Key findings of IEA EBC Annex 68 - Indoor Air Quality Design and Control in Low Energy Residential Buildings

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Problem statement

- Highly energy efficient buildings are airtight, and their need for ventilation should be optimized
  - but may be energy consuming
- Risk of high levels of pollutants indoors: Humidity, CO2 and chemical compounds
  - Influence of materials in the building fabric and inventory of buildings

Energy ⟷ IAQ

Knowledge Gap

Mission

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

Target audience

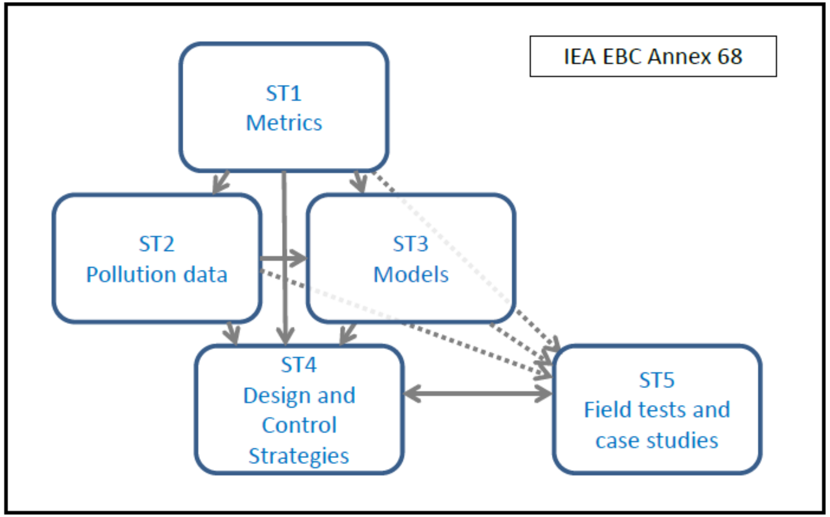
The project addresses the following stakeholders:

- Building designers (engineers and architects)
- Suppliers of HVAC and control systems
- Suppliers of materials used in building construction and indoor furnishing
- Providers of building management systems

The project shall also address the interests of building owners, facility managers and users, as well as authorities

Subtasks

- ST1 - Defining the metrics
- ST2 - Pollutant loads in residential buildings
- ST3 - Modeling
- ST4 - Strategies for design and operation
- ST5 - Field measurements and case studies



Participants

1. **Austria (Univ. Innsbruck;** TU Wien**)**
2. **Belgium (UGent)**
3. **Canada (BCIT; Health Canada)**
4. **China (Univ. of Shanghai for Sci. and Techn.**; Nanjing Univ.; Tsinghua Univ.; The Univ. of Hong Kong; Shenzhen Institute of Bldg. Res.)
5. **Czech Republic (CVUT Praha**; TU Liberec; VUT Brno)
6. **Denmark (Techn. Univ. of DK; Danish Bldg. Res. Inst.; Techn. Inst.)**
7. **Estonia (Tallinn Univ. of Techn.)**
8. **France (Univ. La Rochelle; Univ. de Savoie; Saint-Gobain;** Insa Lyon**)**
9. **Germany (TU Dresden;** RWTH Aachen; Stuttgart Univ.**)**
10. **Korea (Korea Institute of Civil Engineering & Building Technology)**
11. **The Netherlands (TU Eindhoven)**
12. **New Zealand (BRANZ)**
13. **Norway (NTNU; Univ. of Life Sci.;** Inst. of Wood Techn.**)**
14. **United Kingdom (UCL;** Strathclyde Univ.; Cardiff Univ.**)**
15. **USA (Syracuse Univ.;** Florida Solar Energy Center; NIST; Univ. of Texas at Austin**)**

16. Finland (Aalto Univ.)
17. Italy (UNIVPM)
18. Japan (Univ. of Tokyo)
19. Slovakia (Techn. Univ. of Kosice)
20. Spain (Eduardo Torroja Inst. for Construction Science)
21. Sweden (IVL)

Subtask 1 – Defining the metrics

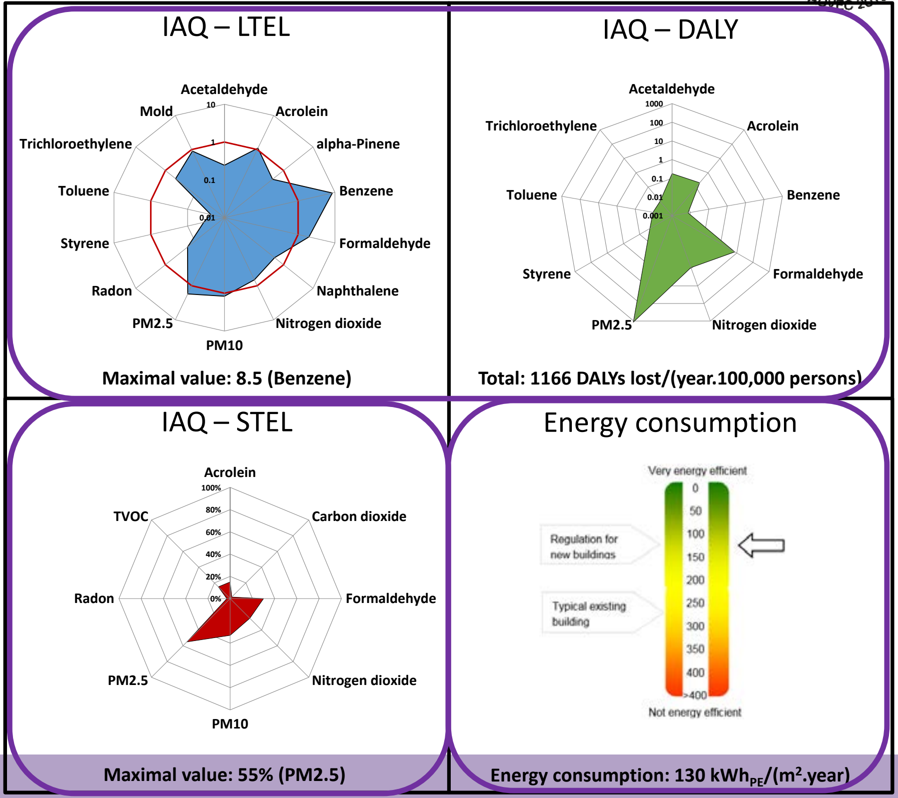
Objectives

- Is exposure to pollutants lower in low-energy buildings compared to non-low-energy buildings?
- What are the target pollutants in low-energy residential buildings?
- How to quantify IAQ?
- Can we aggregate IAQ and energy into one index?

AIVC CR 17: Indoor Air Quality Design and Control in Low-energy Residential Buildings- Annex 68 | Subtask 1: Defining the metrics | In the search of indices to evaluate the Indoor Air Quality of low-energy residential buildings

Building IAQ and Energy Signature

Long-term exposure



Short-term exposure

Energy

Annex 68 target pollutants

Table 8. List of selected target pollutants for Annex 68 with their respective exposure limits.

	Long-term Exposure			Short-term Exposure		
	ELV*	Averaging period	Source	ELV*	Averaging period	Source
Acetaldehyde	48	1 year	Japan	-	-	-
Acrolein	0.35	1 year	USA-California	6.9	1 h	France
α-Pinene	200	1 year	Germany	-	-	-
Benzene	0.2	whole life (carcinogenic risk level: 10^{-6})	France	-	-	-
Formaldehyde	9	1 year	USA-California	123	1 h	Canada
Naphthalene	2	1 year	Germany	-	-	-
Nitrogen dioxide	20	1 year	France	470	1 h	USA-California
PM10	20	1 year	WHO	50	24 h	WHO
PM2.5	10	1 year	WHO	25	24 h	WHO
Radon	200	1 year	Austria, Canada	400	8 h	Austria, China, Portugal
Styrene	30	1 year	Germany	-	-	-
Toluene	250	1 year	Portugal	-	-	-
Trichloroethylene	2	whole life (carcinogenic risk level: 10^{-6})	France	-	-	-
TVOC	-	-		400	8 h	Japan, Korea
Mold	200	1 year	EU	-	-	-
Carbon dioxide	-	-	-	*1000*	*8 h*	*Hong-Kong, Korea*

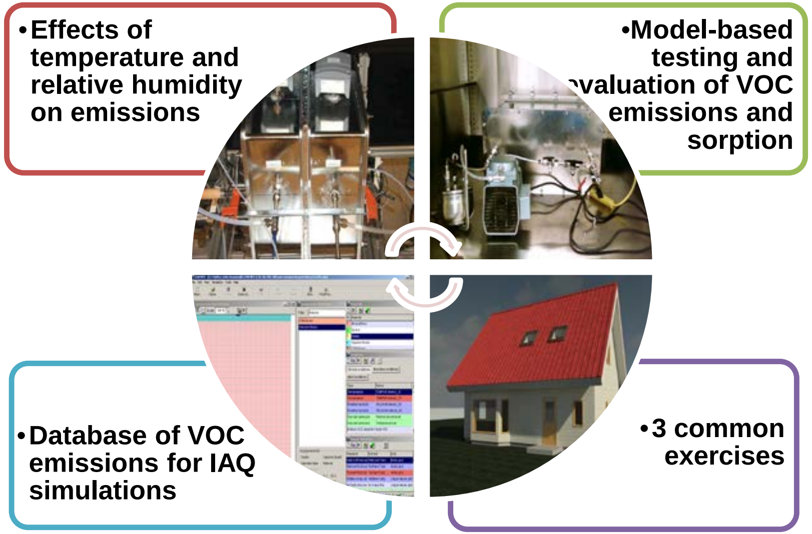
* ELV concentration in µg/m³ except for carbon dioxide in ppm, radon in Bq/m³ and mold in CFU/m³

Subtask 2 – Pollutant Loads in Residential Buildings

Objectives

- This subtask is to collect / provide data about properties for transport, retention and emission of chemical substances in new and recycled materials in residential buildings under various temperature, humidity and airflow conditions.

- Development of reliable methods and data for estimating pollutant loads in residential buildings in the way heating/cooling loads are routinely estimated.



Subtask 3 – Modeling

Objectives

- Survey of contemporary modelling capabilities
- Development of reference cases (common exercises)
- Identification of gaps in current modelling capabilities
- Development of new standards for quality assurance
- Recommendation of a modelling framework (tool coupling, co-simulation)

Annex 68 CHAMPS modeling platform

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MODELICA

Annex 60 buildings library

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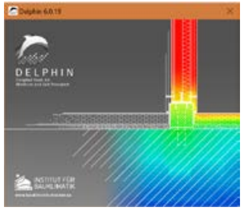
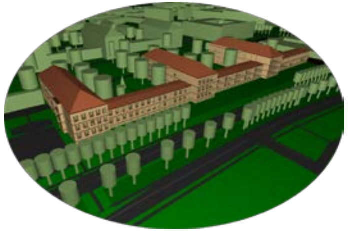
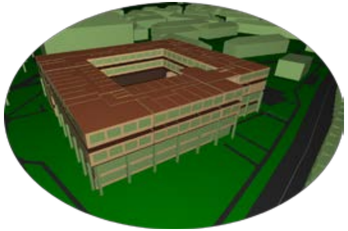
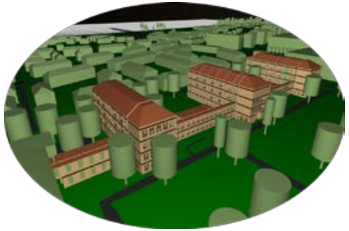
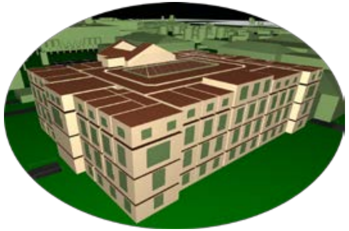


Multizone Building Energy Simulation

HVAC-Systems and Operation Simulation

Building Envelope Systems Simulation


Subtask 4 - Strategies for design and control of buildings

Objectives:

- Gather results and approaches of the other subtasks of the Annex 68 and annex participants
- Address optimal and practically applicable design and control strategies for high IAQ in residential buildings
- Present results in context with existing knowledge

Room based ventilation by Sustain Solutions A/S

Evaluation of Mechanical Extract Ventilation systems in 'low-energy' dwellings in the UK (Innovate UK 2013 & 2014)

Results:

- **Review -** standards, national building codes, guidelines with respect to design of IAQ/ventilation in residences
- **Survey** - interviews with relevant stakeholders with focus on current IAQ design practices: 44 interviews, 6 countries
- **The Annex 68 guide for practitioners:** Current challenges, innovative solutions and case studies on indoor air quality design and control in residences
  - Focused on practitioners
  - Organized in short informative chapters
  - Includes case studies conducted within the Annex 68
  - Overview of other relevant research – digest by Annex 68 experts

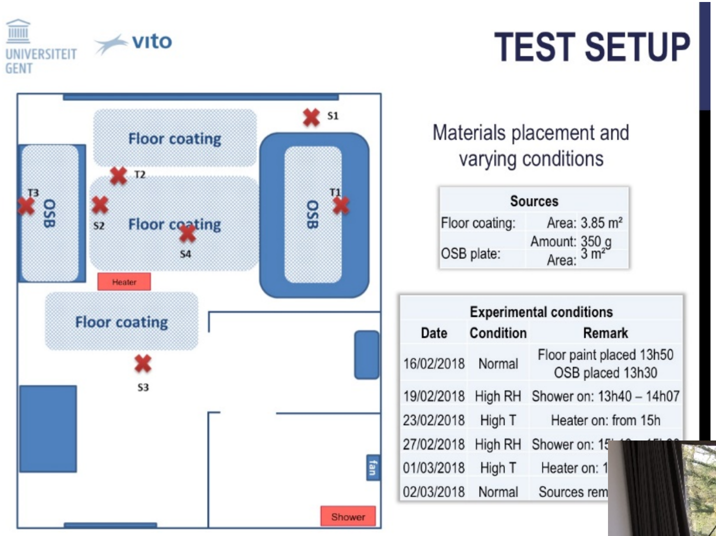
The Annex 68 guide through current challenges, innovative solutions and case studies on indoor air quality design and control in residences

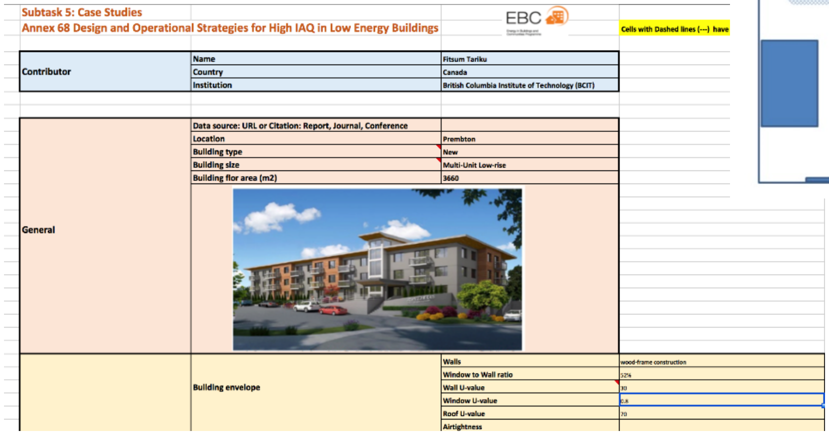
TABLE OF CONTENTS	
1/ Introduction	
2/ How do we design residential ventilation today?	
3/ Ways to design residential ventilation in the future/How to overcome nowadays challenges?	12 contributions
4/ Towards better performance, user satisfaction and easier maintenance	8 contributions
5/ Conclusions and outlook	

Subtask 5 – Field measurements and case studies

Objectives

- Measurement strategy
- Controlled experiments
- Case study reports





Subtask 5: Case Studies
Annex 68 Design and Operational Strategies for High IAQ in Low Energy Buildings
EBC
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Contributor	Name	Fitsum Tariku	
	Country	Canada	
	Institution	British Columbia Institute of Technology (BCIT)	
General	Data source: URL or Citation: Report, Journal, Conference		
	Location	Prembton	
	Building type	New	
	Building size	Multi-Unit Low-rise	
	Building flor area (m2)	3660	
	Building envelope	Walls	wood-frame construction
		Window to Wall ratio	52%
		Wall U-value	30
		Window U-value	0.8
		Roof U-value	70
		Airtightness	

http://www.iea-ebc-annex68.org/