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A Framework to Describe Energy-Related Occupant Behavior in Buildings

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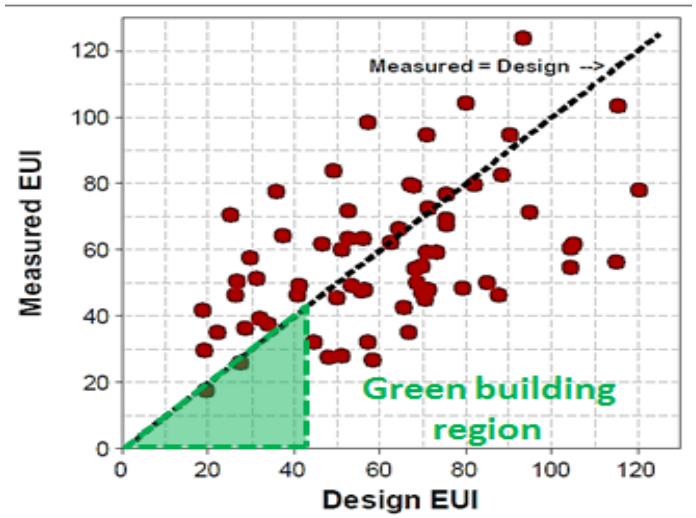
Simulation Research Group

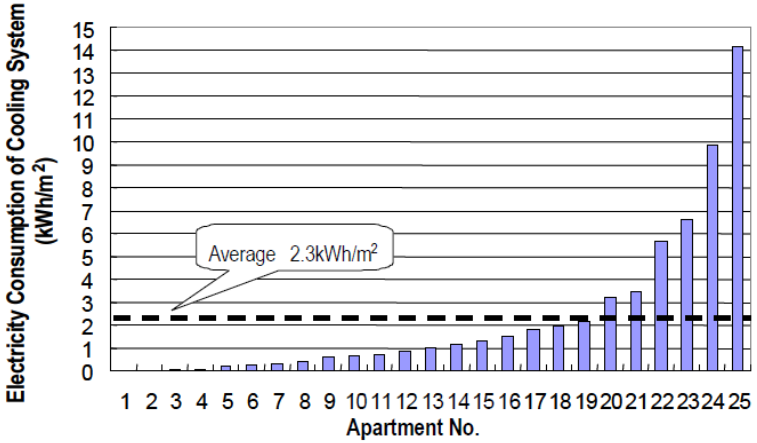
Outline

- Research Background
- A Framework to Describe Occupant Behavior
- Relate to the Big Picture
  - U.S.-China CERC-BEE
  - IEA EBC Annex 66

Research Background



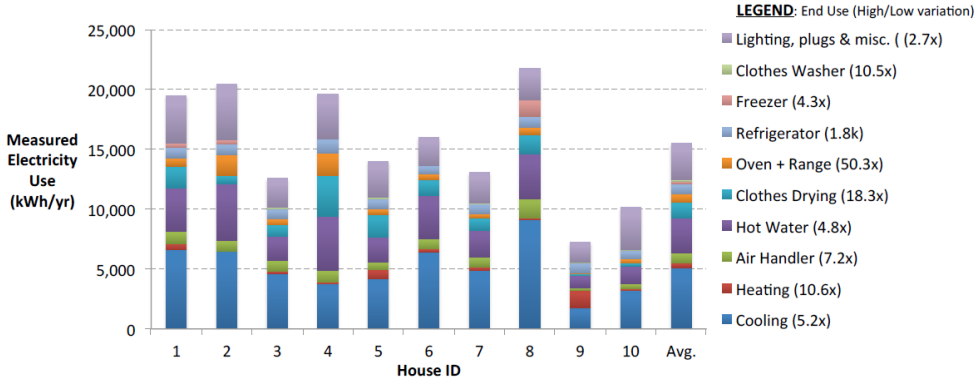
Courtesy: 2008 NBI Study



Annual household electricity usage of split type air-conditioners in 2006, Beijing, China. Source: Tsinghua University

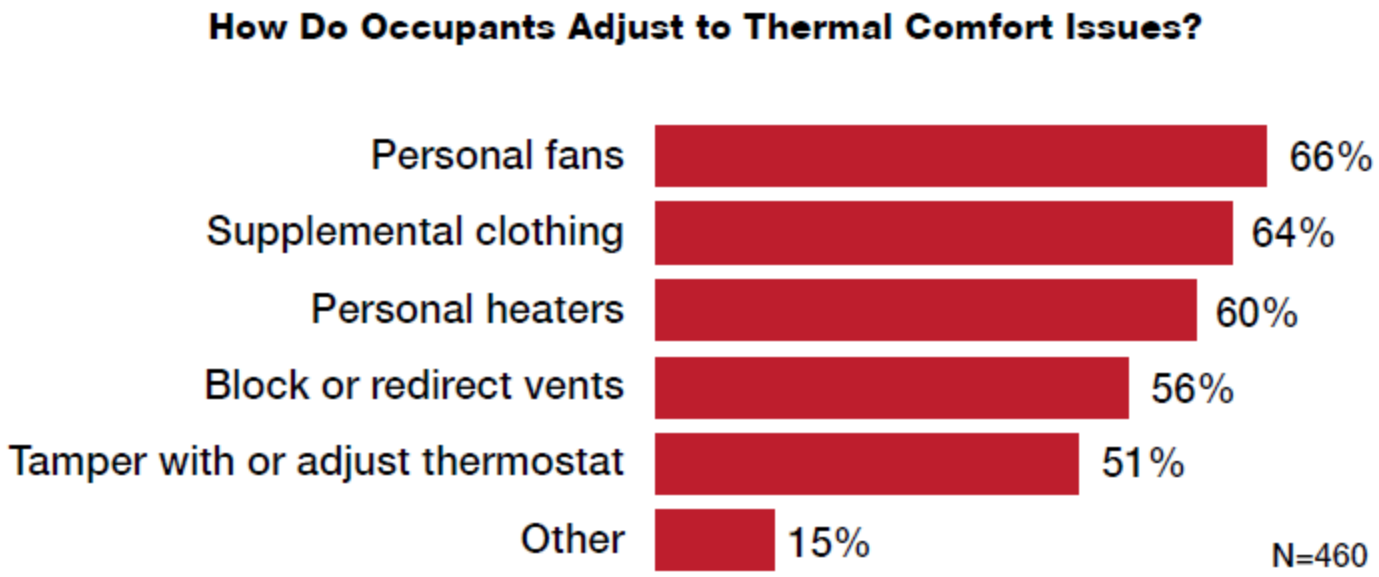
Homestead Cohort:
Virtually identical Homes & Efficiencies…
… but 3x Variation in Energy Use

- Even greater differences at end-use level
- End-use data extremely valuable for forensic accuracy assessment



Courtesy: Danny Parker, FSEC

Occupants Responses to Discomfort



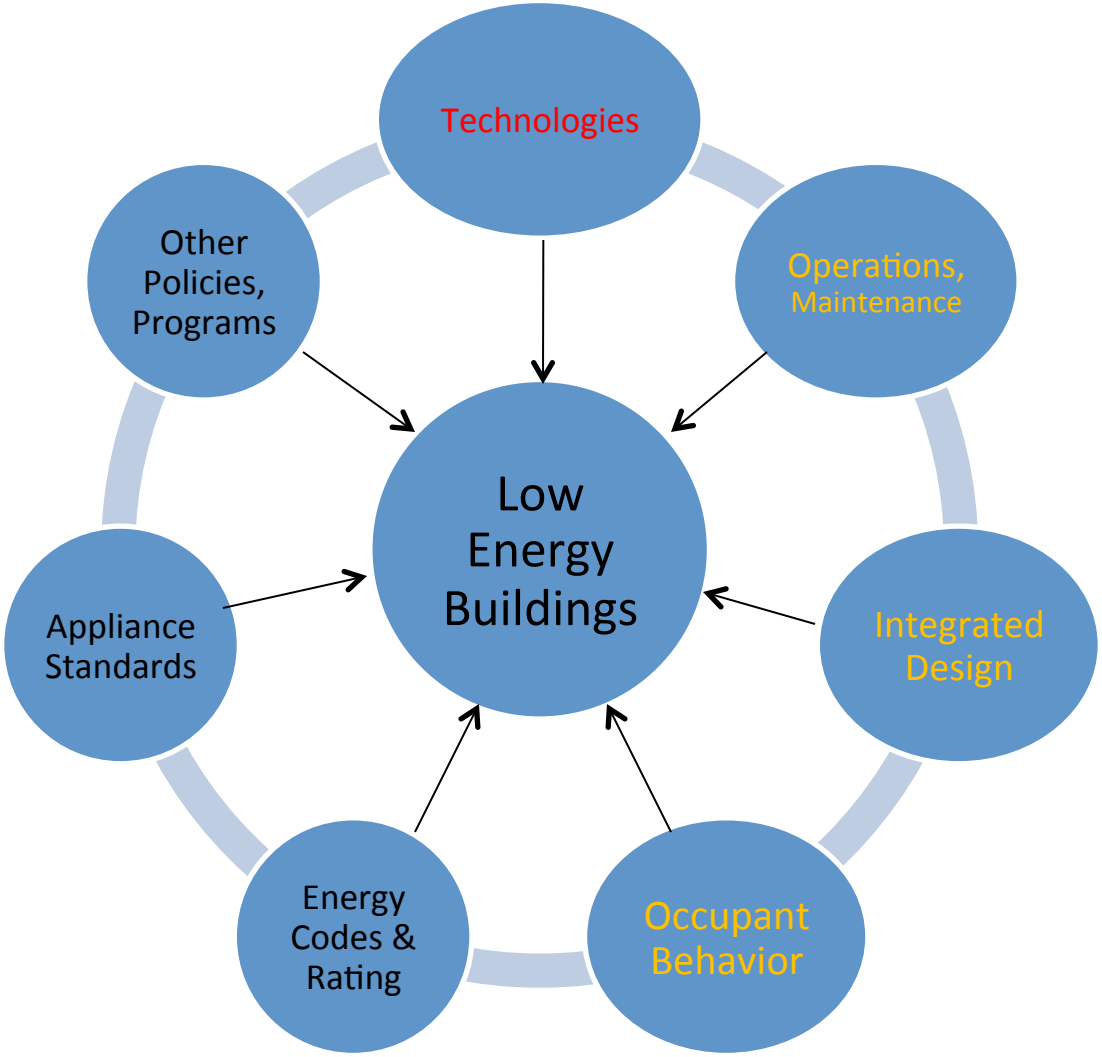
Other responses include: complain, contact facilities department, keep blankets and sweaters within reach, and open windows.

IFMA 2009 HVAC Survey of IFMA members in US and Canada
with 452 responses from 3357 samples

Various Ways of Operating the Air-Conditioners

- ☑ always turn on
- ☑ turn on when entering
- ☑ turn on when feeling hot
- ☑ turn on before sleep
- ☑ never turn on
- ☑ randomly turn on

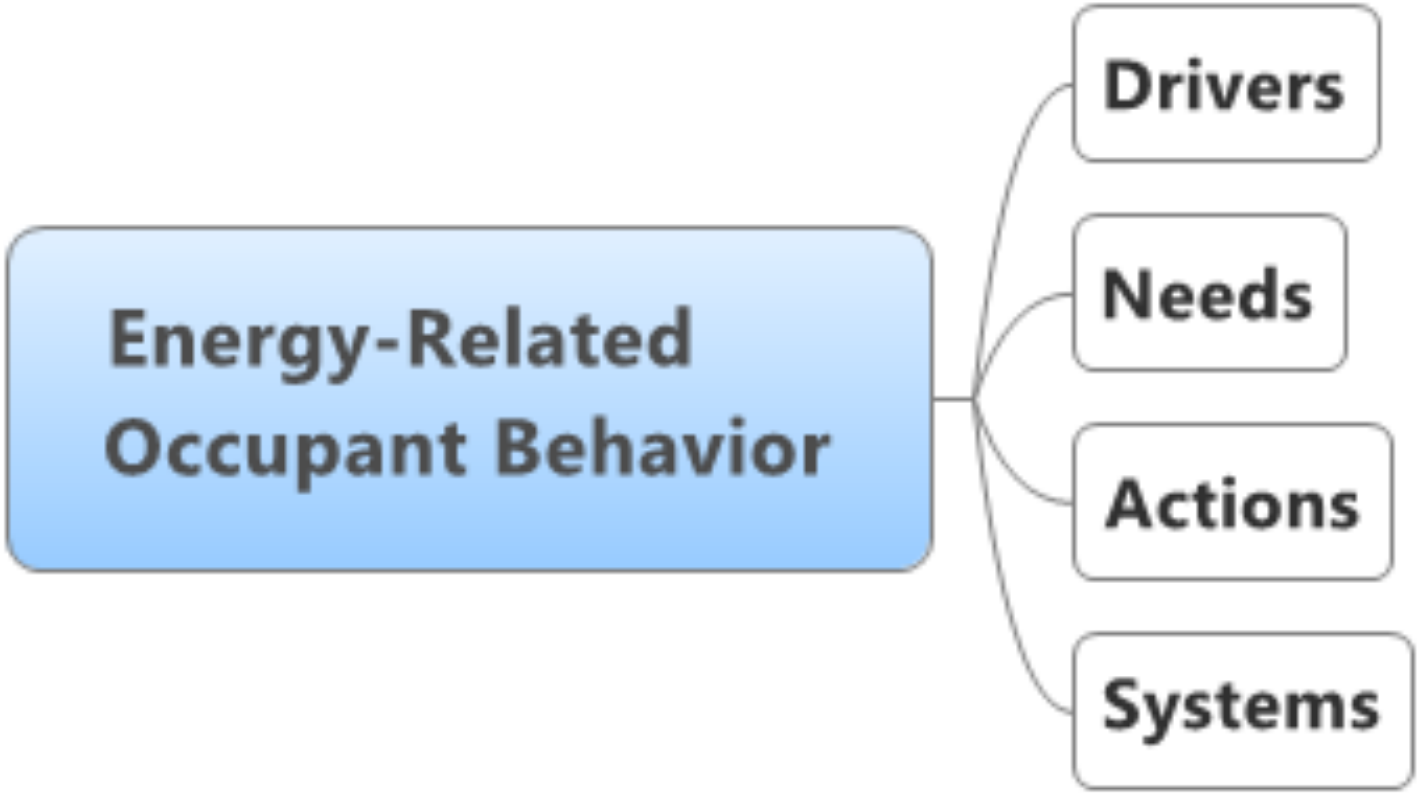
Occupant Behavior is one of the Key Elements to Achieving Low Energy Buildings



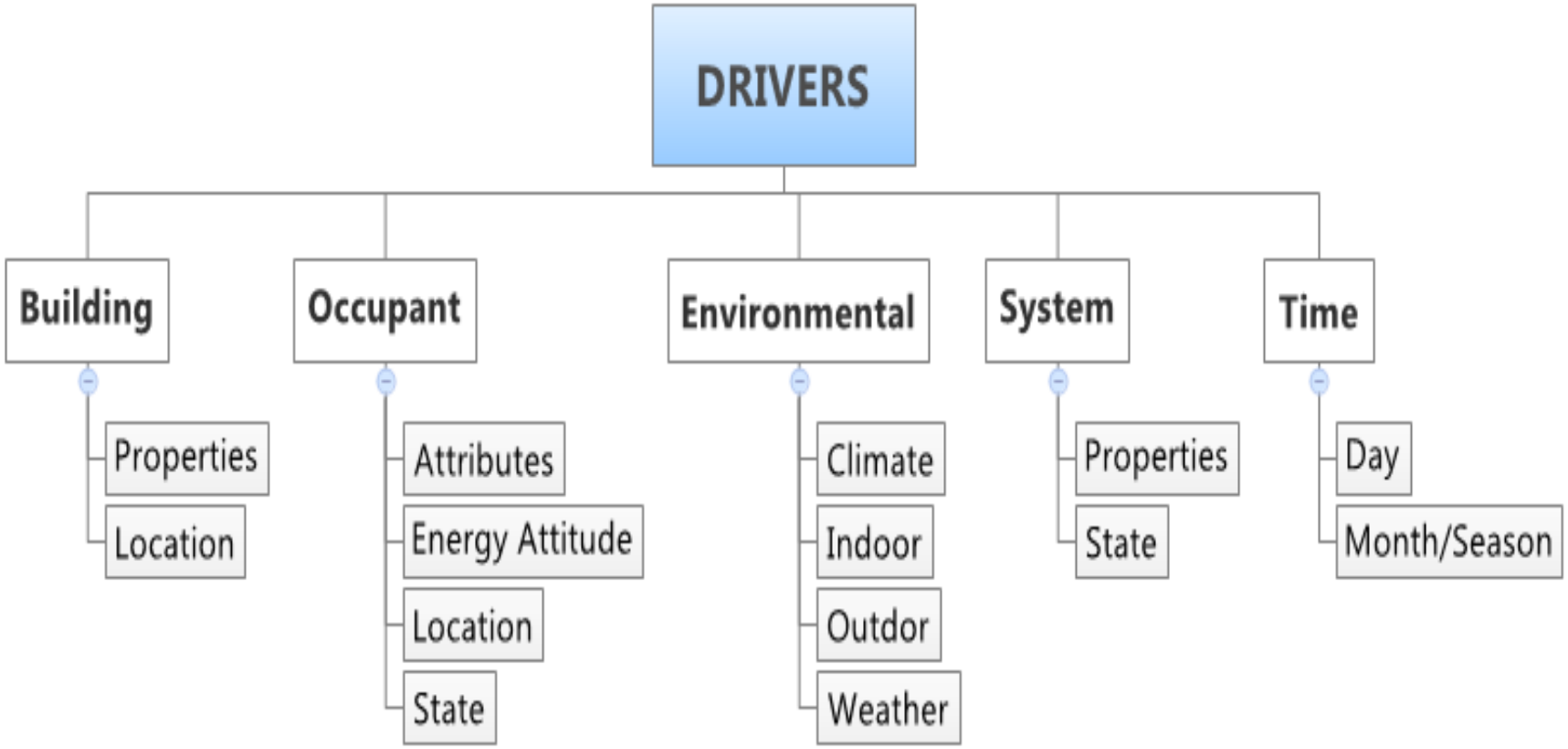
Significance of Research

- Technologies alone not necessarily guarantee low energy use in buildings
- Human behavior plays an essential role in building design, operation and maintenance, but it is not well understood and usually over-simplified or ignored!
- Behavior changes, usually no or low cost, has demonstrated 5 to 30% energy savings in buildings, but potential savings can be much more!

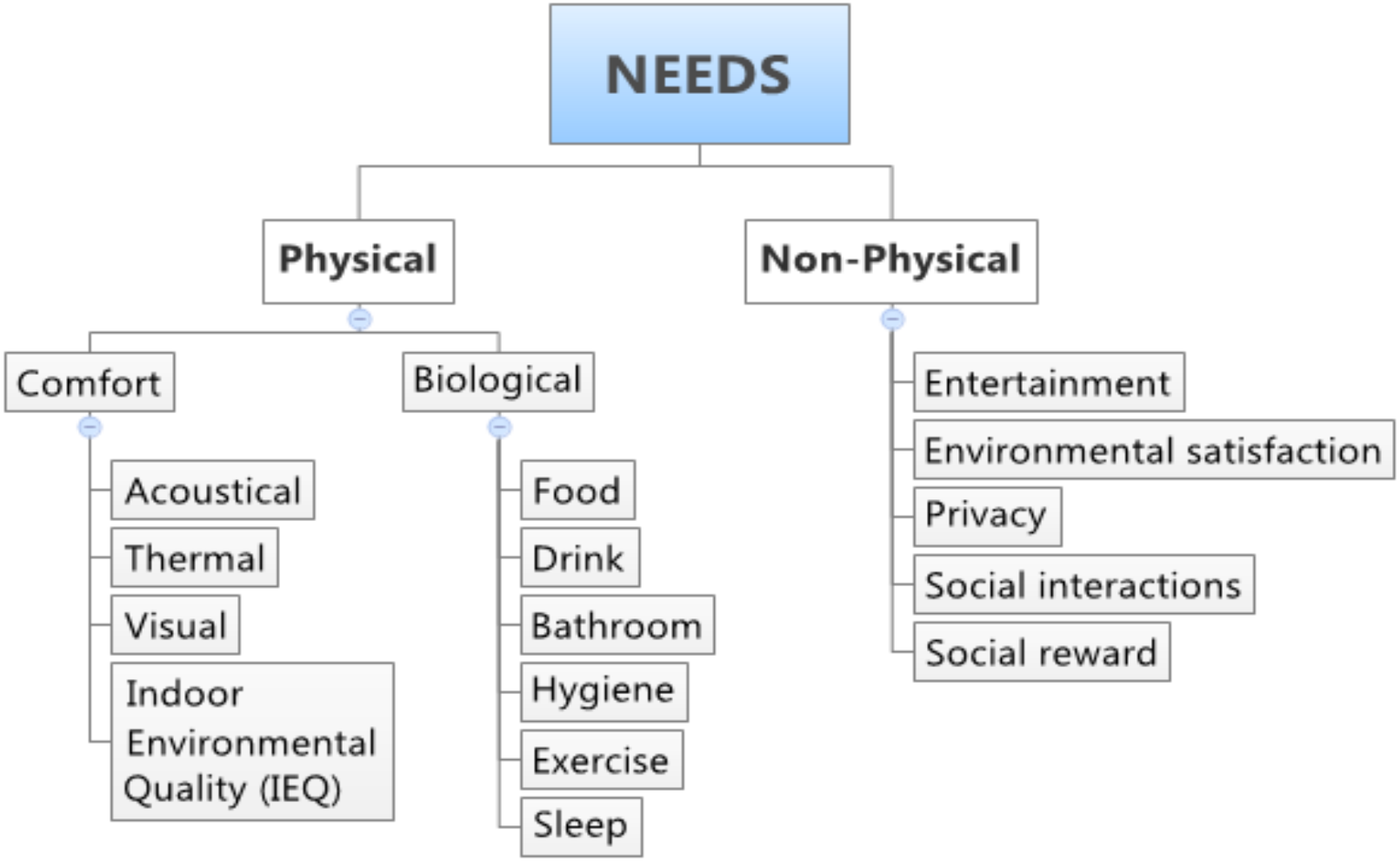
A Framework to Describe Occupant Behavior - the concept…



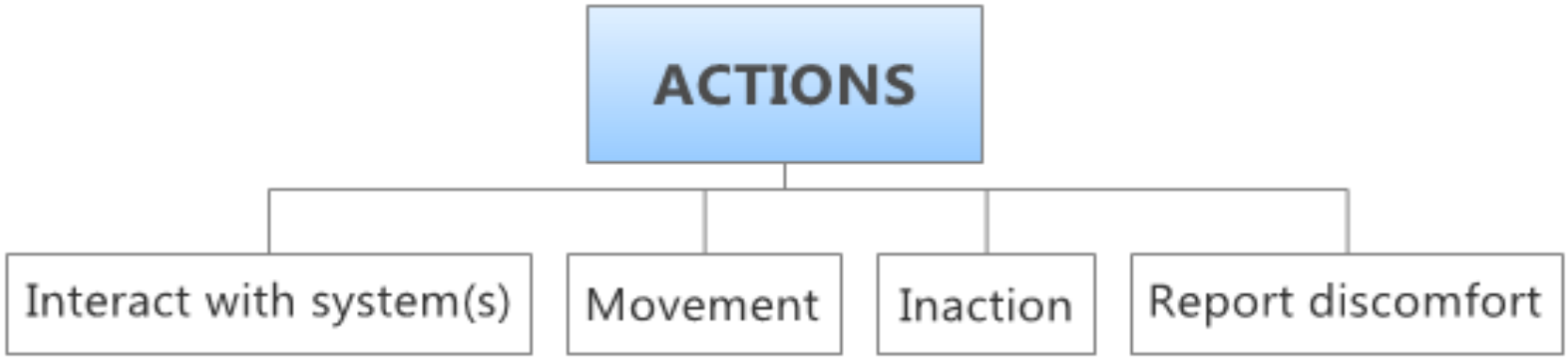
Drivers represent the stimulating factors that provoke energy-related occupant behavior



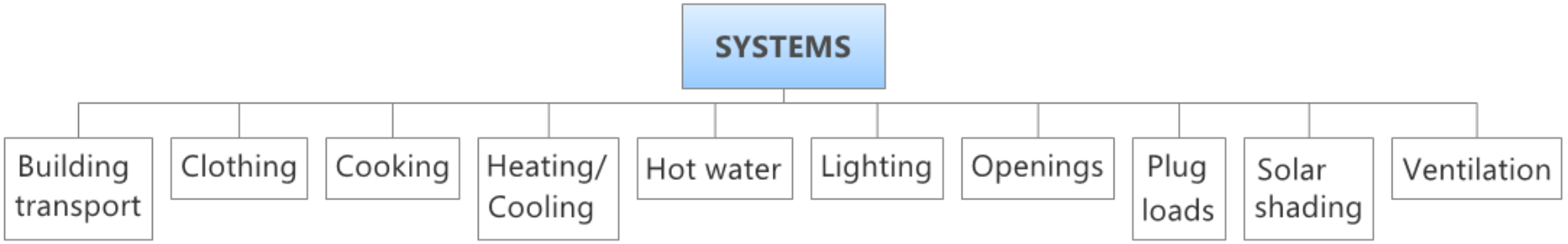
Needs represent the requirements of an occupant that must be met in order to ensure satisfaction with the environment



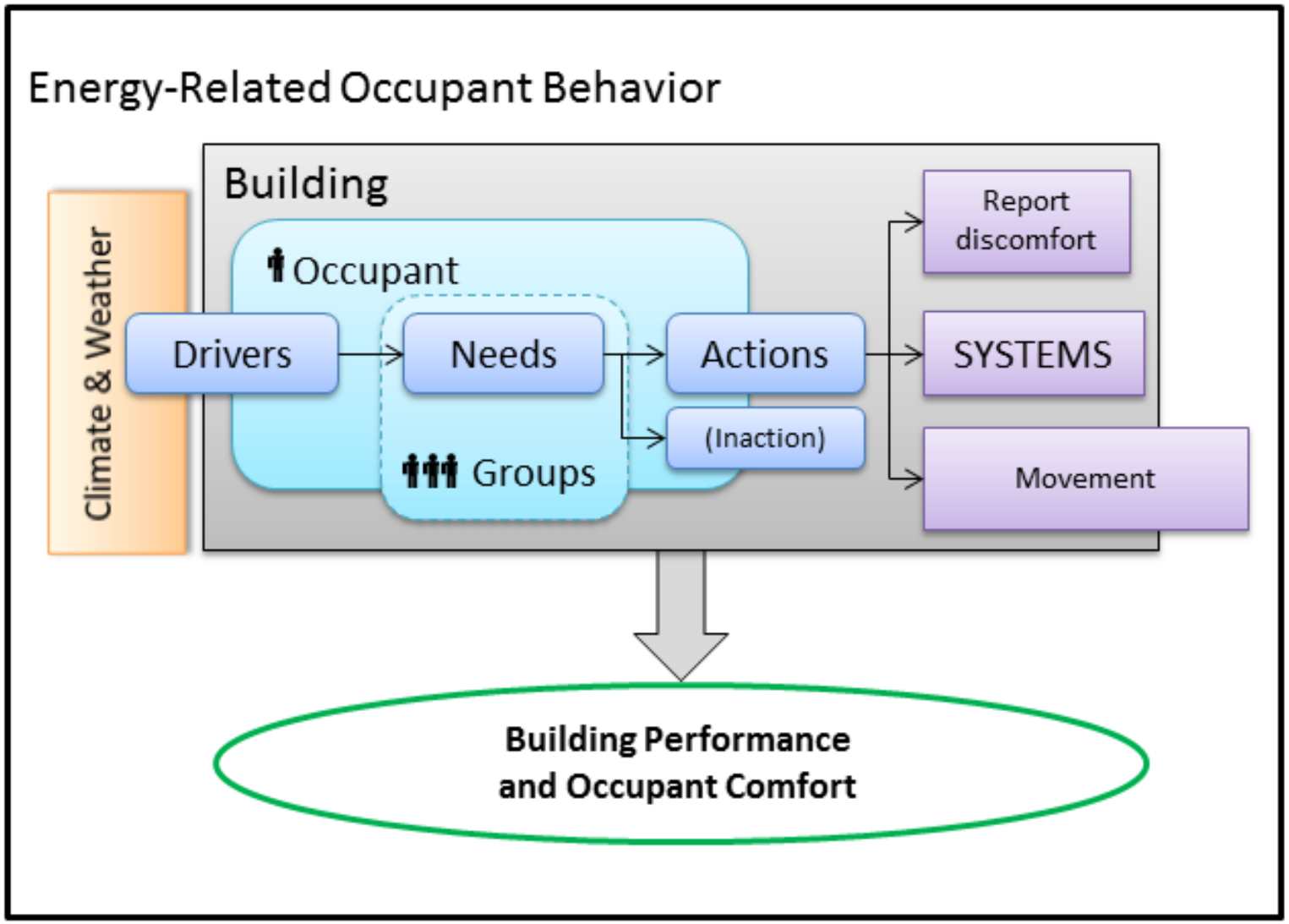
Actions are interactions with building systems or activities that an occupant can conduct in order to satisfy their needs



Systems are the equipment or mechanisms with which an occupant may interact to restore comfort



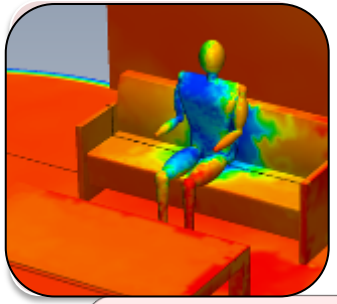
The DNAS Framework



Example 1 – Window opening

Driver:

Indoor air temp



Need:

Thermal comfort

Action:

Open

System:
Window

Example 2 – Light operation

Driver:

Work plane illuminance

Need:

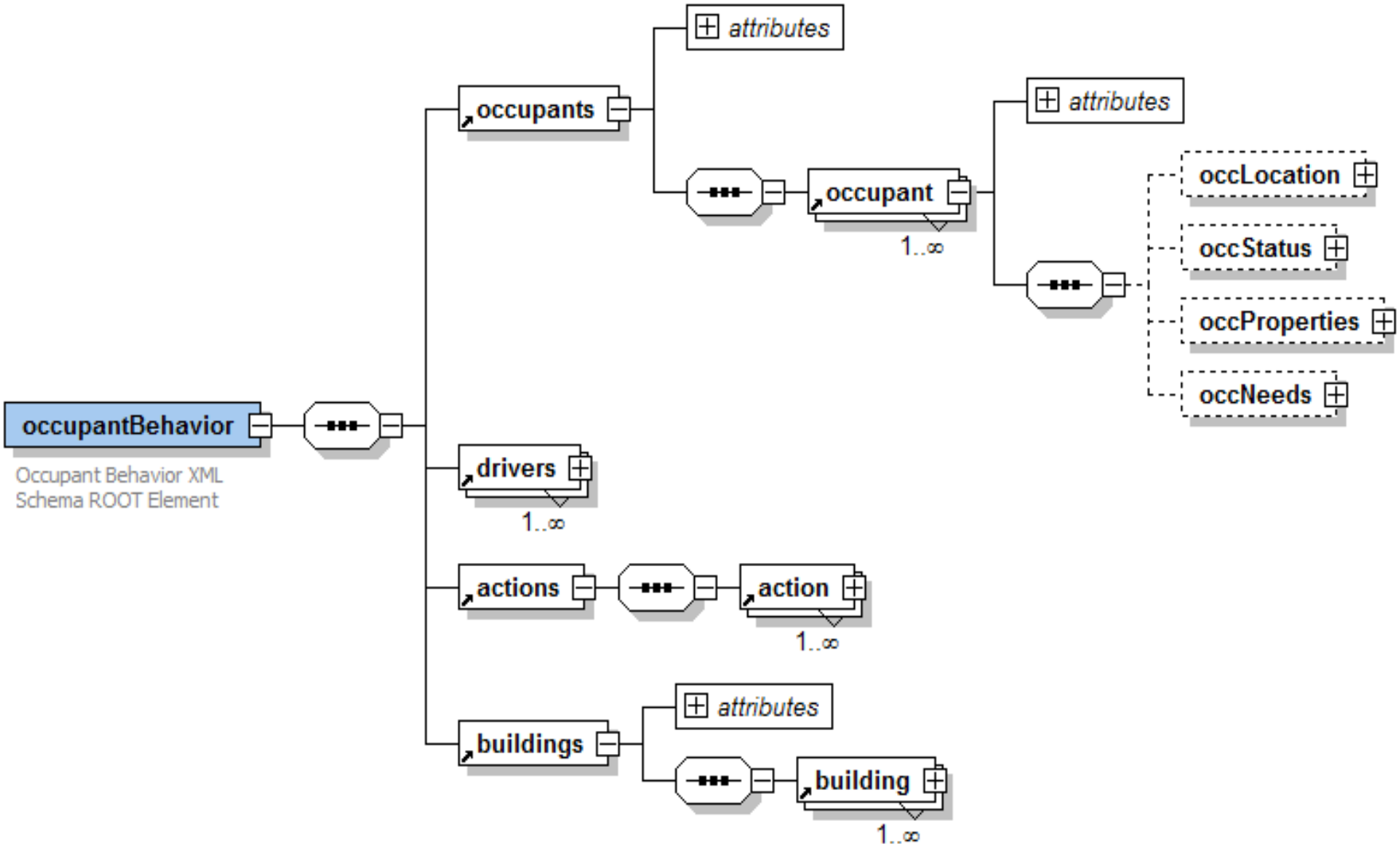
Visual comfort

Action:

Switch on

System:
Lights

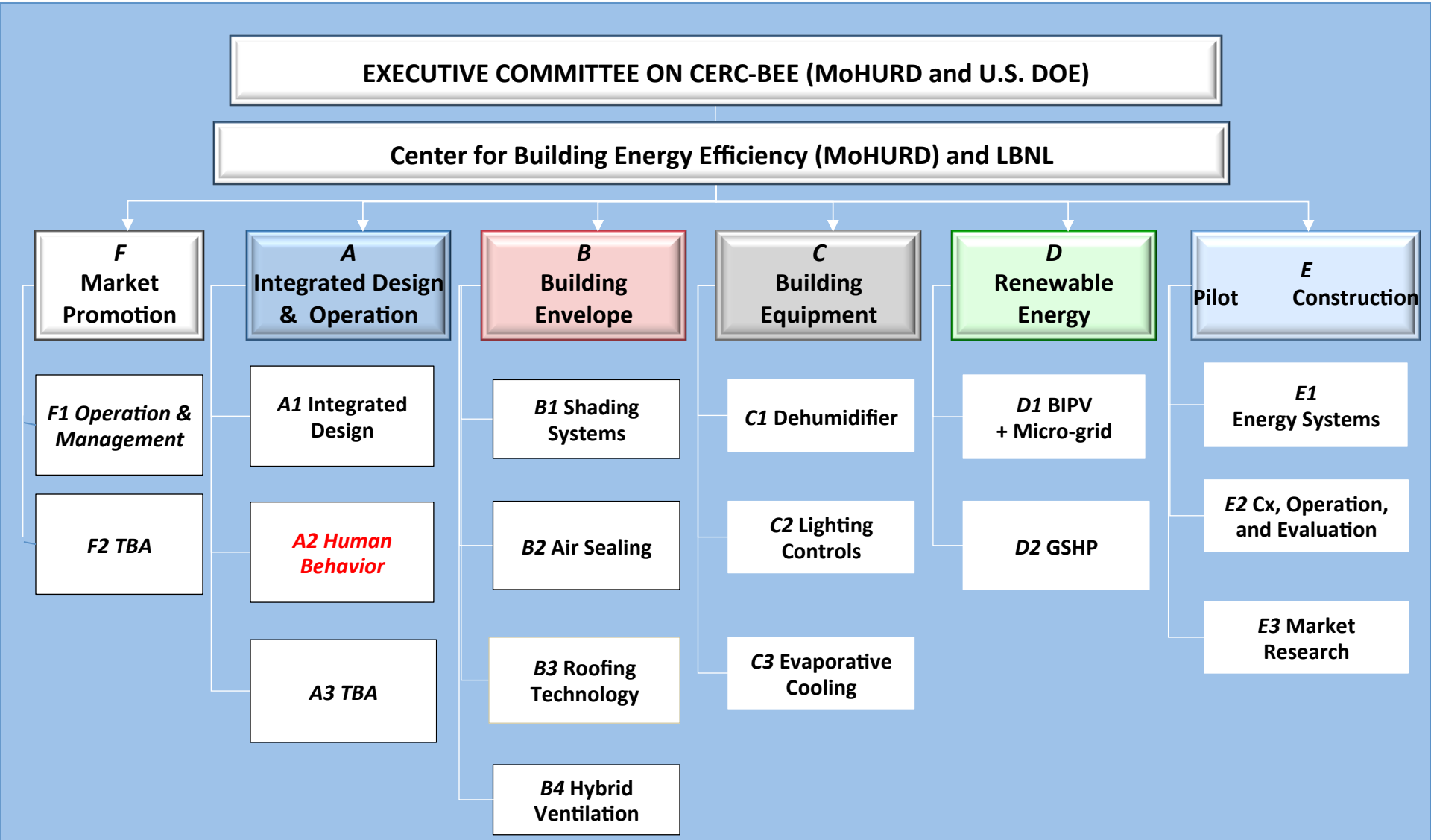
The XML Schema - *obXML*



Applications of the Framework

- Building energy modeling
  - Improve evaluation of building technologies and designs
  - Better predict actual energy use in buildings
- Energy policy
  - Energy benchmarking and performance rating
  - Codes and standards
  - Incentive programs
- Long term can be part of BIM

The U.S.-China Clean Energy Research Center for Building Energy Efficiency: Phase 2 Research Projects



EBC

Energy in Buildings and Communities Programme

New IEA EBC Annex 66:

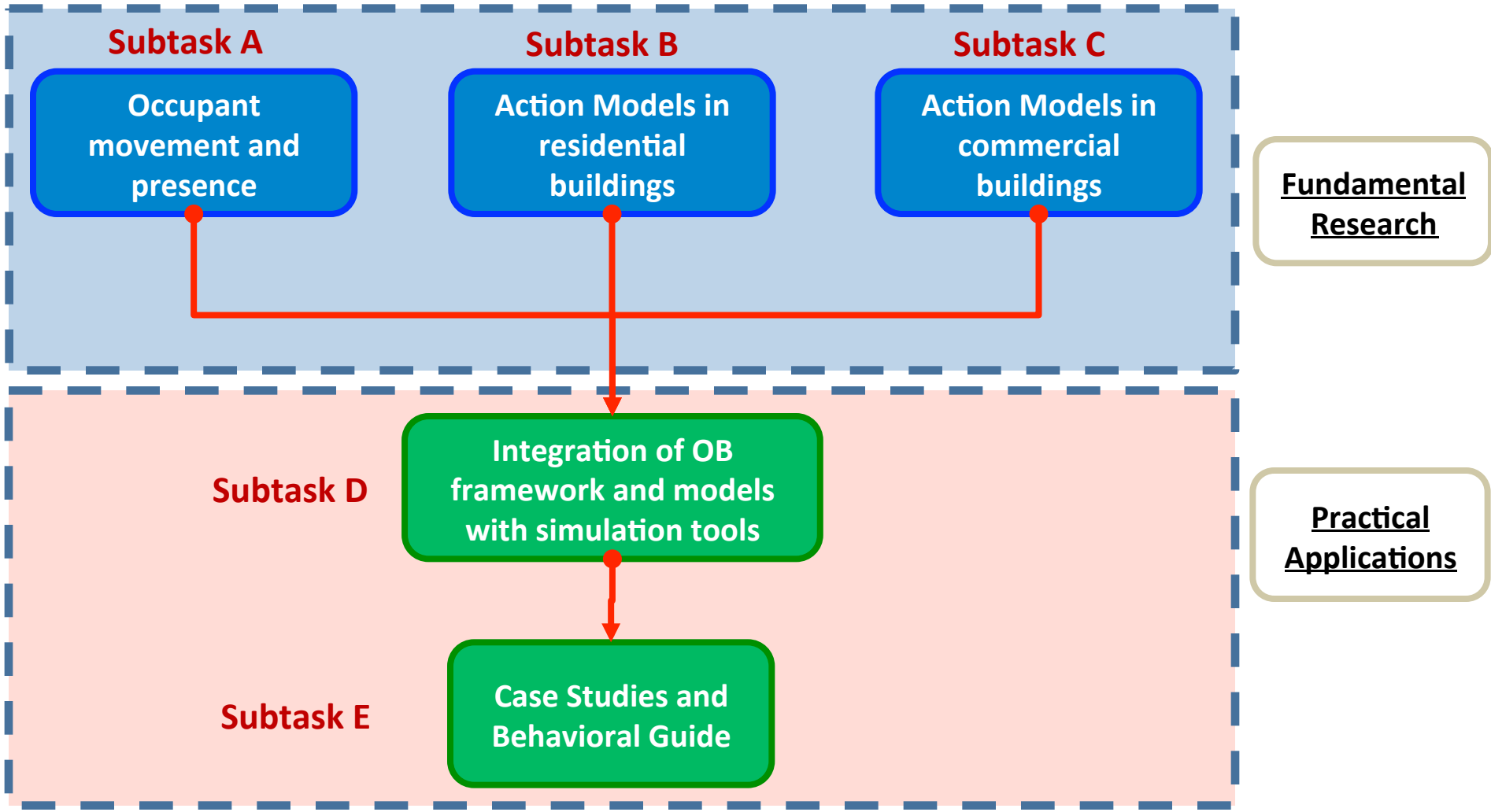
Definition and Simulation of Occupant Behavior in Buildings

Operating Agents:

Da Yan, Tsinghua University, China

Tianzhen Hong, LBNL, USA

Five Technical Subtasks



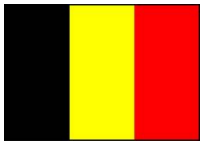
Outcomes & Audience

Subtask	Outcomes	Target Audience
A	Standard definition, description and classification of occupant behavior in buildings	**Building Energy Researchers** **Energy Modellers** **Simulation Software Developers**
B	Systematic measurement approach, simulation modelling and validation methodology	
C	Occupant Behavior Database with data of different temporal and spatial resolutions	
D	Software to simulate OB, integrated with a building thermal and energy model	**Building Designers** **Energy Saving Evaluators** **HVAC Engineers** **System Operators** **Energy Policy Makers**
E	Case studies and guidelines to demonstrate applications of the new OB definitions and models	

Participants from 24 Countries and Regions

Australia

Austria

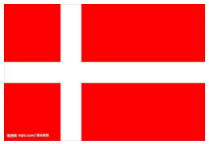


Belgium

Brazil

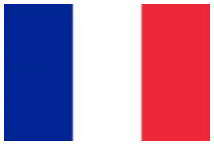
Canada

China



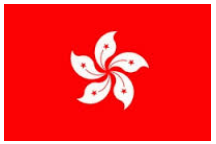
Denmark

Finland



France

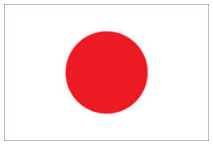
Germany



Hong Kong

Hungary

Italy



Japan

Korea

Netherland

Norway

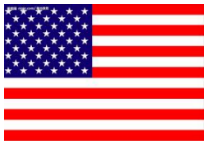
Poland

Spain

Sweden

Switzerland

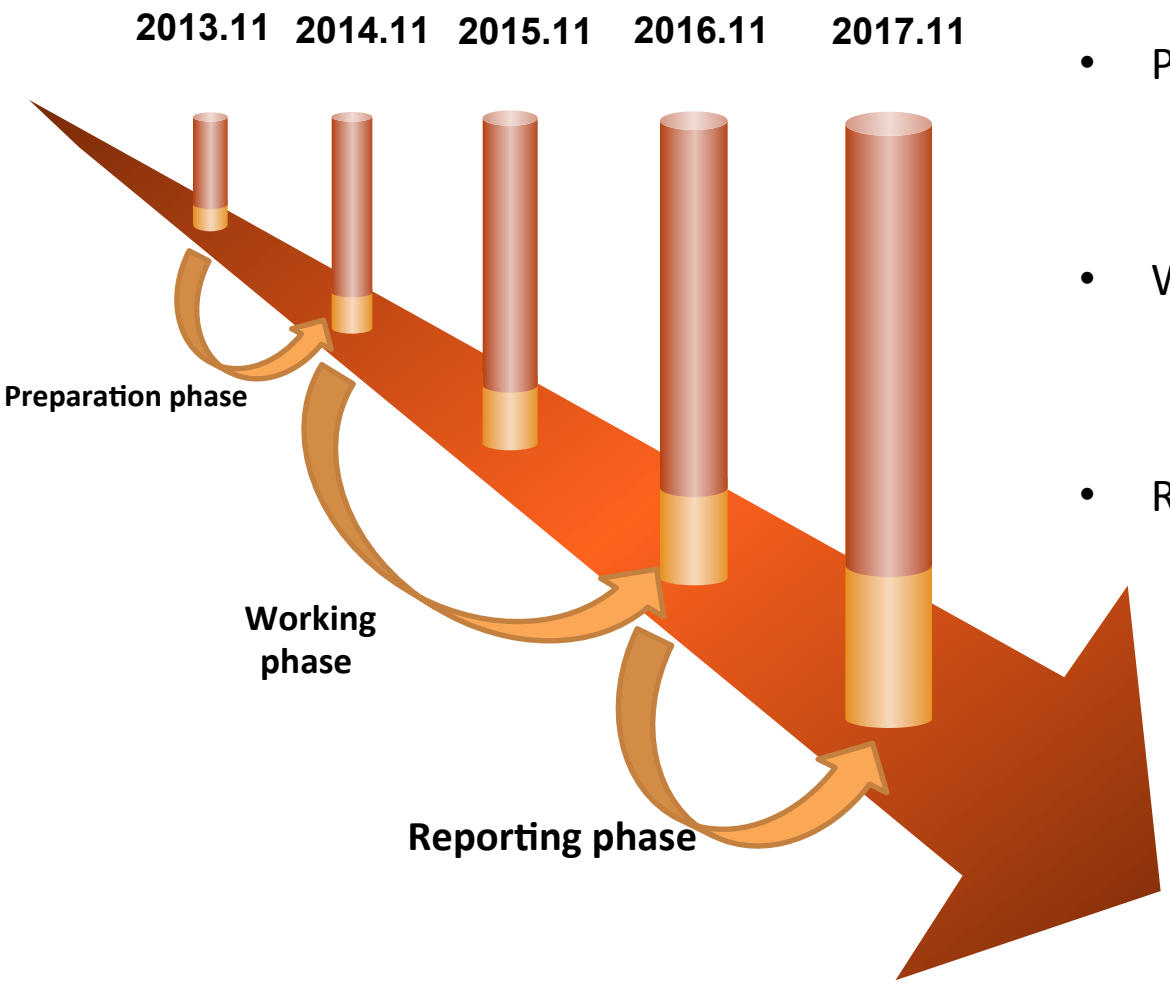
UK



USA

Singapore

Schedule



- Preparation phase
  - One year (2013.11 — 2014.11)
- Working phase
  - Two years (2014.11 — 2016.11)
- Reporting phase
  - One year (2016.11 — 2017.11)

Questions?

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