



TOWARDS
SMART
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Improving the supplied ventilation air through filtration

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Overview

1. Why air filtration?
2. Brief overview of air filter classification
3. Research findings on filters for small residential systems
4. Translational research to midsized systems (cSBO)

2

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Road to a good Indoor Air Quality...

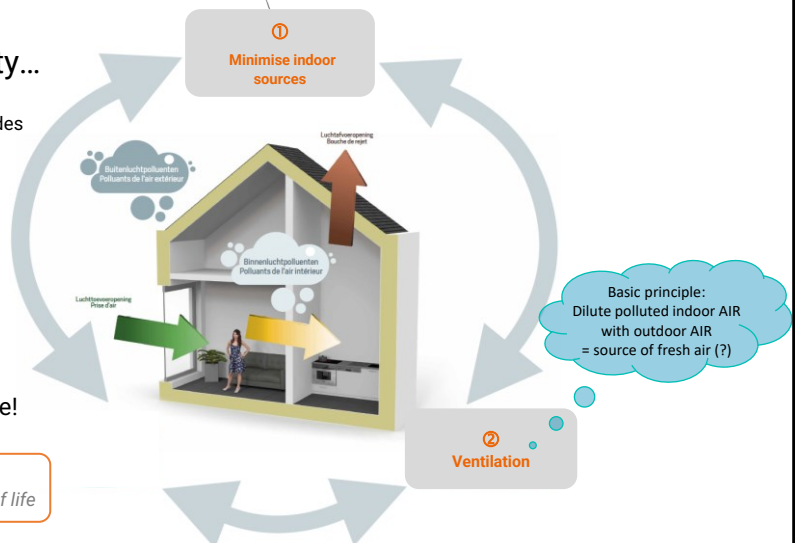
- **Outdoor Air Quality** improved in last decades
- ! Some pollutants **remain problematic** (PM_{2.5}, ozone, NO₂)



Of EU urban population are exposed to [PM_{2.5}] > WHO guidelines

- **Health impact** of poor Air Quality is huge!

Belgium: 8340 deaths = 86.000 years of life
↔ Traffic in Belgium: 597 deaths = 40.800 years of life



General Context: Indoor Air Quality

4

Road to a good Indoor Air Quality...

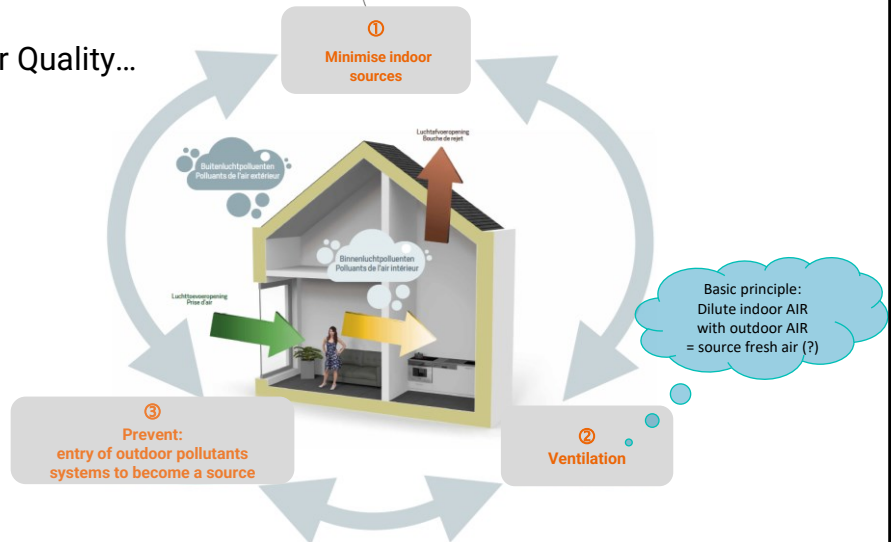
Out2In (residential)

!Pollutants do enter

! Improvement possible:

- F7-ePM_{2.5} bag filter
- ESP

? Applicable in AHU (cSBO)



General Context: Filtration

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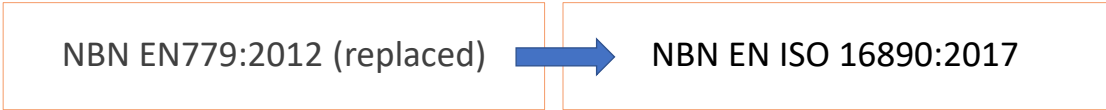
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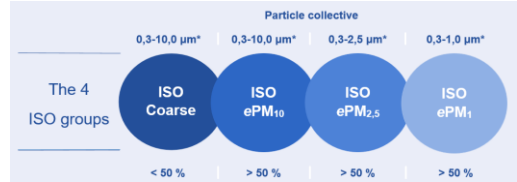
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General air filters: classification



- Classes = Eff. for particules of **0.4µm**
- Classification
 - G = Coarse (Grossier) G1, G2, **G3, G4**
 - M = Medium M5, M6
 - F = Fine F7, F8, F9
- 9 classes of filters (**5 often used**)
- Still indicated on datasheets

- Classification in 4 groups (**0.3-10µm**)




- Classification within a group (/5%)
49 classes of filters! (coarse 5-95%, others 50-95%)
- Labelling according to ISO standard mandatory since **July 2018**




☞ Fundamental differences (test procedure & classification)
 = no 1:1 relation between EN 779 and ISO 16890 classification
 ☞ The same EN779 filter can be classified differently: F7 = ePM2.5 (65-95%) or ePM1 (50-65%)


Same class, different type...


Iso Coarse 60% (G4)


 Folded panel


 Bag

ePM1 55%/ ePM2.7 70% (F7)

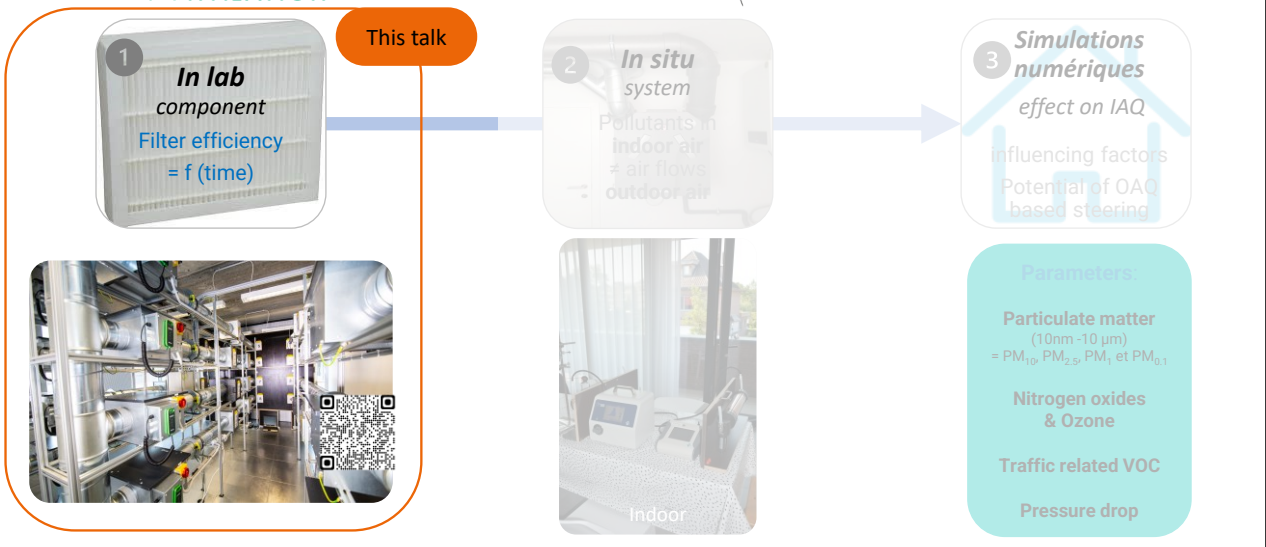

 Folded panel


 Bag

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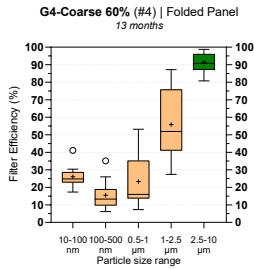


Existing knowledge: Out2In with focus on single family residential systems Approach

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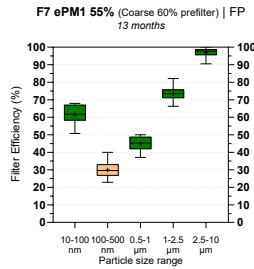
Coarse filters = system protection

- \geq Coarse 50-60% (G4)
- no improvement SUP Air Quality (except for pollen $> 10\mu\text{m}$)



Fine filters = PM_{2.5}

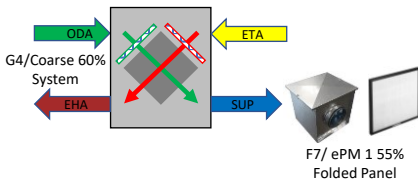
- \geq ePM1 55% (F7) folded panel + Coarse or ePM2.5 70% (F7) bag filter alone
- = [PM_{2.5}] in SUP < WHO (5 $\mu\text{g}/\text{m}^3$) given [outdoor] @ BXL



Existing knowledge: Out2In with focus on single family residential systems Main conclusions

Fine filters: 2 options with equal efficiency

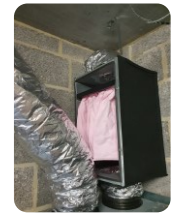
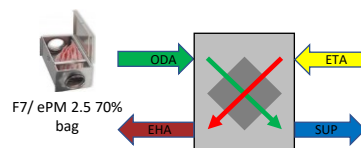
Option 1:
Coarse 60% (G4) + ePM1 55% (F7) folded panel



Coarse prefilter needed
 $\Delta P_{28} 51^{193} \text{ Pa}$

Interesting solution
Protection & Improvement in 1

Option 2:
ePM2.5 (F7) bag type alone in front of system

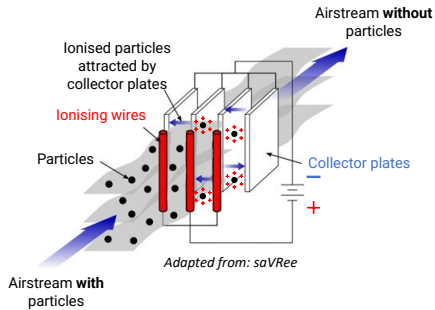


No prefilter needed
Lower pressure drop over 13mths runtime: $\Delta P_{25} 31^{38} \text{ Pa}$

Midsize system = x times tested filters in a frame
Equal performance?, Points of attention?

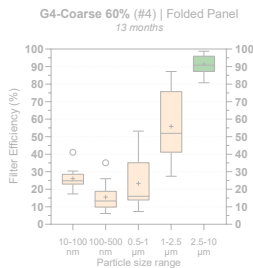
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Electrostatic precipitator = Ioniser + collector



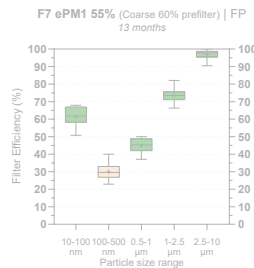
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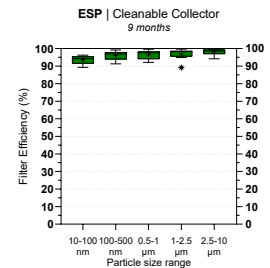
Fine filters = PM_{2.5}

- ≥ ePM1 55% (F7) folded panel + Coarse or ePM2.5 70% (F7) bag filter alone = [PM_{2.5}] in SUP < WHO (5µg/m³) given [outdoor] @ BXL
- [ePM1 80% (F9) & E10 (HEPA)] = much higher pressure drop



Electrostatic Precipitator = PM₁₀ + PM_{2.5} + UFP

- high consistent performance for all particle sizes (10nm-10µm) (when maintained)
- very low pressure drop << F7



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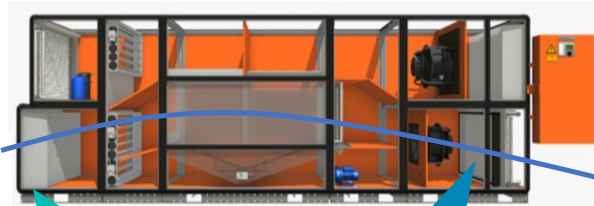
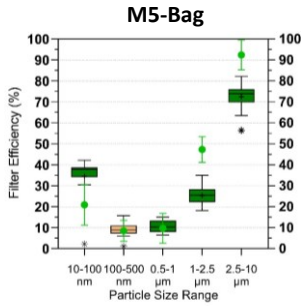
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In situ test of different configurations

- 1 M5-coarse 80%-filtre bag + F7-ePM₁ 55% folded panel
@ nominal air flow: 4400 m³/h
- 2 F7-ePM_{2.5} 70% bag
@ nominal air flow: 4400 m³/h
- 3 F7 bag filter at different air flows
800 – 1600 - 2500 m³/h

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Setup 1

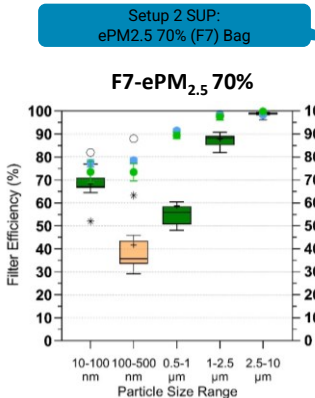


cSBO@3937 m³/h
 M5 0.51 m/s
 F7 0.098 m/s

Out2In@150m³/h
 M5 0.052 m/s
 F7 0.034 m/s

Translational research to mid-sized systems (cSBO)

Setup 2



Setup 1 SUP: Coarse 80% (M5) Bag

Setup 1 SUP: ePM1 55% (F7) folded Panel

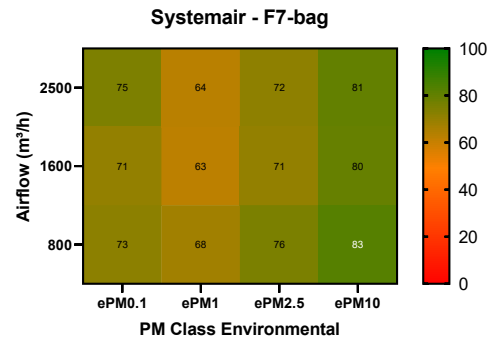
Setup 2 SUP: ePM2.5 70% (F7) Bag



Filter	State	Pressure drop (Pa)	Airflow (m³/h)
M5-coarse 80% Bag + F7-ePM ₁ 55% Folded Panel	New	81.3 ± 2.5 Pa 27.9 ± 2.2 Pa Σ = 109.8 ± 3.3 Pa	3937 ± 26 m³/h
F7-ePM _{2.5} 70% Bag	New	95.5 Pa (new) 99.9 ± 1.7 Pa (2 months in use)	3937 ± 30 m³/h

Translational research to mid-sized systems (cSBO)

Setup 3



Test @ different air flows

- No significant difference in eff.

Translational research to mid-sized systems (cSBO)

Conclusion et recommandations

General: consistency between results of both projects
= recommandations Out2In, *based on long-term follow-up measurements,*
can be transposed to AHU

Filters

- Class, type, place: possible to install different setups in AHU itself
(coarse + fine FP or fine bag)
- Installation: ! Structural stability of the filter
! Connection between filter and its housing and between filters!
! Bag filters: bags in vertical position
+ be careful during installation
- Replacement: follow-up of ΔP by BMS = targeted filter replacement (\leftrightarrow residential)
- Potential of ESP: needed space is available within the AHU





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Filters:

Van Herreweghe *et al.* (2022) Real-life ventilation filter performance: final results of an in-depth study

