Follow-up Study on the Review of Commission Regulation 1253/2014 (Ecodesign) and 1254/2014 (Energy Labelling) on Ventilation Units

Phase 1.1: Technical Analysis (Draft)

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1.1.1 Topic introduction

A ventilation product is the unit as sold to end-user whereas the system is the HVAC system in which it resides, i.e., including installation and application-related details. The fundamental functioning elements of the product define its capabilities in a stand-alone/laboratory bench condition. The product's functionality when it has been installed are determined by the multitude of elements that define the in-situ functioning system.

The overall energy consumption of the Residential Ventilation Unit (RVU) is based upon the fittings, controls, and run time as the device works to move the right amount of air to achieve comfort and maintain indoor air quality.

For consumers to select the right RVU for their application, the product label must clearly provide an adequate number of comparative highlights that can be easily assimilated without excessive technical jargon. And since optimum laboratory measurements cannot always be easily or accurately achieved in the field for verification purposes, uniform laboratory testing and certification procedures must provide reliable information.

While the labelling regulation is legally a product regulation, the question is whether external system-level factors should be considered in great detail (as is the case in the draft proposal), or in less detail (as is the case in the current regulation), or to some other level of detail: How many system related elements can be included in pre-installed product labelling?

To analyse the system-level factors included in the label, the specific energy consumption (SEC) formula for RVUs is analysed. This is to determine whether it is a clear and fair metric for manufacturers to measure the energy efficiency of these products.

Under the current regulation 1254/2014, the SEC (expressed in kWh/m²) sets out the classification for the label and is calculated via the following formula:

$$SEC = t_a \cdot pef \cdot q_{net} \cdot MISC \cdot CTRL^x \cdot SPI - t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot (q_{ref} - q_{net} \cdot CTRL \cdot MISC \cdot (1 - \eta_t)) + Q_{defr}$$

The proposed new version of the SEC formula in the Draft Revised Ecodesign Regulation 1253 omits the MISC factor and is calculated as follows:

$$SEC = t_a \cdot pef \cdot q_{net} \cdot CTRL^x \cdot SPI - t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot (q_{ref} - q_{net} \cdot CTRL \cdot (1-\eta_e)) + CTRL \cdot (1-\eta_x) \cdot Q_{defr}$$

Whereby,

- t_a is annual operating hours [h/a];
- pef is the primary energy factor for electric power generation and distribution [-];
- q_{net} is reference net mechanical ventilation rate demand per m² heated floor area for achieving category II ventilation performance [m³/h.m²];
- CTRL is the ventilation control factor [-]
- x is an exponent that takes into account non-linearity between thermal energy and electricity saving, depending on motor and drive characteristics;
- SPI is specific power input [kW/(m³/h)];
- t_h is total hours heating season [h];
- ΔT_h is the average difference in indoor (19 °C) and outdoor temperature over a heating season, minus 3 K correction for solar and internal gains [K];

- η_h is the average space heating efficiency [-];
- c_{air} is the specific heat capacity of air at constant pressure and density [kWh/(m^3 K)];
- q_{ref} is the reference natural ventilation rate per m^2 heated floor area [m^3/h.m^2];
- n_e is the total energy recovery ratio [-], determined according to Table 5 in the draft Regulation
- n_x is the humidity recovery ratio [-]
- Q_{defr} is the annual heating energy per m^2 heated floor are [kWh/m^2.a} for frost protection with CTRL-factor =1, to be taken from Table 5 in Annex IV in the Draft Revised Ecodesign Regulation 1253 where default values for Q_{defr} are given based on the frost protection strategy that is used in the BVU. Q_{defr} applies only to bidirectional units with recuperative heat exchanger; for unidirectional units or units with regenerative heat exchanger is Q_{defr} = 0.

These terms can be categorised as follows:

Default parameters set in the draft Regulation:

- x – depends on the motor & drive. Set as 1.2 for 2-speed, 1.5 for multi-speed and 2.0 for variable speed;
- t_h – depends on the climate. Set as 6446 for cold, 4910 for average, and 3590 for warm.
- ΔT_h – depends on the climate. Set as 14.53 for cold, 10.94 for average, and 5.21 for warm.
- q_{ref} – Set as 1.00 for Non-ducted RVU-ES, 1.50 for Non-ducted RVU-HS, and 2.50 for Ducted RVU ES&HS
- q_{net} – Set as 0.79 for Non-ducted RVU-ES, 1.18 for Non-ducted RVU-HS, and 1.97 for Ducted RVU ES&HS
- t_a – set as 8760
- pef – set as 2.1
- η_h – set as 75%
- c_{air} – set as 0.000344
- CTRL - Depending on the type of RVU and its level of flow control (through controllable valves), and depending on the type of ventilation demand control (VDC), the CTRL-factor can be determined from Table 3 in Annex IV in the Draft Revised Ecodesign Regulation 1253
- Q_{defr} is the annual heating energy per m^2 heated floor are [kWh/m^2.a} for frost protection with CTRL-factor =1, to be taken from Table 5 in Annex IV in the Draft Revised Ecodesign Regulation 1253 where default values for Q_{defr} are given based on the frost protection strategy that is used in the BVU. Q_{defr} applies only to bidirectional units with recuperative heat exchanger; for unidirectional units or units with regenerative heat exchanger is Q_{defr} = 0.
- n_e is the total energy recovery ratio [-], determined according to Table 5 in the draft Regulation

Values derived from tests and calculation methods:

- SPI - specific power input [kW/(m^3/h)];
- n_x - humidity recovery ratio [-]

1.1.2 Research and Discussion

Ventilation units (VU) are clearly defined in Commission Regulation 1254/2014[1] article 2 as an electricity driven appliance equipped with at least one impeller, one motor and a casing and intended to replace utilised air in a building or part of a building. The 'system'

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1254

considerations would include the wider ventilation system, which may mean the control setup, but could extend also to the ducting, the building itself, and the local climate.

In the Preparatory Review Study Task 1[2] “looks at EPBD-related standards, dealing amongst others, with the required performance of the ventilation units and related system” implying the separation between the units and the ‘related system”.

The testing specification CEN – EN13141-7 specifies the laboratory test methods and test requirements for the testing of aerodynamic, thermal, acoustic and electrical performance characteristics of ducted mechanical supply and exhaust residential ventilation units {RVUs} that contain at least within one or more casing, fans for mechanical supply and exhaust, air filters, air-to-air heat exchange and or air-to-air heat pump for heat recovery, and control system.

By widening the definition circle for ‘system’ to include leakages and mixing, indoor/outdoor airtightness and airflow sensitivity, ventilation effectiveness, energy use of auxiliary devices, impact of ventilation on dwelling heat loads, and the influence of ventilation on local IAQ, the ‘system’ becomes dependent on the ambient conditions of the installation and challenging to include on the label for a mass-produced product.

A ventilation system might include numerous other components such as the ductwork components including elbows and termination fittings, valves or backdraft dampers, and controls.

Comprehensive system diagnostic tools have been developed for commercial applications allowing for a quick, easy, and reliable way to compare the energy and life cycle costs for various HVAC systems at one time. This approach addresses the problems system by system and is particularly useful for customised commercial installations. Although these diagnostic tools can’t be added to the label, they present a direction of travel for the technology efficiency efforts.

The proposed SEC formula is comprised of product, location (or system), and default factors. The location or system factors are t_a (annual operating hours), q_{net} (reference net mechanical ventilation rate), t_h (total hours in the heating season), ΔT_h (the average difference in indoor and outdoor temperatures), and c_{air} (the specific heat capacity of air). The product related factors are CTRL (the control factor), x (exponent for the CTRL factor that tax into account various linearity issues), SPI (Specific Power Input), η_h (average space heating efficiency), q_{ref} (reference natural ventilation rate), η_e (total energy recovery ratio, η_x (the humidity recovery ratio), and Q_{defr} (exchanger defrost factor).

$$SEC = t_a \cdot pef \cdot q_{net} \cdot CTRL^x \cdot SPI - t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot (q_{ref} - q_{net} \cdot CTRL \cdot (1-\eta_e)) + CTRL \cdot (1-\eta_x) \cdot Q_{defr}$$

Recent HVAC industry research[3], for example, from the Society of Building Science Educators) has shown the importance of modelling the energy efficiency of complete heating and cooling systems vs relying on equipment ratings and the significant impact it can have on total life cycle costs. Such modelling and design software can be used to optimise life cycle costs, comfort, and indoor air quality. Modelling software can reduce energy consumption for ventilation systems in buildings via optimised ducting, fan, and unit placement. Engineers can visualise numerical simulation results to assess program requirements and energy efficiency and comfort goals. Such system modelling requires complete knowledge of the system installation details and is presently not available for ventilation systems alone.

[2] Supporting study for the review of the Ecodesign and Energy Labelling regulations on ventilation units, 2020, VHK

[3] https://www.sbse.org/resources/heed

Modelling can help predict thermal comfort by testing the placement and/or number of air supply and return registers and grilles and evaluating thermal comfort parameters as per ASHRAE 55 and ISO 7730, which are based on Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD).

Comparing three UVU products from three manufacturers that have approximately the same airflow, all of which achieve a B classification, but use very different amounts of energy, are listed below in Table 1.1.

Table 1.1 Comparison of three B-Graded UVU products technical specifications

UVU Product	Grade	Airflow	Pwr Input of fan	SPI	Annual Electricity Consump.	Heating Energy Saved Av Climate
Product A	B	301 m^3/h	53.5 w	0.16 $W/m^3/h$	84 kWh	2,830 kWh
Product B	B	307 m^3/h	32 w	0.07 $W/m^3/h$	55 kWh	2,830 kWh
Product C	B	3 388 m^3/h	43 w	0.07 $W/m^3/h$	0,4 kWh	2,830 kWh

All of these products save exactly the same amount of annual heating per climate zone. The third product (Product C) appears to have incorrectly listed their results on their product fiche by a factor of 10. This may just be a simple error or it may be indicative of an inconsistency in understanding. The variations make it challenging to compare products. The complete UVU product fiches can be found in Annex 1.

1.1.2.1 What are the pros and cons associated to the two approaches?

Pros of the product label approach

A ventilation product, defined and performance tested under laboratory conditions, can provide fundamental performance information such as the airflow, power consumption, and sound level that can be used to provide comparative product labelling. Labelling clarity is necessary for consumer acceptance and product promotion and sale. End users only pay attention to the letter grade on the label. Other product elements can be found on product fiches and company websites.

Product labelling allows for general distribution of mass-produced products. A product description including laboratory condition (63 Pascals) airflow, sound level, exchanger efficiency, and power consumption allow the product to be installed in any application that requires those performance characteristics.

Cons of the product label approach

Product labelling does not define the installed energy performance as that will be controlled by the operator, the configuration and location of the installation.

Product energy performance has to be estimated from generalised installation parameters.

Pros of the system label approach

System labelling requires a clear definition of the boundaries (the definition circle) of the system and will define the efficiency of the system for a specific application. System labelling will provide more accurate installed performance because it takes into account product external variables that will impact the actual performance of the system.

System labelling can be designer and installer friendly providing an accurate system component selection and performance.

Cons of the system label approach

System labelling confines the prescribed parameters such as location and control operational time, as well as installation within prescribed specifications. Such labelling limits the market for a particular system.

System labelling requires knowledgeable design and specific application matching narrowing product distribution and may lead to incorrect grading due to a lack of understanding of the system parameters by manufacturers.

1.1.2.2 What were the stakeholder views regarding the two different approaches?

Discussions with stakeholders including Pradillo, Pluggit, Helios, Atlantic, Soler & Palau, Kermi, Uniclima, Aldes, Evia, Bosch, Eurovent, and AMCA revealed the following views on this issue:

- Eurovent expressed support for a system label, in the sense of a label which considers system impacts (for example, via the specific energy consumption or SEC metric) while still staying within the purview of the product manufacturer.
- On the other hand, the Air Movement and Control Association (AMCA), whose focus is mainly on the fan component of ventilation units, expressed less comfort with a system label, particularly for residential ventilation units (RVUs) since they are typically mass-produced at the product-level and therefore a system label may not be very relevant or helpful to the end-user.
- Consumers are buying a ventilation unit – not a ventilation system. It is difficult for the consumer to compare ventilation units with the energy label because the SEC-calculation is based on the ventilation system and not the product alone.
- Proposed labelling scaling does not provide an effective incentive for the decision-making process.
- Labelling must be kept simple and clear. End-users rely on the letter grade.
- Different scales for climate zones are necessary.
- Funding and financial support will be granted based on labelling class.
- Errors in efficiency formulas must be corrected prior to labelling.
- Vagueness and lack of understanding of the SEC calculation and CTRL factors may lead to manufacturer misrepresentation of product performance.

End-users are selecting products based on the letter grade and assumption about product functional suitability. The SEC calculation for determining the letter grade is confusing, particularly because it includes both product and system (location) factors which may only be assumptions for mass produced, residential products.

1.1.2.3 Can the system label realistically be implemented and verifiable?

If the ‘system’ label clearly defines the elements of the system, verifying would mean confirming that those elements are included. For example, beyond the SEC formula, a system that includes a fan, a CO_2 control, and an ISO ePM2.5 filter would be complete if those elements were included in the packaging.

System labelling can be extremely accurate on a one-off basis. All the required system specific factors can be included in the SEC calculation and could be implemented and verifiable.

Because of the application specific nature of the system calculation, the system label approach would be difficult to implement and verify on a broad basis. It would also be a barrier for accurate consumer product acceptance. It would also be challenging to enforce.

It is a distinct challenge, however, to generate accurate energy efficient calculations relying on the product label since a greater number of installation assumptions and estimates are required.

Comparing the two SEC formulas the existing SEC formula in 2014 regulations:

$$SEC = t_a \cdot pef \cdot q_{net} \cdot MISC \cdot CTRL^x \cdot SPI - t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot (q_{ref} - q_{net} \cdot CTRL \cdot MISC \cdot (1 - \eta_t)) + Q_{defr}$$

MISC is an aggregated general typology factor, incorporating factors for ventilation effectiveness, duct leakage and extra infiltration.

There are two values for MISC: Ducted ventilation units 1,1 and Non-ducted ventilation units 1,21.

In the proposed SEC formula:

$$SEC = t_a \cdot pef \cdot q_{net} \cdot CTRL^x \cdot SPI - t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot (q_{ref} - q_{net} \cdot CTRL \cdot (1-\eta_e)) + CTRL \cdot (1-\eta_x) \cdot Q_{defr}$$

The proposed formula eliminates the MISC factor, and the CTRL factors are quite different in the two formulas. In the existing formula there are four CTRL factor values: manual control (no DCV), clock control (no DCV), central demand control, and local demand control. The proposed formula having removed the MISC factor provides more clarity, as the MISC factor may lead to double counting of the ventilation effectiveness.

In the proposed formula, "the CTRL-factor represents the reduction factor for the reference airflow that is needed to achieve a reference ventilation performance with a reference manually controlled UVU-system". In the existing formula, CTRL is defined as, "'control factor (CTRL)' means a correction factor for the SEC calculation depending on the type of control that is part of the ventilation unit, according to the description in Annex VIII Table 1". The definition in the existing formula is clearer than the proposed definition.

In the existing formula, qnet is simply the "net ventilation requirement per m2 heated floor area, qnet in m3/h.m2" with a single default value (1,3). In the proposed formula, the ducted/non-ducted element is included in the default values for qnet and there are three significantly different values. Those values are dependent on how the product is intended to be used – the spaces that it is intended to ventilate, assuming that it will be used as intended. The single value in the existing formula provides more flexibility of use and probably more installed performance accuracy.

The proposed formula replaces ηt (the thermal efficiency of heat recovery) in the existing formula with ηe (the total energy recovery ratio) and adds ηx (the humidity recovery ratio) modified by the CTRL factor. Energy (or enthalpy) recovery includes both heat and moisture migration between airstreams. In warm climates for installation with air conditioning, the humidity transfer becomes a significant factor for both energy impact and occupant comfort. The proposed formula may be double counting that element in its calculation and lead to inaccuracies.

1.1.3 Recommendations

For mass produced and widely distributed residential ventilation units, the most accurate labelling comes from laboratory fundamental product testing for elements such as airflow at a standardised pressure, electrical power consumption, and sound level for UVUs. For BVUs, these also include supply airflow at a standardised pressure, adjusted sensible recovery efficiency (ASRE), and power consumption at max SRE.

The letter grade derived from the SEC calculation is the driving factor for product acceptance, incentives, and marketing. Narrowing down the calculation to the most fundamental factors, reduces the number of situational assumptions that have to be made such as the annual operating hours (t_a) and the total hours in a heating season (t_h) (which impacts the product's impact on a cooling season).

There are a number of factors in the formula that are constants including t_a, pef, and q_{net} which could be simply multiplied together. Keeping them separate, however, clarifies the fact that these elements are included in the calculation. Combining them would not change the result of the calculation.

The energy cost of ventilation system operation is based on the energy demand of the ventilating product (SPI) and the conditioned air energy cost based on the volume of air from the inside to the outside of the conditioned space.

The energy demand or electrical cost is the electrical demand of the ventilation system multiplied by its hours of operation. The electrical power consumption will vary, however, depending on the product's operating mode.

The conditioned air energy cost is the cost of energy to condition the air moving through the ventilation product as well as that air movement's impact on the building. Calculating the conditioned air cost begins with the number of cubic meters of air moved through the system while it is operating modified by the climatic conditions in the location. If the ventilation system includes a heat recovery element, that will reduce the conditioned air energy cost.

A BVU is designed to have a balanced pressure impact on the building pressure boundary. Because of this, the conditioned energy cost is the sum of both the air moving through the ventilation unit as well as the building's leakage. This will reduce the energy efficiency of the ventilation product.

A UVU that exhausts air from the building lowers the pressure in the building, drawing in outside air, and offsetting the amount of natural building infiltration. Because of that offset, the conditioned air energy cost for a UVU is not a straight-line calculation of the air moving through the ventilation product.

The heat or energy recovery of a balanced ventilation product can be measured in a laboratory under prescribed and standardized conditions, but the impact on the natural ventilation can only be estimated.

Standardised product performance ratings can be compared by end users and designers. All of the external factors – ductwork, termination fittings, controls, location, etc. – can then build the installed system performance from the fundamental product building blocks delivering a ventilation system that will exchange the right amount of air (to optimise the health of the occupants and the building) at the right time, cost, and power consumption.

1.1.4 Effects to the regulation

On the one side, removing all the elements of the SEC calculation that are not directly product related, will, by definition, accurately reflect the performance of the product in terms of a laboratory performance calculation. It will not provide installed performance information. Each 'system' factor that is brought into the calculation brings a number of assumptions along with it along with user interpretations. As long as the assumptions are understood and the margin for error in user interpretations are confined, the results of the ‘system’ based SEC calculation and the resulting letter grade can be relatively comparable. This can be reflected by limiting the number of control options.

On the other side, the more the non-product related aspects are taken out from the SEC formula, the less representative the SEC value might be with regard to providing information concerning the energy consumption of the overall system (where the ventilation unit is installed). The chosen policy solution should ideally balance both the issues.

The following sections 1.2 and 1.3 deal with specific elements of the SEC formula where changes are recommended.

1.2 Split label between UVUs and BVUs

1.2.1 Topic introduction

In the draft proposals for revision to Commission Regulation 1254/2014, unidirectional ventilation units (UVUs) and bidirectional ventilation units (BVUs) are both subject to the same RVU label scaling (A through F) in Table 1 of the draft proposals.

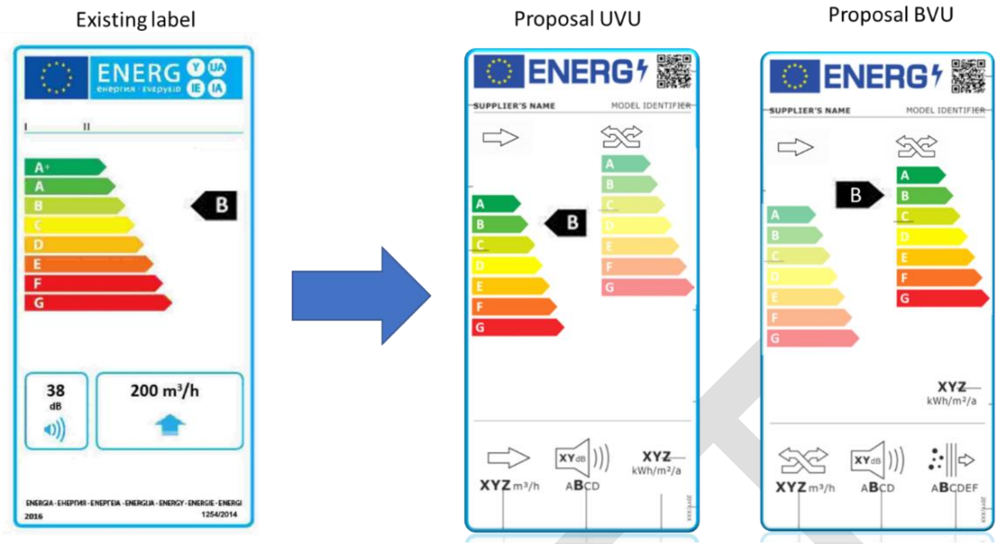
The European Ventilation Industry Association (EVIA) considers this unfair and supports splitting the label’s scaling, as noted in their Position of Energy Labelling for Residential Ventilation EU 1254:

“It is not understandable why it is proposed to split the label between unducted and ducted units, which perform similarly but a split label for UVUs and BVUs is not being considered. Labelling for residential units must remain based on a common SEC calculation for all types of ducted and non-ducted BVUs and UVUs. On that basis a split labelling scaling is a possibility.”

EVIA also added that UVUs are a significant part of the ventilation unit market in some countries (for example, 90% of the French market according to EVIA), and therefore they believe that such a split for their sake would be warranted. Lastly, they note that UVUs and BVUs are not interchangeable (i.e., a customer in an existing building can only change from one to the other at significant cost), and therefore it would be unfair to subject UVUs to the same scaling as BVUs.

EVIA’s suggestion is to split the label scaling in some manner, such as their example shown below in Figure 1.1, such that a UVU’s scaling is less stringent than a BVU’s (i.e., the grade-B UVU’s efficiency below would be given a grade of D if it was a BVU).

Figure 1.1 EVIA proposal for a split label scaling between UVUs and BVUs



This suggestion will be evaluated in the following sections.

1.2.2 Research and Discussion

Per the 2020 Review Study's read of the 2014 VHK Building Heat Demand study[4], UVUs were used in 29% of residential dwellings. This is a significant portion of the market, corroborating EVIA's claim, and although this value may have reduced in the decade since, it is not likely to have become insignificant since UVUs are not easily interchangeable with BVUs. For new construction, it is relatively easy to select one instead of the other, but for retrofits, replacing an existing building's UVU with a typical BVU often requires significant and cost-prohibitive ducting changes.

It is true that the energy recovery system (ERS) within a BVU will often generate significant energy savings, as pointed out by BVU manufacturers.[5] However, in certain scenarios, demand-response UVUs may provide direct pollutant removal, limited operating time, and the least impact on energy use.

1.2.2.1 Is this split distinction feasible? Is it needed? Is it relevant?

The split distinction is certainly feasible and potentially relevant, but its need is tied to whether the current state of the market warrants it based on stakeholder input. The fan laws defining airflow and energy performance are the same regardless of the direction of flow, and the ventilation function of both BVUs and UVUs are the same. Therefore, a split would only be needed if the current grading of UVUs is so poor that the UVU market is not being encouraged to become more efficient.

1.2.2.2 What is the 'unfair' (if any) treatment of UVUs, vis a vis BVUs, in the current way of rating them via the SEC?

The formula for the Specific Energy Consumption (SEC) in the draft proposal is as follows:

$$SEC = t_a \cdot pef \cdot q_{net} \cdot CTRL^{x} \cdot SPI - t_h \cdot \Delta T_h \cdot \eta_h^{-1} \cdot c_{air} \cdot (q_{ref} - q_{net} \cdot CTRL \cdot (1-\eta_e)) + CTRL \cdot (1-\eta_x) \cdot Q_{defr}$$

[4] Supporting study for the review of the Ecodesign and Energy Labelling regulations on ventilation units, 2020, VHK

[5] https://www.linkedin.com/pulse/how-has-eu-regulation-12532014-changed-heat-recovery-market-lakomy/

This formula inserts a difference between UVUs and BVUs via the CTRL or control factor, whose value comes from Table 3 of the draft proposal[6]:

Figure 1.1 Table 3 from draft proposal for Ecodesign Regulation 1253/2014.

Type of RVU incl. level of flow control	no control	manual	clock	central VDC-ES	central VDC-HS	zonal VDC-ES	zonal VDC-HS	local VDC-ES	local VDC-HS
UVU - no valves	1.00	1.00	0.95	0.95	0.90	0.90	0.85	0.85	0.80
UVU + zonal valves	1.00	0.95	0.90	0.95	0.90	0.80	0.75	0.75	0.65
UVU + valves for all rooms	0.95	0.95	0.85	0.95	0.90	0.80	0.75	0.70	0.45
BVU1 - no valves	0.95	0.95	0.90	0.90	0.85	0.85	0.80	0.80	0.65
BVU1 + zonal valves	0.95	0.90	0.85	0.90	0.85	0.75	0.70	0.70	0.60
BVU1 + valves for all rooms	0.95	0.80	0.75	0.90	0.85	0.75	0.70	0.70	0.50
BVU2 - no valves	1.20	1.20	1.10	1.10	1.00	1.00	0.95	0.95	0.80
BVU2 + zonal valves	1.20	1.05	1.00	1.10	1.00	0.95	0.90	0.90	0.75
BVU2 + valves for all rooms	1.20	0.95	0.90	1.10	1.00	0.95	0.90	0.80	0.70
BVUs with constant flow control and internal leakages ≤3%									
BVU1 - no valves	0.80	0.75	0.70	0.70	0.65	0.65	0.60	0.60	0.50
BVU1 + zonal valves	0.80	0.75	0.65	0.70	0.65	0.60	0.55	0.55	0.45
BVU1 + valves for all rooms	0.80	0.65	0.60	0.70	0.65	0.60	0.55	0.55	0.35
BVU2 - no valves	1.00	1.00	0.90	0.90	0.85	0.85	0.80	0.80	0.65
BVU2 + zonal valves	1.00	0.95	0.85	0.90	0.85	0.80	0.75	0.75	0.60
BVU2 + valves for all rooms	1.00	0.90	0.80	0.90	0.85	0.80	0.75	0.65	0.50
L-UVU for ES only		1.00**fs*	0.95**fs*	N/A	N/A	N/A	N/A	0.65**fs*	0.85**fs*
L-BVU for ES only		1.00**fs*	0.95**fs*	N/A	N/A	N/A	N/A	0.65**fs*	0.85**fs*
L-UVU for HS only		0.95**fs*	0.85**fs*	N/A	N/A	N/A	N/A	0.70**fs*	0.45**fs*
L-BVU for HS only		0.95**fs*	0.90**fs*	N/A	N/A	N/A	N/A	0.80**fs*	0.70**fs*
L-BVUs with constant flow control and internal leakages ≤3%									
L-BVU for ES only		1.00**fs*	0.95**fs*	N/A	N/A	N/A	N/A	0.65**fs*	0.85**fs*
L-BVU for HS only		0.95**fs*	0.80**fs*	N/A	N/A	N/A	N/A	0.60**fs*	0.50**fs*

Compared to UVUs, the control factors for BVU1s (BVUs extracting air from only wet spaces) are generally lower, while those for BVU2s (BVUs extracting air from all wet and habitable spaces) are generally higher. Lower control factors lower the SEC, and are hence more favourable as this increases the energy efficiency class.

Since the purpose of the SEC calculation is to determine the energy efficiency of the ventilation product, a device that can recover some of conditioned air energy cost will be more efficient. That efficiency should be reflected in the grading of the product. But that should not impact the suitability of a product for particular purpose.

The formula also accounts for the difference implicitly; for example, the defrost energy Q_{defr} would be zero for UVUs, and this would lower their SEC.

The formula also includes the factors for heat and energy recovery for BVUs which lower their SEC calculation and improve their letter grade.

[6] Draft Working Document on Energy Labelling of Residential Ventilation Units (Review EU1254/2014).

Because BVUs recover some of the heat from the conditioned air rather than simply expelling it from the building, they are inherently more efficient than UVUs and that improved efficiency should be included in their grading.

The Adjusted Sensible Recovery Efficiency (ASRE) (as defined by the Home Ventilating Institute) defines the “sensible energy recovered minus the supply fan energy and preheat coil energy, divided by the sensible energy exhausted plus the exhaust fan energy. This calculation corrects for the effects of cross-leakage, purchased energy for the fan and controls as well as defrost systems.” Wattage for air movement is separately accounted for in the energy model. Because of the condensation that collects on the exchanger element and is subject to freezing in various climates, several approaches to defrosting are used. That energy is included in the SRE calculation and is reflected by the Q_{defr} factor in the SEC calculation.

But once the SEC metric is calculated, both UVUs and BVUs are graded according to the same scaling in Table 1 of the regulation[7], so the question of “fairness” is whether the above “accounting” within the current SEC formula is sufficient or not. This is not a purely technical question, but also related to policy considerations. If, from evidence brought by stakeholders, it would emerge that the most efficient UVUs in the market are receiving a poor grade even though they would be the most efficient and feasible solution for some end-users, then the current scaling may be unfair. Stakeholders believe that end-users perceive that BVUs are more efficient. This perception is fostered by the heat/energy recovery that are included in BVUs. UVUs impact less obvious elements which are not included in the SEC calculations such as the offset of natural infiltration/exfiltration in building leakage which can be as much as a 50% reduction in natural leakage, reducing the full amount of energy/heat ‘penalty’ by half.

If the low scaling of even the best of the UVU products diminishes their use significantly, retrofit projects may proceed with no mechanical ventilation.

To illustrate this, we conducted an SEC calculation for one manufacturer’s UVU fan with the following energy label:

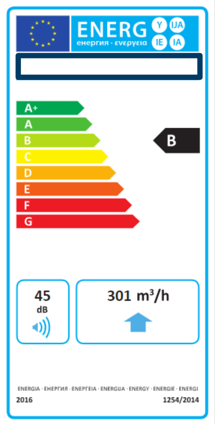
Figure 1.2 Fan energy label and technical specifications

— General information

B

301 m3/h

Specific energy consumption (cold zone)	-53,3	kWh/(m2.a)
Specific energy consumption (average zone)	-26,2	kWh/(m2.a)
Specific energy consumption (warm zone)	-10,7	kWh/(m2.a)
Type of drive	Variable speed drive	
Electric power input of the fan drive	53,5	W
Sound power level	45	dB
Reference flow rate	0,06	m3/s
Reference pressure difference	124	Pa
Specific Power Input	0,16	W/(m3/h)
Control typology - control factor	Local demand control - 0,65	
DUCTED UNIT		
Annual Electricity Consumption	84	kWh electricity/annum



Download the label for printing

An SEC rating of -26.2 kWh/m^2 in the existing formula (reflected in this label) rates the product as a B, the same rating in the proposed new formula would move it down to an F with no change in the product. (Figure 1.3). This showcases the significant change in scaling for UVUs in the new energy efficiency classes.

[7] Draft Working Document on Energy Labelling of Residential Ventilation Units (Review EU1254/2014).

Figure 1.3 Energy efficient labelling classes from the draft proposal for 1254/2014

ANNEX II
Energy Efficiency Classes

The energy efficiency class of residential ventilation units shall be determined on the basis of the specific energy consumption (SEC) as set out in Table 1.

Table 1
Energy efficiency classes of ducted and non-ducted RVUs

SEC-EL in kWh/a.m²			
Energy Efficiency Class	**Warm climate**	**Average climate**	**Cold climate**
A	SEC < -20	SEC < -60	SEC < -105
B	-20≤SEC<-17	-60≤SEC<-52	-100≤SEC<-93
C	-17≤SEC<-14	-52≤SEC<-44	-89≤SEC<-81
D	-14≤SEC<-11	-44≤SEC<-36	-78≤SEC<-69
E	-11≤SEC<-8	-36≤SEC<-28	-67≤SEC<-57
F	-8≤SEC<-5	-28≤SEC<-20	-56≤SEC<-45
G	-5≤SEC<-2	-20≤SEC<-12	-45≤SEC<-33

The SEC of a residential ventilation unit shall be determined in accordance with Annex IV.

The number of CTRL variations has increased from four in the current regulation to one hundred and thirty-five in the draft proposal which adds to the complexity and calculation challenges for manufacturers and excessive variability linked to the actual installation conditions.

Calculating the SEC value and resultant letter grading for a UVU product while varying only the CTRL factor in the formula results in the following:

Table 1.2 SEC values for different CTRL factors

Control Type	CTRL Factor	SEC value (kWh/a.m²)	Energy Efficiency Class
Manual Control (no DCV)	1	-7.26	F
Clock control (no DCV)	0.95	- 10.25	E
Central demand control	0.85	-16.15	E
Local demand control	0.65	- 27.60	B

The change in the CTRL factor for a clock control and central demand control is not reflected in the letter grade for the product. And local demand control covers a wide array of control configurations from an expensive CO_2 sensor to a simple motion detector which would have different impacts on the operational energy consumption of the product. Simplifying the CTRL factors and changing the scaling as suggested by EVIA so as to avoid any arbitrariness in the metric would help to address any unfairness.

Table 1.3 EVIA CTRL Factors for Residential Ventilation[8]

CTRL	Control			
	Current 1253	Central	Zonal Min 2 Zones	Local
Manual	1,0	1,0	0,95[a]	0,90[a]
Clock	0,95	0,95	0,85	0,80[a]
Central	0,85	0,85	NA	NA
Zonal	0,65	0,75	0,65	NA
Local	0,65 (0,5)	0,65	0,55	0,45

[a]Further consideration needed to avoid too much detail and too many options.

1.2.2.3 In case of unfairness, can it be solved/improved with different formulations of the SEC parameter?

What is presently not reflected by the SEC calculation is a UVUs impact on the building's natural infiltration and exfiltration. Any unfairness could technically be solved within the SEC parameter by including a constant to the total energy recovery ratio (50%) to resolve that discrepancy.

There is natural infiltration and exfiltration of a building. Ideally installed BVUs are balanced and have no impact on the pressure on the building envelope and therefore no impact on the natural infiltration rate. The conditioned air cost of a building with a balanced ventilation system would include the natural infiltration rate plus the differential in sensible recovered energy. A building with 75% efficient BVU would have to include a 25% conditioned air cost, for example.

An exhaust UVU puts the building under negative pressure by design. Air is drawn in through either inadvertent cracks and holes or via 'smart holes', devices such as slot vents. When the UVU is not running, air will move in and out of the building via infiltration and exfiltration, driven by the wind, pressure, or the stack effect. The UVU will increase that leakage, but the total amount of the 'new' airflow is partially accounted for in the increased infiltration. So only a portion of the air moving through the UVU—approximately 50%--is 'new air' and should be counted in the conditioned air cost calculation. Because these systems change the neutral pressure levels, the added flow is less than the flow through the fan.

Analysis of the physical pressure-flow relationship shows that the totals will come out smaller than additivity because the unbalanced fan will impact the internal pressure which effectively reduces the amount infiltration contributes to the total. It should be noted that the total infiltration is never less than the flow through the fan. "The induced infiltration is one-half of the unbalanced fan flow if the unbalanced flow is less than twice the natural infiltration rate. Otherwise, the induced flow is the difference between the fan flow and the natural infiltration".[9]

[8] Definition of ErP CTRL factors for Residential Ventilation based on EVIA VPA Tool

[9] Palmiter, Larry and Bond, Tami 1991 "Interaction of Mechanical Systems and Natural Infiltration" – Ecotope Presented at the AIVC Conference on Air Movement and Ventilation Control Within Buildings, Ottawa, Canada, September 1991 (Ecotope Publications Database – Ecotope)

Hurel, Nolwenn, Sherman, Max H., Walker, Ian S. 2015 "Sub-additivity in combining infiltration with mechanical ventilation" – Lawrence Berkeley National Laboratory, October, 2015

1.2.2.4 What are, in general, the pros and cons of having – or not – a split UVU/BVU label?

The following are the benefits and drawbacks of following EVIA's suggestion of a split label scaling:

Benefits

By having an offset between the A through F scaling of UVUs versus BVUs, the scaling would incentivise UVUs to be the best within their unit type and earn a grade of A, instead of comparing them to more efficient BVUs with heat recovery. For cases where a UVU would not be interchangeable with a BVU, the separate scaling may therefore assist both unit types in moving towards their respective A grades and becoming more efficient.

Drawbacks

While this offset enables selection for greater efficiency *within* UVUs and BVUs, it discourages comparison *between* them (for those cases where either unit type may be feasible). Stakeholder feedback indicated that end-users are primarily driven by installation details and price, so they would select BVUs over UVUs in cases where the project configuration and the relative price allows. For these cases, the split scaling would encourage fewer end-users to save even greater energy by moving from UVUs to BVUs with heat recovery.

This drawback could be eased by clearly showing the offset on the label (i.e., in EVIA's proposed label image above it is clear that the grade-B UVU corresponds to a grade-D BVU). This way, those who are able to transition to a BVU with heat recovery are still encouraged to do so. However, this (i.e. showing two labels at the same time) seems not legally feasible with the Energy Labelling framework.

1.2.2.5 What were the stakeholder views regarding the two different approaches?

In addition to the aforementioned comments by EVIA, discussions with other stakeholders revealed the following views on this issue:

- Eurovent commented that it fully supports a common label for residential UVUs and BVUs, on the basis that their function is the same and therefore the energy efficiency rating metric should be the same for the benefit of the end-user.
- The ventilation unit manufacturer Kermi stated that the label does not currently impact purchase decisions significantly in their market, and therefore there would not be much pushback either way, whether splitting the label scaling or not.
- On the other hand, AMCA commented that ventilation units without air treatment and UVUs should not be treated the same as BVUs, as the former are much simpler and therefore the metric itself may need to be different between these two.
- The CTRL factor must correctly reflect the reduction of the required airflow rate.

1.2.3 Recommendations

In light of the fact that UVUs and BVUs are not always interchangeable, it would be feasible and potentially beneficial to address the scaling in Annex II Table I such that both UVUs and BVUs have a reasonable distribution of products in each grade (i.e., such that the majority of products are middle-grade while only the highest-efficiency products get grades of A or B); however, the magnitude of this offset would have to be determined through further research. By taking into account the impact on natural infiltration for UVUs which is presently ignored in the SEC calculation, assigning a constant total recovery ratio for UVUs would offset the difference between the two products and allow for a single comparative label for both products.

1.2.4 Effects to the regulation

The addition of a constant total recovery ratio of 50% for η_e to Table 5 for UVUs to the SEC calculation would take into account the impact of the ventilation system on the building shell and allow for a single comparative label for both products.

1.3 Product vs. system effects of the revised control factors for the energy label calculations

1.3.2 Topic introduction

According to the requirements within the draft proposals for the revision to Ecodesign Regulation 1253/2014, the Control Factor (CTRL) is a “reduction factor for the reference airflow needed to achieve a reference ventilation performance with a reference manually controlled UVU system.” This factor regulates the percentage of run-time of the ventilation product.

1.3.3 Research and Discussion

Control technology is developing rapidly in response to recent health conditions, increasing indoor occupancy times, tighter buildings, and the cost, accuracy, and durability of sensors. These developments are helping to move system control away from unpredictable operator response. Fan motor technology has also developed from simple split capacitor, one speed motors to infinitely variable speed EC motors. At the same time, fan blade and venturi designs have improved to reduce the sound level of the products resulting in longer acceptable run times. Such controls restrict the runtime of the ventilation system to when airflow is required to maintain a satisfactory level of air quality. But many factors impact the quality of the air, so the challenge for the system designer is to make the right controlling assumptions. Some controls are included with the product packaging and as such can be included in the SEC calculation. These controls have a significant impact on the rating of the product because of the CTRL factor. They also expand the number of products the manufacturer can put on the market, depending on the plug-in modules sold with the ventilation unit, such as for motion, moisture, CO_2, run-time, or mixed gases.

Controls that are added on as an after-market element cannot be included in the manufacturer’s calculation of energy efficiency because it is unknown if these would be installed with the ventilation unit.

Energy consumption due to how long a fan runs at an elevated speed due to the presence of a pollutant is one factor. Fans with Electronically Commutated motors (ECM) will automatically vary their speed and resulting airflow due to installation details.

1.3.3.2 What are the environmental savings associated to the factoring in of system-related parameters?

Fan motor efficiency has reached a level where the electric cost for operating the fan is reduced to the level of a doorbell transformer. The operational savings is derived from managing the conditioned air cost after installation. Clearly if the ventilation unit (VU) can operate only when and for how long there is a need for indoor air quality improvement, the conditioned air cost and energy consumption is minimised.

1.3.3.3 What are the challenges for the assessment of these control factors?

The energy savings for the control of a residential ventilation system falls to the user of the system. A manually controlled system (ON/OFF or timer), relies on the operator to decide when ventilation is needed commonly based on comfort issues such as odour and 'stuffiness'. There are numerous Indoor Air Quality (IAQ) issues which are not obvious to human sensitivity such as carbon dioxide, carbon monoxide, or particulates.

Demand or automatic controls with sensors for these olfactory invisible contaminants, will cause the ventilation system to run automatically, but if the occupant doesn't understand the system, they may believe it to be operating defectively and defeat it. Occupant understanding is one of the greatest challenges for any control system.

1.3.3.4 Is it viable, to only include product elements that are verifiable at the moment of placing the product on the market?

Ideally a control would be able recognise all the elements of perfect air exchange, recognising the pollutants in the occupant air as well as the condition of the replacement air and run the ventilation system long enough and with enough flow to achieve perfect air quality balance.

If all the product components (such as the control and defrosting element) are packaged with the product, it is a simple matter to verify.

1.3.3.5 In case it is viable, what are the pros and cons of an exclusion/simplification of the parameters?

Simplification can improve replicable, comparative accuracy. A product can either have heat recovery or not. A product can have a two-speed motor or not.

The drawback to simplification is that it reduces the granularity of the result.

The accuracy of that granularity depends greatly on the accuracy of the inputs. And since the ultimate result of the SEC calculation is a letter grade, there is not a great deal of shading or granularity in what appears on the label.

1.3.3.6 What are the stakeholder views regarding the use of these parameters?

Discussions with stakeholders revealed the following views on this issue:

- Eurovent commented that controls are important, but manufacturers should not be allowed to "trade off" energy efficiency in return for including controls. RVUs are mass-produced and installed into a variety of systems, so generalising a control factor for a given RVU's controls may allow for loopholes and selective calculations. Therefore, they recommend the European Ventilation Industry Association's (EVIA's) "EVIA Comments on Residential Ventilation Units Control Aspects" which suggests a simplified table of control factors. Lastly, Eurovent suggests that if the controls must be labelled, then the responsibility would have to be split between a product label for the manufacturer and a system label for the installer.
- EVIA considers the currently proposed control factors to not be feasible, and has submitted a position paper ("Definition of ErP CTRL factors for Residential Ventilation based on EVIA VPA Tool") which recommends a different, simplified approach to them using their Ventilation Performance Assessment (VPA) calculation tool. They advocate to not implement an additional indicator for ventilation performance on the label, because this is already covered by the control factor and because such performance varies greatly between each real-world installation.

1.3.3.7 BVU sample products comparison

Multiplying variables multiplies the possibilities of errors as well as increasing the challenges of product comparisons.

For a good BVU product, there is little difference in the grading between the different controls with the existing SEC calculation.

Table 1.4 Effect of CTRL factor on SEC Value for an A-graded BVU

Control	CTRL Factor	Calculated SEC Value	Grade
Manual Control (no DCV)	1	-35.10	A
Clock control (no DCV)	0.95	- 37.32	A
Central demand control	0.85	-41.48	A
Local demand control	0.65	- 48.66	A+

Comparing three BVU products which received grades from A+ to G on the EPREL website, it is difficult to understand why they received the grades that they did. The worst product saves the most heat energy. And the airflow numbers seem inconsistent.

Table 1.5 Comparison of three BVU products from A+ to G Rated

BVU Product	Grade	Airflow	Thermal Efficiency Heat Rec	Pwr Input of fan	SPI	Annual Heat Saved Average Climate
–Product D - BVU	A+ 0.65 ctrl	780 m^3/h	84,8%	325 w	0.23 W/m^3/h	45.9 kWh
–Product E - BVU	C 1.0 ctrl	250 m^3/h	80%	180 w	0.55 W/m^3/h	4263 kWh
– Product F - BVu	G 0.85 ctrl	5700 m^3/h	76,3%	130 w	0.33 W/m^3/h	5643.1 kWh

The complete BVU product fiches can be found in Annex 1.

1.3.4 Recommendations

For products to be selected effectively, the data must be consistent to allow for accurate comparison. The letter grade is a useful tool for assisting in product selection, but only if it accurately reflects the best product to deliver the required airflow most efficiently. If the grading is inaccurate, it is meaningless.

The airflow, the noise level, and the letter grade that are included on the present UVU label is clear and simple and useful for product selection. The same information is included on the BVU label, but what is missing is the heat or energy recovery efficiency.

What is in question is the accuracy and consistency of the calculation from which the letter grade is derived along with the change in scaling.

The proposed CTRL factor is too complex which risks creating too much variability for the label to be useful to the end user and doesn't reflect significant changes in efficiency.

1.3.5 Effects to the regulation

The proposed changes to the CTRL factor provide subtle changes in the granularity of product efficiency selection, while opening up a world of unnecessary complexity. A carefully considered modification (including stakeholder input) to the existing simpler list of factors would reflect a more relevant impact on the SEC calculation result (See EVIA Table listed above in 1.2.2.2).

1.4 Calculation of the Ventilation performance index

1.4.2 Topic introduction

The Ventilation Performance Index (VPI) contained within the draft proposals for the revision to the Energy Labelling Regulation 1254/2014 is a new metric which is not present in the existing regulation. It is defined as "an indicator for the ability of the RVU to exchange the right amount of air in the right place at the right time." The RVU's VPI would earn it a "ventilation performance class" ranging from A (at best) to G (at worst), which would be listed on the label alongside the SEC-determined "energy efficiency class." The formula for VPI is as follows:

$$VPI = \frac{q_{opt}}{q_{net;VPI} * CTRL}$$

Where q_{opt} and $q_{net;VPI}$ are fixed airflow intensity values which are defined by RVU type in Table 6 of the draft proposal, reproduced in Figure 1.4 below:

Figure 1.4 Table 6 from draft proposal for Energy Labelling Regulation 1254/2014.

Table 6.

Default q_{opt} and $q_{net;vpi}$ values for calculating VPI

Reference airflows for achieving Category II ventilation performance	**Non-ducted* RVU-ES** *in $m^3/h/m^2$*	**Non-ducted* RVU-HS** *in $m^3/h/m^2$*	**Ducted RVU ES&HS** *in $m^3/h/m^2$*
Reference net mechanical ventilation rate for manually controlled RVU per m^2 heated floor area, $q_{net;VPI}$	0.79	1.60	1.97
Reference mechanical ventilation rate for an optimized ducted UVU and BVU1 per m^2 heated floor area, q_{opt}			0.67
Reference mechanical ventilation rate for an optimized ducted BVU2 and non-ducted RVUs per m^2 heated floor area, q_{opt}	0.38	0.62	1.00

And where CTRL is the control factor from Table 3 of the draft proposal (discussed in the previous point), which is a fixed value based on the RVU type and its controls.

The VPI is therefore a ratio of the flow rate needed to achieve Category II ventilation performance of a theoretical RVU with optimal controls versus the flow rate of the actual RVU, and hence an indicator for the efficacy of the unit's air exchanges. Unlike the SEC metric and the SEC-determined energy efficiency class which indicate the total energy savings of the unit (by its controls, energy recovery, heat recovery, and all other features) relative to natural ventilation, the VPI and the VPI-determined ventilation performance class solely indicate the energy saved by the unit's controls relative to theoretically optimal controls.

1.4.3 Research and Discussion

1.4.3.1 Which would be the parameters to take into account for the calculation of this index, as a result of the analysis carried out for section 1.3 on CTRL factors?

In the draft proposal, the only approach for improving the VPI is the CTRL factor. The example below shows how a ducted UVU with no valves (a simple exhaust only system for a bathroom) could be improved from Class F to E. This would represent a simple scenario where a UVU serves an area like a bathroom. The Manual control switch would rely on an occupant to turn the fan on and off when ventilation was needed, whereas a control could be on the fan that turns it on and off only when ventilation is needed (i.e., high humidity).

Manual control (switch):

*VPI = 0.670/(1.97*1.0) = 0.340 (ventilation performance Class F)*

Central ventilation demand control for exhaust spaces (VDC-ES) (humidity control):

*VPI = 0.670/(1.97*0.95) = 0.358 (ventilation performance Class E)*

1.4.3.2 How close is the value of the proposed index to "real life" conditions?

The calculations of VPI generally follow trends that are true in "real life" conditions. Specifically, that:

- BVUs achieve a higher VPI than UVUs. This reflects that in practice that the BVUs will be exhausting and supplying a roughly equal amount of air from known sources. While UVUs will be mechanically moving air one direction, while at the same time there is natural ventilation air from an unknown source. This makes controlling the precise amount of air more difficult and also introduces other risks to moving air in and out of a building from unknown sources.
- More control means a higher VPI. Having more control through a VDC that responds to measurements like humidity and carbon dioxide will mean air is delivered when needed and reduced unnecessary ventilation (e.g., when there are no occupants), which will increase energy use in buildings with little value to occupants.
- More precise control means a higher VPI. Zonal and Local VDCs achieve higher VPIs because the ventilation units can respond to needs in more precise locations. For example, they could respond to a high ventilating need in one room with many occupants, and limit ventilation in another room when unoccupied.

Again, when considering accuracy to "real life" conditions, actual performance is dependent on installation practices. For example, a very poorly installed BVU (e.g., ducts that are damaged or installed incorrectly, controls that are programmed incorrectly) may not necessarily be more effective at providing ventilation needs as a UVU. However, assuming that products are properly installed, the VPI accurately depicts trends and benefits of the various products and control strategies.

The general opinion of the stakeholders on this subject was:

- The VPI factor is not 'mature' enough to be used;
- It cannot be accurately used to reflect installed performance;
- It unnecessarily complicates the SEC calculation.

1.4.4 Recommendations

In light of stakeholder feedback and the fact that UVUs and BVUs are not always interchangeable, the VPI metric may not be an effective way to push the market towards more efficient ventilation. Although its trends match real life conditions, a lot of what the VPI is intended to measure (ventilation efficacy and air quality) depends on the quality of each specific installation, which the VPI metric cannot take into account. Therefore, we recommend not including it in the label.

1.4.5 Effects to the regulation

We recommend that all references to the VPI metric in the regulation be removed. Namely, the entirety of Step 4 in Annex IV, the entirety of Table 6, and the references to VPI in Tables 3, 7, and 8 should be removed from EU1254, and the reference to VPI in Table 3 of EU1253 also be removed.

2 Concerning non-residential ventilation units (Regulation 1253/2014)

2.1 The proposed ‘new approach’ on $\eta_{e\_nrvu\_min}$ and SFP_{int} (Known/unknown place of installation)

2.1.1 Topic introduction

In Annex III of the draft proposal, there are separate requirements for the thermal efficiency ($\eta_{e\_nrvu\_min}$) and the internal specific fan power (SFP_{int}) depending on whether the NRVU’s place of installation (i.e., its climate location and therefore its minimum outdoor temperature) is known or unknown.

By contrast, in the existing regulation, $\eta_{e\_nrvu\_min}$ is simply required to be 68% everywhere (with an efficiency bonus score given where this value is exceeded), and the equation to calculate SFP_{int} is the same within each NRVU unit type (BVU with run-around HRS, BVU with other HRS, and UVU used with a filter).

Unlike the RVUs’ SEC metric which is evaluated and listed for warm, average, and cold climates, the above two NRVU metrics do not vary by climate in the existing regulation and therefore may not sufficiently ensure an efficient product in some climates. The potential for the draft proposal’s new approach to resolve this issue will be explored in the following sections.

2.1.2 Research and Discussion

2.1.2.1 What are the benefits of this new approach compared to the one in the existing Regulation?

The justification for this change is noted by Eurovent: “Wherever needed and justified, lower requirements for the temperature ratio combined with higher requirements for SFP_{int_limit} will contribute for further energy savings and decarbonisation. We also believe that making requirements dependent on the outdoor temperature does not create additional burdens and challenges for market surveillance.”

In other words, this split would force manufacturers to either account for the most conservative (unknown) minimum outdoor temperature or to confine their product to the regions with a known temperature where they know they can meet the regulation. This would increase the energy efficiency of products compared to the current regulation, as products would not be installed in climates where their energy consumption would not meet the draft proposal’s more stringent metrics compared to the existing regulation.

It should also be noted that the new approach is based on models developed by Dr. Christoph Kaup, honorary professor at the Environmental Campus Birkenfeld, in a paper[10] which provides strong research and scientific backing to its calculations and also notes that there is only a slight difference between the quality of the location-specific models and those which are location-agnostic. Hence, another benefit of the new approach would be its stronger scientific basis.

[10] Kaup, Christoph. 2021. “The optimum of heat recovery - Determination of the optimal heat recovery based on a multiple non-linear regression model.”

2.1.2.2 What are the drawbacks – if any – of the new proposed approach?

A drawback could be that the increased complexity of the split requirements may confuse manufacturers and result in products either being removed from markets where they may actually be compliant or included in markets where they are noncompliant. However, Eurovent (which represent over 1,000 largely small- and medium-sized manufacturers) provided feedback that NRVU suppliers already select products based on outdoor air temperature, so as long as the regulation's information requirements provide the outdoor air temperatures for which an NRVU is compliant, there would be no confusion for either end-users or for manufacturers in this regard.

Another drawback could be increased market surveillance challenges, since the new approach would require enforcing different limits in different countries. For example, a product may be compliant for the climate of the country into which it enters the EU, but later gets distributed to another country in which it is not compliant. However, since NRVU systems are usually purchased for and assembled at the specific sites where they will operate, this issue is unlikely to be of concern.

2.1.2.3 What were the stakeholder views to the proposed new method?

Discussions with stakeholders revealed the following views on this issue:

- Eurovent commented that the distinction between known and unknown places of installation is essential for a fair comparison and will result in better installations and therefore energy savings. At the same time, they noted that the formulas for known vs. unknown place of installation were not consistent, and hence suggested changes to the formulas to align them with each other. The following formula changes suggested by Eurovent appear reasonable, do not significantly affect stringency, and are well-supported by calculations and rationale:
  - "1.4.1 Required temperature efficiency depending on outdoor design temperature" and "1.4.2 Required maximum basic internal specific fan power": Eurovent proposes using a single formula for each of these metrics ($\eta_{e\_nrvu\_min}$ and SFP_{int}) which can cover the proposed split in requirements between known and unknown place of installation. This is possible because this revised formula is determined by the outdoor design temperature, and wherever the place of installation is unknown, this temperature is set at -14°C. As a result, the existing error in the draft proposal's formula, which results in a discrepancy between the requirement at the lowest outdoor temperature (-14°C) and the requirement for unknown place of installation, is resolved by this formula change.

2.1.3 Recommendations

We recommend accepting the new approach in the draft proposal, while also accepting Eurovent's suggested changes to the draft proposal's formulas as outlined in Section 1.4 of their comments.[11]

The specific changes to the formulas will be outlined in the section below.

2.1.4 Effects to the regulation

The following changes to the draft proposal should be implemented:

[11] *"Eurovent comments to draft working documents on Ecodesign requirements for VU and Energy Labelling of RVUs."* Eurovent. April 30, 2021.

Annex III's "Requirements for non-residential BVUs for which the place of installation is not known" and "Requirements for non-residential BVUs for which the place of installation is known" should be deleted completely and replaced as follows:

"~~Requirements for non-residential BVUs for which the place of installation is not known~~

~~– For BVUs having an ERS equipped with a heat exchanger designed for thermal energy recovery only, except for run-around ERS~~

~~o The minimum temperature ratio ηt nrvu shall be 73 % ;~~

~~o The maximum internal specific fan power (SFPint_limit) in W/(m^3/s) is~~

~~460*E*C + Fsup + Fexh if qnom ≥ 2 m^3/s and~~

~~760*E*C – 300*qnom/2 + Fsup + Fexh if qnom < 2 m^3/s,~~

~~Where~~

~~E = 1 if ηt_nrvu =73%; if ηt nrvu >73%, E = 0.3698*ηt nrvu /(1- ηt nrvu)~~

~~– For BVUs having a run-around ERS~~

~~o The minimum temperature ratio ηt nrvu shall be 68 % ;~~

~~o The maximum internal specific fan power (SFPint_limit) in W/(m^3/s) is~~

~~960*E*C + Fsup + Fexh if qnom ≥ 2 m^3/s and~~

~~1260*E*C – 300*qnom/2 + Fsup + Fexh if qnom < 2 m^3/s,~~

~~where E=1 if ηt_nrvu= 68 to73%;if ηt nrvu>73%, E = 0.3698*ηt nrvu /(1- ηt nrvu~~

~~– For BVUs having an ERS equipped with a heat exchanger designed for thermal energy recovery and moisture recovery,~~

~~o The minimum total ERS-efficiency ηe nrvu shall be 75 % ;~~

~~o The maximum internal specific fan power (SFPint_limit) in W/(m^3/s) is~~

~~460*E*C + Fsup + Fexh if qnom ≥ 2 m^3/s and~~

~~760*E*C – 300*qnom/2 + Fsup + Fexh if qnom < 2 m^3/s,~~

~~Where~~

~~E=1 if ηe_nrvu =73%; if ηe nrvu >73%, E = 0.3698*ηe nrvu /(1- ηe nrvu)~~

~~And where~~

~~C = control bonus, determined according to Table 6 of Annex VII~~

~~Fsup = the supply filter correction value for the required filter-class supply filter in Pa as indicated in Table 5 of Annex VII~~

~~Fexh = the exhaust filter correction value for the required filter-class exhaust filter in Pa as indicated in Table 5 of Annex VII~~

~~Requirements for non-residential BVUs for which the place of installation is known~~

~~- The minimum required energy recovery ratio ηe_nrvu_min is:~~

~~ηe_nrvu-min = -1,02302*ODA -0,05813*ODA2 – 0,00134 ODA3 + ηe_nrvu-base~~

~~Where ODA is the design winter outdoor temperature at the installation site, with the valid range : -14°C to 2,5 °C. For cases where higher or lower ODA values are applicable the limit values of -14 °C and + 2.5 °C are to be used.~~

~~ηe_nrvu-base is the base energy recovery ratio figure and depends on the ERS-type having the following default values:~~

~~- run around ERS : 61,44%~~

~~- thermal ERS : 66,44%~~

~~- thermal and moisture ERS : 68,44%~~

~~– The maximum internal specific fan power (SFPint_limit) in W/(m³/s) is~~

~~o for a BVU with run-around ERS SFP_{ERS}*2.6*E*C – 300*qnom/2 + Fsup + Fexh if qnom < 2 m³/s and SFP_{ERS}*2.0*E*C + Fsup + Fexh if qnom ≥ 2 m³/s;~~

~~o for a BVU with other ERS SFP_{ERS}*1.6*E*C – 300*qnom/2 + Fsup + Fexh if qnom < 2 m³/s and SFP_{ERS}*E*C + Fsup + Fexh if qnom ≥ 2 m³/s;~~

~~Where~~

~~$SFP_{ERS} = -15,423*ODA - 0,90772*ODA^2 - 0,03227*ODA^3 + 261$~~

~~ODA is the design winter outdoor temperature at the installation site, with the valid range : -14°C to 2,5 °C. For cases where higher or lower ODA values are applicable the limit values of -14 °C and + 2.5 °C are to be used.~~

~~E-factor~~

~~o If ηe_nrvu = ηe_nrvu_min : E = 1~~

~~o If ηe nrvu > ηe_nrvu_min : E = ηe nrvu /(1- ηe nrvu) / ηe_nrvu_min *(1- ηe_nrvu_min)~~

~~C = control bonus, determined according to Table 6 of Annex VII~~

~~Fsup is the default SFPfilter value for the required filter-class supply filter in W/(m³/s) as indicated in Table 5 of Annex VII.~~

~~Fexh is the default SFPfilter value for the required filter-class axhaust filter in W/(m³/s) as indicated in Table 5 of Annex VII.~~

<u>The base BVU energy recovery efficiency η_{e_base} requirements are:</u>

For outdoor design temperatures t_{ODA} below and up to -14 °C:

73 %

For outdoor design temperatures t_{ODA} between -14 and 2.5 °C:

$-1.02 * t_{ODA} – 0.058 * t_{ODA}^2 – 0.00134 * t_{ODA}^3 + 66.44$ %

For outdoor design temperatures t_{ODA} from and above 2.5 °C:

63.5 %

<u>Minimum η_{e_nrvu} requirements for different HRS types are:</u>

For BVU with run-around HRS the temperature efficiency η_{e_nrvu} is:

η_{e_base} - 5 % points

For BVU with moisture HRS the calculated energy efficiency η_{e_nrvu} is:

η_{e_base} + 2 % points

For BVU with other HRS the temperature efficiency η_{e_nrvu} is:

η_{e_base} %

<u>The basic specific fan power of an HRS (SFP_{HRS_base}) is:</u>

For outdoor design temperatures t_{ODA} below and up to -14 °C:

388

For outdoor design temperatures t_{ODA} between -14 and 2.5 °C:

$-15.42 * t_{ODA} - 0.907 * t_{ODA}^2 - 0.0323 * t_{ODA}^3 + 261$

For outdoor design temperatures t_{ODA} from and above 2.5 °C:

216

The required value for the BVU consists of SFP_{HRS_base} , a bonus factor based on the required efficiency (E), and an additional fixed value which is proposed to be altered for different tiers and the additional amounts for the filters.

<u>Requirements for different HRS types in the calculation of the correction factor (E) are:</u>

For BVU with run-around HRS the reference efficiency ηe_ref is:

ηe_ base - 5 %-points

For BVU with BVU moisture and other HRS the reference efficiency ηe_ref is:

ηe_base %

E = ηe_act /(1 - ηe_act) * 1/ ηe_ref * (1 – ηe_ref)

ηe_act is the energy efficiency that is built in the specific ventilation unit.

<u>Requirements for $SFP_{int\text{-}limit}$ (W/(m³/s)):</u>

For BVU with run-around HRS:

A x C x (840 – 140 * qnom + E * SFPHRS_base + Fsup + Fexh) if qnom < 2 m³/s

A x C x (560 + E * SFPHRS_base + Fsup + Fexh) if qnom ≥ 2 m³/s

For BVU with other HRS the additional value $SFP_{int,\ HRS,\ add}$ is:

A x C x (375 – 140 * qnom + E * SFPHRS_base + Fsup + Fexh) if qnom < 2 m³/s

A x C x (95 + E * SFPHRS_base + Fsup + Fexh) if qnom ≥ 2 m³/s

Where:

A - is an adjustment factor equal to 0.83 to ensure that for a unit equipped with all smart control options (C = 1.15 x 1.1) the SPFint-limit value is approximately the same as the current ErP2018 limit. For units without smart controls (C = 1), the SPFint-limit is approximately 25% lower compared to ErP2018 requirements.

C - is the control bonus

F_{sup} - is the sum of F factors for all filtration stages (if applicable) in the supply air stream according to table 5 of Annex VII

F_{exh} - is the sum of F factors for all filtration stages (if applicable) in the exhaust air stream according to table 5 of Annex VII”

2.2 The Eurovent proposal for a general method on the Energy Consumption Evaluation of Air Filters

2.2.1 Topic introduction

Eurovent has proposed a method based on EN ISO 16890 to use synthetic dust to measure the change in pressure drop over a filter's lifetime; this proposal is now an official Eurovent standard ("Energy Consumption Evaluation of Air Filters for General Ventilation in NRVUs in the context of Ecodesign requirements") which could be quoted in regulation. The test involves loading the filter with synthetic test dust and aims to account for the increased pressure drop over the lifetime of the filter due to the cake filtration process of dust accumulation. This in turn allows for estimating the energy consumption of air filters for general ventilation under actual operating conditions, taking into account:

- Wide range of airflow rates
- Actual filter dimensions
- Approach to the filter change (condition-based and time-based method)
- Actual operating time
- Actual fan efficiency

In contrast, the current regulation addresses the filter pressure drop measurement as follows: "After proper preparation, calibration and checking the airstream for uniformity, initial filter efficiency and pressure drop of the clean filter are measured." This means the NRVUs' performance will be evaluated for a lower filter pressure drop and energy consumption which is not representative of the filter's total lifespan. To resolve this, the draft proposal makes references to "final pressure drop" conservative measurements as well as a direct reference to this proposal (in its earlier form, "Eurovent Industry Recommendation 4/21- 2019"). The following sections will evaluate this proposal and recommend whether it is necessary (as well as any necessary changes to it).

2.2.2 Research and Discussion

The energy consumption of air filters can be determined as a function of the volumetric flow rate, the fan efficiency, the operation time, and the average pressure drop. Under actual conditions, the sieving process of filtration is reduced over time, and hence the pressure drop of an air filter increases over time, due to the dust loading during operation. The related energy consumption during a certain period of time is calculated from the integral average of the pressure drop over this period of time[12].

If the flow is too restricted, the coil can be burned. HVAC filters generally operate at a high velocity which improves dust interception. Higher velocity increases the number of impacts. Dust will accumulate due to coagulation, condensation, and biological growth.

As the dust accumulates, the fan's work increases along with its energy consumption. At the same time the clean air delivery to the space is reduced. By anticipating that reduction in performance due to filter loading, filter maintenance frequency can be projected and anticipated.

[12] https://www.eurovent.eu/publications/eurovent-4-24-2023-energy-consumption-evaluation-of-air-filters-for-general-ventilation-purposes-first-edition-english/

The ASHRAE 52.2-2017 Standard provides a comprehensive procedure for testing air-cleaning devices for removal efficiency.

2.2.2.1 Time-based method and condition-based method comparison

Air filters are typically replaced when reaching a predefined final pressure drop (condition-based method). They are alternatively changed based on hygiene conditions on a fixed time schedule (time-based method). The time-based method usually applies when the final pressure drop is not reached before the predefined change time is reached.

The following equation is common for both the time-based and condition-based method:

$$W = \frac{q_v * \overline{\Delta p} * t}{\eta * 1000}$$

Where,

W = the portion of the total yearly energy consumption which is related to the filters' pressure drop [kWh'

q_v = volumetric flow rate of air [m^3/s]

$\overline{\Delta p}$ = average pressure drop [Pa]

t = operating time [h/a] (6000 h/a default value if not known)

η = fan efficiency [dimensionless] (0.5 default value if not known)

Time-based method

The pressure drop curve and the final pressure drop have to be determined to calculate the average pressure drop. The average pressure drop is determined from a loading of the filter according to ISO 16890-3 using a synthetic test dust specified in ISO 15957 as L2 (AC Fine) as a laboratory test method.

In case the yearly energy consumption is calculated using the time-based method, the average pressure drop is calculated as follows:

The rating shall be carried out for a full-size filter element (592 mm x 295 mm according to EN 15805). Filters with different face dimensions can also be taken into consideration in Annex 1 of the document. The filter face velocity has to be above 1.2 m/s. The steps are as follows:

1. Carry out a full test according to the ISO 16890 series of standards at nominal volumetric flow rate and determine the ePM_x efficiencies and the ISO ePM_x group as described in ISO 16890-1.
2. Load the filter with ISO L2 dust (AC Fine) according to the procedure described in ISO 16890-3. Feed the total amount of dust given in Table 2.1 (rounded up to 10 g) or to the final pressure drop (300 Pa), whichever comes first. The pressure drop curve versus dust fed is recorded with at least nine data points over the course of dust loading, providing a smooth curve of pressure drop versus dust fed.
3. The average pressure drop from the data points, pressure drop versus mass of dust fed, is calculated as follows:

$$\overline{\Delta p} = \frac{1}{M_X} * \sum_{i=1}^{n} \overline{\Delta p_i} * \Delta m_i$$

Where,

M_X = Amount of L2 dust fed to the test filter in accordance with ISO 16890-3 [g]

Used to calculate the average pressure drop

M_X is depends on the ISO group for the flow rate q_v [m^3/s] via the following table:

Table 2.1 Dust amount used for the time-based method

ISO group	ISO ePM_1	ISO $ePM_{2.5}$	ISO ePM_{10}
Amount of dust fed M_x for the flow rate q_v [m^3/s]*	$\frac{q_v}{0.944} * 200\ g$	$\frac{q_v}{0.944} * 250\ g$	$\frac{q_v}{0.944} * 400\ g$

*The amount of dust is based on estimated dust concentrations in real life: ePM_1: ~10 µg/m^3, $ePM_{2.5}$: ~12 µg/m^3, ePM_{10}: ~20 µg/m^3

4. Now that the average pressure drop is known, the yearly energy consumption, *W*, related to the filter can be calculated.

Condition-based method

In the case that filters are changed when they have reached the final pressure drop, the average pressure drop is not time dependent (as long as the time interval for calculating the average pressure drop always considers full filter lifetime intervals), and the only variable to determine the average pressure drop is the shape of the pressure drop curve as a function of the time. In this case, the average pressure drop can be estimated by using the following equation:

$$\overline{\Delta p} = \frac{2}{3}\Delta p_0 + \frac{1}{3}\Delta p_{final}$$

Where Δp_{final} is the predefined final pressure drop at which filters are changed.

In the case that the final pressure drop is defined as a multiple *x* of the initial pressure drop, the following equations can be used:

$\Delta p_{final} = x * \Delta p_0$ and $\overline{\Delta p} = \Delta p_0(\frac{2}{3} + \frac{1}{3}x)$

Assuming that, after EN 13053, that the multiplier *x* equals 3, the equation becomes:

$$\overline{\Delta p} = 1.67 * \Delta p_0$$

In the case that the final pressure is defined as the initial pressure drop increased by a certain value Δp, this equation can be written as follows:

$\Delta p_{final} = \Delta p_0 + \Delta p$ and $\overline{\Delta p} = \Delta p_0 + \frac{\Delta p}{3}$

Assuming that, after EN 13053, that Δp = 100 Pa, the equation becomes:

$$\overline{\Delta p} = \Delta p_0 + 33.3$$

The yearly energy consumption, *W*, related to the filter can then be determined.

2.2.2.2 What are the environmental savings associated with the evaluation on the Energy Consumption of Air Filters?

Requiring filter manufacturers to meet an annual energy consumption (AEC) limit while loaded with synthetic dust as opposed to while empty could push them to design filters with lower pressure drops and thus lower energy consumption across their lifetime.

Changes in the filter loading over time impacts both the energy consumed by the fan motor and the reduction in clean air delivered to the space as the airflow through the system is reduced.

2.2.2.3 Is the proposal feasible? Is it needed? Is it relevant?

The proposal appears feasible as the procedure is specified in detail, and it is relevant as it could save energy by improving filter pressure drops. As to its need, the magnitude of these savings would have to be weighed against the increased burden of effort placed upon filter manufacturers to conduct the procedure.

However, Eurovent are confident that there are no downsides to this proposed evaluation. They believe that the condition-based approach (i.e. testing with a clean filter) does not add as much value as the time-based approach (testing filled a filer filled with dust) since the measured energy consumption only depends on the clean filter pressure drop. This is unrealistic in real applications where the filter is often not completely clean. Furthermore, the ‘time-based’ approach is significant in the EU market already, with members of the Eurovent Product Group ‘Air Filters’ representing around 80% of the EU market. The time-based approach is requested by some national regulations, and currently used in practice by facilities management companies that change filters at regular intervals. Additional burden and costs are minimised further by the proposal stating that a single test needs to be carried out by the manufacturer, either:

- For a filter size of 592 mm x 592 mm at 3.400 m^3/h
- For a filter size of 592 mm x 592 mm at a flow rate that meets the AEC limit
- For any customised filter size at a flow rate that meets the AEC limit

In light of the above evidence and given that the proposal is already in use by Eurovent clients of filter manufacturers who represent the majority of the EU market, it seems to be a feasible and viable proposal.

Feedback from many stakeholders has been that this proposal is needed. Until now, the energy consumption evaluation of air filters has been considered without a specific calculation that could account for the technical peculiarities/unique features of each filter. This new proposal better considers the energy performance of a filter, and thus a better evaluation of the performance of the air handling unit too.

2.2.2.4 What are the drawbacks – if any – of the proposed evaluation of Air Filters?

One stakeholder stated that there is a risk that too much space could be allowed for interpretation in this, making market surveillance more difficult. This is due to the choice manufacturers have between time based and condition-based methods. For the time-based method (which is the new method being proposed by Eurovent), the volumetric flow rate[13] of the actual application needs to be known, which is difficult to know prior to a filter being placed on the market due to the actual application of it not being confidently known. For the condition-based method (which is the method in the existing regulation), it is dependent on the way that the final pressure drop is defined. Defining default values for the volumetric flow rate and final pressure drop in the regulation could be a solution to this. Making the time-based approach mandatory in conjunction with the condition-approach EN ISO 16890 testing

[13] The study team’s understanding is that the ‘volumetric flow rate’ used in the time-based method is the ‘nominal flow rate’ used in the ISO 16890 series of standards. The Eurovent proposal states that ‘To compare different filters for one application, qv,t η, and dimensions must be the same for all filters’. Thus, the nominal flow rate according to ISO 16890 series of standards is used in the time-based method calculation to maintain consistency.

specifications would solve the issue of market surveillance with regards to the choice that manufacturers have.

However, there has been feedback from one stakeholder that claims that there are a limited number of ventilation unit manufacturers that have testing equipment, along with a lack of independent testing laboratories. Thus, if the choice is given, there is a risk that most manufacturers would not choose the time-based method if Eurovent's proposal is incorporated into the final revision of GROW LOT 6. A solution to this would be for authorities to support manufacturers with testing resources needed by air filter manufacturers by making independent testing facilities available and accessible. Furthermore, making the time-based approach mandatory would solve the confusion aspect of there being two separate methods.

2.2.3 Recommendations

The Eurovent proposal, which uses the EN ISO 16890 time-based method to measure a more accurate filter pressure drop than the existing regulation's measurement at initial conditions, for the time-based method would help to predict the maintenance requirements of filters and thus the consistency of the clean air delivered to the space – the right amount of air and the right time. It will give more precise, realistic data and encourage filter suppliers to develop new technologies to research lower pressure drops when dust is loaded in the filter. The fact that the 'time-based' approach is significant in the EU market already, with members of the Eurovent Product Group 'Air Filters' representing around 80% of the EU market currently using it in practice, it appears feasible, useful and viable. It is an important step towards achieving more efficient ventilation systems.

Thus, it is recommended that the time-based method is added into the Regulation as a mandatory Ecodesign requirement for NRVUs for the final pressure drop calculation.

2.2.4 Effects to the regulation

The draft proposal's references to "EN ISO 16890" and "final pressure drop" sufficiently incorporate this proposal from Eurovent; the only change to the draft proposal needed to add this method into the Regulation would be to replace the "Reference Test Method / Title" of "Eurovent Industry Recommendation 4/21- 2019" (which was the older version of this proposal) with the following text: "Eurovent Industry Recommendation 4/25- 2023."

3 Further items of review

3.1 Interplay/synergy with the review of the Ecodesign Regulation No 327/2011 on industrial fans

3.1.1 Topic introduction

EU1253/2014's ventilation unit regulation and EU327/2011's fan regulation overlap to an extent, such that it is not clear which applies to certain ventilation products, namely box fans and rooftop fans.

EU1253 states that it does not apply to "axial or centrifugal fans only equipped with a housing in terms of Regulation 327/2011." EU327 defines that housing as follows: "structural components that hold the assembly in place and may interfere with the airflow (such as brackets supporting the motor or the bearings)."

Per the above, clarification is needed as to whether box and rooftop fans are considered "axial or centrifugal fans only equipped with a housing" and therefore must meet EU327, or whether they are considered "ventilation units" and therefore must meet EU1253, or whether both regulations would apply. Furthermore, EU327 has recently been revised; however, these changes do not overlap with those in the draft proposal on EU1253. If both regulations were to apply, in any case where one was more stringent than the other, the more stringent requirement would have to be met.

3.1.2 Research and Discussion

AMCA provided feedback on this subject, as they expressed concern that roof and box fans are already regulated by EU327 and hence such products would be double-regulated; however, given the above language from EU1253, if such were considered "axial or centrifugal fans only equipped with a housing," they would then be exempt from EU1253.

EVIA also provided feedback, stating that they too favour the shift of box and roof fans to EU327 and a "clear and unequivocal" exclusion of them from EU1253. They propose to include the definitions proposed in EU327's guidance document for calculating fan energy efficiency, EN 17166, as a means of clarifying the definitions.

3.1.3 Recommendations

Box fans and rooftop fans are intended to be ventilation units and are typically equipped with more than just "housing" per the EU327's structural definition above. Therefore, the intent of EU1253 would be to apply to their function as ventilation units, while EU327's additional regulations upon just the fan component (produced separately by fan manufacturers such as those represented by AMCA) would still be needed. Hence, both regulations would apply to box and rooftop fans, and this would not be redundant. Therefore, we recommend no further action be taken with the draft proposal in this regard.

3.1.4 Effects to the regulation

No changes to the regulation.

3.2 Interplay/synergy with the revision of the Directive on the energy performance of buildings

3.2.1 Topic introduction

The revised Energy Performance of Buildings Directive (EPBD) was adopted in April 2024[14]. With regards to 2010/31/EU, amended in 2018[15], ventilation systems have been added to the list of measures that national Member Sates inspectors should cover. These new inspections can support a revised regulation on non-residential ventilation units.

3.2.2 Research and Discussion

Including ventilation systems as part of the EPBD measures is aimed at addressing the quality of indoor air.

In the EPBD, Member States are required to establish regular inspections of the accessible parts of heating systems, ventilation systems and air-conditioning systems, including any combination thereof, with an effective rated output of over 70 kW at least every 5 years and at least every 3 years for systems with an effective rated output of over 290 kW.

Inspectors will compare the sizing of the ventilation system to the requirements of the building and consider the capabilities of the ventilation system to optimise its performance under typical or average operating conditions. In addition, national inspection schemes are being developed to ensure that delivered construction and renovation works meet the designed energy performance[16].

It is also proposed that as of 2030, the threshold for the mandatory installation of building automation and control systems should be lowered for non-residential buildings, and that it is mandatory to equip new residential buildings and residential buildings undergoing major renovations with monitoring and control functionalities to ensure their management and operation is optimal. Buildings equipped with such systems are exempted from the regular inspections.

In addition, the revised EPBD supports high indoor environmental standards by requiring that new non-residential zero-emission buildings are equipped with measuring and control devices for monitoring and regulating indoor air quality. This is also the case for buildings undergoing major renovations, where technically and economically feasible. Member States may introduce the same obligations also for residential buildings.

These measuring and control devices will monitor and regulate the operation of the building's technical building systems in order to ensure that they operate optimally and provide the required indoor environmental quality conditions, while maintaining high efficiency levels.

It is noted that the EPBD only inspects products years after they are installed. Hence, the EPBD would not make an immediate impact on ventilation systems that are newly installed.

Member States shall lay down requirements to ensure that, where economically and technically feasible, building automation and control systems are installed in non-residential

[14] https://www.consilium.europa.eu/en/documents-publications/public-register/public-register-search/?WordsInSubject=&WordsInText=&DocumentNumber=102%2F23&InterinstitutionalFiles=&DocumentTypes=&DateFrom=&DateTo=&MeetingDateFrom=&MeetingDateTo=&DocumentLanguage=EN&OrderBy=DOCUMENT_DATE+DESC

[15] EUR-Lex - 02010L0031-20210101 - EN - EUR-Lex (europa.eu)

[16] https://eur-lex.europa.eu/resource.html?uri=cellar:c51fe6d1-5da2-11ec-9c6c-01aa75ed71a1.0001.02/DOC_1&format=PDF

buildings with an effective rated output for heating systems or systems for combined space heating and ventilation of over 290 kW by 31 December 2024. By 31 December 2029, this threshold for the effective rated output will be lowered to 70 kW. Two years after the entry into force of the directive (mid 2026), MSs will also need to ensure that BACS also provide indoor environmental quality (IEQ) monitoring[17].

3.2.3 Recommendations

The new EPBD inspection directive could be a useful mechanism for future enforcement of Ecodesign NRVU as well as a mechanism to gather data on building and ventilation performance. Therefore, it is recommended that the EPBD can be used as an inspection tool to verify the Ecodesign Regulation, especially for NRVUs. Furthermore, it is recommended that the EPBD considers the NRVU requirements and includes these in their inspection schemes.

3.2.4 Effects to the regulation

As the above recommendations pertain to the EPBD and not this regulation, no changes would be needed to this regulation related to the above.

3.3 Other comments/proposals from stakeholder in the context of the stakeholder consultation process.

3.3.1 Topic introduction

Notable feedback from stakeholders' comments and position papers which do not fall into the previous categories, particularly feedback related to technical issues and definitions, will be recorded here.

3.3.2 Research and Discussion

Some notable additional comments from stakeholders which were gathered from the comment documents and stakeholder discussions are as follows:

- The Danish Energy Agency (DEA) had several comments on definitions which are considered below:
  - DEA suggested that air treatment (such as a "filter, ERS, cooling/ heating by coils or a heat pump") should be part of the definition of a VU, so that some types of fans can no longer be defined as VUs and therefore cannot find loopholes between fan and VU regulations. However, as noted in Section 3.1 above, these fans may in fact need to be regulated by both regulations, so this change would not be warranted.
  - DEA also recommended removing the 250 m^3/h maximum flow rate from the definition of RVUs, so that NRVUs below this flow rate are not classified as RVUs and subjected to sound requirements which are only relevant to residential homes. The challenge with this recommendation is that without this maximum flow rate, an RVU could be argued to be not "exclusively for a residential ventilation application" and

[17] The EPBD Recast define IEQ as the result of an assessment of the conditions inside a building that influence the health and wellbeing of its occupants, based upon parameters such as those relating to the temperature, humidity, ventilation rate and presence of contaminants. Member States will retain the competence for regulating indoor environmental quality, and they will need to define the indoor conditions to be maintained in buildings in order to ensure healthy conditions.

therefore considered as an NRVU even while its maximum flow rate is less than this. Therefore, we would not recommend this change either.

   – The other comments from DEA are largely slight edits in wording which may not have a significant impact on the interpretation of the regulation, and therefore can also be set aside until backed up by other stakeholders' comments.

- Eurovent commented that internal leakages must be considered for RVUs in terms of how they significantly alter a unit's thermal efficiency, as detailed in Item 2.3 of their comments on the draft proposal.[18] They recommend not applying any correction related to the internal leakage factor "w" in Table 5 of the draft proposal until further research and discussion with Eurovent and the experts of CEN/TC156 WG2 in charge of the relevant EN 13142 and EN13141-7 standards.
   – The justification provided by Eurovent, which consists of a study titled "Comparative test and analysis of internal leakages in bidirectional RVU by various test methods" which indicates large differences in internal leakage, appears well-founded, and therefore no correction should be applied to the internal leakage factor "w" in the draft proposal until further research to be resolved by the next revision of the standards.
- EVIA commented that multifunctional ventilation units (for example, ventilation units which are also heat pumps) should be regulated in light of all of their functions rather than being categorized by just one of their functions. Although the market for such units is relatively small, the current ambiguity in how these are categorized could allow companies to find loopholes (for example, adding a small heat pump just to get the unit categorized as a heat pump); detailed information requirements and special categorization for multifunctional units may help prevent this.
   – Additional regulation of these less common multifunctional ventilation units may only provide marginal benefit, and it is not clear exactly how the current categorisation allows for loopholes in this regard. The draft proposal already includes several information requirements specific to multifunctional units, which would sufficiently alert the end-user to the overlapping functions of the unit. Therefore, without evidence of significant mis-categorisation, no regulatory changes would be needed here.

3.3.3 Recommendations

Of the above comments, the following should be acted upon:

- In light of Eurovent's research finding large discrepancies in the calculation of the internal leakage factor "w" in Table 5 of the draft proposal, no correction should be applied to this factor in the draft proposal until further research to be resolved by the next revision of the standards.

3.3.4 Effects to the regulation

In Table 5 of the draft proposal for EU1253, the internal leakage correction factor "w" should be removed (and all formulas and variable names adjusted accordingly), and such a factor should not be added back in until further research to be resolved by the next revision of the standards.

[18] *"Eurovent comments to draft working documents on Ecodesign requirements for VU and Energy Labelling of RVUs."* Eurovent. April 30, 2021.

Annex 1 – Example Product Fiches

UVU Product Fiches:

Product fiche for Product A - UVU

Product fiche

Delegated Regulation (EU) 1254/2014

Supplier name or trademark	[redacted]
Model identifier	[redacted]
Specific energy consumption (cold zone)	-53,3 kWh/(m² x a)
Specific energy consumption class (average zone)	B
Specific energy consumption (average zone)	-26,2 kWh/(m² x a)
Specific energy consumption (warm zone)	-10,7 kWh/(m² x a)
Typology	Unidirectional Ventilation Unit (UVU)
Type of drive	Variable speed drive
Type of heat recovery system	-
Thermal efficiency of heat recovery	- %
Maximum flow rate	301 m³/h
Electric power input of the fan drive	53,5 W
Sound power level	45 dB
Reference flow rate	0,060 m³/s
Reference pressure difference	124 Pa
Specific Power Input	0,16 W/(m³/h)
Control factor	0,65
Control typology	Local demand control - 0,65
External leakage rates	2,6 %
Position of visual filter warning	Sur l'écran de contrôle Voir notice d'utilisation disponible sur https://www.aldes.fr/produits/confort-thermique/eau-chaude-sanitaire/t.flow-hygro-nano-maison-individuelle
Description of visual filter warning	Affichage d'une alarme sur l'écran de contrôle et le rétroéclairage reste allumé Voir notice d'utilisation disponible sur https://www.aldes.fr/produits/confort-thermique/eau-chaude-sanitaire/t.flow-hygro-nano-maison-individuelle
Installation instructions	Selon Notice d'installation disponible sur https://www.aldes.fr/produits/bouches-et-entrees-d-air/bouches-et-terminaux
Pre-/dis-assembly instructions URL	[redacted]
Annual Electricity Consumption	84,0 kWh electricity/annum
Annual Heating Saved at cold climate	5 536,0 kWh primary energy/annum
Annual Heating Saved at average climate	2 830,0 kWh primary energy/annum
Annual Heating Saved at warm climate	1 280,0 kWh primary energy/annum

Product fiche for Product B - UVU

Product fiche

Delegated Regulation (EU) 1254/2014

Supplier name or trademark	[redacted]
Model identifier	[redacted]
Specific energy consumption (cold zone)	-54,0 kWh/(m² x a)
Specific energy consumption class (average zone)	B
Specific energy consumption (average zone)	-26,9 kWh/(m² x a)
Specific energy consumption (warm zone)	-11,4 kWh/(m² x a)
Typology	Unidirectional Ventilation Unit (UVU)
Type of drive	Variable speed drive
Type of heat recovery system	-
Thermal efficiency of heat recovery	- %
Maximum flow rate	307 m³/h
Electric power input of the fan drive	32,0 W
Sound power level	61 dB
Reference flow rate	0,060 m³/s
Reference pressure difference	0 Pa
Specific Power Input	0,07 W/(m³/h)
Control factor	0,65
Control typology	Local demand control - 0,65
External leakage rates	2,7 %
Position of visual filter warning	refer_to_the_manual
Description of visual filter warning	refer_to_the_manual
Installation instructions	refer_to_the_manual
Pre-/dis-assembly instructions URL	[redacted]
Annual Electricity Consumption	55,0 kWh electricity/annum
Annual Heating Saved at cold climate	5 536,0 kWh primary energy/annum
Annual Heating Saved at average climate	2 830,0 kWh primary energy/annum
Annual Heating Saved at warm climate	1 280,0 kWh primary energy/annum

Product fiche for Product C - UVU

Product fiche

Delegated Regulation (EU) 1254/2014

Supplier name or trademark	[redacted]
Model identifier	[redacted]
Specific energy consumption (cold zone)	**-54,3 kWh/(m^2 x a)**
Specific energy consumption class (average zone)	**B**
Specific energy consumption (average zone)	**-27,2 kWh/(m^2 x a)**
Specific energy consumption (warm zone)	**-11,7 kWh/(m^2 x a)**
Typology	**Unidirectional Ventilation Unit (UVU)**
Type of drive	**Multi-speed drive**
Type of heat recovery system	**-**
Thermal efficiency of heat recovery	**- %**
Maximum flow rate	**3 388 m^3/h**
Electric power input of the fan drive	**43,0 W**
Sound power level	**46 dB**
Reference flow rate	**0,066 m^3/s**
Reference pressure difference	**201 Pa**
Specific Power Input	**0,07 W/(m^3/h)**
Control factor	**0,65**
Control typology	**Local demand control - 0,65**
External leakage rates	**5,0 %**
Position of visual filter warning	**-**
Description of visual filter warning	**-**
Installation instructions	**Do not install this product in areas where the following may be present or occur: - Excessive oil or a grease laden atmosphere. - Corrosive or flammable gases, liquids or vapours. - Subject to direct water spray from hoses Precautions must be taken to avoid the back-flow of gases into the building from the open flue of gas or other fuel-burning appliances. The exhaust grille should be located at least 600mm away from any flue outlet**
Pre-/dis-assembly instructions URL	[redacted]
Annual Electricity Consumption	**0,4 kWh electricity/annum**
Annual Heating Saved at cold climate	**55,4 kWh primary energy/annum**
Annual Heating Saved at average climate	**28,3 kWh primary energy/annum**
Annual Heating Saved at warm climate	**12,8 kWh primary energy/annum**

BVU Product Fiches:

Product fiche for Product D - BVU

Product fiche

Delegated Regulation (EU) 1254/2014

Supplier name or trademark	[redacted]
Model identifier	[redacted]
Specific energy consumption (cold zone)	**-80,8 kWh/(m² x a)**
Specific energy consumption class (average zone)	**A+**
Specific energy consumption (average zone)	**-42,3 kWh/(m² x a)**
Specific energy consumption (warm zone)	**-17,7 kWh/(m² x a)**
Typology	**Bidirectional Ventilation Unit (BVU)**
Type of drive	**Variable speed drive**
Type of heat recovery system	**Recuperative**
Thermal efficiency of heat recovery	**84,8 %**
Maximum flow rate	**780 m³/h**
Electric power input of the fan drive	**325,0 W**
Sound power level	**51 dB**
Reference flow rate	**0,150 m³/s**
Reference pressure difference	**50 Pa**
Specific Power Input	**0,23 W/(m³/h)**
Control factor	**0,65**
Control typology	**Local demand control - 0,65**
Maximum internal leakage rates	**1,2 %**
Maximum external leakage rates	**0,6 %**
Position of visual filter warning	**Control Panel Display**
Description of visual filter warning	**Flashing icon indicating a clogged filter**
Pre-/dis-assembly instructions URL	[redacted]
Annual Electricity Consumption	**1,7 kWh electricity/annum**
Annual Heating Saved at cold climate	**89,7 kWh primary energy/annum**
Annual Heating Saved at average climate	**45,9 kWh primary energy/annum**
Annual Heating Saved at warm climate	**20,7 kWh primary energy/annum**

Product fiche for Product E - BVU

Product fiche

Delegated Regulation (EU) 1254/2014

Supplier name or trademark	[redacted]
Model identifier	[redacted]
Specific energy consumption (cold zone)	-66,2 kWh/(m² x a)
Specific energy consumption class (average zone)	C
Specific energy consumption (average zone)	-25,4 kWh/(m² x a)
Specific energy consumption (warm zone)	-2,1 kWh/(m² x a)
Typology	Bidirectional Ventilation Unit (BVU)
Type of drive	Multi-speed drive
Type of heat recovery system	Regenerative
Thermal efficiency of heat recovery	80,0 %
Maximum flow rate	250 m³/h
Electric power input of the fan drive	180,0 W
Sound power level	44 dB
Reference flow rate	0,049 m³/s
Reference pressure difference	50 Pa
Specific Power Input	0,55 W/(m³/h)
Control factor	1,0
Control typology	Manual control (no DCV) - 1
Maximum internal leakage rates	- %
Maximum external leakage rates	- %
Carry over	5,0 %
Position of visual filter warning	Display
Description of visual filter warning	Display
Pre-/dis-assembly instructions URL	[redacted]
Annual Electricity Consumption	689,0 kWh electricity/annum
Annual Heating Saved at cold climate	8 340,0 kWh primary energy/annum
Annual Heating Saved at average climate	4 263,0 kWh primary energy/annum
Annual Heating Saved at warm climate	1 928,0 kWh primary energy/annum

Product fiche for Product F - BVU

Product fiche

Delegated Regulation (EU) 1254/2014

Supplier name or trademark	[redacted]
Model identifier	[redacted]
Specific energy consumption (cold zone)	**96,3 kWh/(m² x a)**
Specific energy consumption class (average zone)	**G**
Specific energy consumption (average zone)	**47,7 kWh/(m² x a)**
Specific energy consumption (warm zone)	**16,5 kWh/(m² x a)**
Typology	**Bidirectional Ventilation Unit (BVU)**
Type of drive	**Multi-speed drive**
Type of heat recovery system	**Recuperative**
Thermal efficiency of heat recovery	**76,3 %**
Maximum flow rate	**5 700 m³/h**
Electric power input of the fan drive	**130,0 W**
Sound power level	**50 dB**
Reference flow rate	**3,500 m³/s**
Reference pressure difference	**50 Pa**
Specific Power Input	**0,33 W/(m³/h)**
Control factor	**0,85**
Control typology	**Central demand control - 0,85**
Maximum internal leakage rates	**0,5 %**
Maximum external leakage rates	**1,1 %**
Position of visual filter warning	**-**
Description of visual filter warning	**-**
Pre-/dis-assembly instructions URL	[redacted]
Airflow sensitivity to pressure variations at + 20 Pa and - 20 Pa	**- %**
Indoor/Outdoor air tightness	**1,0 m³/h**
Annual Electricity Consumption	**455,8 kWh electricity/annum**
Annual Heating Saved at cold climate	**2 551,9 kWh primary energy/annum**
Annual Heating Saved at average climate	**5 643,1 kWh primary energy/annum**
Annual Heating Saved at warm climate	**9 999,0 kWh primary energy/annum**