Comments to the first EU F-Gas Consultation Forum

Submission by shecco

September 2015

Following the first EU F-Gas Regulation Consultation Forum held on 10 September 2015, shecco would like to submit input that reflects some of the major concerns of the natural refrigerant industry in relation to standards & legislation, training on f-gas alternatives and public procurement.

GENERAL COMMENTS

- There is need to use neutral language in relation to natural and non-natural refrigerants in order to avoid misconceptions and to alleviate the barriers to introduction of natural refrigerant-based technologies. Moreover, it is essential to avoid misinformation, such as including HFOs under non-f-gas refrigerant group.

- Legislation and standards make it look like the flammability and toxicity of natural refrigerants is a problem. Industry is ready to roll out products with natural refrigerants but there are too many barriers that concentrate on flammability, toxicity and high pressure, which then create non-technical and rather psychological barriers. The characteristics of natural refrigerants are not an issue for their rollout it is the general communication and perception that makes it look like there is a problem.

- While there is too much focus on flammability levels of different refrigerants there is no focus at all on the consequences of flammability, which could be very serious in case of unsaturated HFCs (or HFOs). Moreover, there is currently no focus on the breakdown products of these new substances. This aspect is seriously undermined in today's discussions, which could become an important and unavoidable problem once there are more systems using these refrigerants in place.

TOPIC A: Barriers related to standards and legislation

One of the major barriers for natural refrigerants in relation to existing standards is the fact that the standards have been created to fit the interests of the traditional HFC industry. The standardisation process is dominated by manufacturers of HFCs and the interests of manufacturers of natural refrigerant-based equipment is underrepresented. As a result the standards for hydrocarbons and other natural refrigerants are unnecessarily restrictive. The interests of HFC industry are different from the interests of the natural refrigerant industry - while the former has interest in promoting HFC refrigerant gases, which are patented; the latter seeks to promote equipment using natural refrigerants, which are widely and cheaply available. The companies working with natural refrigerant-based equipment do not dispose of the necessary resources to participate in the intense standardisation processes, which is one of the reasons why the existing standards treat natural fluids unfairly. Governments shall ensure that natural refrigerants are treated fairly before the standards are finally approved, as the industry cannot manage this on its own due to strong business interests.

It is important to not mix HFOs (unsaturated HFCs) together with hydrocarbons and other natural refrigerants when it comes to standards. A safety standard for natural refrigerants designed by companies that work with the technology and have the necessary data to support the safety requirements would create a level playing field in the industry. It is therefore strongly recommended that the European Commission requests a mandate to the European Standardisation Organisations to work on separate standards for hydrocarbons and other natural refrigerants, independent from existing standards designed to fit HFC-based technology;

and supports the participation of companies working with natural refrigerant technology in the standardisation process. When developing a standard on hydrocarbons, it is important to get the right experts from the field, who have a vested interest in solving these problems.

The briefing document prepared by Ricardo-AEA and Gluckman Consulting puts mentions several times the A2L group in relation to the standard EN 378, which is currently being reviewed. It is understood by the industry that it is still not decided that the A2L will be included under the EN 378. It is therefore premature and misleading to use this category as if it was already decided.

The section below outlines some concrete barriers to introduction of natural refrigerant-based technology at EU and national level.

EU LEVEL

CO_2 HEAT PUMPS FACING AN IMPORTANT BARRIER DUE TO EN 14511 & EN 14825 AND ECODESIGN DIRECTIVE

The briefing paper prepared by Ricardo-AEA and Gluckman Consulting notes that "CO_2 is being adopted in a wide range of different applications and the current standards provide a reasonable and appropriate set of constraints to ensure safe operation of this high pressure fluid." However, serious barriers exist for the introduction of CO_2-based heat pumps due to performance standards EN 14511 & EN 14825 and the Ecodesign Regulation 813/2013[1], which refers to these standards. **Due to the requirements that come in force in 2017 under the Ecodesign Regulation, CO_2 heat pumps will not be able to meet the Ecodesign requirements for space heating even though their overall efficiency when considering space and water heating function is better than an equivalent HFC heat pump - this is a serious concern for the CO_2 heat pump industry.**

Starting in 2017, the Ecodesign Regulation introduces stricter energy efficiency requirements, requiring that minimum efficiency should be higher than 125% for low temperature space heating and 110% for high temperature space heating. With tests based on EN 14511 & EN 14825, CO_2 heat pumps cannot meet the minimum requirements for space heating (10% lower than the minimum requirement), even though they perform much better for water heating and as combined space and water heaters, especially in low energy and passive houses.

The performance standards EN 14825 & EN 14511 have been adapted to the refrigeration cycle of HFC-based heat pumps. This is unfavorable to the transcritical cycle of CO_2 heat pumps. The test conditions determined in this standard set a very small different in inlet and outlet temperature, which is very small for CO_2 heat pumps to show a good performance. CO_2 heat pumps can achieve very high temperatures for water heating and the bigger the temperature difference (delta T) the better their performance. Moreover, **a bigger temperature difference would better reflect the actual real life conditions**.

With the increased focus on energy performance of buildings set by the EPBD and national building regulations, the share of energy demand for space heating will become less important, while the importance of energy demand for water heating will increase. CO_2 heat pumps are

[1] COMMISSION REGULATION (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination

recognized as best in class when it comes to water heating and hot water storage - such technology should therefore be supported for the future low energy and passive houses. However, with the Ecodesign requirements that will enter in force as of 2017, CO_2 heat pumps will not be able to penetrate the market, unlike other less energy efficient water heating technologies such as gas boilers or electric space heaters.

It is therefore essential to **introduce at least a 15% energy efficiency bonus to CO_2 heat pumps as of 2017** under the Ecodesign Regulation in order to allow the technology to reach the Ecodesign requirements for space heating.

In addition, **the standards EN 14511 & EN 14825 need to be revised** in order to better reflect real life conditions and to not disadvantage CO_2 based heat pumps, which are climate friendly and energy efficient solution for both space and water heating.

INCONSISTENCY ACROSS ECODESIGN REGULATIONS

While the Ecodesign Regulation for small air conditioning (LOT10) provides a 15% energy efficiency bonus for low GWP refrigerants (GWP < 150), the Ecodesign Regulation for heat pumps (LOT1 & LOT2) fails to apply the same concept, which creates barriers to introduction of CO_2 heat pumps as already mentioned earlier.

NATIONAL LEVEL - FRANCE

The briefing document prepared by Ricardo-AEA and Gluckman Consulting before the Consultation Forum notes that there is a decree in France that forbids the use of hydrocarbons in areas with public access.

It is important to note that Article CH35 of the French decree 'Arrêté du 25 juin 1980 — Etablissements recevant du Public'[2] indeed forbids the use of flammable substances for air conditioning, but its **scope does not cover refrigeration equipment**. The provision has created confusion among industry as the regulation mentions "refrigeration" when it only refers to air-conditioning. An Austrian manufacturer of hydrocarbon-based refrigerated cabinets filed a lawsuit against this regulation due to the unclear interpretation. The result of the case is that they were allowed to sell HC systems in France and the decision clearly says that the ban does not apply to food refrigeration equipment. According to the French authorities, the provision that indicates the scope of section 7 of the act is article CH 28, which only refers to ventilation and air conditioning applications.[3]

Nevertheless a barrier to introduction of hydrocarbons does exist due to the misleading text of Article 35, which creates confusion among end users and manufacturers who are often not sure whether it is legal to use hydrocarbons. The provision shall be revised and the government should actively raise awareness of the fact that hydrocarbons can be legally used in refrigeration applications in areas with public access.

[2] http://www.legifrance.gouv.fr/affichTexte.do;?cidTexte=LEGITEXT000020303557#LEGIARTI000020304611
[3] http://www.interieur.gouv.fr/content/download/31689/237167/file/avis-ccs-03042008.doc (p. 6-7)

TOPIC B: Barriers related to training on f-gas alternatives

While the EU F-Gas Regulation does not require training and certification on natural refrigeration, it is important to note that training on f-gas alternatives is mandatory as this is requested by other standards, which say that a technician cannot enter the machinery room without being qualified. Nevertheless enforcement of the training requirements and awareness raising of natural refrigerants will be essential in ensuring safety and faster update of technologies.

Skilled personnel are essential in ensuring safe handling of natural refrigerants and smooth transition to the low-carbon economy. Natural refrigerants that will replace high-GWP substances have different characteristics, system layouts, components and servicing practices. **Lack of knowledge among technicians on how to handle these refrigerants poses a serious barrier to the market uptake of natural refrigerant technologies - the share of which is bound to rise - as well as successful implementation of the F-Gas Regulation.**

Engineers are reluctant to take on new training unless they are requested by legal obligation or incentivised by public authorities or manufacturers. It is key to motivate the engineers and contractors to upgrade their training in order to ensure safe handling of new technologies and their smooth introduction in the market. There is especially a significant gap when it comes to practical training on natural refrigerants. **Governments should take responsibility in incentivising the industry in taking on a new training on natural refrigerants** through providing financial or non-financial incentives.

Government support for training is especially vital for **residential and commercial refrigeration and air conditioning technologies using hydrocarbons and CO_2**. A number of equipment manufacturers as well as end users already offer training for technicians in order to ensure accurate and safe handling of their equipment. However, it is not possible for the manufacturers to train the whole industry as this adds additional costs to the companies that aim to reduce the reliance on f-gases in across different applications.

It is important that **promotion of NR product and promotion of training are implemented at the same time**. If there are no products in the market, the knowledge doesn't reach service people and engineers, and they don't have motivation to learn. On the other hand, if there are products in the market, but sellers like retailers and installers do not have the necessary knowledge, they do not sell those products.

Another issue is the **lack of recognition / approval of training & certificates** between countries, but also between different companies.

If mandatory certification on natural refrigerants is introduced, it needs to be done in a **neutral way so as not to create a barrier for the natural refrigerant industry** but rather to accelerate the uptake of training related to these refrigerants.

TOPIC C: Green Public Procurement

Governments have a huge role in driving the market for low GWP natural refrigerants across different sectors, not only through introduction of legislation that limits the use of high GWP substances, but also through setting an example and **helping innovative companies prove that their solutions are technically feasible and cost effective** and thereby creating the necessary demand and economies of scale. Public procurement is therefore a very **effective tool in driving the uptake of cutting edge climate friendly technology**.

Procuring HFC-free heating and cooling technologies will help the country's industries scale up their development and production of their most environmentally friendly products.

At the national level, Member States shall adopt public procurement policies that make it mandatory to always **consider HFC-free options for procurement of heating, cooling or refrigeration equipment** and only choose a different option in cases where it can be proven that an HFC-free option is not available or technically feasible.

There are already a number of examples where installations using natural refrigerants were procured by public authorities and a few of such cases are listed in the **Annex** of this document, which follow below.

ANNEX

EXAMPLES OF CASE STUDIES WITH NATURAL REFRIGERANT INSTALLATIONS IN PUBLIC BUILDINGS

Denmark

1. Experience with R600a heat pumps installed at Danish hospital

As the Aarhus University Hospital Skejby in Denmark has been gradually expanding and the heating and cooling capacity has become insufficient over the years, new hydrocarbon chillers replacing out of date R22 chillers but also most recently hydrocarbon heat pumps supplied by Johnson Controls have been installed.

The first hydrocarbon chillers were already installed in 2003 and as the hospital has been gradually expanded additional hydrocarbon chillers have been installed.

The larger chiller system:

- Uses 9 air-cooled propane (R-290) based chillers each with a cooling capacity of 250 kW, coefficient of performance (COP) of 4.5 and a total of about 210 kg R290
- Uses a free-cooler with a capacity of 300 kW
- The chillers deliver a 35% propylene glycol/ water solution at 9°C and return at 15°C

On top of the 9 chillers there are also some special chillers around on the site working at different temperature levels, bringing the total number of hydrocarbon chillers on site to 15.

Moreover the latest installation made in the context of the gradual expansion encompassed two heat pumps that were put into operation in November 2010, with:

- Hydrocarbon refrigerant isobutane (R600a) of a total of about 80 kg
- A total heating capacity of about 450 kW and a cooling capacity of about 325 kW
- The units are built as two independent circuits on one frame

More information:
http://www.hydrocarbons21.com/articles/2782/experience_with_r600a_heat_pumps_installed_at_danish_hospital

UK

2. MHI provides the best efficiency solutions to Colne House (Medical Centre)

"Colne House" is a brand new medical centre containing two doctors surgeries. The new Q-ton CO_2 heat pump was installed to provide sanitary hot water to 15 consulting rooms and 4 treatment rooms.

The 3 pipe KX6R VRF system for space heating and cooling comprises of 4 outdoor units feeding 40 indoor fan coils. The system is centrally controlled by an intelligent touch screen panel for extensive programming for optimal energy efficiency.

Both surgeries are supplied by one 30 kilowatt Q-ton model which is connected to a 1,000 litre stainless steel tank with water stored at 75°C. The combined system enables low running cost and carbon reductions.

More information:
http://www.mhiae.com/docs/default-source/case-studies/education-healthcare/case-study---colne-house---06-03-2014.pdf?sfvrsn=2%20

3. A UK first: CO_2 for a hospital catering facility

A CO_2 unit supplied by Green & Cool has been installed and commissioned by CCS Refrigeration, through principle contractor Aggora on behalf of Compass Group, trading as Medirest to provide for the on site catering requirements of patients, restaurant and hospital staff at the Homerton University Hospital in London, UK.

The water supply for the large CO_2 chiller coldroom is run from the existing ammonia chillers supplied by J & E Hall and installed some 75 metres away. The complete system, hence, runs on natural refrigerants, with the ammonia system chilling water and CO_2cooling the evaporators.

The two existing ammonia chiller units each with 0.5 MW cooling capacity, which cool water from 12°C to 6°C, enabled the design of a sub-critical system. Nonetheless, due to the relatively high condensing temperature, CCS Refrigeration required trans-critical compressors even though the system would run sub-critically year round.

More information:
http://www.r744.com/articles/1246/a_uk_first_co_sub_2_sub_for_a_hospital_catering_facility

4. CO_2 cooling system in the Imperial College in London

A CO_2 cooling system extension has been installed in the ICT Data Centre on Level 4 of the Mechanical Engineering Building. The provision of additional high density cooling has allowed ICT to increase capacity for the central High Performance Computing (HPC) installation in the Data Centre.

This CO_2 cooling system is more efficient than conventional cooling, therefore a higher density of computing equipment can be installed in the same area than with other cooling systems. The use of this centralised CO_2 cooling permits high density computing that is space saving, energy efficient and meets the need for short connectivity distances between computer systems within the HPC cluster. This achieves very high bandwidth connectivity which in turn boosts system performance overall.

More information:
http://www3.imperial.ac.uk/estatesprojects/aboutus/news/archive/article5

5. Packaged Ammonia Chillers at Homerton University Hospital

J & E Hall has designed, built and installed a new natural refrigerant cooling system at a London hospital by employing the latest technology, protecting the environment and delivering efficient cooling for critical medical areas. The ammonia-based system at Homerton University Hospital in Hackney is responsible for cooling the operating theatres, the maternity and the intensive care units – so safety is a high priority.

Stand-out features are U-tube suction separators fitted to the chillers – reducing the refrigerant charge by a third – and a safety shutdown program ensuring that any leaks are contained within the system. The two J & E Hall special Aquachill units with a half a mega-watt of cooling capacity each are employed to cool water from a temperature of 12°C to 6°C.

More information: http://live.toces.netxtra.net/news/article.jsp?newsid=53

6. Ammonia Chillers at Great Ormond Street Hospital

Star Refrigeration has installed a 1.2MW ammonia chiller package as part of the redevelopment project taking place at Great Ormond Steet Hospital. The £321 million development scheme will provide a children's medical centre, compromising a new clinical building and the rebuilding and refurbishment of the old cardiac wing. There will be two linked, brand new buildings totalling more than 30,000m2.

With the existing R22 refrigerant gas chillers at the end of their useful life the hospital was experiencing seal problems with the risk of refrigerant gas leaks. Star Refrigeration have had previous experience of installing ammonia chillers in London, in Government buildings and large office blocks and were the obvious choice of provider.

More information: http://www.star-ref.co.uk/star/images/stories/news/GOSH-Star%20(Med%20Res)%20%202009.pdf
http://www.star-ref.co.uk/star/star-gosh-leading-the-way.html

7. The UK's largest air conditioning thermal storage system, using ammonia and slurry-ice

At Middlesex University an air conditioning system has been installed, incorporating slurry ice thermal storage in a similar fashion to domestic storage heaters. It builds ice over night, which can then be pumped around the premises during the day. The installation has a capacity of 72 cubic metres, which makes it the largest slurry ice system in the UK. Additionally, it is Very Environmentally Friendly, using energy efficient ammonia natural refrigerant. The installation is used to provide cooling for the whole of the university site at Bounds Green, North London. This is providing them with annual running cost savings of almost 50% relative to conventional installations for the same application.

More information: http://www.unep.fr/ozonaction/information/mmcfiles/6294-e-Earthcareheatpump.pdf

8. Large HC chiller in a church in Westminster abbey

In 2007, a 625kW air-cooled water chiller using hydrocarbon refrigerant R290 (propane) was supplied for comfort air conditioning by Earthcare at the historic Church House building in Westminster, London, close to the Houses of Parliament. "This project proved that larger hydrocarbon chillers can be used safely in the urban environment. Since commissioning, the chiller has been completely uneventful, providing reliable cooling and achieving the predicted energy efficiency. The subsequent project for the DEFRA VLA at Weybridge proves the commercial viability of our range" said Nicholas Cox, Managing Director of Earthcare, to hydrocarbons21.com.

The chiller installed at Westminster is part of the Earthcare Hydrocarbon Series (EHS) range which was designed within the constraints of the EU's Best Available Technology (BAT) protocol

and comprised the first set of air-cooled chillers operating on hydrocarbon refrigerants to deliver very large cooling outputs of up to 1,265kW. The chiller at Westminster, Britain's largest ever hydrocarbon refrigerant chiller for a building services application, was specified by Max Fordham consulting engineers, while the installation was carried out by AMEC.

More information:
http://www.hydrocarbons21.com/articles/2392/625kw_propane_chiller_keeps_westminster_cool

9. Ground Source Heat Pump Using Hydrocarbon in Buntingsdale Infant School

The project was joint-funded by Shropshire County Council's Energy Conservation and Sustainable Construction Unit and the UK Government's Carbon Trust. The newly installed system demonstrates the cost, logistical and technological issues that surround the use of heat pump systems in non-domestic applications.

The heat pump chosen was one Earthcare Wesper CWP21 reversible heat pump chiller, as shown in figure 5.1, providing 36.4 kW heating output as water at 46°C. The power input is 8.46kW, giving a COP of 4.3 when using propylene glycol at 0°C as the heat source. Noise levels were specified to be suitable for classroom / meeting room / lecture theatre applications.

More information:
https://www.sintef.no/globalassets/project/annex29/installasjoner/gshp_r12701.pdf

10. SANYO CO_2 heat-pump technology at Beechdale Manor Care Home

As part of their sustainable action plan, the operator of Beechdale Manor Care Home, a home in Nottingham that specialises in care for the elderly, set out to source 10% of the energy used by the building from renewable sources. To meet this requirement, mechanical and electrical contractor Drayton Beaumont Services worked with heating specialist AVC UK to specify the high-efficiency SANYO ECO CO_2 system, supplied by distributor Oceanair.
As a result, five SANYO ECO CO_2 9kW units have been installed at Beechdale Manor, delivering a total of 45kW heating capacity. The CO_2 heat pump system is being used to pre-heat water before it is fed to gas-fired boilers for use in the home's domestic hot water supply, as well as for use in washing, bathing and showers. The dual system significantly improves the energy efficiency of hot water production, ensuring lower fuel bills and reduced carbon emissions.

More information: http://www.r744.com/articles/138620110413.php

11. Hydrocarbon chillers on the roof of the Department for Transport Great Minister House

Hydrocarbon refrigerants are used in three rooftop chillers installed at the Department for Transport Great Minster House building in Westminster. Each has a cooling duty of 127 kW. The three Earthcare EHS chillers were specified by consulting engineer Operon and installed by P&R Morson.

Tony Marshall of Operon explained that they were selected for their suitability for the application and because they conformed to Government purchasing policy on equipment using refrigerants. Current policy for the Government estate is that HFCs as refrigerants 'should be

avoided wherever practicable' and that no equipment using ozone-depleting HCFCs should be purchased.

Four key steps have been taken to maximise energy efficiency. Their combined effect is to more than halve energy consumption for chillers that operate all year, compared with chillers without these features. First, hydrocarbon refrigerants reduce energy consumption compared with other alternatives because of their more favourable thermodynamic characteristics. Secondly, the use of a fully flooded evaporator achieves zero superheat by the application of a plate suction liquid heat exchanger with the phial of the expansion valve located downstream of the heat exchanger. The lower condensing temperature compared with R22 improves the efficiency of the internal heat exchanger. Heat is transferred between the liquid upstream of the expansion valve and the vapour upstream of the compressor, improving the COP even more. Floating head pressure control allows the condensing temperature to fall as low as 20°C if ambient conditions allow, instead of the normal 40°C. Finally, at part-load, the voltage and current to the compressor motor are modulated to reduce losses in the motor core and windings. The payback on such control is typically less than 18 months.

More information:
http://www.modbs.co.uk/news/archivestory.php/aid/1121/Hydrocarbon_chillers_on_the_roof.html

12. London Olympics venues - 90% HFC-free

Following a recommendation by the Commission for a Sustainable London 2012, responsible for assuring sustainability across the London 2012 Olympic and Paralympic Games, stating that "HFCs must not be used where other safe, technically feasible, cost effective, energy efficient and more environmentally acceptable alternatives exist" the cooling system of the Aquatic Centre has been converted to ammonia-based system, reducing the climate change impact. Designed by Zaha Hadid, the Aquatic Centre in London is to some extent temporary in design. While the current design allows for the capacity of 17,500 people, by removing the two wings, it can be dramatically removed to 2,500. The post-games design for the Centre was built to the BREEAM excellent standard.

A large-scale Olympic Energy Centre also features ammonia chillers. The new Energy Centre and network being built on the site provides efficient and low-carbon power by using new technology including biomass boilers and a Combined Cooling Heat & Power plant to capture the heat generated as a by-product of electricity production. Apart from being at the heart of the Olympic power infrastructure, the primary Olympic Park Energy Centre makes claim to being one of the largest combined cooling, heating and power generating facilities built in the UK.

More information:
http://www.ammonia21.com/articles/3421/london_olympic_aquatic_centre_uses_ammonia-based_refrigeration

13. Ammonia keeps Heathrow Terminal 5 cool

UK manufacturer Johnson Controls / Sabroe supplied Heathrow's central chilling plant with four energy efficient chillers, each with a cooling capacity of 6.6 mW, or 1,875 tons. The units, powered by high-voltage electricity, use twin compressors ensuring a good part load performance, while the 11 kW motors reduce transformer losses. Safety features include a minimal refrigerant volume through plate heat exchangers, separate sealed compartments, a leak detection system, and an electrical switching outside the compartments. As the large-scale

R717 chillers deliver higher efficiencies than smaller local chillers, they are expected to reduce energy consumption by at least 30% and possibly more from the chilled water store benefit. Storing the chilled water reduces the system capacity and takes advantage of night electricity rates.

More information:
http://www.ammonia21.com/articles/1678/ammonia_keeps_heathrow_terminal_5_cool

Ireland

14. CO_2 heat pump water heaters in Ireland – Nursing Care Facility

Cúil Dídin Residential and Nursing Care Facility in Tralee county Kerry also opted to install a transcritical CO_2 heat pump, to ensure a more energy efficient and secure hot water supply.

Previously, Cúil Dídin Nursing Care Facility had a Liquefied Petroleum Gas (LPG) boiler to supply the large volumes of hot water the facility requires for the laundry facilities, kitchens and for the care of the residents. However, Tralee is not connected to the Irish national gas network, and the management were dissatisfied with having to rely on fuel deliveries for the LPG boiler.

As a replacement, a new CO_2 heat pump was installed, capable of producing 2,500 litres of hot water per night at 90°C. The hot water is stored in a dedicated vessel and mixed down to the required temperature for distribution to specific areas of the building.

More information:
http://www.r744.com/articles/1446/co_sub_2_sub_heat_pump_water_heaters_in_ireland

Norway

15. Ammonia Heat Pump System in Akershus Hospital

Norway's Akershus University Hospital in Lørenskog is a large capacity borehole thermal energy storage (BTES) system that has been in operation since 2007. Initiated and owned by the regional health authorities in the southeast, this thermal energy storage system includes ground source heat pumps connected to 228 borehole wells. These wells are drilled to a depth of 200 meters.

This system was originally built in order to meet the country's national goal that renewable energy resources be used to provide at least 40% of heating and cooling demand. It was expanded in 2010 and now supplies 85% of total heating demand (40% of total energy demand) for the Baerum heating district. At a total cost of USD 19.5 million for the BTES system – including the 8MW combined ground-source heat pump and ammonia chiller system – the project has an estimated payback period of less than 10 years.

More information:
https://www.iea.org/media/freepublications/technologyroadmaps/AnnexA_TechnologyAnnexforweb.pdf

16. Ammonia heat pumps installed at StatoilHydro Research Centre in Trondheim

The Directorate for Public Construction and Property in Norway (Statsbygg) installed several ammonia heat pumps because ammonia is an environmentally friendly working fluid with excellent thermophysical properties. A 900 kW ammonia heat pump system for space heating, space cooling and hot water heating was installed at the StatoilHydro Research Centre in Trondheim, Norway. The heating and cooling demands at design conditions for the 28,000 m2 building are 1.50 and 1.35 MW, respectively. Sea water from 60 metres depth is used as a heat source. A large ammonia chiller and heat pump system (CHPS) were installed at Oslo Airport Gardermoen, Norway. The maximum heating and cooling capacity of the CHPS is 7.5 MW and 6.0 MW, respectively, and the system utilizes the vast groundwater aquifer in the area as a thermal energy storage.

More information: http://publication.shecco.com/publications/view/26

Switzerland

17. Ammonia heat pump at the Swiss post

The heart of the heating and cooling system is one of the largest ammonia heat pumps in Europe, with a cooling capacity of 4,300 kW. As ammonia does not contribute to ozone depletion, the system does not contribute to global warming. The Johnson Controls heat pump is set to deliver a heating capacity of 5,600 kW of hot water at a constant temperature of 62°C. Approximately 50 percent of the heating energy will be taken from purifi ed waste water from the waste water plant one kilometre away, with a further 30 percent taken in the form of heat recovery from the buildings air conditioning system. When there is no requirement for heating, the system uses the waste water for re-cooling of the heat from the cooling production. This is the case in the summer, when the numerous automated devices for letter sorting require a cooling output of 4.9 megawatts.

More information:
http://www.johnsoncontrols.be/content/dam/WWW/jci/be/eu_library/case_studies/english/SWISS_POST_case_study.PDF

Germany

18. Public Utilities in Lübbecke use R290 for economical and environmentally friendly cooling

The Lübbecke public utilities were looking for a new cooling system for the air-conditioning of their building as well as the cooling of the server room. The refrigeration contractor Wilhelm Schriefer GmbH offered an environmentally friendly solution with a brine cooling unit using the natural refrigerant propane. Based on the estimated refrigerant charge of 2,5 kg, various safety precautions were taken, including the outdoor installation of the unit on the roof of the public utilities building.

The system realised by Schriefer demonstrates that without any great difficulty, it is possible to design a cooling unit with propane in accordance with local and national safety requirements. What is more, the R290 unit helps to reduce operating costs and in light of current discussions about a possible ban on certain HFC refrigerants, guarantees a high level of investment security.

A suction line heat exchanger improves the efficiency of the system as the increased enthalpy difference at the same refrigerant charge allows the absorption of more heat energy. The achieved cost savings pay off the investment for the heat exchanger within one year.

According to Karl Huber, Managing Director of HKT Huber-Kältetechnik-GmbH: "The slightly higher initial investment cost will be amortisised in less than three years."

More information:
http://www.hydrocarbons21.com/articles/4697/public_utilities_in_l_bbecke_use_r290_for_economical_and_environmentally_friendly_cooling

19. Absorption chillers cool transformed Reichstag

The sustainable redevelopment of the German Parliament building provides a prime example of how absorption chillers can contribute to sustainable architecture projects. The Reichstag building, which now incorporates solar panels, combined heat and power units that run on biodiesel, a waste heat reservoir and absorption chillers, has resulted in a 94% reduction in carbon dioxide emissions.

In Reichstag building, which covers a total floor area of approx. 240,000 m^2, three absorption chillers are used during the summer to cool the building. The surplus heat resulting from operation of the motor-driven cogeneration plants is stored as hot water in an aquifer deep below ground that can either be pumped up to heat the building or used to drive an absorption cooling plant to produce chilled water. The system includes an 850 kilowatt absorption device to provide cooling during July or August if needed, and which can function as a heat pump during the.

Thanks to the chillers and other green technologies, the building's energy requirements are so small that it produces more energy than it consumes, allowing it to act as a mini power station supplying nearby government buildings.

More information:
http://www.r718.com/articles/4124/sustainable_architecture_absorption_chillers_cool_transformed_reichstag

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