# Luftrening som komplement till ventilation

## IEA EBC Annex 78 - Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications

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# Annex 78 Participants

11 Countries,
18 Universities
12 Companies

# Annex 78 team members

KTH:

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- Christophe Duwig, PhD, Prof
- Adnan Ploskic, PhD
- Behrouz Nourozi, PhD

Reference group: BeBo, Belok, Installatörsföretagen, Bravida

## Introduction and background

- **Ventilation** systems are important for maintaining a **healthy and comfortable indoor** environment.
- In cold climates, ventilation systems contribute to approximately **30%** of **building heat losses**.
- **Indoor emissions** and **outdoor pollutants** affect **indoor air quality** and need to be controlled by ventilation.
- **Gas-phase air cleaning** as an extension to the ventilation might help maintain **acceptable indoor air quality**, yet **reduce energy use**.
- Based on Swedish building regulations for residential buildings, recirculation of ventilated air is **not allowed**.

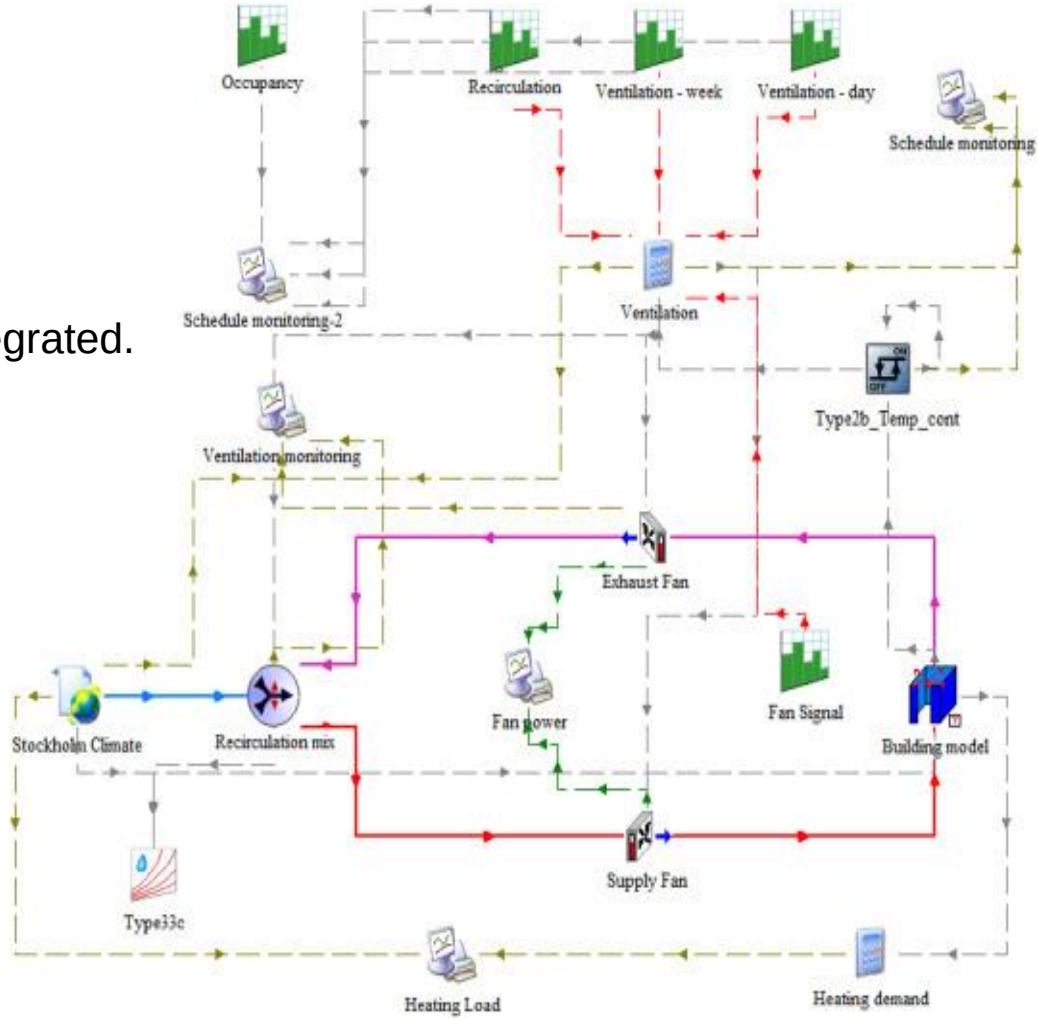
## Energy simulation using TRNSYS

### Investigated parameters

- **Heating demand** of a ventilated building.
- Indoor **TVOC level** (with 60% capturing efficiency).
- Indoor **$CO_2$ level** as a monitoring parameter.
- Possibility of **air recirculation** when air cleaner is integrated.

### Simulation case

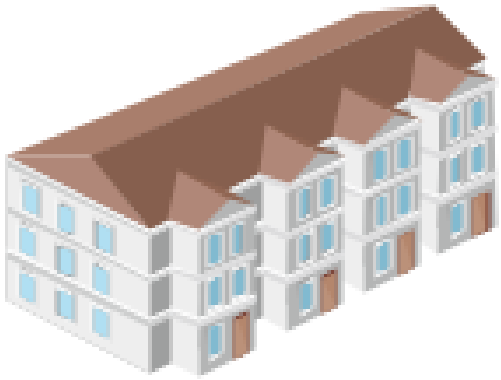
- Newly constructed or renovated buildings with heat recovery ventilation.
- Older buildings without heat recovery ventilation.
- Residential and office Buildings with various ACH.



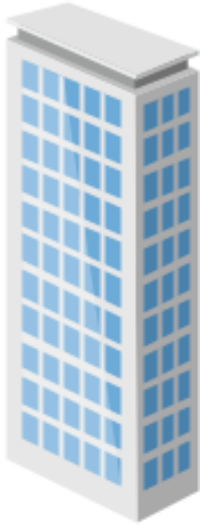

Nourozi, Behrouz, et al. "Heating energy implications of utilizing gas-phase air cleaners in buildings' centralized air handling units." *Results in Engineering* 16 (2022): 100619.

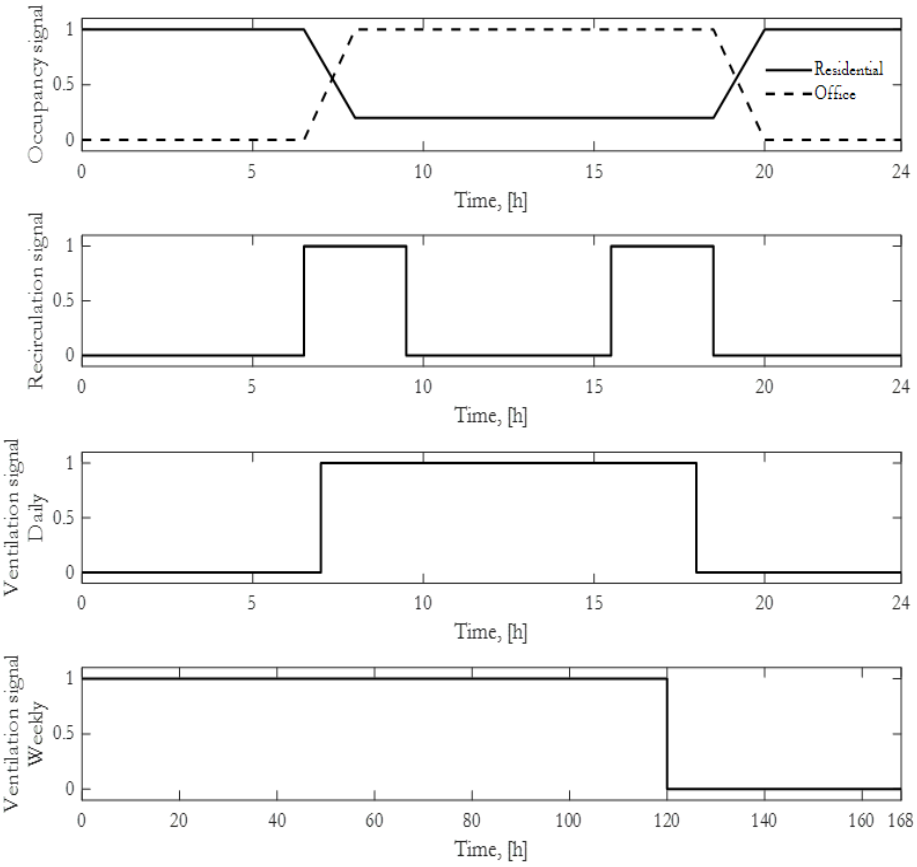
# Simulation cases study in Stockholm climate equipped with centralized air handling unit (2000 $m^2_{vent.\ area}$)

- **Residential building**
  - 0.45 ACH
  - Occupancy schedule



- **Office building**
  - 2.1 ACH
  - Occupancy schedule
  - **Ventilation schedule**






$$ACH_{Office}/ACH_{Residential}=4.7$$

## Indoor and outdoor emission rates

| Air pollutant | TVOC | | | $CO_2$ | |
|---|---|---|---|---|---|
| **Source** | Outdoor | Occupants | Interior furnishing | Outdoor | Occupants |
| **Value** | $\mu gr.m^{-3}$ | $mgr.h^{-1}.person^{-1}$ | $\mu gr.m^{-3}h^{-1}$ | $mgr.m^{-3}$ | $gr.h^{-1}.person^{-1}$ |
| | 110 | 6.3 | 120 | 720 | 120 |

## Guideline values for indoor TVOC concentration

| Location | Reference | TVOC concentration $\mu g.m^{-3}$ |
|---|---|---|
| **Europe** | Report EUR 14449 EN. 1992 | Comfort range < 300<br>Multifactorial exposure range < 3000<br>Discomfort range < 25000<br>Toxic range > 25000 |
| **Finland** | Finnish Society of IAQ and Climate. 2000 | Individual indoor climate < 200<br>Good indoor climate < 300<br>Satisfactory indoor climate < 600 |
| **Germany** | Federal Environment Agency of Germany | Hygienically safe < 1000<br>Hygienically noticeable < 3000<br>Hygienically alarming < 10000<br>Hygienically unacceptable > 1000 |
| **Germany** | Seifert B. | 300 |

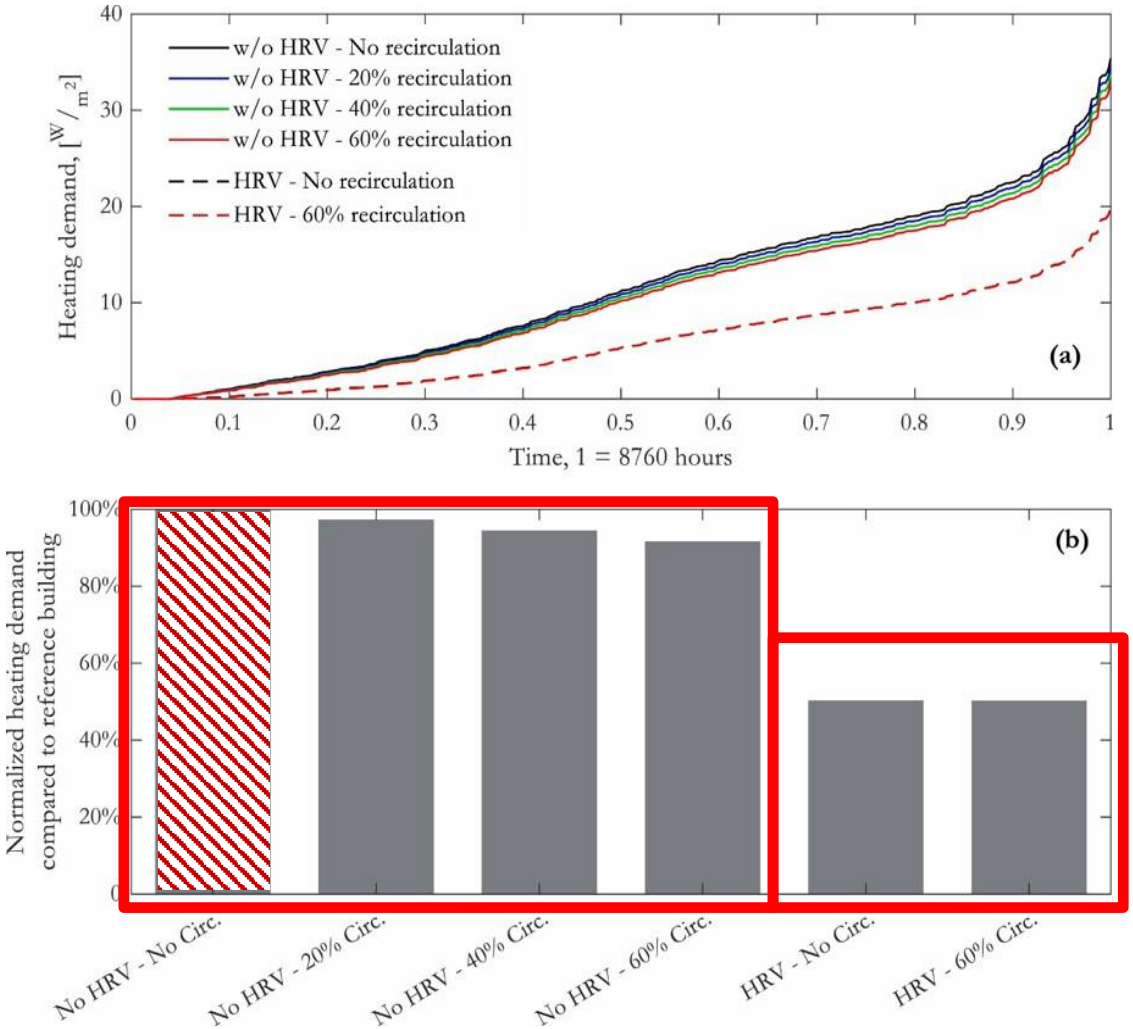
# Residential building (0.45 ACH)

Ventilation **with** heat recovery:

- The **recirculation** effect on **heating demand** is negligible!
- Air cleaner implementation **might not be** that effective!

Ventilation **without** heat recovery:

- The **recirculation** effect on **heating demand** is small!
- Air cleaner implementation might **reduce** building **heating demand**!



# Office building (2.1 ACH)

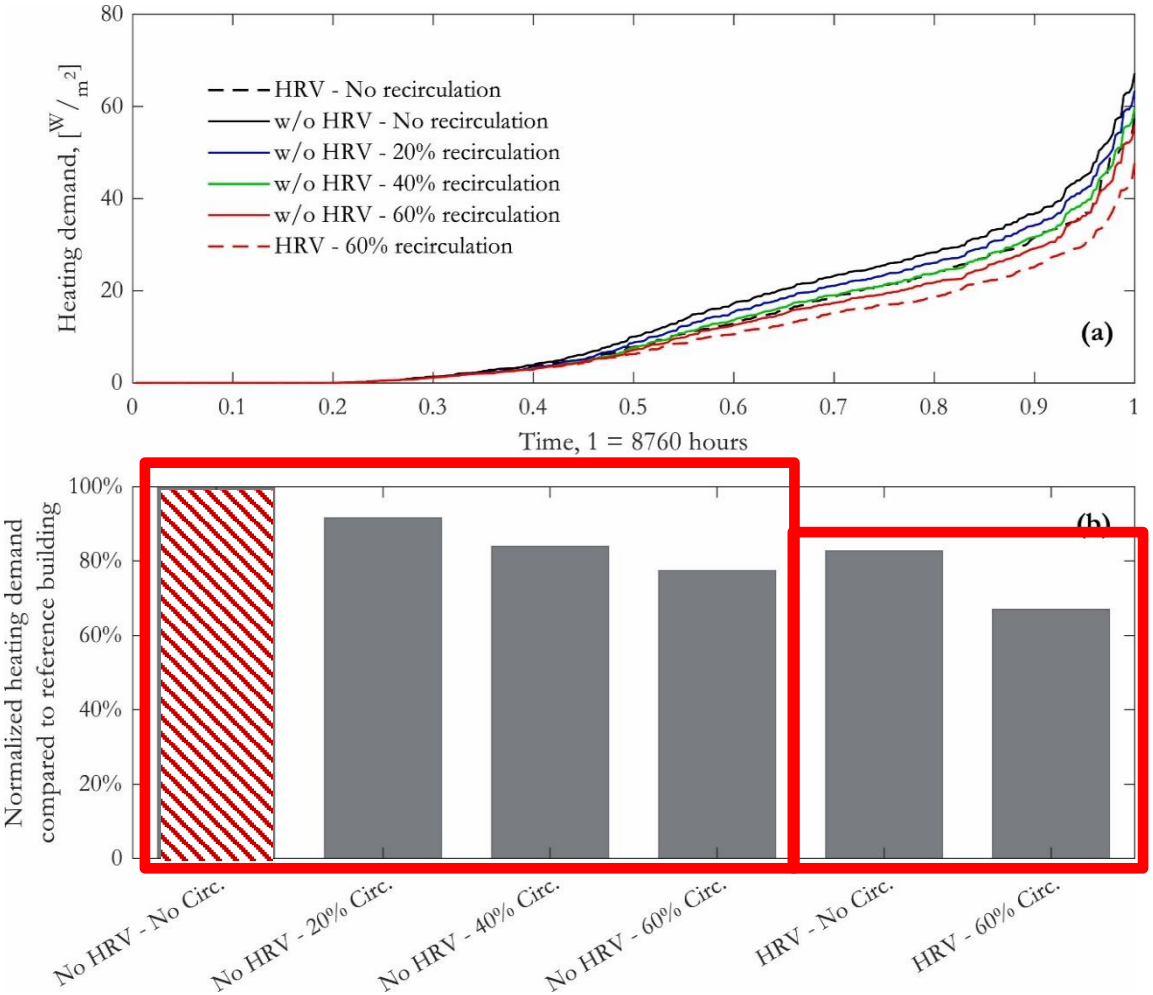
Ventilation **with** heat recovery:

- **The recirculation** effect on **heating demand** is **notable** compared to the residential buildings!
- This is the case for both **with and without** heat recovery!
- Air cleaner implementation **is effective**!

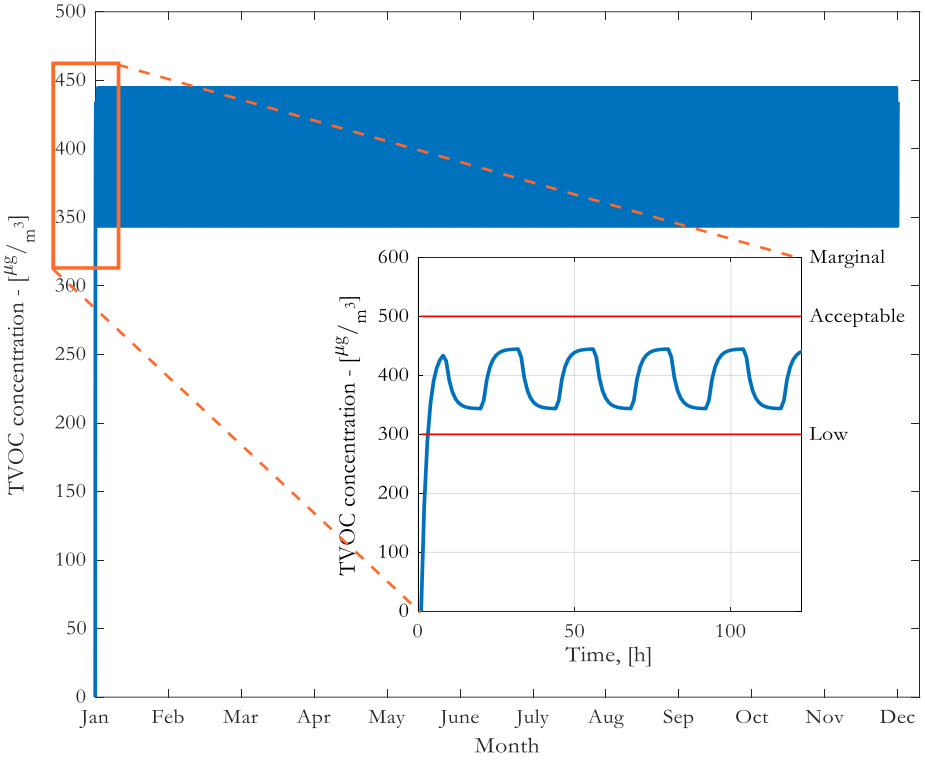
**Residential vs Office**

Ventilation schedule & different ACH

Thus **ACH** is an important parameter that needs to be considered.

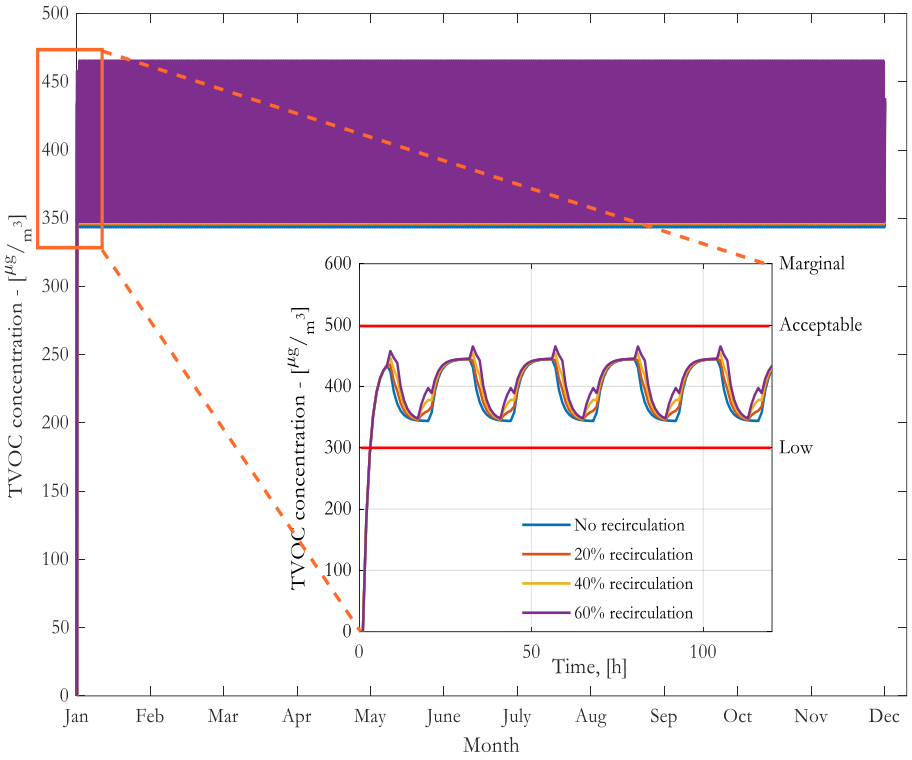


# **Residential building:** Impact of **<u>air recirculation</u>** on TVOC concentration (<500 μg/m³)




**<u>Without</u> air recirculation**

TVOC concentration is within the acceptable range

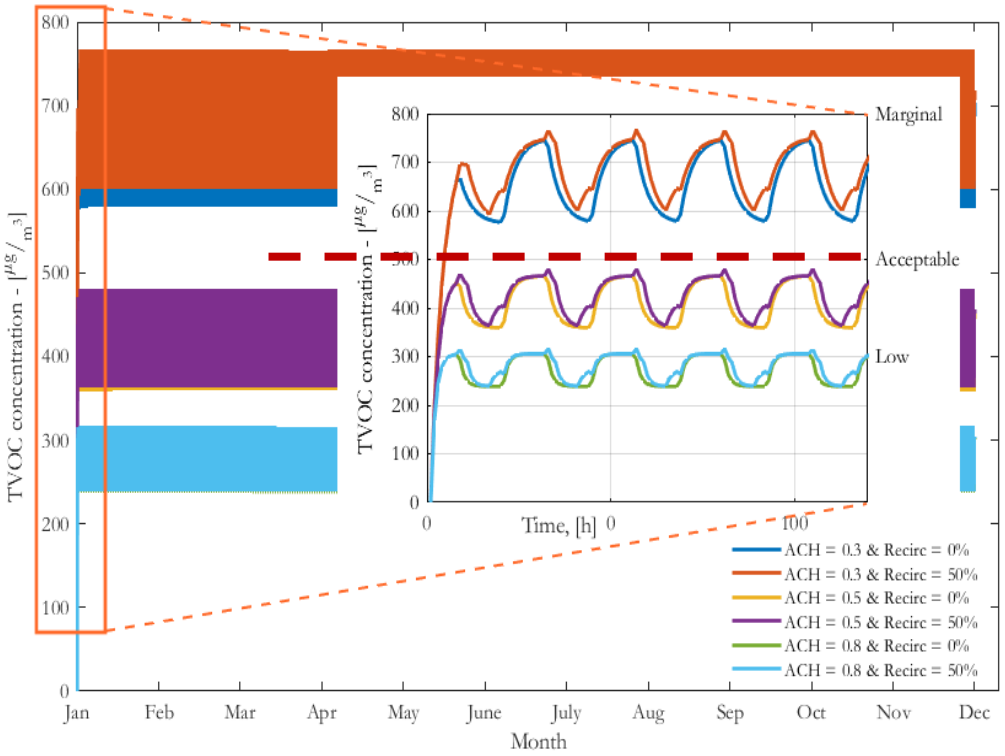



**<u>With</u> air recirculation (and air cleaner)**

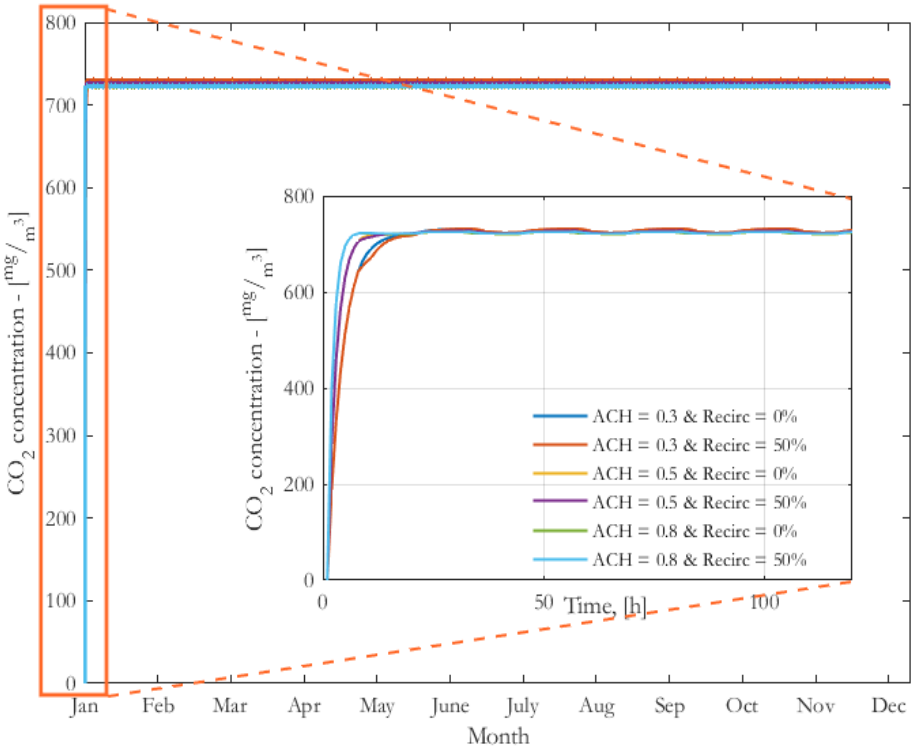
Recirculation <u>does not</u> result in increased TVOC level

(60% capturing efficiency)

# **Office building:** Impact of **air recirculation** and **ACH** on TVOC & $CO_2$ concentration




**TVOC concentration with 0 and 50% air recirculation**




**$Co_2$ concentration with 0 and 50% air recirculation**

- High ACH (>0.5) maintains TVOC concentration within an acceptable range, regardless of recirculation level
- Thus, adding **air cleaner** and **recirculation** is **beneficial** to reduce building heating demand

Recirculation % and ACH do not changes $CO_2$ level since the main $CO_2$ source is the outdoor air.

**Conclusion:**

- This study examines the effect of **gas-phase air cleaners** on **building heating demand**.
- The study also explores indoor **concentrations of TVOC and $CO_2$** when gas-phase air cleaners are used.
- Different parameters were also discussed, such as **ACH**, **air recirculation**, **ventilation**, and **occupancy schedule** on indoor **TVOC** and **$CO_2$** levels.
- Increasing recirculation rate **reduced heating demand** in the office building more than in residential.
- 60% recirculation rate reduced heating demand by **9%** in **residential** and **24%** in the **office building**.
- Integrating gas-phase air cleaner and increasing recirculation rate during rush hours of mornings and evenings kept TVOC and $CO_2$ concentrations acceptable.
- Indoor $CO_2$ concentration value was affected **less than** TVOC's by increasing the recirculation rate.
- **Higher ACH minimizes** the **impact** of **recirculation rate** on TVOC and $CO_2$ levels.

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# Heating energy implications of utilizing gas-phase air cleaners in buildings' centralized air handling units

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