Enhancing indoor air quality and energy efficiency through life cycle cost analysis

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Abstract

Life Cycle Cost (LCC) Analysis of air filters predicts total ownership usage cost related to air filtration in commercial buildings including energy consumption, labour, waste disposal, and filter acquisition cost. It takes into account the critical outcome in air quality ensuring that the primary objective of air filtration, being to deliver clean air to the services space, is met.

This study compares the life cycle cost (LCC) of air filters under various performance scenarios, using ISO 16890 classification.

Air filters represent about 0.01% of the total building cost of an average office block (1 full size ISO16890 ePM2.5 50% air filter at ~$100 per 185m2 floor space; $5,000 / m2 base building construction cost). As such, air filter costs are often neglected in the building's design. Yet, operational costs of air filtration can vary by as much as 100%, ranging from $1/m2 to $2/m2, with the cheaper of the two even delivering an improvement in indoor air quality over commonly used filtration solutions. Conversely, on current budget of $2/m2, a fivefold improvement in air quality can be achieved, from ePM1 17% to ePM1 87%.

This document demonstrates that to achieve best outcomes, the total cost of ownership (TCO) related to air filtration must be considered over the simple acquisition cost of the filter. LCC Analysis is the ideal tool to select the best filters for users/owners of both new and existing buildings.

Key Innovations

- Load-Curve accurate LCC Analysis formula for accurate life cycle cost prediction
- Filtration related greenhouse gas emissions and landfill waste calculation
- Optimum filter change report to optimise building performance

Practical Implications

Previously, air filters were of little regard to building designers due to their small fraction of the total building cost.

Mechanical contractors selected standard compliant filters for their HVAC systems without consideration of the filter's life cycle cost.

Advances in air filter design enable energy saving air filters. Increased desirability of power efficiency encouraged by NABERS (NABERS,2025), filtration requirements of recently the released Australian Standard AS1668.2:2024, and the rising costs of energy, labour, and waste raise the need for LCC analysis of air filters.

Today, LCC analysis allows building designers to accurately take filtration related costs, energy consumption, and waste generation into account when simulating a building's operational performance. Further, for existing buildings the LCC analysis allows owners to model outcomes to achieve higher energy ratings (e.g. NABERS).

Introduction

According to the WHO (2019) Nine out of 10 people breathe polluted air every day making air pollution is the greatest environmental risk to health, annually killing 7 million people globally. Current research indicates that this number may be significantly understated, as more and more diseases show links to particulate matter air pollution, including Alzheimer's and Parkinson's Disease (Dominici, 2024), and COVID19 (Morawska, 2020). Current evidence shows that COVID and many other respiratory diseases are transmitted by aerosols (Wang, 2021). Conversely, Djukanovic (2002) showed that the benefits of clean indoor air far outweigh the costs of filtration.

As we spend 90% of our time indoors, indoor air pollution is of greater significance in terms of long-term exposure than outdoor air pollution. Effective solutions to increase indoor air quality, such as smart building design and effective air filtration, are readily available (Allan, 2024). The WHO (2000) states that: "Those who design, provide, build, maintain and occupy indoor environments have a duty to do no harm to indoor air quality in that environment."

In the remainder of the paper, a case study is presented that examines three scenarios of air filtration using LCC: The status quo solution, a cost optimised solution and an air quality optimised solution. The case study examines different filtration solutions and operational strategies, comparing their long-term economic and environmental impacts. The methodology used to perform the LCC analysis is outlined, followed by data-driven evaluations of each scenario. The findings are then discussed in terms of their implications for decision-makers in facility management and environmental engineering. This approach demonstrates how LCC can serve as an effective tool for optimizing both cost efficiency and sustainability in the design and operation of air filtration systems.

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Theoretical Background

Filtration Efficiency

A filter's ability to remove particulate matter from the air flow is called filtration efficiency. Air filters use several methods to remove particulate matter from the air stream including straining, inertial impingement, interception, diffusion and electrostatic effect (ASHRAE, 2020).

For this article, the focus will be on electrostatic charged filters and non-electrostatic charged filters as this is the main change in testing requirements for filters in the 2024 update of the Australian Standard AS1668.2. The former rely on an electrostatic charge of the filter medium which attracts naturally charged particles. These filters come from the factory with an electrostatic charged synthetic filter medium. As AS1324.1 (Standards Australia, 2001) rates filters when new, the filters are rated with the full advantage of their electrostatic charge. However, this charge diminishes over time, with filtration efficiency dropping accordingly. This is a key reason for the update of AS1668.2, which in its 2024 revision requires compliance with filtration standards that include ratings for fully discharged filters, such as ISO16890 (ISO, 2016) and ASHRAE 52.2 Appendix J's MERV-A rating (ASHRAE 2017).

When speaking about a filter's filtration efficiency it is also crucial to understand the nature of the particles that are being removed from the airstream. Airborne particles come in a range of sizes, ISO16890 particularly groups particles by sizes 10 microns, 2.5 microns and 1 micron and rates a filter's efficiency for each size, the fractional efficiency. Each group includes all particles up to the defined size, e.g. particles of 2.5 microns and smaller also include particles of 1 micron and smaller. Aerosolised particulate matter of this size is not visible to the human eye which only detects particles 40-50µm in size and larger.

Of particular importance is the most penetrating particle size (MPPS), which typically falls around 0.3 µm. Filters are least efficient at capturing particles of this size due to the transition between dominant filtration mechanisms (diffusion and interception). The MPPS is therefore critical in assessing filter performance and risk reduction. Studies show that particles of this size can remain suspended for long durations and penetrate deep into the lungs, with strong links to cardiovascular and respiratory conditions (Chen et al., 2017; Nazaroff, 2004). As such, assessing filter efficiency near the MPPS is essential for indoor air quality management.

Typically, particulate matter pollution levels for general use areas are measured in µg/m3 of air. For instance, a room may measure 5ug of 2.5µm particles. However, this scale is very coarse, and for clean rooms actual particle counts are required per ISO 14644 (ISO, 2015). On balance, it is important to note that the actual number of particles in 1ug per m3 of 1µm size can be an order of magnitude greater than those of 2.5µm size. So, the same air sample may return 1µg/m3 for 1µm particles and 1µg/m3 for 2.5µm particles.

When discussing filtration to protect humans, the main factor to consider is the damage particles of any given size can cause. Cheng (2017) demonstrated that 1 µm particles are the most damaging to health. The AQEG (2005) showed in their comprehensive analysis of atmospheric particulate matter that smaller particles remain in the air far longer than larger particles. This means that the most critical parameter to consider when selecting a filter is its filtration efficiency of particles in the PM1 and PM2.5 range. The focus of this article is on ePM1 and ePM2.5 filtration efficiency.

Pressure drop is the measurement of resistance to air flow the filter poses to the air stream and is measured as the difference in air pressure (described in Pascal or Pa) upstream of (before) and downstream of (after) the filter. Higher pressure drop decreases air flow at constant fan speed. To provide the required air flow to the occupied spaces, the ventilation fans must ramp up which increases energy consumption.

In any given situation and all other parameters being equal, higher levels of filtration efficiency result in increased pressure drop. DEECCW (2022) states that HVAC is the largest energy consumer in commercial buildings in Australia, and within HVAC, ventilation fans are the single largest energy consumer in Australia (2013). One key reason for HVAC fans' energy consumption are air filters. Other reasons are fan efficiency, and airflow resistance in the overall mechanical structure such as ducts and coils.

Filter pressure drop is not constant, but changes over time as the filter loads with dust. This change as the filter loads is not linear, but exponential.

Accurate LCC analysis is required to allow the modelling and comparison of filters in common running conditions to identify the best (lowest overall cost / lowest carbon or waste / longest life) filter for any given situation, and the most effective pressure drop or elapsed time for replacement.

Filter Standards

Any building constructed or refitted in Australia must comply with the National Construction Code (NCC). The NCC adopts AS1668.2 for the mechanical ventilation in buildings. AS1668.2 was revised in June 2024 (Standards Australia, 2024), requiring filters to be compliant with ISO16890, where previously AS1324 applied. This is a major change as where previously filters were assessed for their filtration efficiency only in their new condition, ISO16890 requires filters to be assessed when their electrostatic charge has been removed. Whilst the technical details are not relevant, it is notable that from 2025 onwards, for any new builds and refits, filtration efficiency requirements to reduce the outside air requirement are significantly more onerous, further increasing the need for careful consideration of the filter's operational costs.

The main filter standards that apply to general mechanical ventilation of indoor spaces in Australia are AS1324 and ISO16890. The American ASHRAE 52.2 Appendix J

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(MERV-A) is also referenced in AS1668.2:2024, but for simplicity I will focus on AS1324 and ISO16890.

Filter Types

Air filters for commercial buildings come in a variety of shapes and sizes. Most common being 'full size' i.e. 600mm x 600mm and formats being 'panel' and 'bag' or 'pocket' filters. This article applies to all sizes and formats. For simplicity I will use the full size bag and panel for my examples.

Filter Grades

AS1324 grades filters by EN779:2002 in G3-4 and F5-9, from least to most filtration efficient. (Note EN779:2012 uses grades G3-4, M5-6, F7-9). Efficiencies above F9 are disregarded in this article as they are rarely applied to general purpose spaces, however LCC can be successfully applied to higher grades including HEPA and ULPA filters just the same.

ISO16890 grades filters by percentage of removal of particles of a certain size from the airstream, starting with ePM10 for 10 micron particles, over ePM2.5 for 2.5 micron particles down to ePM1 for 1 micron particles. A filter that achieves 50% or higher efficiency in a particulate size grade is rated at that grade, with the smallest particulate size taking precedence. For example, a filter that achieves ePM2.5 55% which also achieves ePM10 80% and ePM1 30% would be rated at ePM2.5 55%.

ISO Testing

ISO16890 consists of four parts.

ISO 16890 Part 1, *Overview and Particle Efficiency Classification*, defines the fundamental principles and overall framework of the ISO 16890 standard, including the classification system for air filters based on their ability to capture particulate matter in the size ranges PM1, PM2.5, and PM10. Filters are tested with both discharged and conditioned (electrostatically neutralized) media to determine the minimum efficiency across the particle size spectrum from 0.3 to 10 micrometres. Based on the minimum efficiency and the standardized ambient air distribution curves, filters are classified as ePM1, ePM2.5, ePM10, or coarse filters. A filter must achieve at least 50% efficiency in a given particle size range to be classified in that category.

ISO 16890 Part 2, *Measurement of Fractional Efficiency*, specifies the test method for determining the fractional particle size efficiency of air filters. This involves exposing the filter to test aerosol in a laboratory test rig and measuring the number of particles before and after the filter across a defined particle size range (0.3–10 µm). These measurements are done first with the filter in its discharged state and then after electrostatic discharge using isopropanol (IPA). The lowest measured efficiency at each particle size is used to ensure conservative and realistic performance data.

ISO 16890 Part 3, *Gravimetric Efficiency and Airflow Resistance*, describes the dust loading procedure used to evaluate the gravimetric (mass-based) efficiency and airflow resistance of a filter. Filters are loaded with standardized test dust (e.g., ISO A2 fine dust) under controlled airflow conditions, and the amount of dust retained is measured in stages. Pressure drop is recorded before and after dust loading, providing insight into the filter's behaviour over time, such as its capacity to hold dust and maintain airflow. This part supports assessments of filter life cycle performance and energy use. The output of this test provides key parameters for the LCC calculation.

ISO 16890 Part 4, *Conditioning and Performance Determination*, outlines the test system setup and procedures for ensuring consistent and reproducible testing, including test rig design, aerosol generation, sampling systems, and calibration requirements. It also covers the conditioning procedures for filters, particularly the IPA discharge process that neutralizes electrostatic charges in the filter media to evaluate true mechanical performance. This ensures that results across laboratories are comparable and filters are tested under standardized, reproducible conditions for both fractional and gravimetric efficiency.

Filtration Costs

Four direct costs that apply to all air filtration universally need to be taken into consideration when considering a filter's TCO:

1. The purchase cost of the filter
2. The delivery / installation cost
3. The cost of energy consumed by the ventilation fans, which typically constitutes the largest cost component
4. The disposal cost of the filter

Other costs that are business dependent that may be of importance but are not considered in this example of LCC include:

1. Cost of scheduling filter replacements and cost of business interruption during filter replacement where applicable
2. Regulatory costs, carbon credits, waste reduction incentives, etc.
3. Other situation dependent factors such as any toxicity that may require HAZMAT handling or special requirements to access the filters for replacement such as special qualifications, security clearances or safety inductions.

There are also indirect costs related to filtration, to name a few:

1. Inadequate filtration leads to increased absences due to illness acquired at the workplace (Mansoor 2024)
2. Productivity, particularly for creative tasks is impacted by lack of air quality (Arikrishnan, 2023)
3. Higher rates of filtration decrease build up of dirt and mould on air conditioning coils, improving heating and cooling performance and reducing cleaning costs.

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This paper, for purpose of LCC calculation, will focus on direct costs. Three of the four direct costs can be immediately quantified, with the energy cost being the notable exception. Energy cost is calculated as follows (Eurovent, 2014):

$$\text{Energy Cost} = \frac{Qv \bullet \Delta p \bullet t}{1000 \bullet \eta} \bullet Ce$$

Qv = Airflow (m^3/s)

Δp = Pressure Drop (Pa)

t = Operational Time (h)

η = Fan Efficiency (%)

Ce = Energy Cost (AUD/kWh)

Methodology

LCC Parameters

The parameters that are used to establish life cycle cost of the filters, as there are:

- Labour cost. This is the cost of labour to replace the filter, including removal of the old filter and installation of the new filter. This cost can be quantified in hours or dollars, and per filter or per exchange (total system).
- Disposal Cost. This is the dollar value cost of disposing the filter at the tip / recycling centre.
- Energy Cost. The gross cost of energy in cents / kWh used over the life of the filter, taken from the building's energy bill.
- Fan Efficiency. The efficiency of the fan/motor assembly as taken from the mechanical system's specifications. Often in the range of 60 – 75%.
- Air Flow or Air Speed. This is the speed of air at the filter face. Air Flow is expressed in m^3/hour, air speed in m/s. Airflow and air speed are proportional to each other. To calculate airflow, multiply the air velocity by the cross-sectional area of the filter face.
    - Of note here is that the commonly used nominal filter air speed is 2.69m/s which on a standard size filter face of 600x600mm equates to 3400 m^3/h.
- Area of filter face used in the system. This is made up of the quantity and size of filters used in the system. For instance, an air handling unit (AHU) may contain 12 full size (600x600mm) and 6 half size (300x600mm) filters, giving a total area of 5.4m2.
- Runtime of the system in hours / year. Many systems are slowed down or turned off during non-operational periods. Filtration related energy cost becomes negligible so these periods are disregarded.
- Return Air. This parameter governs the proportion of return air as opposed to outside air in the airstream.
- Outdoor air quality (ODA) as described in EN16798-3:2017 and EN13779:2007. This parameter is only relevant if return air is below 100%
- Indoor air quality. This represents the air quality from the space the are is sourced. This parameter is only relevant if return air is above 0%
- Filter replacement trigger. This parameter sets when filters are replaced in practice. For instance it could be when a certain pressure drop is exceeded, or at set time intervals such as every 6 months.
- Number of filter stages. Many AHUs are multi-stage systems that include a pre-filter and a secondary filter. Some systems further include a third and even a fourth filter stage for specific applications. LCC should assess filtration cost as a whole, taking all filtration stages and how they interact with each other into account.
- LCC period in years. Since modern filters can for the most part last for several years, it is recommended to run filtration cost LCC simulations over a period of at minimum five years, or at least two replacements of the longest lasting filter under analysis.
- Greenhouse Gas Emissions. This parameter is adjusted to reflect the kg of CO2 / kWh as reflected on the building's energy bill.
- Filter Selection. Filters to undergo LCC analysis are selected once all other parameters are set to match the site specifications and requirements. As different filters are selected, comparative analysis is possible against identical environmental parameters. Filter selection determines for each filter:
    - Filter installed cost. This is the cost of the new filter as delivered to site and installed in the filter opening, and the old filter removed and disposed.
    - Pressure Drop as per ISO 16890 testing. This is the pressure drop over time as the filter loads with dust, from when the filter is new (initial pressure drop) to the point of filter replacement (final pressure drop). Note that pressure drop increase is not linear and for accuracy pressure drop data for each filter should be established in laboratory testing.
    - Dust Holding Capacity (DHC). DHC is also established by ISO16890 standard. DHC impacts filter longevity and the steepness of the pressure drop curve.
    - Waste per filter in m^3.

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- Filtration efficiency expressed in ISO16890 ePMx X%.

Case Study:

To illustrate the power of LCC, three examples were created to demonstrate (Table 1):

1. The current status quo of a typical filtration solution commonly found in today's office building AHUs.
2. A solution to meet AS1668.2:2024 minimum requirement for outdoor air reduction (ISO 16890 ePM2.5 50%), optimised to reduce total ownership cost.
3. A solution to return maximal air quality by ISO16890 at a similar total ownership cost of the status quo filtration solution.

Table 1: Comparison of LCC solutions

Solution	Filtration Stages	Filtration Solution	ISO 16890 ePM1	ISO 16890 ePM2.5	Energy Usage (kWh)	Energy Cost	Replacement Cycle (months)	Waste Volume	Filter Change Cost (AUD)	TCO 5 years (AUD)
Status Quo	Pre Filter	30/30 4" G4	17%	39%	28621	7155	6	3.05m³	$4,530	$11,685
	Fine Filter	S-Flo W UF7					12			
Cost Optimised	Fine Filter	HI-FLO XLT6	40%	54%	11913	2978	15	0.84m³	$3,600	$6,578
Air Quality Optimised	Fine Filter	Hi-Flo II F9	87%	91%	26812	6703	12	1.05m³	$5,100	$11,803

In situ validation

A Case Study to validate the optimal air quality premise was conducted for a major healthcare organisation in the Melbourne metropolitan area. For simplicity a single AHU filter was investigated. The AHU services a general area of a hospital located on Melbourne's outskirts.

Current HVAC filters include AS1324 G4 rated prefilters and AS1324 F7 rated secondary 8 pocket filters. Note AS1324 is based on EN779:2002.

New filter configuration based on LCC to achieve optimal air quality at same total cost: Single stage ISO16890 ePM1 85% rated 12 pocket filters which are designed to be installed without prefilters.

The following in-situ metrics were measured:

- Upstream particulate matter count, previous filters
- Downstream particulate matter count, previous filters
- Pressure Drop, previous filters
- VSD Hz, previous filters
- Filter Waste, previous filters
- Labour, previous filters
- Upstream particulate matter count, new filters
- Downstream particulate matter count, new filters
- Pressure Drop, previous filters
- VSD Hz, new filters
- Filter Waste, new filters
- Labour, new filters
- Temperature and humidity at filter replacement

Equipment used

The in-situ AHU is a Walker-Cold Magic® CW120-S with Air Flow of 3585 L/s, Fan Motor 6.75KW 415V / 3PH / 50Hz / 10.3A with 1385 RPM nominal fan speed, equipped with ABB Variable Speed Drive.

Particulate Counter is Lasair III, calibrated 01/05/2024.

Manometer is TSI DP-Calc Micromanometer 5815.

Filters used

Status Quo Filtration Solution

Camfil 30/30 4inch

Camfil S-Flo UF7 (592x592-8x600)

Air Quality optimised Filtration Solution

Camfil Hi-Flo II HFGS-F9-592x592x640-12

The filters used comply with the standards per Table 2.

Table 2: Standards as rated per individual filter

Solutions	Standards		
	AS1324	EN779:2012	ISO16890
3030	G4	G4	Coarse
S-Flo UF7	F7	M6	ePM10 80%
Hi-Flo II F9	F9	F9	ePM1 85%

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In-Situ measurement Methodology

On-Site filter replacement and in-situ data sampling for each AHU:

1. Record AHU label information
2. Record label information and configuration of existing filters
3. Record Hz and other information on VSD display
4. Record external air louvre position
5. Record pressure drop across existing filters using manometer
6. Record particulate count at upstream plenum
7. Record particulate count at downstream plenum
8. Remove old filters per best practices and site regulations
9. Install new filters per best practices and site requirements
10. Record Hz and other information on VSD display
11. Record pressure drop using manometer
12. Record particulate count < 1um at upstream plenum
13. Record particulate count at downstream plenum

The AHU under investigation is located on the roof of the building. Readings and measurements were taken from the AHU per Table 3.

Table 3: Common Conditions for AHU under investigation

Condition	Parameter
Fan System Operating Hours	8760 hours / year (hospital being 24/7)
No of Filter Openings	6 x full size
System Air Flow	1.8m/s
Return Air	70%
Energy Cost (Gross)	$25c/kWh
LCC period	5 years
Labour Cost (per filter)	$8
Waste Cost (per filter)	$2

Results

The LCC simulation (Table 1) indicates that there are significant upsides for the client by replacing their status quo filters with modern ISO compliant filters:

The cost optimised solution reduces total ownership cost from $11,685 to $6,578 whilst improving indoor air quality from $ePM1_{min}$ 17% to $ePM1_{min}$ 40% and $ePM2.5_{min}$ 39% to $ePM2.5_{min}$ 54%.

The air quality optimised solution improves indoor air quality from $ePM1_{min}$ 17% to $ePM1_{min}$ 87% and $ePM2.5_{min}$ 39% to $ePM2.5_{min}$ 91% whilst remaining within 4% of original total ownership cost.

The client in this case chose the air quality optimised solution, which was implemented site wide. During implementation in-situ observations and measurements of the AHU were taken as per Table 4.

Table 4: Observed and Measured In-Situ AHU Data

Item	Observation / Measurement	
AHU	AHU1	
Filter Openings	6 of 600x600	
External Air Louvres	30% open	
Filters	Current Filters	Air quality optimised Filters
Pressure Drop	45 Pa	39 Pa
VSD Frequency	15.7 Hz	16.6 Hz
VSD Current	1.1 A	1.2 A
VSD Load	31.3%	32.2%

Particulate counts were taken before and after filter replacement, documented in Table 5. The upstream measurement counts particulates before the filter, the downstream measurement counts particles after the air passes through the filter. The "percentage removed" metric reports the fractional efficiency (percentage of particulate removal for each particle size) from the airstream. Note that due to equipment limitations the upstream and downstream measurements were conducted sequentially, not concurrently.

Each measurement was conducted before the filter replacement for the status quo filters and after the filter

Table 5: In-Situ particulate matter measurements

Particle size µm	Status Quo			Air Quality Optimised			Improvement of particulate removal
	Upstream	Down stream	Percentage removed	Upstream	Down stream	Percentage removed	
0.3	12538492	8945013	29%	10399782	4507641	57%	98%
0.5	4254571	1056229	75%	3380069	403283	88%	17%
1	1615609	364169	77%	1242186	117673	91%	17%

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replacement for the indoor air quality optimised filters. Column "Improvement of particulate removal" shows the percentage improvement of removal efficiency between the status quo and indoor air quality optimised filters, with an increase of removal of particle sizes of 1µm by 17%, 0.5µm by 17% and 0.3µm by 98%.

Discussion

The results confirmed that the indoor air quality optimised filters outperformed the status quo filters particularly in smallest and most hazardous particulate matter sizes as predicted by the LCC. The lesser improvement in the larger particle sizes can be explained by the loading effect, by which a filter becomes more efficient for larger particles as it loads with dust over time (Wang, 2016). The reduced pressure drop of the indoor air quality optimised filtration solution as measured in the in-situ situation stands in contrast to the increased VSD Amperes shown. This can be attributed to a delay in VSD ramping up after the pressure drop measurement was taken with the manometer. The readings were within the expected range and consistent with LCC predictions.

Limitations

Time Frame: The case study validation occurs during a very short period and investigates particulate removal and energy consumption at a point in time. A long-term case study that encompasses all four seasons would be beneficial.

Exceptions: HVAC systems are at times exposed to exceptional loads, for example bushfire or pollen events. Whilst it is difficult to anticipate such events, long term and widely distributed studies would have a greater likelihood of capturing data during such exceptions.

Broader Applicability: The study uses a single AHU in a Hospital building. Although the AHU model is common across all manner of building types such as offices, shopping centres and educational facilities, further research across these sectors would increase applicability across the built environment.

Real-World Variability: Given the study's narrow investigative window of focus on one AHU in a hospital, variations in maintenance procedures, installation errors, and other inconsistencies were not considered.

Conclusion

This study establishes that LCC analysis is indispensable when selecting air filters to ensure best outcomes, be they cost or air quality prioritised. The in-situ measurement of particulate matter removal confirms the veracity of the ISO16890 standard. A long-term study with continuous trended data is desirable to further validate predictions in real-world scenarios. Given the long time frame (5 years) of LCC analysis, this raises other challenges such as random polluting events (e.g. bushfires) which have significant impact on air filter pressure drop, or energy price fluctuations which would have major impact on cost calculations.

Air filtration is a significant component of a building's operational cost, with the main cost component being energy consumption, and even more so when considering greenhouse gas emissions and landfill waste. LCC models allow building designers, owners and operators to quantify these costs and optimise the building to achieve desired outcomes.

As more stringent ventilation and filtration standards are being introduced in Australia with AS1668.2:2024, total ownership cost and operational phase cost modelling is necessary to understand the impact of this long overlooked component of our built environment.

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