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MODULE 3

Why is UBEM required, and how does it work?

KRISHNAJI PAWAR - CEO & FOUNDER

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FUNDAMENTALS OF URBAN BUILDING ENERGY MODELING OVERVIEW

Urban energy modeling improves energy efficiency, sustainability, and city administration by assessing technology, building, climate, systems, and policy, aiding in sustainable built environment development.

Learning Objectives

- Introduction
- Why is UBEM required, and how does it work?
- The UBEM workflow
- The need for a decision-making tool
- Urban building energy modeling workflow.
- How can local weather data be generated and used for UBEM?
- How can results from UBEM be calibrated?
- What are some examples of applications of UBEM?
- Summary and Resources
- UBEM Quiz_Test Your Knowledge!

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INTRODUCTION

- Existing approaches to estimate urban building energy demand use a restricted number of archetype buildings and scale up by building floor area, which underestimates urban building complexity, notably interconnections.
- Most urban energy flow modeling uses top-down building stock energy models, starting with one region's building energy demand and subdividing the stock into smaller subsections.
- These top-down models estimate energy analysis for additional buildings of a certain sort.
- When studying urban building performance, such models are limited in their predictive power.
- Bottom-up urban building energy models should investigate and plan integrated energy supply-demand scenarios at this scale.

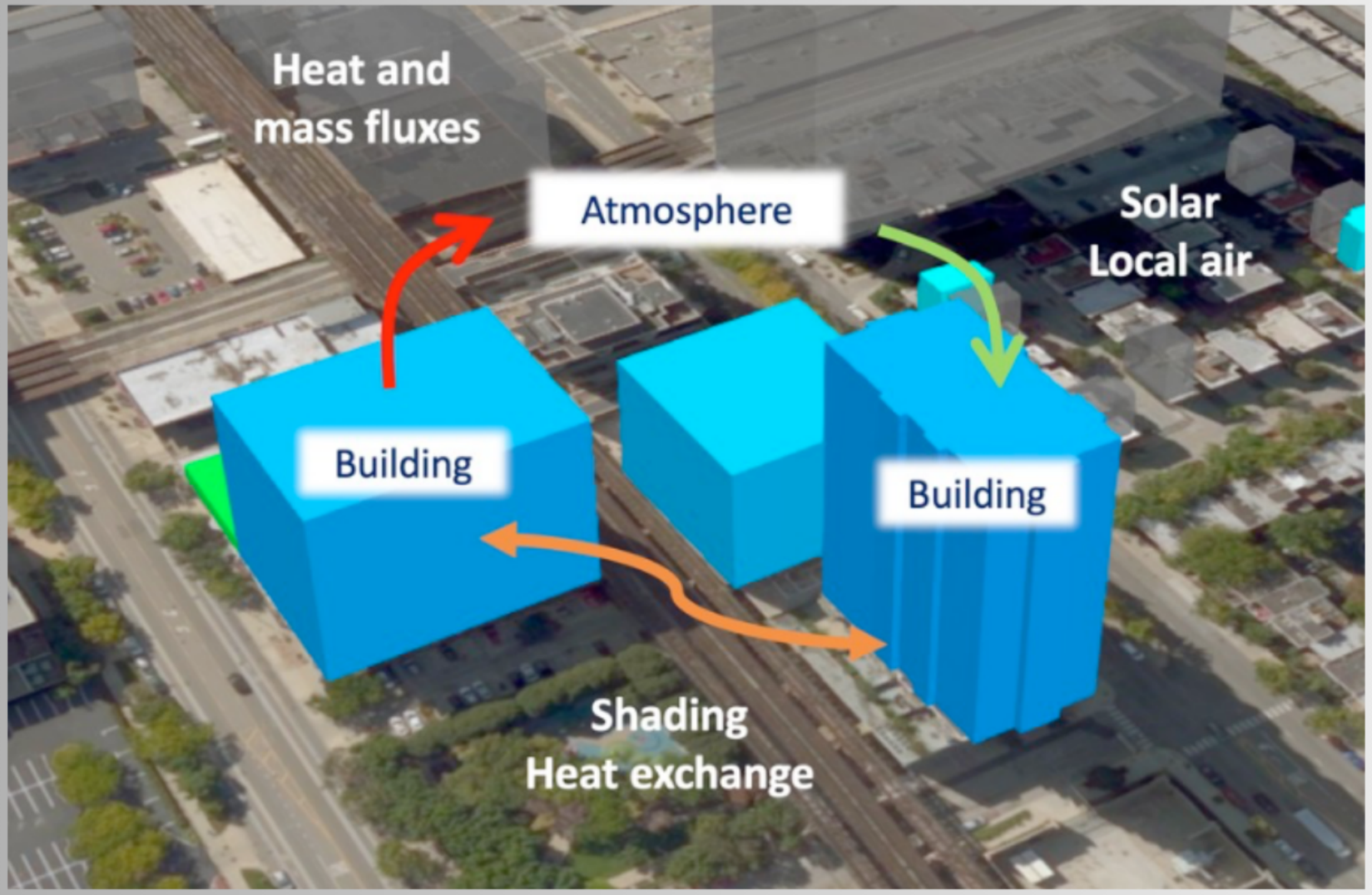
WHY IS UBEM REQUIRED, AND HOW DOES IT WORK?

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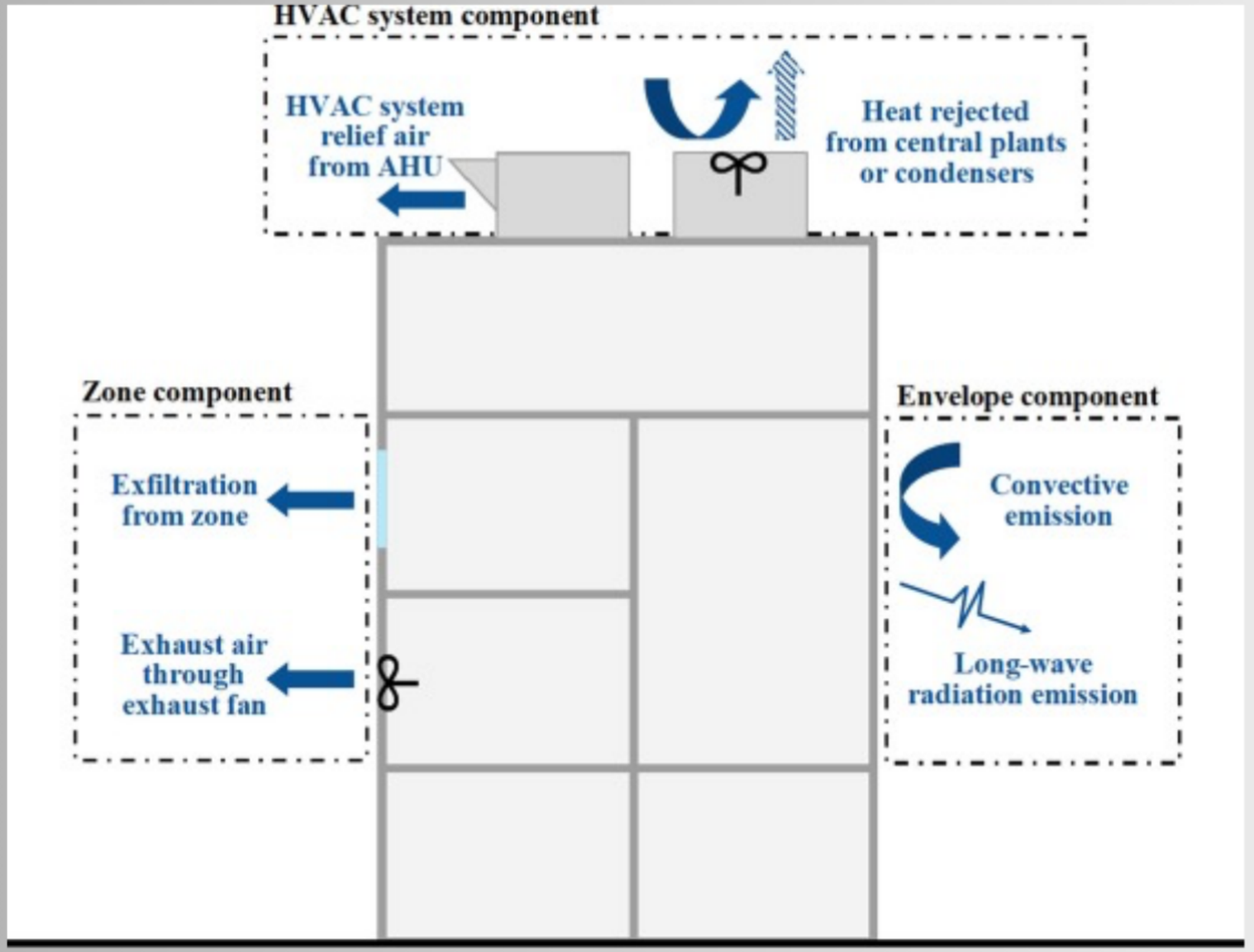
- UBEM captures the complex relationships between urban buildings and the urban environment rather than linearly scaling energy modeling from one to many structures.
- Urban settings considerably impact building performance, whereas buildings strongly influence them.
- Figure 1 suggests that UBEM should represent building interactions (shading, longwave radiant heat exchange, and solar reflection) and the urban microclimate.
- The coupling effect of building heat emissions heating the surrounding microclimate influences building energy demand, yet most UBEM methods overlook it.



THIS INCLUDES SHADING, LONG-WAVE RADIANT HEAT EXCHANGE, AND BUILDING INTERACTION WITH THE NEARBY AIR.



HEAT EMISSIONS FROM BUILDINGS TO AMBIENT AIR THROUGH FIVE MECHANISMS



WHY IS UBEM REQUIRED, AND HOW DOES IT WORK? ++

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UBEM is a robust simulation and analysis tool for urban energy planning and design, building carbon emissions, and local building energy or GHG laws and code compliance. UBEM can help users address several key questions about urban building technology adoption and policy, such as:

- Which buildings can save the most energy and be retrofitted cheaply?
- Which energy efficiency technologies yield the most savings?
- Where in the city do districts have the ideal load density and diversity for district energy systems or local energy storage to reduce energy use?

WHY IS UBEM REQUIRED, AND HOW DOES IT WORK? ++

- What methods are used to identify buildings at risk of heat waves and assess retrofits to mitigate them?
- How much electricity can be generated if all buildings in a city have solar PV installed on their roofs? How does this meet city renewable energy goals? What does a PV deployment plan cost? How does this affect city building energy demand?
- What technologies effectively reduce the urban heat island effect? Building heat contributes how much to the UHI effect? UBEM and urban microclimate simulations can solve these questions.

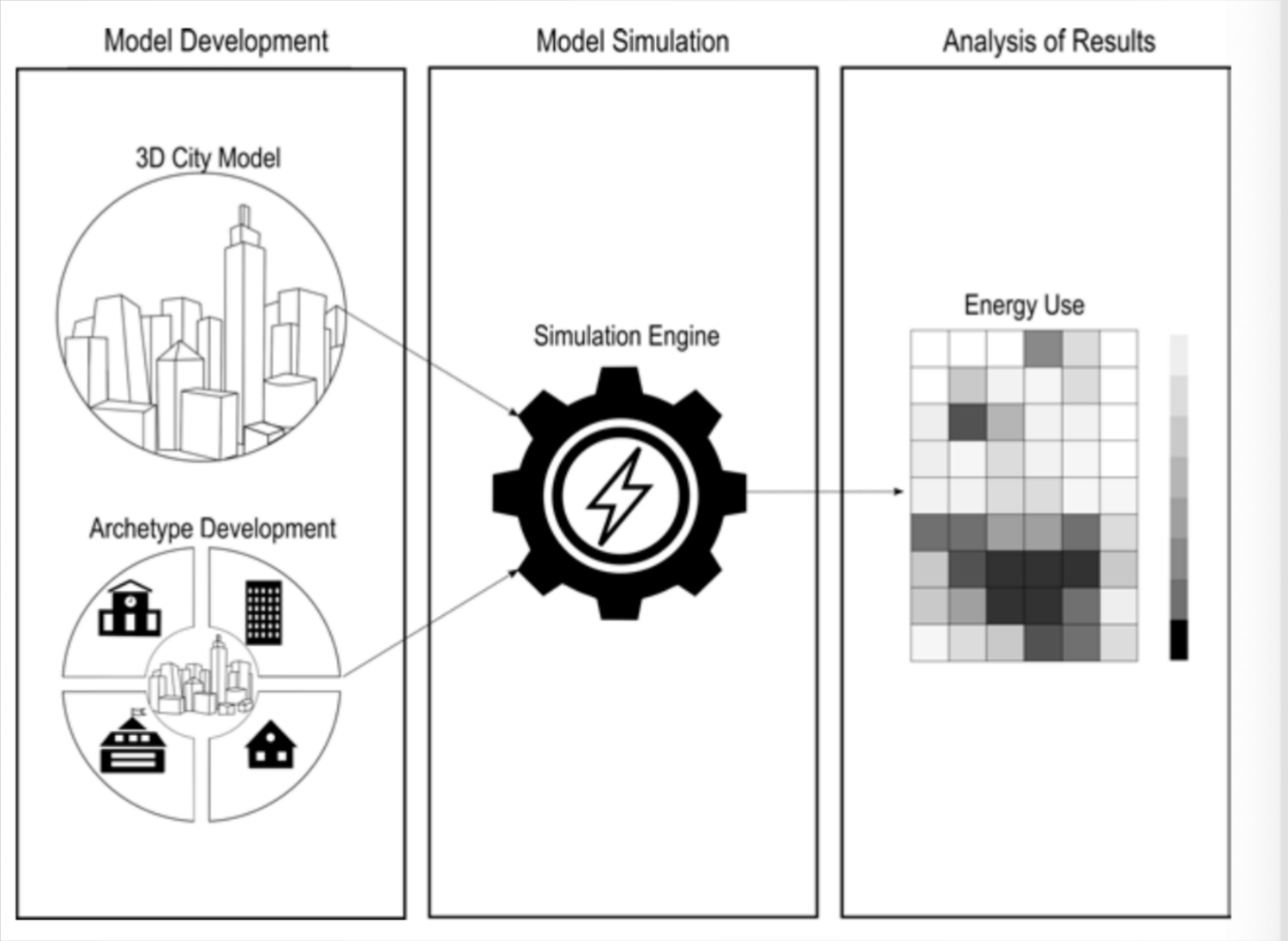


UBEM PROCESS

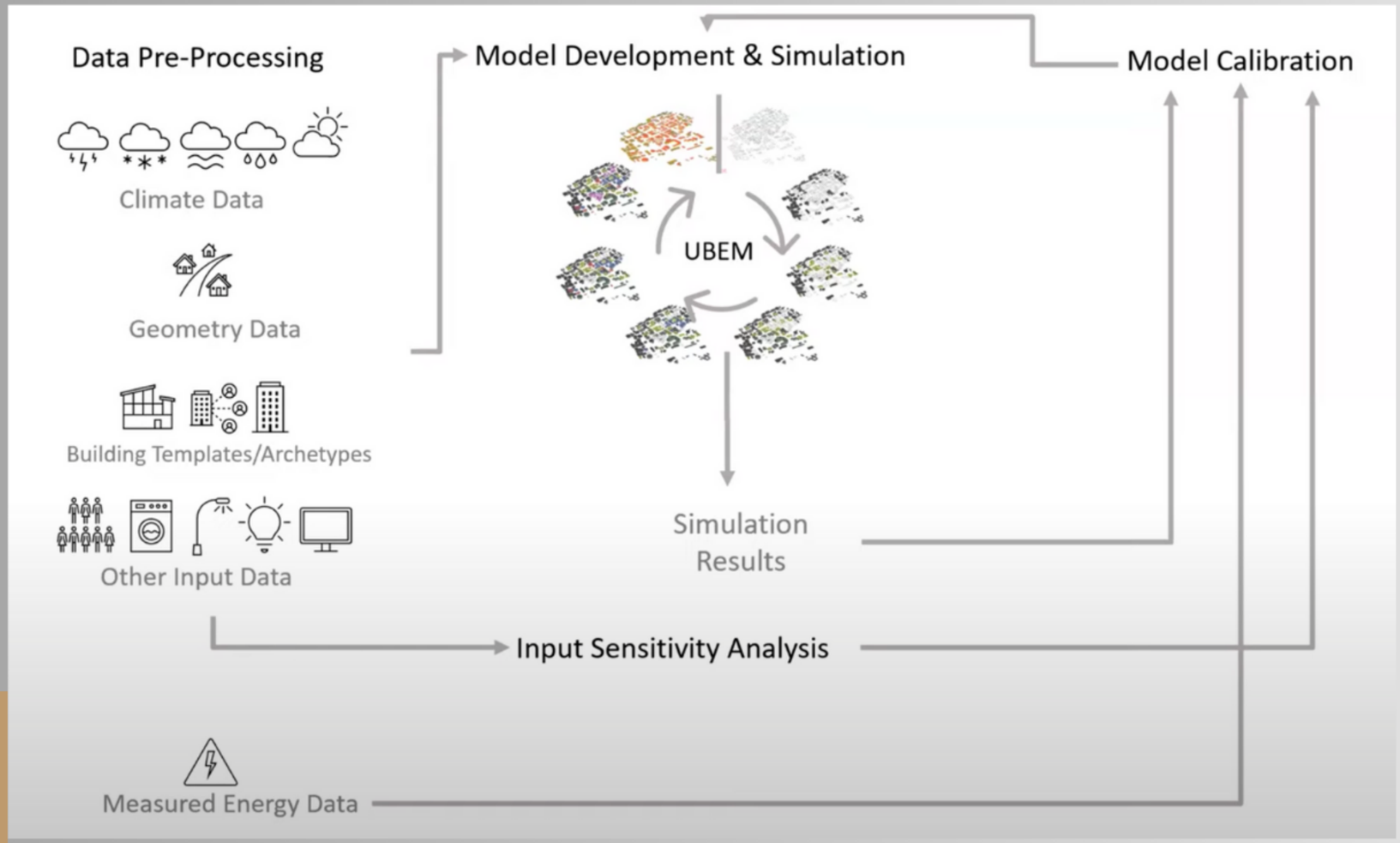
- Like individual building energy modeling (BEM), UBEMs are shaped around geometrical and non-geometrical information, such as construction, materials, systems, and occupancy, which are imported to a simulation engine to calculate and analyze building energy performance under specific weather conditions.
- However, urban building energy modeling is too large to use the same method as BEM.
- However, UBEMs lack the time and resources to turn enormous amounts of data into unique building models.
- The 3D city model, building archetypes, and meteorological data are integrated into a UBEM simulation engine to implement building models and calculate and output energy demand.
- However, not all UBEM simulation engines can represent buildings, energy systems, and their components like district heating and electricity distribution.



WHOLE URBAN BUILDING ENERGY MODELING WORKFLOW.



UBEM PROCESS





3D CITY MODEL WITH LOD1

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THE DEFINITION OF THE ARCHETYPES OF BUILDINGS

- As mentioned, collecting and handling data are some of the main challenges of large-scale energy modeling of buildings and, in particular, UBEMs.
- However, the introduction of building archetypes, i.e., reference buildings that are representative of a group of buildings with similar characteristics, is expected to moderate modeling complexities to some extent.
- To define building archetypes, the building stock is first classified based on common characteristics that are likely to affect the energy performance of buildings.
- With a deterministic approach, it suffices to classify the buildings based on a collection of features such as the buildings' use, type, year of construction, HVAC system, or heated floor area.



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CONTACT US

+91 6363032722

info@beyondsmartcities.in

learn.beyondsmartcities.in

#55,HMR Layout ,Bengaluru ,India



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