

CO₂ heat pumps in europe

market dynamics & legislative opportunities

As companies seek to find new ways to reduce their energy consumption and invest in environmentally sound technologies, more and more are turning to natural refrigerant applications. For heating cold water to high temperatures CO₂ heat pumps represent a climate and ozone friendly, energy efficient technology, gradually making clear inroads in both the residential and commercial building sectors as well as in large district heating projects across Europe. Depicting this budding market shecco shares some of the latest policy, market and technology developments relevant to CO₂ heat pumps.

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CO₂ heat pump water heaters (HPWH) technology was developed in Japan over the last decade under the brand name “EcoCute” or “Eco Cute”. This type of water heater is becoming increasingly popular in many parts of the world due to the increased level of environmental awareness. As mitigating climate change becomes more pressing, applications that presently use high global warming potential (GWP) refrigerants need to be replaced with solutions like CO₂, a burgeoning trend across the HVAC&R sector.

Market potential of R744 in European countries

Part of a series of unique free publications, shecco’s “GUIDE 2012: Natural Refrigerants – Market Growth for Europe” captures a snapshot of the growing natural refrigerant market in the areas of industrial, commercial and residential heating, air conditioning and refrigeration. Based on a refrigerant survey that received more



GUIDE 2012:
 Natural Refrigerants - Market Growth for Europe, shecco publications. Available also at <http://guide.shecco.com/guide.php>

than 1338 industry expert opinions (666 from Europe), including those of heat pump manufacturers, results revealed increasing investment in CO₂ technologies and favourable market conditions for CO₂ products. For example, among the European respondents 35% currently offer CO₂-based products or services, whilst 42% of respondents stated that their future products and services would involve CO₂-based solutions. (Figure 1&2)

QUESTION: “Which Products & Services for Natural Refrigerants do you HAVE?”

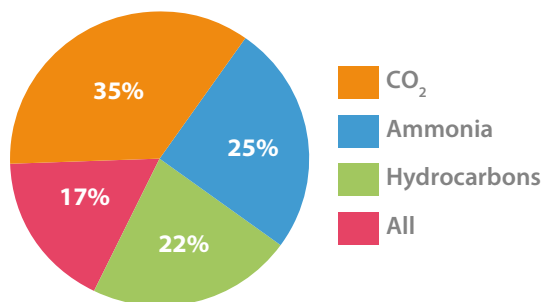


Figure 1. Market share of Natural Refrigerants Products in Europe based on 1338 industry expert opinions. [1]

QUESTION: “Which Products & Services do you PLAN TO HAVE?”

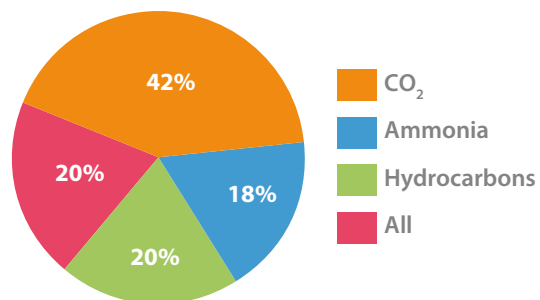


Figure 2. Market potential of Natural Refrigerants Products in Europe based on 1338 industry expert opinions. [1]

With regard to market policy conditions 63% of participants believe the business and policy climate for CO₂ in Europe to already be “rather” or “very” positive. (Figure 3)

QUESTION:
“How is the Business and Policy Climate evolving in your country (location of organisation)?”

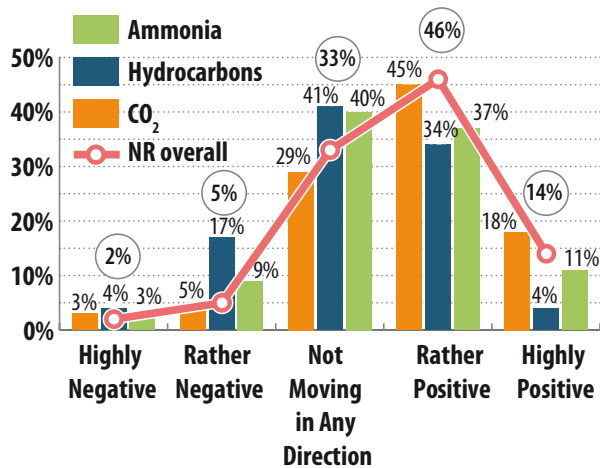


Figure 3. Market and Policy Environment of Natural Refrigerants in Europe. Responses of 1338 industry experts. [1]

Benefits of CO₂ heat pump water heaters (HPWH)

HPWHs are a relatively mature technology and have gained popularity over the past decade within the water heating industry because of their ability to deliver significantly more heat for the same amount of electricity compared to traditional electric storage water heaters (SWH).

The CO₂ heat pump water heater cycle is transcritical, operating at much higher temperatures and pressures than conventional subcritical cycles. The transcritical cycle operation provides a large continuous temperature glide and can offer a higher service temperature with limited capacity loss.

CO₂ heat pumps installations in commercial applications in Europe

Today most of the CO₂ heat pumps are designed for Domestic Water Heating (DWH), with Japanese companies like Panasonic, Daikin, DENSO, Sanden, Itomic and Mitsubishi some of the most active promoters of the technology. Whilst the Japanese market can be considered mature, CO₂ heat pumps represent a niche market in Europe. However, more and more Japanese compa-

nies are entering the European market, redesigning their CO₂ heat pumps to fit the European way of life, climate, housing structures as well as EU and national energy and safety standards.

Local CO₂ heat pump manufacturers are also emerging, with companies like Stiebel, enEX, ICS, Thermea, Kylma, CTC, JCA, and Viessmann adding CO₂ heat pumps to their product ranges.

Outside the domestic market, commercial real estate owners are beginning to see CO₂ heat pumps as a promising, high performance option for high temperature sanitary hot water for hotels, restaurants, hospitals, schools and other public buildings. Evidence of this can be seen in some most recent examples of commercial applications of CO₂ heat pumps in Europe:

Denmark: A large scale 100% renewable energy project that provides the Danish city of Marstal with a large-scale district heating system incorporates a 1.5 MW thermally CO₂ driven heat pump. The project, developed with a grant from the EU’s Seventh Framework Programme (FP7), includes a solar plant, a combined heat and power (CHP) system, an Organic Rankine Cycle (ORC) Unit and a 75 000 m³ pit for heat storage, with the CO₂ heat pump moving energy to the energy storage pit.

Ireland: Ecocute Innovation and Design Limited (Ecocute Ltd) has installed an air to water transcritical CO₂ heat pump (TCHP) water heating system to supplement the O’Donovan’s Hotel’s existing solar thermal system. The Hotel’s domestic hot water is now supplied by a 25 kW transcritical CO₂ heat pump that can operate at a seasonal performance factor of 3.2 when generating hot water at 75°C in Irish ambient conditions of 9.4°C air temperature and 10°C water inlet temperature.

Also in Ireland, the Cúil Dídín Residential and Nursing Care Facility in Tralee county Kerry has installed a transcritical CO₂ heat pump to supply hot water for the laundry facilities, kitchens and for the care of the residents. The new CO₂ heat pump can produce 2 500 litres of hot water per night at 90°C, which is able to meet the hot water demand 24 hours a day. Overall, cost savings of 70-80% are expected.

France: A McDonald’s in France installed a CO₂ heat pump produced by Panasonic to comply with the energy and emission reduction priorities for new and existing buildings in the French government’s Grenelle

Environment project (Grenelle de l'environnement). The CO₂ heat pump is able to reach a high pressure of 130 bars (most other heat pumps that can only reach 15 bars) providing comfort cooling.

Switzerland: In 2011, thermea. Energiesysteme installed a high-temperature heat pump thermeco2 at the campus of the University of Applied Sciences South Westphalia. The heat pump uses low-temperature waste heat from the ventilation and refrigeration plant and supplies the university canteen with hot water and heating. With a total heating capacity of 45 kW, the thermeco2 heat pump reaches high performance values (COP) even with a temperature lift of about 65°C. The COP values of 3.0 and 3.5 measured by the manufacturer surpassed values predicted by thermea.

Building regulations in EU Member States underpin trend towards sanitary hot water heat pumps

The year 2011 saw a trend towards sanitary hot water heat pumps - an application most suitable for R744: according to latest statistics by the European Heat Pump Association sales of sanitary hot water heat pumps have close to doubled in 2011 compared to 2010 levels reaching about 48 000 units.

This trend is underpinned by new building codes and regulations adopted in different EU Member States, regulations that typically place a ceiling on primary energy consumption of buildings or require the integration of renewable energy. Sanitary hot water heat pumps provide a straightforward means to integrate renewable energy sources (RES) and reduce primary energy consumption in buildings.

This is the case in France for example where the 2012 Thermal Regulation (Réglementation Thermique 2012 - RT2012) was launched at the end of 2010, replacing 2005 Thermal Regulations (RT2005). In general, all new building constructions must achieve average primary energy consumption of less than 50 kWh/m²/year for heating, domestic hot water, cooling, lighting and auxiliary equipment (e.g. fans and pumps) compared to the average of 150 kWh/m²/year required by RT2005.

This trend is expected to continue in the long term as more and more national governments in the EU are expected to adopt building codes and regulations that encompass similar requirements and accommodate the requirements of the recast EU Energy Performance of Buildings Directive agreed back in 2010.

For example the amendment of the Energy Saving Ordinance ("Energieeinsparverordnung - EnEV") that regulates energy performance for new and existing buildings in Germany is underway and is expected to raise current requirements further. The Ordinance sets requirements regarding primary energy demand, taking into account both insulation of the building envelope and the energy efficiency of equipment used for heating, sanitary hot water etc.

The Joint Research Centre estimates that by 2020 heating and cooling will represent the highest sectoral share in the gross final energy consumption, of 48% (http://ec.europa.eu/dgs/jrc/downloads/jrc_reference_report_2011_reap.pdf). Within this context and as the EU moves towards low or zero energy buildings that encompass minimal space heating requirements, sanitary hot water and energy efficient technologies for its provision are set to become all the more important.

Conclusion

Growing environmental awareness coupled with more stringent European building codes and regulations have provided a strong boost to environmentally friendly heating and cooling solutions. Since the revival of CO₂ as a refrigerant, started almost 20 years ago in Europe, there has been a strong development of new technology, with CO₂ now widely recognised an attractive and competitive alternative refrigerant to the synthetic fluids in heat pump applications.

Reference:

- [1] GUIDE 2012: Natural Refrigerants - Market Growth for Europe, shecco publications. Available also at <http://guide.shecco.com/guide.php>



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