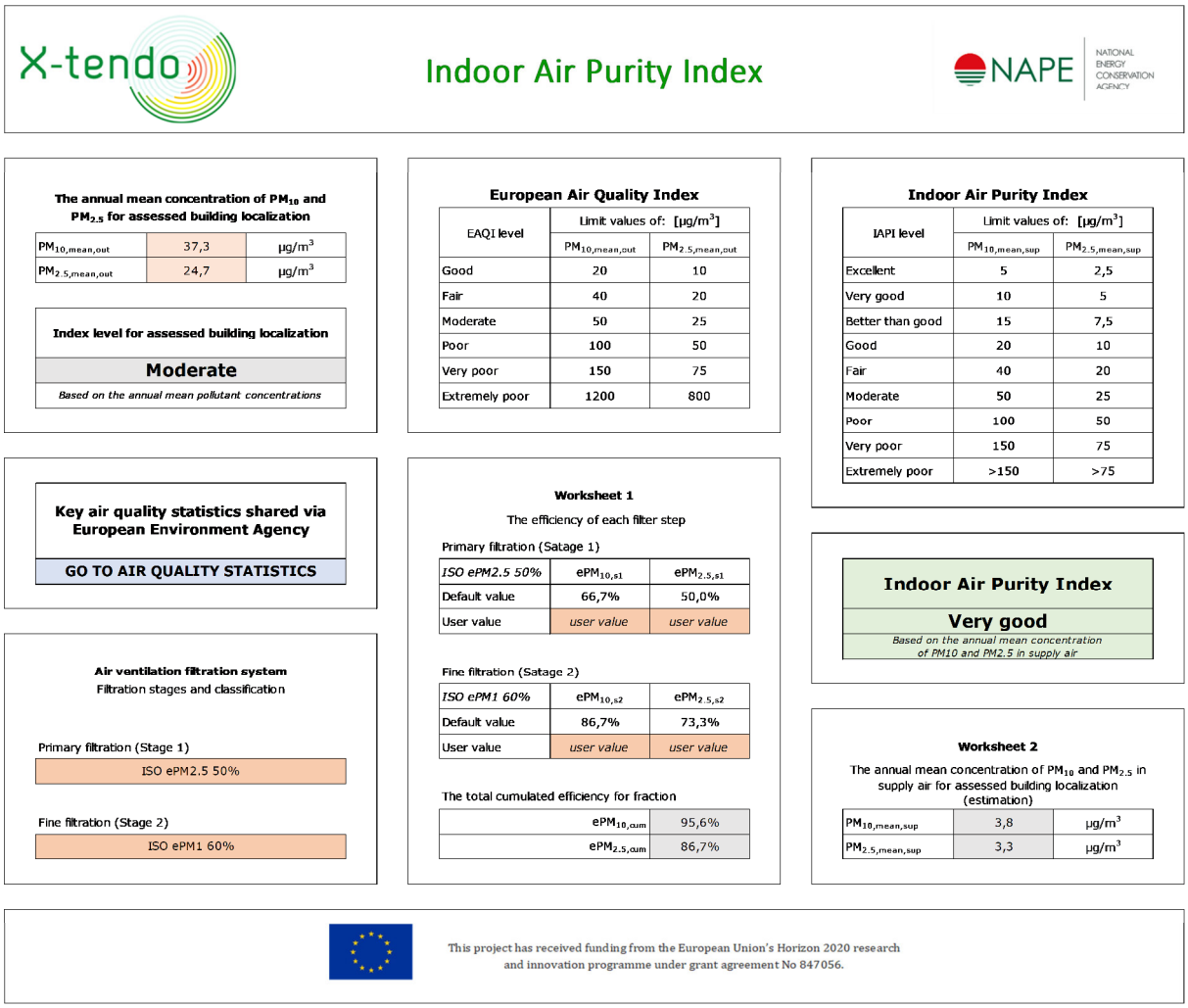
eXTENDing the energy performance assessment and certification schemes via a mOdular approach

GUIDELINE

Indoor Air Purity Index

Final version

June 2022



Indoor Air Purity Index

The annual mean concentration of PM_{10} and $PM_{2.5}$ for assessed building localization

$PM_{10,mean,out}$	37,3	µg/m³
$PM_{2.5,mean,out}$	24,7	µg/m³

Index level for assessed building localization

Moderate

Based on the annual mean pollutant concentrations

European Air Quality Index

EAQI level	Limit values of: [µg/m³]	
	$PM_{10,mean,out}$	$PM_{2.5,mean,out}$
Good	20	10
Fair	40	20
Moderate	50	25
Poor	100	50
Very poor	150	75
Extremely poor	1200	800

Indoor Air Purity Index

IAPI level	Limit values of: [µg/m³]	
	$PM_{10,mean,sup}$	$PM_{2.5,mean,sup}$
Excellent	5	2,5
Very good	10	5
Better than good	15	7,5
Good	20	10
Fair	40	20
Moderate	50	25
Poor	100	50
Very poor	150	75
Extremely poor	>150	>75

Key air quality statistics shared via European Environment Agency

GO TO AIR QUALITY STATISTICS

Worksheet 1

The efficiency of each filter step

Primary filtration (Satage 1)

ISO ePM2.5 50%	$ePM_{10,s1}$	$ePM_{2.5,s1}$
Default value	66,7%	50,0%
User value	*user value*	*user value*

Fine filtration (Satage 2)

ISO ePM1 60%	$ePM_{10,s2}$	$ePM_{2.5,s2}$
Default value	86,7%	73,3%
User value	*user value*	*user value*

The total cumulated efficiency for fraction

$ePM_{10,cum}$	95,6%
$ePM_{2.5,cum}$	86,7%

Indoor Air Purity Index

Very good

Based on the annual mean concentration of PM10 and PM2.5 in supply air

Air ventilation filtration system

Filtration stages and classification

Primary filtration (Stage 1)

ISO ePM2.5 50%

Fine filtration (Stage 2)

ISO ePM1 60%

Worksheet 2

The annual mean concentration of PM_{10} and $PM_{2.5}$ in supply air for assessed building localization (estimation)

$PM_{10,mean,sup}$	3,8	µg/m³
$PM_{2.5,mean,sup}$	3,3	µg/m³

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TABLE OF CONTENT

1 OVERVIEW

The proposed method considers outside air quality and indoor air purity in the building with a ventilation system equipped with an air filter. This method indicates that buildings located in the area with high outdoor air pollution require higher air filtration system efficiency to get the same air purity inside the building as in the cases of location with low outdoor air pollution.

The scheme of the Indoor Air Purity Index estimation procedure is presented in Figure 1 below.

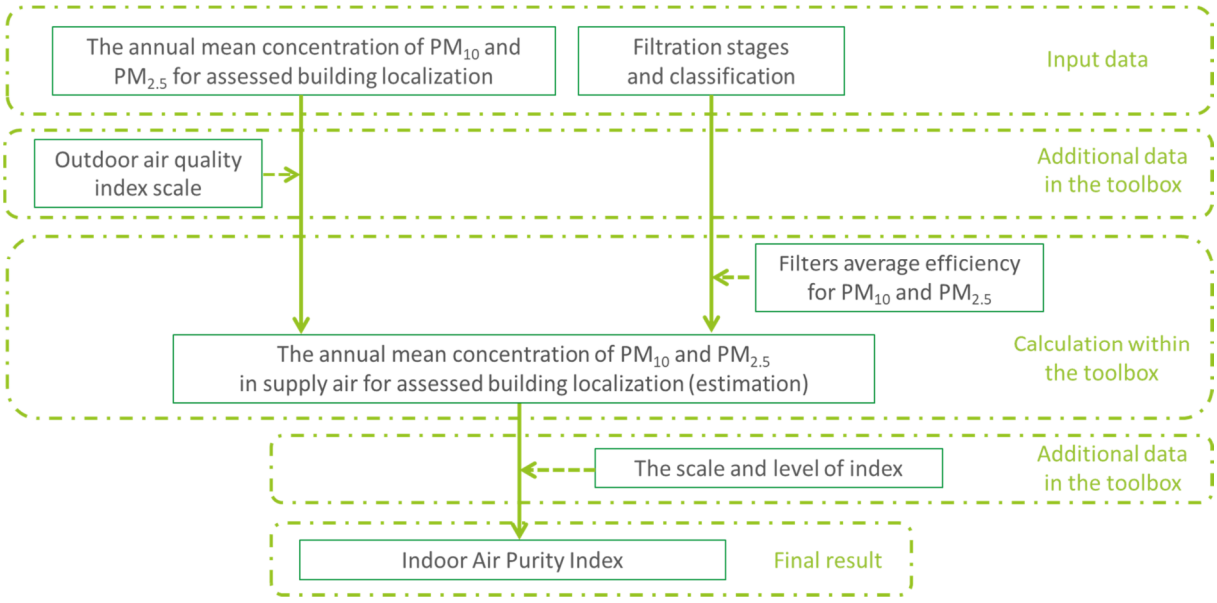


Figure 1: Scheme of the Indoor Air Purity Index estimation procedure

2 GUIDELINE

2.1 Definitions and symbols

Definitions:

- **assessed building (unit)**

  building or part of the building resp. building unit that is the object of the energy performance assessment

- **filtration system**

  single filter or multi-stage filtration systems with a cumulated efficiency in the ventilation system

Symbols:

$PM_{10,mean,out}$	The annual mean concentration of PM_{10} for assessed building localization [µg/m³]
$PM_{2.5,mean,out}$	The annual mean concentration of $PM_{2.5}$ for assessed building localization [µg/m³]
ePM_{10}	Efficiency of an air-cleaning device to reduce the mass concentration of particles with an optical diameter between 0,3 µm and 10 µm
$ePM_{2.5}$	Efficiency of an air-cleaning device to reduce the mass concentration of particles with an optical diameter between 0,3 µm and 2.5 µm
$ePM_{10,cum}$	The total cumulated filtration efficiency for PM_{10} fraction for the specified air filtration system [%]
$ePM_{2.5,cum}$	The total cumulated filtration efficiency for $PM_{2.5}$ fraction for the specified air filtration system [%]
$PM_{10,mean,sup}$	The annual mean concentration of PM_{10} in supply air for assessed building localization and the specified air filtration system [µg/m³]
$PM_{2,5,mean,sup}$	The annual mean concentration of $PM_{2.5}$ in supply air for assessed building localization and the specified air filtration system [µg/m³]

2.2 Entering the value of the annual mean concentration of particulate matter

1. **The window in Figure 2**
   - Enter the value of the annual mean concentration of PM10 and PM2.5 for assessed building localization in cells marked with a red frame.
   - The value of the annual mean concentration of PM10 and PM2.5 should be taken from the air quality statistics shared via European Environment Agency (EEA). Figure 3 shows the window in which users can go to air quality statistics by EEA. If EEA does not provide data for a given location, users can use national or local databases.
   - The toolbox will display the index level for assessed building localization according to European Air Quality Index (EAQI) (1). Figure 4 shows the EAQI levels with limit values in µg/m^3 for pollutant concentrations of PM10 and PM2.5. Note that the index level in the toolbox is based only on the annual mean concentration of particulate matter what is a modification of the method.

     In fact, EAQI level is determined by current air quality pollution (the hourly concentrations for NO_2, O_3 and SO_2, and based on 24-hour running means for PM10 and PM2.5). The current air pollution is available on:

     https://airindex.eea.europa.eu/Map/AQI/Viewer/

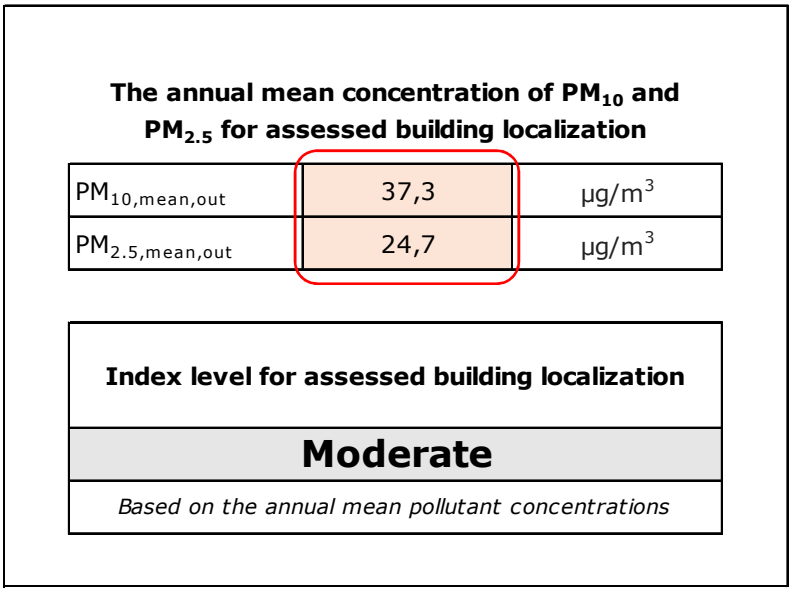


Figure 2

2. **The window in Figure 3**
   - The user can go to key air quality statistics shared via EEA by pressing the highlighted grey cell or by selecting the link below (2):
     https://www.eea.europa.eu/data-and-maps/dashboards/air-quality-statistics
   - Air quality annual statistics calculated by the EEA are available on (3):
     https://www.eea.europa.eu/data-and-maps/data/aqereporting-8/estatistics

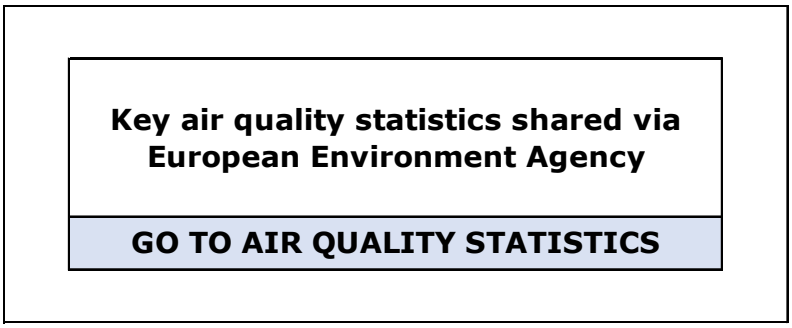


Figure 3

European Air Quality Index

EAQI level	Limit values of: [µg/m^3]	
	$PM_{10,mean,out}$	$PM_{2.5,mean,out}$
Good	20	10
Fair	40	20
Moderate	50	25
Poor	100	50
Very poor	150	75
Extremely poor	1200	800

Figure 4

2.3 Defining air ventilation filtration systems in the assessed building

3. **The window in Figure 5**
    - The user defines the air ventilation filtration system in the assessed building. The toolbox allows defining two-stage of filtration (primary and fine filtration).
    - The user selects the type of filter in each stage. The drop-down list includes filters classification according to the current ISO 16890 standard (4) and in force until 2018 the EN 779:2012 standard (5).
    - If the system has only one filtration stage, choose cell fine filtration (stage 2) "Not applicable".
    - If the mechanical ventilation does not have filters, choose in both red cells "Not applicable".

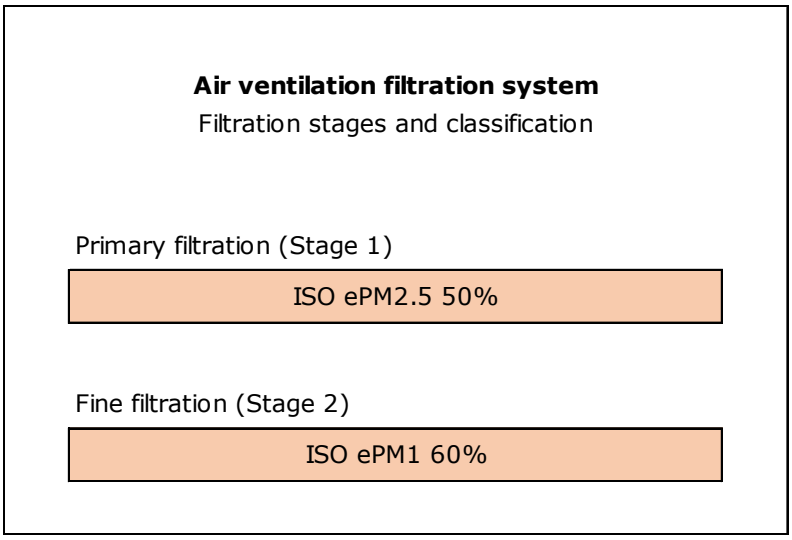


Figure 5

4. **The window in Figure 6**
   - The default values of the filtration efficiency of each filtration step.
   - If the user knows the value of the efficiency, he/she should choose a suitable value from the drop-down list. If not, „user value" should be selected from the list. The toolbox will then use the default value of filter efficiency for the calculation.
   - The total cumulated efficiency for each fraction is then shown at the bottom of the window.

Worksheet 1

The efficiency of each filter step

Primary filtration (Stage 1)

ISO ePM2.5 50%	$ePM_{10,s1}$	$ePM_{2.5,s1}$
Default value	66,7%	50,0%
User value	*user value*	*user value*

Fine filtration (Stage 2)

ISO ePM1 60%	$ePM_{10,s2}$	$ePM_{2.5,s2}$
Default value	86,7%	73,3%
User value	*user value*	*user value*

The total cumulated efficiency for fraction

$ePM_{10,cum}$	95,6%
$ePM_{2.5,cum}$	86,7%

Figure 6

2.4 Calculation results

5. **The window in Figure 7**
   - The level of Indoor Air Purity Index (IAPI) for the assessed building is shown.
   - The level is estimated by the annual mean concentration of PM10 and PM2.5 in the supply air for the assessed building location and the previously specified air filtration system with reference to the scale of index and rate shown in Figure 9.
   - The lower index (worse rated) for the annual mean concentration of PM10 and PM2.5 in the supply air is used to determine the level of Indoor Air Purity Index (IAPI) for assessed building.

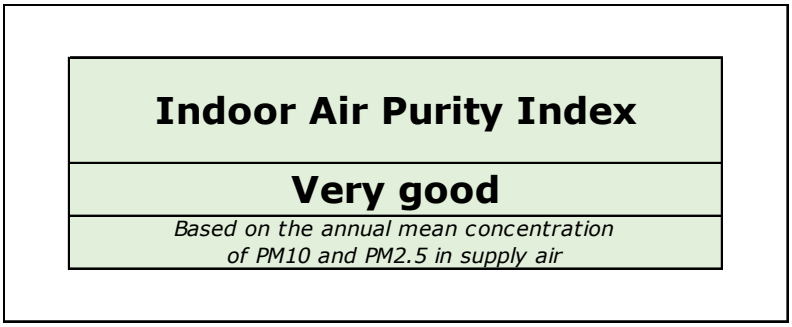


Figure 7

6. **The window in Figure 8**
   - The estimated annual mean concentration of PM10 and PM2.5 in the supply air for the assessed building location and the previously defined air filtration system.
   - The procedure for calculating the concentration of pollutants in the supply air is discussed in the next section.

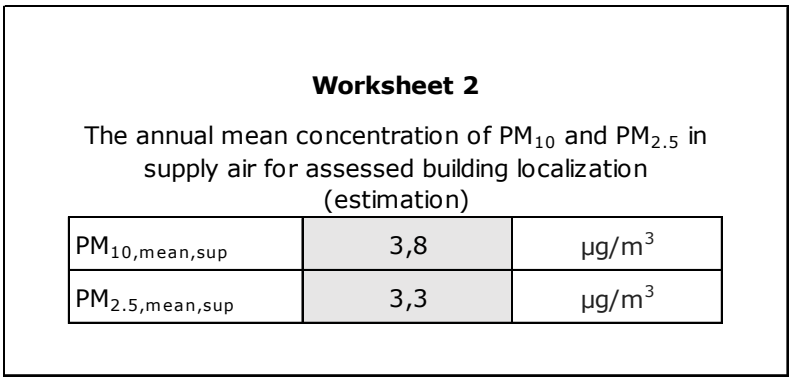


Figure 8

7. **The window in Figure 9**

- The scale and level of Indoor Air Purity Index.

Indoor Air Purity Index

IAPI level	Limit values of: [µg/m^3]	
	$PM_{10,mean,sup}$	$PM_{2.5,mean,sup}$
Excellent	5	2,5
Very good	10	5
Better than good	15	7,5
Good	20	10
Fair	40	20
Moderate	50	25
Poor	100	50
Very poor	150	75
Extremely poor	>150	>75

Figure 9

8. **The window in Figure 10 shows summary results.**

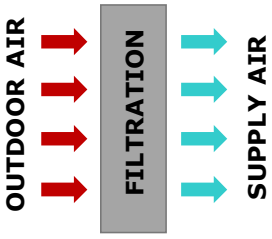
Outdoor Air Purity Index	The total cumulated filtration efficiency for respective particle		Indoor Air Purity Index
			
Based on the annual mean concentration of PM10 and PM2.5 in outdoor air	$ePM10_{cum}$	$ePM2.5_{cum}$	*Based on the annual mean concentration of PM10 and PM2.5 in supply air*
Moderate	**95,6%**	**86,7%**	**Very good**

Figure 10

3 CALCULATION WITHIN THE TOOLBOX

3.1 Calculation procedure

1. The user enters the value of the annual mean concentration of PM10 ($PM_{10,mean,out}$) and PM2.5 ($PM_{2.5,mean,out}$) for localization.

$$PM_{10,mean,out} \quad \left[\frac{\mu g}{m^3}\right]$$

$$PM_{2.5,mean,out} \quad \left[\frac{\mu g}{m^3}\right]$$

2. The user defines the air ventilation filtration system, selects the type of filter and determines the filtration efficiency of each filtration step and for each fraction (user values or default values).

$$stage\ 1\ (primary\ filtration) - ePM_{10,s1} \quad and \quad ePM_{2.5,s1}\ [\%]$$
$$stage\ 2\ (fine\ filtration) - ePM_{10,s2} \quad and \quad ePM_{2.5,s2}\ [\%]$$

3. Next, the total cumulated efficiency for each fraction is calculated.

$$ePM_{10,cum} = 1 - \left(\left(1 - ePM_{10,s1}\right) \cdot \left(1 - ePM_{10,s2}\right)\right)\ [\%]$$

$$ePM_{2.5,cum} = 1 - \left(\left(1 - ePM_{2.5,s1}\right) \cdot \left(1 - ePM_{2.5,s2}\right)\right)[\%]$$

The combined filtration efficiency for respective particle size fraction is estimated according to the formula recommended in Eurovent 4/23 – 2018 (6).

4. Finally, the annual mean concentration of PM10 ($PM_{10,mean,sup}$) and PM2.5 ($PM_{2.5,mean,sup}$) in supply air are calculated.

$$PM_{10,mean,sup} = PM_{2.5-10,mean,out} \cdot \left(1 - ePM_{10,cum}\right) + PM_{2.5,mean,in}\left[\frac{\mu g}{m^3}\right]$$

$$PM_{2.5,mean,sup} = PM_{<2.5,mean,out} \cdot \left(1 - ePM_{2.5,cum}\right)\left[\frac{\mu g}{m^3}\right]$$

where:

$$PM_{2.5-10,mean,out} = PM_{10,mean,out} - PM_{2.5,mean,out} \left[\frac{\mu g}{m^3}\right]$$

$$PM_{<2.5,mean,out} = PM_{2.5,mean,out} \left[\frac{\mu g}{m^3}\right]$$

5. The values of the annual mean concentration of PM10 and PM2.5 in supply air are matched to the scale and level of the index (Figure 9).

6. The lower index (worse rated) for the annual mean concentration of PM10 and PM2.5 in the supply air is used to determine the Indoor Air Purity Index (IAPI) level for assessed building.

3.2 The default value of the filtration efficiency

The methodology of determining the default values of the filtration efficiency for PM10 and PM2.5 is presented in Table 1.

Table 2 shows the expected filtration efficiency for filter classes according to EN 779:2012 standard (5). Proposed values were based on a comparison of EN 779 and ISO 16890 classes (4) for the same filters, which was made by the Eurovent Association (publication in Eurovent 4/23 – 2018 (6)).

Table 1: Default value of average efficiency for PM10 and PM2.5 (estimation)

	ISO ePM_1X [%] ISO $ePM_1 \geq 50\%$	$ISO\ ePM_{2.5}X$ [%] $ISO\ ePM_{2.5} \geq 50\%$	$ISO\ ePM_{10}X$ [%] $ISO\ ePM_{10} \geq 50\%$	$ISO\ Coarse\ X$ [%] $ISO\ ePM_{10} < 50\%$
$ePM_{2.5}$	$X + 0{,}33 \cdot (1 - X)$	X	$X/2$	0
ePM_{10}	$X + 0{,}66 \cdot (1 - X)$	$X + 0{,}33 \cdot (1 - X)$	X	$X/2$

Table 2: Expected filtration efficiency for filter classes according to EN 779:2012 standard

Filter Class	$ePM_{2.5}$	ePM_{10}
G3	*0%*	*25%*
G4	*0%*	*30%*
M5	*25%*	*55%*
M6	*35%*	*70%*
F7	*70%*	*85%*
F8	*85%*	*95%*
F9	*90%*	*95%*

REFERENCES

(1) European Air Quality Index, European Environment Agency, on-line access: https://airindex.eea.europa.eu/Map/AQI/Viewer

(2) Air quality statistics, European Environment Agency ,on-line access:

https://www.eea.europa.eu/data-and-maps/dashboards/air-quality-statistics

(3) Air quality annual statistics, , European Environment Agency ,on-line access:

https://www.eea.europa.eu/data-and-maps/data/aqereporting-8/estatistics

(4) ISO 16890-1:2016, Air filters for general ventilation — Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)

(5) EN 779:2012, Particulate air filters for general ventilation - Determination of the filtration performance

(6) Eurovent 4/23 – 2018, Energy Efficiency Evaluation of air filters for general ventilation purposes

(7) ISO 54000-1 2017, Energy performance of buildings – Overarching EPB assessment – Part 1: General framework and procedures

(8) ISO 52003-1:2017, Energy performance of buildings — Indicators, requirements, ratings and certificates — Part 1: General aspects and application to the overall energy performance

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