

NxtHPG Project. Executive Summary

For heat pumps to become broadly accepted, an important effort is still required to increase their efficiency, reduce their environmental impact and become more economical. In regard to their environmental performance, one very important issue must still be solved, i.e. the use of refrigerants with 0 Ozone Depletion Potential and very low Global Warming Potential. HFC refrigerants, nowadays massively employed, have a very high GWP and consequently they were declared as Greenhouse Gases in the recent GHG European regulation.

The NxtHPG project strived to give a definitive step forward to overcome the barriers impeding the spread of natural refrigerants and usher in a new generation of heat pumps based on Hydrocarbons and CO₂. In order to do so, NxtHPG project decided to concentrate on the development of a few selected applications in which it is feasible to develop a safe and cost effective solution and at the same time offer good prospects for commercial exploitation.

With this aim, the main objective of the NxtHPG project has been the development of a set of 5 reliable, safe, high efficiency and high capacity heat pumps (prototypes capacity around 50kW) working with the two most promising natural refrigerants: HCs and CO₂. The finally selected case were:

- CASE 1 is a 40kW air to water heat pump (HP) for the production of hot water for heating also covering a low demand of domestic hot water (DHW) with the use of a de-superheater. The unit is reversible on the refrigerant circuit, so providing either heating in winter and cooling in summer.
- CASE 2 is a 60kW geothermal HP for hot water production for heating also covering a low demand of DHW with the use of a de-superheater. The unit is reversible on the refrigerant circuit, so providing either heating in winter and cooling in summer.
- CASE 3 consists of a 50kW HP booster from a neutral water loop, (10-30 °C) (e.g. recovery of waste heat from condensation (25-30°C) or sewage water (10-15°C)) up to 60°C for DHW production.
- CASE 4 is a 30kW air to water HP for sanitary water production at 60°C or up to 80°C for high temperature applications.
- CASE 5 is a 50kW air to water HP for heating applications. It targets the replacement of old gas boiler heating systems (5-6 families house) with old high temperature radiators as terminal units and high water return temperature. It provides DHW all over the year.

The project has been able to develop an optimized solution for each selected case (case1, 2 and 3 with propane, and case 4 and 5 with CO₂) reaching the specified targets:

- High efficiency: 10 to 20% increase on Seasonal Performance Factor (SPF) compared to current HFC's and HFO's equivalent equipment.
- Very Low CO₂ emission.
- Efficient and flexible capacity modulation.
- Tight containment and minimum charge. Design incorporating all the necessary safety measures and high reliability.
- Affordable cost: similar to that of equivalent HFC's or HFO's solution or slightly higher (10%).

The most important result of the project is the compilation of a set of design guidelines for the optimal design of each of this kind of heat pumps working with natural refrigerants, and a number of innovation and knowhow results acquired both for the heat pumps and their components: compressors, evaporators, condensers, and auxiliaries, optimized for the use of each of the selected refrigerants: propane and CO₂.

NxtHPG project has proven that safe, reliable and cost effective heat pumps employing natural refrigerants are perfectly feasible and cost effective.