

SEMINAR ON BUILDINGS ENERGY SIMULATION

Sofia, 13 November 2018

Why do we need buildings energy simulation?

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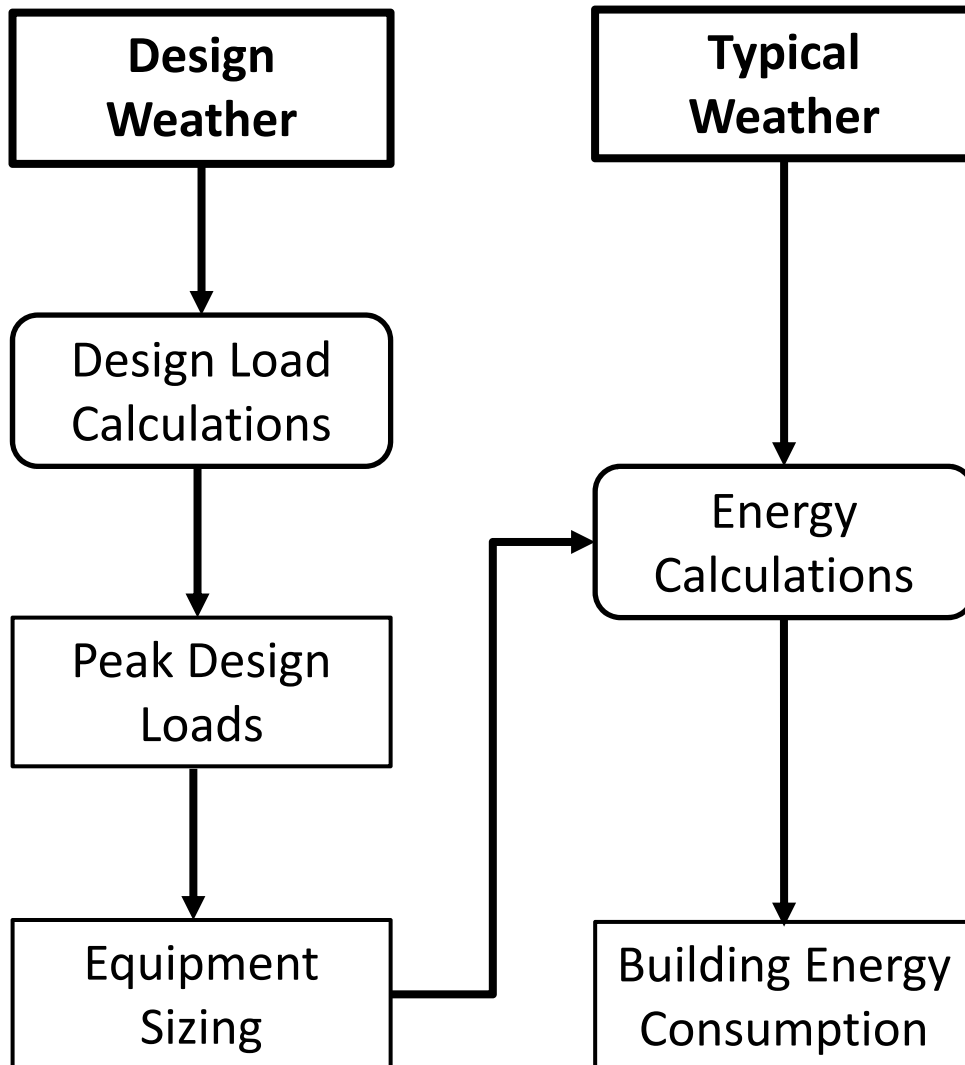
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Energy Calculations



Work flow for building energy analysis

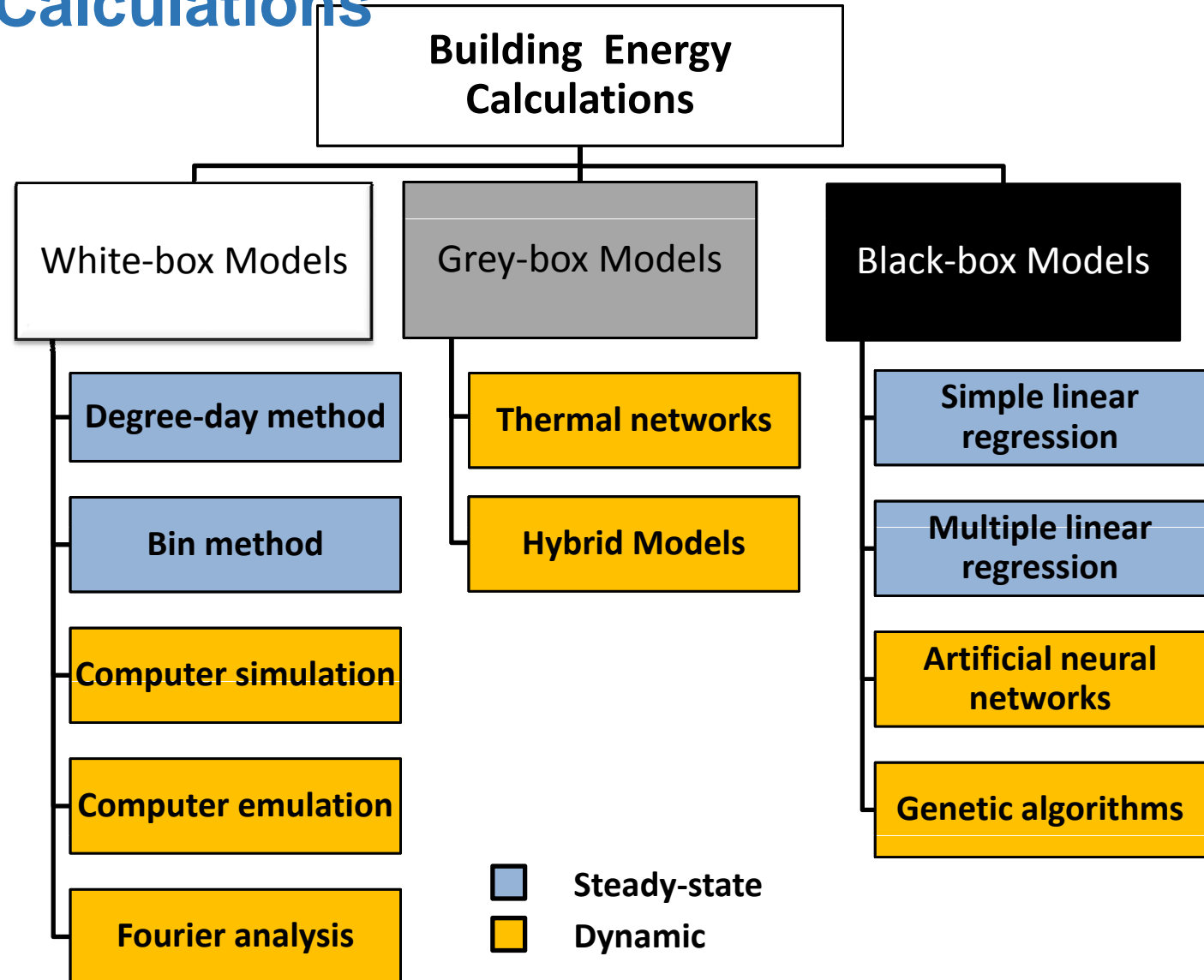
- ✓ Load Calculations
 - Generally used for determining sizing of equipment such as pumps, fans, chillers, boilers, radiators, fan coils, etc.
- ✓ Energy Analysis
 - Helps evaluate the energy cost of the building over longer periods of time (energy consumed by the equipment)

Energy Calculations

Two main categories:

- ✓ Steady-state methods
 - Degree-day method
 - Variable base degree-day method
 - Bin and modified bin methods
- ✓ Dynamic methods
 - Using computer-based building energy simulation
 - Try to capture dynamic response of the building
 - Can be developed based on transfer function, heat balance or other methods

Energy Calculations



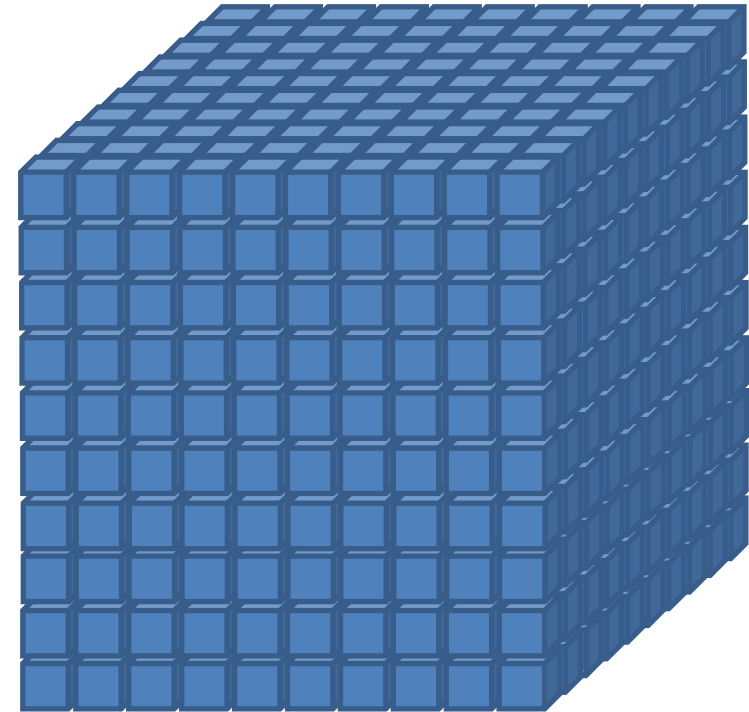
Energy Calculations

Fundamental difference between computer simulation and other engineering calculations is one of complexity



Steady – state methods

Up to 10 variables



Dynamic Methods

Easily more than 10,000 variables

Energy Calculations

Dynamic simulation methods:

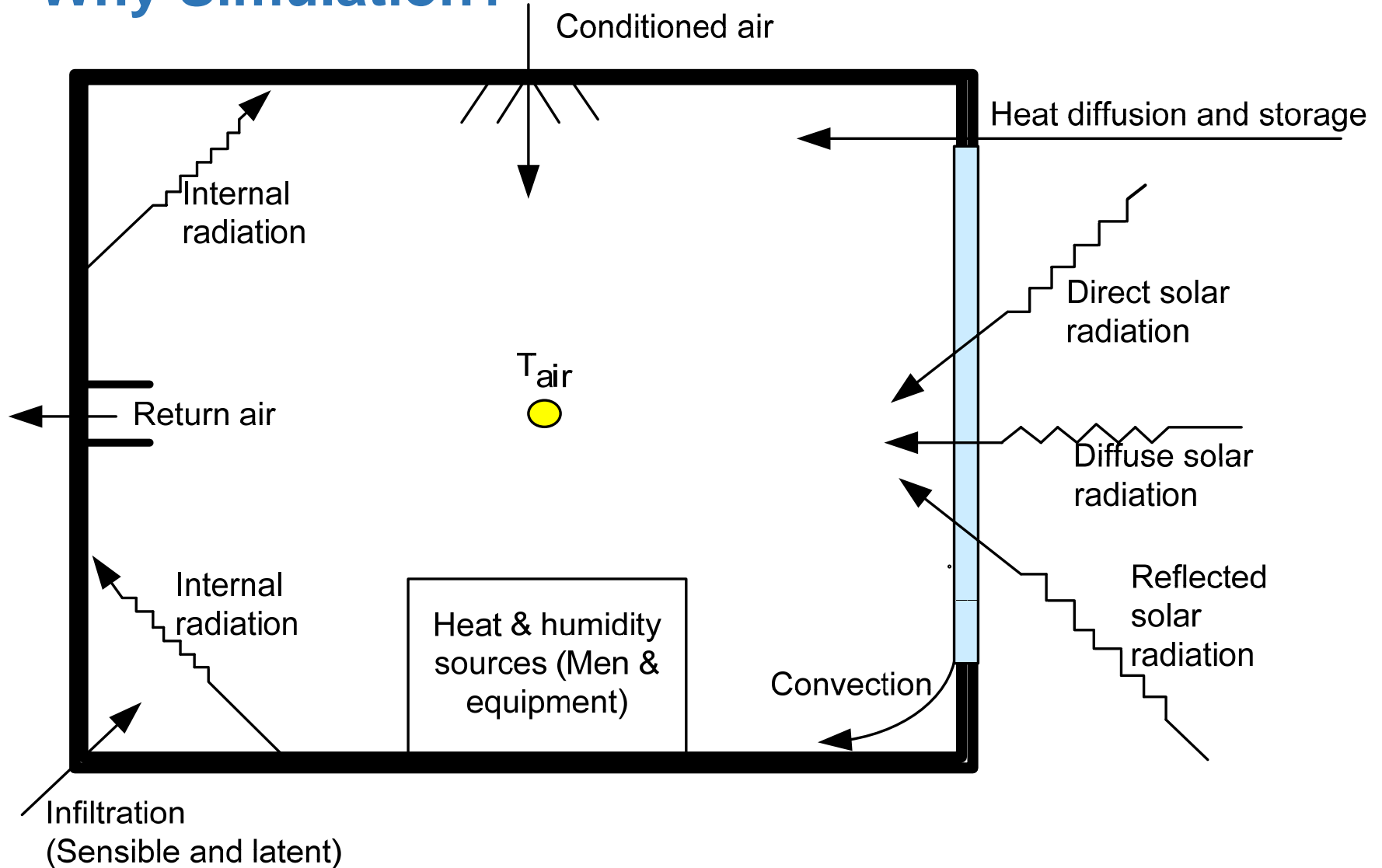
- ✓ Usually hour-by-hour, for 8,760 hours (24 x 365)
- ✓ Energy calculation sequence:
 - Space or building load
 - Secondary equipment load (e.g. airside system)
 - Primary equipment energy requirement (e.g. chiller)
 - Parasitic energy consumption (e.g. pumps)
- ✓ Computer software
 - Building energy simulation programs, e.g. EnergyPlus, TRNSYS, ESP-r, IES VE, DOE-2, TAS

Why Simulation?

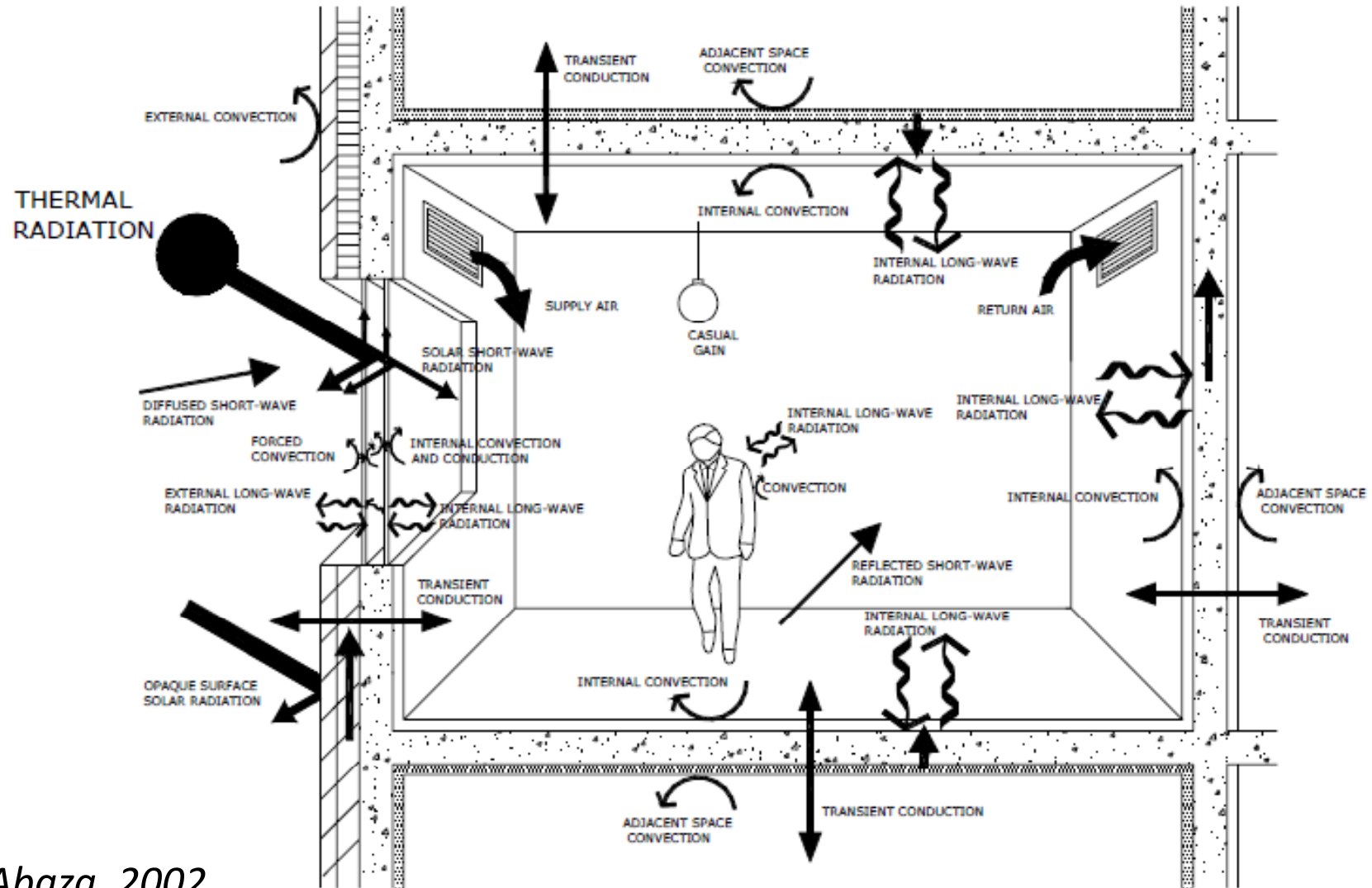
What building simulation offers:

- ✓ Peak heating and cooling loads calculation
- ✓ HVAC systems sizing
- ✓ Energy analysis
- ✓ Thermal comfort analysis
- ✓ Energy Management and Control of Systems
- ✓ Complying with buildings regulations and standards
- ✓ Cost analysis
- ✓ Daylighting calculations
- ✓ Environmental performance calculations

Why Simulation?

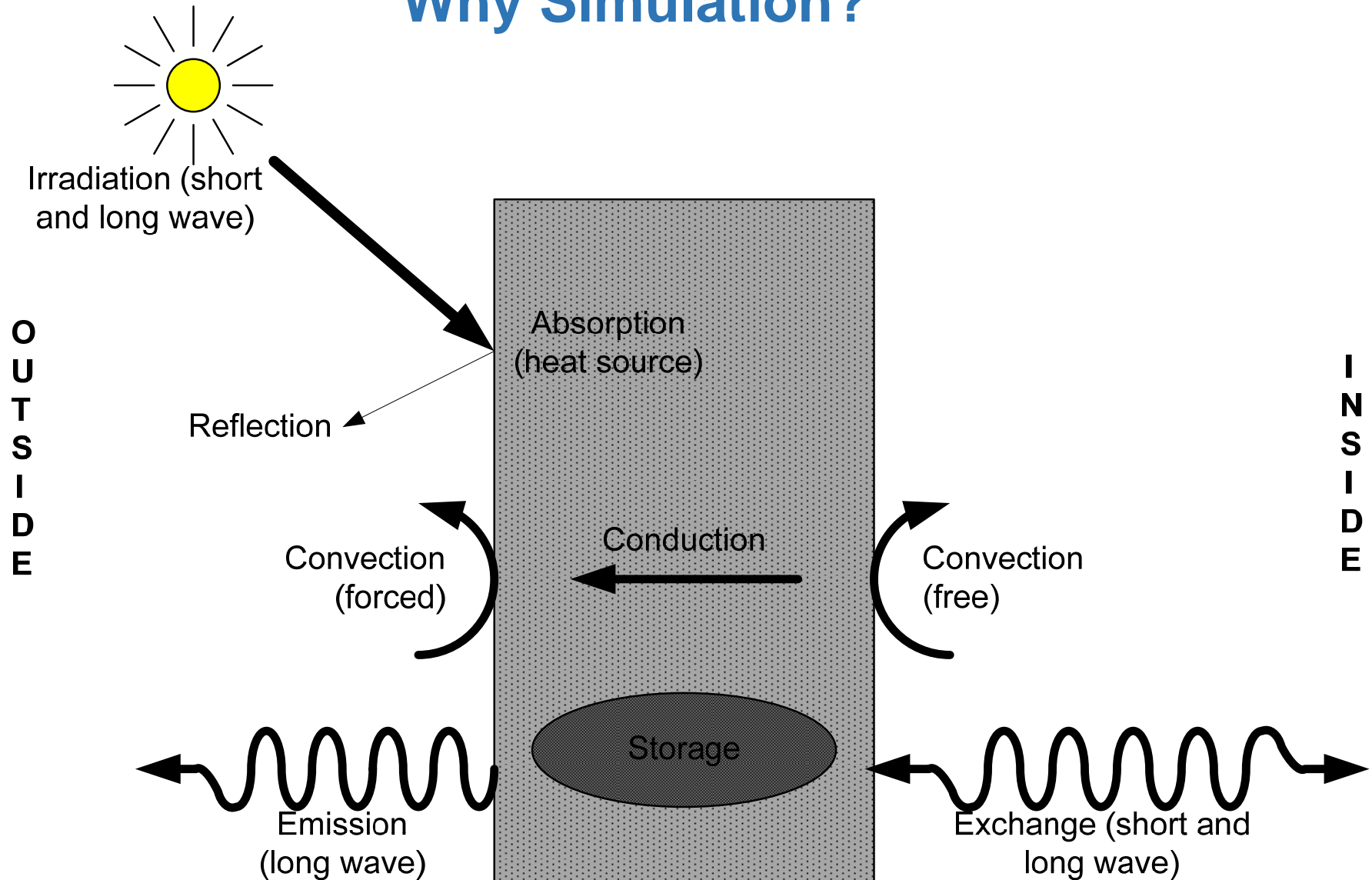


Why Simulation?

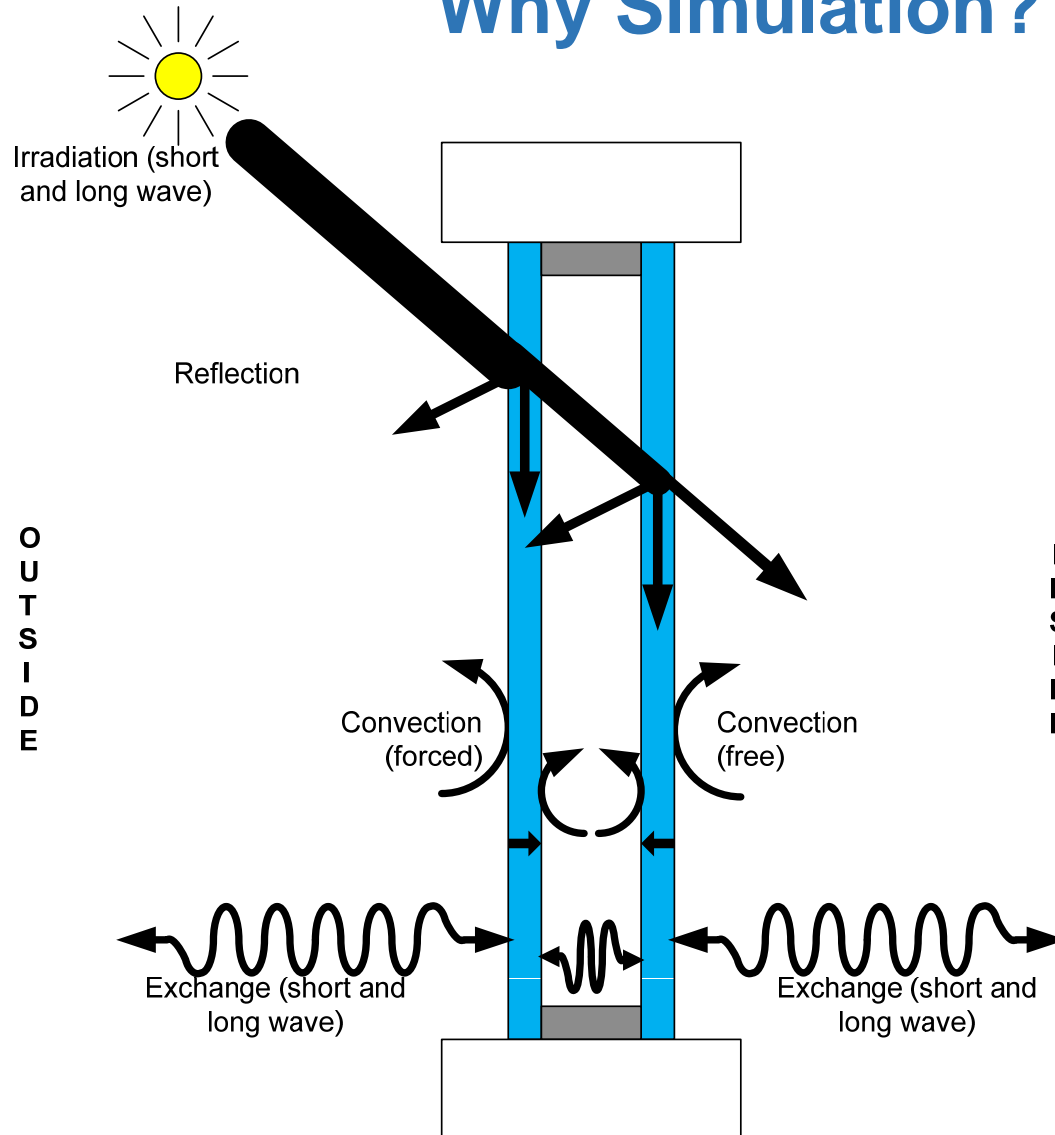


Source: Abaza, 2002

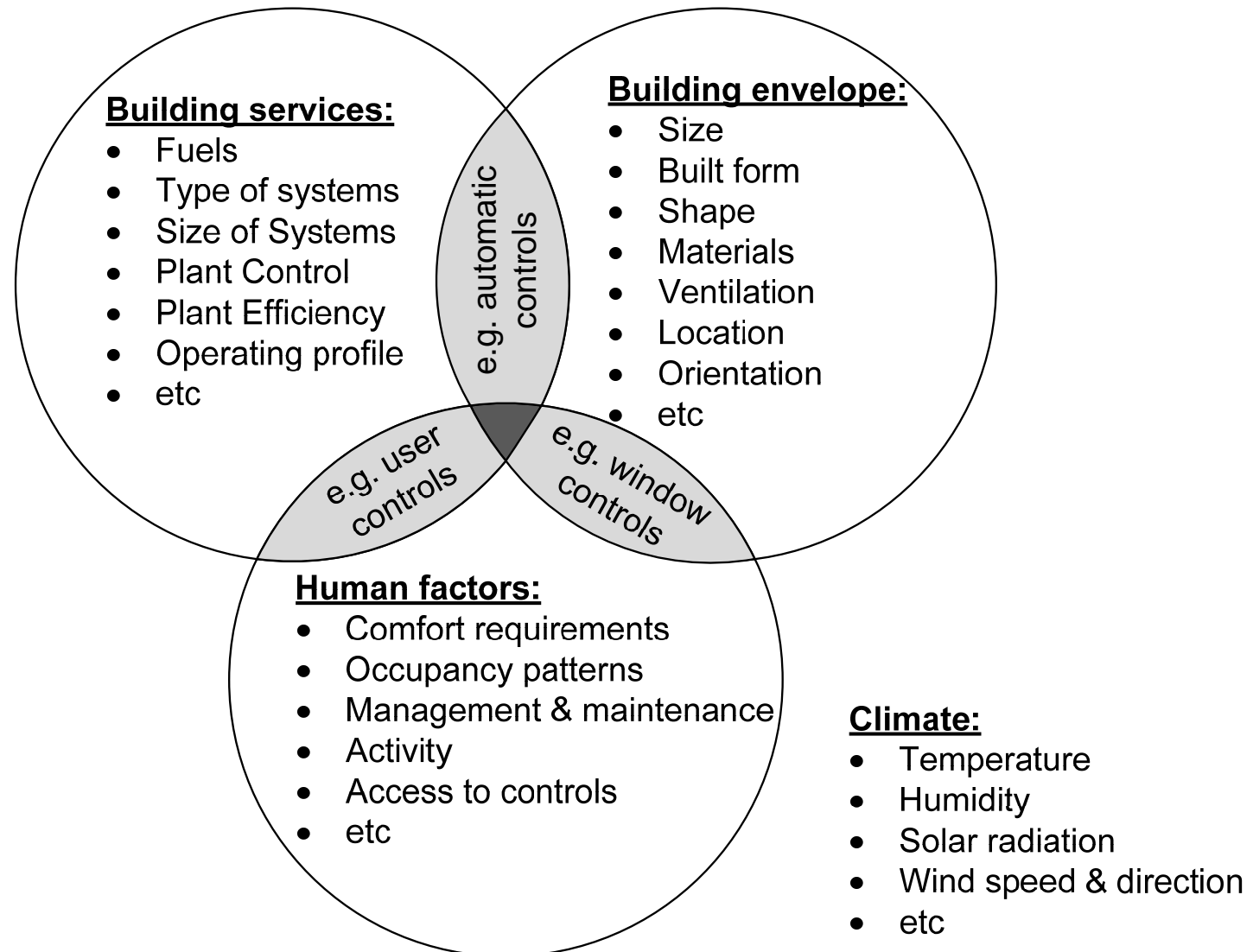
Why Simulation?



Why Simulation?



Why Simulation?



Why Simulation?

Categories of simulation:

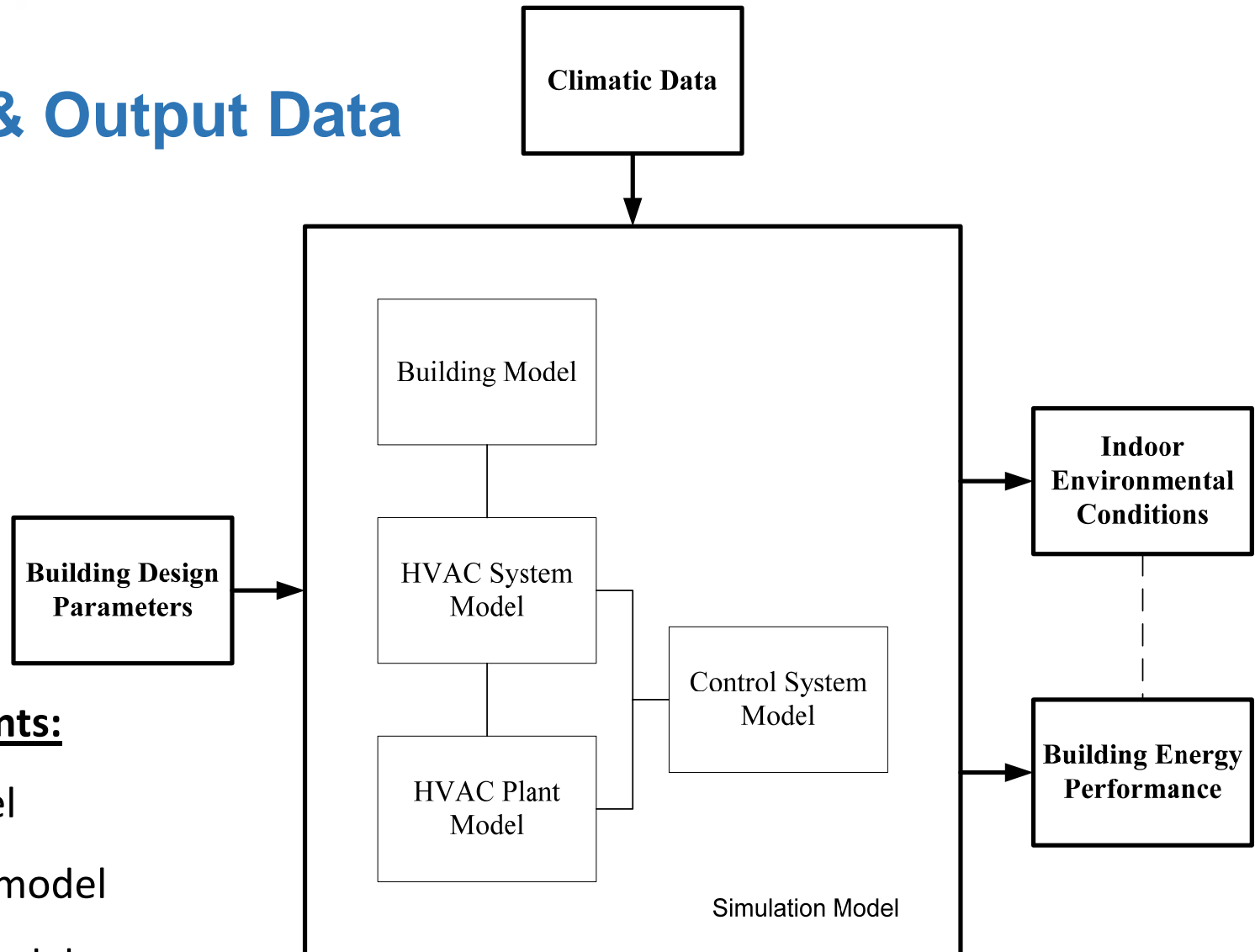
- ✓ **Simple analysis level:** Few inputs, limited information needed. At this level, often many assumptions are made that have little impact on results. Generally used to explore a design concept. A program may be capable of performing both simple and detailed level simulations, or limited to only simple simulations.
- ✓ **Detailed analysis level:** Many inputs, with detailed information needed. Generally used for evaluating the performance of a specific and well-defined design, and more towards the end of the design phase.
- ✓ **Special purpose:** single-purpose, such as documenting energy code compliance or HVAC load calculations.

Why Simulation?

How does Simulation save Energy:

- ✓ Building thermal simulation allows one to model a building before it is built or before renovations are started
- ✓ Simulation allows various energy alternatives to be investigated and options compared to one another
- ✓ Simulation can lead to an energy-optimized building or inform the design process
- ✓ Simulation is much less expensive and less time consuming than experimentation (every building is different)

Input & Output Data



Four major elements:

- ✓ Building model
- ✓ HVAC system model
- ✓ HVAC plant model
- ✓ Control system model

Input & Output Data

INPUTS:

- ✓ Weather data
- ✓ Building geometry
- ✓ Construction type
- ✓ Air exchange
- ✓ HVAC type / usage
- ✓ Occupancy info
 - Quantity of users
 - Lights
 - Equipment
 - Usage

OUTPUTS:

- ✓ Space temperatures
- ✓ Surface temperatures
- ✓ Humidity levels
- ✓ HVAC parameters
- ✓ Energy consumption
 - Component
 - System
 - Whole-building

Thank you

Questions?

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