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ONLINE TRAINING BY KRISHNAJI PAWAR

LEED AP(BD+C), GSAS CGP, GCP, ISO 14001

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MODULE

04

Key Factors in Whole-Building Simulation for Commissioning

KRISHNAJI PAWAR - CEO & founder

LEED AP(BD+C), GSAS CGP, GCP, ISO
14001

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Key Factors in Whole-Building Simulation for Commissioning

The "Commissioning of Buildings and HVAC Systems for Improved Energy Performance" task investigating the use of Whole Building Simulation in Commissioning has identified the following applications of whole building simulation in the commissioning process:



LEARNING OBJECTIVES

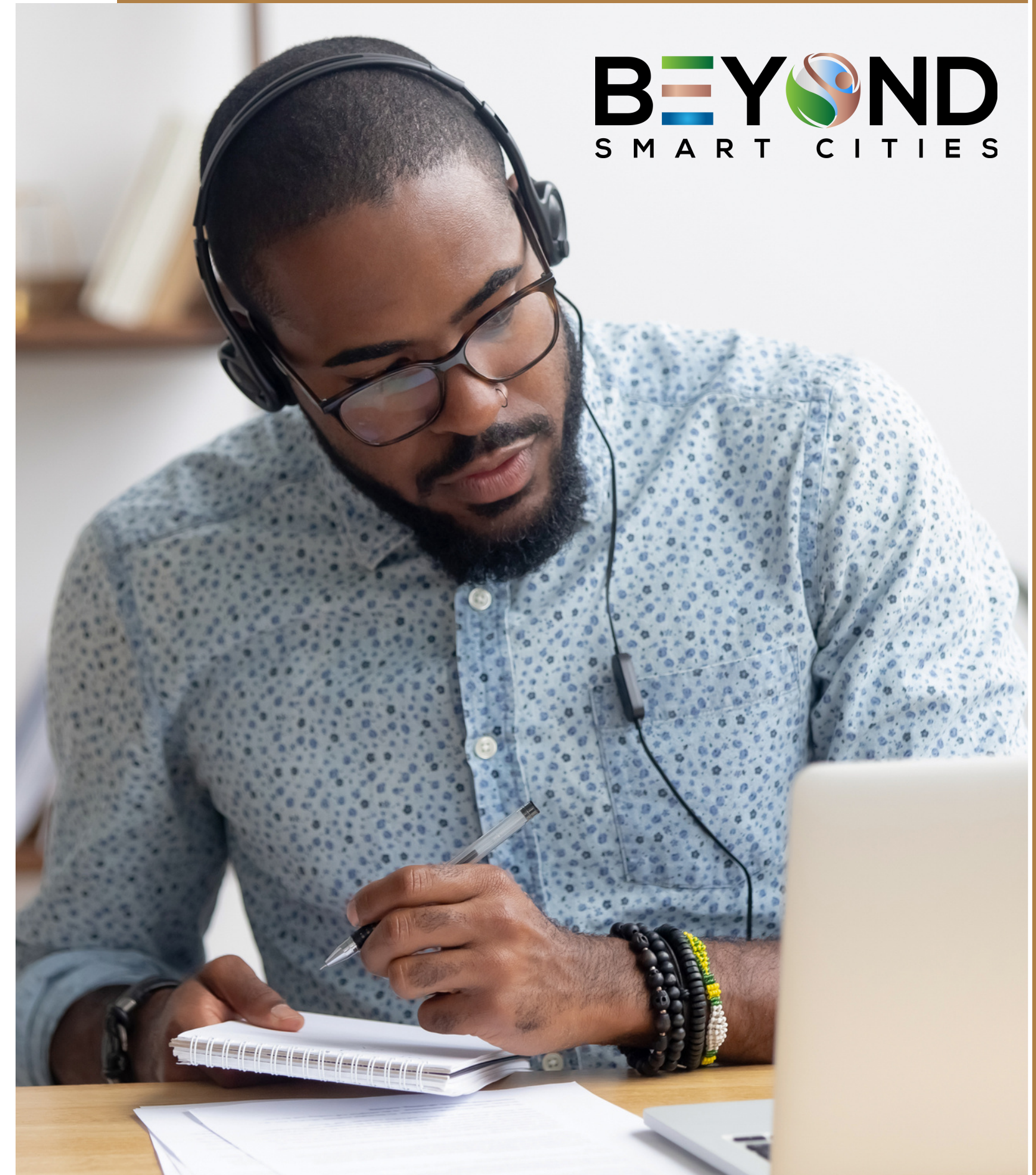
- ✓ Introduction
- ✓ Key Factors in Whole-Building Simulation for Commissioning
- ✓ Passive testing
- ✓ Active Testing
- ✓ Different Applications Of Building - Level Models for Commissioning

Introduction

The "Commissioning of Buildings and HVAC Systems for Improved Energy Performance" task investigating the use of Whole Building Simulation in Commissioning has identified the following applications of whole building simulation in the commissioning process:

- 1) During the design process;
- 2) In the post-construction commissioning of new buildings;
- 3) Design simulation for on-going commissioning;
- 4) Calibrated simulation for retro-commissioning;
- 5) Calibrated simulation for on-going commissioning; and
- 6) Simulation to evaluate the new control code

Discussed and illustrated are these applications. Calibrated simulation for retrocommissioning is the only one used routinely. The other examples have been used in research, and costs must be lowered for routine application, but simulation may be useful in commissioning.



Using Simulation Models For Building Commissioning

- Whole-building models are used for HVAC system design but not commissioning. Pre-design models and simulations are used. These models simplify input with many default inputs to speed use and provide early feedback on major envelope or system configuration options.
- Detailed models are used to size heating and cooling equipment during design, and a simulation model like DOE-2, TRNSYS, EnergyPlus, Visual DOE 4.1, etc. can be used to explore the effects of a few design options on annual energy use. Simulating a building's life cycle has been considered for at least 20 years, but it has never been done.
- Simulation is also used to "commission" the design. Participants believed there were other significant simulation opportunities to improve the commissioning process.
- Simulation models are especially useful for design, savings determination (e.g., Option D of the International Performance Measurement and Verification Protocol), and building diagnostics.

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Key Factors in Whole-Building Simulation for Commissioning

- The use of whole-building simulation in commissioning is likely to be most practical in cases where a simulation has already been performed as part of the design process or as part of a retrofit evaluation.
- The input deck for the design simulation will then become a direct expression of the design intent.
- The simulation can then be used to predict building performance, and deviations would indicate the need for commissioning measures to bring the building to design intent.
- However, the specific comparisons that can be performed will be dictated in part by the capabilities of the simulation model and in part by the performance data available for comparison with the simulation.
- In most cases, EMCS data will be used for comparison with the simulation, necessitating appropriate energy consumption sensors on the EMCS. The simulation will generally be used to evaluate what we will term "passive testing" or "active testing."
- The term passive testing will refer to the use of data collected during normal operation of the building without any intervention to extend the range of operating variables implemented during any particular time interval.

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FIGURE 3.2: ILLUSTRATION OF SAVING MEASUREMENTS

Passive testing

Passive commissioning has traditionally used simulated and measured consumption data. Time series data or plots of heating and cooling consumption versus outside air temperature are used for these comparisons. If the simulation is idealized, significant differences between simulated and measured consumption indicate that the system is not performing as designed. Passive tests are shown below. It's incomplete. Many more tests will be developed and used.





Passive testing



- Check room temperatures and humidity. Every zone's temperature and humidity can be trended over one or more days. Temperature and humidity control are acceptable if these values stay within set points and any control undershoot, overshoot, or throttling range. If not, diagnostics (which may or may not involve simulation) are needed to determine why the excursions occurred. Pass this test,
- Compare energy use with predictions over several days. This test passes if measured consumption matches predicted consumption within an acceptable range. Creating practical "passing" criteria for this type of test is difficult. Change inputs if "pass" criteria are narrowly missed.
- Apply limited trend data to design conditions. Equipment capacity must be assessed.

Depending on the simulation's accuracy and the EMCS's sensors, airflows and temperatures supplied to each zone, waterside system parameters, and primary system performance should be checked.





Active Testing

- Active diagnostic tests are triggered by passive test failures. Active testing may include functional tests to evaluate the system's comfort control and dynamic response under various operating conditions. Active tests provide empirical input variables for the simulation program.
- Active testing typically controls an input variable that affects building comfort and energy performance through a sequence of values. It may involve cycling a known lighting load or other major load on and off on a specific cycle to test HVAC system response and performance. It may test system capacity and control by changing space temperature set points.
- A variety of tests are needed to test the system's response to a variety of loads in the spaces and to determine how efficiently the primary and secondary systems are working with the control system to meet space loads.





Active Testing

- Simulation has been used in some commissioning applications, but active and passive testing methods still need to answer many questions. General queries:
- What capabilities do simulation models need to commission specific applications?
- How do building and system types affect simulation requirements?
- Which model(s) should be tested?
- Should the model support a necessary test suite?
- Energy balance and simulation in commissioning—how?
- Should experiments tune model inputs?
- Simulation time?
- Simulating how long?

Questions include:

How can peak load capacity be assessed? Oversizing, anyone? Undersizing?

How can equipment efficiency meet building needs under normal operating conditions be determined?

- User behavior affects windows, lights, and thermostat settings. Which parameters define this behavior?
- Europe and Asia prioritize envelope performance over North America.
Commissioning envelopes: what matters most? How important are shapes vs. W/k/
m²-floor area, window area/m², operable windows, window tightness, etc.?



CONTACT US



+91 6363032722



info@beyondsmartcities.in



learn.beyondsmartcities.in



#55,HMR Layout ,Bengaluru ,India



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