IEQ in the EPBD – How to set national requirements in line with revised EPBD?

Revised EPBD is making an effort to cover IEQ both in renovation and new buildings. While in new buildings demand controlled and smart operation is required to ensure energy performance there is also a slight focus change in renovation to move from avoiding possible negative effects to optimal indoor environmental quality.

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Within 20 years, energy performance of buildings directive (EPBD) has developed to be a comprehensive and technically complex document. The first directive was launched in 2002 and with about 8 years step it has been revised in 2010, 2018 and the ongoing third revision is expected to come into force in spring 2024. REHVA has a long history in the development of technical guidance for harmonised national implementation of IEQ issues which have an important role in EPBD. The role of EPBD is stressed by the fact that there are no other EU polices for indoor air while outdoor air has its own directive. In such a situation, indoor environmental quality (IEQ), indoor climate conditions, ventilation, comfort and recently, **optimal indoor environmental quality** are addressed in many articles in EPBD, but establishing explicit requirements are on the responsibility of Member States (MS). Current revision of EPBD includes new requirements for measuring, control and monitoring of IEQ. Inspired from European Parliament proposal on Article 11a 'Indoor environmental quality', REHVA developed technical guidance to understand IEQ in the building design and operation as well as for possible options how to set national IEQ requirements [1]. While Art 11a may be deleted, its important principles will stay in the EPBD.

IEQ in EPBD articles

IEQ is not an easy issue in EPBD because the mandate is for energy. EPBD addresses an essential requirement that energy improvements cannot result in negative effects on IEQ, but general improvement of IEQ is not in the scope of EPBD, however there is often such need in renovation of old buildings. More specifically this important principle has already been addressed

Toxic air killed more than 500,000 people in EU in 2021, data shows

(The Guardian, 24 Nov 2023) European Environment Agency says half of deaths could have been avoided by cutting pollution to recommended limits.

Dirty air killed more than half a million people in the EU in 2021, estimates show, and about half of the deaths could have been avoided by cutting pollution to the limits recommended by doctors.

The researchers from the European Environment Agency attributed 253,000 early deaths to concentrations of fine particulates known as PM2.5 that breached the World Health Organization's maximum guideline limits of 5µg/m3. A further 52,000 deaths came from excessive levels of nitrogen dioxide and 22,000 deaths from short-term exposure to excessive levels of ozone.

"The figures released today by the EEA remind us that air pollution is still the number one environmental health problem in the EU," said Virginijus Sinkevičius, the EU's environment commissioner.

Doctors say air pollution is one of the biggest killers in the world but death tolls will drop quickly if countries clean up their economies. Between 2005 and 2021, the number of deaths from PM2.5 in the EU fell 41%, and the EU aims to reach 55% by the end of the decade.

The Guardian, 24 Nov 2023: Toxic air killed more than 500,000 people in EU in 2021, data shows

in 2018 EPBD Art 5 and there is no change in the current revision:

> 'When setting minimum energy performance requirements, those requirements shall take account of **general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation**…'

IEQ definition in EPBD (Art 2, 57a) has developed to focus to thermal comfort and indoor air quality (IAQ): 'indoor environmental quality means the result of an assessment inside a building based upon parameters such as relating to the **temperature, humidity, ventilation rate and presence of contaminants**, influencing the health and wellbeing of its occupants.' Based on this definition, it can be expected that minimum requirements in these two IEQ domains (thermal comfort and IAQ/ventilation) are to be set in national regulation or building codes.

Revised Art 7 for new buildings and Art 8 for existing buildings stress IEQ for both new buildings and major renovations by stating that 'the issues of **optimal indoor environmental quality** shall be addressed', thus, national regulation at least on thermal comfort and IAQ/ventilation should be established if currently not present. However, Art 9 for renovation according to minimum energy performance standards (MEPS), does not address IEQ issue. MEPS renovation is expected to be typically a light renovation improving energy performance certificate by 1-2 classes that will pose a high risk to deteriorate IAQ in residential buildings if ventilation improvement is not considered.

It is quite evident that ventilation requirements are most crucial in any renovation of residential buildings, independently is it a major, deep or MEPS renovation. While Renovation Wave strategy aims to renovate 35 million units by 2030, by doubling and deepening renovation rates and applying MEPS, there is a serious issue of ventilation. It is well known that additional insulation and replacement of windows will block air change by natural ventilation if ventilation system would not be installed, resulting in mould and other IAQ problems. 'Build airtight and ventilate right' principle is evident for experts, but unfortunately often not followed in residential renovation practice if clear requirements are not established, **Figure 1**.

EPBD IEQ three-fold challenge

According to EPBD scope for renovated and new buildings there are three types of challenges to address IEQ:

1. Minimum energy performance standards **MEPS** – how IEQ and ventilation will be addressed in step-by-step renovation? Currently this is not addressed.
2. **Deep and major renovation** – IEQ requirements should push to install new ventilation systems in residential buildings, that is covered by Art 8.
3. **IEQ in Zero-emission buildings** – demand controlled and smart operation is needed to execute a new vision to transform EU building stock into zero-emission buildings by 2050, that is addressed in Art 11 for technical systems.

While MEPS is new instrument, 2018 EPBD introduced long term renovation strategies with ambitious targets for deep renovation. EU28 deep renovation rate was estimated in 2020 to be 0.2-0.3% per year, and the annual weighted energy renovation rate 1.0-1.2% per year in residential and non-residential buildings respectively [2]. Renovation wave strategy targets to

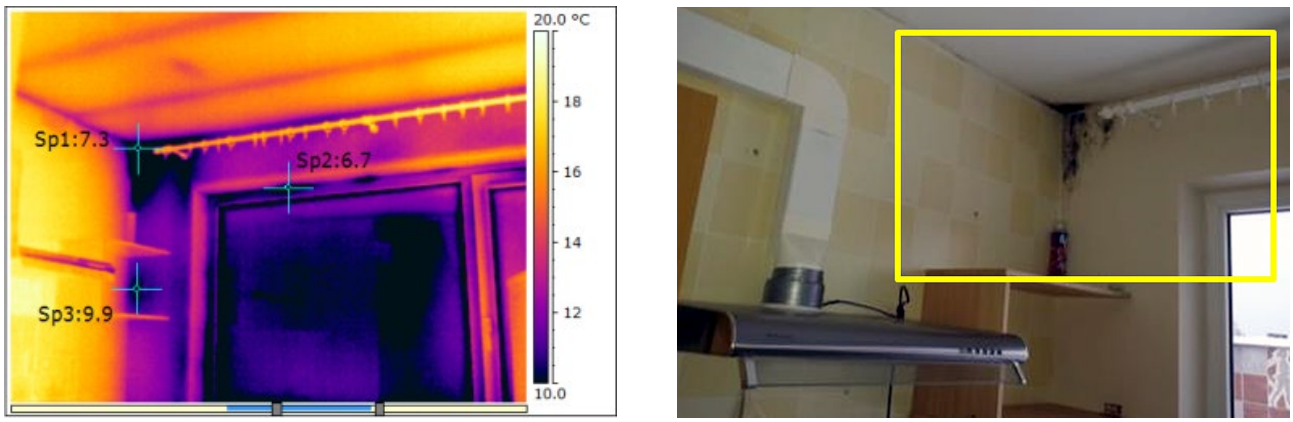

Figure 1. Example of light renovation with deteriorated IAQ. Replaced, new airtight window has blocked ventilation resulting in mould growth on thermal bridges. Thermal image on the left, photo on the right.

double the energy renovation to 2% per year. This will result in high renovation volumes supported by renovation grants and other incentives. While incentives are available, it would be important to set adequate ventilation requirements together with minimum energy performance requirements. Such experience is available for instance from Estonian renovation grants for multifamily apartment buildings, having a requirement to install heat recovery ventilation in major renovation (**Figure 2**) from 2015. This development was based on lessons learnt, as a first generation of renovation grants resulted in poorly functioning ventilation solutions and even in mouldy apartments in some cases. The situation was changed by developing regulation and model solutions for deep renovation.

Zero emission buildings

While for existing buildings the driving force in EPBD is avoiding negative effects on IEQ, in new zero emission buildings (ZEB) the concern is on energy performance of ventilation and air conditioning systems.

Figure 2. Estonian apartment building renovated with KredEx grant (30% of financial support) that requires to install heat recovery ventilation. On the photo, ventilation supply air ductwork and some parts of extract ductwork are installed on the façade before additional insulation, and heat recovery ventilation unit will be installed to the renovated roof.

This is addressed in Art 11 for technical building systems:

- Member States shall require non-residential zero-emission buildings to be equipped with **measuring and control devices for the regulation of indoor air quality at relevant unit level**.
- In existing buildings, the installation of such devices shall be required, where technically and economically feasible, when a building undergoes a major renovation.

This is perhaps the most important new requirement that will have direct implications to construction of future new buildings. Demand controlled ventilation systems with sensors (**Figure 3**) have been in the markets for a long time, but the use has been limited because of quality issues in installation and commissioning. It is not evident that these systems work as designed in operation, therefore there is clear need for the industry to develop a robust and reliable demand-controlled systems which are compatible for

Figure 3. In non-residential new buildings it is expected that demand-controlled ventilation and air conditioning systems contribute to zero emission building energy performance. Temperature and CO_2 based control would be essential for effective ventilation and room conditioning units' operation.

continuous commissioning and do not require too much maintenance. These considerations make it reasonable that the requirement in EPBD is limited to non-residential buildings. 'At relevant unit level' guides to use demand-controlled systems and measure CO_2 and temperature in continuously occupied spaces, such as classrooms, offices, meeting rooms, restaurants, kitchens, shops, gyms, etc.

The wording in EPBD on measuring and control devices for the regulation of indoor air quality in non-residential buildings may raise a question which parameters are actually to be measured. There is no guidance in Art 11, but Art 11a stated that requirements shall be set according to measurable indicators based on to those of the Level(s) framework. Level(s) is European framework for sustainable buildings [3], where IAQ and thermal comfort indicators 4.1 [4] and 4.2 [5] refer to EN 16798-1:2019. If Art 11a is deleted, Level (s) remains a valid reference. As direct monitoring of all indoor air pollutants is impossible in practice, EN 16798-1:2019 supports of using CO_2 concentration that can be continuously monitored as a proxy for ventilation that is the most important factor for good IAQ. There are also low-cost sensors for PM2.5 monitoring to ensure that outdoor air for ventilation is clean or adequately filtered and there are no significant indoor sources of particulate matter. Thus, to control IAQ, ventilation and filtration requirements should exist, and the use of low polluting building materials should be promoted to limit indoor sources. Ventilation and thermal comfort requirements are specified in EN 16798-1:2019 and fine particle filters of ePM1 or ePM2.5 may be recommended as specified in EN 16798-3:2017. While IAQ guidance for non-residential buildings is quite detailed in these standards, **operation of ventilation systems for optimal indoor air quality** is not covered in existing standards. Thus, to implement EPBD requirement on regulation of IAQ will need some guidance development how to select relevant CO_2 setpoints for common space categories, as these depend on occupant density and indoor climate category. Some guidance is provided in REHVA document [1] and this topic is also dealt in the ongoing revision of EN 16798-1:2019.

Ventilation and IAQ in residential buildings

Ventilation requirements for residential buildings is another topic that is not covered in detailed fashion in existing standards because of diverse practices and requirements in MS. EN 16798-1:2019 specifies just 0.42 ℓ/s m² (0.6 ach) total ventilation of a whole residence and 7 ℓ/s per person supply air flow requirements which is not enough to design adequate supply or intake air to bedrooms and living rooms as well as extract air flow rates to wet rooms and kitchens. These general requirements are developed further in REHVA GB 25 [6], offering one possible example on a table to be used in the regulation, **Table 1**.

Table 1. *Example of possible ventilation requirements for residential buildings.*

	Supply airflow rate, ℓ/s	Extract airflow rate, ℓ/s
Living rooms[1] >15 m²	8+0.27 ℓ/(s·m²)	
Bedrooms >15 m²	14	
Living rooms and bedrooms 11-15 m²	12	
Bedrooms <11 m², 3rd and successive bedrooms in large apartments	8	
WC		10
Bathroom		15
Bathroom in one room apartment		10
Utility room		8
Wardrobe and storage room		6
Kitchen[2]		8
Kitchen[2], one room apartment		6
Kitchen, cooker hood in operation		25
Average airflow rate of a whole residence ℓ/(s m²)	0.42	
Staircase of an apartment building, ACH	0.5	

[1] Transfer air from bedrooms can be used as a part of supply air, but 12 ℓ/s is minimum outdoor air rate
[2] Airflow rate in the kitchen when cooker hood is not in operation

Conclusions

- EPBD revision maintains in Art 5 an important principle of taking into account general indoor climate conditions, in order **to avoid possible negative effects such as inadequate ventilation**, when setting minimum energy performance requirements.
- Art 11 stresses that zero emission energy performance needs smart controls by establishing new ambitious requirement for installation of **measuring and control devices for the regulation of indoor air quality at relevant unit level in non-residential ZEB.**
- Art 7 and 8 require to address the issue of **optimal indoor environmental quality** in new buildings and major renovation indicating that national IEQ requirements are to be established if not yet present.
- Art 8 and 9 (MEPS) **DO NOT address IEQ issue in MEPS renovation** – in national implementation it is recommended to extended IEQ requirements from major renovation to MEPS renovation too.
- IEQ is defined in EPBD as **temperature, humidity, ventilation rate and presence of contaminants**, with reference to Levels(s) framework and EN 16798-1:2019.
- When the final wording of EPBD is available, REHVA will update the guidance document on how to set national IAQ/ventilation and thermal comfort requirements. ■

References

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[4] Dodd N., Donatello S. & Cordella.M., 2021. Level(s) indicator 4.1: Indoor air quality user manual: introductory briefing, instructions and guidance (Publication version 1.1)

[5] Dodd N., Donatello S., & Cordella M., 2021. Level(s) indicator 4.2: Time outside of thermal comfort range user manual: introductory briefing, instructions and guidance (Publication version 1.1)

[6] REHVA Guidebook No 25, Residential Heat Recovery Ventilation. https://www.rehva.eu/eshop/detail/residential-heat-recovery-ventilation