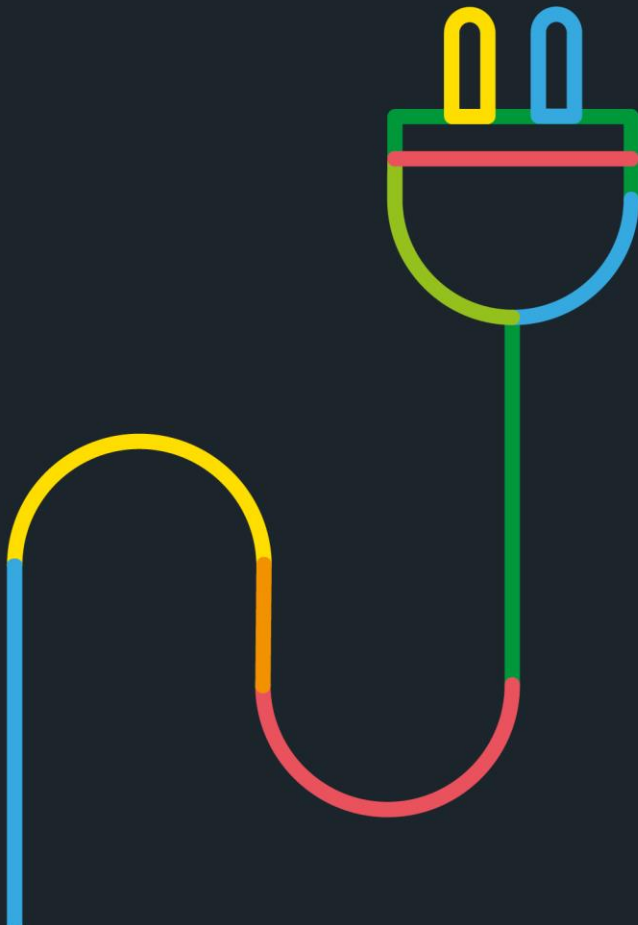


# TAIL - a pragmatic IEQ indicator for building certification (ALDREN project)

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# ALDREN project, basic facts

- Horizon 2020 Coordination and Support Action (CSA)
- Alliance for Deep RENovation in buildings (ALDREN). Implementing the European Common Voluntary Certification Scheme, as backbone along the whole deep renovation process
- Project number ALDREN 754159
- Duration: November 2017-April 2020
- Main objective: To consolidate, promote and implement an extended harmonized procedure based on the European Voluntary Certification Scheme for non-residential buildings (EVCS) and a set of relevant instruments in order to support building deep energy renovation operations all along the process tackling its organizational, financial and technical components issues.
- Focus: offices and hotels



# ALDREN specific goals

- Development of a harmonized energy performance rating method based on the European Voluntary Certification Scheme (EVCS) mandated by the new Energy Performance of Buildings Directive (EPBD).
- Reduction of the gap between predicted (modelled) and actual energy performance of buildings to increase their reliability and compliance.
- **Inclusion of indoor environmental quality (IEQ) in the scope of deep energy renovation to promote solutions supporting comfort and health and to ensure that renovations will not be detrimental to indoor environmental conditions.**
- Linking the building rating in terms of energy, sustainability and IEQ with the private and national financing instruments to emphasize enhanced building value and thus create strong incentives for investment.
- Developing a building passport that integrates, illustrates and documents the different phases of a deep renovation process for proper documentation and dissemination.



# **DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency**

‘Article 2a Long-term renovation strategy

1. Each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings. Each long-term renovation strategy shall be submitted in accordance with the applicable planning and reporting obligations and shall encompass:

(...)

**(g) an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.**



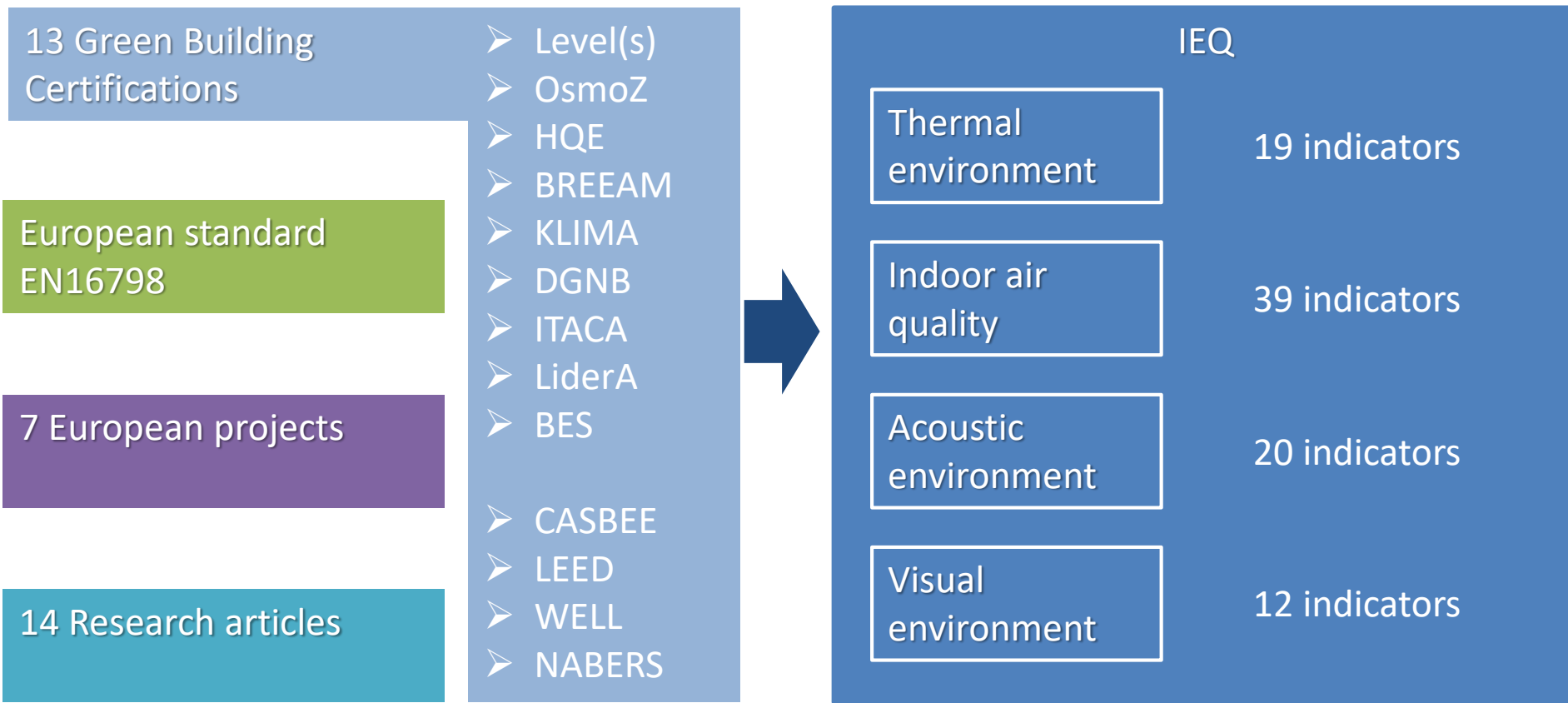
# Classification of IEQ

The ALDREN project attempts to harmonize the IEQ indicators and develop a systematic method for IEQ rating in buildings:

- 1) To guarantee that IEQ is not degraded during renovation to satisfy the EPBD mandate.
- 2) To document any improvements in IEQ after renovation.
- 3) To estimate potential additional benefits from renovation including benefits for health and well-being, as well as the financial benefits from improved productivity and increased value of a building on a market.



# Review of current certification schemes and standards

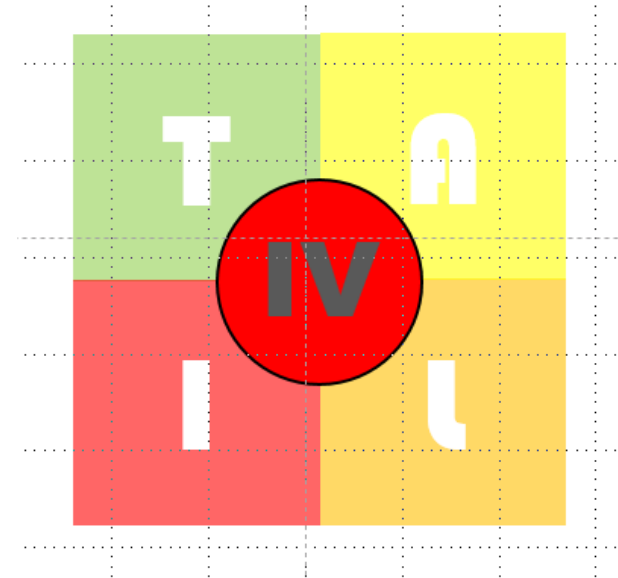


*Wei et al. (2019) Energy and Buildings, in the Press*

# TAIL index as a method of classifying IEQ

Four components:

- Thermal environment
- Acoustic environment
- Indoor air quality
- Light – Luminous (visual) environment

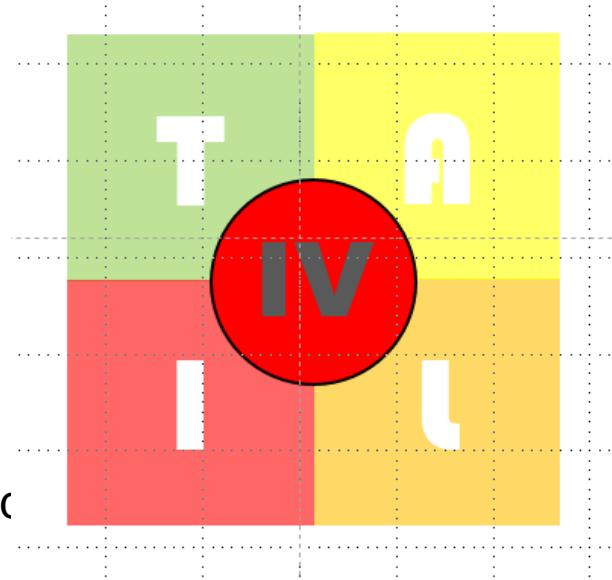


Overall IEQ:

- I II III IV

# The quality of IEQ, the TAIL rating

- Colors: green, yellow, orange, red
- Roman numbers: I, II, III, IV
- Compliant with EN16798-1(2019)
  - Category **I**: High level of expectation and recommended for spaces occupied by sensitive and fragile people with special requirements like some disabilities, sick, very young children and elderly persons, to increase accessibility
  - Category **II**: Normal level of expectation
  - Category **III**: Moderate level of expectation
  - Category **IV**: Low level of expectation. Poor quality. Unacceptable regarding health





# Criteria for selection of parameters defining the quality of components of TAIL

- Parameters that may be changed due to the process of deep energy renovation (no deliberate action to change IEQ)
- Parameters that are included in existing building certification schemes and/or prescribed by the current standards (to allow quick adoption of ALDREN procedures)
- Parameters that can be measured and/or modelled (to allow verification)
- Parameters that have been shown to affect productivity, as well as health, well-being and comfort of building occupants (to allow estimation of economic benefits)
- No parameters selected that directly measure comfort, well-being, health or productivity



# Rating selected IEQ parameters

	IEQ parameter	Measured	Modelled	Visual inspection
<u>T</u>	Indoor temperature (°C)	x	(x)	
<u>A</u>	Noise level (dB(A))	x		
<u>I</u>	CO <sub>2</sub> (ppm)	x	(x)	
	Ventilation rate (L/s)	x	(x)	
	Formaldehyde (µg/m <sup>3</sup> )	x		
	Benzene (µg/m <sup>3</sup> )	x		
	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	x		
	Radon (Bq/m <sup>3</sup> )	x		
	Indoor air relative humidity (%)	x	(x)	
	Visible mold (cm <sup>2</sup> )			x
<u>L</u>	Daylight factor (%)		x	
	Illuminance (lux)	x		



# TAIL IEQ parameters in Green Building Certifications

	TAIL IEQ parameters	EN16798	Level(s)	WELL	HQE	OsmoZ	BES	LEED	BREEAM	KLIMA	CASBEE	NABERS	DGNB	LiderA	ITACA
<u>T</u>	Indoor temperature (°C)	x	x	x	x		x			x	x	x	x	x	
<u>A</u>	Noise level (dB(A))	x		x	x	x	x	x	x	x	x	x			
<u>I</u>	CO <sub>2</sub> (ppm)	x	x	x		x	x	x		x		x			
	Ventilation rate (L/s)	x	x	x	x	x	x	x	x		x	x	x		x
	Formaldehyde (µg/m <sup>3</sup> )	x	x	x	x	x	x	x	x	x		x	x		
	Benzene (µg/m <sup>3</sup> )	x	x	x	x	x									
	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	x	x	x	x	x		x							
	Radon (Bq/m <sup>3</sup> )	x	x	x	x		x								
	Indoor air relative humidity (%)	x	x	x						x					
	Visible mould (cm <sup>2</sup> )		x	x											
<u>L</u>	Daylight factor (%)	x	x		x	x			x		x		x		x
	Illuminance (lux)	x	x	x			x	x	x		x			x	
	<i>Number of parameters</i>	<i>11</i>	<i>11</i>	<i>11</i>	<i>8</i>	<i>7</i>	<i>7</i>	<i>6</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>4</i>	<i>2</i>	<i>2</i>



# Criteria for the rating

- Limit values from WHO, Level(s), GB certifications or EN16798-1
- For example:
  - Noise

## LANDSCAPE OFFICES

- **Green**.  $\leq 35$  dB(A)
- **Yellow**  $\leq 40$  dB(A)
- **Orange**.  $\leq 45$  dB(A)
- Indoor air quality – radon:
  - **Green**  $< 100$  Bq/m<sup>3</sup>
  - **Yellow** & **Orange** [100 – 300] Bq/m<sup>3</sup>
  - **Red**  $\geq 300$  Bq/m<sup>3</sup>
- Illuminance:

## OFFICES AND HOTELS DURING DAY (9 am to 5 pm):

% of time with illuminance between 300-500 lux at work desk height

- **Green** [60 – 100%]
- **Yellow** [40 – 60%]
- **Orange** [10 – 40%]
- **Red**  $< 10\%$



# Rating protocol, overall design

## Intention

- Measurement to be performed before and after DER at the **same season**, or ideally in summer + winter before and summer + winter after
  - Measurements are performed 5 days (MO-FR) in offices and 7 days (MO-MO, or TU-TU, etc.) in hotels
  - Measurements only offices/workplaces in office buildings and only in rooms in hotels
- 

## Potential waivers

- **Modelling** can be used in addition. Modelling can cover all year long.
- Before renovation: results from previous surveys can be used provided that the same or similar methods were implemented



# The cost of TAIL rating

- For one campaign, for a large building (more than 5 rooms):
  - Human resource cost: around 5 days, around 2500 € tax excluded

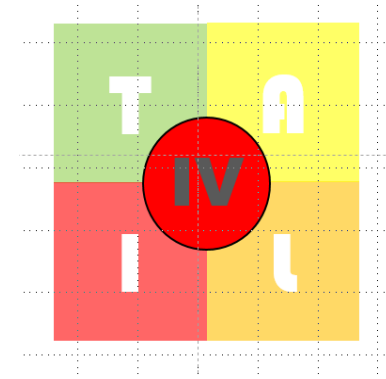
	Number of days (minimum)
Preparation: contact & documents	1
Preparation	0.5
On site: day 1	1 (2 persons x 0.5 day)
On site: day 5 or 8	1 (2 persons x 0.5 day)
Work after the survey: download files, shipment of sampling tubes and filters, etc.	0.5
Ranking and report	1
<b>TOTAL</b>	<b>5</b>

- Consumables (passive samplers, filters), shipment and analyses per room: around 300 €



# Summary

- The framework for rating of IEQ and its components is proposed.
- TAIL - an integrated index describing IEQ level in offices & hotels that undergo deep energy renovation – allows rating of IEQ level before and after renovation.
- TAIL integrates all IEQ components. Based on actual measurements and measuring results. No arbitrary credits are given.
- TAIL treats all IEQ components equally. No weightings are used.
- TAIL complements the existing approaches for IEQ ratings and addresses EPBD mandate.
- TAIL is compliant with major certification schemes, EN16798-1 and Level(s).
- TAIL needs validation.
- TAIL may be extended to schools and homes; must be verified.
- Even though TAIL may be perceived as fairly crude, it is expected to increase the interest of investors in IEQ.



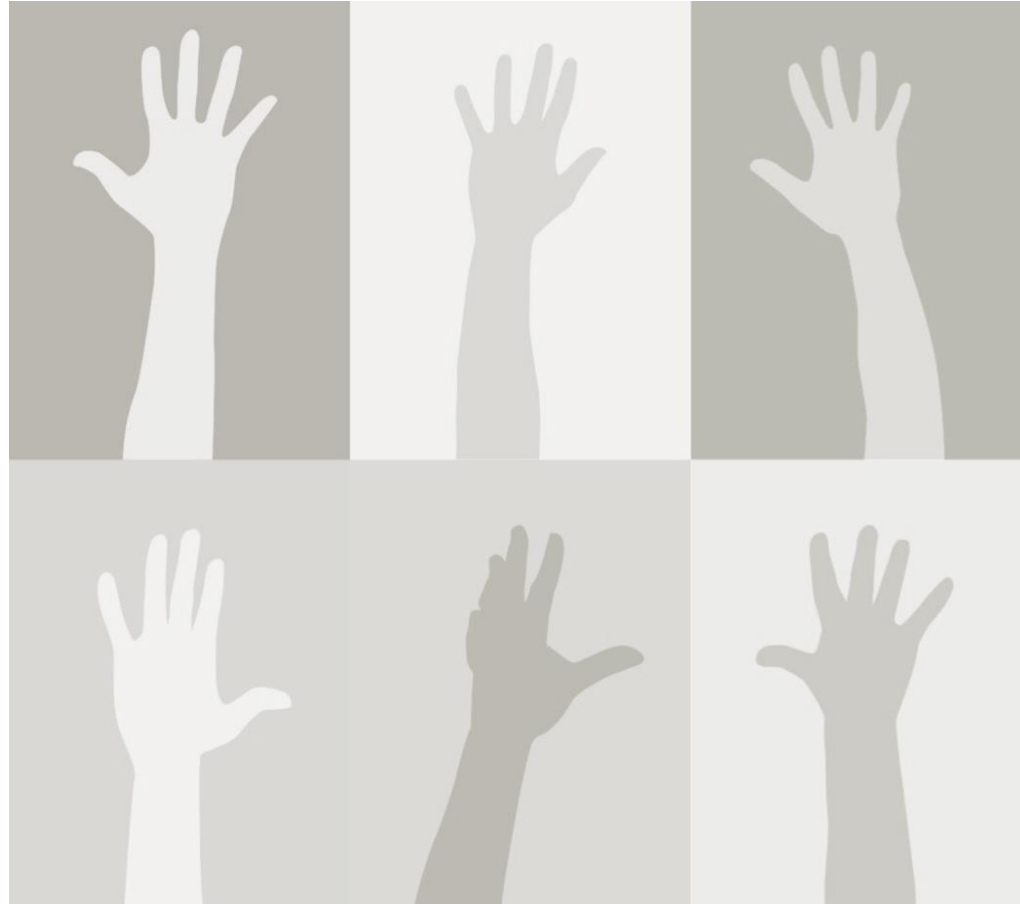
# TAIL perspectives

- Short-time frame: validation of the TAIL concept through ALDREN pilot measurements in buildings undergoing DER.
- Medium-time frame: sensitivity analysis to distinguish differences in IEQ across buildings, applicability of overall rating of IEQ based on the worst IEQ components, verification against modelling and occupant responses and against long-time measurements with more sophisticated instrumentation.
- Long-time frame: extension to new, other public and residential buildings, increasing number of parameters underlying TAIL, inclusion of occupant ratings, extension to include occupant control and preferences, monetizing TAIL and developing instrument measuring TAIL.





# Questions and comments





**ALDREN** Alliance  
for Deep RENovation  
in buildings



[www.aldren.eu](http://www.aldren.eu)

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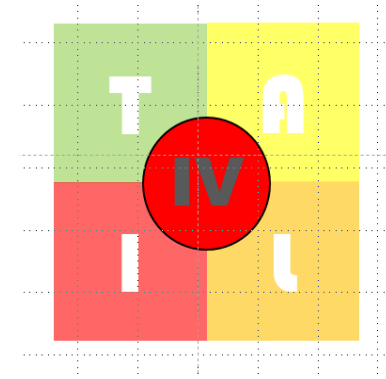
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# The ALDREN - TAIL index, in short TAIL

