



Trends in building ventilation requirements and inspection in Belgium

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1 General introduction

In Belgium, the requirements for ventilation in buildings can be found in national regulations for health and well-being, in regional environmental regulations and in regional EPB regulations (Energy Performance and Indoor Climate), which refer to national ventilation standards. In 2006 the regional EPB regulations were introduced for the first time including mandatory requirements for ventilation. From then on it was mandatory to install a natural or mechanical ventilation system for acceptable indoor air quality in all new and renovated, residential and non-residential buildings for which a building permit is necessary. This paper discusses the present ventilation requirements in buildings (both residential and non-residential), current trends in the Belgian building ventilation market, energy requirements, requirements for inspection of the systems, innovations in the market and the impact of COVID-19. This paper is an update of an older VIP on trends in the Belgian building ventilation market (Wouters et al. 2008).

Although standards and guidelines are generally published at a national level in Belgium,

building energy performance regulation is a regional matter, including ventilation requirements. This means that each of the three regions – Flemish, Brussels Capital and Walloon Region – can have a different approach. Although most regulations are similar, some parts of the regulation, for instance in relation to inspection, do not apply in all regions. The paper mentions the differences between the regions when this is the case.

2 National trends in IAQ requirements and market

2.1 Requirements for the ventilation of dwellings

The Regional decrees on Energy Performance of Buildings in Flanders, Wallonia, and Brussels Capital Region (Energiebesluit 2010, Guide PEB 2015, Environnement Brussels 2024) refer to Annexes which specify the residential ventilation requirements. In general, these Annexes stipulate that ventilation in residential buildings must follow the Belgian

standard NBN D50-001 (1991)¹, and list the exceptions and additions to that standard. The standard contains guidelines for ventilation that were made mandatory through the decrees on Energy Performance of Buildings in 2006 in Flanders, and 2008 in Wallonia and Brussels Capital Region. The standard was already 15 years old at that time, and it was already in force in the Walloon region for new dwellings since 1996. However, it only started to have an important impact in practice when it was integrated in the Regional Energy Performance Regulations, mainly as a result of the strictly enforced compliance framework of the Energy Performance Regulations, with declaration of performances after completion of construction works, and a fully operational fine system. As a consequence, the compliance rate of energy performance requirements and ventilation requirements is high.

The standard defines a general minimum air flow rate of 3.6 m³/(h.m²) (or 1 l/(s.m²)) supply air for habitable rooms (also named dry rooms), which are the rooms where people typically spend most of their time, like living rooms, offices, or bedrooms. For service rooms (also named wet rooms) such as kitchens, bathrooms, laundry rooms and toilets, the same general rule applies to the extract air. Additionally, minimum and permissible maximum flow rates are set for the various room types, as listed in Table 1. The total supply or exhaust flow rate of the system is equal to the sum of the minimum required flow rates per room. Application examples are given in Annex A.

Table 1: Minimum required and maximum permissible flow rates in dwellings according to EPB based on NBN D50-001

General rule (supply, extract)	3.6 m ³ /(h.m ²)
Living room (supply)	min: 75 m ³ /h, max: 150 m ³ /h
Bedroom, office, games room, etc. (supply)	min: 25 m ³ /h, max: 72 m ³ /h
Closed kitchen, bathroom, laundry rooms (extract)	min: 50 m ³ /h, max: 75 m ³ /h
Open kitchen (extract)	min: 75 m ³ /h
Toilet (extract)	25 m ³ /h

The standard also specifies that the habitable and the extract rooms should be connected through grilles or slots that can transfer an

airflow of 25 m³/h (50 m³/h for kitchens) at a pressure difference of 2 Pa. In practice, this is achieved by means of openings of minimum 70 cm² between rooms (140 cm² for kitchens), corresponding to the typical door undercuts of 1-2 cm.

The possible ventilation systems in the standard are natural ventilation systems (defined as system 'A' in the standard), mechanical supply ventilation systems (B), mechanical extract ventilation systems (C) and mechanical supply and extract ventilation systems (D). Systems A, B and C need to include trickle ventilators or passive stacks, which are sized to achieve the nominal flow at 2 Pa. The EPB ventilation annexes also allow sizing these components at 10 Pa, if the room is served by a mechanical component, for instance if there is mechanical extraction in a room with supply through trickle ventilators.

The user is not obliged to achieve the required flow rates in each room at all times. It is allowed to reduce the flow rates according to the demands at a given moment. Control can be manually via a simple control mechanism (switch or button) or via an automatic control system in response to measurements of humidity, CO₂,... Mechanical systems should however still maintain a permanent, although reduced, flow rate at all times.

2.2 Ventilation systems in residential buildings stock and market

In Belgium, the energy performance of new and renovated buildings is assessed at the moment of completion of the works by an EPB-assessor, who collects the as-built information, creates the necessary input in the EPB-software, and evaluates whether the building meets the requirements. The EPB-declarations with the results are uploaded to a database, managed by the regional authorities. The analysis of part of this data is publicly available in Flanders: <https://apps.energiesparen.be/energiekaart/vlaanderen>

This database also contains extensive information about residential ventilation systems installed in the market, which allows to follow market evolutions. Most data relate to

¹ This standard will be replaced by the revised European standard EN 15665 in the future.

new residential buildings for which data are available since 2006. Although the ventilation requirements were also mandatory for renovation projects with building permit, they were only partially mandatory, depending on the extent of the renovation works. As a consequence this data has not been systematically documented in the database. Since 2015 a ventilation system is also mandatory in residential buildings undergoing a deep energy renovation, for which financial benefits applied in Flanders until October 2025. These data are also public.

Figure 1 shows the evolution of the distribution of residential ventilation systems since 2006 in Flanders. The mechanical extract (System C) and balanced mechanical systems (System D) dominate the market. Of all systems installed in the over 440.000 new dwellings constructed in between 2006 and 2022, 4% are natural ventilation systems (A), 53% are mechanical extract systems (C) and 43% are balanced mechanical systems (D). Since 2014 the share of balanced mechanical systems has gradually been increasing from 50% up to 69% since 2021. This is the result of an associated tightening of energy performance requirements during these years, which were easier to meet when balanced mechanical ventilation with heat recovery was installed. For a long time this type of system has been more prevailing in single family dwellings (60% in 2014), compared to multifamily dwellings (43% in 2014), but in recent years the difference has become smaller (respectively 70% and 68% in 2022). Also in deep energy renovation projects, the systems C and D dominate, with a share of respectively 55% and 43% of the projects constructed in between 2015 and 2022. The mechanical extract systems include systems with demand control, which can be taken into account in the energy performance calculation. The share of these systems is not specifically documented in the regional analysis reports. However, because of the stricter energy performance requirements, it can be expected that the share of demand controlled extract ventilation prevails for this system type.

The figures shown in Figure 1 relate to newly constructed dwellings. The implementation of

ventilation systems in the existing dwelling stock is much smaller. Analysis of the database of Energy Performance Certificates for dwellings that were for sale or for rent in between 2015 and 2018 showed that only 4% of existing dwellings were equipped with a mechanical ventilation system (B, C or D) (Van Hove et al. 2021).

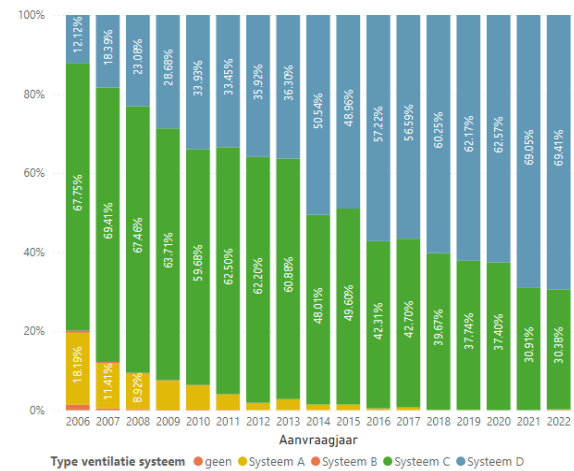


Figure 1: Evolution of the distribution of the type of ventilation systems in new dwellings in Flanders, Belgium between 2006 and 2022 (year of building permit), all dwellings combined: no system (orange), system A (yellow), B (pink), C (green), D (blue).

2.3 Requirements for the ventilation of non-residential buildings

Similar to residential buildings, ventilation requirements for non-residential buildings are specified in separate Annexes to the Regional decrees on Energy Performance of Buildings in Flanders, Wallonia, and Brussels Capital Region. They also became mandatory for all types of new and renovated non-residential buildings with building permit, when the Energy Performance Regulations were introduced in 2006 in Flanders, and 2008 in Wallonia and Brussels Capital Region. For renovations, the requirements are partially mandatory, depending on the extent of renovation works. In the Walloon region, ventilation requirements have been in force for office and school buildings since 1996.²

The Annexes refer to concepts and classes as defined in the standard NBN EN 13779:2004 to express minimum requirements for the design

du Territoire, de l'Urbanisme et du Patrimoine (15/02/1996)

² Arrêté du Gouvernement Wallon modifiant, en ce qui concerne l'isolation thermique et la ventilation des bâtiments, le Code wallon de l'Aménagement

and operation of ventilation systems. When sizing ventilation systems, the minimum flow rates corresponding to indoor air class IDA3 must be met. When specifying flow rates a distinction is made between rooms serving for typical human occupancy (offices, class rooms,...), and rooms not intended for long term human occupancy (corridors, toilets, storage rooms,...):

- In rooms for human occupancy a minimum flow rate of outdoor air needs to be supplied depending on a flow rate per person (min. 22 m³/h per person), and the design occupation of the room. The design occupation follows from the design brief of the construction project, but should at least be equal to minimum design occupancies listed in the regulation as a function of the floor area, for a range of functions including restaurants, hotels, offices, theatres, shops, sport clubs, schools, prisons and hospitals.
- The required flow rates in rooms not for human occupancy depend on a minimum flow rate per unit of floor area (1.3 m³/h/m²), and the total floor area of the room. In case of sanitary facilities 25 m³/h per toilet needs to be provided. These flow rates may be met by transferring air from adjacent rooms and not necessarily by supplying outdoor air.

Apart from specifying minimum flow rates, the regulation also imposes that a control system must be in place at least meeting class IDA-C3 (time control). This means that systems without control or with only a manually controlled switch are not allowed. Furthermore, supply and exhaust design flow rates don't need to be balanced, as long as an imbalance does not cause an underpressure larger than 5 Pa, or an overpressure larger than 10 Pa at building level. Finally, the regulation Annexes impose a maximum specific fan power that cannot be larger than class SFP-3 (< 0.4 W/(m³/h)). This requirement was abandoned in Flanders after 2014, since auxiliary energy use was already covered in the overall energy performance requirements (E-level, see §3).

In addition to the regional legislation on energy performance, there is a federal law "Codex on Well-Being at Work" (Belgian Government, 2017) which also imposes ventilation requirements, specifically for spaces where

workers are employed. The requirements for ventilation came into force in 2020 for new buildings, and imposed the development of action plans for existing buildings to meet the requirements when planning renovations. As a result the Codex has had a stronger impact on the design of ventilation systems for non-residential buildings, than ventilation guidelines in older legislation for employment protection. In many non-residential buildings, the Codex leads to larger flow rates compared to the requirements for IDA3 in the energy performance regulations, thus in that case the Codex is decisive for the required design flow rates. Application examples for both EPB and Codex methodology are given in Annex A.

The Codex requires the employer to take the necessary measures to ensure that the CO₂-level in the workspace remains below 900 ppm or to ensure a ventilation flow rate of 40 m³/h per person present in the workspace. The CO₂-concentration requirement should be met during 95% of the occupation time, and assuming an outside concentration of 400 ppm. If the outdoor concentration is higher, the difference between the actual outdoor concentration and 400 ppm can be taken into account. As an alternative, if the employer can demonstrate that pollution sources affecting indoor air quality have been eliminated or significantly reduced, e.g. by applying low-emission materials, the CO₂ requirement may be relaxed to 1200 ppm, or the minimum flow rate to be ensured amounts to 25 m³/h per person present. The employer needs to seek advice from the relevant prevention adviser and committee in this case.

The pollution sources mentioned in the Codex include building materials, flooring, finishing, furniture, equipment and cleaning of the workspace, among others. However, in practice, based on the methods and product information currently available in Belgium, only floor coverings and floor application and finishing products have to meet legal emission requirements, see Table 2 (FOD WASO 2019, Belgian Government 2014).

Table 2: Threshold concentration levels after 28 days determined according to CEN/TS 16516

TVOC	≤ 1000 µg/m ³
TSVOC	≤ 100 µg/m ³
Acetaldehyde	≤ 200 µg/m ³
Toluene	≤ 300 µg/m ³
Formaldehyde	≤ 100 µg/m ³

2.4 Ventilation systems in non-residential buildings stock and market

Similar to residential buildings, non-residential buildings constructed or renovated after 2006 have installed ventilation systems to comply with ventilation requirements in EPB regulation. Even though ventilation requirements were in force for all non-residential building functions, only schools and offices also had to comply to energy performance requirements from 2006 (Flanders) or 2008 (Wallonia and Brussels). For schools and offices data on ventilation are available in the Flemish EPB database from 2009 onwards. For other non-residential building functions, e.g. health care or retail, energy performance requirements were only introduced in 2017. From that moment on also ventilation data for this broad category were available in the EPB database, including data for schools and offices. Figure 2 shows the share of ventilation system types in new or renovated non-residential buildings with building permit, based on the analysis of Flemish EPB-declaration data: 84% are systems with mechanical supply and extract, for which heat recovery is possible. A smaller share of the systems are mechanical extract systems (14%). These figures are almost the same for schools, offices, and non-residential buildings.

For the existing non-residential building stock in Belgium, there is little systematic information available on the market share of ventilation systems. However, more recently, data on ventilation systems have been collected as part of the energy performance certificates for existing non-residential buildings (EPC-NR) which have become mandatory in Flanders since 2023. As a result, more than 25000 certificates have been issued in the period January 2023 until August 2025, which give an indication on the presence of ventilation systems in non-residential buildings. EPC-NR's are issued at the level of a building unit (smallest functional unit). A single building or site can consist of multiple building units. It is possible that different types of ventilation may be present within a single building, while some rooms may not be equipped with ventilation at all. Figure 3 shows the share of ventilation system types in existing non-residential building units per designated use.

In total, 46% of the existing building units do not have a ventilation system, 32% has a mechanical supply and extract system, and 17% a mechanical extract system. The presence and type of ventilation depends a lot on the building function. Mechanical supply and extract systems are prevailing in office buildings (42%) and buildings for sports and recreation (41%). Mechanical extract systems are more common in healthcare (34%). Over 50% of building units in schools, hotels, restaurants and bars don't have any ventilation system.

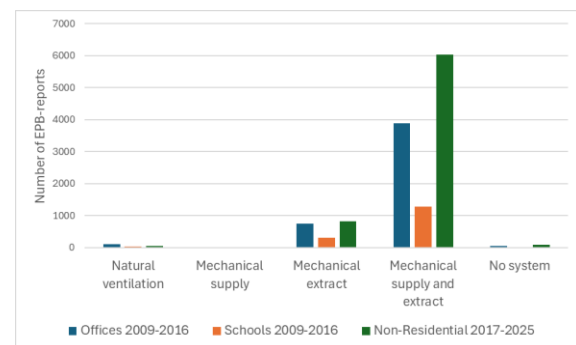


Figure 2: Distribution of ventilation system type in new and renovated non-residential buildings in Flanders, Belgium (13395 EPB-reports)

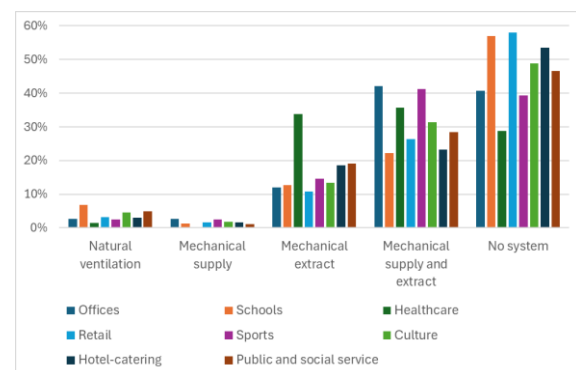


Figure 3: Distribution of ventilation system type in existing non-residential buildings in Flanders, Belgium (25057 EPC's)

3 National trends in energy requirements and market

3.1 Energy requirements

The energy requirements concern both energy efficiency of the building and indoor climate (summer comfort and ventilation), and are specified in a number of sub-requirements to which all new and renovated buildings have to comply:

- thermal insulation: maximum U-value of building envelope components and maximum overall heat loss coefficient
- maximum E-level (measure for total primary energy use of the project)
- minimum ventilation requirements
- maximum value of overheating indicator (summer comfort, only for dwellings)

The influence of ventilation is taken into account in the calculation of the heat loss coefficient of the building, and has an influence on the calculated E-level and overheating indicator. As a consequence, energy performance requirements have an impact on ventilation system selection and design. There are two calculation procedures: one for residential buildings, and one for non-residential buildings. The following parameters, related to ventilation, can be taken into account (* = residential only, ** = non-residential only):

- Design flow rate** (for dwellings the flow rate is a function of the building volume only, regardless of design flow rates or system types)
- Building function**: defines function specific operation time of ventilation, e.g. 100% for patient rooms in health care, 30% for offices or schools.
- Heat recovery: temperature efficiency, automatic flow control to balance air flow rates, summer by-pass
- Demand control (see §3.2)
- Fan energy use
- Ventilative cooling (opening of windows, increased mechanical ventilation rates**, night ventilation**, earth-to-air heat exchanger, evaporative cooling)
- Pressure controlled trickle ventilators*
- Correctly commissioned flow rates*
- Ductwork airtightness*

As can be observed, these parameters not only involve system or product selection made in the design stage, but also parameters that are a result of high quality installation and commissioning work.

In between 2010 and 2021 the energy performance requirements saw a tightening to move towards nearly zero energy buildings, with the E-level to be achieved in new dwellings shifting from E100 to E30 (reduction in primary energy use of 70%). As a consequence, energy

efficient ventilation techniques received more and more attention.

For existing buildings there are also energy requirements if the energy performance certificates which are mandatory issued for buildings which are for sale or for rent show a poor performance. Specifically in Flanders, there are renovation obligations for both residential and non-residential buildings. The residential obligation requires that homes with an EPC label E or F be renovated to label D within five years of purchase, with stricter requirements in the future. A similar five-year obligation applies to non-residential buildings, including a minimum package of measures and an energy label. This requirement became mandatory in 2022 for non-residential buildings and in 2023 for residential buildings. The Walloon and Brussels-Capital Region will also gradually introduce renovation obligations to make homes more energy-efficient in the future, but the rules and deadlines differ.

The renovation obligations do not include a requirement to install ventilation systems. However, the EPC calculation method has been updated to make sure that the presence of a ventilation system in a building always improves the energy rating compared to a building where no ventilation system is present. To achieve this, a mechanical supply and extract system without heat recovery is considered as the default system in the calculation. This way an incentive is given to install energy efficient ventilation systems when renovating a building. Furthermore, in Flanders a label premium is installed as a financial incentive for renovation of dwellings. The installation of a ventilation system leads to a higher premium if the system provides extraction in kitchen and bath rooms and if it serves at least 65% of the rooms in the dwelling.

3.2 Other drivers in energy performance

The approval of EPB product data is a service that the Regions offer to all stakeholders with the aim of providing user-friendly and reliable product data that provides legal certainty for calculations in the context of the EPB regulations (Caillou 2017). The approval of EPB product data is based on a voluntary scheme with procedures that ensure that the product data will be accepted without

reservation by the administrations. This data is collected in an EPB-product database www.epbd.be and will never be questioned by the three Belgian regions when checking EPB declarations. The validity of the product data is 4 years. It includes performance data of over 1000 ventilation components and systems:

- Trickle ventilators
- Air handling units and fans
- Demand controlled residential ventilation systems (DCV)

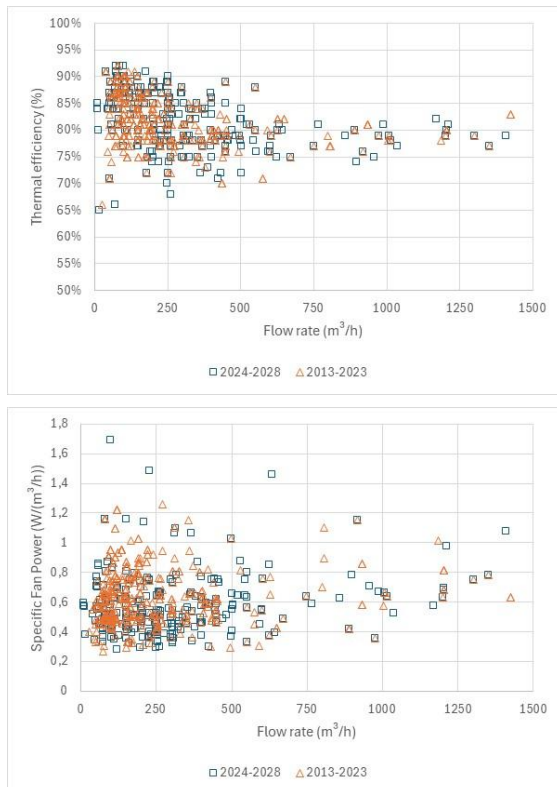


Figure 4: Performance data of air handling units for balanced mechanical ventilation with heat recovery: thermal efficiency of heat recovery system (top), and specific fan power (bottom) as a function of ventilation flow rate.

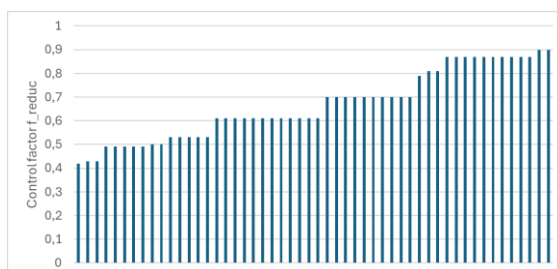


Figure 5: Performance data of the approved demand controlled residential ventilation systems.

As an example, Figure 4 shows the performance data of air handling units for balanced mechanical ventilation with heat recovery available in the database. There are data of units with a flow rate of up to 8000 m³/h, but since the majority of systems in the database are for residential applications the figure is restricted to units below 1500 m³/h. The comparison between systems with approved data until 2023 and after 2024, does not show a systematic better performance for newer systems. The specific fan power was calculated as the ratio of maximum fan power (2 fans) and maximum ventilation flow rate documented in the database. The data show a large variation in SFP with only a small share meeting the SFP-3 class (< 0.4 W/(m³/h)).

The performance of DCV is taken into account by means of a control factor which expresses the ratio between the ventilation heat loss in the DCV system and the ventilation heat loss in a reference system with constant air flow (CAV) achieving the same IAQ-level as the tested DCV system. In the energy performance calculation method for dwellings 60 different classes of DCV are described each with a predefined control factor varying in between 0.35 for systems with local CO₂-control of supply flow rates and local control of extraction rates in all spaces, and 0.95 for systems without specific control of supply flow rates and with central control of extraction rates (Caillou et al. 2014, Flemish Government 2018). Control of supply flow rates should be based on CO₂ sensors or presence detection. Control of extraction flow rates should be based on humidity sensors, and for toilets on VOC or presence detection. The performance depends on the type and locations of detection, and the type and locations of flow rate controls. Detection and control of supply and extraction flow rates can be either local, semi-local or central. In 2025 there were over 50 approved residential DCV systems on the market. Figure 5 shows the control factors for these systems.

For non-residential buildings DCV control factors are related to the control classes defined in NBN EN 13779:2004 with values ranging from 0.70 (IDA-C6, direct control e.g. CO₂) to 1.00 (IDA-C3, time control).

4 National trends in the inspection of ventilation systems

4.1 Requirements on the inspection of ventilation systems

As explained in §2.1 a strictly enforced compliance framework is part of the Energy Performance Regulations. It is based on the declaration of performances by independent EPB-assessors after completion of construction works. As part of their assessment, EPB-assessors also report on the installed ventilation system components, flow rates and energy performance data.

In addition to this assessment, the Flemish government has introduced inspection requirements, to improve the quality of residential ventilation systems. As a result, two documents have been required as of 2016:

- (1) a ventilation preliminary design (VPD) before the start of the construction works,
- (2) a ventilation performance report (VPR) after the construction works have been completed.

Both are mandatory in Flanders for all new residential buildings and all residential buildings undergoing a deep energy renovation.

The preliminary design of the ventilation system comprises a floor plan with indication of all ventilation components, including the position of the ventilation unit, the position and the indicative diameter of the ductwork. Details can be found in a separate document (STS Werkgroep 2017a). The ventilation performance report is so far the only mandatory document that relates to the ventilation system after it has been installed and thus it is the only document requiring an inspection. The result is an objective overview of the as-built energy related performances of the installation which must be used as a reference in the energy performance reporting of the dwelling by the EPB-assessor (STS Werkgroep 2017b).

There are no obligations about inspection of ventilation systems for non-residential buildings. Although in the Brussels Capital region and Walloon region a reporting of the ventilation performance is necessary as part of the energy performance reporting of the building, no formal inspection framework is implemented there.

The key document is the “unified technical specifications for ventilation in residential buildings” (STS-P 73-1 2015). In these STS-P, the criteria for ventilation systems that could be prescribed and could be reported are listed. STS-documents are edited by the Belgian Federal Public Service for Economy and can thus be applied in the three regions in Belgium. In complement to the STS-P, technical guidance for installers was developed (Caillou & Van den Bossche 2016). The STS-P does not prescribe requirements for the ventilation system, but lists possible evaluation criteria for ventilation systems and how to prescribe and determine the performance of the ventilation system for each of the criteria. For example, the STS-P does not impose or advice a certain specific fan power of the system (SFPsystem), but it defines the formula for calculating the SFPsystem, the classes, and the method for measuring the power consumption of the ventilation unit. It is then up to the builder to define which class of SFPsystem should be reached and to the ventilation inspector to determine the actual class of SFPsystem.

Different levels of requirements may apply to a ventilation system. For example. the energy performance regulation sets only minimal ventilation flow rates, but a builder could require better IAQ with higher ventilation flow rates. Therefore the output of the ventilation inspection is not a declaration of conformity to a requirement, but a report (the VPR) with objective data and figures about the performance of the ventilation system such as (neither exhaustive, nor applicable to all):

- per room the measured air flow or the nominal air flow of trickle ventilators,
- the thermal efficiency of the heat recovery unit,
- the power consumption of the fan at nominal air flow,
- the description of the demand controlled ventilation system,

The main concern within the inspection framework is the correct reporting of the performances of the ventilation systems. There is a system of auditing the ventilation reporters, described more in detail by De Strycker et al. (2019) to guarantee that the content of the VPR is representing the actual situation of the ventilation system at the moment of inspection.

4.2 Inspection protocols

The ventilation performance report must be compiled by one or more qualified ventilation reporters and delivered by a company, recognised by one of the organisers of a quality framework, which are recognised by the authorities. The qualification procedure for the reporters includes:

- Optional theoretical training
- Theoretical exam for each component of the ventilation system
- For reporters qualified for measuring mechanical air flows a practical exam

Apart from passing the required exams and being recognised by an organiser of a quality framework there are no restrictions on who can compile the VPR. Mostly installers, EPB-assessors and airtightness measurers are acting as ventilation reporters.

In December 2017 and October 2020, the Flemish government has tightened the requirements for organisers of the quality framework for the inspection of residential ventilation systems. The organiser of a quality framework must have a qualification procedure for ventilation inspectors, which includes at least an optional training, and a mandatory theoretical and practical exam. The organiser must guarantee the reliability of the ventilation reporting by running desktop and on-site audits combined with effective enforcement. Minimal random annual desk and on-site audits is 10% each. Random checks are supplemented by targeted checks so that 90% of the active inspectors are checked at least once a year. The organiser has to develop a database gathering all measurement data that can be consulted by the authorities. He should not have any members or directors who also carry out ventilation reporting in the context of the regulation.

Two types of measurement devices are necessary for the inspection: flow measurement devices and a power meter for the power consumption of the fan(s). The air flow measuring method used, must have a measurement deviation that does not exceed 15% of the measured flow value. The device must be calibrated every two years (BCCA 2024). The requirements for the power meter are defined by ministerial decree (Flemish Government 2018). It is not mandatory to measure and report the power of the fans, but it

is done in the majority of cases. When the installed ventilation system does not comply with the energy performance regulations, a predefined penalty is imposed by the Flemish authorities, depending on the size of the deviation.

5 National trends in innovative systems and market

Until 2015, demand controlled residential ventilation (DCV) systems were considered as “innovative” products and were not directly taken into account in the energy performance calculation method. Their energy performance was then considered through a principle of equivalence, based on a performance based simulation and assessment approach for ventilation. As DCV systems became more and more common, it became considered as a “mature” technology by the authorities and then was included in the basic energy performance calculation method in 2015 (see §3.2). The reduction factors of the method were determined using an updated assessment method based on the equivalence approach applied in between 2007 and 2012.

The equivalence approach was based on multizone airflow simulations using CONTAM (BCCA 2012, Caillou et al. 2014). The standardized input data were both deterministic (geometry of the typical house, air leakage, moisture buffering parameters, indoor temperature, exterior climate file) and stochastic (building orientation, wind shielding, number of occupants, occupancy profiles and contaminant generation). Contaminants considered were CO₂, water vapour, a tracer gas emitted in toilets at times of occupation as indicator for smells, and a tracer gas emitted in all rooms as indicator for emissions from building materials and furniture. The IAQ performance was evaluated through four indicators: the per-person cumulative CO₂ exposure above 600 ppm above ambient, the time per month critical thermal bridges were exposed to relative humidity above 80% as indicator for mould risk, the exposure to the tracer gas from the toilets, and exposure to material emissions. The average simulated ventilation heat loss was then compared to the heat loss of a reference system with constant

flow rate to quantify the energy performance (control factor) of the DCV system.

For small-scale renovations, there are also new ventilation concepts developed based on a similar performance based approach (Caillou et al. 2023). These are easier to install than the standard systems and guarantee a similar indoor air quality and have a positive impact on the Energy Performance Certificates for existing dwellings as they are accepted as ventilation system within that context. However, these new concepts do not meet the ventilation requirements for deep energy renovations or new construction, where only the standard ventilation concepts are allowed as discussed in §2.1. In deep energy renovations, decentral ventilation solutions gain more attention.

6 Impact of the COVID-19 pandemic

In the aftermath of the COVID-19 pandemic, Belgium has passed a law in 2022 aiming to enhance the indoor air quality in publicly accessible spaces (Belgian Government, 2022). One of the objectives of this legislation was to raise public awareness about indoor air quality in the general population as they are often not aware of the risks linked to high pollutant concentrations indoors. This law, among other things, requires publicly accessible spaces to apply a CO₂ meter, defines two reference levels for IAQ based on the requirements of the Codex, and requires to hold a label available based on a certification procedure that allows publicly accessible spaces to quantifiably showcase the efforts done to monitor and improve IAQ.

Since then, the Belgian Federal Public Health Service has been developing the more detailed, practical implementation of this new law, in consultation with stakeholders and research institutes. Originally it was the intention to have all necessary royal decrees ready to be able to bring into force all elements of the law by 2025. However a change in law has postponed the mandatory entry into force until 2038 at the latest: the criteria for spaces to which the obligations will apply will be defined and gradually expanded from 2027 onwards. Meanwhile, operators of publicly accessible spaces may implement elements of the law on a voluntary basis, by installing CO₂-meters, draw up a risk analysis and action plan in relation to

IAQ, and communicate information on CO₂-concentrations or outdoor air flow rates in the space to the public. To support the legislation and ensure reliable devices on the market, Royal Decrees establishing requirements for CO₂-meters and air cleaners have been published in 2024.

7 Other points of attention or trends

The acoustical criteria applicable to residential buildings in Belgium are included in the NBN S 01-400-1 standard. A new edition of this standard was published in July 2022. The criteria in this standard serve as best practice for residential buildings for which a building permit application is submitted. There are also detailed acoustical criteria for non-residential buildings, see [Buildwise-website](#). However, measuring campaigns have shown that compliance with acoustical criteria in practice is still challenging (Van den Bossche et al. 2013).

As an example, the acoustical requirements for installation noise in dwellings are listed below. When two values are given, they refer to normal and minimum acoustical comfort. When three values are given, they refer to increased, normal and minimum acoustical comfort.

- Permanent noise from mechanical ventilation for IAQ:
 - Bedroom, study: $L_{Aeq,nT} \leq 25/28$ dB
 - Living rooms: $L_{Aeq,nT} \leq 29/32$ dB
 - Bathroom, toilet: $L_{Aeq,nT} \leq 32/35$ dB
- Noise from range hoods:
 - Kitchen: $L_{Aeq,nT} \leq 48/56/63$ dB
 - Living: $L_{Aeq,nT} \leq 39/47/54$ dB
- Other temporary installation noise (max):
 - Bedroom: $L_{AFmax,nT} \leq 29/34$ dB
 - Living rooms: $L_{Aeq,nT} \leq 34/39$ dB

The new standard also has strengthened criteria for acoustical insulation of the facades, with consequences for trickle ventilators, specifically in bedrooms.

8 Conclusion

In 2006 the Belgian regions implemented the EPBD regulations including mandatory requirements for ventilation. From then on it was mandatory to install a natural or mechanical ventilation system for acceptable indoor air quality in all new and renovated buildings for

which a building permit is necessary, both residential and non-residential. As a result, since 2006, substantial progress has been achieved in terms of air flow specifications, energy efficient ventilation techniques, smart demand-controlled ventilation and compliance. Furthermore, quality assurance of ventilation systems received more attention. As a result the Flemish region introduced inspection requirements for residential ventilation systems. The data collected by the authorities from EPB declarations and EPC's constitute a valuable resource to investigate the market share evolution of ventilation systems in residential and non-residential buildings, and to monitor the impact of policy measures.

However, still substantial further steps are needed, mainly in relation with indoor air quality and ventilation in existing buildings, acoustical performances and maintenance of ventilation systems. The federal laws on well-being at work from 2017 and on IAQ in public spaces from 2022 may offer a framework for improving IAQ in the existing building stock.

9 Annex A: Examples of mandatory flow rates

9.1 Dwellings

House of 90 m², 1 main room (32 m²), 3 bedrooms (1 master (2 adults, 12 m²), 2 kids (10 m² each)), 1 kitchen (12 m²), 1 bathroom (4 m²) and 1 toilet (2 m²)

- Total minimum supply flow rate: 230 m³/h
 - Main room: 115 m³/h
 - Master bedroom: 43 m³/h
 - Children rooms: 36 m³/h each
- Total minimum extract flow rate: 125 m³/h
 - Kitchen: 50 m³/h
 - Bathroom: 50 m³/h
 - Toilet: 25 m³/h

Apartment of 50 m², 1 main room (24 m²), 1 bedroom (12 m²), 1 kitchen open to the main room (8 m²), 1 bathroom with toilet (4 m²)

- Total minimum supply flow rate: 130 m³/h
 - Main room: 87 m³/h
 - Bedroom: 43 m³/h
- Total minimum extract flow rate: 125 m³/h
 - Open kitchen: 75 m³/h
 - Bathroom with toilet: 50 m³/h

9.2 Non-residential

A classroom of 50 m² with 25 students, 1 teacher:

- Based on ventilation requirements EPB: minimum ventilation rate = 572 m³/h (26 occupants with 22 m³/h/person; design occupation is larger than nominal occupation of 13 persons (50 m² with max. 4 m² per person), so the design occupation is decisive
- Based on ventilation requirements Codex:
 - If low-emission classroom: minimum ventilation rate = 650 m³/h (26 occupants with 25 m³/h/person)
 - Otherwise: minimum ventilation rate = 1040 m³/h (26 occupants with 40 m³/h/person)
 - Another flow rate can be estimated based on the requirement of maximum CO₂-concentration of 900 ppm and an estimate of CO₂-emission rate for the expected metabolism and age of occupants.

An office of 12 m² with 1 occupant:

- Based on ventilation requirements EPB: minimum ventilation rate = 22 m³/h (design occupation is equal to nominal occupation (12 m² with max. 15 m² per person))
 - If the office would be larger than 15m², then the nominal occupation would become 2 persons and be decisive, even if the design occupation is 1. In this case the minimum flow rate would become 44 m³/h, and the EPB requirement would be larger than the Codex requirements.
- Based on ventilation requirements Codex:
 - If low-emission office: minimum ventilation rate = 25 m³/h
 - Otherwise: minimum ventilation rate = 40 m³/h

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