

**WHITE PAPER**

# CHANGE LESS, GAIN MORE

*How choosing the right prefiltration strategy can optimize the performance of your ventilation system and reduce environmental impact.*



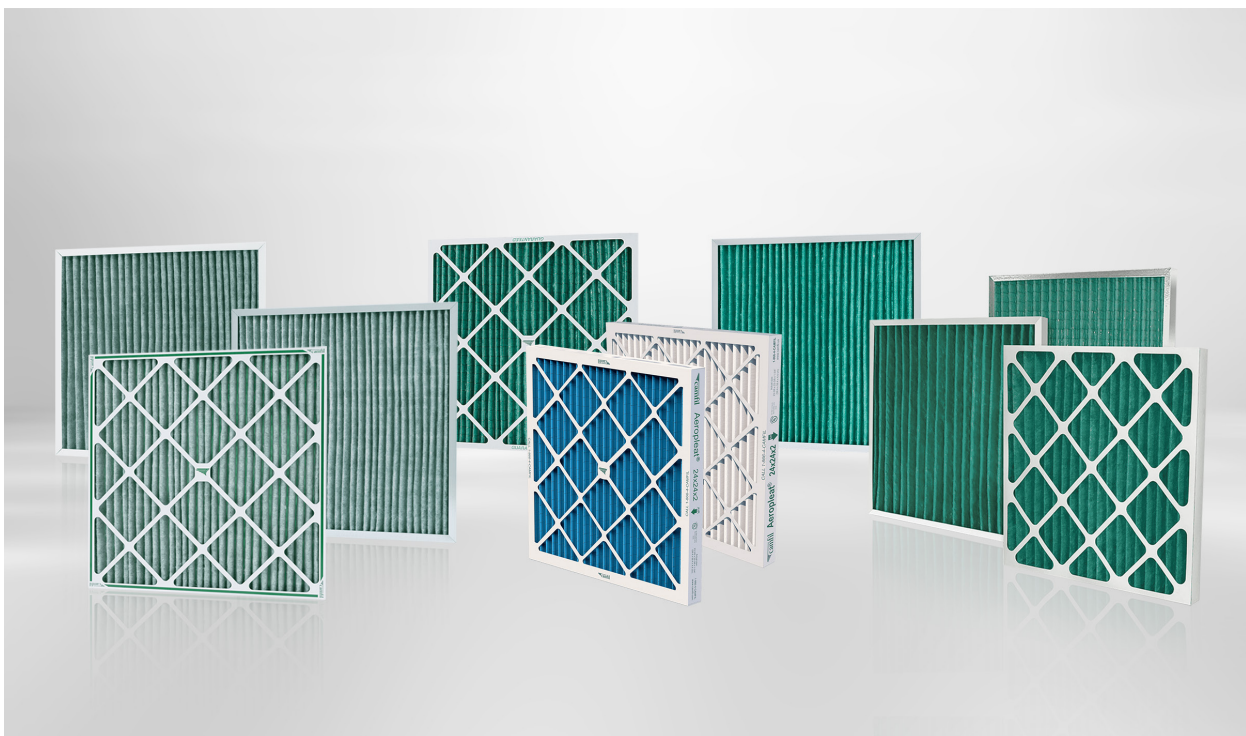
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CLEAN AIR SOLUTIONS

## Abstract

Prefilters fulfill an important role in a ventilation system. Firstly, by protecting fine filters from larger particles that can cause a reduction in performance lifetime. Secondly, by keeping the components of an air handling unit clean, which directly contributes to providing optimal working conditions of the heating, ventilation and air conditioning (HVAC) systems. Using prefilters, however, has an impact on the operating parameters of the HVAC system, such as pressure drop, energy consumption, and filtration efficiency. The crucial aspect while selecting a prefilter is its lifetime in regards to the filter's recommended exchange pressure drop <sup>[1]</sup> – following the principal **“Change Less, Gain More”**. Many of basic prefilters available on the market last less than 3 months in operation. Yet, long lifetime of prefilters brings tangible monetary benefits as it translates to savings related to less frequent purchase and replacement of the prefilters. In addition, long lifetime of prefilters equals less raw materials consumed, less waste generated, less electricity used for filter production, and less kilometers driven due to shipping. Going further down the sustainability track there are even more advantages that contribute to the climate and use of resources, depending on the specifics of the supply, maintenance and waste handling chain of your filters.

## Range of panel filters for prefiltration



## Outdoor air pollution as the main driver to demands on higher filtration efficiency and how the prefilter helps to prolong the lifetime of the fine filtration stage.

According to the World Health Organization (WHO), more than 90 percent of people worldwide live in areas impacted by polluted air <sup>[2]</sup>. The main culprits behind global air pollution are the burning of fossil fuels for power generation and emissions from vehicles running on fossil fuels. Air pollution is a silent killer, causing approximately 7 million premature deaths each year <sup>[3]</sup>. Breathing polluted air increases the risk of respiratory diseases, heart conditions, stroke, and cancer. Even low concentrations of air pollutants cause reduced wellbeing, and people who are exposed to poor Indoor Air Quality (IAQ) often experience headaches, nose and throat irritation, fatigue, decreased productivity and even dizziness.

Often the quality of the outdoor air is beyond the control of an individual. Fortunately, the air indoors can be easily improved by introducing the right level of filtration. The required filtration grade comes from the combination of analysing the outdoor air quality and the specific requirements on the indoor air environment.

Apart from the filtration grade, filter type has to be selected. Most common fine filters used in ventilation systems are either bag filters or compact filters. Depending on the air handling unit construction the type of filter is often predetermined due to space restrictions. Usually, compact filters take less space than bag filters, and at the same time provide similar filtration efficiency, resistance and energy consumption. The lifetime of these two filter types can differ depending on the characteristics of the airborne particles, specifically the ratio of large (>PM<sub>2,5</sub>) to small particles (<PM<sub>2,5</sub>). Thanks to its voluminous media, high quality bag filters can handle both larger and smaller particles, which allows a longer service life. The fine media fibers in compact filters often get clogged by the larger particles (>PM<sub>2,5</sub>), and therefore reduce the filter lifetime.



Due to this aspect, it is common to protect the compact filters by adding an extra stage of prefilters that remove the fraction of the largest particles. Then, the pretreated air passes further towards the second stage filters that take care of the remaining particles. This way the usually quite expensive compact filter lasts longer in installation providing required indoor air quality, while prefilters serve as a shield for the compact filters against coarse pollutants.

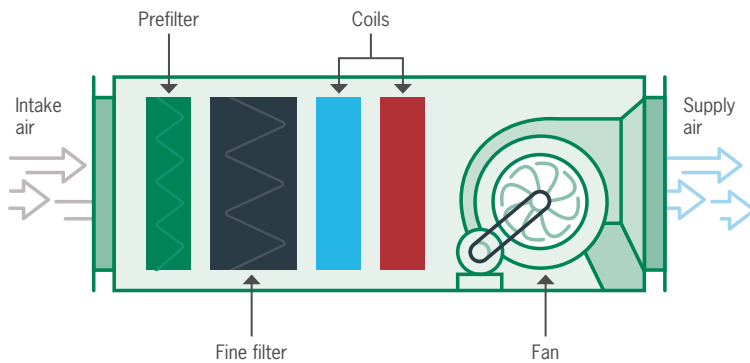
OUTDOOR AIR			SUPPLY AIR				
CATEGORY	PM <sub>2,5</sub>	PM <sub>10</sub>	SUP 1*	SUP 2*	SUP 3**	SUP 4	SUP 5
			ePM <sub>1</sub>	ePM <sub>1</sub>	ePM <sub>2,5</sub>	ePM <sub>10</sub>	ePM <sub>10</sub>
ODA 1	≤ 5	≤ 15	70%	50%	50%	50%	50%
ODA 2	≤ 7,5	≤ 22,5	80%	70%	70%	80%	50%
ODA 3	≤ 7,5	≤ 22,5	90%	80%	80%	90%	80%

**Table 3:** Recommended min. ePM<sub>x</sub> filtration efficiencies according to EN 16798-3 depending on ODA and SUP (annual mean PM<sub>x</sub> values in µg/m<sup>3</sup>)

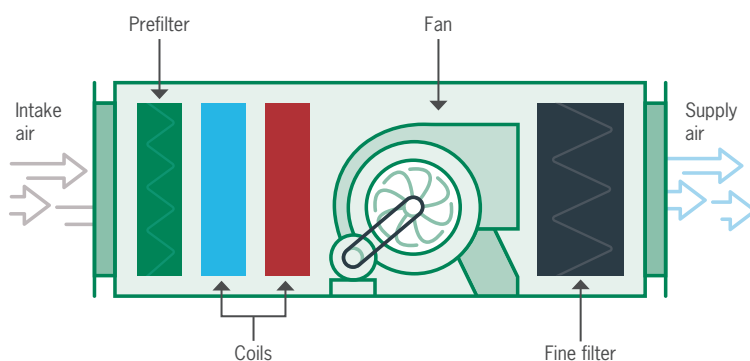
\*Minimum filtration requirements ISO ePM<sub>1</sub> 50% refer to a final filter stage  
 \*\*Minimum filtration requirements ISO ePM<sub>2,5</sub> 50% refer to a final filter stage

## Types of Air Handling Units (AHU) and how the right prefilter strategy can help to achieve optimal performance of HVAC systems.

Most common air handling units in general consist of the following sections or components: fan, cooling and heating coils, and filters sections – either one or two. The arrangement of these sections can differ and there is no standard design that all AHU manufacturers follow. Nevertheless, with respect to the location of filter stages there are two general types of arrangements:



**Type "A"** where all filter stages are located before the coils and the fan in the direction of air.



**Type "B"** where prefilter stage is located before the coils and the fan, while the fine filter stage is located after the fan.

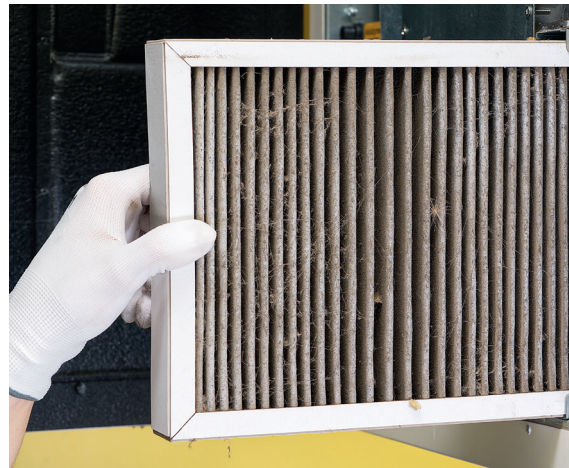
While using high quality filters is always beneficial for the customer and the ventilation system, for “Type B” AHU it is particularly important to respect the performance, lifetime and timely exchange of the prefilters used, in order to ensure efficient operation of the farther equipment of the air handling unit. **Prefilters with high filtration efficiency ensure that the coils and the fan are free from extensive dust. In addition, using prefilters with longer lifetime allows for less frequent filter changeouts and at the same time ensuring the correct level of filtration.**

## To have in mind when choosing a prefilter strategy

There are many reasons why using a prefilter in some cases can bring economic, operational or social benefits. What’s important to remember is that adding prefilters to your ventilation system should always be evaluated with consideration to the fan capacity. With prefilters there are a few aspects to be taken into account.

### Regular replacement

The construction of the majority of panel filters available on the market follows similar principal – pleated media and a frame. Such construction of a filter brings one main benefit which is space savings. Yet, it also comes with a limitation in terms of filter lifetime. Because the prefilters take so little space, there is only a certain amount of media that can be fitted in a filter. The amount of media translates directly to the dust holding capacity of a filter, which in its turn defines the filter lifetime. In case a prefilter is being used after it has reached the recommended changeout time, it will significantly increase the operating cost due to its high pressure drop. High pressure drop equals high energy cost. In addition, extended use of prefilters impose a risk for its damage and later collapse, which can lead to contaminating further parts of the ventilation system with not only particles that passed through gaps around the prefilters but even with fragments of the destroyed prefilters itself. Losing the designed functionality of the prefilters will cause a reduction of the benefits described above, such as the protection of the second-stage filter or the functional elements of the air handling unit.

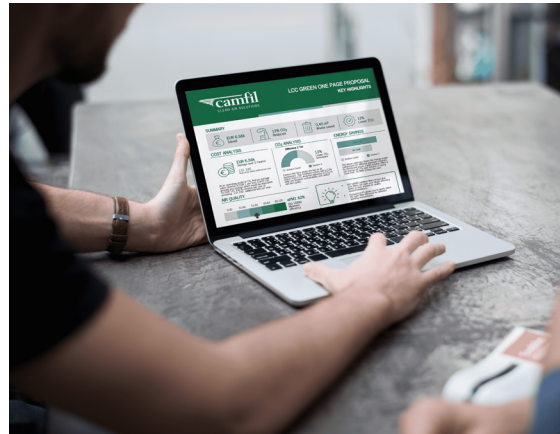


The key to prolong the lifetime of the fine filter and provide for optimal operation of the HVAC components is to regularly replace your prefilters. However, depending on the prefilter type and quality, and the working environment the lifetime will vary.

The best way to recognize the optimum time for the prefilter replacement is to monitor its pressure drop. One of the recommendations for filter exchange is specified by **EN 13053:2019** and it states <sup>[1]</sup>:

- For prefilters with Coarse efficiency recommended exchange takes place when the **pressure drop** = initial pressure drop +50 Pa or 3 x initial pressure drop (whichever is lower)
- For prefilters with ISO ePM efficiency recommended exchange takes place when the **pressure drop** = initial pressure drop +100 Pa or 3 x initial pressure drop (whichever is lower)

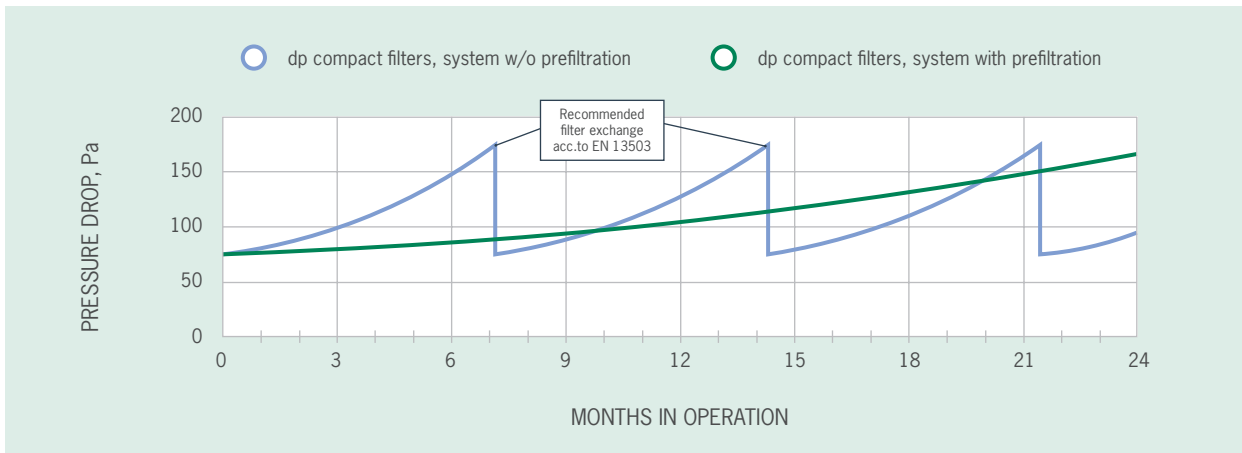
Pressure drop monitoring may not always be possible depending on the access to the sensors or other limitations of your air handling unit. Another reliable way to optimize the prefilter exchange intervals is to evaluate the predicted lifetime of the prefilter in your outdoor and indoor air environments. This can be done easily with help of a filtration expert in a customized life cycle study. Such evaluation will help to pinpoint the approximate optimal time for your prefilter replacement based on your operational requirements. Get in touch with a Camfil representative to learn more about Life Cycle Cost (LCC).



### Pressure drop

Adding an additional filter to your system will increase the total initial pressure drop, which will equal the sum of initial resistance per each individual filter stage. As the time passes and the filters collect more dust the pressure drop of both stages will increase. The difference between a system with prefilter versus system without prefilter will be noticeable in the pace of the pressure drop increase on the fine filter. When the fine filter is protected by a prefilter it can last much longer in the installation before it reaches the recommended final pressure drop. The more polluted outdoor environment the longer the lifetime difference will be when comparing systems with and without prefiltration.

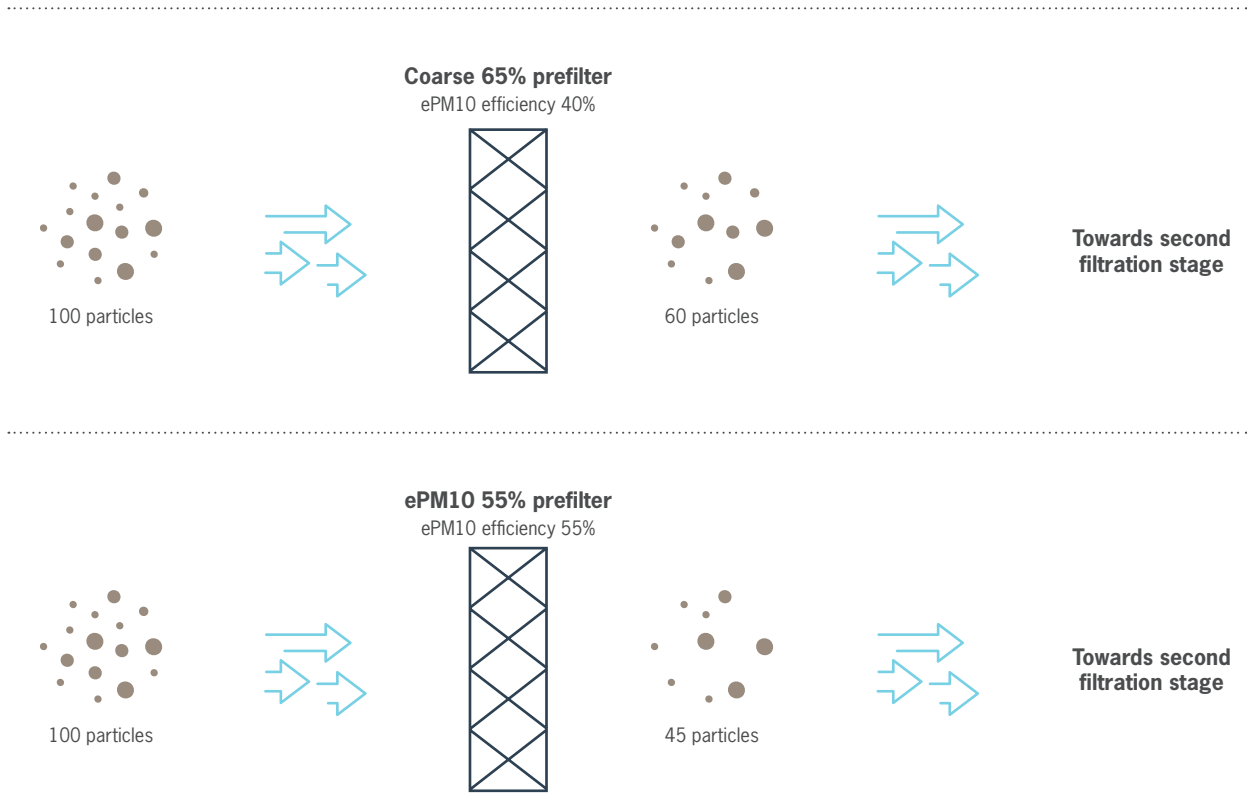
### Exchange interval for fine compact filter, with and without prefiltration



The chart presents a comparison of fine filter exchange intervals, comparing if prefiltration is used versus no prefiltration. What is apparent is that a fine compact filter can last more than 3x longer if prefilters with filtration efficiency ePM10 55% are used in the HVAC system. The evolution of pressure drop in cases shown on the chart is simulated in exactly same outdoor/indoor air conditions <sup>[4]</sup>.

### Efficiency

Prefilters will improve the total filtration efficiency of your system – the higher efficiency of the prefilter, the higher the total efficiency of the filtration system. Worth mentioning is the fact that as per Eurovent 4/23-2022 recommendations it is advised to use at least ePM10 50% prefiltration in combination with fine filters [5]. The resulting efficiency of all filter stages is dependent on the individual filtration classes of the filters used and can be estimated by a Camfil representative/expert.



Filtration efficiency on PM10 particles for Coarse filter and ePM10 filter.

### Energy consumption

A ventilation system with two filtration stages, that is a prefilter together with a fine filter, in general requires more energy than an identical system with only one stage – fine filter.

Energy consumption of a filter is a result of three factors: pressure drop, airflow, and particles concentration in the air before the filter. This means that for systems with prefiltration the energy consumption of the fine filter will be lower than for the same filter without air pretreatment. It is because the air before the fine filter will have lower concentration of particles when the prefilter is present. However, even if the prefilter will reduce the energy consumption of the fine filter, it also requires a dose of energy for itself. This is why the total energy consumption of such 2-step system is usually higher than a system with only one filtration stage.

The total cost of ownership (TCO) of an air filter is as follows:

- 80% Energy cost
- 10% Filter cost
- 8% Change cost
- 2% Disposal cost

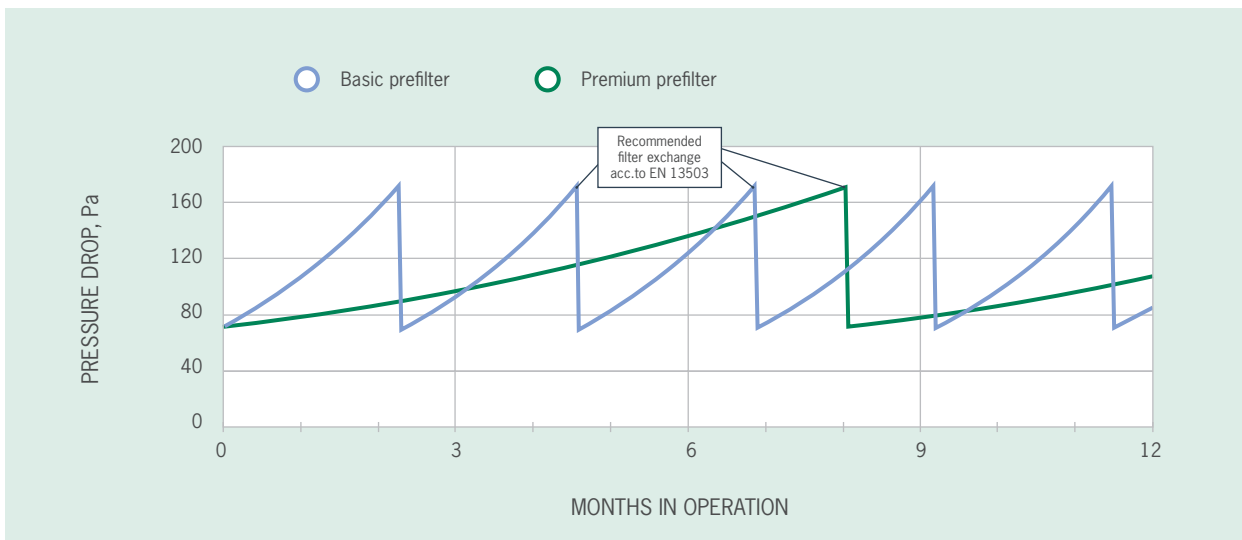
## Prefilter lifetime and its economic impact - “change less, gain more”

Regular prefilter replacement will minimize the expenses on the fine filter purchase and maintenance as well as create optimal conditions for effective work of the HVAC system. In addition, clean elements of air handling units reduce the risk of their premature breakdown. However, if the prefilter changeout occurs several times a year this will jeopardize the benefits of prefiltration strategy. Frequent replacement of prefilter means more maintenance stops and possible downtime of your operations. If the maintenance of your HVAC system is managed by an external company this may imply further expenses for you as the facility owner. For this reason, it is crucial to ensure that also the service technicians are aware of the benefits of premium prefilters and their estimated lifetime. Such knowledge help achieving the best performance of the HVAC system and allow to precisely plan the optimal cadence for filter replacement. Finally, every prefilter, even the low quality ones, has a certain purchase price. Simply put, more prefilters means more expenses.

Lifetime duration of every filter is strictly related to the local conditions, therefore the same filter, even if operated at the same airflow, will have different lifetime in various outdoor environments.

To demonstrate how big an impact the choice of prefilter has on the frequency of replacement Camfil conducted a study. In it two prefilters have been compared – one is a basic, budget prefilter and a second one is a high quality prefilter. The operating and outdoor conditions are identical for both filters.

### Exchange interval for various prefilters



The chart presents the results which indicates that over one year in operation and the basic prefilter would need to change 5 times. Comparing this to a premium prefilter in exactly same conditions the end user can spare 4 replacement breaks, as it needs to be changed only once during one year.



## Prefilter lifetime and its impact on the environment – “less is more”

When consuming fewer filters – both pre- and fine filters – you can directly make a positive contribution to the environment. Less resources used equals less waste generated. But there are other, less obvious aspects of using high quality prefilters that will make a positive climate impact.

Firstly, as with every other product, air filters have to be manufactured. However, if the demand for frequent delivery of your filters drops, the filter manufacturer consumes less energy for the manufacturing processes. Furthermore, this also means less raw materials used and therefore less transportation of the raw materials is required to the air filter manufacturing plant. Finally, to conclude the lifetime of filters from the raw materials extraction until filters delivery, less demands equals less shipment to the end or intermediate user.

Secondly, when your filters are exchanged less frequently, your service supplier does not need to visit your site as often, which relates to lower car fuel consumption, or – in the case of electric vehicles – less electricity used.

Frequently replaced commodities are often purchased in advance and stored to ensure steady supply without long waiting time. If, instead of 5 filter changeouts per year, only 1 or 2 replacements are required, this will reduce the necessary storage capacity, which means less energy consumed that would otherwise be needed for heating, lighting, and maintenance of the warehouse halls.

Prefilters help to keep the ventilation system free of excessive dust, and therefore improve the operational efficiency of your HVAC system. Keeping heat transmitting elements clean will reduce the required energy to ensure the desired temperature in your building. Finally, a few more words about the amount of generated waste. Using high quality prefilters with longer lifetime will naturally reduce the waste volume. This also means that less waste has to be processed, either recycled, incinerated or landfilled, and thus less energy will be spent on those processes.

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## References

- [1] EN 13053:2019. Ventilation for buildings - Air handling units - Rating and performance for units, components and sections.
- [2] WHO ambient air quality database, 2022 update. Status report. (<https://www.who.int/publications/item/9789240047693>)
- [3] [https://www.who.int/health-topics/air-pollution#tab=tab\\_1](https://www.who.int/health-topics/air-pollution#tab=tab_1)
- [4] Camfil. (2023) Camfil Filtration Solution System (CFSS), LCC Green EMEA software. Own study.
- [5] Eurovent AISBL / IVZW / INPA. (2022). Eurovent 4/23 – 2022. Selection of EN ISO 16890 rated air filter classes. Fourth edition. Brussels: Eurovent.

# Camfil – a global leader in air filters and clean air solutions

For more than half a century, Camfil has been helping people breathe cleaner air. As a leading manufacturer of premium clean air solutions, we provide commercial and industrial systems for air filtration and air pollution control that improve worker and equipment productivity, minimize energy use, and benefit human health and the environment. We firmly believe that the best solutions for our customers are the best solutions for our planet, too. That's why every step of the way – from design to delivery and across the product life cycle – we consider the impact of what we do on people and on the world around us. Through a fresh approach to problem-solving, innovative design, precise process control and a strong customer focus we aim to conserve more, use less and find better ways – so we can all breathe easier. The Camfil Group is headquartered in Stockholm, Sweden, and has 30 manufacturing sites, six R&D centres, local sales offices in 35 countries, and about 5,600 employees and growing. We proudly serve and support customers in a wide variety of industries and in communities across the world. To discover how Camfil can help you to protect people, processes and the environment.

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