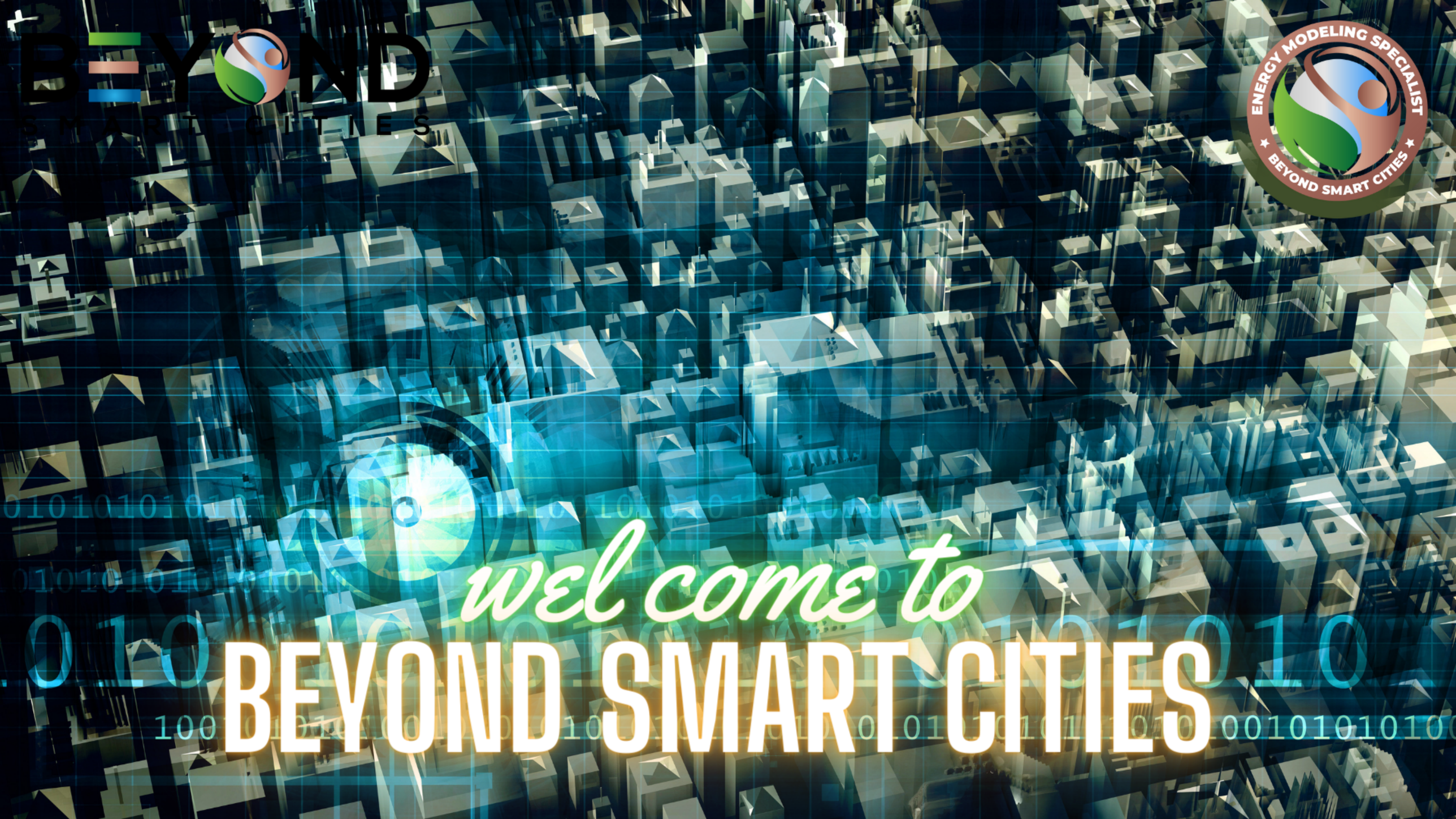

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MODULE 6

Methodology and UBEM use cases

KRISHNAJI PAWAR - CEO & FOUNDER

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FUNDAMENTALS OF URBAN BUILDING ENERGY MODELING OVERVIEW

The primary obstacle faced by numerous model developers in UBEM is the limited availability of high-quality data. This course utilizes diverse data sources to address this problem. The accuracy, integrity, and completeness of the data may vary across datasets, depending on the source of the data.

Learning Objectives

- Introduction
- Overview of BEM and simulation
- Model complexity and zoning configuration
- How can local weather data be generated and used for UBEM?
- How can local weather data be generated and used for UBEM?
- What's new in the field of 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

- The geometry description, building thermo-physical characterization, and meteorological dataset are input data for all tools.
- Uploading a manually built 3D model sets constructing stock geometry.
- SimStadt, CityBES, CEA, and TEASER are directly integrated with GIS because large-scale 3D modeling of the built environment is difficult.
- Users can submit CityGML (Open Geospatial Consortium, 2018) XLM-based format files to SimStadt, CityBES, and TEASER to store and exchange virtual 3D city models.
- Thus, all technologies allow users to import a geometric model of the area of interest from manually made 3D files.

INPUT DATA

- Characterizing the 3D geometry is crucial to the settings.
- Therefore, an urban weather dataset should be produced.
- This method uses urban characteristics to transform a rural station weather dataset into an urban one that accounts for hourly urban heat island effects.

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OUTPUT DATA

- Building energy needs and system performance are assessed using several methodologies.
- All models except CitySim and TEASER directly evaluate home hot water and power consumption as outputs.
- California has the most advanced resource potential model, which considers ambient heat potential (geothermal, lake water, and waste heat sources) and solar potential.

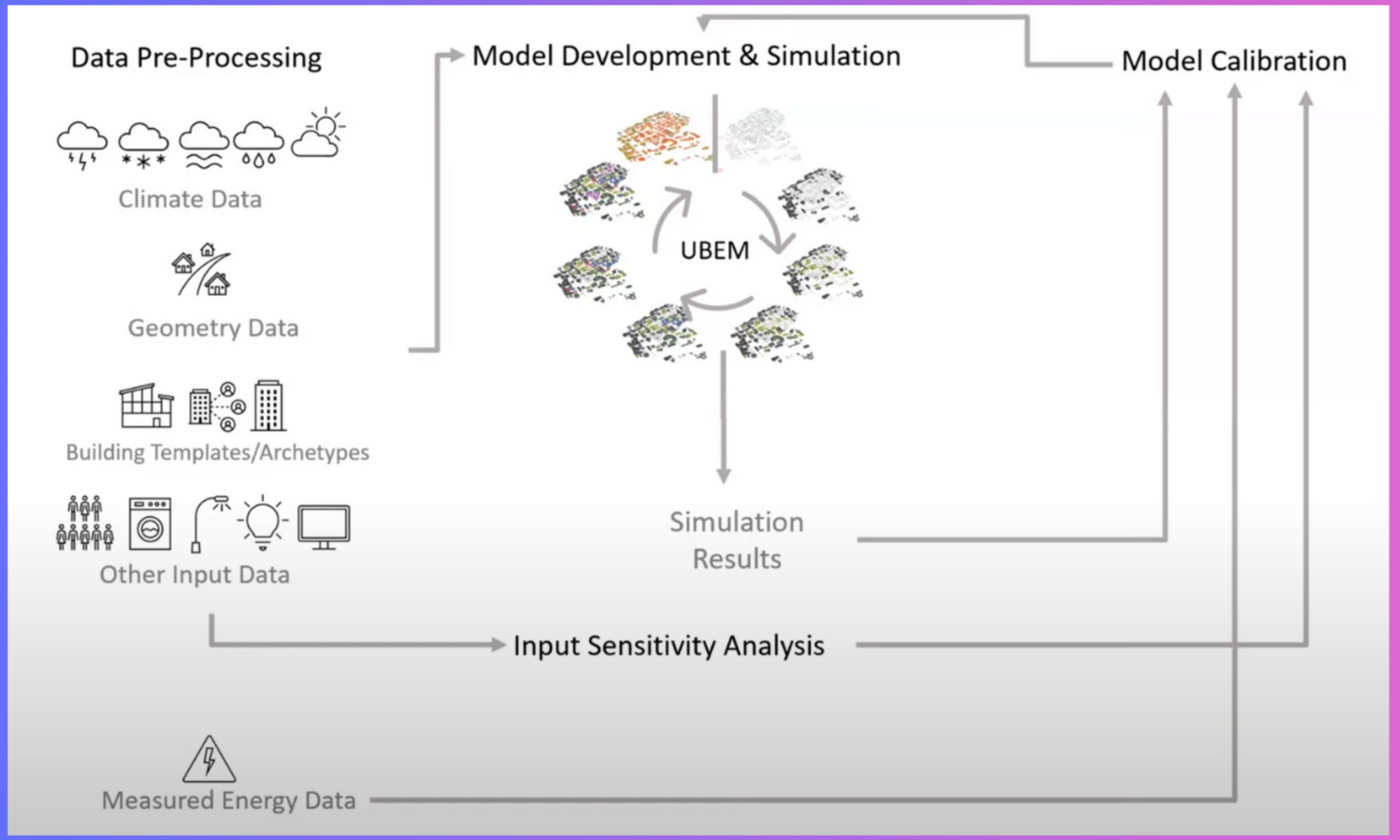
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OUTPUT DATA+

- Few methods can incorporate urban energy systems into metropolitan region modeling.
- CityBES has 75 strategies to compare and evaluate.
- Costs and benefits can be assessed using the Cost-Effectiveness Analysis (CEA) framework.
- The outcomes may affect transportation and mobility.
- A district's walkability and efficacy are assessed using numerous tools.

UBEM PROCESS



HOW CAN LOCAL WEATHER DATA BE GENERATED AND USED FOR UBEM?

- Urban climatic influences must be integrated into UBEM to better analyze urban building energy usage.
- Many methods have been used to study the urban microclimate and collect local meteorological data.
- Weather Underground, Dark Sky, and Weather Observations allow users to access hyper-local, real-time weather observations and forecasts from local weather stations.
- However, CFD is still a popular tool for simulating and predicting urban microclimates due to the need for greater resolution and comprehensive boundary information and recent developments in computational infrastructure.



HOW CAN LOCAL WEATHER DATA BE GENERATED AND USED FOR UBEM? +

- One of the most widely used weather forecasting methods in climate research is the Weather Research and Forecasting (WRF) model, which can capture atmospheric motions from continent to near-building scales.
- The Urban Multi-scale Environmental Predictor (UMEP) is a Quantum GIS (QGIS) plugin that generates weather data for urban energy consumption evaluation (Lindberg et al.,
- Other tools that generate local weather data and could be integrated with UBEM include the Parallelized Large-Eddy Simulation Model (PALM), which models atmospheric turbulence and various boundary layers based on the non-parallelized LES code (Maronga et al.,



MODEL COMPLEXITY AND ZONING CONFIGURATION

- As mentioned, to overcome the complexity of simulating a large number of building models, in the UBEM, the aim is to abstract the buildings and their systems and estimate their performance without having to deal with all their details.
- Some examples of such simplification are reducing the number of thermal zones or reducing the level of detail in the building models.
- To untangle these questions about model complexity in an UBEM, in course, some of the most common zoning configurations and levels of detail are systematically compared.
- Differences in heating and air conditioning as well as influences on the inner walls of the building are neglected, and it is assumed that the whole building can be described as one thermal zone.



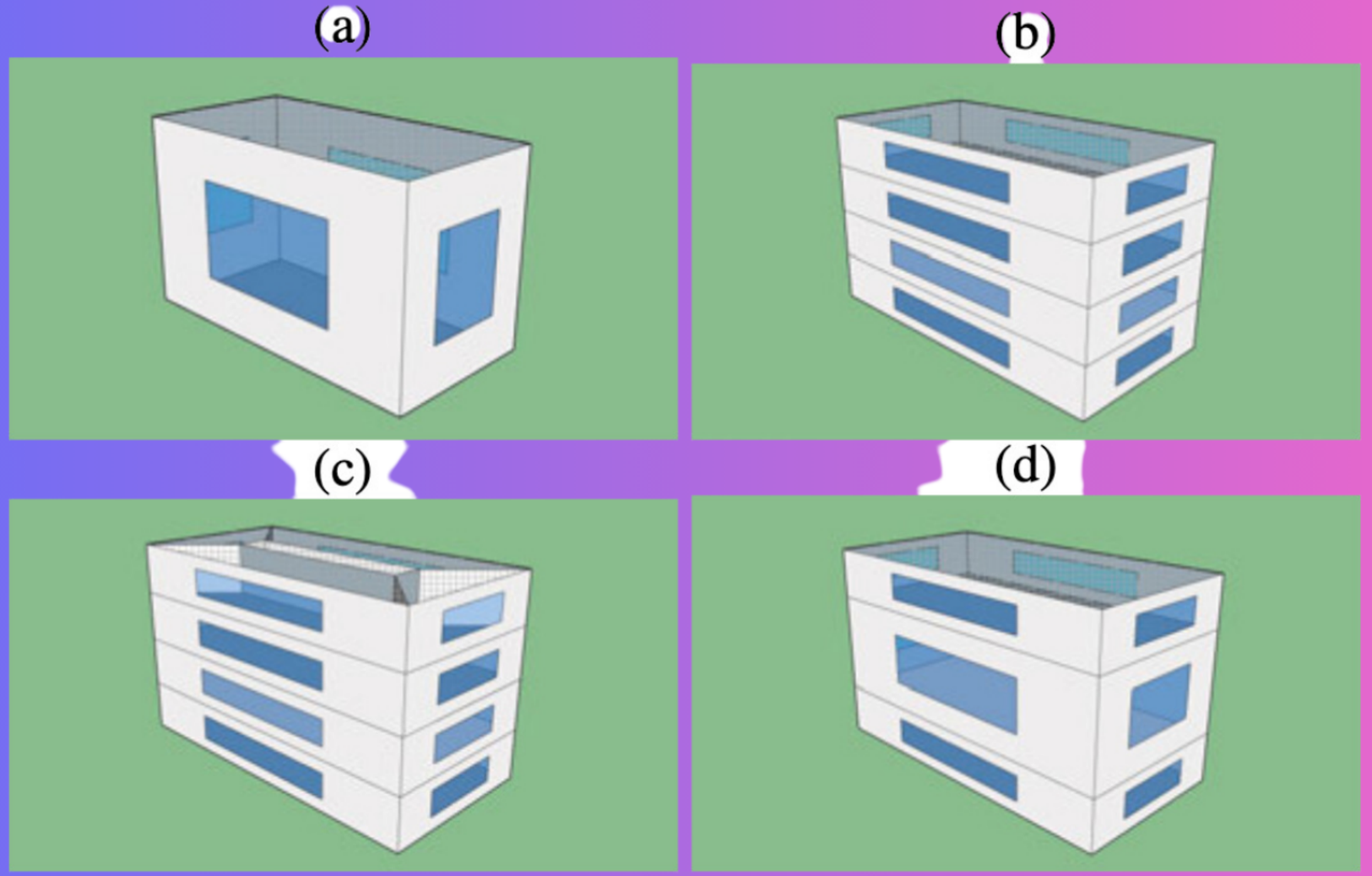


Figure 1.Thermal zoning configurations in UBEM: (a) single-zone model (1 zone per building), (b) multi-zone model (1 zone per floor), (c) multi-zone model (5 zone per floor) and (d) multi-zone model (3 zones per building: one for bottom floor, one for top floor and one for all middle floors).

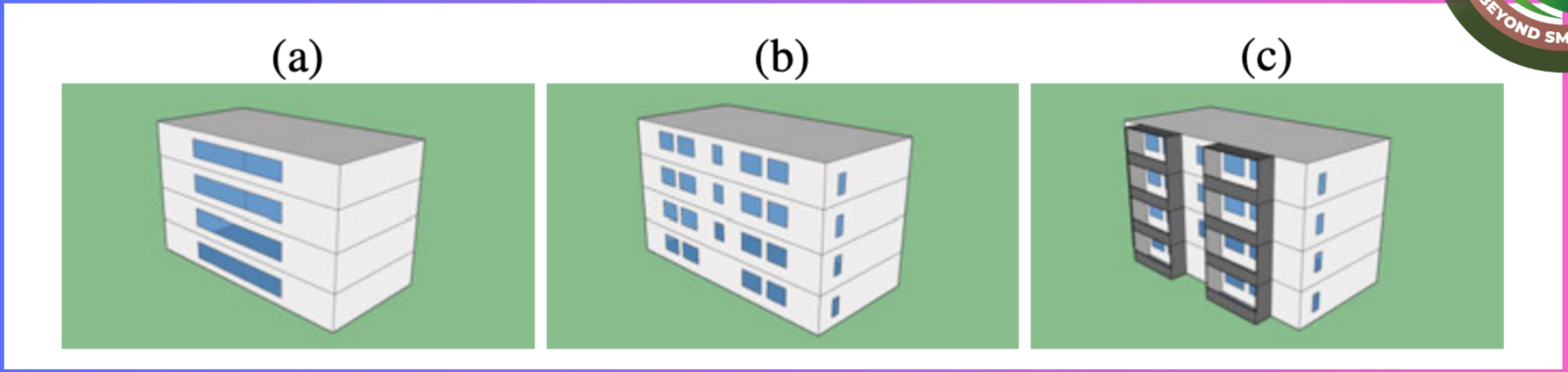


Figure 2 Level of detail in building modeling: (a) LoD1, Shoe-box model of the building with 25% window area on long walls, (b) LoD2⋆, Detailed building model excluding the shading components, (c) LoD3, Detailed building model with precise geometry of windows and shading components

MODEL COMPLEXITY AND ZONING CONFIGURATION+

- Defining a simple multi-zone model is expected to slightly capture the contribution of internal building elements, e.g., adjacent floors, but still run the simulation in an acceptable time.
- The third and most common method for multi-zone modeling follows the ASHRAE guidelines for envelope setting and zoning configuration.
- According to ASHRAE 90.1, Appendix G , different temperature zones are assumed for perimeter and interior spaces that are at least 4.6 m away from the exterior or semi-exterior walls.
- This means, for a square-base building, that at least 5 thermal zones, i.e., one core and four perimeter zones, are required for every floor of the building (5 zones per floor), as visualized in Figure 2(c) (5 zones per floor).In addition to these three configurations, when tall buildings are of interest, there is another alternative in which the building is divided into three main thermal zones.



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CONTACT US

+91 6363032722

info@beyondsmartcities.in

learn.beyondsmartcities.in

#55,HMR Layout ,Bengaluru ,India



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