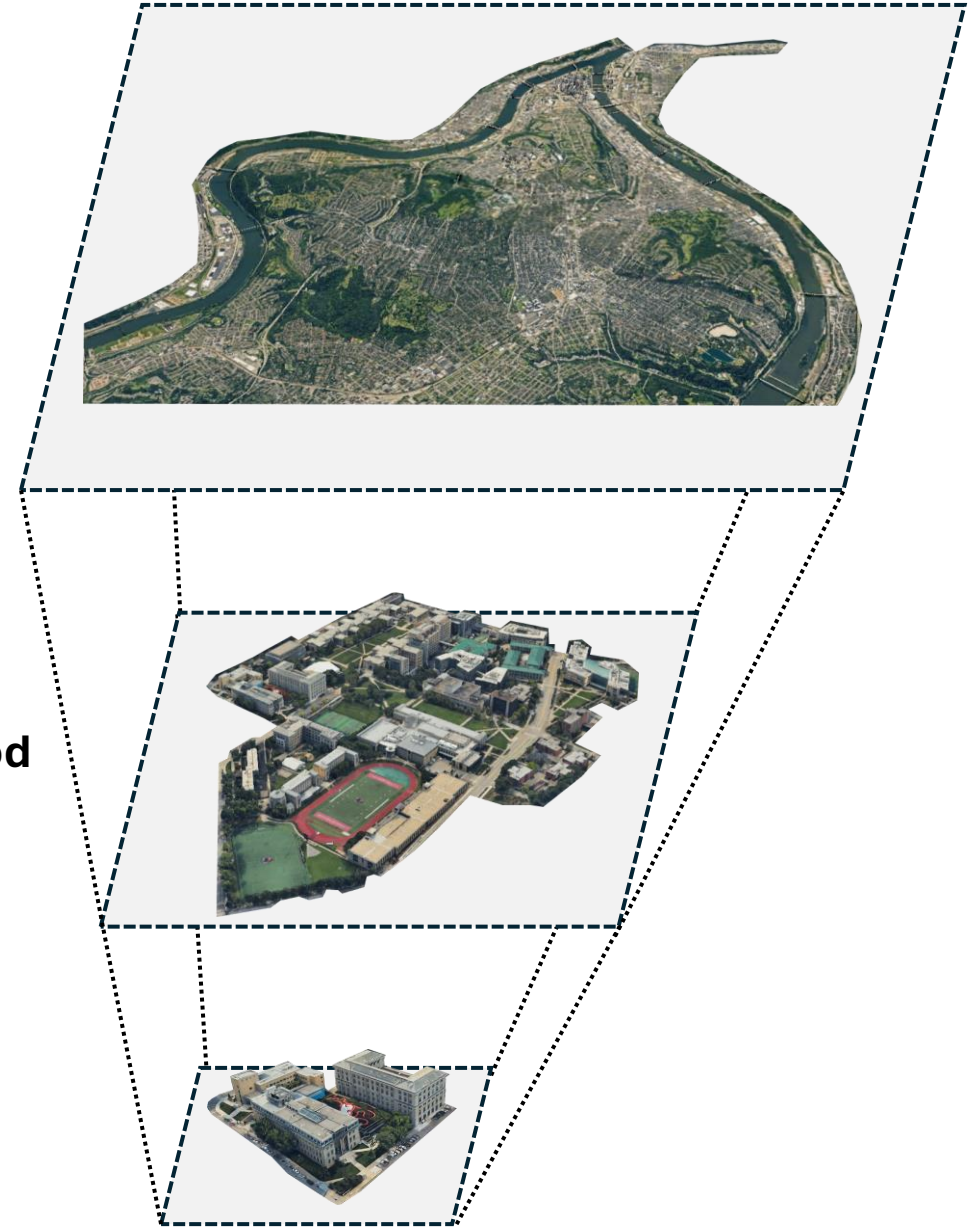
Dynamic

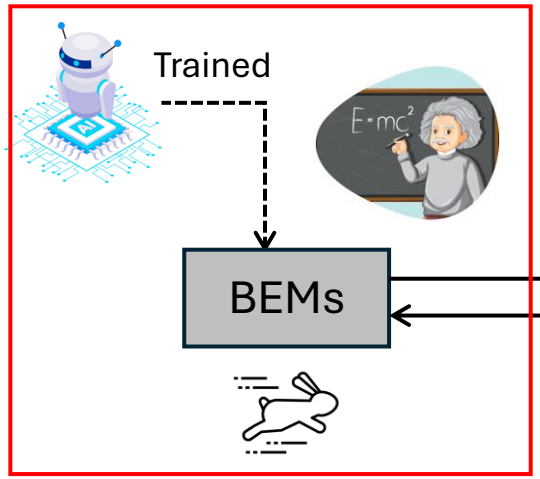

Data integration
Model generation
Simulation
Calibration
Application
3D city model
White box building energy models
or
Grey box building energy models
BEMs
Uncertain parameters of white box BEMs
Trained or calibrated model
Weather data
Oke et al. (2017)
Co-simulate from t_0 to t_N
Sensitivity analysis
Anthropogenic heat
Heating
Cooling
Thermal images
Grey box urban canopy model
UMM
Sampling generation
Surrogate modelling
Energy data
Optimization
UHI countermeasures
Cool pavement
Trees

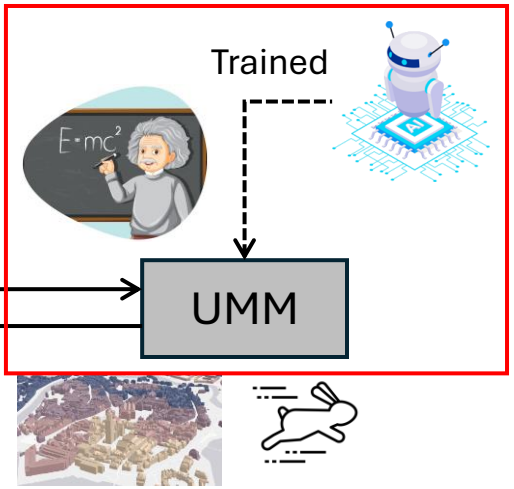
City scale

Neighbourhood scale

Building scale

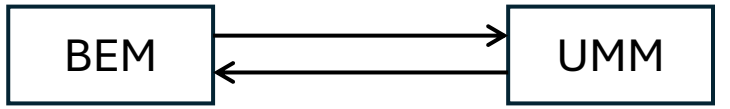




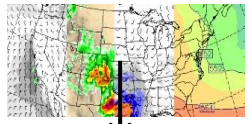


Urban morphology

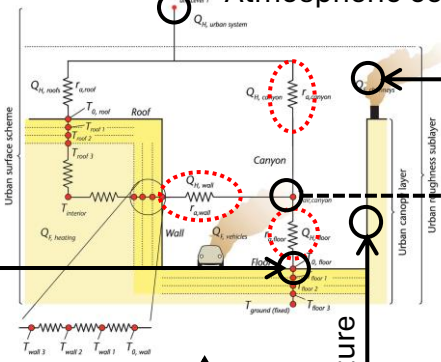
Computational efforts



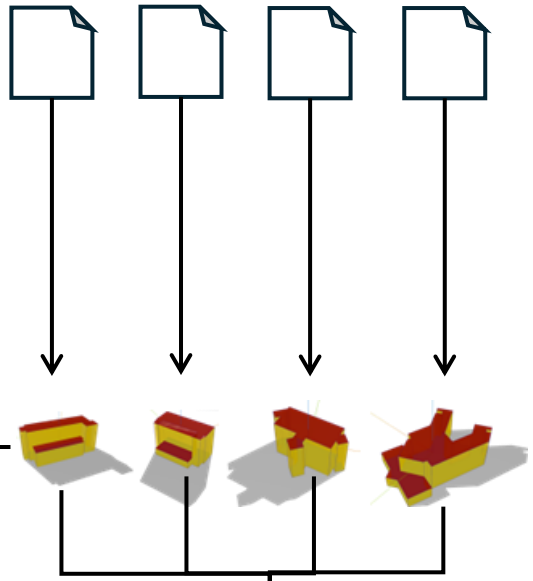
Weather simulations



Atmospheric conditions



Weather files

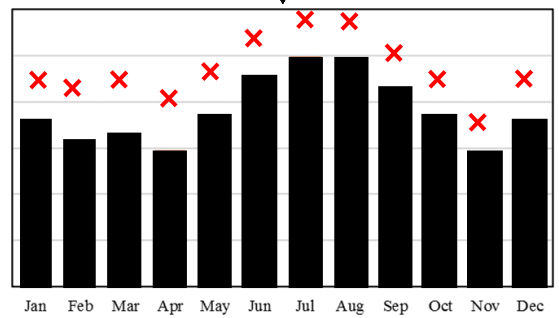


Genetic algorithm

Wall surface temperature

Waste heat releases

Total energy consumption (E_n)



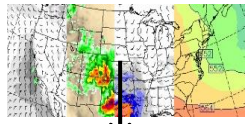
$n = 1$

$n = 0$

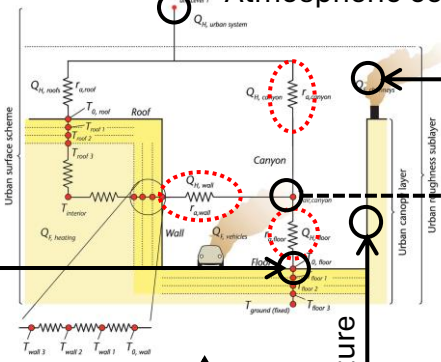
Repeat until

$d(E_{n+1}, E_n) < \tau$

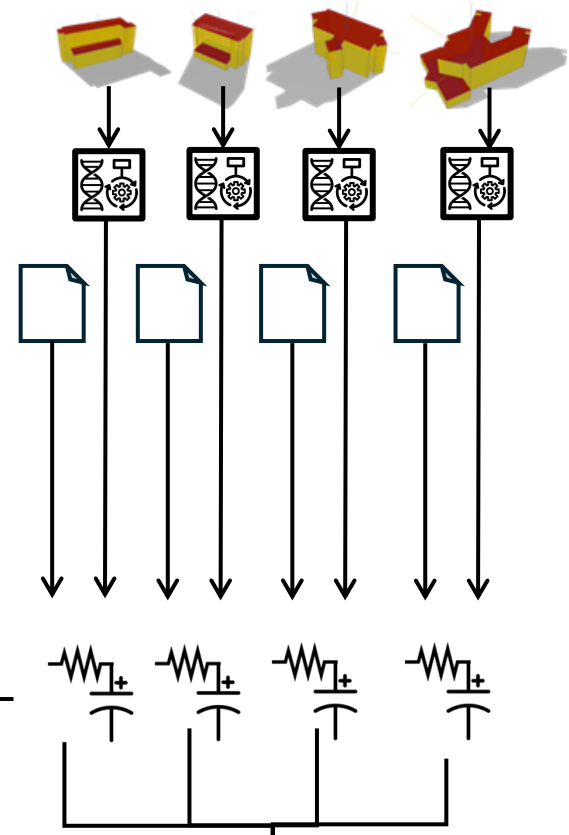
Weather simulations



Atmospheric conditions



Calibrated white box models



Genetic algorithm

Wall surface temperature

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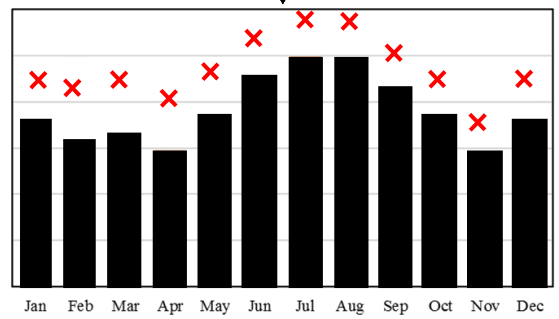

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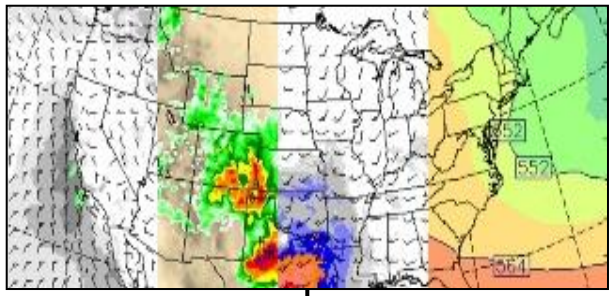
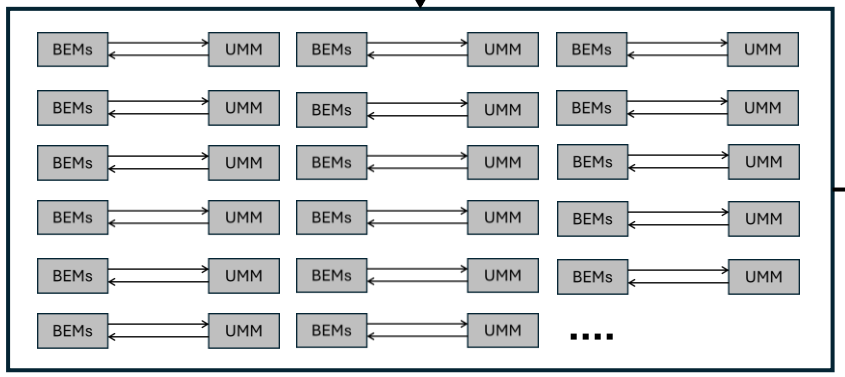
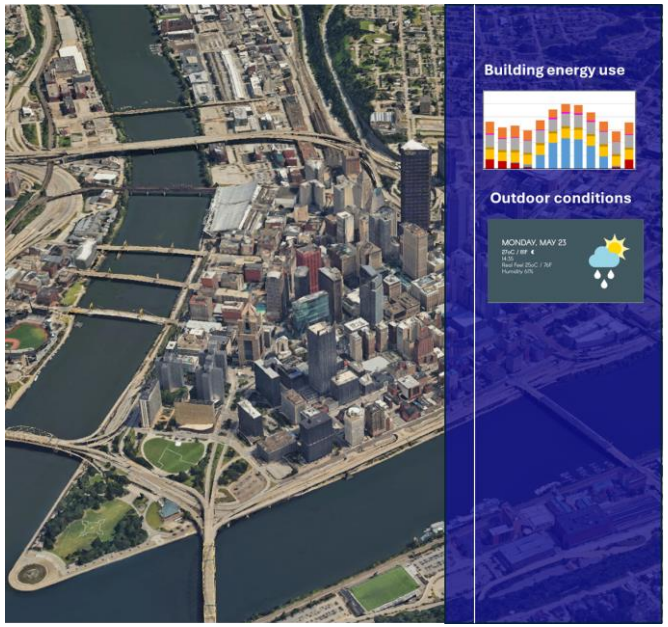


Atmospheric conditions



Integrated

City digital twin platform



City

Architects

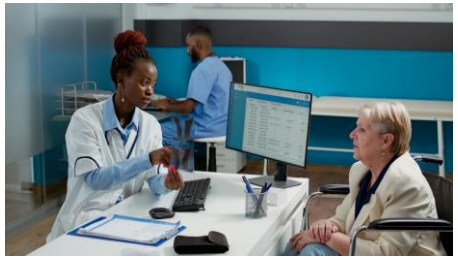
Urban planners

Climate risk assessment

Greenhouse gas emissions

Economy

Public health



Q&A session