Potential of heat and moisture recovery for future reduction of dehumidification and humidification demands in Swiss office buildings

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Background

- Active ventilation is essential to assure good air quality in modern highly air-tight buildings.
- Mechanical ventilation systems combined with air-to-air heat recovery (HRV) is an effective method of reducing the energy required for heating and cooling in building
- Enthalpy Recovery Ventilation (ERV) enables the combined recovery of heat and moisture, resulting in improved occupant comfort and a potential reduction in the need for additional energy and peak power for humidification and dehumidification.

- Expected increase in the demand for dehumidification due to the effects of climate change
  - Rising temperatures in Europe and Switzerland in coming decades, even if drastic measures are taken worldwide to protect the climate
  - Increased sultriness due to higher indoor dew point temperatures as a result

- Expected increase in the demand for humidification in order to meet more demanding comfort requirements
  - Campaigns are underway in Europe to increase minimum indoor humidity requirements
  - Possibility to choose the indoor air humidity level (categories) according to European standard EN 16798-1:2019

Research question

To what extent can ERVs reduce the dehumidification and humidification demands in future climate with more demanding comfort requirements?

Objectives

1. Assess the need for active dehumidification and humidification to achieve the humidity design criteria of the Swiss standard prSIA 382/1.

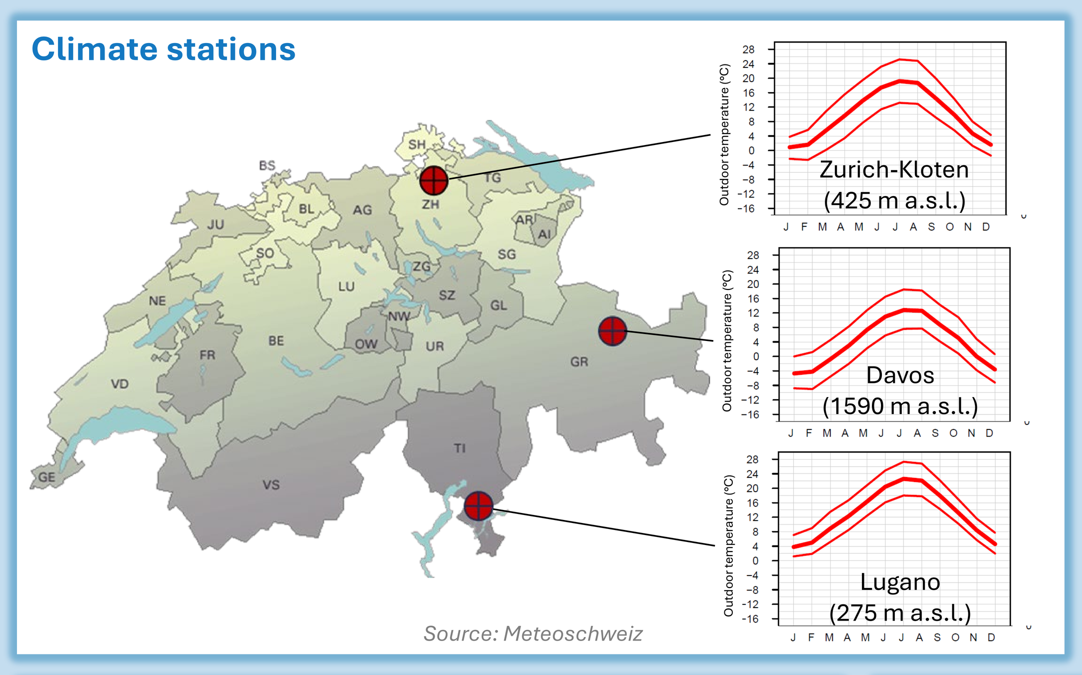
2. Evaluate the potential for reducing the peak power for cooling and dehumidification in summer, and for heating and humidification in winter with ERV.

3. Evaluate the potential for reducing the additional energy demand through ERV.

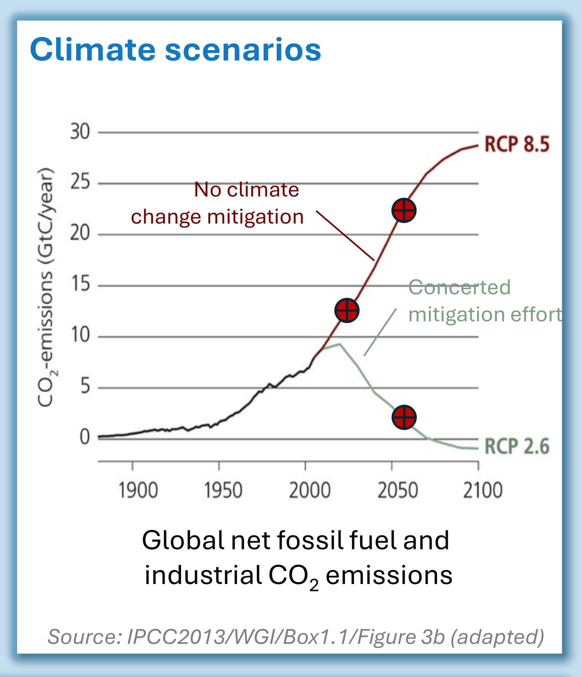
Methods

Building simulations were carried out for a typical office building in Switzerland with HRV and ERV under different boundary conditions.

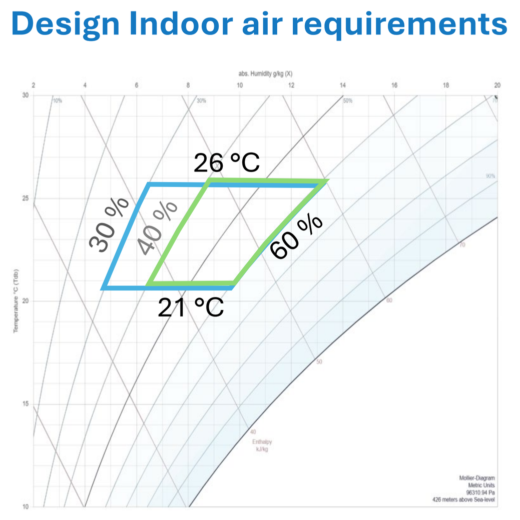
Climate stations



Climate scenarios



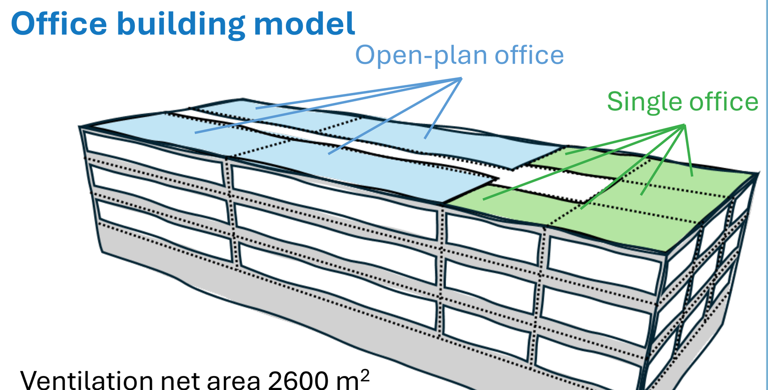
Design Indoor air requirements



Fresh air volume flow rate requirement per person **29 m³ h⁻¹**.

Flow rate reduction (down to half) for particularly high or low outside temperatures (for a maximum of 10 % of the annual utilisation period9.

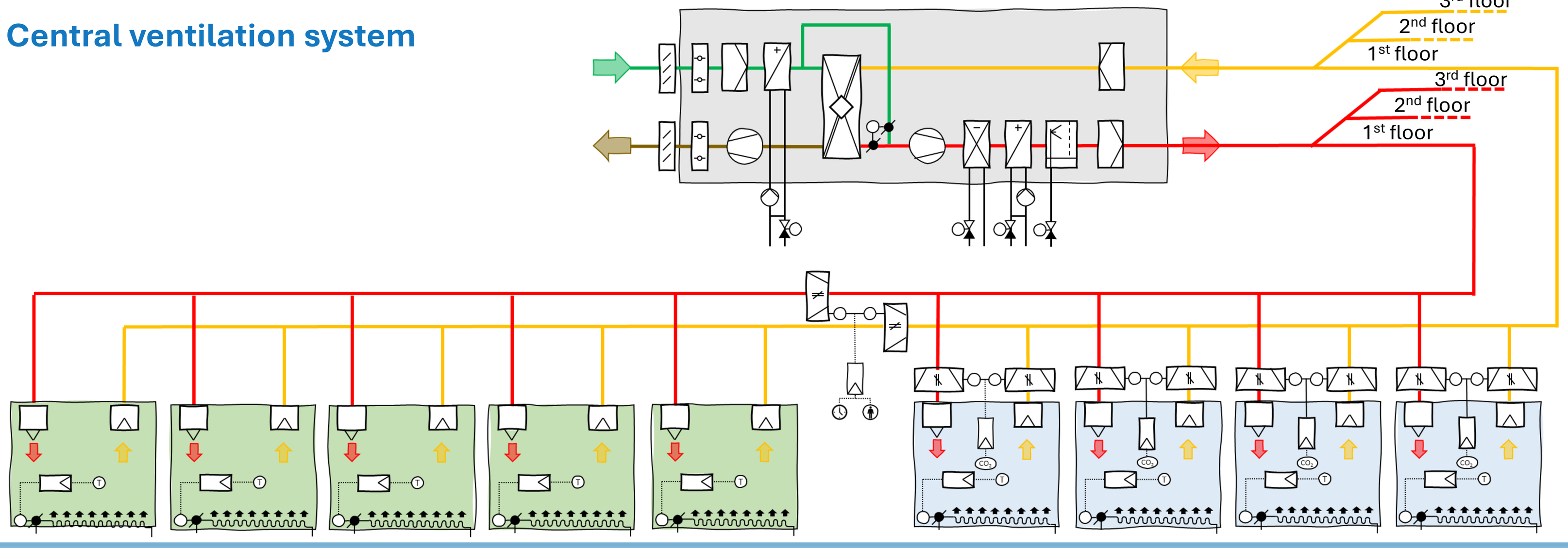
Office building model



Ventilation net area 2600 m²

Infiltration rate:
0.15 m³ h⁻¹ m⁻² - *new costruction with good airtighness*
0.40 m³ h⁻¹ m⁻² - *existing building with renovated AHU*

Central ventilation system



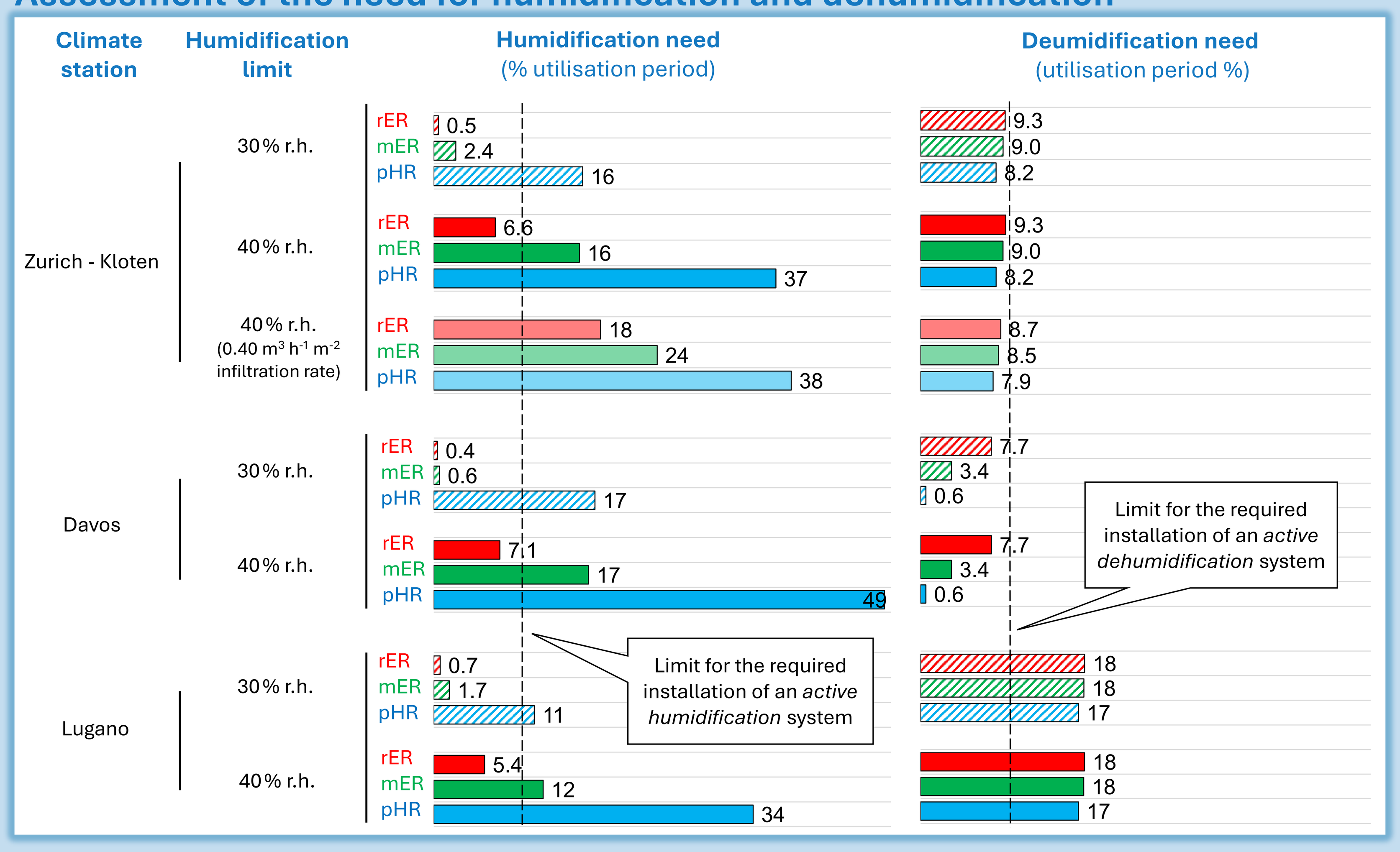
Heat and humidity recovery

Technology	Temperature efficiency	Humidity efficiency	Frost protection temperature 40% r.h	Frost protection temperature 30% r.h.	Control logic
pHR	73 %	-	-3.1 °C	-3.1 °C	Temperature-based
mER	73 %	64 %	-7.4 °C	-10.4 °C	Humidity-based
rER	80 %	80 %	-16 °C	-21 °C	Humidity-based

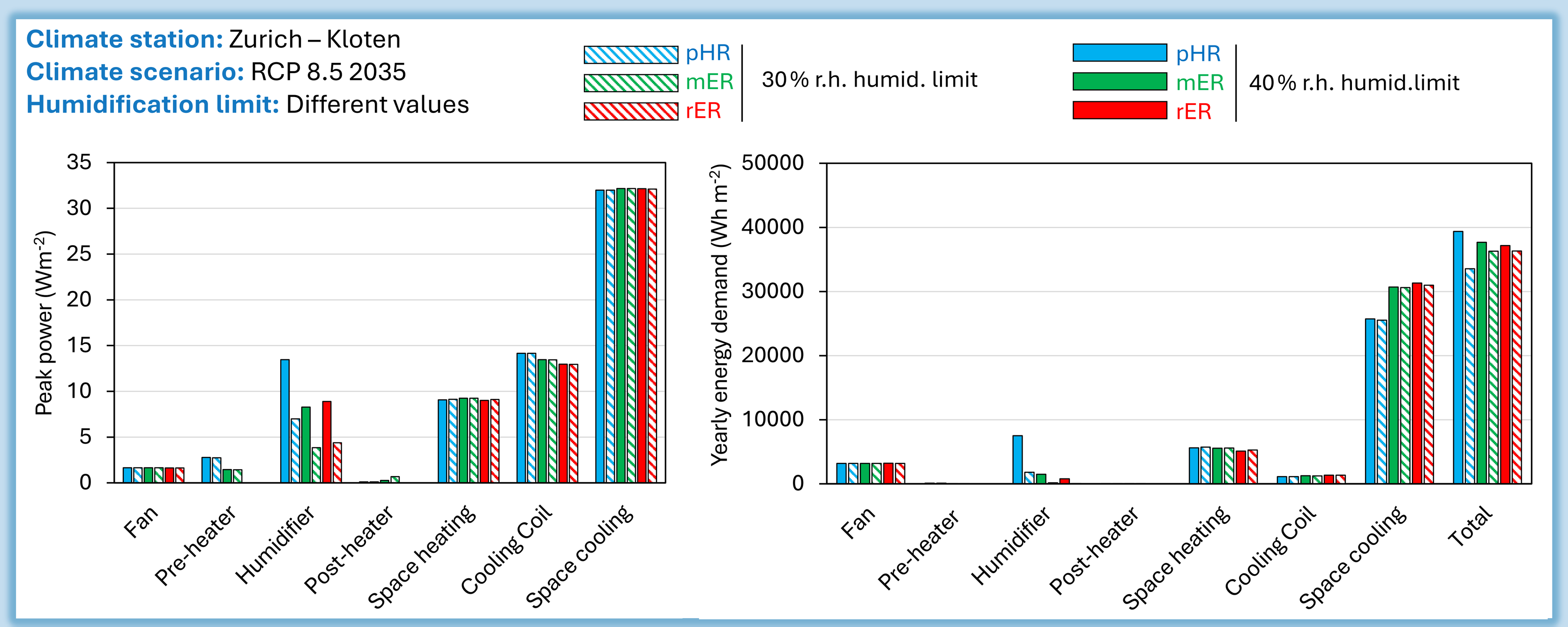
Semi-empirical models for heat and enthalpy recovery components have been implemented in the simulation model.
The validity of the models has been verified by experimental measurements or manufacturer data.

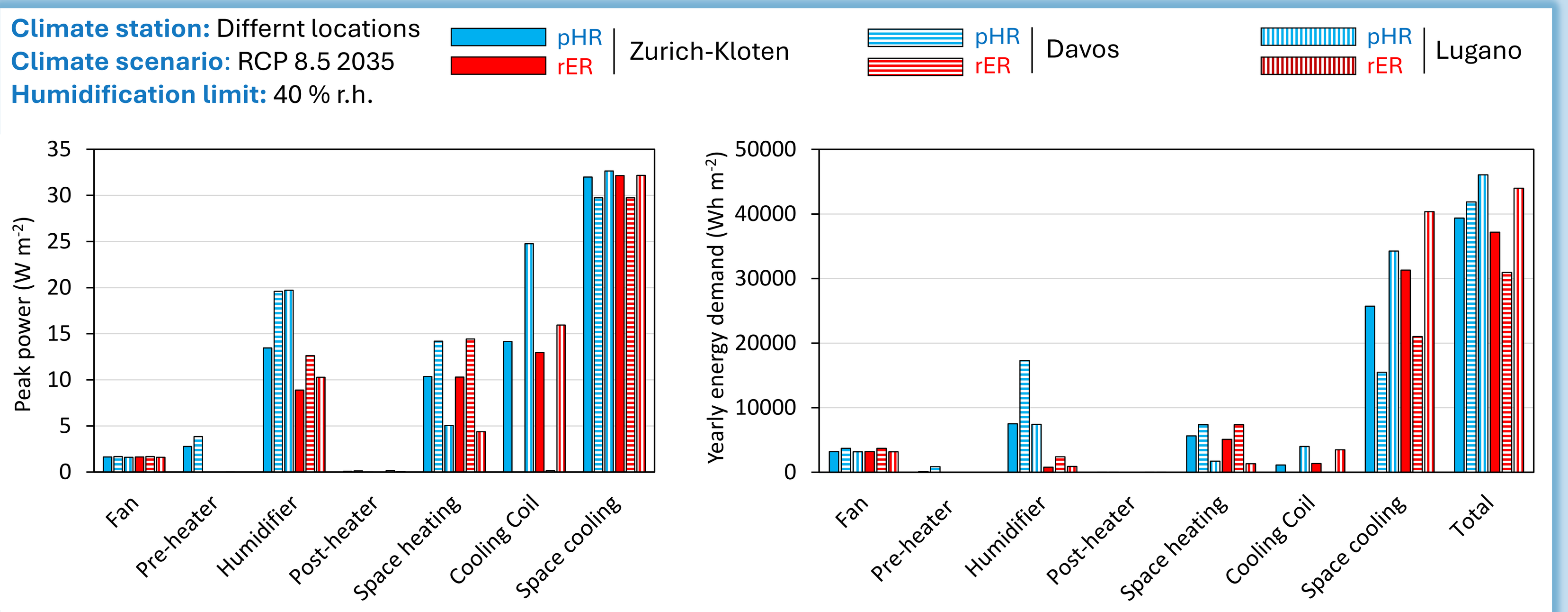
Results

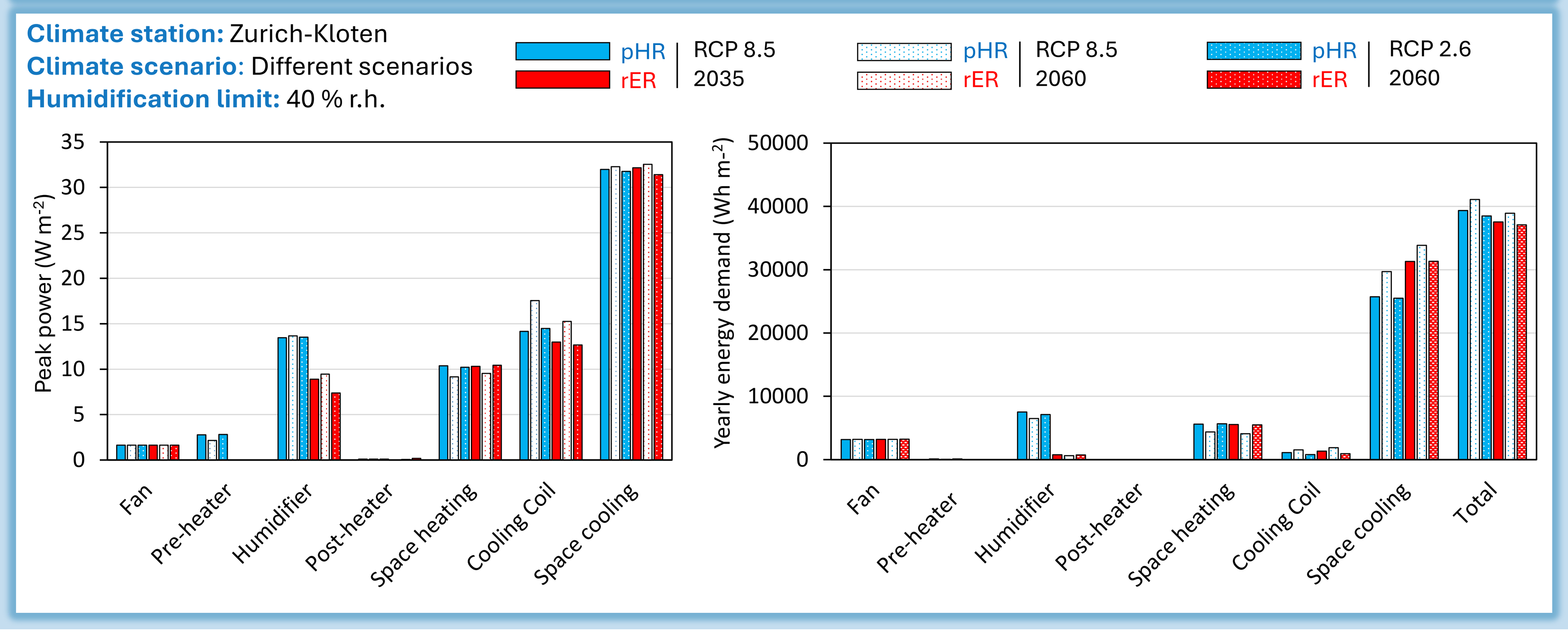
Assessment of the need for humidification and dehumidification



Evaluation of peak power and energy demand for ventilation, heating and cooling







Conclusion

Dehumidification
- Future *(RCP 8.5 2035)* increase in the dehumidification need in all climate station compared to current climate design conditions
- The need to install an active dehumidification system was only identified for the station with a subtropical mediterranean climate *(Lugano)*
- The dehumidification need cannot be significantly reduced by installing an ERV

Humidification
- Future *(RCP 8.5 2035)* slightly decrease in the humidification need compared to current climate design conditions
- Sharp increase in the humidification need due to increased requirements for the minimum indoor relative humidity *(from 30 % to 40 %)*. The highest humidification need was found for the alpine climate station *(Davos)*.
- Significantly reduction in the humidification need and related power by installing an ERV: the higher the humidity efficiency of the exchanger, the greater the reduction
- Higher outdoor air infiltration rate increases the humidification need and reduces the recovery efficacy.
- Significant reduction in the power and energy demand for humidification by installing an ERV in the ventilation unit

Frost protection
- With ERV significant reduction in power demand for frost protection

Control logic
- Changing the control logic from *temperature-based* (for HRV) to *humidity-based* (for ERV) has an impact on the energy demand for space cooling.

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The full report of the RePPER project is available on the Aramis portal (Project number SI/502513).

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