Ventilation Performance Assessment Tool

EVIA
European Ventilation Industry Association

Van Holsteijn en Kemna B.V.

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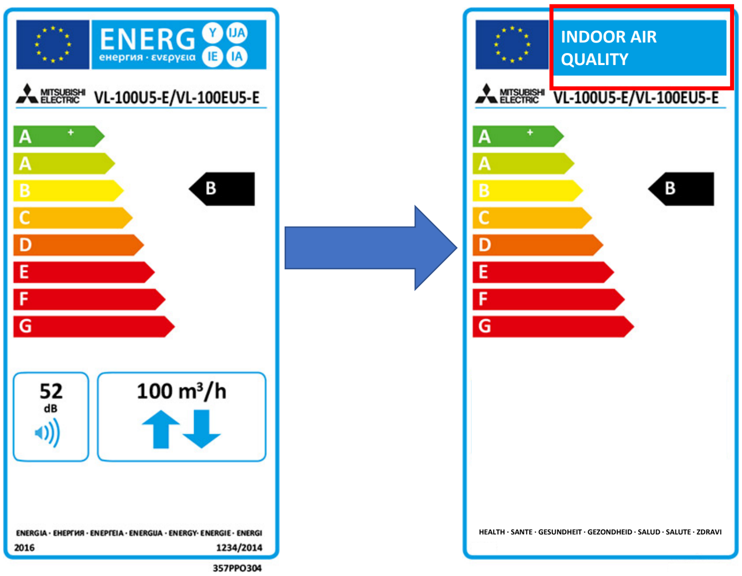
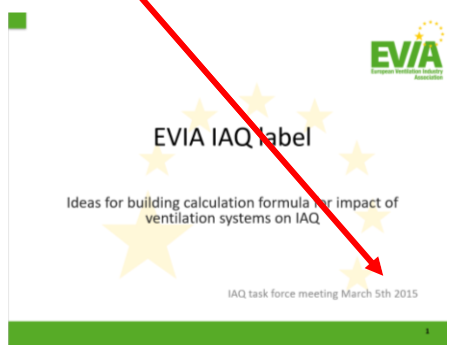
1. Goal: promotion of high performance ventilation systems





2. Methodology

The methodology assesses the actual occurring air exchange rates on room type level during presence and absence.

The Air Exchange Performance (AEP) determines to which extent the ventilation system is able to remove and/or dilute pollutant concentrations in the various rooms, especially during presence when exposure occurs.

Compared to current practice, where only the air exchange rate over the building is assessed, this represents a major step towards more relevant ventilation performance assessment. Current practice after all does not differentiate between the places in which the air exchanges occur nor between periods of presence or absence.

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2. Methodology

VENTILATION PERFORMANCE ASSESSMENT TOOL

Calculation method for assessing the air exchange performance of residential mechanical ventilation units

Documentation related to the Excel Calculation Models

Version December 2022

Client: European Ventilation Industry Association (EVIA)

Prepared by

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Delft, December 2022

Ventilation Performance Assessment Tool
Indoor Air Performance Label calculation

User manual

VPA-tool was developed by VHK and UGhent
for and in cooperation with EVIA

Brussels, December 2022

Prepared by: VHK (R. van Holsteijn, W. Li), UGhent (J. Laverge)
and EVIA (Y. Lambert, L. van Bohemen)

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2. Methodology

Assessment Method

Defining room types and ventilation strategy (1)

Habitable spaces: HS (living rooms, bedrooms, study, etc.)
Pollutants : Bio-effluents, building material emissions, emissions from interior products, pollutants from human activities
Exposure : Inhabitants during presence
Occupancy time: Long / very long

Reference ventilation strategy
Air-exchange : During presence, supply of sufficient fresh outdoor air is key
During absence, basic ventilation rates are required to prevent accumulation of building- and interior products emissions

2. Methodology

Assessment Method

Defining room types and ventilation strategy (2)

Wet or Extract spaces: ES (kitchen, bathroom, toilet, laundry room)

Pollutants : Moisture, odour, building material emissions, emissions from human activities

Exposure : Inhabitants during presence / building to high humidity levels

Occupancy time: Short

Reference ventilation strategy

Air-exchange : During presence, extraction of sufficient air (incl. moisture/odour) is key (supply is adjusted accordingly)
During absence, extraction of air until humidity levels are below threshold values; basic ventilation rates after that.

2. Methodology

Assessment Method

Defining technical system parameters

1. Ventilation System Type (VST) and associated air-exchange provisions in ES and HS
2. Type of MDE/MDS fan and type of NDS (natural direct supply)-grids used in the VST
3. Installed maximum and minimum airflow capacity (limiting factor for achievable air exchange rates)
4. Type of operation / controls (affects system's ability to achieve requested air-exchanges at the right time in the right place)
5. Type of dwelling: number and type of ES and HS, surface of HS, airtightness

2. Methodology

UVU

Ventilation System Type

BVU

VST	roomtype	air exchange provision		abbrev.
1	habitable spaces	supply	natural direct supply	NDS
		extract	natural indirect extract	NIE
	exhaust spaces	supply	natural indirect supply	NIS
		exhaust	natural direct exhaust	NDE
2	habitable spaces	supply	mechanical indirect supply	MIS
		exhaust	natural direct exhaust	NDE
	exhaust spaces	supply	mechanical indirect suply	MIS
		exhaust	natural direct exhaust	NDE
3	habitable spaces	supply	natural direct supply	NDS
		extract	mechanical indirect extract	MIE
	exhaust spaces	supply	mechanical indirect supply	MIS
		exhaust	mechanical direct exhaust	MDE
4	habitable spaces	supply	natural direct supply	NDS
		exhaust	mechanical direct exhaust	MDE
	exhaust spaces	supply	mechanical indirect supply	MIS
		exhaust	mechanical exhaust	MDE
5	habitable spaces	supply	mechanical direct supply	MDS
		extract	mechanical indirect extract	MIE
	exhaust spaces	supply	mechanical indirect supply	MIS
		exhaust	mechanical direct exhaust	MDE
6	habitable spaces	supply	mechanical indirect supply	MIS
		exhaust	mechanical direct exhaust	MDE
	exhaust spaces	supply	mechanical indirect supply	MIS
		exhaust	mechanical direct exhaust	MDE
7	habitable spaces	supply	mechanical direct supply	MDS
		exhaust	mechanical direct exhaust	MDE
	exhaust spaces	supply	mechanical indirect supply	MIS
		exhaust	mechanical direct exhaust	MDE

2. Methodology

Assessment Method

Principle for calculating occurring ***AER*** : $AER = q_{v;inst} * P_{qv;inst} * f_{ctrl}$ *(1)*

$q_{v;inst}$ = Installed min. and max. ventilation capacity in ES and HS

$P_{qv;inst}$ = The probability that installed ventilation capacity in ES &HS is actually achieved. This is calculated, taking into account the following parameters:

- Driving force (natural versus mechanical)
- Number and position of internal doors (i.e. open or closed, applicable to certain VSTs)
- Airtightness of the dwelling and location of leakages (applicable to certain VSTs)
- Duct leakages RVU (reducing intended mech. supply/exhaust airflows)
- Filter compensation BVU (reducing supply airflow due to clogging filters, acc EN13142)
- Internal leakage BVU (reducing share of air that is supplied or extracted, acc. EN13142)
- Airflow sensitivity 'v' (sensitivity RVU for pressure variations over façade, acc. EN13141-8)
- Indoor/outdoor airtightness 'q_{vio}' of (local) RVU (acc. EN13141-8)

2. Methodology

Assessment Method

Principle for calculating occurring ***AER*** *:* $AER = qv;inst * Pqv;inst * fctrl$ *(2)*

fctrl = The probability that the controls of the ventilation provisions are in the right position to achieve the required airflow rate.

*f*ctrl is calculated, taking into account the PCO-values of the related controls. For a list of *Ctrl*-types PCO values have been determined for ES and HS for both periods of presence and absence.

For **all ES** and combined **HS** the occurring **AER** is calculated for periods of presence and absence.

2. Methodology

Assessment Method

Principle for calculating Air Exchange Performance ***AEP*** *:* $AEP = AER / AER_{ref}$ *(1)*

AERref = The reference air exchange rate; a value is determined for ES and HS and for periods of presence and absence based on EN 16798-1, Annex B, Category II

AER*ref*	AER*ref* for HS	AER*ref* for ES		
		bathroom	kitchen	toilet
During presence	0,47 l/s/m²	20 l/s	10 l/s	10 l/s
During absence	0,13 l/s/m²	4 l/s	2 l/s	2 l/s

For **all ES** and combined **HS** the **AEP** is calculated for periods of presence and absence.

3. Input/output sheet

VST 5	EXHAUST SPACES (ES)	HABITABLE SPACES (HS)
SUPPLY PROVISIONS	MIS	MDS
EXHAUST PROVISIONS	MDE	MIE

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1. Dwelling airtightness

airtightness parameter	n50	value:	2,00	air changes per hour

2. Specify number of Exhaust (ES) and Habitable Spaces (HS)

open_kitchen	bathroom	toilet	utility	other	total ES	habitable spaces	
number	number	number	number	number	number	number	total surface area in m²
1	1	1	0	0	3	3	66,00

3. Select BVU-type

BVU-type	1	CENTR.BIDIR.VENT.UNIT| VARIABLE FLOWRATE | FIXED FLOWRATE RATIO ES &HS
BVU *Ffc*	20%	Measured filter compensation factor according to Annex D EN 13142; if not known a default of 20% is used
BVU *Fil*	6%	Measured fraction of exhaust air recirculating in supply air, measured acc. to chamber tracer gas method EN13142; if not known a default of 6% is used

4. Specify maximum MDE (= MDS) capacity to be installed

5. Specify minimum MDE (= MDS) capacity

6. MIS- and MIE capacity as % of MDE and MDS acc. Good Practice

	MDE capacity per ES type						installed MDS capacity HS (with clean filter and not corrected for *Fil*)	
	open_kitchen	bathroom	toilet	utility	other	total MDE	habitable spaces	
	l/s	l/s	l/s	l/s	l/s	l/s	l/s	l/s/m2
4. maximum	30,00	15,00	10,00			55,00	55,00	0,83
5. minimum	6,00	3,00	2,00			11,00	11,00	0,17
	20,0%	Ratio min/max capacity must be idential when MDE-type 1 is selected						
	MIS capacity						MIE capacity	
6.	100%	100%	100%			100%	100%	

7. Specify type of control from Exhaust and Habitable Spaces

Controls ES					Controls HS	
MDE kitch.	MDE bathr.	MDE toilet	MDE utility	MDE-other	MDS habitable spaces	
cntrl type	cntrl type	cntrl type	cntrl type	cntrl type	% of HS area	cntrl type
RH-local	RH-local	PIR			100%	no control

RESULTS

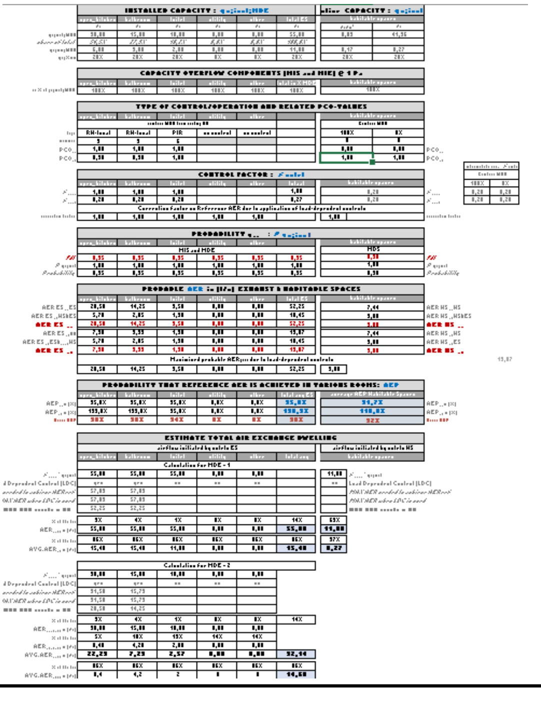
Probability that requested air exch. rate occurs in indiv. spaces

	AEP ES						AEP HS	
	open_kitchen	bathroom	toilet	utility	other	average ES	average HS	
presence	95%	95%	95%			95%	32%	presence
absence	133%	133%	95%			130%	119%	absence
overall AEP	98%	98%	94%			98%	32%	overall AEP

Average air exchange rate (AER) over total dwelling @ default occupation

average AER DWELLING			
dm³/s	m³/h	ach	dm³/s/m² A
21	75	0,31	0,23

4. Calculation sheet



5. Lookup tables

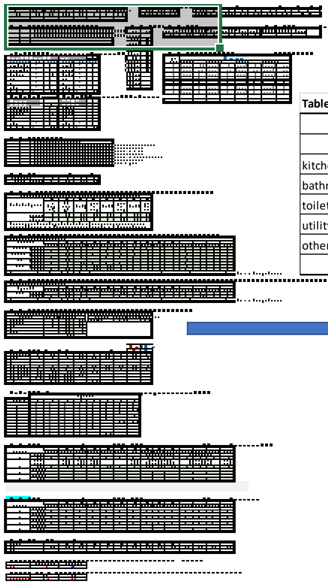
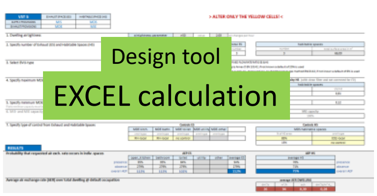
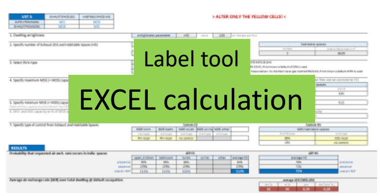


Table 13 : REFERENCE VALUES FOR OCCUPANCY IN ES AND HS									
Average occupation Exhaust Spaces					Average occupation Habitable Spaces				
Type ES		Number	% of the day		Type HS		%Occ;Inhab	% of the day	% Occ;Ahab
kitchen		1	9%	9%	all HS		60%	**63%**	50%
bathroom		1	4%	4%					
toilet		1	1%	1%					
utility		0	1%	0%					
other		0	1%	0%					
			Occupation ES	**14%**					





Ventilation Performance

Ventilation Performance Label

Design tool	Label tool
Any size of dwelling	Reference dwelling (source : EU28 Buildings Database)
National Air Exchange Rates (source: national ventilation standard)	EU Air Exchange Rates (source: prEN 16798-1)
VU product data (source: company)	VU product data (source: company)

Table 8. Parameters of reference dwelling

Total dwellings surface (heated space)	92,40 m^2
Total internal volume	240 m^3
Total surface of habitable spaces	66 m^2
Number of Exhaust Spaces	3 : kitchen, bathroom toilet
Type of kitchen	Open kitchen (combined with dining room)
Number of habitable spaces	3
Airtightness dwelling	N50 = 2.00

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VST 5	EXHAUST SPACES (ES)	HABITABLE SPACES (HS)
SUPPLY PROVISIONS	MIS	MDS
EXHAUST PROVISIONS	MDE	MIE

> ALTER ONLY THE YELLOW CELLS! <

1. Dwelling airtightness

airtightness parameter	n50	value:	2,00	air changes per hour

2. Specify number of Exhaust (ES) and Habitable Spaces (HS)

open_kitchen	bathroom	toilet	utility	other	total ES
number	number	number	number	number	number
1	1	1	0	0	3

habitable spaces	
number	total surface area in m^2
3	66,00

3. Select BVU-type

BVU-type	1	CENTR.BIDIR.VENT.UNIT| VARIABLE FLOWRATE | FIXED FLOWRATE RATIO ES &HS
BVU *Ffc*	5%	asured filter compensation factor according to Annex D EN 13142; if not known a default value of 20% is used
BVU *Fil*	1%	Measured fraction of exhaust air recirculating in supply air, measured acc. to chamber tracer gas method EN13142; if not known a default of 6% is used

4. Specify maximum MDE (= MDS) capacity to be installed
5. Specify minimum MDE (= MDS) capacity

Ratio min/max capacity must be idential when MDE-type 1 is selected

6. MIS- and MIE capacity as % of MDE and MDS acc. Good Practice

	MDE capacity per ES type					
	open_kitchen	bathroom	toilet	utility	other	total MDE
	l/s	l/s	l/s	l/s	l/s	l/s
4. maximum	20,00	10,00	10,00			40,00
5. minimum	4,00	2,00	2,00			8,00
ratio	20,0%	20,0%	20,0%			
6. MIS capacity	100%	100%	100%			100%

	installed MDS capacity HS (with clean filter and not corrected for *Fil*)	
	habitable spaces	
	l/s	l/s/m2
4. maximum	40,00	0,61
5. minimum	8,00	0,12
6. MIE capacity	100%	

7. Specify type of control from Exhaust and Habitable Spaces

Controls ES					
MDE kitch.	MDE bathr.	MDE toilet	MDE utility	MDE-other	
cntrl type	cntrl type	cntrl type	cntrl type	cntrl type	
RH-centr.	RH-centr.	RH-centr.			

Controls HS	
MDS habitable spaces	
% of HS area	cntrl type
85%	CO2-local
15%	no control

RESULTS

Probability that requested air exch. rate occurs in indiv. spaces

AEP ES	open_kitchen	bathroom	toilet	utility	other	average ES
presence	84%	84%	84%			84%
absence	279%	279%	279%			279%
overall AEP	102%	102%	102%			102%

AEP HS	average HS
presence	96%
absence	68%
overall AEP	94%

Average air exchange performance (AEP) and air exchange rate (AER) over total dwelling @ default occupation

combined AEP DWELLING

95%

average AER DWELLING

dm^3/s	m^3/h	ach	$dm^3/s/m^2$ A...
25	90	0,38	0,27

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When selecting the controls for HS, there is a possibility to choose the location and the type of sensor.

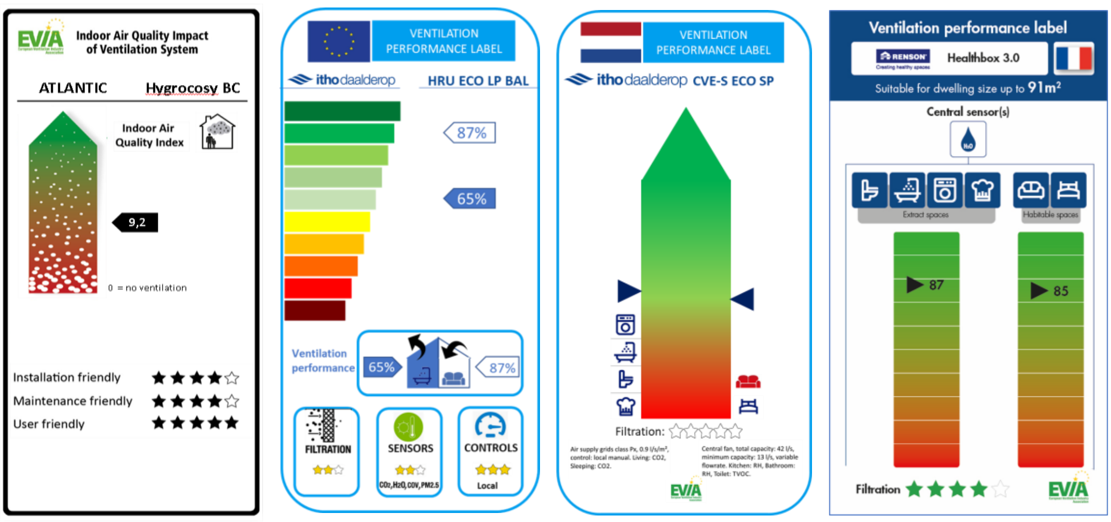
Controls HS

% of HS area	cntrl type	% of HS area	cntrl type	% MDE
100%	manual	60%	CO2-local	100%
		40%	no control	

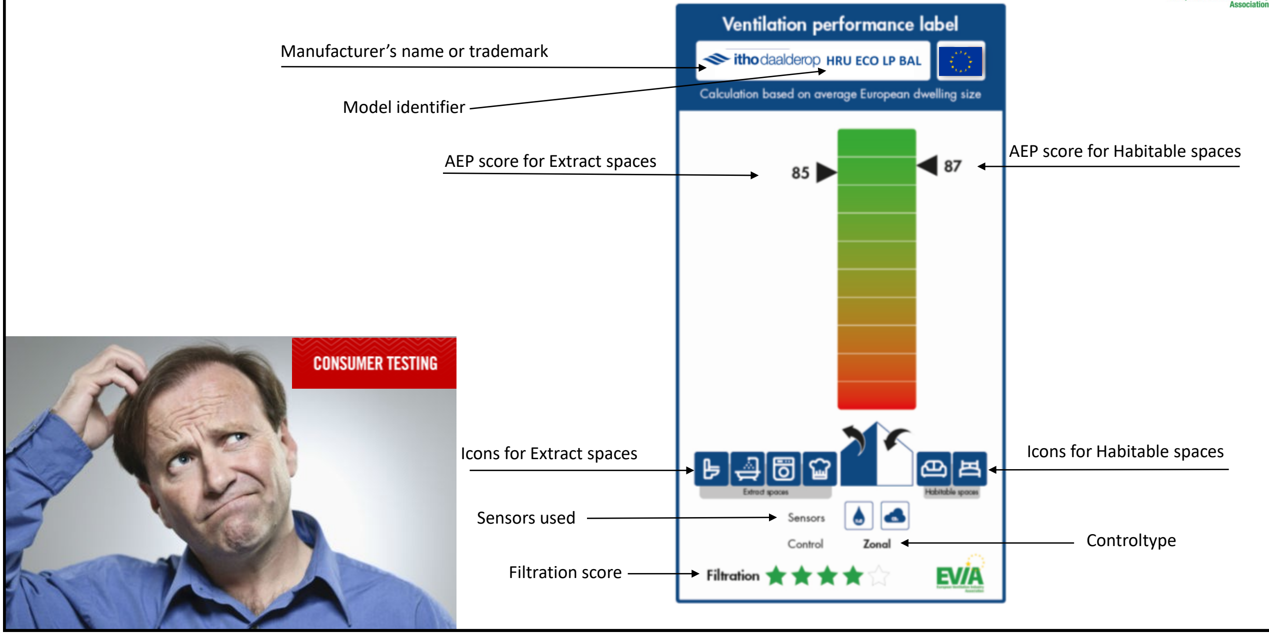
The % of HS area it affects is determined by this table :

Sensor in						
Living room	X	X	X			
Master Bedroom	X	X		X	X	
Children's bedroom	X			X		X
% of HS	**100%**	**85%**	**60%**	**40%**	**25%**	**15%**

6. Label design



6. Label design



7. Merged Air Exchange Performance

RESULTS

Probability that requested air exch. rate occurs in indiv. spaces

	AEP ES						AEP HS	
	open_kitchen	bathroom	toilet	utility	other	average ES	average HS	
presence	72%	31%	31%			57%	33%	presence
absence	171%	95%	95%			119%	89%	absence
overall AEP	79%	30%	30%			59%	32%	overall AEP

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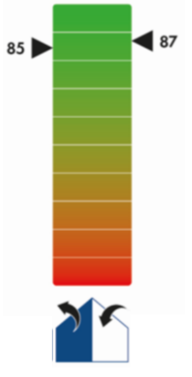
Merged AEP %



Exposure occurs only during presence, so it is valid approach to use occupancy as the dominant weighting factor. According to the occupancy schedule, total occupancy in ES = 14% and in the HS = 63% of the day. This gives the following formula and subsequent classes:

AEPdwelling = ((AEP-ES)*14% + (AEP-HS)*63%) / 77%

55%	70%	C
70%	85%	B
85%	>100%	A

8. Indoor Air Performance label generator

Name or logo (upload)

Supplier's name or trade mark *

Supplier's name or trade mark

Supplier's model identifier *

Supplier's model identifier

VPAT score

A

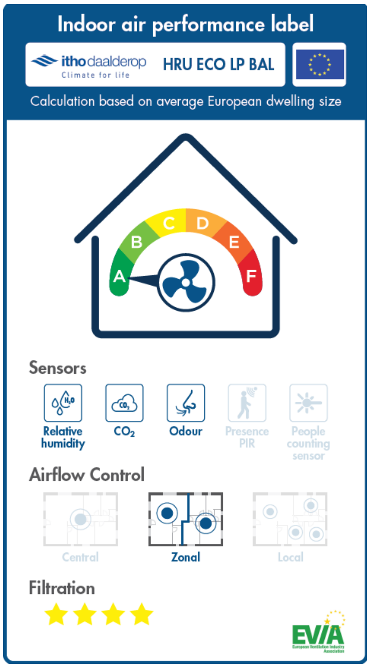
Sensor(s)	Yes	No
Relative Humidity	O	O
CO_2	O	O
Odour (TVOC)	O	O
Presence (PIR)	O	O
People counting sensor (Bidirectional laser)	O	O

Airflow Control

Central

Filtration

★★★★☆



9a. Example: VST5 manual control

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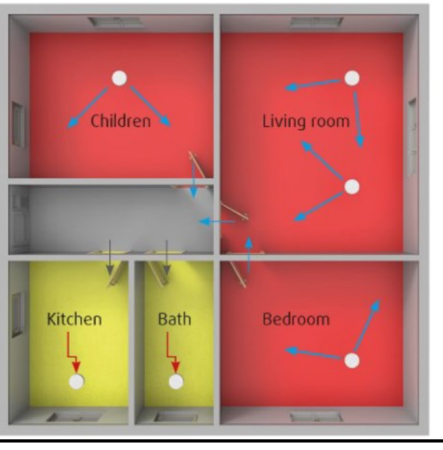
Manual control

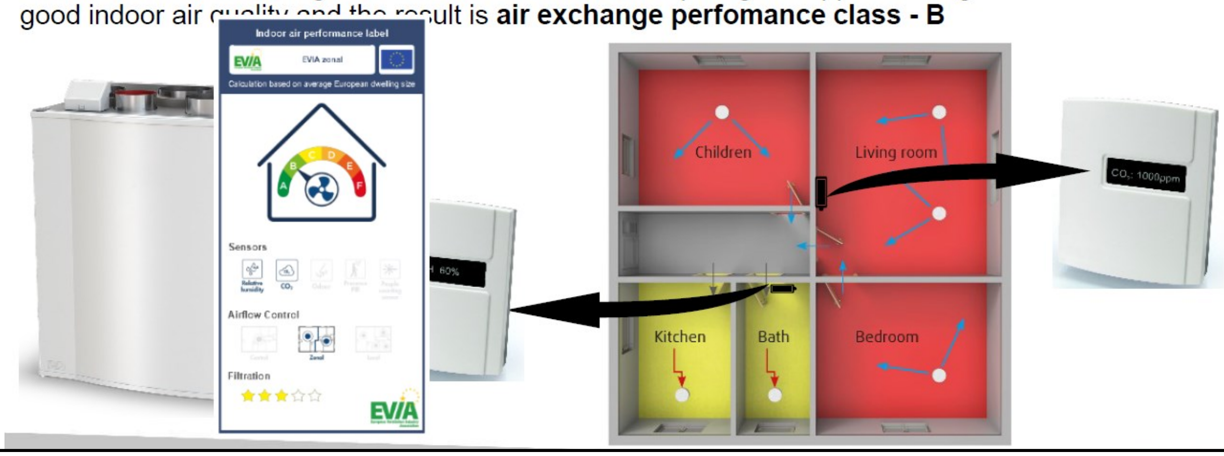
Adaption of the Ventilation effect depends on actions of the user and the air volume change effects all rooms. In most cases, the result is an under or over ventilation which leads to a rather bad **air exchange perfomance class - D**



9b. Example VST5 zonal demand control

Zonal demand control with 2 sensors

Adaption of the Ventilation effect depends on changes of the measured parameters and the air volume change effects all rooms. This is a quite good approach to get a good indoor air quality and the result is **air exchange perfomance class - B**



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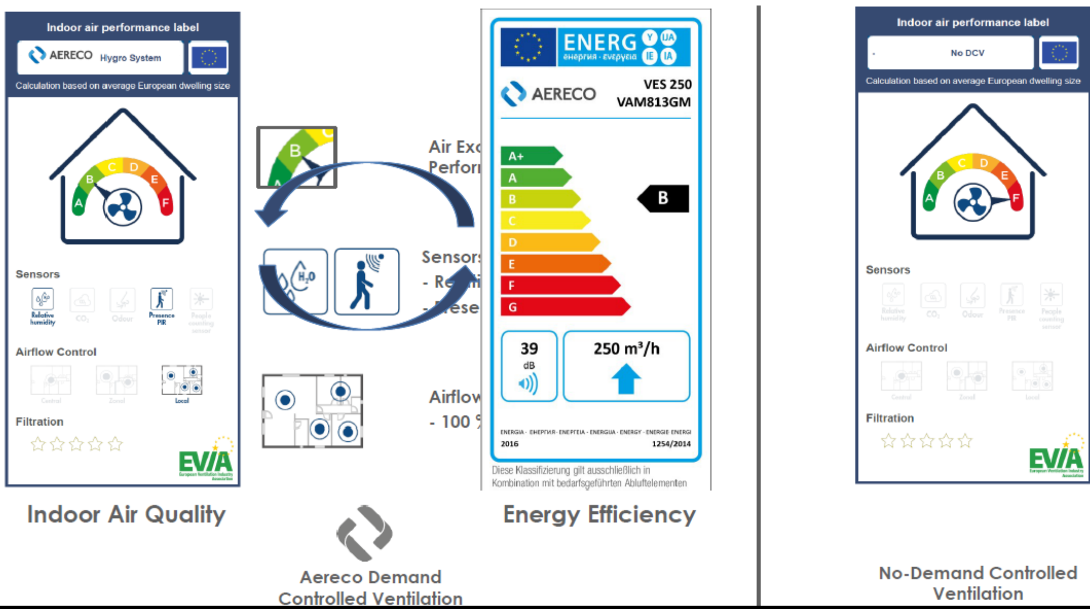
10. Example: VST3 without/with demand control



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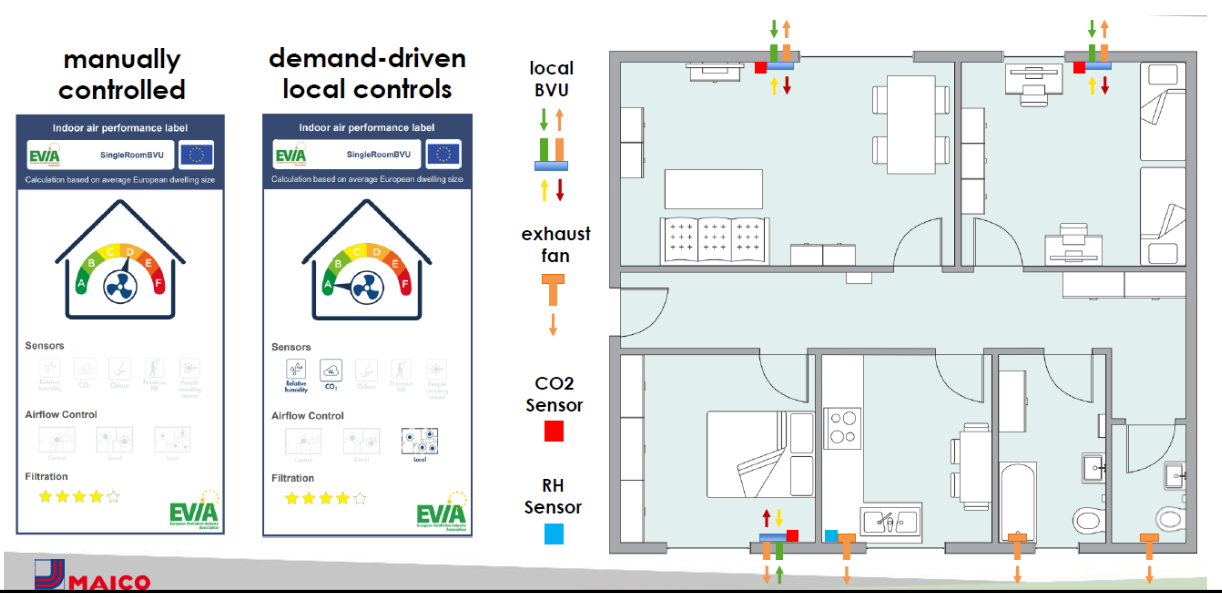
11. Example: VST7 Single room unit with heat recovery



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Ventilation Performance Assessment Tool

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