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Energy in Buildings and Communities Programme

an update on IEA-EBC Annex 86
energy efficient IAQ management strategies in residential buildings

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IEA-EBC Annex 86

Energy Efficient IAQ Management in residential buildings

AIVC Workshop 2023 Tokyo

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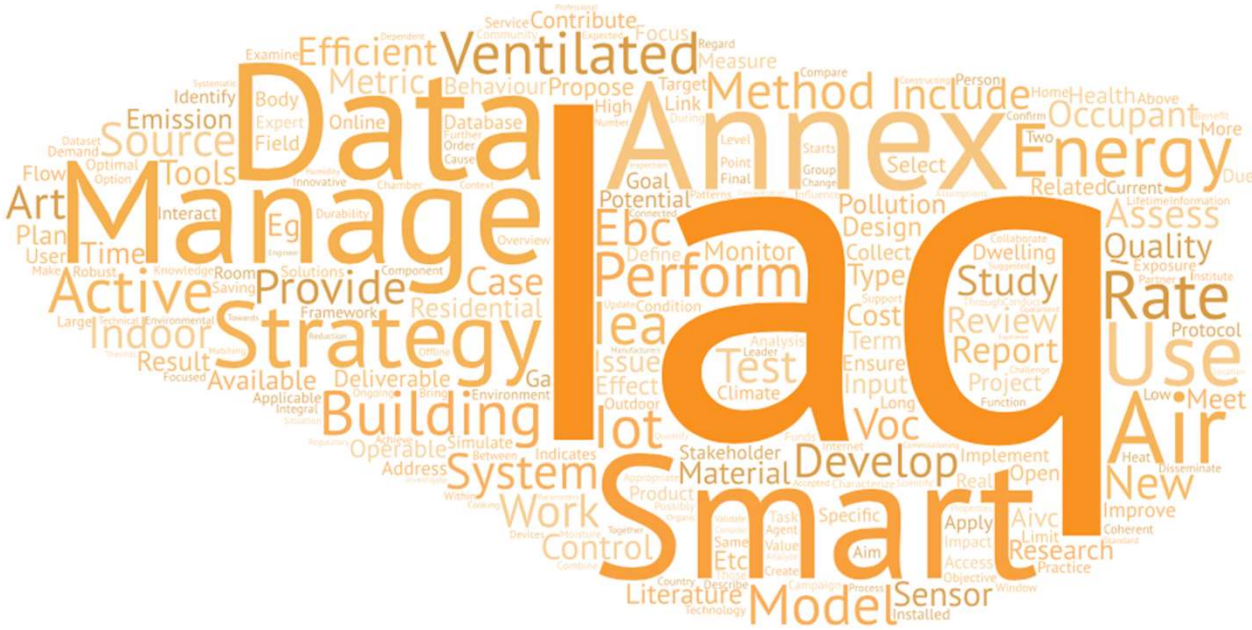
Context

IAQ is an important constraint for energy efficiency optimisation in buildings

There is no consensus on a framework to rate IAQ as a basis for this optimisation



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Scope and Goals

Provide a framework to improve energy efficiency of IAQ management for

Residential buildings

both new construction and refurbishment

To select metrics to assess energy performance and indoor environmental quality of an IAQ management strategy and study their aggregation
To improve the acceptability, control, installation quality and long-term reliability of IAQ management strategies by proposing specific metrics for these quality issues
To set up a coherent rating method for IAQ management strategy that takes into account the selected metrics
To identify or further develop the tools that will be needed to assist designers and managers of buildings in assessing the performance of an IAQ management strategy using the rating method
To gather existing or provide new standardized input data for the rating method
To study the potential use of smart materials as (an integral part of) an IAQ management strategy
To develop specific IAQ management solutions for retrofitting existing buildings
To benefit from recent advances in sensor technology and cloud-based data storage to systematically improve the quality of the implemented IAQ management strategies, ensure their operation and improve the quality of the rating method as well as the input data
To improve the availability of these data sources by exploring use cases for their providers
To disseminate about each of the above findings.

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Workplan

6 Subtasks

ST 1 and 2: methodology

ST 3 and 4: application to technology

ST 5: new opportunities through IoT

ST 6: dissemination and management

Subtask 1 Metrics and development of an IAQ management strategy rating method

This subtask is devoted to the development of a general rating method for the benchmarking of the performance of IAQ management systems. In addition to relevant metrics, a set of appropriate tools, consistent modeling assumptions and monitoring protocols are also proposed.

Subtask 2 Source characterization and typical exposure in residential buildings

This ST creates consistent input values for the assessment method developed in ST 1 and control strategies in ST 4. It starts from information available in literature, adding new experimental results where needed and reviewing and developing models (empirical, semi-empirical or physical models) for characterizing relevant residential sources.

Subtask 3 Smart materials as an IAQ management strategy

This ST identifies opportunities to use the building structure and (bio-based) building materials (focussing on hemp concrete) and the novel functional materials inside it to actively/passively manage the IAQ, for example, through active paint, wallboards, textiles coated with advanced sorbents or hemp concrete, and quantifies their potential based on the assessment framework developed in ST 1.

Subtask 4 Ensuring performance of smart ventilation

This subtask focuses on practical conditions that assure reliable, cost effective and robust implementation of smart ventilation. This includes both installation and operation. A poor performance of smart ventilation systems can not only lead to waste of energy and aggravated IAQ. It can also create a bad reputation of smart ventilation among relevant stakeholders - designers, installers as well as occupants. This, in the end, can lead to adoption of more primitive, less efficient (in terms of energy use) and less effective (in terms of IAQ) forms of IAQ management. The subtask defines a smart ventilation according to the AIVC

Subtask 5 Energy savings and IAQ: improvements and validation through cloud data and IoT connected devices

This subtask is exploring the potential of the new generation of IoT connected devices (both standalone and embedded in eg. AHU's) for smart IAQ management. What can we learn from big data? Can we benchmark system energy and IAQ performance based on this data? How can we make sure that the data is available and can be accessed? Can we update what we think we know about what happens in dwellings based on what we see in big data rollouts? What are the best protocols and ontologies? How to create viable services out of the data/business plans? How can we integrate data with smart grids?

Subtask 6 Dissemination, management and interaction

The final subtask assures the close alignment of the activities within the annex and the interaction with the AIVC. This subtask includes the outreach of the annex, eg. by managing the dedicated section of the IEA EBC webpage. It uses the different platforms that the AIVC provides to interact with the broader target audience. This task will also ensure the continuation of the link with (the results from) other ongoing and ended annexes, especially annex 68.

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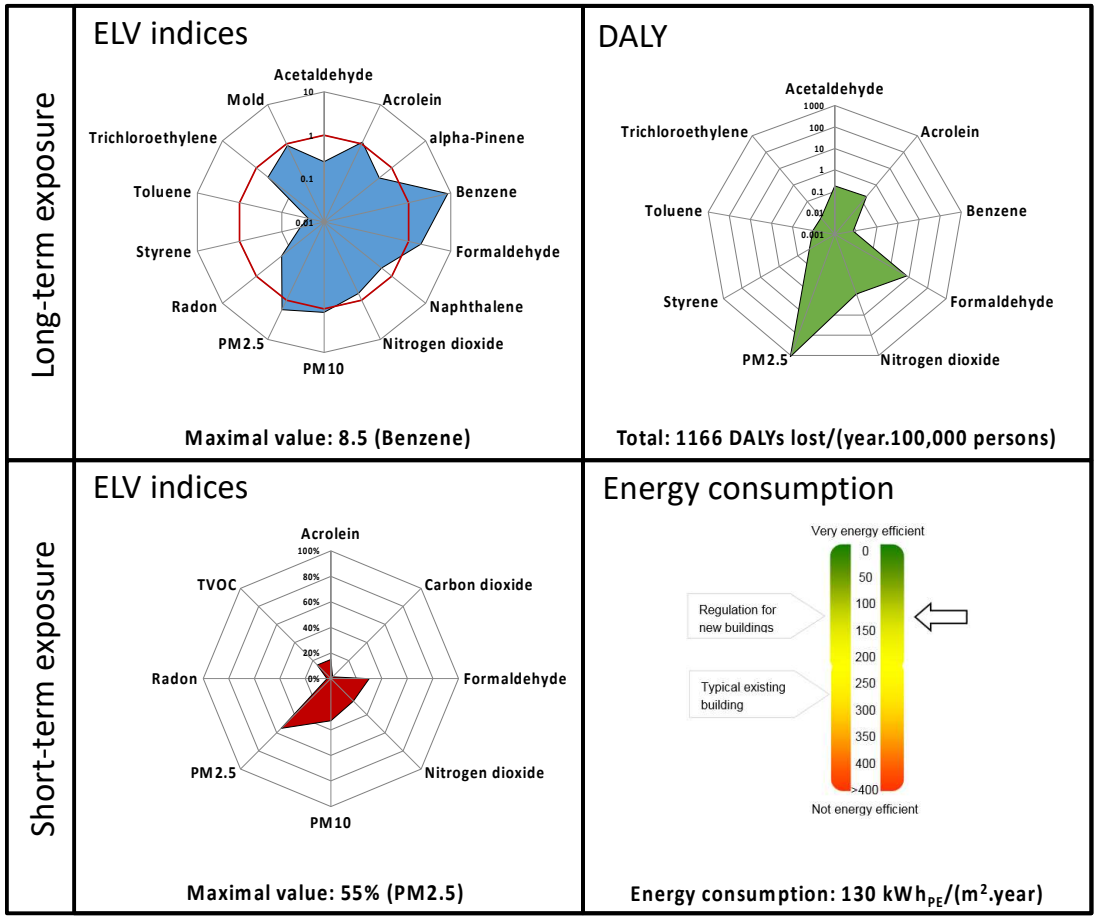
Rating?

3 cases

Comparing cases

Ranking options / engineering case

Across buildings / generic options



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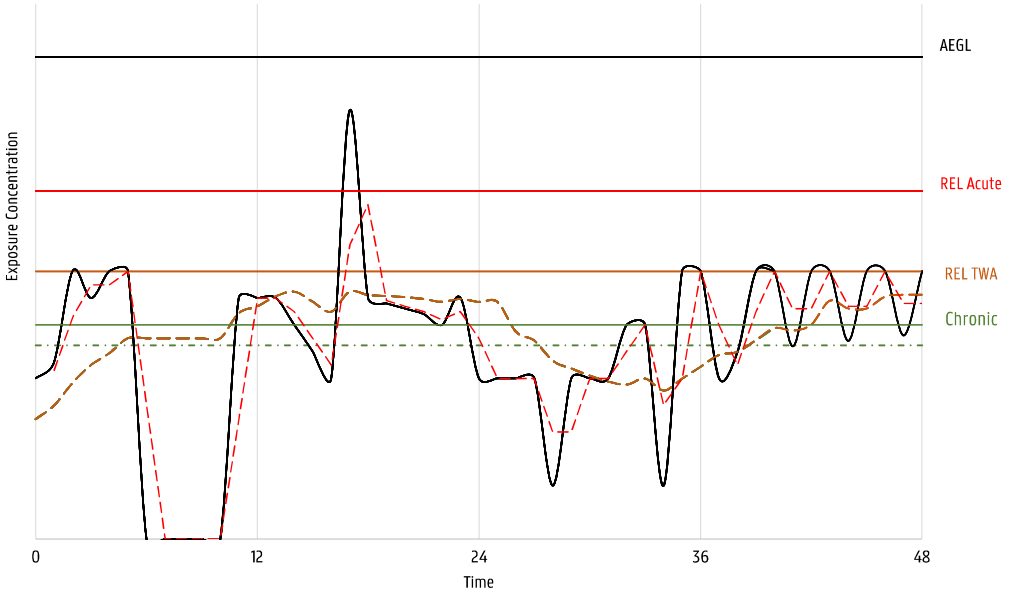
Methodological issues

Conflicts of longterm vs shortterm effects

Resillience?

SBS?

Acceptibility of IAQ?



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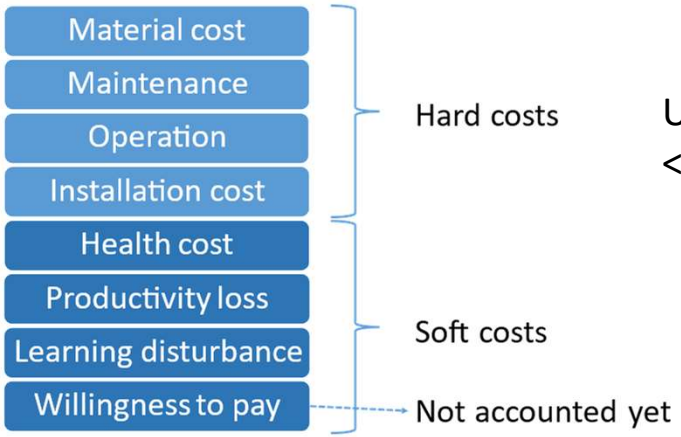
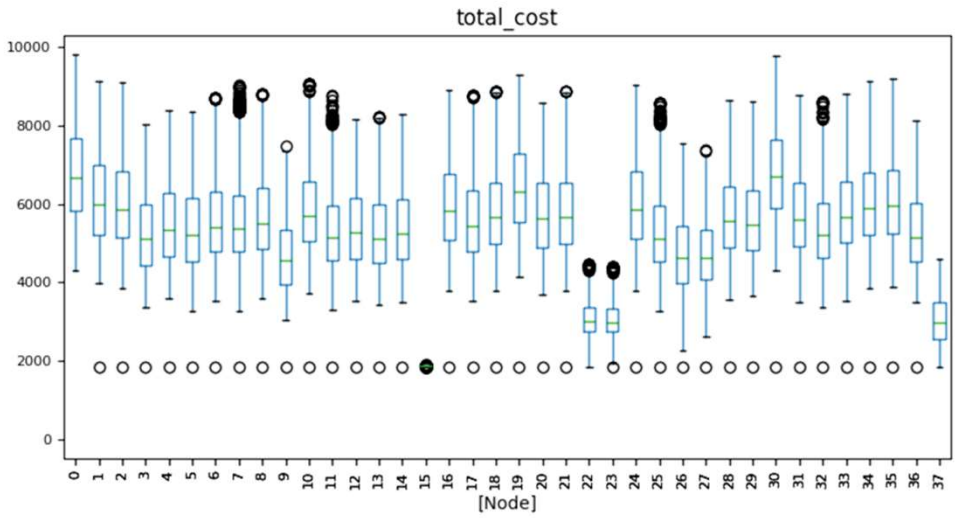


Update on total cost
<> Boulanger et al.



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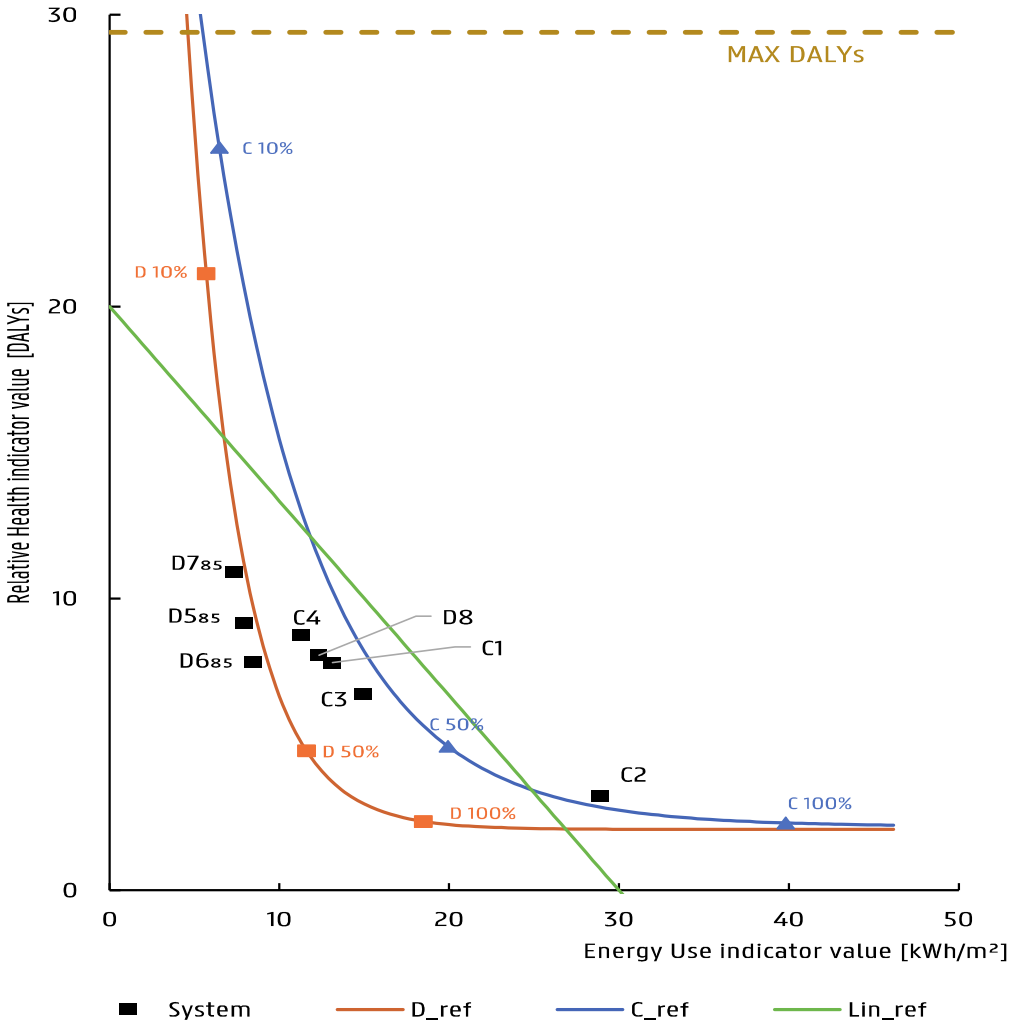


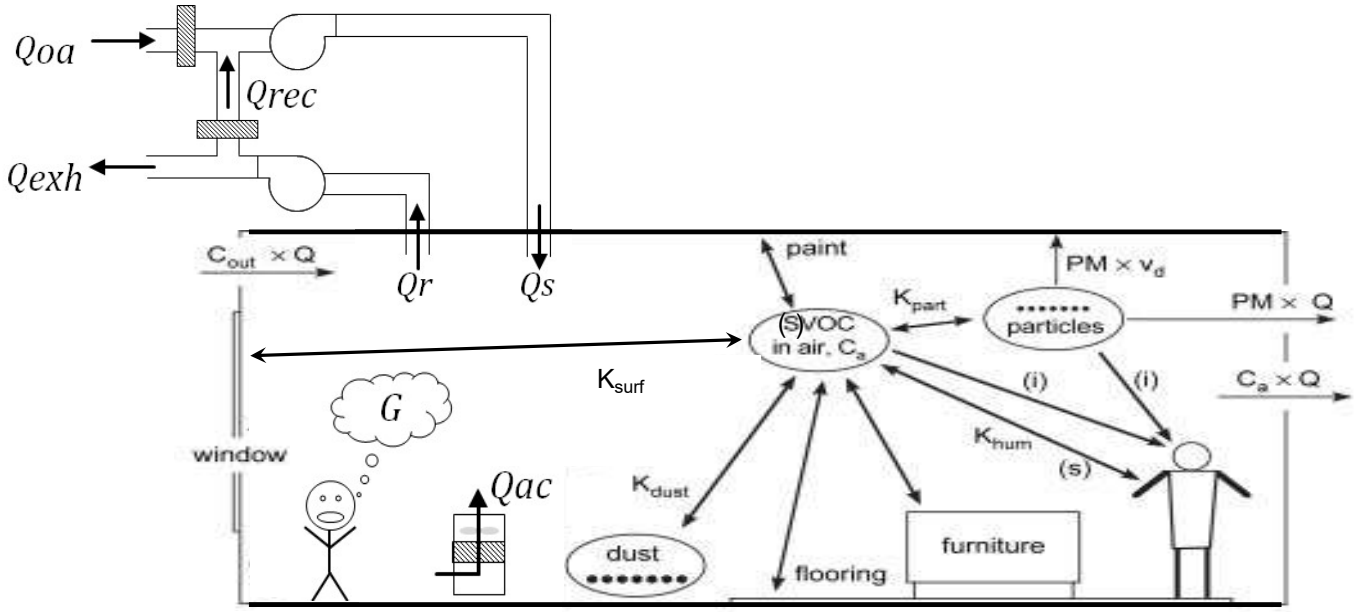
Rating Ecology

Back to cases 2 and 3

Input variables

Standard conditions & physics?

Standardised scenarios?



Mash-up of Weschler et al. & Dols, 2020, https://doi.org/10.6028/NIST.TN.2095

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Rating Ecology

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Missing dose-response curves?

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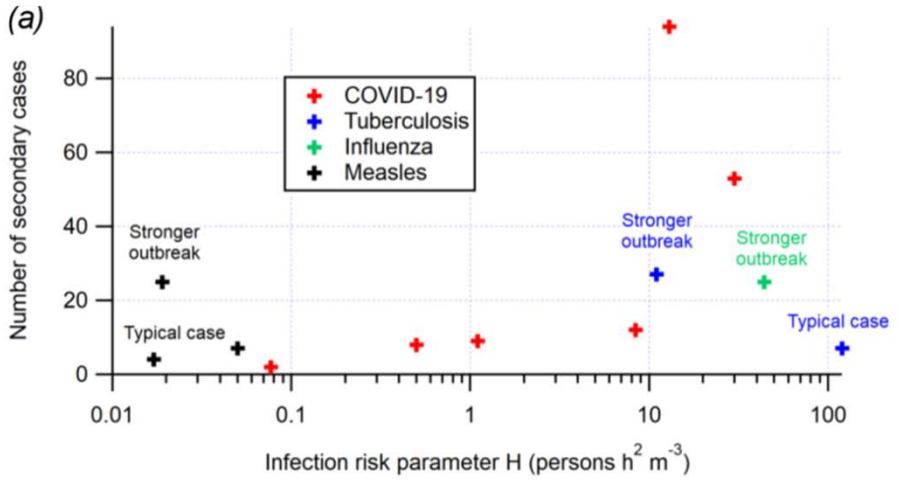

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A2.1b Review of emission rate studies for PANDORA database

Pandora
https://db-pandora.univ-lr.fr/

ST2

1st step: Updating PANDORA with data from 2014-2022

--> EMISSION RATES from published papers/reports and Annex86's data (*Link to TEAMS files)*

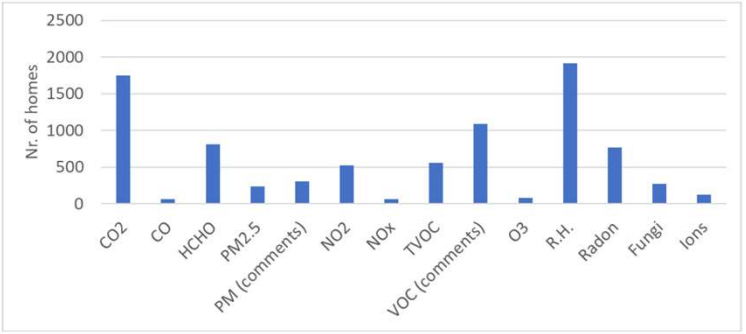
#	First Name	Last Name	Email	Reference of scientific journal paper/conference/report	Pollutants	Sources	Web link to download the reference	File name in ER2PANDORA Files folder
-1	Example: Marc	Abadie	mabadie@univ-lr.fr	*ECA-IAQ 1998. Evaluation of VOC Emission from Building Products: Solid Flooring*	*Various*	*Construction and Decoration Materials*	*https://jpa-prodis.eu/Images/ECA_Report18.pdf*	
0	Example: Marc	Abadie	mabadie@univ-lr.fr	*multiple files*	*Formaldehyde*	*Occupants and Occupant Activities*		*#000_data-ULR.zip*
					PM2.5	*Occupants and Occupant Activities*		
					Benzene	*Furniture*		
					PM2.5	*Bedroom*		
1	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	Nicolas M., Quivet E., Karr G., Real E., Buiron D., Maupetit F. 2017. Exposition aux polluants émis par les bougies et les encens dans les environnements intérieurs : Emissions et risques sanitaires associés. Rapport. 98 pages.	VOCs	Cleaning Products and Air Fresheners	https://librairie.ademe.fr/air-et-bruit/1787-ebene-exposition-aux-polluants-emis-par-les-bougies-et-les-encens-dans-les-environnements-interieurs.html	
2	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	F. MAUPETIT., M. NICOLAS, J. NICOLLE, O. SERAFIN, P. BLONDEAU, 2017. Emissions des matériaux de construction assemblés sous forme de parois : Caractérisation expérimentale et modélisation simplifiée de la qualité de l'air intérieur. Rapport. 193 pages.	VOCs	Construction and Decoration Materials		Rapport PREDICTAIR.pdf
3	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	P. Blondeau, J. Nicolle, G. Séraffin. INCITAIR : Prise en compte du critère qualité de l'air dans les marchés publics destinés aux écoles, Rapport final de l'étude ADEME n°1462C0016, Juillet 2016, 79 p.	VOCs	Furniture and products for school activities	rer-la-qualite-de-l-air-dans-les-creches-les-maternelles-et-les-ecoles-elementaires-de-la-rochelle.html#44-type_de_produit-format_electronique	
4	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	Data compiled by Wei W., Mandin C., Ramalho O. 2018. Influence of indoor environmental factors on mass transfer parameters and concentrations of semi-volatile organic compounds. Chemosphere 195, 233-235 (Table 1)	VOCs	Construction and Decoration Materials		Wei et al compilation emission rates of SVOCs.pdf
5	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	Cantau C., Kinadjian Caplat N., Desauziers V., Plaisance H., Garray H.,Costarramone N. 2020. Émissions de polluants et vieillissement des revêtements de sol commercialisés. Rapport. 104 p.	VOCs	Construction and Decoration Materials		SafeMATER.pdf
6	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	Gross A. 2018. Vers une maitrise de l'impact réel des choix de conception sur la qualité de l'air intérieur des bâtiments tout au long de leur vie. Thesis report. University of Pau and Pays de l'Adour.	VOCs	Construction and Decoration Materials	https://www.theses.fr/2018PAUU3029	
7	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	Nicolas M., Karr G., Real E. Maupetit F. 2019. Impact des produits d'entretien sur la qualité de l'air intérieur. PEPS - Définition d'un protocole d'essais simple et harmonisé pour l'évaluation des émissions en composés volatils. Rapport, 162 pages.	VOCs	Cleaning Products and Air Fresheners		PEPS - rapport final 2019.pdf PEPS - annexes 2019.pdf
8	Patrice	Blondeau	patrice.blondeau@univ-lr.fr	EmiBio : emission des matériaux biosourcés. Report will be available soon !	VOCs	Construction and Decoration Materials	Available soon ...	
9	Jin	Zhou	jenny.zhou@monash.edu	Influence of moisturizer and relative humidity on human emissions of fluorescent b	fluorescent bio	Occupants and Occupant Activities	https://onlinelibrary.wiley.com/doi/10.1111/ina.12349	
10	Marc	Abadie	mabadie@univ-lr.fr	Emission Rates of Volatile Organic Compounds from Humans	VOCs	Occupants and Occupant Activities	https://pubs.acs.org/doi/pdf/10.1021/acs.est.1c08764	
11								

--> New: if you have unpublished data you want to share → please also fill the Teams files.

--> Implementation not started yet, later this year.

A2.1a „Registry" of IAQ monitoring studies

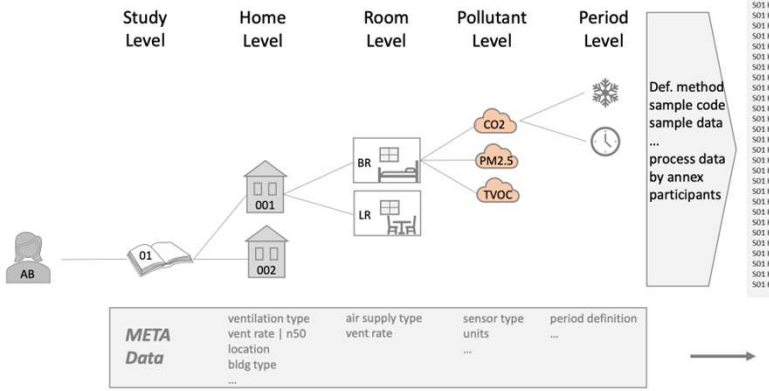
Big Thank you for all entries so far!



>40 monitoring studies from:

Australia	Norway
Austria	Portugal
Belgium	Singapore
Chile	Slovakia
Denmark	Spain
France	Switzerland
Italy	Sweden
Germany	UK
Mexico	USA
Netherlands	

A2.2 - Processing & Analyzing the available data
Status: defining statistical analysis method



STAT data

		AVG	STD	P2.5	P25	P50	P75	P97.5
S01 H001 BR CO2	Heat							
S01 H001 BR CO2	Night							
S01 H001 BR PM2.5	Heat							
S01 H001 BR PM2.5	Night							
S01 H001 BR PM2.5	Heat							
S01 H001 BR PM2.5	Night							
S01 H001 BR TVOC	Heat							
S01 H001 BR TVOC	Night							
S01 H001 BR CO2	Heat							
S01 H001 LR CO2	Night							
S01 H001 LR PM2.5	Heat							
S01 H001 LR PM2.5	Night							
S01 H001 LR PM2.5	Heat							
S01 H001 LR PM2.5	Night							
S01 H001 LR TVOC	Heat							
S01 H001 LR TVOC	Night							
S01 H002 BR CO2	Heat							
S01 H002 BR CO2	Night							
S01 H002 BR PM2.5	Heat							
S01 H002 BR PM2.5	Night							
S01 H002 BR PM2.5	Heat							
S01 H002 BR PM2.5	Night							
S01 H002 BR TVOC	Heat							
S01 H002 BR TVOC	Night							
S01 H002 LR CO2	Heat							
S01 H002 LR CO2	Night							
S01 H002 LR PM2.5	Heat							
S01 H002 LR PM2.5	Night							
S01 H002 LR PM2.5	Heat							
S01 H002 LR PM2.5	Night							
S01 H002 LR TVOC	Heat							
S01 H002 LR TVOC	Night							

-> data repository
-> meta analysis (CE)
-> typical exposure

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ST5

Rating Ecology

Back to cases 2 and 3

Input variables

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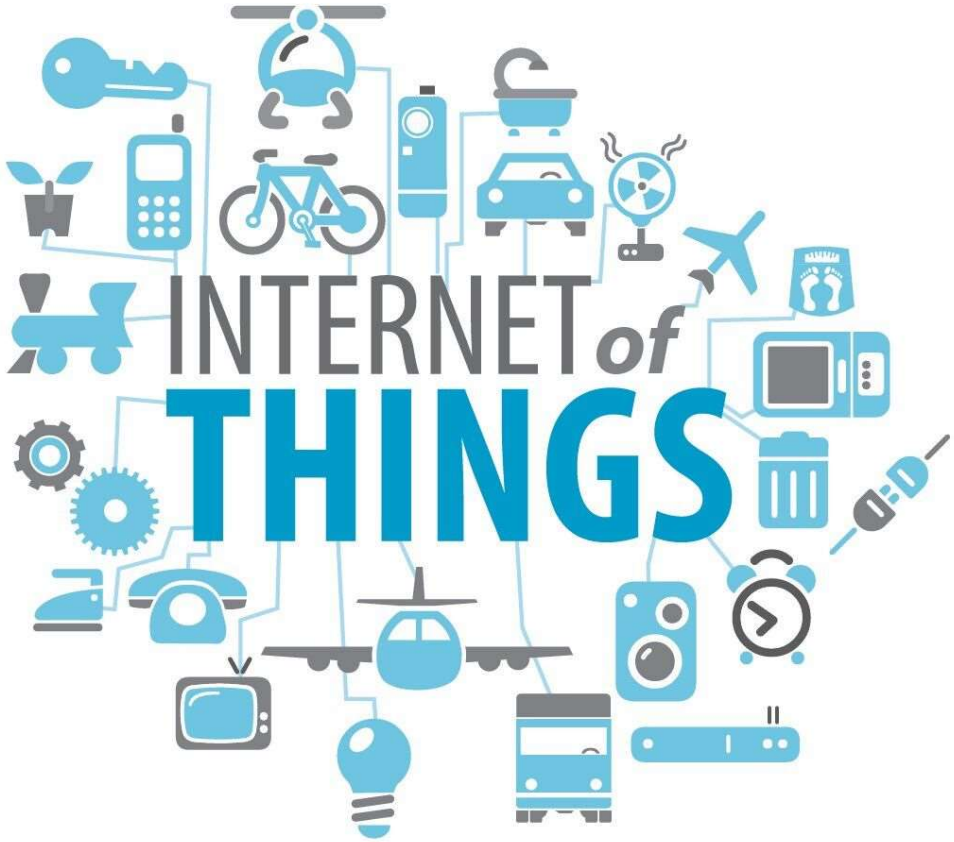
Standard conditions & physics?

Standardised scenarios?



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Rating Ecology

Back to cases 2 and 3

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Standard conditions & physics?

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Annex I
(informative)

Basis for the criteria for indoor air quality and ventilation rates

I.1 Default design ventilation air flow rates

I.1.1 General

Due to health reasons the total minimum airflow rate during occupancy expressed as l/s per person should never be below 4 l/s per person (Table I.3) and the WHO Guideline values in Annex M is met. The default air flow rates given in this Annex I are design ventilation air flow rates.

The default air flow rates given in this Annex assume complete mixing in the room (concentration of pollutants is equal in extract and in occupied zone). For non-residential buildings ventilation rates should be adjusted by the ventilation effectiveness in accordance with prEN 16798-3 if the air distribution differs from complete mixing.

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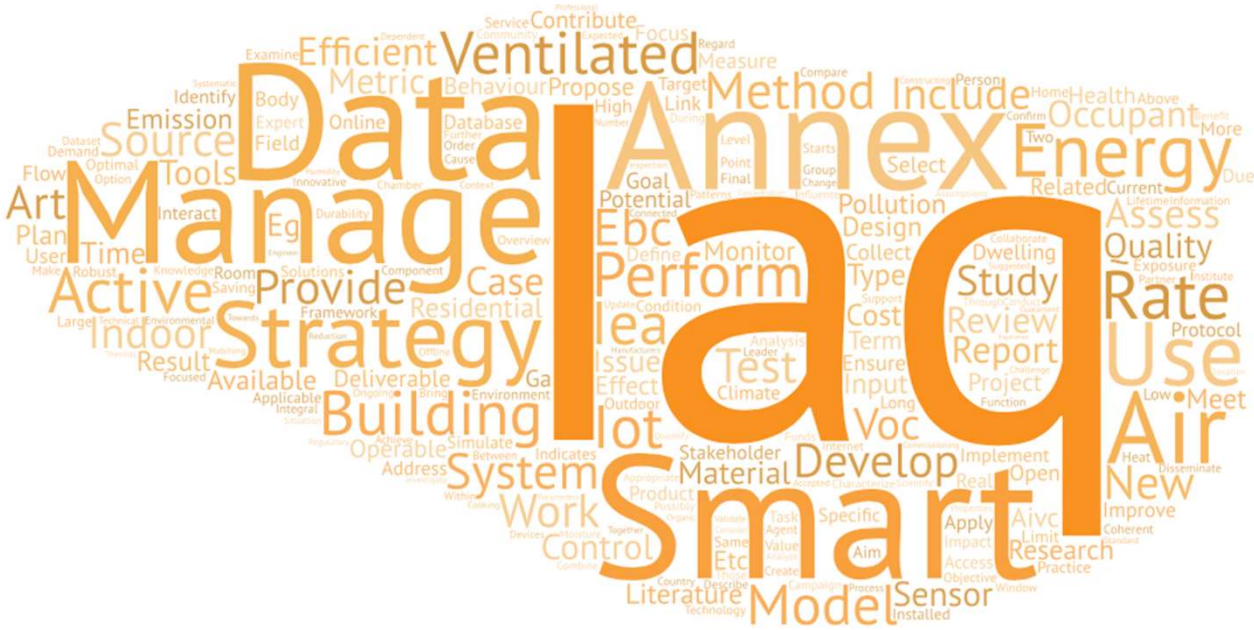
Conclusions

There is no consensus on a framework to rate IAQ as a basis for energy efficiency optimisation in residential buildings

To successfully get there, we need to

- Advance methodologically to define constraints and cost functions
- Provide a ’rating ecology’

Thanks to AIVC for partnering with us to collect your input



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