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MODULE 5

Urban modeling approaches

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FUNDAMENTALS OF URBAN BUILDING ENERGY MODELING OVERVIEW

This lecture provides a practical overview of urban building energy modeling (UBEM) tools, comparing their potential and limits. It compares available methods and approaches, aiming to create a selection guide for new users, focusing on energy-efficient buildings and energy supply systems for a sustainable future.

Learning Objectives

- Introduction
- Urban modelling approaches
- Model calibration and validation
- What are the available UBEM tools?
- What data models and technologies reflect urban building characteristics?
- 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

- Decision-makers need evaluation criteria and scenarios to choose the optimal energy-saving strategies for cities.
- This study analyzes UBEM methods that focus on buildings but may aggregate results on an urban scale and combine additional urban-specific analysis.
- Urban building energy modeling assessments abound, but a user-oriented overview is lacking.
- This study highlights these distinctions to help users choose the best UBEM tool for their analysis.
- Future one-to-one comparison assessments will focus on specific subjects, tools, and outputs because such an analysis cannot provide a general perspective of such a diversified array of tools.

URBAN MODELLING APPROACHES

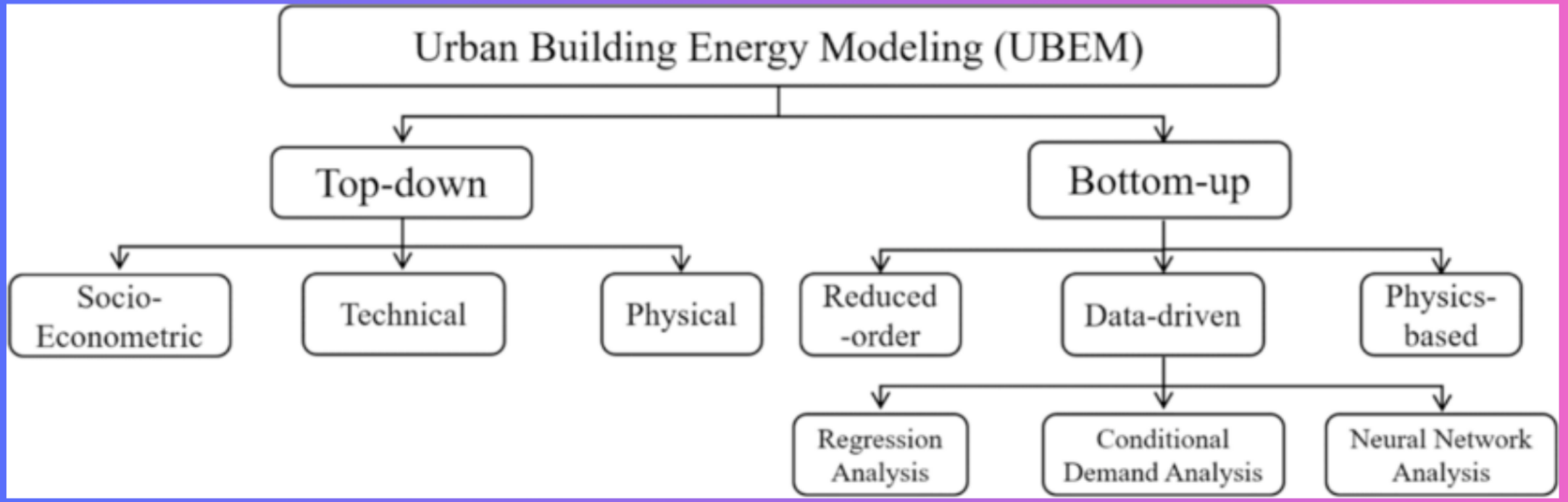




- Urban modeling is a vast subject that encompasses various aspects of urban life, including flows of goods, energy, waste, and people.
- Three main areas of interest in urban modeling include land-use and transportation models, Urban Energy System Modeling (UESM), and Building Modeling at the Urban Scale (UBEM).
- Land-use and transportation models, such as UrbanSim, OPUS, ILUTE, and ALBATROSS, are the first dynamic models applied to the urban environment.
- UESM focuses on simulating and optimizing cities' energy systems, considering distribution and transmission networks.

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FIG.1 SCHEMATIC OF THE UBEM APPROACHES.



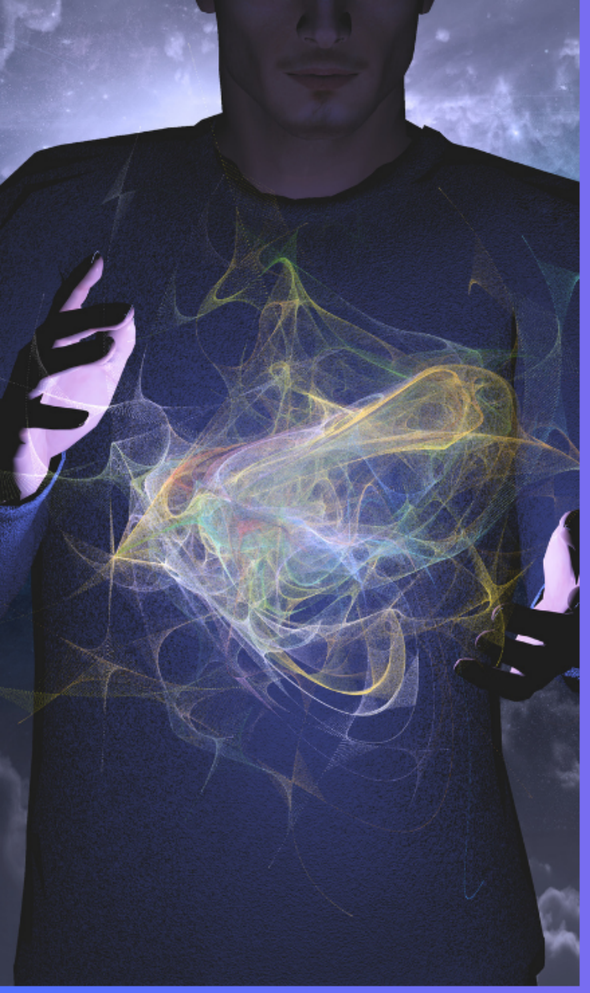


URBAN MODELLING APPROACHES +



- UBEM, on the other hand, focuses on building modeling at the urban scale, encompassing various tools and methodologies.
- These tools can assess daylight optimization, the effect of new green areas, life cycle assessment, or energy savings derived from building renovations.
- More complex tools and methodologies are needed to consider different aspects together, with two main categories: top-down and bottom-up modeling approaches.

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TOP-DOWN MODELLING METHODS



- On a large scale, top-down models estimate the energy consumption of buildings using agglomerated data.
- Long-term relationships between the energy consumption of an urban area and specific drivers are estimated.
- Additional differentiation results from the classification of these variables into physical, technical, and socio-econometric models.
- Nevertheless, this establishes another constraint, as they attempt to forecast forthcoming energy consumption by relying on historical interdependencies between the energy and economic domains.

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BOTTOM-UP MODELLING METHODS

- Bottom-up models compute energy consumption at the level of individual buildings and subsequently aggregate the findings across various levels, all the while taking into account an integrated framework.
- They require a substantial amount of data to function correctly, but the accessibility of such data may be impeded by concerns related to privacy and other factors.
- Additional differentiation is feasible within this classification of models by distinguishing statistical models from physics-based models.
- This differentiation is proposed in this paper using the method for calculating energy demand.



BOTTOM-UP PHYSICS-BASED UBEM TOOLS

- Different functions are available for urban building energy modeling.
- Physics-based modeling captures building performance dynamics with the highest detail.
- The EnergyPlus (U.S. DOE BTO, 2019) modeling engine analyzes complicated building systems.
- EnergyPlus prototype building energy models (US DOE, 2018a) enable widespread use for urban building stock energy research.
- The first physics-based UBEM models use BEM tools and co-simulate with other detailed software for certain topics.





CONCLUSION AND FUTURE OUTLOOKS

- This topic gives an outline of the different UBEM tools.
- First, a description of the two main urban modeling approaches is given.
- Then, bottom-up physics-based UBEM tools are the major focus.
- The most advanced tools on the market right now are looked at and talked about in great depth.

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