

An Overview of IEA EBC Annex 66

Definition and Simulation of Occupant Behavior in Buildings

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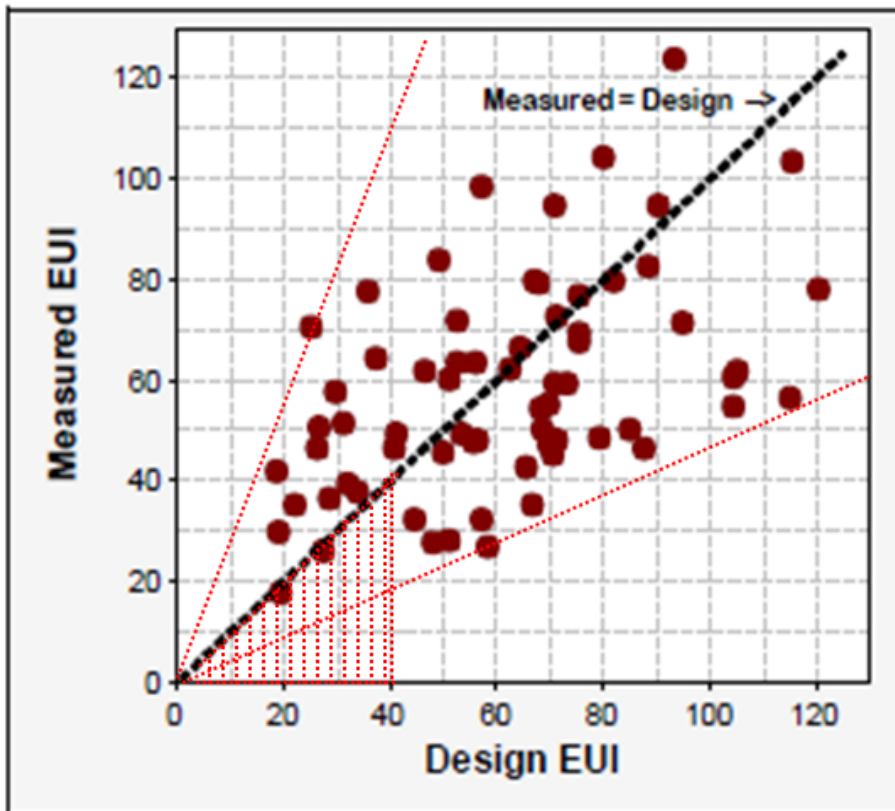
Annex 58 and 60 Seminar

Lawrence Berkeley National Laboratory

September 17, 2014

Background

Large gaps between measured and simulated energy use

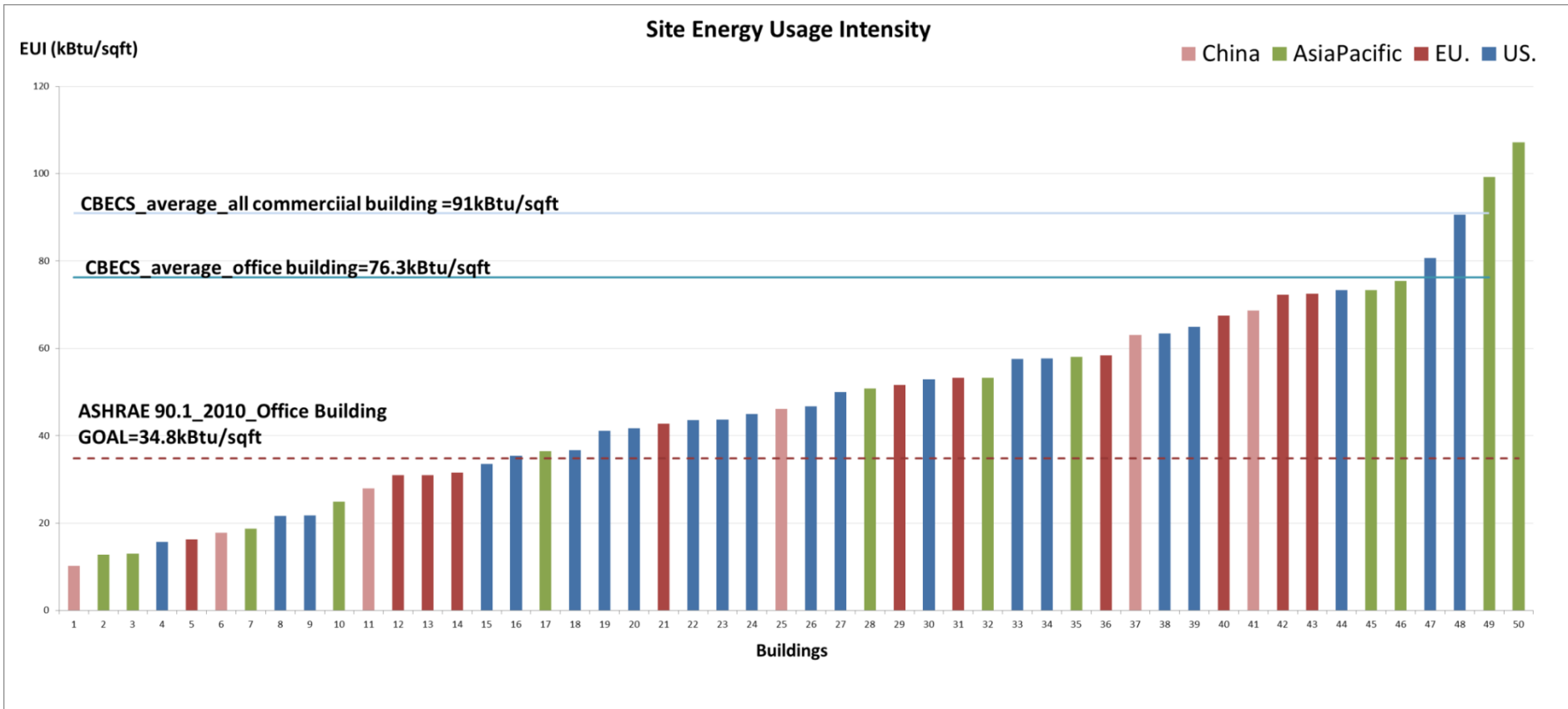


Source: NBI report 2008 *Energy Performance of LEED For New Construction Buildings*

Influencing factors in energy modeling:

- Occupancy
- Operation and maintenance
- Occupant behavior
- Controls
- Actual equipment performance
- Weather data
- Simplification and errors in models!

Energy Use of High Performance Buildings



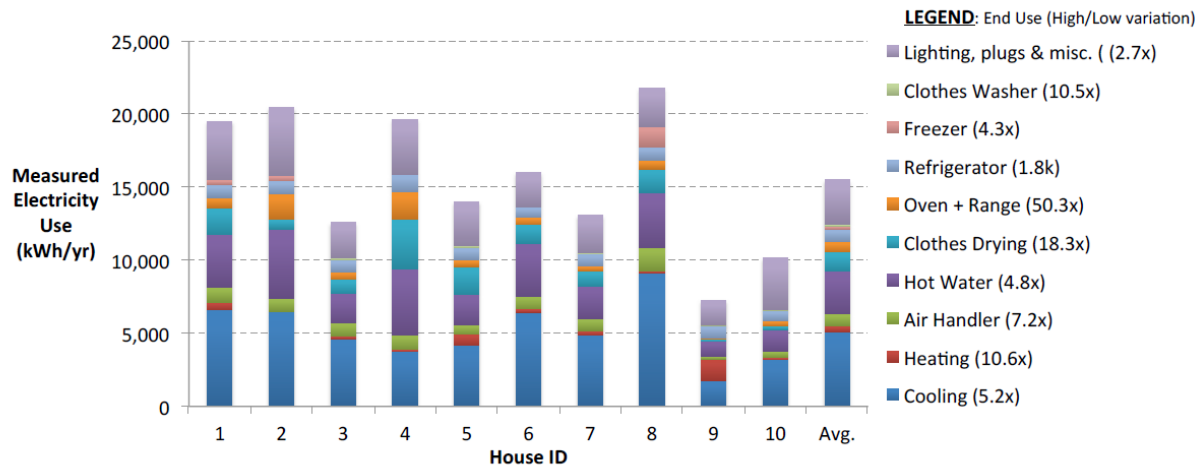
Samples Distribution

	Total number of buildings	Proportion of Buildings (EUI < 34.8 kBtu/sqft)	Proportion of Buildings (34.8 kBtu/sqft < EUI < 76.3 kBtu/sqft)	Proportion of Buildings (EUI > 76.3 kBtu/sqft)
US	21	23.8%	66.7%	9.5%
EU	11	36.4%	63.6%	0.0%
Asia	12	33.3%	50.0%	16.7%
China	7	50.0%	50.0%	0.0%

Background

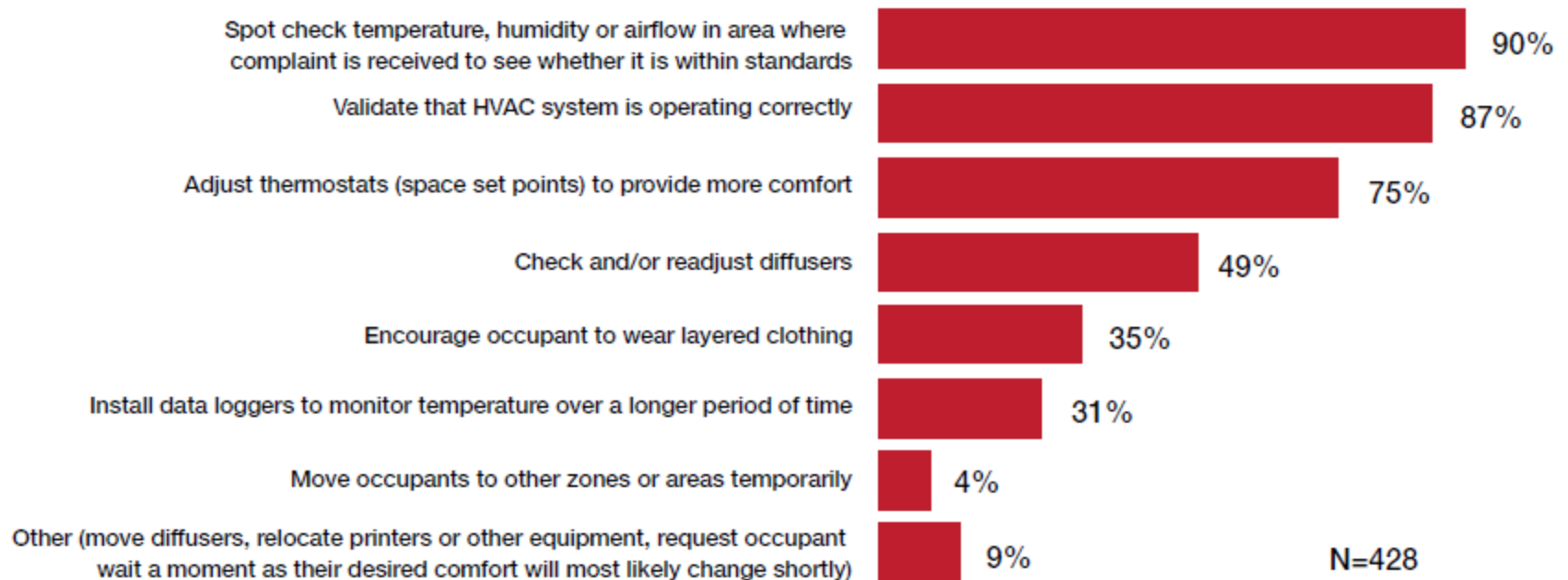
Homestead Cohort: Virtually identical Homes & Efficiencies... ... but 3x Variation in Energy Use

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



Courtesy: Danny Parker, FSEC

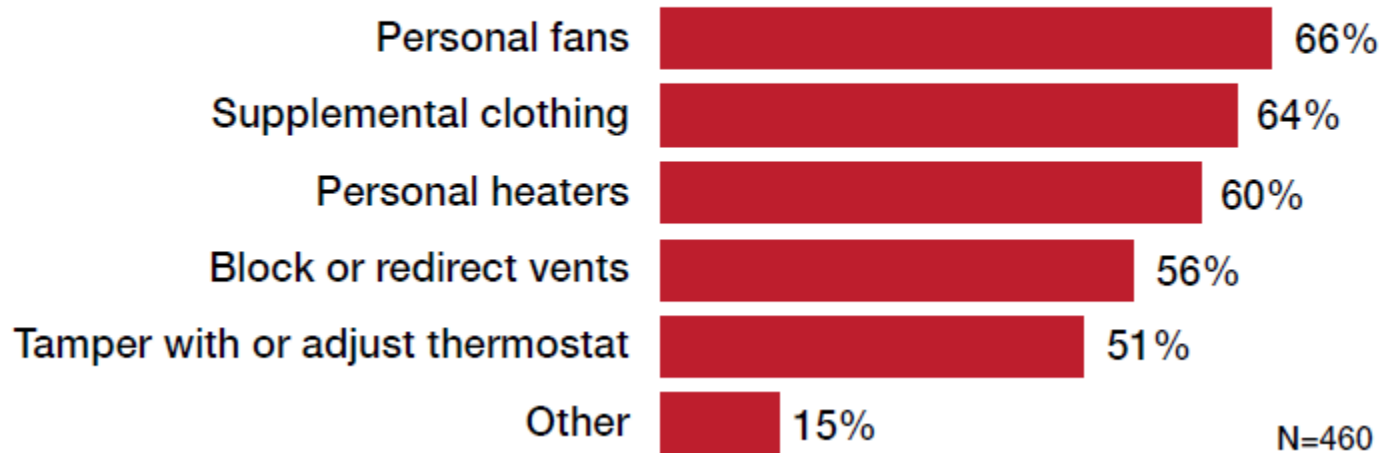
Steps Taken by Building Operators to Address Thermal Complaints



IFMA 2009 HVAC Survey

Diversity of Occupant Behavior

How Do Occupants Adjust to Thermal Comfort Issues?



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

Practical Reasons that Natural Ventilation may not work

Occupants may not open windows due to:

- 1.Outdoor air dusty**
- 2.Outdoor air polluted**
- 3.Outdoor air bad smell**
- 4.Outdoor too noisy**
- 5.Raining**

Complexity of Human Behavior in Buildings

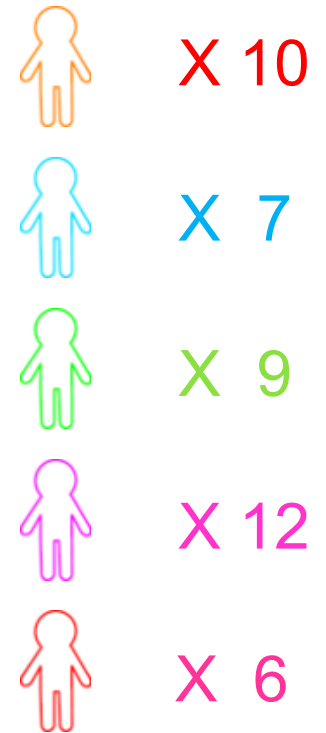
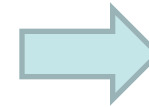
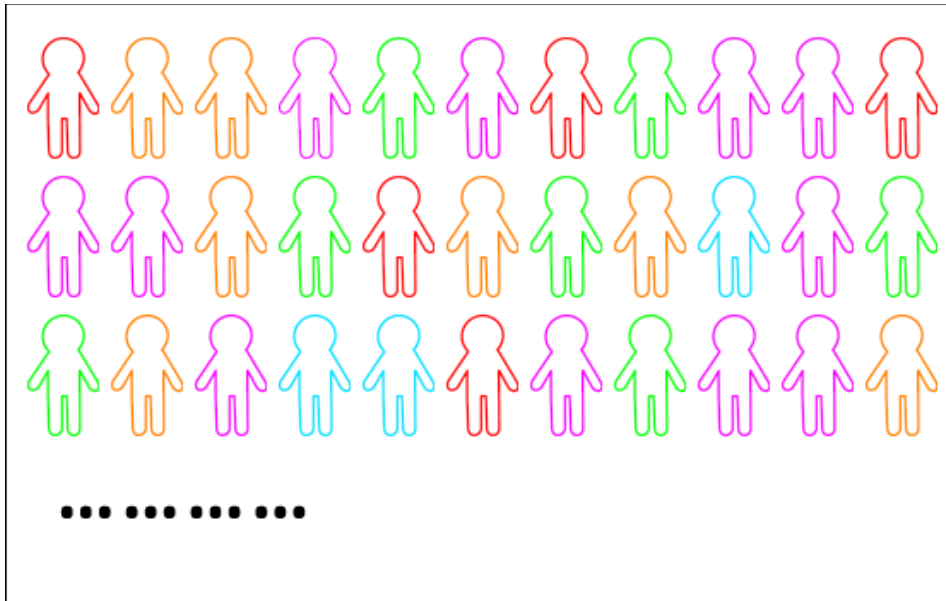
- Stochastic
- Multi-disciplinary
- Various driving factors:
 - Individual: culture, lifestyle, habit, environmental awareness
 - Temporal: time of the day, day of the year
 - Spatial: office, home,...
 - Indoor and outdoor environmental conditions
- Very limited data to help us understand

Diverse ways to turn on air-conditioning:

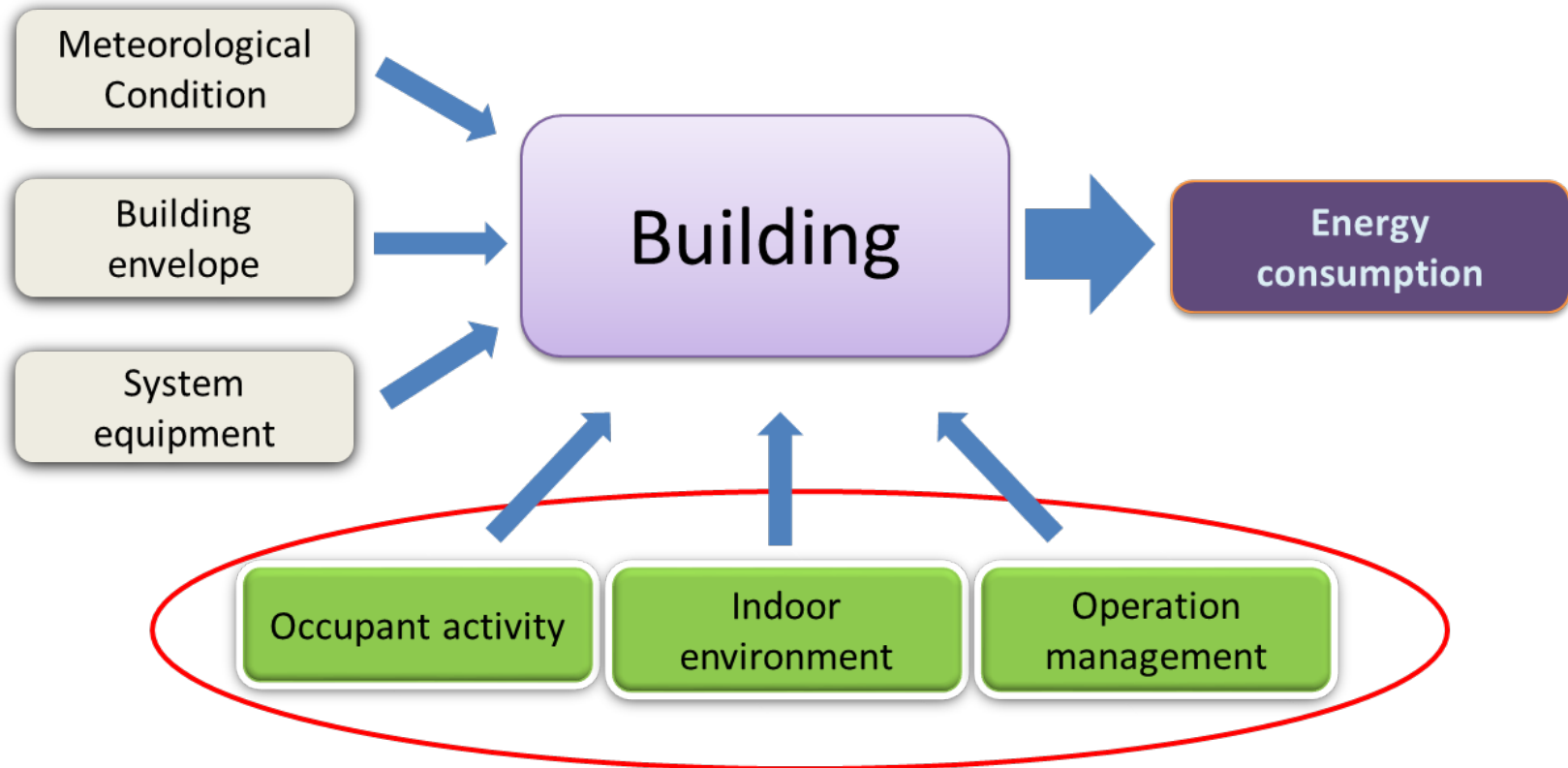
- always turn on**
- turn on when entering**
- turn on when feeling hot**
- turn on before sleep**
- never turn on**
- randomly turn on**

Challenges

- Typical OB Category and Distribution



Occupant behavior is a key factor



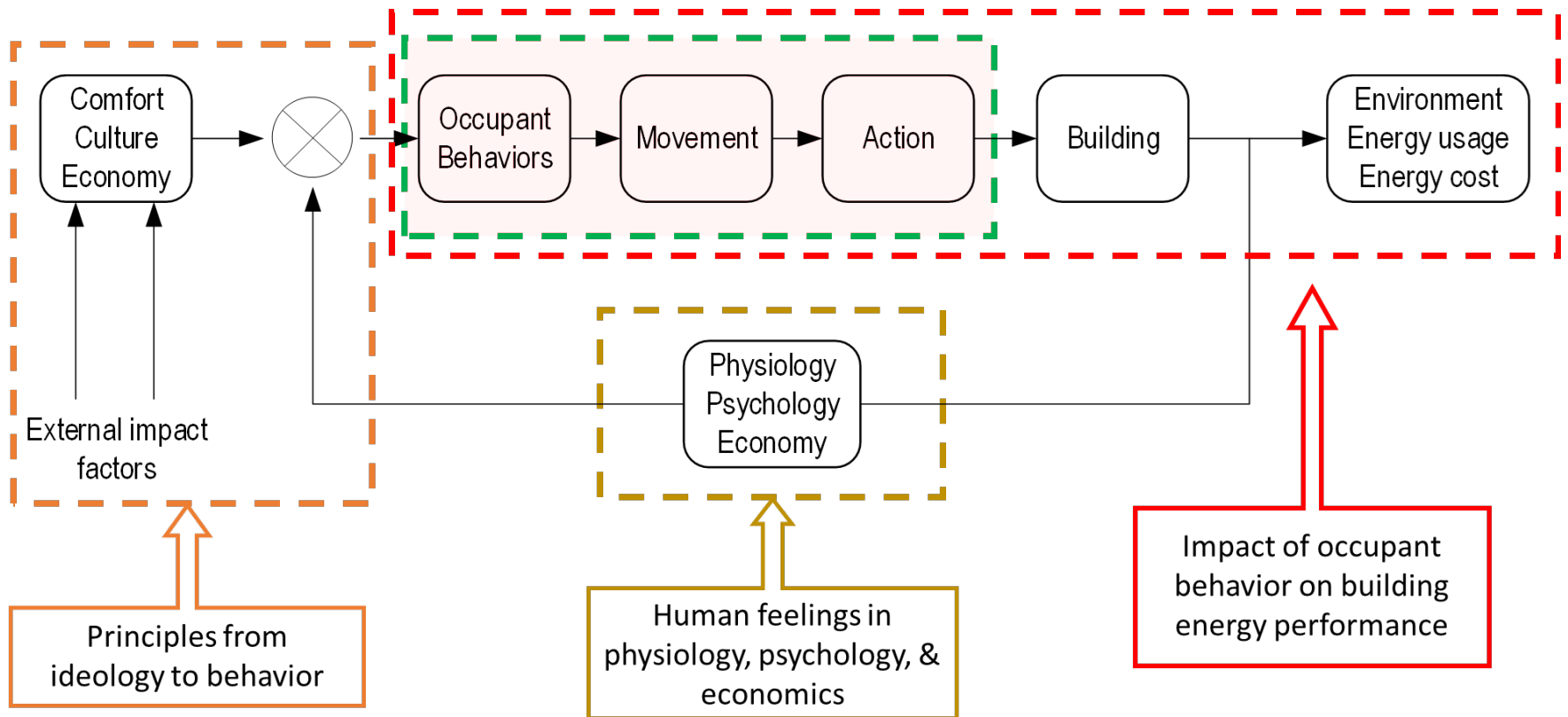
Occupant behavior is a key influencing factor of building energy consumption

Importance and Urgency

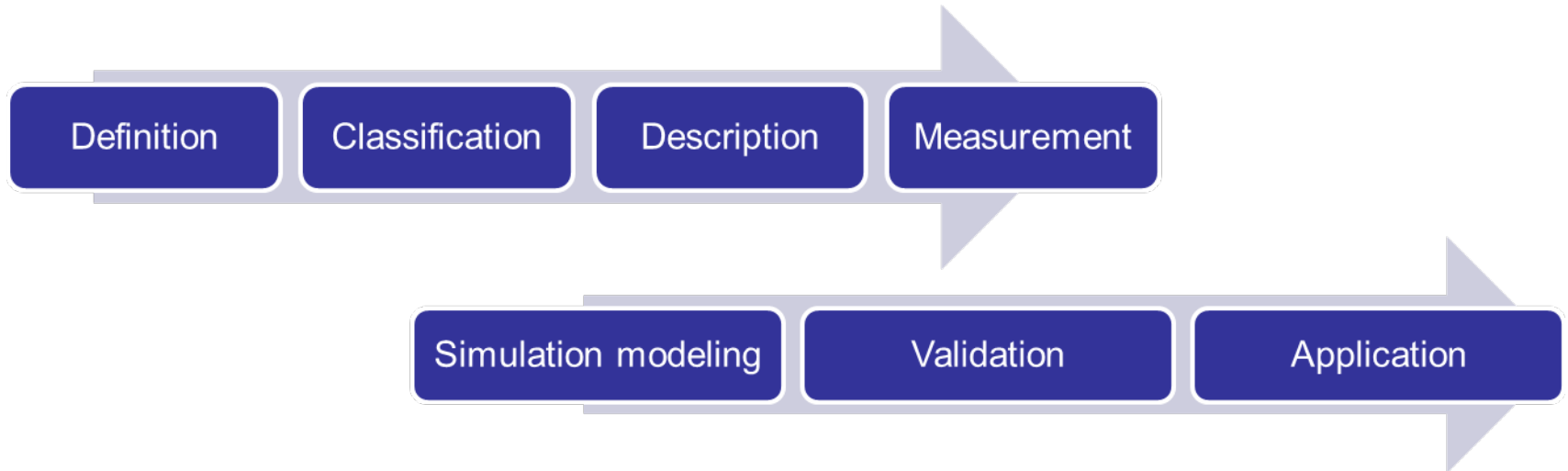
- OB is a **Key factor** for design optimization, energy diagnosis and performance evaluation, and also building energy simulation
- Limited understanding or inadequate over-simplification on OB;
- **In-depth quantitative analysis** urgently needed;
- Over 20 groups all over the world studying OB individually
- **Lack of consensus** in common language, in good experimental design, and in modeling methodologies.
- An international cooperation is extremely important for both knowledge gaining and data sharing

Focus

- Focus on how OB physically and quantitatively affect on building performance**



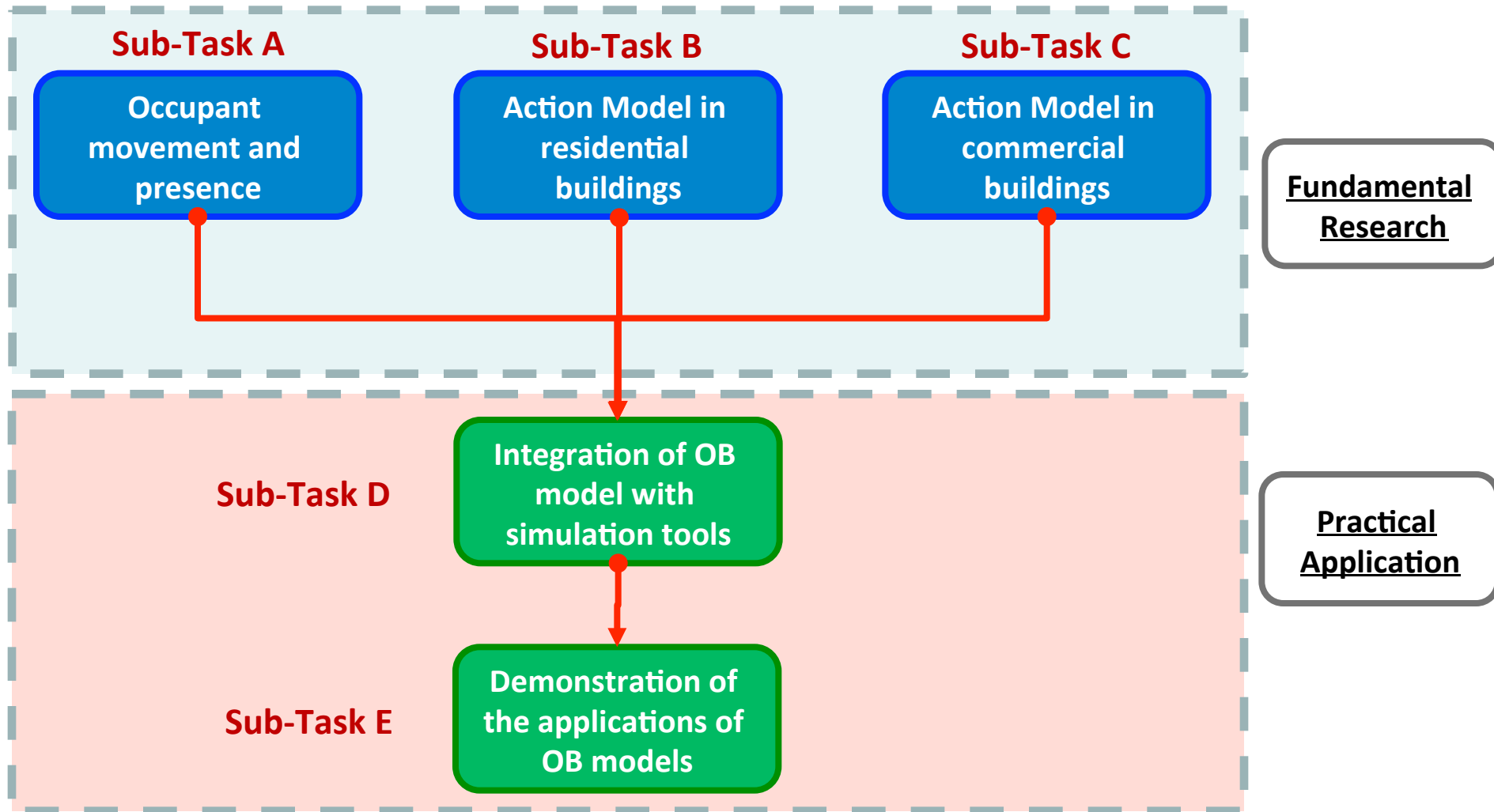
Research Target



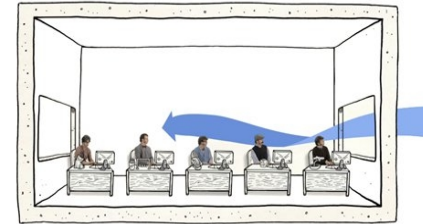
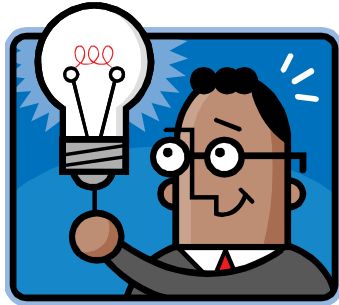
Develop a **scientific framework** for OB quantitative definition and simulation methodologies

Technical Approach

Targeting Building types:
Residential buildings & Office buildings



ST-A Personnel presence and movement model

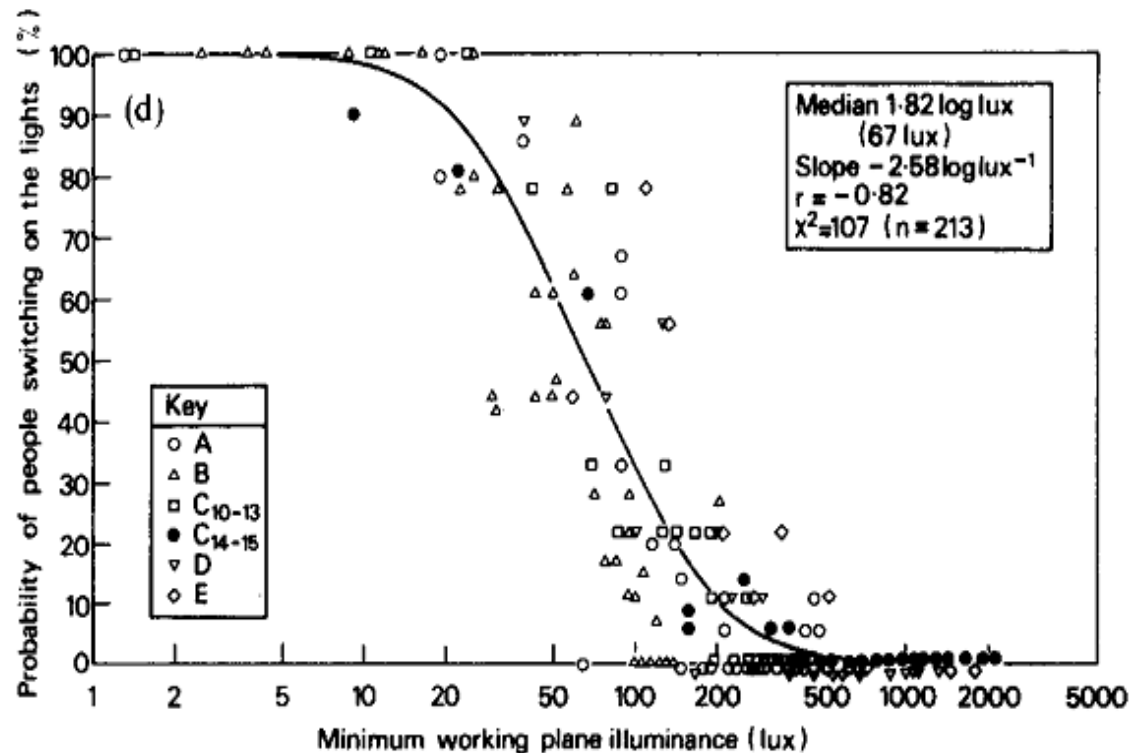


Personal
Presence & Movement



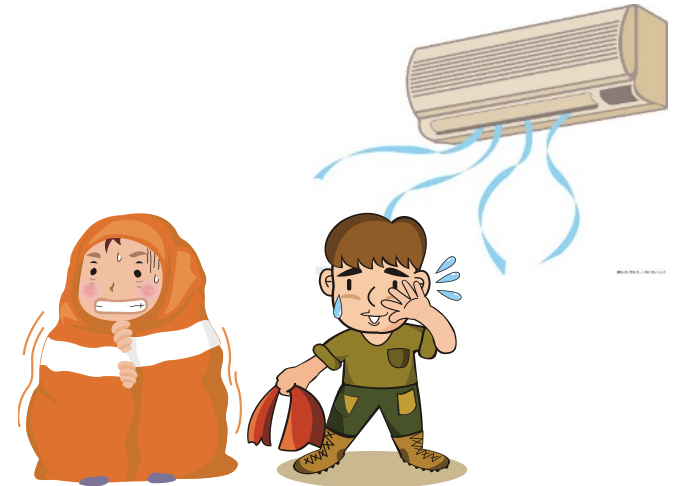
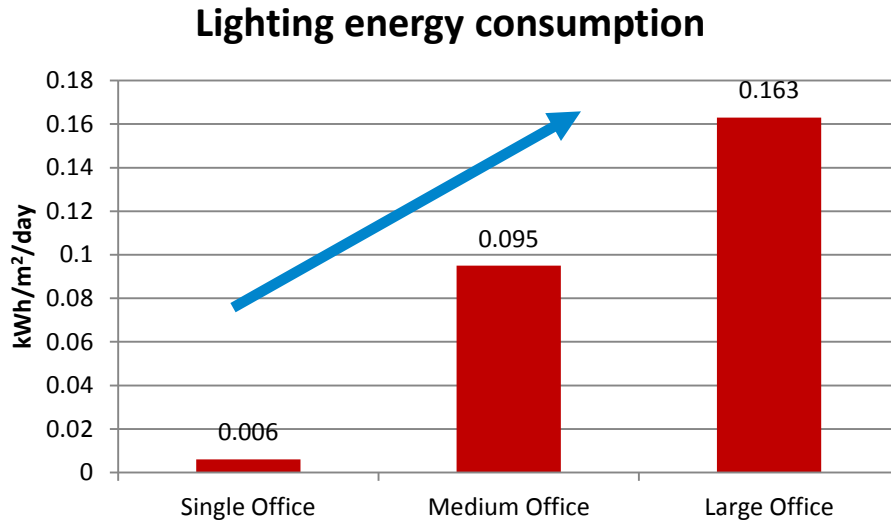
Occupant's presence and movement is strongly connected
with Space, Time and Events

ST-B Action model in residential buildings



Occupant's actions are influenced by environmental and physical parameters in a stochastic way

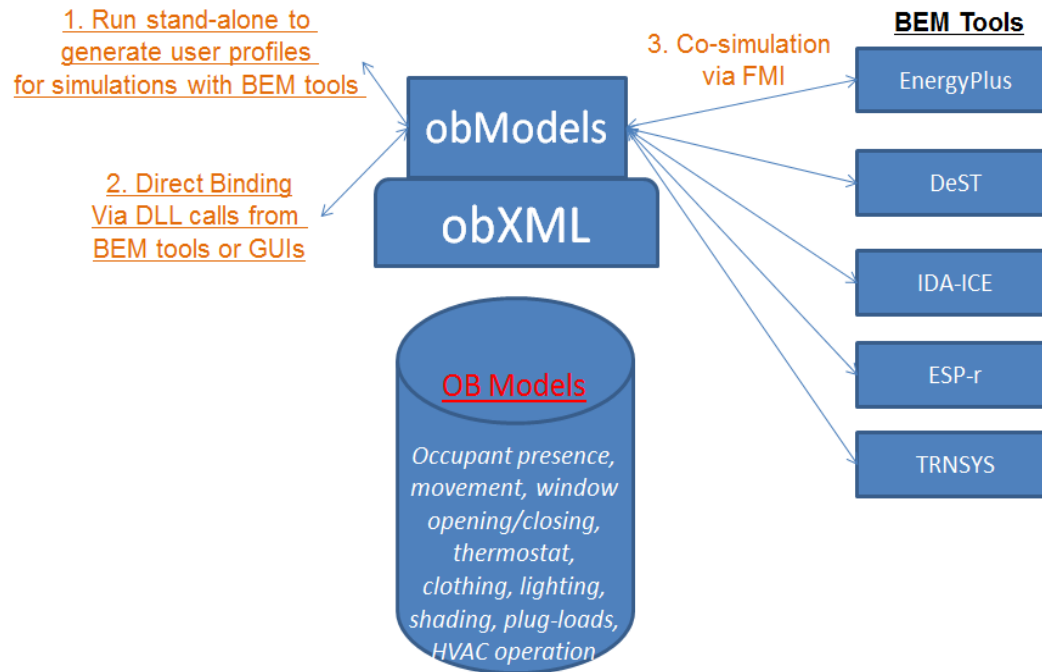
ST-C Action model in commercial buildings



Higher possibility of interaction and negotiation among occupants in commercial buildings

ST-D Integration with simulation software

The Behavior Module obModels builds upon the behavior framework obXML, and can be used in three ways



Essential to integrate the OB models with BEMs to exhibit the influence of OB on building energy and performance

ST-E Applications of OB models

- Robust energy simulation results:
 - More accurate system/equipment sizing
 - More robust system for green building assessment tool
 - More reliable data for government to establish relevant policies
- Understand the energy impact of different occupant behavior so as to:
 - Design more people-centered facilities
 - Control building systems smarter
 - Interact and encourage the appropriate action of individuals
- Bring industry into OB applications

Outcomes & Audience

	Outcomes	Target Audience
1	Standard definition, description and classification of occupant behavior	Building Energy Researchers Energy Modellers Simulation Software Developers
2	Systematic measurement approach, modelling and validation methodology	
3	Occupant Behavior Database with data at different temporal and spatial resolutions	
4	Software to simulate OB, integrated with BEM programs	Building Designers Energy Saving Evaluators HVAC Engineers System Operators Energy Policy Makers
5	Case studies and guidelines to demonstrate applications	

Participants

22 Countries



Australia



Austria



Belgium



Brazil



Canada



China



Denmark



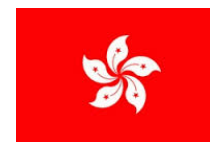
Finland



France



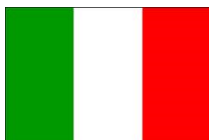
Germany



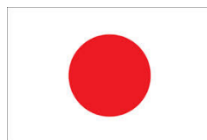
HongKong



Hungary



Italy



Japan



Korea



Netherland



Norway



Poland



Spain



Sweden



UK



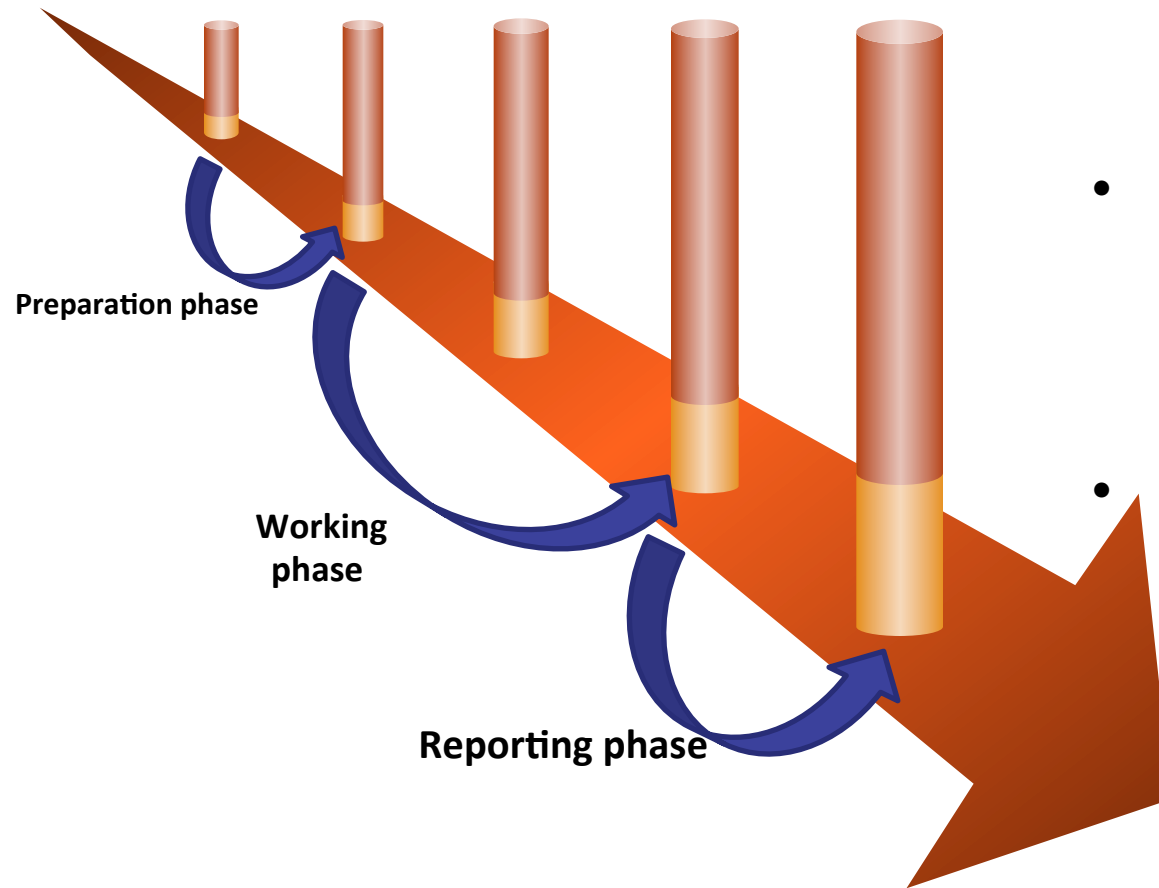
USA



Singapore

WORK PLAN

2013.11 2014.11 2015.11 2017.6 2017.12



- **Preparation phase**
 - One year (2013.11 — 2014.10)
- **Working phase**
 - Two and a half years (2014.11 — 2017.6)
- **Reporting phase**
 - Half a year (2017.7 — 2017.12)

Summary

- OB has great influence on building energy usage and technology evaluation
- There still lacks quantitative methods and common language for OB description and simulation
- ANNEX 66 focuses on setting up a scientific framework for OB definition, description, simulation and applications

3rd expert meeting at LBNL

- One day Technical Forum + two days expert meeting

IEA EBC Annex 66
Definition and Simulation of Occupant Behavior in Buildings

**First Expert Meeting in Working Phase, and
International Technical Forum
Berkeley, California**

March 30 - April 1, 2015



More Information

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