Chair of Building Systems
Prof. Hansjürg Leibundgut

Frontiers in Energy Research

A Novel Ventilation Strategy with CO_2 Capture Device and Energy Saving in Buildings

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Contents

What is ventilation ?

Changing or replacing air

For high air quality

Purposes of Ventilation

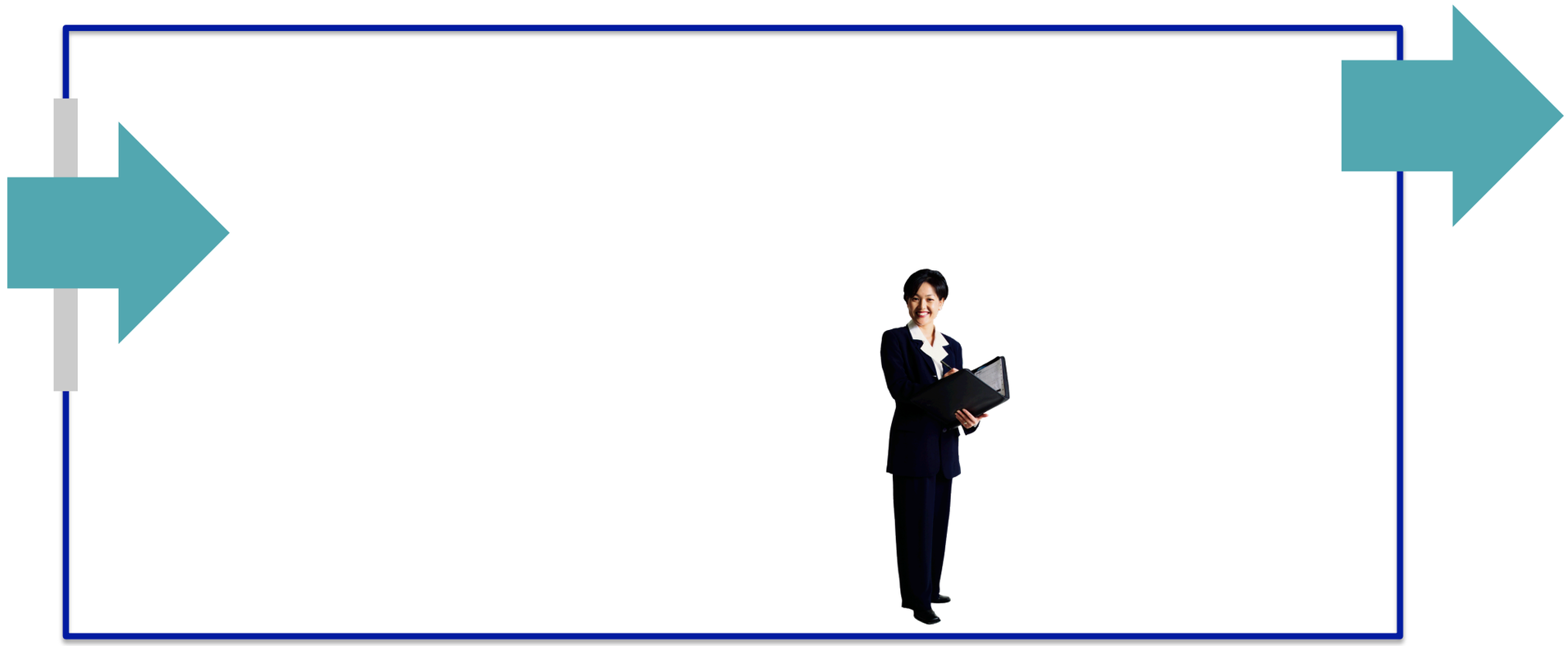
Control temperature

Replenish oxygen

Remove or add moisture

Dilute or remove dust, odors, smoke, bacteria, viruses, Volatile Organic Compound (VOCs), and carbon dioxide (CO_2)

If ambient condition is mild and fresh



Natural ventilation or Economizer (air fan)

supplies outdoor air without thermal energy consumption

If ambient condition is extreme weather e.g. desert, tropics or artic

In order to save energy, supplying outdoor air quantity should be minimized

ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) standard 62.1-2010 defines outdoor airflow rates

$$V_{bz} = R_p \bullet P_z + R_a \bullet A_z$$

A_z= zone floor area
P_z= zone population
R_p=outdoor airflow rate per person
R_a=outdoor airflow rate per unit area

Default value of **combined outdoor air rate** for office is 8.5 L/s/p

European Standard EN 13779 defines outdoor airflow rate

Default value for moderate indoor air quality is 8.0 L/s/p

Is around 1.0 ACH (air changes per hour)

Outdoor air flow rate can be minimized more?

Dust

Odors

Bacteria, viruses

VOCs

Captured or removed

by

Filters (HEPA H14, carbon filter, G3/4 prefilter, F7/8 fine-filter)

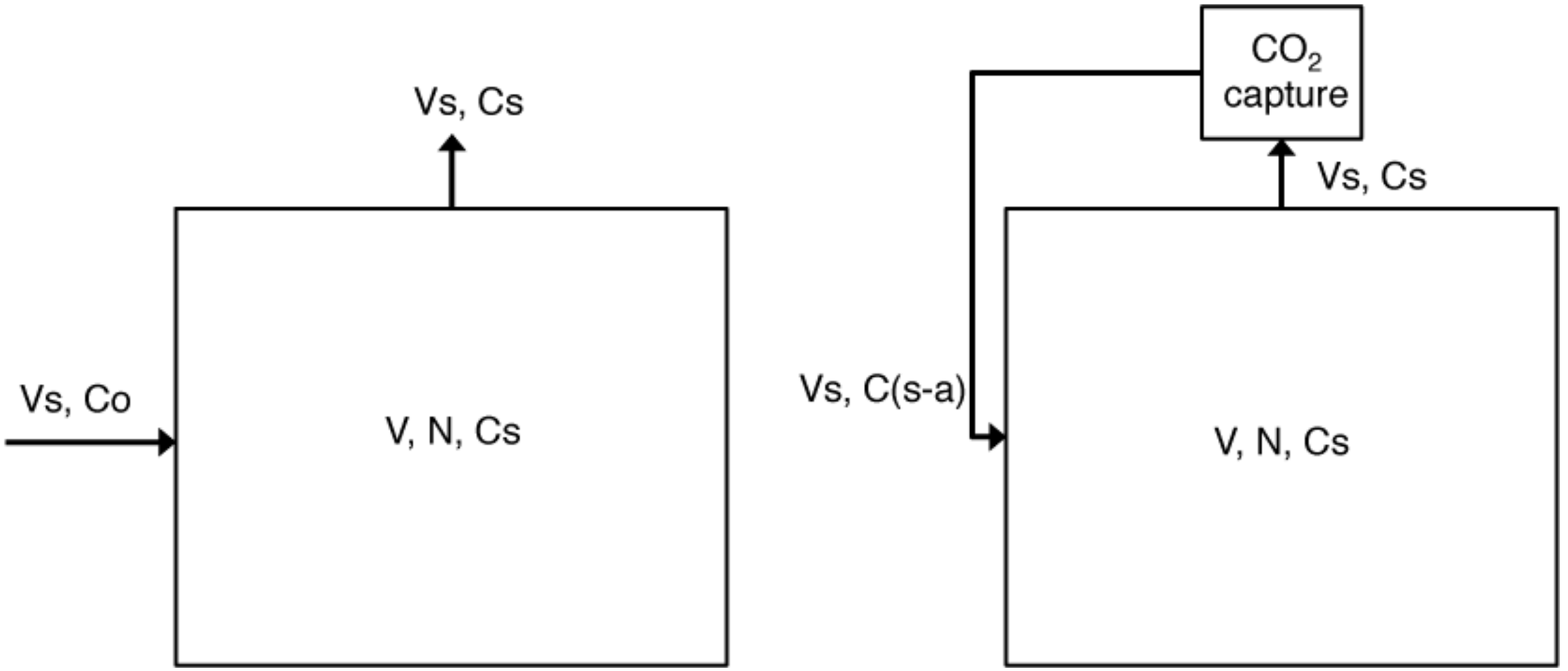
And UVGI (ultraviolet germicidal irradiation)

CO_2 dilution

O_2 refill

?

Methodology



Cs = CO_2 concentration in a space
N = CO_2 generation per person
V = outdoor airflow rate per person

Mass balance equation leads to the equation for CO_2 concentration

$$V\ dC/dt=QCo-QC(t)+G(t)$$

where V is the space volume,
C(t) the indoor CO2 concentration at time t,
Q the volume flow rate,
Co the outdoor CO_2 concentration, and
G(t) is the CO_2 generation rate at time t

A case study

the room volume : 800 m^3

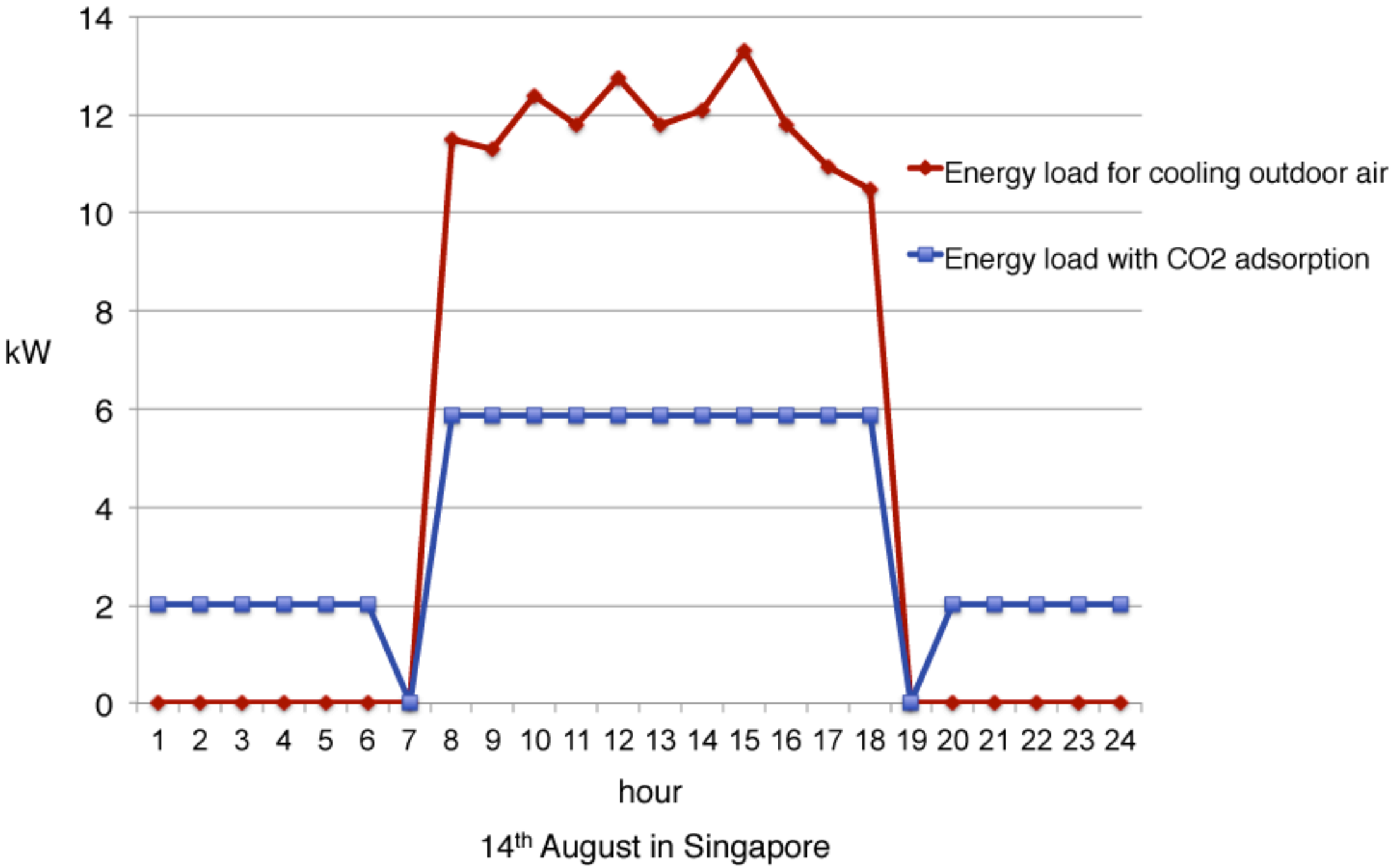
and the floor area : 320 m^2,

the air ventilation ratio is 29 $m^3/h/p$ (8 L/s/p),

occupants are 28 people

and it is assumed that there is 100% air recirculation and no infiltration for the simulation.

Energy consumptions in summer



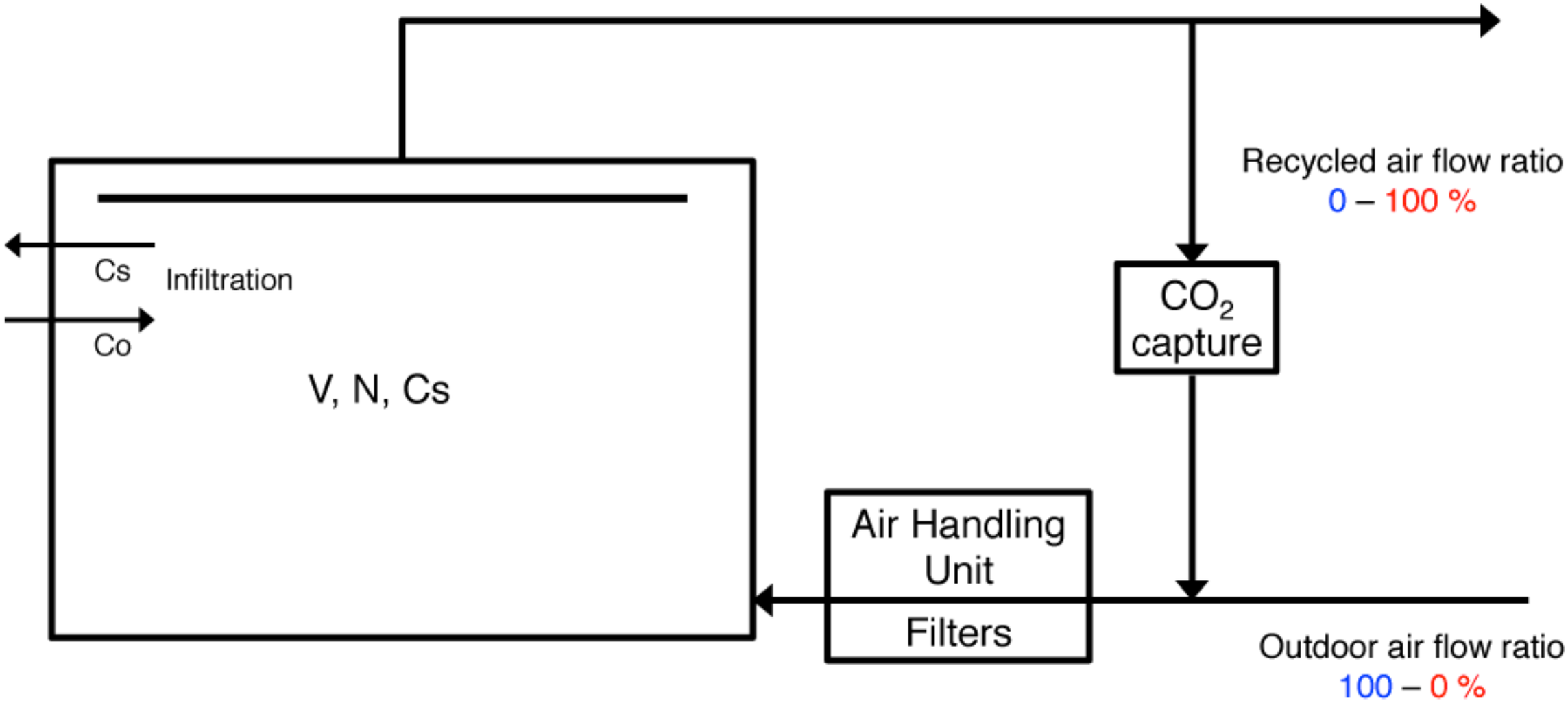
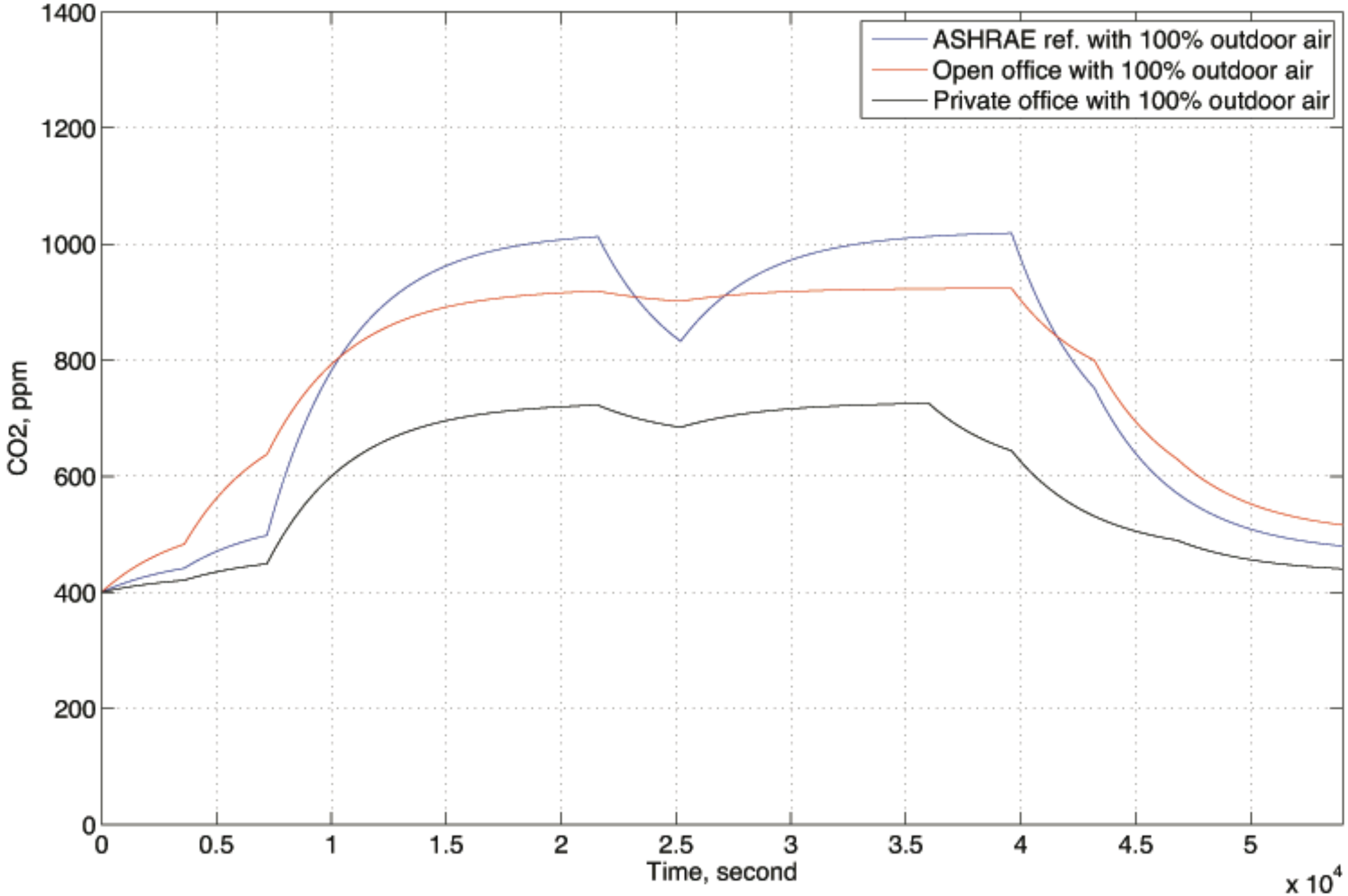


Diagram of new air ventilation system with CO2 capture device (V is outdoor airflow rate,
N is CO_2 generation per person, and Cs is CO_2 concentration in a space)



Change in the indoor CO_2 concentrations with 100% out door air (1.0 ACH) for a typical weekday in office (6 AM to 9 PM) based on ASHRAE 90.1, and Duarte et al's measurements

Conclusion

- Possibility of implementing a CO_2 capture device in the operation of air ventilation systems

- To maintain a comfortable indoor air quality through the CO_2 capture device.

- Roughly 30-60% of air ventilation cooling and heating energy can be saved

- Adjusting indoor air recirculation ratio highly influences indoor air quality and energy savings