Annex 54

Heat Pump Systems with Low GWP Refrigerants

To reduce greenhouse gas emissions and achieve sustainable, low-carbon cooling and heating solutions, a transition to use of refrigerants with low global warming potential (low-GWP) in heat pump systems is essential. This process is accelerated by the development of guidelines for optimized components and systems to ensure safety, efficiency, and market readiness.

Key Findings

Structured according to the tasks of each participating country:

Austria identified low-GWP refrigerants and provided an overview of the Austrian heat pump market and examples of low GWP refrigerants in applications.

France investigated the water-to-brine heat pump for a 5 kW residential space heating application that can be placed inside a house with a maximum admissible R-290 charge of 150 g.

Germany summarized the heat pump market survey, integrated fluid screening, and evaluated SCOP of HCs, HFOs, and mixtures.

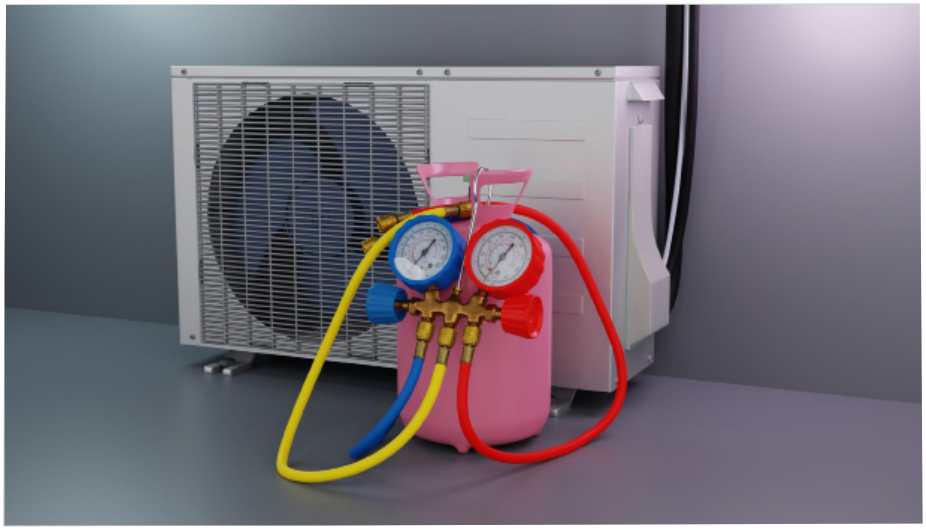
Italy reported a solar-assisted heat pump water heater using CO_2 and compared R410A alternatives (R32, R454B, and R454C) for residential heat pumps.

Japan provided an in-depth analysis of the LCCP and risk evaluations for heat pump systems using low GWP refrigerants like R-410A, R-32, R-454C, R-290, and R-22.

Korea conducted a comparative study on the performance of R-32 versus R-410A refrigerants in residential air conditioners such as window-type and wall-mounted air conditioners.

Sweden provided the Swedish heat pump market for residential and commercial units, shared case studies and design guidelines for a geothermal R290 HP for multifamily buildings (EBOX), a CO_2 heat pump system for commercial buildings, and a R290 heat pump and chiller for the process cooling and heating.

USA reported the next-generation HX design framework and provided 5.3 kW condenser optimization for R32 and R454B.



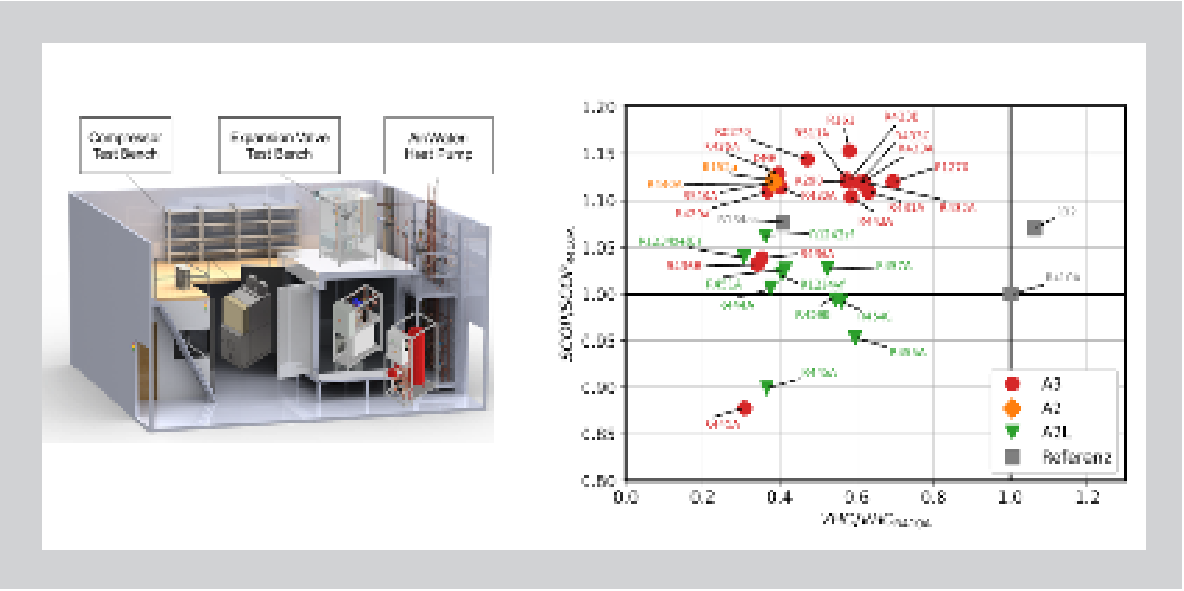


Figure 1: Schematics of heat pump test facilities (left) and Seasonal COP (SCOP) evaluations (right) - RWTH Aachen University.

Background

In 2016, 197 countries adopted an amendment to phase down hydrofluorocarbons (HFCs) to attain the NetZero 2050. Future heat pump systems will utilize refrigerants with low global warmig potential (low-GWP) and energy-efficient technologies to comply with the latest international regulations and reduce overall environmental impacts. Potential low-GWP refrigerants include R-32, R-32 mixtures, and natural refrigerants (hydrocarbons and CO_2), with low-GWP values. Since these refrigerants have a wide range of thermophysical properties and thermodynamic characteristics different from current refrigerants, customized and optimized components and system designs are crucial. Annex 54 explored this opportunity and expanded the use of optimized low-GWP air conditioning and heat pump systems. It advanced these systems' technology readiness levels (TRL) by developing design guidelines, reducing market barriers, and promoting international collaboration.

Objectives

- Promote low-GWP refrigerant application and accelerate the phase-down of high-GWP HFCs.
- Develop design guidelines for: 1) Optimize heat pump components and systems for low-GWP refrigerants and 2) Review available low-GWP refrigerants, their properties, and applicable standards.
- Ensure safety, address flammability of low-GWP refrigerants, and promote the safe use of flammable refrigerants.
- Optimize heat pump components and systems, focusing on heat exchanger and compressor optimization.
- Analyze LCCP Impact and compare the current design with optimized designs using low-GWP refrigerants.
- Evaluate the market potential for heat pumps with low-GWP refrigerants and assess the availability of low-GWP refrigerants for 2030 with the target applications for residential and commercial buildings.

Further information

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Publications:	Final report and Executive Summary of Annex 54, available at www.heatpumpingtechnologies.org/publications
Internet:	www.heatpumpingtechnologies.org/annex54