EuroSun2026

Requirements for HVAC systems due to climate change

Summary

Temperature increase due to climate change means that summers but also winters become warmer which reduces space heating and increasingly entails space cooling even in Middle Europe. In Southern Europe heating will become negligible but cooling increases a lot. In Northern Europe cooling will still be negligible but heating decreases (Ochs, Streicher, et al. 2024). The following contribution shows the changing heating/cooling demand for SFH with different insulation standards for Middle European climate and derives changes of current hydraulic schemes for heating systems to supply also cooling for reversible heat pump use. Also, the specific power ranges of heating and cooling surfaces and the limitations due to higher dew point temperatures arising with climate change for cooling are addressed.

Keywords: climate change, combined heating/cooling system,

Field of application for the findings: Sustainable Heating and Cooling Systems

Addressed audience: Researchers, HVAC planers, HVAC companies

1. Introduction

In 2024 the world average ambient temperature increased due to climate change by 1.5°C compared to the average of the years 1991 – 2020 (Copernicus, 2024). In Austria the increase was already 3.2°C warmer compared to the average of the years 1961- 1990. This means that summers but also winters become warmer which impacts space heating and increasingly entails space cooling even in Middle Europe. Especially for Middle Europe this demands a change in standard space heating systems to allow also for space cooling. As heat pumps are increasingly used, this is quite easy and already standard to let it run both ways as heater or cooler (reversible heat pumps). Hydraulics that allow space heating (SH), domestic hot water (DHW) and cooling delivery including summer double use of cooling and DHW production as well as the systematic of heating/cooling delivery systems (radiators, floor/ceiling, wall, fan coils etc.) about their capability of heating and cooling are not yet developed on the marked. System built today must be able to supply all functions in Middle Europe to be sustainable in times of climate change.

2. Space heating and cooling adaptation for climate change

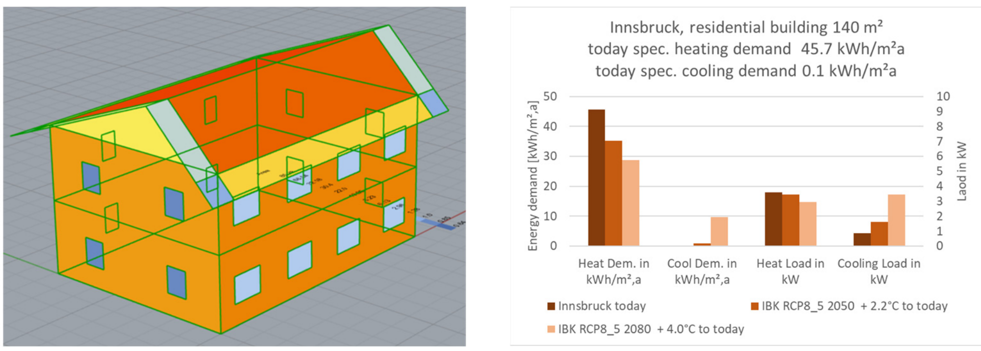

Fig. 1: Sketch of the simulated building and seasonal energy demands and loads for heating and cooling for climate change of today, +2°C and +4°C and seasonal average for a medium insulated SFH (today 45 kWh/m²a space heating) Streicher, 2025.

For a single-family house (slightly adapted from a references SFH building of several IEA tasks, Dott et al. 2013) the annual space heating and cooling demand as well as the design heating and cooling loads according to ASHRAE standards were simulated with the software package Rhino8/Pollination/OpenStudio/EnergyPlus (RobertMcNeel, 2025, Pollination). Today's climate and two climate projections with +2°C and +4°C average seasonal ambient temperature were defined using IPCC RCP scenarios represented in the climate data generator Meteonorm 8 (2025) for specific future years. Fig. 1 Shows as example the results for the city of Innsbruck for a house with 45 kWh/m²a space heating demand for today's climate. Heating demand will reduce more than cooling demand increases but heating load will be similar to cooling load. Whereas the total energy demand is reduced the demand for cooling will become a normal need in future in all Middle Europe but still not the dominant energy demand. The energy shift is releasing the burden of the electricity network in winter and the increased electricity demand in summer matches with increased solar PV production and partly with Hydro power availability. More details can be found in Ochs, Streicher, et al. 2024. From this point climate change does not induce a risk for building energy demand.

3. Adaptation of HP hydraulics

3.1. Possibilities of heat delivery and heat rejection systems for heating/cooling

Table 1 shows the maximum specific power for heating and cooling of different air- and water-based heat/cold delivery systems to rooms. The maximum Temperature T_{max} relates to the limits of thermal comfort of the different systems. Additionally, the power of a low temperature heating systems at 40°C forward temperature is shown. The limitations of dew point temperature and condensation on cooling surfaces for cooling is not taken into account. Nevertheless, as the dew point temperature is rising up to 25°C for a 4°C temperature rise additional dehumidification measures have to be taken into account. Only the circulating air systems (fan coils and single split, multisplit or VRF systems) can dehumidify the air in the apparatus itself.

Tab. 1: Specific thermal power for heat delivery and heat rejection to/from the room for different heating/cooling surfaces (Streicher, 2025)

	Air Systems	**Water Systems**			
Heating		Wall	Floor	Ceiling	Radiator
T_{max} (comfort) Flow Temperature	50°C	50°C	40°C	35°C	90°C
Heating Power (at T_{max})	10 $W/m^2_{Linvingarea}$ at n = 0.5 1/h 60 W/m² bei n= 3.0 1/h (Vent+Fan Coils)	200 $W/m^2_{Heatarea}$	80 W/m^2 Heatarea	40 W/m^2 Heatarea	1300 W/m^2 Heatarea
Spec. Heating Power at 40°C Flow Temperature	5 W/m^2 Linvingarea. at n = 0,5 1/h	130 $W/m^2_{Heatarea}$	80 W/m^2 Heatarea	40 W/m^2 Heatarea	260 W/m^2 Heatarea
Cooling					
Possible spec. Cooling Load Suspended Cooling Ceiling, activated concrete ceiling	3 W/m^2 Linvingarea at n = 0,5 1/h 18 W/m^2 Linvingarea at n= 3,0 1/h (Vent+ Fan Coils)	50 $W/m^2_{Coolarea}$	20 $W/m^2_{Coolarea}$	80 $W/m^2_{Coolarea}$ 40 $W/m^2_{Coolarea}$	Nearly none except: Additional Fans on the radiator => Fan Coils

3.2. Flexible high-efficient water-based heat pump hydraulics for space heating (SH), domestic hot water (DHW) and cooling

Fig. 2 and Fig. 3 show possibilities to change existing heat pump hydraulics for only SH and DHW production to deliver also space cooling in summer and allow for heat pump double use if DHW and space cooling occur simultaneously thus increasing the COP. Both solutions would need a second condenser in the DHW store (Fig. 2.) or a seperate DHW condenser for the cooling case (Fig. 3). All schemes produce in priority DHW compared to space heating and take into account a water temperature increase of only 5°C in the condenser and 5°C water temperature decrease in the evaporator of the heat pump. Of course, solutions for new plants will not need a conventional heat exchanger for DHW production but simple one condenser in the DHW part that will be used in summer and winter with switching valves in the refrigerant circle of the heat pump. In Fig. 2 space heating is done with a large surface heat delivery system with similar use for all space heating circuits, which can be driven in a self-regulating mode not needing any storage or automatic adjusting valve. Only one reference room temperature switches on or off the heating pump. The regulation is done automatically by a changing room temperature (e.g., passive solar input) due to low temperature difference between heating surface and room temperature. A DHW storage is only needed for DHW production.

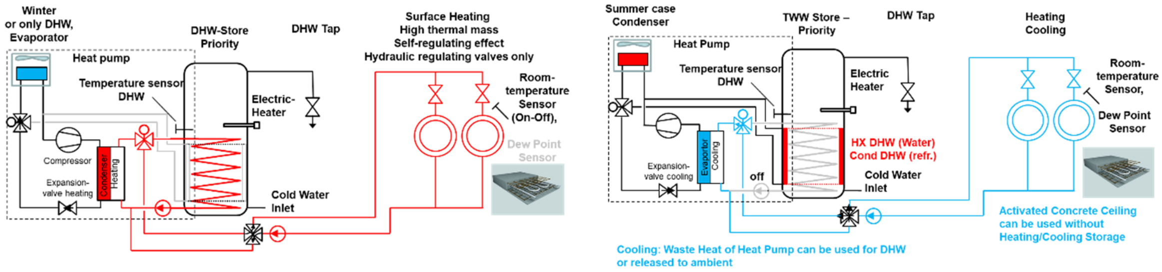

Fig. 2: Monvalent heat pump, space heating activated concrete self-regulating, additional condenser DHW, summer double use, left conventional winter, right additions for summer cooling and DHW (Streicher, 2025)

Fig. 3 shows a system with heating circuits for different characteristics with separate either ambient temperature-controlled flow temperatures or mass-flow controlled circuits (e.g. thermostatic valves) or both. Here a space heating storage is also needed in order to decouple mass flows if heat pump and heating system and increase the running time of the heat pump. In the shown case a combistore fulfills both purposes: DHW in the upper part and SH in the lower part but also preheating of the DHW zone in the lower part. DHW itself is produced in a once through heat exchanger (DHW station). For cooling an additional cold storage is needed.

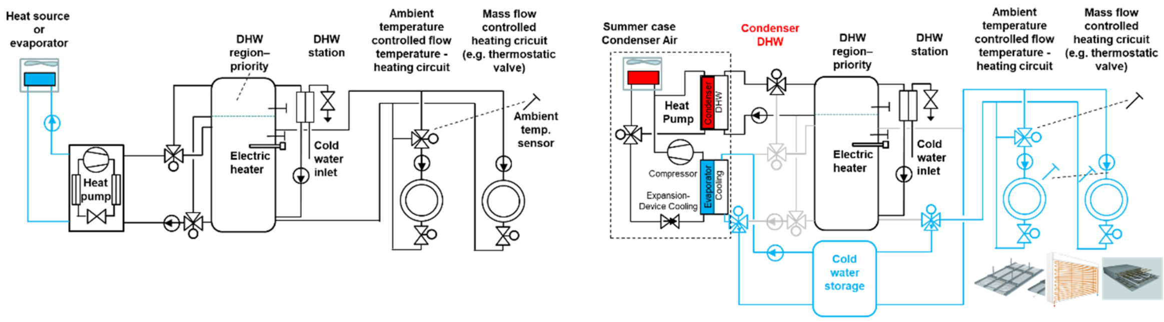

Fig. 3: Monvalent heat pump, combistore, conventional space heating circuits, additional condenser for DHW and cold water store, summer double use, left conventional winter, right additions for summer cooling and DHW (Streicher, 2025)

4. References

Copernicus 2024. EU Programme [online], „https://climate.copernicus.eu/sites/default/files/custom-uploads/GCH-2024/GCH2024-PDF-1.pdf,“ 10 1 2025, accessed 21 3 2025.

Dott, R., Haller, M. Y., Ruschenburg, J., Ochs F., Bony, J., 2013. The Reference Framework for System Simulations of the IEA SHC Task 44 / HPP Annex 38, Part B: Buildings and Space Heat Load,“ Internationale Energieagentur, Solar heating and Cooling Programme Task 44, 2013.

Meteonorm, 2025. S. Meteotest AG, „Meteonorm Software, Version 8,“ Meteotest AG, Schweiz, [Online]. Available: https://meteonorm.com/meteonorm-version-8, accessed 21 3 2025.

Ochs, F; Streicher, W., van Karsbergen, V., Thür, A. 2024. Space Heating And Cooling Demand Of Buildings With Climate Change For A Cold And A Hot Climate – Is This A Risk?, in EuroSun 2024. Available at: https://proceedings.ises.org/conference/eurosun2024/papers/eurosun2024-0008-Ochs.pdf

Pollination, 2024. „Pollination Solutions,“ 2024. [Online]. Available: https://www.pollination.solutions, accessed 21 3 2025.

Robert McNeel & Associates, 2025. „Rhinoceros, Rhino 8,“ 2025. [Online]. Available: https://www.rhino3d.com, accessed 21 3 2025.

Streicher, W., 2025. Gebäudetechnik – Lecture Book, Universität Innsbruck, Innsbruck, 2025.