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SIMULATION-BASED DEVELOPMENT OF A FAÇADE-INTEGRATED AIR-SOURCE MINI-SPLIT HEAT PUMP

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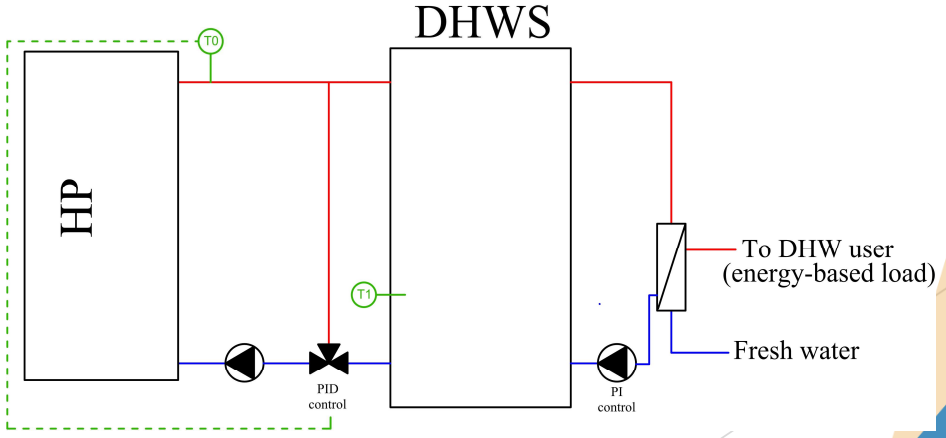
Understanding the problem: why façade-integration?

- Renovation rate on a European level of about 1.5%, in Austria around 1% [1][2]
- Space heating and domestic hot water preparation are still partly fossil based in renovated buildings [3]
- Retrofitting central heating systems in existing buildings is extremely challenging, especially in densely populated areas.
- Gas/Oil boilers to be phased out in the EU [4]
- The heat pump market does not provide compact modular flat-wise alternatives which require minimal invasive construction work

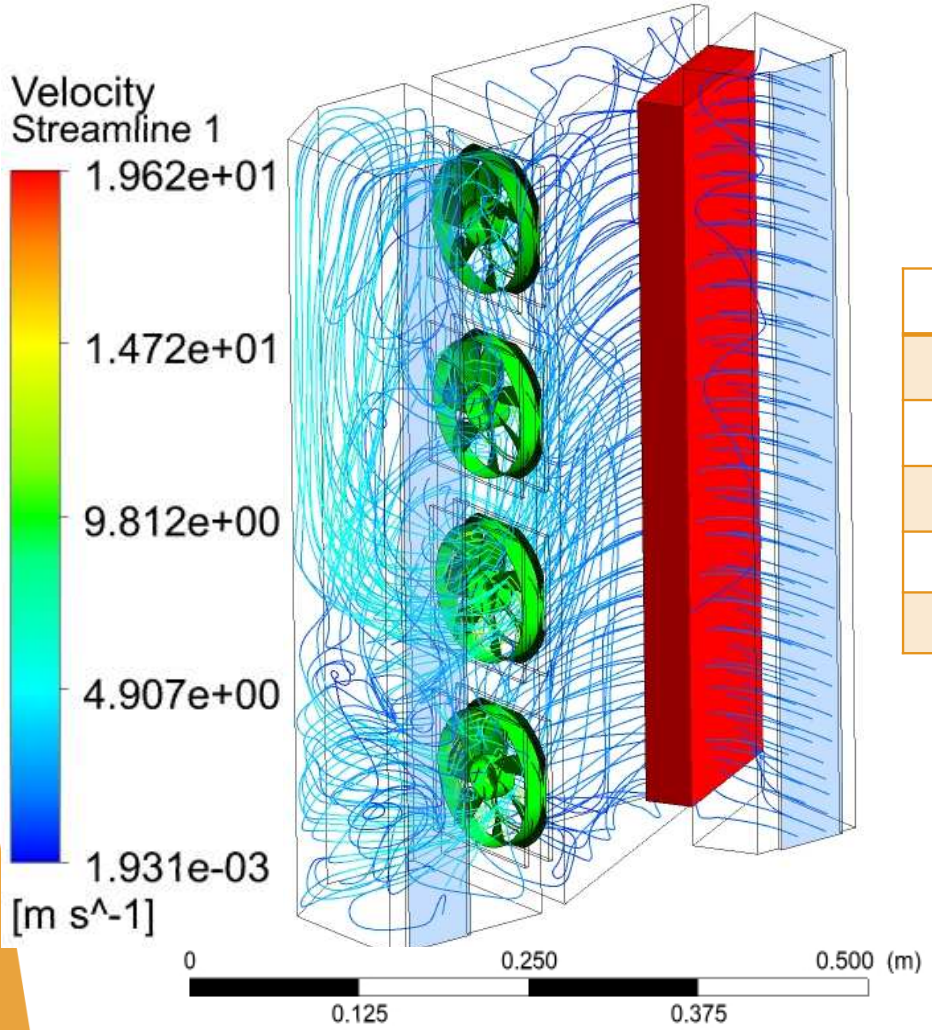
Source: Statistik Austria, Registerzählung 2011

Developed mini-split concept

- Façade-integrated mini-split heat pump
  - Primarily for domestic hot water preparation, extendable for heating purposes
  - Design heating power of 1.5 kW at A7W50
  - Storage size 120 liters
  - Hot water delivery through freshwater station
- Propane (R290) based
  - GWP = 3
  - A2L class refrigerant (flammable)
  - 150 g maximum refrigerant charge for indoor components



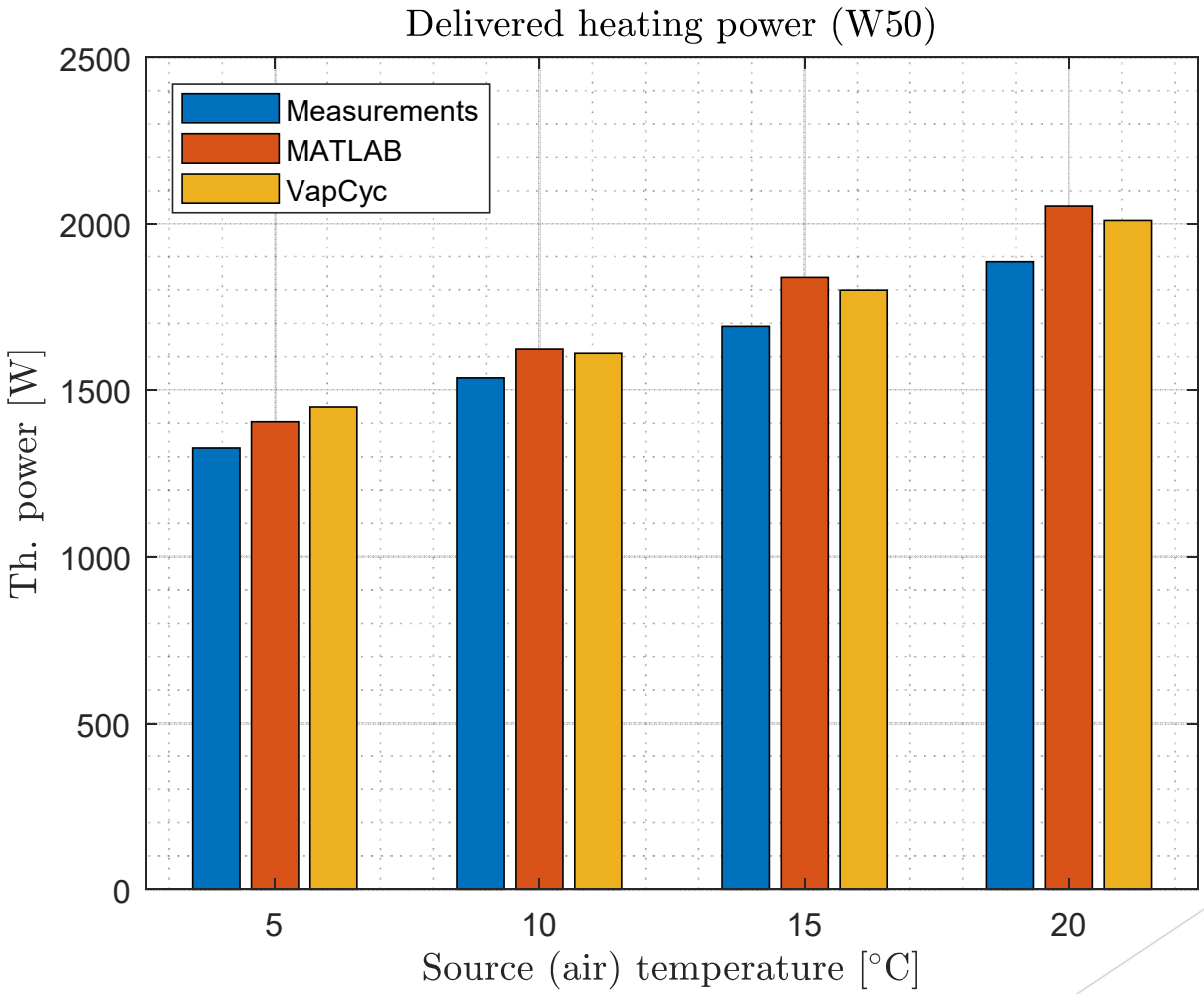
CFD-based optimization of outdoor unit



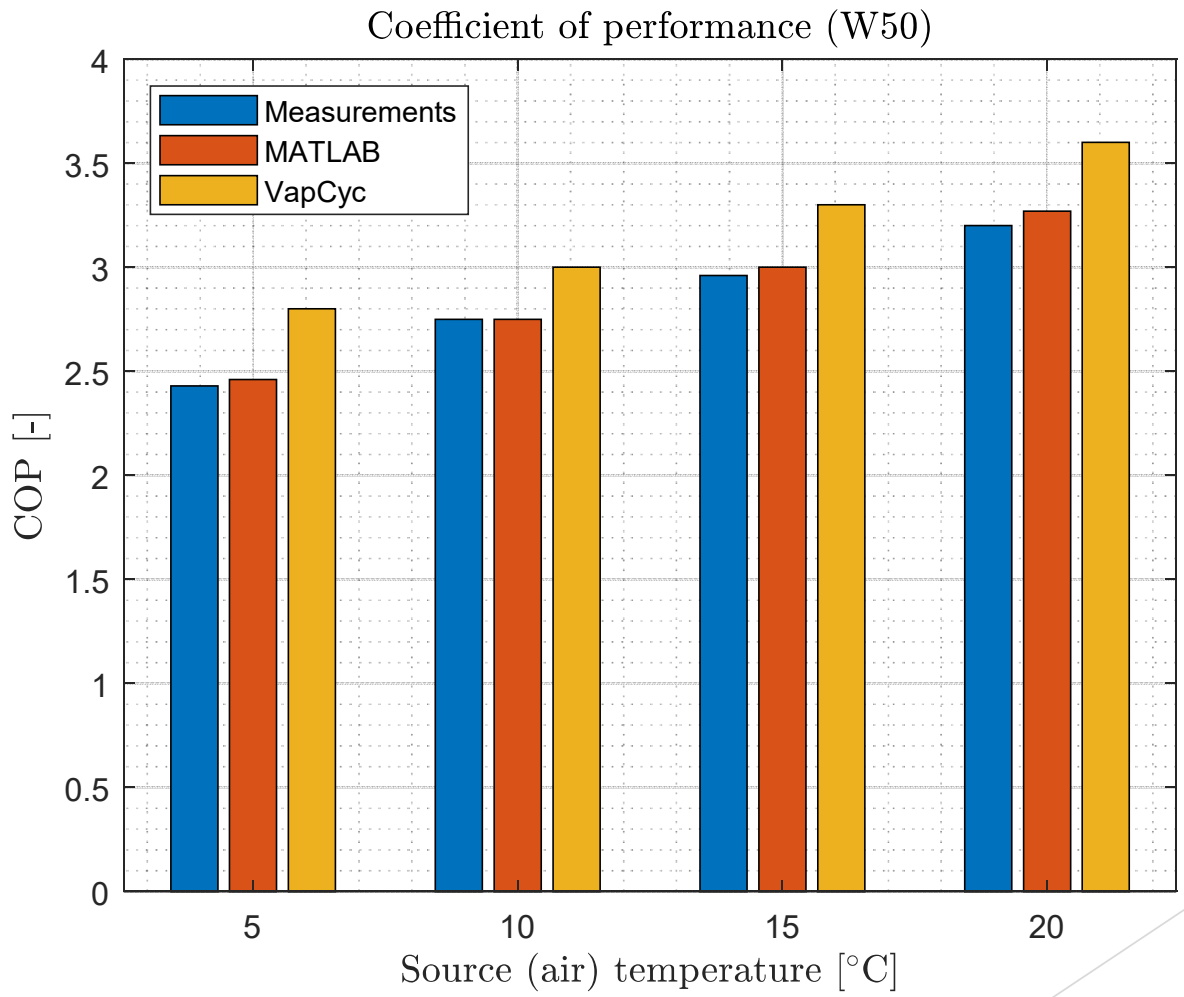
Design air volume flow [m³/h]	350
Standard deviation evap. (%)	11.5
Max. velocity evap. (m/s)	1.1
Min. velocity evap. (m/s)	0.6
Δp evaporator (Pa)	11.9
Δp evaporator + inflow (Pa)	12.4

Optimization through refrigerant cycle analysis – modelling approach

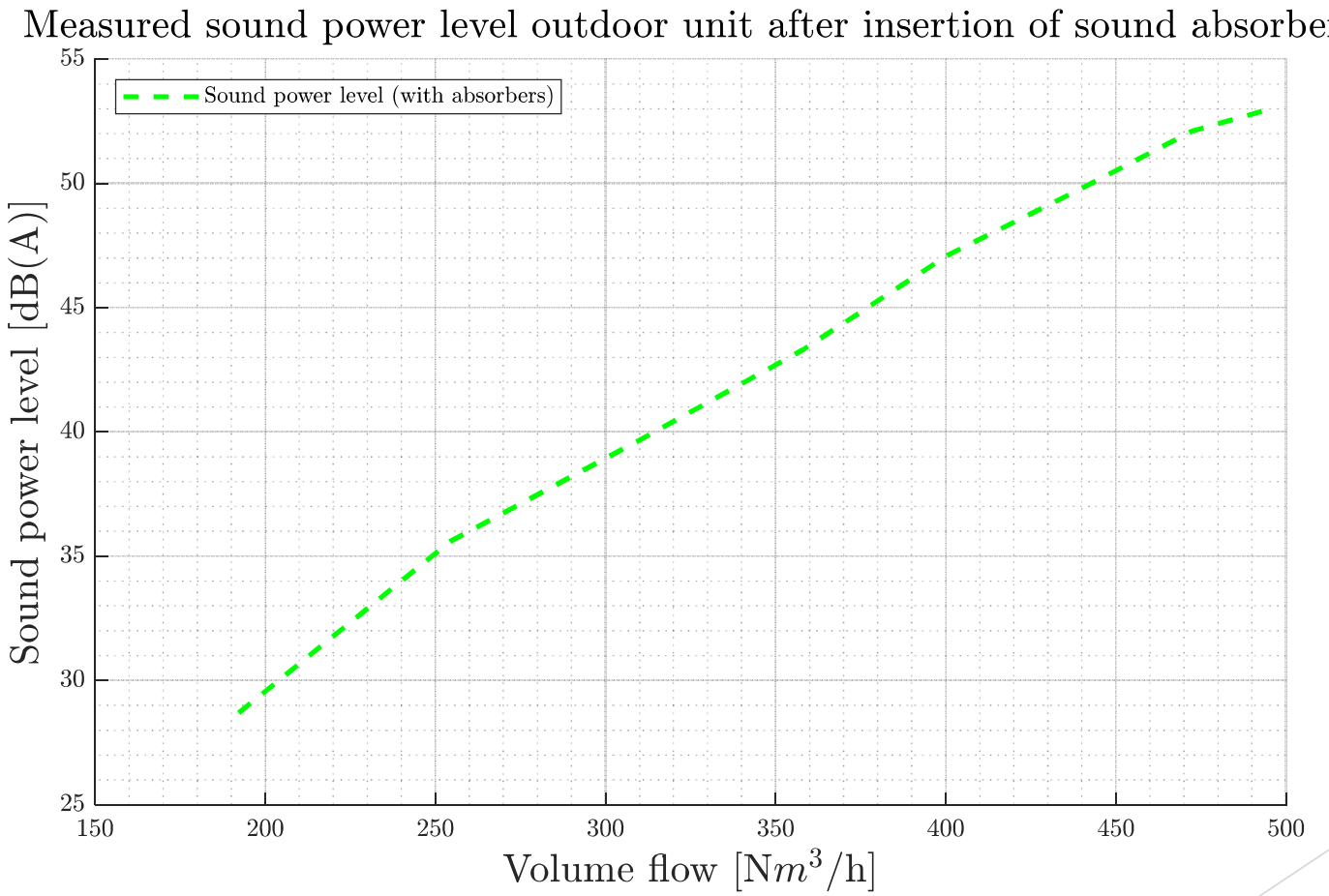
Simulation results – Heating power



Simulation results – COP HP



Assessment of sound emissions through laboratory tests



Conclusions

- Mini-split façade-integrated heat pump for domestic hot water preparation, suitable for renovated multiple-family houses but also new constructions
- Coupling with heating system also possible, but depending on renovation depth, delivery system and water supply temperature
- Internally developed refrigerant cycle model able to forecast the performance of the heat pump with good agreement with measurement data.
- Further implementation of the model in a dynamic system simulation is necessary
- Acceptable measured sound power level for the outdoor unit due to implementation of sound absorbers

References

[1] M. Amtmann, Reference buildings - The Austrian building typology - A classification of the Austrian residential building stock, Austrian Energy Agency, 2010.

[2] M. Losch, J. Streitner, W. Gary, P. Berger, Energie in Österreich - Zahlen, Daten, Fakten 2020, Bundesministerium Für Klimaschutz, Umwelt, Energie, Mobilität, Innov. Und Technol. (2020) 48.

[3] IEA, Austria 2020: Energy Policy Overview, Int. Energy Agency. (2020). https://www.iea.org/reports/austria-2020

[4] Environmental Coalition on Standards - Member States' Ambition to Phase out Fossil-Fuel Heating – an Analysis, 2021. https://www.coolproducts.eu/wp-content/uploads/2021/07/ECOS-Coolproducts-Background-Briefing-MS-ambition-to-phase-out-fossil-fuel-heating.pdf.

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