Indoor Air Quality Design and Control in Low Energy Residential Buildings

IEA EBC Annex 68

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With:

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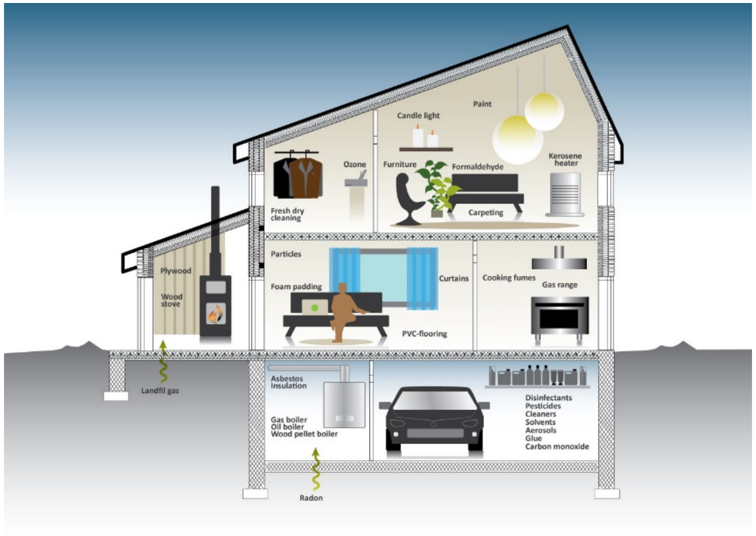
Problem Statement

- Highly energy efficient buildings are airtight buildings, and their need for ventilation should be optimized.
  - but may be energy consuming

- Risk of high levels of pollutants indoors: Humidity, CO_2 and chemical compounds,
  - Influence of materials in the building fabric and inventory



Energy ⟷ IAQ

Knowledge Gap

Mission

- Based on scientific data and tools, the project shall provide guides for the design and operation of buildings towards highest energy efficiency while ensuring good & healthy indoor conditions
- Specific target: New and refurbished residential buildings

Subtasks

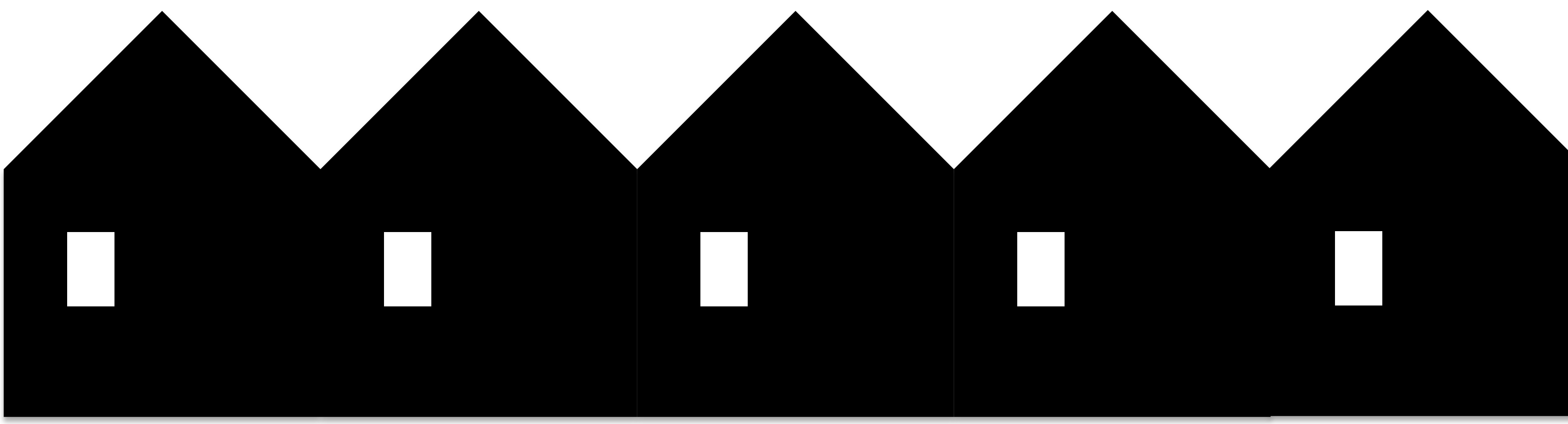
ST1 - Defining the metrics

ST2 - Pollutant loads in residential buildings

ST3 - Modelling

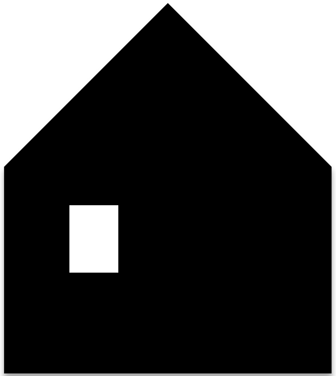
ST4 - Strategies for design and operation

ST5 - Field measurements and case studies



ST 1 (leads: F, DK) – Defining the metrics

- Identify the indices and markers, which can be used to quantitatively:
  - describe the IAQ, and
  - allow comparison with the indices describing energy use.
- The metrics would allow quantifying the benefits of different methods for achieving high IAQ and compared in parallel with consequences for energy and greenhouse gas emission.



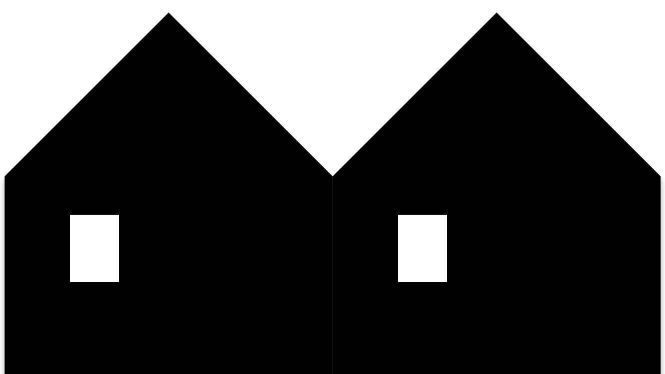
ST 2 (lead: CN, USA)
Pollutant loads in residential buildings

Results will be collected and analysed from tests of emission of harmful compounds under various temperature, humidity and air flow conditions, and supplemented where such data under combined exposures generally do not exist today.

Activities:

2.1 Literature survey to gather relevant data and existing knowledge on pollutant loads in buildings, including model

2.2 Laboratory testing and model setup to provide examples of new data, which will improve knowledge on combined effects that must be taken into consideration.



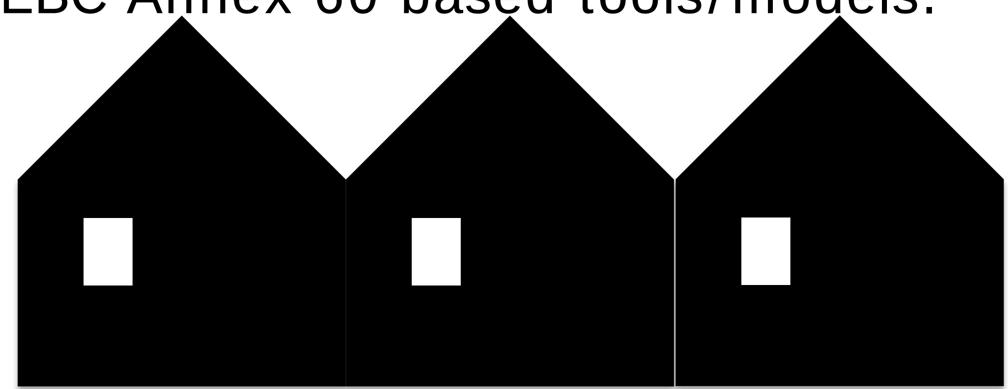
ST 3 (leads: D, USA)

Modelling - review, gap analysis & categorization

Collection and development of knowledge regarding whole building analysis tools and methods to predict the hygrothermal conditions, absorption and transport of humidity and chemical substances, and energy consumption within whole buildings.

Focus on methods to predict the emission and absorption of chemical compounds from materials under realistic in-use conditions regarding the CHAMPS-exposure in buildings.

Predominantly building upon existing BES tools and IEA EBC Annex 60 based tools/models.



ST4 (leads: DK, N)
Strategies for design and ctrl of bldg.s

Devise optimal control strategies for the operation of residential buildings, not least with regards to ventilation requirement and ventilation mode, such that the building energy performance, user comfort and health conditions can be optimal

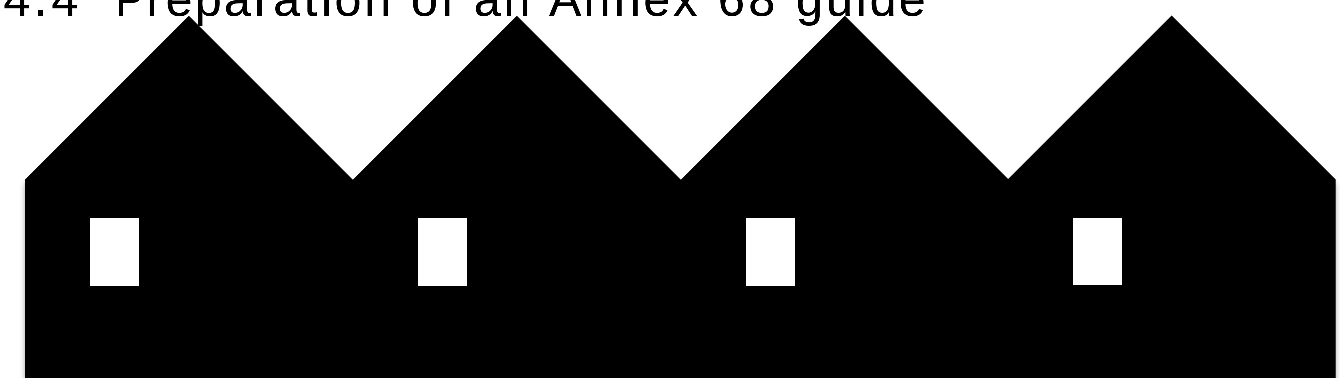
Activities:

4.1 Review of relevant international information sources/ activities related to IAQ design and control in residences.

4.2 Investigation of possible design strategies

4.3 Investigation of possible operational strategies

4.4 Preparation of an Annex 68 guide



ST5 (lead: B, N)
Field measurements and case studies

This subtask is to carry out field tests and analysis of residential buildings that can be used to test and verify the findings of the other subtasks. Several sites/climates will be comprised.

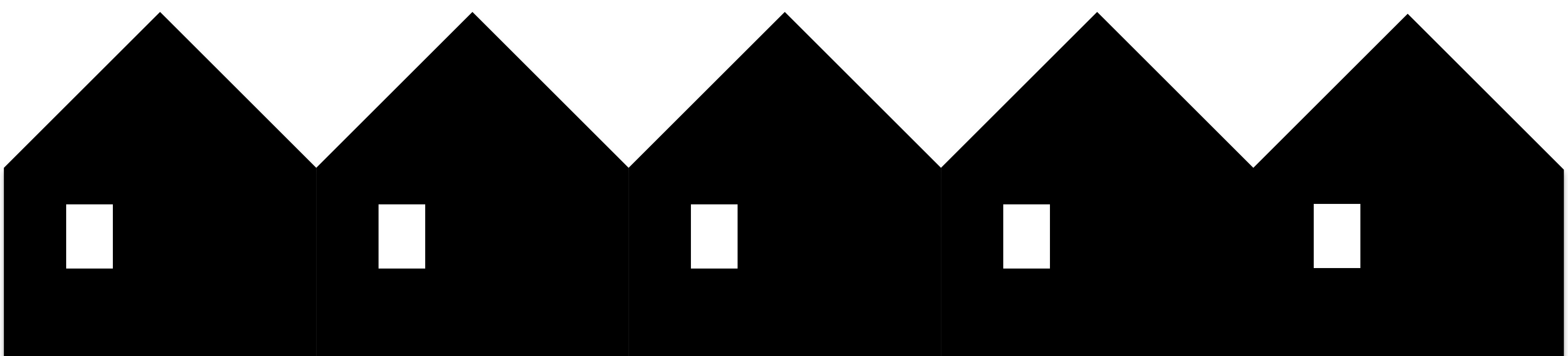
Activities:

5.1 State of the art and measurement strategy

5.2 Controlled measurements: In labs and test houses

5.3 In situ measurements: Examples of residential buildings, which are either new or existing (possibly retrofitted)

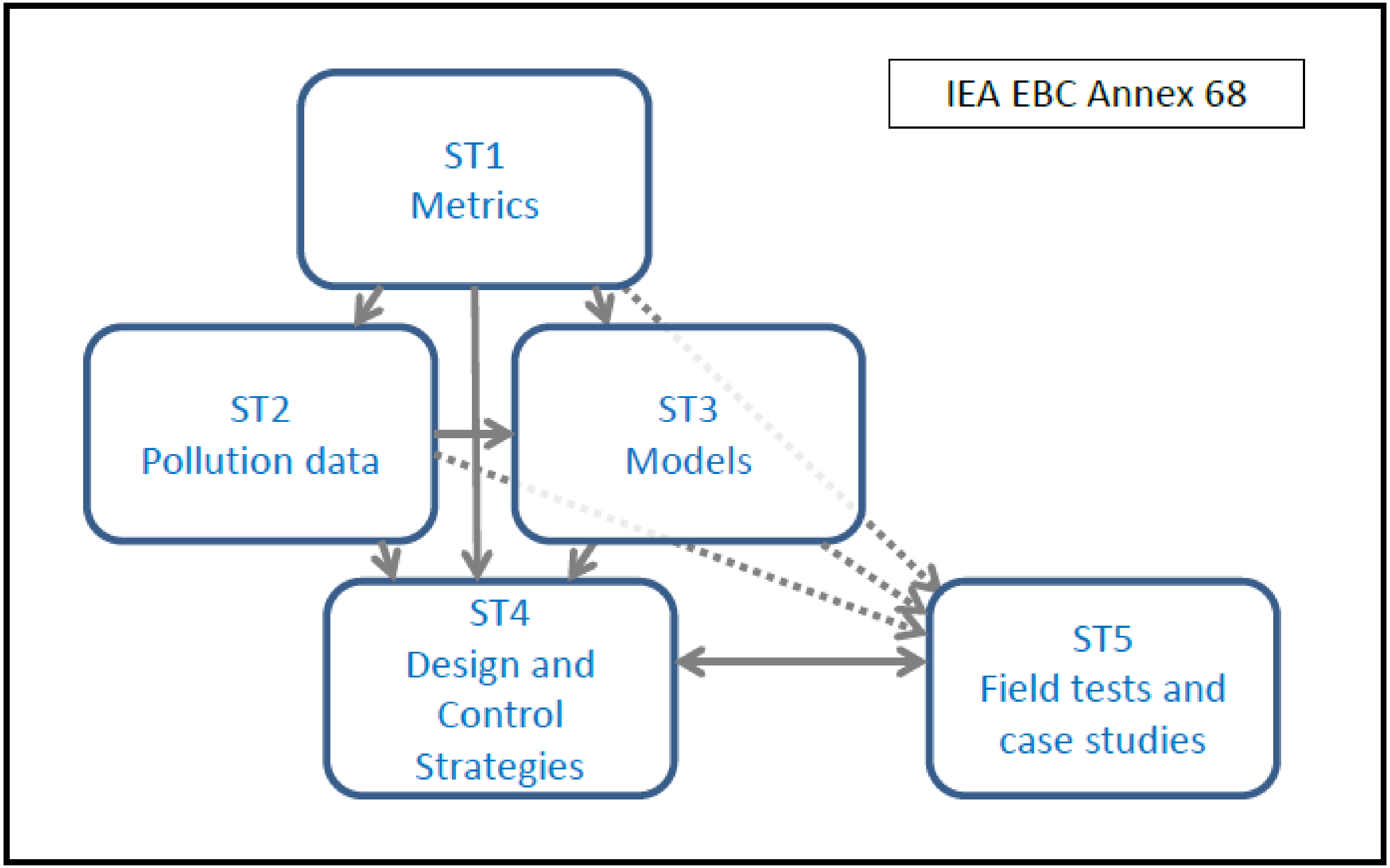
5.4 Analysis and dissemination



Subtask leadership

	Subtask leader	Co-lead
ST1 – Metrics	France (Univ. La Rochelle, Abadie)	Denmark (DTU, Wargocki)
ST2 – Pollutant loads	China (Nanjing Univ., Qin)	USA (Syracuse Univ., Zhang)
ST3 – Modelling	Germany (TU Dresden, Grunewald)	USA (Syracuse Univ. Zhang)
ST4 – Strategies	Denmark (DTU, Kolarik)	Norway (NTNU, Cao)
ST5 – Field tests and case studies	Belgium (Ugent, Laverge)	Norway (Treteknisk, Kraniotis)

Structure between subtasks



Schedule

	2015		2016		2017		2018		2019	
Preparation Phase	x	x								
ST1			x	x						
ST2			x	x	x	x	x	x		
ST3			x	x	x	x	x	x		
ST4			x	x	x	x	x	x		
ST5			x	x	x	x	x	x		
Reporting									x	X

Deliverables

- Data – especially on emission and sorption properties of building products – focusing on combined effects
- Tools and paradigms to analyse, design and manage energy- and IAQ-optimized buildings
- Field test results
- Guidelines and recommendations for authorities and building users/operators

- Overall, we anticipate to deliver data and tools that can and will be used by practitioners

Collaborators

1. Austria (Univ. Innsbruck)
2. Belgium (UGent)
3. China (Nanjing Univ.; Tsinghua Univ.; Hong Kong Univ.; Shanghai Univ.; Shenzhen IBR
4. Denmark (Techn. Univ. of Denmark; Techn. Institute; Danish Bldg. Res. Institute)
5. Estonia (Tallinn University of Technology)
6. France (Univ. La Rochelle; Univ. de Savoie; Saint Gobain)
7. Germany (TU Dresden)
8. The Netherlands (TU Eindhoven)
9. Norway (Institute of Wood Technology; University of Life sciences; NTNU)
10. United Kingdom (UCL; Strathclyde University)
11. USA (Syracuse Univ.)

Annex Text

Nov. 15, 2015

EBC

Energy in Buildings and Communities Programme

International Energy Agency
EXCO Energy in Buildings and Communities

IEA EBC Annex 68 – November 2015

Carsten Rode, Technical University of Denmark

Annex text

Indoor Air Quality Design and Control in Low Energy Residential Buildings

The project will gather the existing scientific knowledge and data on pollution sources in buildings, models on indoor hygrothermal and air quality as well as thermal systems, and will look to ways to optimize the provision of ventilation and air-conditioning. Gaps of knowledge will be identified and filled, not least by establishing links between knowledge that exists in the field of indoor air chemistry, modelling, and HVAC technology and controls.

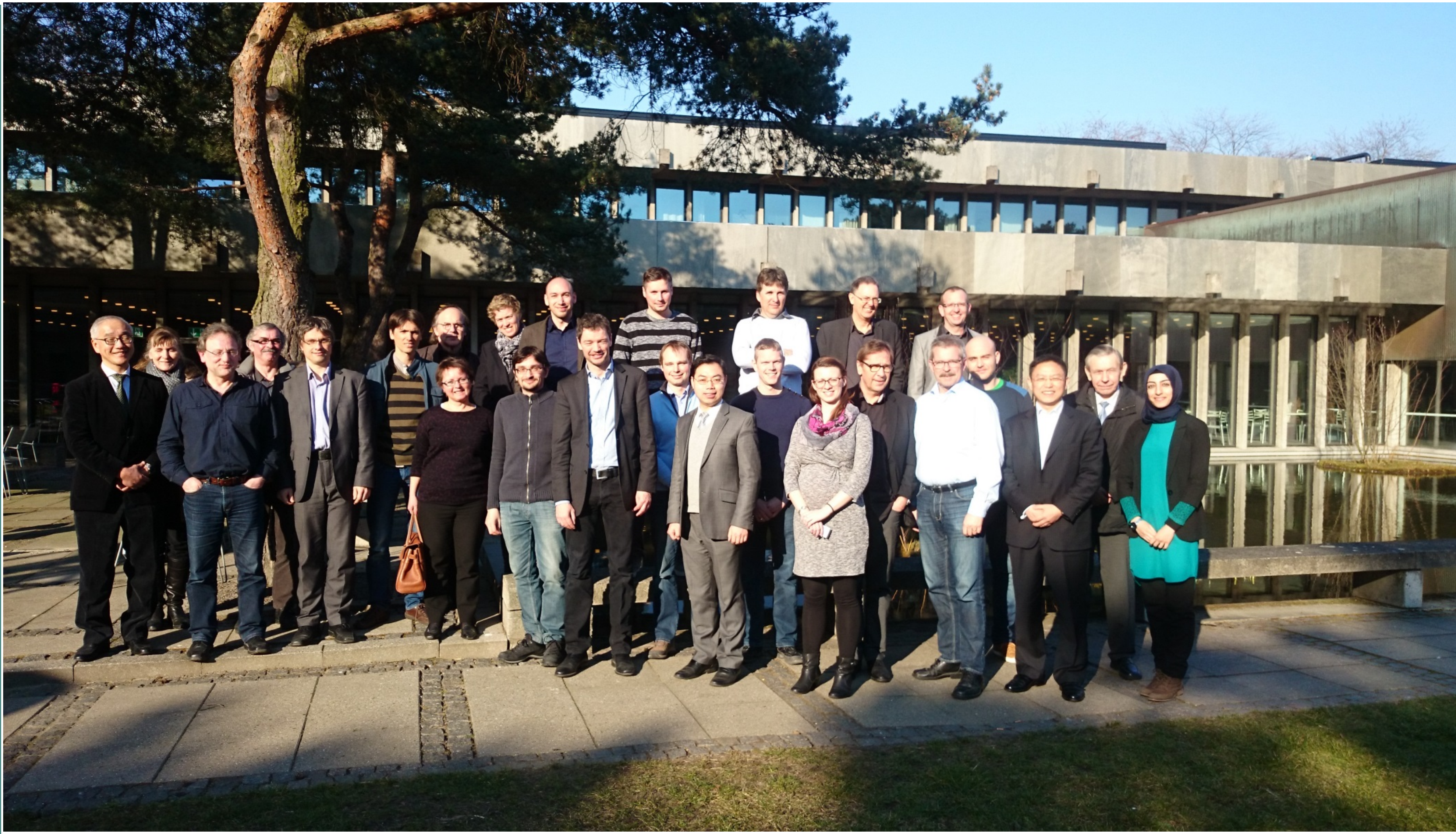
The overall objective is to provide a generic guideline for the design and operational strategy of residential buildings which have minimal energy consumption, and at the same time maintain a very high standard regarding Indoor Air Quality based on the control of sources, sinks and flows of heat, air, moisture, and pollutants under in-use conditions.

1. Background

Highly energy efficient residential buildings need to be rather airtight, and they will include systems to ensure that the need for ventilation is met in an optimal way. Achieving such energy optimized performance can encompass a risk of high levels of pollutants indoors: Humidity, particles and various chemical compounds, where the first and the latter can both be absorbed by and emitted from materials in the building fabric and furnishings. Users influence the operation of the buildings and the generation of some of these pollutants. Building services systems, particularly the ventilation system, control and moderate indoor air pollutants, but require energy to do so. The physical condition of the pollutants, e.g. their properties affecting transport and retention in materials are often strongly influenced by the temperature, moisture and airflow conditions.

With a tighter building envelope, some atmospheric influences in indoor climates may come closer to the limits for acceptability. Indoor Air Quality may be influenced by the chemical and hygrothermal states and properties of materials, which influence the need for ventilation. Also the distribution of fine particles will be altered with new surface temperatures and airflow patterns.

IEA ECBCS Annex 41 has provided a toolset to predict the hygrothermal condition of whole buildings using HAM (Heat, Air and Moisture) analysis approaches. Some laboratory data exist regarding absorption and emission of chemical compounds from materials, but there has been insufficient consideration of the combined effects of chemical atmosphere, temperature, humidity, and ventilation requirement. The problem has relevance both where new and recycled building products are used. The whole building HAM tools, together with further data should be combined such that optimal HVAC control strategies can be investigated with the purpose to conserve energy, while not compromising the quality of the indoor environment for human occupancy.



Webpage: IEA-EBC-Annex68.org

Next meeting: Syracuse, NY, USA. Sept. 8-10, 2016