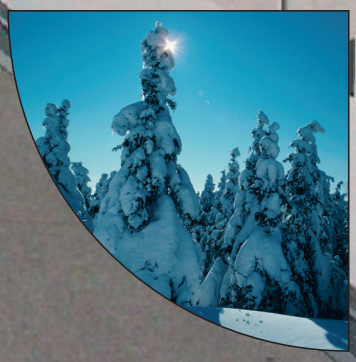
IEA Heat Pump CENTRE
NEWSLETTER
Volume 27
No. 2/2009

Heat pumps in year-round space conditioning system

EU progress towards more efficient air-to-air air heat pumps and air conditioners

Ground source heating and cooling in Sweden

Heat pump with dehumidification mode of operation



IEA OECD heat pump centre

IEA Heat Pump CENTRE
NEWSLETTER
Volume 27 - No. 2/2009

In this issue

In this issue

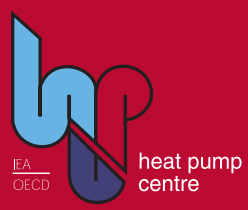
The main theme of this issue is heat pumps for year-round space conditioning. That heat pumps can be used for heating and domestic hot water production is generally widely known, but the fact that heat pumps are also used in air-conditioning and cooling applications is less well known. People tend to think that refrigeration and cooling is a different technology, which it of course it isn't. It's just looking at the heat pump cycle from another perspective. Enjoy the newsletter.

Roger Nordman
Editor, HPC Newsletter

Published by IEA Heat Pump Centre
Box 857, SE-501 15 Borås,Sweden
Phone: +46 10 516 55 12
Fax: +46 33 13 19 79

Publisher:
IEA Heat Pump Centre
PO Box 857, S-501 15 BORAS
SWEDEN
Tel: +46-10-516 50 00, Fax: +46-33-13 19 79
E-mail: hpc@heatpumpcentre.org
Internet: http://www.heatpumpcentre.org

Editor in chief: Monica Axell
Technical editing: Roger Nordman,
Ulf Mårtensson - IEA Heat Pump Centre
Language editing: Neil Muir, Angloscan Ltd



Heat Pumps for Year-Round Space Conditioning

Sophie Hosatte
Chairman of the IEA
Heat Pump Programme
Natural Resources Canada

This newsletter addresses the theme of heat pumps for year-round space conditioning. Heat pumps have been identified by the IEA as a technology that will play a major role in reducing greenhouse gas emissions and energy consumption of the building sector. The technology is in fact unique, as it is the only available technology that can provide heating with efficiency higher than 100 %.

Recent publications show the significant performance increase that heat pump systems have achieved in the last few years. COPs of 4 or even 6 can be reached, with further increases expected. This opens great opportunities for applications in both the new and retrofit markets. Because they can upgrade thermal energy from various sources, heat pump systems are the core technologies for meeting near-zero and net-zero energy performance. They will provide efficient heating, cooling and hot water by integrating renewable energy and thermal storage.

Heat pumps dominate the air-conditioning market. It is essential that, when choosing a cooling system, a reversible heat pump should be the preferred option, thus providing year-round space conditioning. Different options exist, and their selection may vary according to the specific application (e.g. new or retrofit), and/or climate conditions (e.g. mild or cold climate, high or low humidity). In particular, attention should be paid to the use of variable-speed compressors, which can provide a substantial increase in performance and reduce sensitivity to load variations.

Air-source heat pumps are attractive as they can now operate down to -25 °C, avoiding the large investment of the ground-source heat pumps but with the inconvenience of lower efficiencies. As their capital costs fall, ground-source heat pumps are an interesting alternative because of their high performance in both the heating and cooling modes.

In order to compare different systems, the use of the seasonal performance factor (SPF) is a valuable tool . It evaluates the heat pump performance based on the local climatic conditions, rather than on specific conditions at which the system may operate only for a short period of time during the year. SPF makes it possible to compare not only different types of heat pump systems but also heat pumps versus conventional options, in terms of energy performance, carbon footprint, and operating costs.

This newsletter will provide you with interesting topical articles on heat pump developments, relevant legislation and successful experience.

Heat pumps - a key technology for heating and cooling in the building sector

Monica Axell,
General Manager,
Heat Pump Centre

Heat pumping technologies can be used for space and water heating as well as for cooling and dehumidification. In fact, heat pumping technology is the only technology which can cover all these applications with the same equipment. The principle can be applied to everything from small reversible heat pumps up to large heat pump systems in combination with thermal storage. Looking into the future, the need for systems offering both heating and cooling in an energy-efficient way can be expected to grow rapidly for several reasons, such as:

- Increased need for cooling because of economic growth and demand for improved building performance
- Increased need for cooling in low-energy buildings in warm climates
- Increased need for cooling because of increased demand for thermal comfort.

The present trend in the automotive sector for air conditioning in more or less all cars can perhaps be expected to be transferred to the building sector as well. Heat pumps for both heating and cooling are commonly used today. Small reversible heat pumps dominate the market for both heating and cooling in individual rooms, houses, retail stores, offices, schools and public buildings. It is estimated that around 30 million units are produced worldwide annually, with over 130 million units in operation in Japan, the USA, China and Europe. These heat pump systems are cost-effective in many regions of the world, as they cost little more than a cooling-only air conditioner. During the last five years, these small systems have been further developed for cold climates and market growth has been substantial, especially in single-family houses with direct electric heating systems. The main reason for buying such systems in colder regions is for heating applications, but the ability to offer cooling is an extra benefit for the end user.

In larger commercial buildings, there is often a simultaneous need for both heating and cooling. Heat pumps in combination with thermal storage can be used very efficiently, while the ability to increase the use of "free cooling", and to recover waste heat, e.g. from ventilation air, can substantially increase the overall efficiency. Free cooling can be, for example, cold outdoor air or cold liquid from a borehole. New systems that combine heating, ventilation and air conditioning in new innovative system solutions can save substantial amounts of energy and thus also contribute to CO_2 savings in the buildings sector. Heat pumps already save substantial CO_2 emissions in the building sector, and their impact can be even greater with more efficient systems and further deployment of the technology. There is still a need for further improvement: with future research and development of heat pumps for both heating and cooling, ranging from small reversible heat pumps up to large systems for commercial buildings and apartment buildings, systems can be expected to become even more competitive.

Response to Jim Crawford about misleading news item in the HPC newsletter

The HPC newsletter has received a letter from Mr Jim Crawford, that argues that the news item US may propose HFC phase-out through Montreal Protocol on page 7 of Volume 27 No. 1/2009 of the Heat Pump Centre Newsletter is misleading.

Mr Crawford says: "When the subject is US plans for treatment of HFCs, you should have gone to several US sources rather than relying on two very Eurocentric sources both of which are advocates for fluids other than fluorinated refrigerants."

A letter from the Department of State, signed by Mr. Reifsnyder sent to the UNEP Ozone secretariat was attached to Mr. Crawford's letter (see http://www.state.gov/documents/organization/122811.pdf).

The main issue Mr. Crawford criticises is the headline that says "phase out", when the issue action under discussion is a phase-DOWN to 15% of a baseline use over a period of 27 years. The baseline would be the average consumption in 2004, 2005 and 2006 based on an EPA analysis. He also criticised the fact that we didn't go to any US sources to verify the news item.

We at the HPC go through a large number of websites, journals and newsletters in pursuit for new news items that may interest our readers. We also applaud readers of the HPC newsletter that contribute news items.

At the time when the news scan was performed, no texts on the US websites reported on this issue, so we relied on the European source.

In retrospect, this was a mistake, and we apologise the confusion this may have caused our readers. In the future, we will increase our efforts to check the sources better than was done this time.

General

Successful right from the start

The first European Heat Pump Summit 2009 –by has ended after two successful days. The enormously broad spectrum of conference participants, exhibitors, honorary sponsors, consultant media partners and sponsors who came from all over Europe created a powerful event in Nürnberg. With some 270 European conference participants, top speakers and 22 exhibitors at the accompanying lobby show, the European Heat Pump Summit in Nürnberg got off to a remarkable start.

"On the basis of the Nürnberg venue's reputation for refrigeration exhibitions developed over three decades, NürnbergMesse has succeeded in putting heat pumps on the right track in the past years," says Gabriele Hannwacker, Exhibition Director of the heat pump event. The successful European Heat Pump Summit 2009 effectively emphasizes this.

"The event has succeeded in attracting great professional interest from a standing start. Then there is the marked European orientation – almost 50 % of participants came from abroad – and the focus on a purely B-2-B level," says Walter Hufnagel, Member of the Management Board of NürnbergMesse. The European heat pump experts and everyone professionally interested in renewable energy were able to garner information and exchange views at a high level in Nürnberg. The summit covered the whole range of power classes for heat pump applications: for industry, commerce, apartment blocks, etc. The heart of the heat pump beats in Nürnberg.
This is also confirmed by Dr. Rainer Jakobs from the Heat Pump and Refrigeration Information Centre (Informationszentrum Wärmepumpe und Kältetechnik IZW), the coordinator of the European Heat Pump Summit 2009: "Participants, speakers and exhibitors are similarly impressed. An enormous spectrum of heat pumps has been presented, and the event has found its home in Nürnberg. This is also underlined by the working talks and board meetings held by the national and international heat pump associations in the summit environment."

Farewell to the refrigeration and air conditioning industry
The successful European Heat Pump Summit 2009 marks the end of a 30-year commitment to European refrigeration, air conditioning and ventilation exhibitions for Walter Hufnagel, Member of the Management Board of NürnbergMesse. Hufnagel is retiring into private life with effect from 1 January 2010.

Outlook
Heat pumps will continue to be covered at Chillventa 2010 with the Industrial Heat Pump Village and the Heat Pump Symposium the day before the exhibition, and the European Heat Pump Summit enters its second round on 28–29 September 2011.

Background
NürnbergMesse will also organise the second European Heat Pump Summit in 2011 in close cooperation with the honorary sponsors IEA-HPP, EHPA, EPEE, BIV, the German Ministry of Economics and Technology, bwp, DKV, IZW and the PTJ Forschungszentrum Jülich.

This and other articles and photos are available in the press section at: *www.hp-summit.de/press*

Four national groups to survey states' geothermal regulations

Four national organisations committed to groundwater protection have agreed to conduct a comprehensive survey of states' regulation of geothermal heating and cooling systems.

The survey, to be completed in early 2010, is underwritten by the Geothermal Heat Pump Consortium,

the Ground Water Protection Council, the International Ground Source Heat Pump Association and the National Ground Water Association (NGWA).

Nationally, installations of geothermal heat pump systems are estimated by the Federal government to have increased by more than 33 percent in each of the last two years.

"With more and more boreholes being drilled to accommodate the increased demand for geothermal heating and cooling systems comes greater potential for groundwater contamination," says NGWA executive director Kevin McCray, CAE.

Geothermal heat pumps (GHPs) - also known as ground source heat pumps - replace conventional heating and cooling systems, and also can be configured to heat some or all of a building's domestic hot water. Because they simply move heat to and from earth, instead of burning a fuel to generate heat, properly designed GHP systems can provide decades of inexpensive renewable energy.

"To help ensure a vibrant geothermal heating and cooling industry, groundwater must be protected. It is important, then, to understand how states are protecting groundwater while allowing this technology," McCray asserts.
Source: National Driller October 2009 e-Newsletter

US powers ahead with GSHPs

Whilst this site is generally restricted to UK-related information, it is worth noting that President Obama announced that the US DOE is to provide $50 million of support for ground source heat pump development, in a country that is already a significant player in this technology and its deployment.

The support will be provided for three areas:

1) Innovative technology demonstrations
2) Life cycle cost tools
3) National certification and accreditation.

The latter is of UK interest, in that it recognises the need for appropriate training of GSHP professionals to increase consumer confidence. This is also the objective of the European GeoTrainet project.
Source: http://www.earthenergy.co.uk/groundswelldetail.asp?id=73

Geothermal panel as part of technology platform on renewable heating and cooling established

The European Commission has already endorsed technology platforms for several industries. It has also asked the different actors from the field of renewable energy use to join forces in a technology platform on renewable heating and cooling (TC-RHC).

This platform has now been established and it has been decided to organise the work in four panels (Biomass, Geothermal, Solar thermal and cross-cutting issues). Interested parties - among them the European Heat Pump Association – have met to establish the panel on geothermal energy use.

The panel will deal with all aspects of energy use from geothermal sources in heating/cooling applications, with the exception of geothermal electricity production.
The participants agreed on the following structure:

Focus Group 1: Shallow Geothermal
WG 1.a: Underground systems technologies and installation
WG 1.b: Site investigation and design, sustainability
WG 1.c: Exploitation and performance monitoring (inc. storage, coupling with others energies)
WG 1.d: Surface systems

Focus Group 2: Deep Geothermal:
WG 2.d: surface systems: direct uses & cascade uses, district heating & cooling, CHP
WG 2.b: Deep drilling
WG 2.a: Resource assessment, exploration
WG 2.c: Production technologies
WG 2.e: EGS

Focus Group 3: Non-technical issues
WG3a : Shallow > Market and Policies (regulations, financing and economics), Communication
WG3b : Deep > Market and Policies (regulations, financing and economics), Communication
WG3c : Training (common for shallow and deep)

A website has not yet been constructed, but will be accessible via the Commission's overview page on all technology platforms.
Source: http://www.ehpa.org/en/aktuell/kat1/akt653.html

The European Commission calls for proposals to boost research in key market areas
On 30 July, the European Commission launched the first round of calls for proposals for three Public-Private Partnerships (PPPs) set up in the European Economic Recovery Plan: Factories of the Future, Energy-efficient Buildings, and Green Cars. From 2010 to 2013, a total of €3.2 billion will be allocated to research to develop new technologies in key market areas, with half of the funds coming from industry and half from the European Commission through the 7th Framework Programme for R&D (FP7).

This collaboration between the Commission and industry will foster global competitiveness for European businesses, bring down the excessive energy consumption of Europe's buildings that make up one-third of EU CO_2 emissions, and develop new and sustainable forms of road transport.
Source: Newsletter no. 320 of 30.7.2009: Energy and Transport in Europe Digest

The road to zero emission in the EU is cabled

The upcoming COP15 meeting in Copenhagen is casting its shadow, and heat pumps are part of the discussion. Europe's energy supply can only be completely carbon-neutral with electric cars and heat pumps, said Lars Aagaard, Deputy Director of the Danish Energy Association.
EHPA will participate in the meeting to present heat pumps and their contribution potential for the climate.
Source: http://www.ehpa.org/en/aktuell/kat1/akt697.html

European Commission publishes template for 27 national renewable energy road maps

The National Renewable Energy Action Plan (NREAP) template gives governments a binding framework for drawing up the steps they will take in order to meet binding national targets set out in the 2009 Renewable Energy Directive (Directive 2009/28/EC).

The template explicitly states that Member States are to set national sectoral targets for electricity, transport, and heating and cooling and outline the expected contribution of each renewable energy technology to these targets.

The template requires national governments to explain the actions that they will take to develop the power grid so that their national renewable electricity target can be met. For example, they must outline their development plans for transmission infrastructure and whether they are planning to reinforce the interconnection capacity with neighbouring countries. The same goes for the planned measures to smoothen administrative procedures.

Governments must list any "unnecessary obstacles or non-proportionate requirements" and outline "whether further steps are needed to ensure that procedures are proportionate and necessary".

Member states must complete and submit their NREAPs to the European Commission by 30 June 2010. Should they fail to do so, or should the Commission consider that a Plan is insufficient to meet the legally binding national renewable energy target, it can start infringement proceedings against the member state in question.
Source: http://www.egec.org/index.html

RES Directive published in the EU official journal

The official publication of the famous RES Directive.
The Directive in question has been published in the Official Journal of the European Union, under the title: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
This directive, along with three other directives, one regulation and one decision, form the Climate-Energy Legislative Package, adopted by the Council on 6th April 2009, with the aim of achieving the environmentally friendly targets of 20-20-20 % by 2020.
Source: http://www.egec.org/index.html

Survey on certification schemes for GSHP installers

In anticipation of the implementation of Article 14 of the Directive on the promotion of the use of energy from renewable sources, obliging member states by December 2012 to develop & mutually recognise accreditation & certification schemes for installers of small-scale renewable energy installations (and notably GSHP installers), the QualiCert project is conducting a concerted action among different member states on this topic.

In a first step, QualiCert is collecting information to assess accreditation & certification schemes existing in the different EU member states. Based on this analysis, a set of success criteria for technical, legal, institutional, financial and communication aspects will be distilled. The identified success criteria will be subject to reality checks in a series of stakeholder validation workshops.
Source: http://www.egec.org/index.html

Beyond energy efficiency

Eceee presents its input paper for the new EU Energy Efficiency Action Plan. "Instead of just creating a long wish list, we have tried to focus on fewer, but very important issues" said Eceee's Executive Director, Nils Borg.
The paper underlines the importance of issues such as minimum energy performance standards, mandatory efficiency targets, the need for clear and manageable objectives, incentives, and capacity building in EU member states.
The paper has been developed by participants at the Eceee 2009 Summer Study, and was further refined through a consultation among Eceee's members.

The paper's conclusions are, in short:
• The new EEAP should contain a finite number of clear and manageable high-level objectives.
These should include: 1. mandatory energy efficiency targets; 2. an agreed and strict measuring system for energy savings; 3. capacity building aiming to improve implementation and enforcement in member states; and 4. improved financing of energy efficiency in all end-use sectors.

• In addition to focusing on energy-efficient technologies, policies should also aim at avoiding the unnecessary use of (even very efficient) energy technologies.

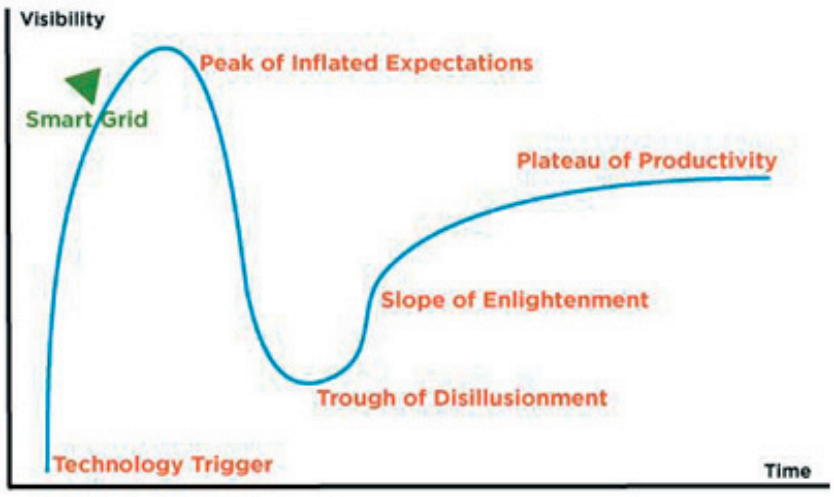
More incentives should be created for consumers and manufacturers to change their ways and save energy.

The necessary technologies and ideas are (largely) there, the challenge is putting them into practice.
Source: http://www.eceee.org/eceees_views/beyond_energy_efficiency/

CEE experts discuss smart grid potential

Preventing regional power blackouts, improving demand-side energy management, offering new customised pricing options, helping the environment - all these benefits were the subject of smart grid presentations at the recent CEE June Programme Meeting. CEE, along with technology partner EPRI (the Electric Power Research Institute), has been keeping tabs on the development of smart grid standards development and smart grid implementation pilot projects across the CEE membership. Smart grid, essentially, is a whole new interactive way of approaching energy distribution and management, from transmission networks to home energy use scheduling, including "smart" communication among appliances, computers, electric meters, consumers, and utilities.
At the June CEE Programme Meeting, Omar Siddiqui of EPRI gave an overview of the subject, noting that EPRI is under contract to NIST (National Institute of Standards and Technology) to develop the road map that will bring the smart grid to fruition.

Omar Siddiqui's humorous take on where smart grid is on the curve of technology expectations.



For more information on the Southern California Edison SmartConnect program, contact: Larry Oliva at Lawrence.Oliva at sce.com or (626) 633-3410. For more information on CEE's burgeoning work in smart grid, contact Rebecca Foster at rfoster@cee1.org or (617) 337-9265.
Source: http://www.cee1.org/resrc/news_items/SmartGrid.html

India's shortage of cold storage threatens nation's harvests

Cold storage facilities for India's agricultural produce is falling short by more than 10 million tonnes, according to a report by KPMG and the Associated Chambers of Commerce and Industry of India (ASSOCHAM).

With only 21.7 million tonnes of such facilities, against a national demand for more than 31 million tonnes, the massive shortfall in the country's cold storage is resulting in 40 % of agricultural produce being lost post-harvesting.

Quoting findings of the report, 'Food Processing and Agri Business of KPMG and ASSOCHAM', ASSOCHAM president, Sajjan Jindal, said cold storage facilities now available are mostly for single-commodity produce including potatoes, oranges, apples, grapes, pomegranates and flowers, which results in poor capacity utilisation.

The report recommended more fiscal incentives to encourage firms to spend on upgrading food processing technology to drive technological improvements.
source: http://www.acr-news.com/news/news.asp?id=1661&title=India%27s+shortage+of+cold+storage+threatens+nation%27s+harvests+

BUILD UP
energy solutions
for better buildings

BUILD UP – New web portal

The European Commission has launched the BUILD UP web portal as a tool for sharing information on reducing energy use of buildings. "The BUILD UP web portal will enable anyone from home-owners to builders to look up and share best practice and information. At the same time, it will inform and update the market about the legislative framework. BUILD UP can be an extremely useful tool to improve building performance."
More information : http://www.buildup.eu/
Source: http://www.rehva.eu/?page=243.build-up-new-web-portal

Working Fluids

Timor-Leste makes Montreal protocol first global environmental agreement to achieve universal ratification

A treaty to protect the ozone layer, which shields all life on Earth from deadly levels of ultra-violet rays has scored a first in the history of international environmental agreements.
Mr. Xanana Gusmão, the Prime Minister of the young Pacific nation of Timor-Leste, announced that it had ratified the Montreal Protocol, making this the first environmental agreement to achieve universal participation by 196 parties.
"Timor-Leste is very pleased to be joining the rest of the world in the fight against the depletion of the ozone layer and the effort towards its recovery. We are proud to be part of this important process to protect the ozone layer and undertake to implement and comply with the Montreal Protocol like all other states that preceded us in this important journey," Mr. Gusmão said.
Source: www.unep.org

Japan: refrigerant leakage larger than expected

According to a survey conducted by the Ministry of Economy, Trade and Industry (METI) of Japan, leakage of fluorinated refrigerants used in air-conditioning equipment in the country is, on average, ten times greater than estimated. Over one year, METI collected results from 260 000 samples from maintenance contractors, equipment users and other parties, and checked the statistical reliability, taking into account data on CFCs, HCFCs and HFCs in order to assess HFC emission coefficients. The annual leakage coefficient for household room air conditioners was revised upwards from 0.2 % in 2007 to 2 % in 2008; the coefficient for commercial packaged air conditioners was raised from 0.9 % to 3 %, that of chilling units from 2 % to 6 %, and that of medium-sized refrigeration units from 1.1 % to 17 %. Possible causes of the erroneous estimates include underestimating the amount of refrigerant discharged from equipment during breakdown/repairs. The amount of fluorinated refrigerant emissions, expressed as equivalent CO_2 emissions, in 2007 have been revised upwards from 6.5 million tons to 13.2 million tons. However, according to JARN, this amount is only about one-third that of the US and two-thirds that of Europe.
Source: https://www.iifiir.org/en/news.php?rub=5&nl=39&id=1975#5

EU compliance with the F-Gas Regulation

With the F-Gas Registration deadline having passed, only 20 out of 27 EU member states were found compliant in setting up the necessary framework, according to a survey conducted by EPEE. The progress of the RAC industry in terms of registering for obtaining F-Gas certificates seems to be even slower.
20 member states are already compliant. The list of compliant countries includes Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Latvia, Luxemburg, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.
Source: http://www.ehpa.org/en/aktuell/kat1/akt671.html

New guidance on permitted use of recycled HCFCs

THE availability and price of reclaimed HCFCs after December 2009 is 'very uncertain', warns F-Gas Support, following reports of large industrial firms reserving stocks of reclaimed R22 and being prepared to pay almost any price.
From January 1, 2010, it will be illegal to use virgin HCFCs to service RAC equipment. It is also illegal to stockpile and use any supplies of virgin HCFCs after the end of 2009.
Any company planning to use reclaimed HCFCs to maintain systems after 2009 is being advised to contact its refrigeration supplier to discuss how to meet expected demand.

The DEFRA-funded team, known as F-Gas Support, has stated that 'recycled' HCFC gas (recovered gas that has undergone a basic cleaning process) may be used only by those carrying out the recovery (i.e. the refrigeration contractor) or the owner. The recycled HCFCs may not be placed on the market (i.e. be supplied to third parties free of charge or in exchange for payment.)

The owner also cannot sell recycled HCFC to a third party, but can use the recycled HCFC in ACR equipment at other sites it operates from.
'Reclaimed' HCFCs (recovered HCFC gas that has been chemically reprocessed to a specified standard) can be placed on the wider market and used by parties other than the owner or original contractor.
F-Gas made the statements as part of its newly published guidance on new legislation concerning R22, which comes into force on January 1, 2010.
The DEFRA guidance covers the availability and permitted use of recycled HCFCs and other proposed amendments to the EC Ozone regulation.
Source: http://www.acr-news.com/news/news.asp?id=1656&title=New+guidance+on+permitted+use+of+recycled+HCFCs

In view of the ongoing debate on the respective efficiency of HFCs and alternative refrigerants in refrigeration and air-conditioning equipment, AREA has provided the European Commission with an input paper. Based on technical data, this paper shows that the best refrigerant very much depends on the type and features of RAC equipment.
Source: http://www.area-eur.be/go/Area/3380/en-US/DesktopDefault.aspx

Technology

SSEEC (Solid-State Energy-Efficient Cooling)

This is an FP7 project aimed at developing magnetic cooling with commercially-driven goals. The consortium of research institutions and companies has the goal of building a high-efficiency heat pump and air conditioner based on a magnetic cooling cycle. Both devices will operate at room temperature. The core materials research will centre around the identification, synthesis, modelling and production of low-cost, environmentally friendly magnetic refrigerant materials that operate in low magnetic fields, and the synthesis and production of inexpensive permanent magnets, as the two key material components of a magnetic cooling engine. By involvement of an SME, a medium-scale materials manufacturer and a major systems end-user, we will ensure industrially-guided feedback on materials design and performance. Furthermore, we will have the opportunity to integrate and assess our materials with the systems components (heat exchangers, motors and pumps) required to produce a heat pump and an air conditioner by completion of the project

Source: http://www.sirac.org.uk/NO07W8614261

Markets

GCC district cooling is booming

According to a MEED recent report, the Gulf Cooperation Council (GCC) district cooling market has experienced rapid growth over the past ten years, and now has a capacity of just over 6300 MW.

The GCC involves the six Persian Gulf states of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. Considering that district cooling technology can be 40 % more efficient than conventional air conditioning, MEED forecasts that an additional 22 800 MW will be built in the GCC area by 2015, and that the cost of this additional capacity is likely to be around USD 19.5 billion.

The report also states that the UAE district cooling market is five years ahead of the rest of the GCC, although Saudi Arabia, Qatar and Bahrain have strong growth potential.

Source: http://www.businesswire.com

India Packaged air conditioner market subdued in 2008/09

(Compiled by Hiru M. Jhangiani, Consulting Editor)

With the econwomic slowdown in the country across most sectors, the market for packaged ACs for normal "comfort" applications in offices, banks, restaurants, showrooms, retail shops, supermarkets etc. saw a downward trend, compared to the previous year. Estimated sales of such units was 500 000 tons (1758 MW) compared to 578 000 tons (2033 MW) last year. This drop occurred in spite of a reduction in excise duty from 14 % to 10 % in December 2008, and a further reduction to 8 % in January 2009, introduced by the government in an effort to help industry sell more goods.

South India had the largest market share, followed by west, north and east. West and north were very close to each other in market share.

Market scenario for VRF units

The market for VRF systems in 2008 increased to an estimated 130 000 hp (95.7 MW), compared to 87 000 hp (64 MW) in the previous year. In 2009, the market is expected to grow further and, as a result, four new players have recently entered the market, in addition to the existing six players. The new players are Samsung, Mitsubishi Heavy Industries (through Stulz-CHSPL), Sanyo (through ETA Engineering) and York. The established players are Daikin, Toshiba, Midea, LG, Mitsubishi Electric and Blue Star Ltd.

Market scenario for precision air conditioners for data centres

The market size for close-control air conditioners used in data centres and server rooms for the IT industry increased substantially, by about 50 % relative to the previous year. The total market size was about 80 000 tons (281 MW), made up almost equally of self-contained DX units and chilled water air handling units connected to a central chilled water system. Blue Box, Italy, was the newest entrant in the market. The existing players were Emerson Network, Stulz-CHSPL, Uniflair, Blue Star Ltd. and Clivet.

Market scenario for telecom units

These special units designed for telecom shelters required for the fast-growing mobile phone network, saw a small drop over last year, mainly because one large player could not finalise an order in time for the year closing, and also because of infrastructure sharing between telecom companies in order to reduce operating costs. The table below summarises the market size for the four types of air conditioners described above. All figures are approximate, but indicative of the market trend.

Source: http://www.ishrae.in/news/news_fullarticle.asp?srno=190

TYPE	TONS	MW	UNITS
RACs (window & split combined)	NA	NA	2.5 million
PACs (for comfort applications only)	500 000	1758	71 000
PACs (for only data centres)	80 000	281	6 000
PACs (for only Telecom shelters	90 000	316	60 000

Heat pump market growing rapidly in China

According to JARN, the heat pump water heaters market in China is growing fast, with sales having reached an estimated 250 000 units in 2008. Although R22 remains the refrigerant of choice at present, some local players have recently begun to develop CO_2 compressors and heat pump systems. A new article by Japan Air Conditioning, Heating & Refrigeration News (JARN) reports that the Chinese market size for heat pump water heaters in 2008 reached an estimated 250 000 units, which corresponds to an estimated RMB 1.3 billion (about US$ 190 million), while for 2009 the market is expected to exceed RMB 1.5 billion (about US$ 220 million). These figures compare to 360 million RMB (€37 million) in 2005 and 1.20 billion RMB (€106 million) in 2007.

To put this into perspective, the overall water heater market in China is about 18.7 million units each year, which could provide a huge potential market for the heat pump water heaters.

Source: http://www.ehpa.org/en/aktuell/kat1/akt650.html

ELENA: A new funding source for local investment in sustainable energy

The European Commission and European Investment Bank (EIB) are setting up a new financing scheme known as "European Local Energy Assistance", or ELENA. ELENA forms part of the IEE programme and should be operational in the second half of 2009.

ELENA will help local authorities develop bankable sustainable energy investment projects or programmes in a variety of sectors, and ensure their eligibility for further EIB funding. Any action supported must contribute to the CO_2 reduction objectives established in the Commission's Covenant of Mayors initiative.

More details will be published as soon as they are available on www.eumayors.eu

What does the future hold for the HVAC market?

Recently BSRIA hosted a private seminar to discuss the new HVAC Overlapping Markets study. The event was well attended by the study subscribers, with a number of senior representatives from some of the market-leading companies from the air conditioning, renewable energy and heating industries.

The were many opportunities for study subscribers to increase their knowledge of the overlapping markets, with an array of topics discussed on the day which included key market trends, impacts and a comprehensive supplier and distributor analysis presentation. Delegates were also treated to an overview of key future drivers and challenges in the European HVAC market up until 2020. The seminar concluded with an overview of EU and national legislation, and the impacts they will have on the HVAC market from market expert Gambi Chiang.

Project leader Greg Corty revealed key influences affecting the market, such as government incentives (particularly in Germany) and improving energy performance, notably in France, where there has been a shift in favour towards nuclear energy. It is clear that the recession has affected the majority of the European countries included in the study, in particular Spain and the UK.

The Overlapping Study was very well received by the delegates, with many eager to incorporate the study into their product development and routes to market strategy.

Source: http://www.bsria.co.uk/news/overlapping-event/

The Renewable Energy of the Year prize goes to the Finnish Heat Pump Association SULPU: A breakthrough for heat pumps

Finland's Minister of Economic Affairs, Mauri Pekkarinen, presented the Finnish Heat Pump Association SULPU with the Renewable Energy of the Year prize at the Savexpo Fair in Vantaa, September 18 2009. The prize was part of the Promoting Renewable Energy series.

The Finnish Heat Pump Association was founded ten years ago. Its role is to promote the heat-pump industry and to improve both the operational conditions of the industry and the quality of installation work and equipment. SULPU also monitors the interests of practitioners in the field and promotes the cooperation of its members.

SULPU has been active in promoting the implementation of the EUCERT

The prize was presented by Minister of Economic Affairs, Mauri Pekkarinen, and it was accepted by Jussi Hirvonen, Chair of the Finnish Heat Pump Association and Petri Koivula, Managing Director

certification system for heat pump installer training as well the EHPA Quality Label guarantee system in Finland.

One million heat pumps in a decade
During the past few years, heat pumps have made a substantial breakthrough in Finland. In 2008, more than 60 000 heat pumps were sold in Finland, which exceeds the previous year by a third. Ground source heat pumps provided the most revenue, whereas air source heat pumps sold most in terms of actual numbers. The new arrival on the market is the air- to-water source heat pump, which produces hot water by using outdoor air, says Mr Jussi Hirvonen, Chair of the Finnish Heat Pump Association.

At present, there are approximately 250 000 heat pumps in use in Finland.

The EU requirement for increasing the use of renewable energy is challenging for Finland – a country that is already one of the leading countries in its use. However, with optimum use of heat pumps, we should be able to reach as much as a third of the 30 TWh annual increase target.

I believe that one million heat pumps will be installed in Finland within the next ten years, Mr Hirvonen estimates.

The Prize Jury's Statement
The prize jury extends its thanks to the Finnish Heat Pump Association for its role as an active developer of the industry. SULPU has promoted the industry in various situations and contexts and has participated, for example, in the creation of the heat pump industry certification system in Finland.

For more information:
Mr Jussi Hirvonen, Chair of the Finnish Heat Pump Association, jussi.hirvonen@ivt.fi , www.sulpu.fi
Mr Petri Koivula, Managing Director of the Finnish Heat Pump Association, petri.koivula@sulpu.fi, www.sulpu.fi

IEA HPP

Solar + Heat Pumps

October 2009
A new task on systems using solar thermal energy in combination
with heat pumps will begin in 2010. Be a part of this new work.
Over the past few years, systems that combine solar thermal technology and heat pumps have been marketed to heat houses and produce domestic hot water. This new combination of technologies is a welcome advance, but standards and codes of practice are still required for its long-term successful commercialisation. At present, most manufacturers are developing systems without a clear framework of what could be the best combinations of the two energy sources, and customers have no means of comparing systems. The result is that systems reaching the market today are far from being optimised, or simple enough to ensure a problem-free life and efficient operation, whether technically or economically.
What is needed is a systematic analysis of the different possible systems and their potential for application in different climates and under different boundary conditions. To begin to tackle this, the SHC Programme has initiated Task 44, Systems using solar thermal energy in combination with heat pumps (HP+Solar).

The task will begin in 2010, concentrating on the following items and aspects:
- Small-scale residential heating and hot water systems that use heat pumps and any type of solar thermal collector as the main components.

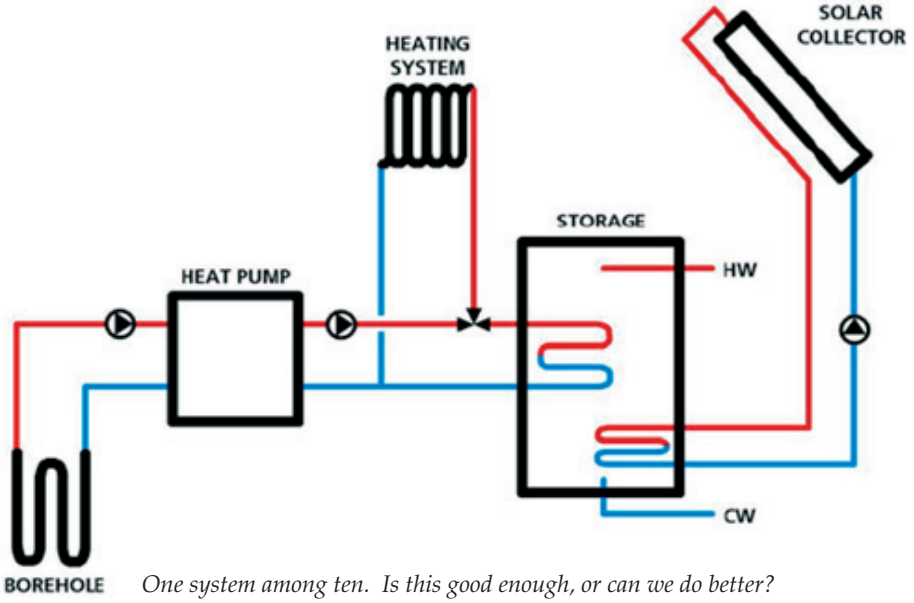
Systems offered as one product from a system supplier/manufacturer and that are installed by an installer.
- Electrically driven heat pumps, although thermally driven heat pumps will not be excluded during development of performance assessment methods.
- Market available solutions and advanced solutions (produced during the course of the task).

In order better to focus on the current market demand, large-scale systems (i.e. systems using any type of district network, or systems for large buildings) are excluded, as is the comfort cooling of buildings. However, a heat pump can also be used for cooling, and the performance assessment methodology should not disregard this "optional" feature.

Task participants are expecting to divide their work into four sub-tasks:
- Overview of solutions (existing, new) and generic systems
- Performance figures and performance assessment
- Modelling and simulation
- Dissemination and market support measures

Why participate ?
- Combined heat pump and solar energy systems will constitute a large market share in future decades. In some regions, systems are already installed in 80 % of new homes.
- An IEA framework provides a unique opportunity to meet and share with experts from universities and industries working on thermal solar and heat pumps.
- We are attracting top engineers and manufacturers to the task.
- Future systems will be sketched and new ideas will emerge from the exchange of practice, knowledge and experience.

The initial work will produce materials to assess performances of combined system, for which there are at present no formal definitions.



One system among ten. Is this good enough, or can we do better?

Interview with Jussi Hirvonen, representing Finland in the IEA HPP

Fact sheet: Jussi Hirvonen
Name: Jussi Hirvonen
Affiliation: Chair of the Finnish Heat Pump Association ry, Managing Director of IVT Lämpöpumput Oy
Lives in (city): Vantaa
Interests (apart from heat pumps): Activities in various associations, lakeside forest cottage.

Dear Mr. Hirvonen, welcome to the IEA Heat Pump Programme (HPP).

Our readers are interested in knowing more about Finland, and are also interested in knowing more about your expectations for HPP.

The heat pump market in Finland

1. Could you briefly describe Finland's heat pump scene today? Which industries are sited in Finland, and what products are manufactured?

In just over ten years, the Finnish heat pump industry has grown from virtually non-existence into a very significant industry. 60 000 heat pumps were installed in 2008, which resulted in an EUR 300 million turnover for the industry. Air source heat pumps are mainly produced in the Asian countries, whereas more than half of the ground source and exhaust air source heat pumps are made by big producers in our neighbouring country of Sweden. There are approximately five ground source heat pump manufacturers in Finland.

We must bear in mind, however, that regardless of where the heat pumps are manufactured, more than two-thirds of the product value is added in the domestic market.

2. What does the market look like? Is it mainly reversible heat pumps for heating and cooling that are sold, or are there other technologies?

When looking at sales figures in terms of simple numbers, air source heat pumps have the highest sales in Finland. They are bought for direct electric heated houses and for summer cottages, with an installed base of about half a million for each type. In addition to cutting down thousands of kWh on the electricity bill, air/air heat pumps are also used as cooling devices during the few hot days of our short summer.

Initially, the ground source heat pump market started with new houses. However, ground source heat pumps have increasingly replaced oil heating or electric hydronic heating. In some cases, the ground is also used as a cooling source for houses.

As many as half of the current single-family house builders choose a heat pump as a form of heating. There are 1,2 million single-family houses in Finland, and 250 000 of them have a heat pump.

3. Market share for different types of heat pumps (air-to-air, air-to-water, GSHP, other?)

Approximately 60 000 air-to-air heat pumps were sold in Finland in 2008: 48 000 air/air heat pumps, 2000 exhaust air heat pumps, 2000 air/water heat pumps and 8000 ground source heat pumps. However, instead of looking at the sales numbers, we should acknowledge the benefits that heat pumps provide. If we look at the kWh or CO_2 emissions that are saved, ground source heat pumps contribute to half of the benefits in each case.

4. Are heat pumps installed mainly in single-family houses or in apartment buildings?

Capital: Helsinki. Population: 5,250,275 (July 2009 estimate.)

The majority of heat pumps are installed in single-family houses. Although district heating is used a lot for the heating of properties, there are many mainly oil-heated housing, industrial and commercial buildings that are not within reach of district heating. Increasingly, the heating systems of these properties are being changed to energy and environment-saving heat pump heating systems.

5. Are there any subsidy schemes, soft loans or other actions in Finland to stimulate market growth?

Each Finnish household can claim a tax reduction of up to EUR 3000

per person per year for outsourced household work that relates to either renovation or household work. Many people allocate this deduction to cover the share of the labour costs of their heat pump investment.
There are no other forms of financial support for energy-saving investments.

Acceptance of heat pumps in Finland

6. What is the general opinion about heat pumps? Are they well known to the public?

As a concept, heat pumps are very well known now, thanks to the high air/air heat pump sales figures. Heat pumps have found general and political acceptance mainly during the past year now that politicians, followed by the press, have commented on the EU Renewable Energy Directive and the practical options thereof. Here, heat pumps offer one solid option that is affordable for consumers in Finland's cold climatic conditions.

There is an enormous demand for information on which type of heat pump should be considered for each type of property.

7. Are heat pumps considered renewable energy in Finland?

Yes they are, naturally in the limits of requirements of the EU Renewable Energy Directive e.g. for Seasonal Performance Factor (SPF).

Research in Finland

8. What research is being carried out in Finland related to heat pumps? Any specific areas of research those are "hot" at the moment?

At present, there is not a lot of ongoing, large-scale national heat pump activity. Unfortunately, the same must be said about training. The heat pump suppliers and users have product-specific or project-specific ventures. There are plans to form national projects that are related to the intended IEA HPP Annexes.

Mr. Hirvonen, thank you for taking your time to answer these questions, and once again, welcome in the IEA HPP.

Interview with Giovanni Restuccia, representing Italy in the IEA HPP Executive committee

Dear Mr. Restuccia, welcome to the IEA Heat Pump Programme (HPP).

Our readers are interested in knowing more about Italy, and we are also interested in knowing more about your expectations about HPP.

Capitol: Rome
Population: 58,1 million

The heat pump market in Italy

1. Could you briefly describe Italy's heat pump scene today? Which industries are sited in Italy, and what products are manufactured?

In Italy, because of a cultural delay in recognising and applying technologies for energy saving and rational use of energy, there is a delay in expansion of the heat pump market, although the favourable climatic conditions would allow good performance of these systems.

In Italy, the HVAC production companies are concentrated in the north-east regions, where they benefit from the typical general advantages of a technological district.

2. What does the market look like? Is it mainly reversible heat pumps for heating and cooling that are sold, or are there other technologies?

The market is mainly orientated towards reversible heat pumps, and because of climatic conditions, air/water systems can be used in the south of the country without being limited by minimum winter temperatures.

3. Market share for different types of heat pumps (air-to-air, air-to-water, GSHP, other?)

A market analysis in 2007 showed that 73 % of the market is covered by split (mono and multi) and autonomous systems for domestic application or for small shops. For these devices, there was a substantial increase over 2006, although with a large majority of imported products.

The strongest national production is of air/water systems from 17 kW up to more than 350 kW. A good percentage of this is exported, particularly of the larger sizes. In this sector, about 70 % of the devices are heat pumps.

4. Are heat pumps installed mainly in single family houses or in apartment buildings?

Installation of heat pumps in the domestic sector in Italy is limited because of the electricity rates. There is a cheap tariff up to 3 kW in apartments, but the use of electric heat pumps would require a higher sup-

ply rating, and thus a more expensive tariff. For this reason, the use of natural gas with boilers for domestic heating is more convenient than electric heat pumps.

The situation is completely different in the tertiary sector, where reversible heat pumps are much more common.

5. Are there any subsidy schemes, soft loans or other actions in Italy to stimulate market growth?
Financial support from the government for installation of ground source heat pumps has been available since 2008.

Acceptance of heat pumps in Italy
6. What is the general opinion about heat pumps? Are they well known to the public?
The general opinion is that heat pumps are not known as much as air conditioners, which is particularly evident in the southern part of the country, where the need for summer air conditioning is evident.

7. Are heat pumps considered renewable energy in Italy?
No, but government financial support for ground source heat pumps is also available for solar thermal energy in residential buildings. So there is a growing realisation that heat pumps can be considered partly as renewable energy.

Research in Italy
8. What research activities is being carried out in Italy related to heat pumps? Any specific areas of research those are "hot" at the moment?
As far as I know, there is no government-supported research into electric heat pumps, although there is some research in the field of thermally driven heat pumps, with some specific application for solar air conditioning.

Mr. Restuccia, thank you for taking your time to answer these questions, and once again, welcome in the IEA HPP.

Ongoing Annexes

Bold text indicates Operating Agent.

Annex 29 Ground-Source Heat Pumps - Overcoming Market and Technical Barriers	29	**AT**, CA, JP, NO, SE, US
Annex 30 Retrofit heat pumps for buildings	30	**DE**, FR, NL
Annex 31 Advanced modelling and tools for analysis of energy use in supermarkets.	31	CA, DE, **SE,** UK**,** US
Annex 32 Economical heating and cooling systems for low-energy houses.	32	CA, **CH**, DE, NL, SE, US, JP, AT, NO
Annex 33 Compact Heat Exchangers In Heat Pumping Equipment	33	**UK**, SE, US, JP
Annex 34 Thermally Driven Heat Pumps for Heating and Cooling	34	AT, **DE**, NL, US

IEA Heat Pump Programme participating countries: Austria (AT), Canada (CA), France (FR), Finland (FI) Germany (DE), Japan (JP), The Netherlands (NL), Italy (IT), Norway (NO), South Korea (KR), Sweden (SE), Switzerland (CH), United Kingdom (UK), United States (US). All countries are members of the IEA Heat Pump Centre (HPC). Sweden is Operating Agent of the HPC.

EU progress towards more efficient air-to-air air heat pumps and air conditioners

Philippe Rivière, Mines Paristech, France

Introduction

The largest heat pump market in Europe is that of reversible air conditioners, with more than 3 million units sold in Europe each year [1]. Air-to-air heat pump performances may vary from EER2.2 and COP 2.4 to EER 5.7 and COP 5.6 [2] under standardized conditions [3]. This wide spread presents a high energy efficiency potential, but with reservation for some uncertainty on final energy consumption gains given the high penetration of variable-speed drive compressors and the present use of a full-load rating standard for inverters. However, with their high energy-saving potential and growing market figures, reversible air conditioners were studied within the framework of the Energy Using Product directive [4].

EuP Process

The Ecodesign of Energy-Using Products Directive is intended to reduce the environmental impact of energy-using products by specifying requirements for CE-marking. The main lines of requirements for products are contained in Article 15 of the EuP directive. A methodology has been established to assess the environmental impacts of EuPs during their life cycle [5]; it also presents some common features required within all product level studies, also referred to as "lots". Of particular interest for heat pumps, the methodology sets the primary energy factor to 2.5: according to Eurostat, the average electric power plant efficiency is about 40 %.

17 preparatory product-specific studies are already completed, and ten studies are ongoing [6]. The preparatory studies provide the necessary information to prepare for the next phases of the legislation process, and in particular the proposal for implementing measures for a specific product and for the impact assessment of these measures. The proposed implementing measures are then discussed in the Consultation Forum, which brings together Member States and main stakeholders (ONGs, industry, …), before the Commission submits a draft regulation proposal to the Regulatory Committee. If approved by MS, the regulation must then be approved by the European Council.

Proposed measures for air-to-air heat pumps and air conditioners

The Ecodesign study on room air conditioning appliances and ventilation [7] formulated policy scenarios on the basis of which the Commission proposed implementing measures that were discussed in the Consultation Forum in June [8]. Being a working document, the proposed measures are only provisional, and the final legislation could change after the remaining steps of the EuP legislative process. In this working document, air conditioners below 12 kW cooling (or 12 kW heating for heat-only air-to-air heat pumps) are proposed to be split into two categories: room air conditioners (fixed split and multi-split), and local air coolers (window, single and double duct). For split air-to-air heat pumps and air conditioners, the proposed measures are as follows.

SEER and SCOP by bin method instead of EER and COP

In heating mode, the SCOP methodology has been made compatible with the seasonal performance metrics for other heating means of the Lot 1 study [9]. The climate of Strasbourg has been set as the reference climate to represent EU-average heating conditions. This is rather cold for an air-to-air heat pump, with the market being rather South of Europe, but it makes it possible to compare all heating means on the same scale for energy labelling, and to set compatible minimum performance requirements. The manufacturer declares the heating capacity of its system (it may include a proportion of resistive heating) at a design temperature of –10 °C for standardised capacities at design conditions. Some flexibility is offered to manufacturers to declare more capacity with lower SCOP for the same machine, with an option to declare the design heating capacity between –7 °C and +2 °C.

A linear load curve is then drawn between the declared design output at design condition and zero load at 16 °C. Four COP values at outdoor temperatures of –7, +2, +7 and +12 °C, with 20 °C indoor temperature and corresponding load ratios are rated. Heat demand that cannot be supplied by the heat pump is assumed to be supplied by an electric heater with a COP of 1. Interpolation rules are set to determine COP and heating capacity at each temperature bin.

The sum of the products of the heating loads of the temperature bins by the bin hours is then divided by the sum of the products of the electric power by the bin hours to obtain the SCOP. Manufacturers may choose to publish supplementary SCOP values for Northern (Helsinki) or Southern (Athens) climates.

In cooling mode, a single SEER value is proposed. The average climate is the weighting of the 27 EU climates versus the sales of split air conditioners in Europe [1]. The method is the same, but now with a design temperature of 35 °C and a zero-load condition of 16 °C. Four EER values are computed along the load curves at outdoor temperatures of 35, 30, 25 and 20 °C, with an indoor air temperature of 27 °C (wet bulb temperature 19 °C) and different part-load ratios. Interpolation rules are defined, to determine EER and cooling capacity in each temperature bin. In both cooling and heating modes, auxiliary power consumptions (oil heater, thermostat off, standby, off mode) are taken into account with specific annual operating hours.

Labelling lower class limits	
SEER	SCOP
(cooling)	(heating)
6.8	4.6
5.7	4
4.6	3.4
4	3.1
3.4	2.8
2.8	2.5
2.4	2.2
2	1.9
2	1.9

Figure 1: SEER and SCOP limits for energy labelling [8].

Energy and refrigerant requirements

Labelling classes are proposed (Figure 1), based on the new seasonal performance indices. The final format of the label is still under discussion in connection with the revision of Labelling Directive 92/75/CE. Tolerances for compliance assessment would be decreased from 15 % to 8 % of declared capacities, SEER and SCOP. Minimum performance values would be based on the seasonal performance indices (Figure 2). All data required to compute SEER and SCOP (including North and South Europe SCOP) should be included in the technical documentation. In addition, it is proposed that the label should include annual equivalent greenhouse gas emissions, with default leak rates for the units. The proposed LCCP indicator of GHG-equivalent emissions has not been used to set specific requirements, as the F-gas Regulation 2006/842/EC already sets requirements for refrigerant fluids.

Minimum energy efficiency performance requirements		
Requirements to apply	RAC	
	SEER	SCOP
2 years after entry into force	3.6	3.2
4 years after entry into force	4.3	3.5

Figure 2: SEER and SCOP MEPS values [8].

Sound intensity level	RAC ≤ 6 kW		RAC 6 - 12 kW	
	Indoor	Outdoor	Indoor	Outdoor
Db-A (EN 12102)	60	65	65	70

Figure 3: Maximum sound intensity requirements

Sound intensity requirements

Noise intensity value inside and outside would now become mandatory. In the present proposal, noise intensity values are required in cooling and in heating mode. Maximum sound intensity requirements are proposed at relatively high values to avoid energy efficiency improvement potential being limited by sound requirements

Discussion

In cooling mode, a minimum SEER of 4 has been identified as the least life-cycle cost value for the cooling function, and proposed targets of 3.6 and 4.3 lead to the implementation of least life-cycle cost as the MEPS requirements as targeted in the EuP directive. With comparable climate and load conditions for the US and EU SEER indices and the inclusion of auxiliary modes, the EU targets would lead after two years to EU requirements equivalent to the present SEER 13 (IP) in the USA.

Minimum SCOP proposed are slightly over the least life-cycle cost calculation for water-based heating systems and translated for air-to-air heat pumps, which gave an equivalent SCOP of about 3.1. However, the least life-cycle cost that has been calculated for air-to-air heat pumps has been found to be higher than for other heating means.

With the publication of the different COP and EER values for several conditions, the proposed measure could also help with the application of calculation of the energy consumption of air-to-air heat pumps and air conditioners for application of the Energy Performance of Buildings Directive 2002/91/EC at member state level and for specific applications. For the first time ever, individual part-load data would then be available, and this should also help to choose the best units for a given application.

These measures should see the end of non-inverter units in the EU market. It becomes then urgent to ensure

that inverter units can be independently tested (i.e. that information required for rating SEER and SCOP is available to testing laboratories). Field monitoring of performances would also provide a useful insight to make sure that in-situ inspection and laboratory pre-programmed settings match each other.

Next steps

Interested readers will find updated information on the web sites of the Commission [6] regarding the status of the implementation of measures for air conditioners and air-to-air heat pumps. It is to be noticed that, in addition to Lot 1 and Lot 10, other lots may be of interest for heat pumps, such as TREN/lot 20 and 21 for local and central air heaters, and ENTR/Lot 6 for air conditioning and ventilation systems.

References

[1] Roger Hitchin and Christine Pout, Trends in the European Air Source Heat Pump Market, IEA Heat Pump Centre Newsletter Volume 26 - No. 1/2008, www.heatpumpcentre.org.

[2] Eurovent database of certified products, www.eurovent-certification.com

[3] EN standard 14511, Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling, September 2004.

[4] EuP Directive, Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products

[5] VHK, 2005: – Van Holsteijn en Kemna BV. Methodology Study Eco-design of Energy-using Products (MEEUP), final report, Delft, http://www.vhknet.com/download/MEEUP_Methodology_fin.pdf.

[6] More information on the EuP Directive, process and methodology can be found on the Ecodesign website of DG TREN, http://ec.europa.eu/energy/efficiency/ecodesign/eco_design_en.htm and of DG ENTR, http://ec.europa.eu/enterprise/eco_design/index_en.htm.

[7] Rivière P. et al., 2009, Preparatory study on the environmental performance of residential room conditioning appliances (airco and ventilation) – www.ecoaircon.eu.

[8] Commission of the European Communities, "Consultation Forum" for Ecodesign of Energy-Using Products Directive, Working document on implementing measures for Boilers, June 2009.

[9] Commission of the European Communities, "Consultation Forum" for Ecodesign of Energy-Using Products Directive, Working document on implementing measures for Room air conditioning appliances, local air coolers and comfort fans, June 2009.

Author contact information
Philippe Rivière
Center of Energy and Processes
Mines Paristech
Tel: 0033(0)140519080
Fax: 0033(0)146342491
philippe.riviere@mines-paristech.fr

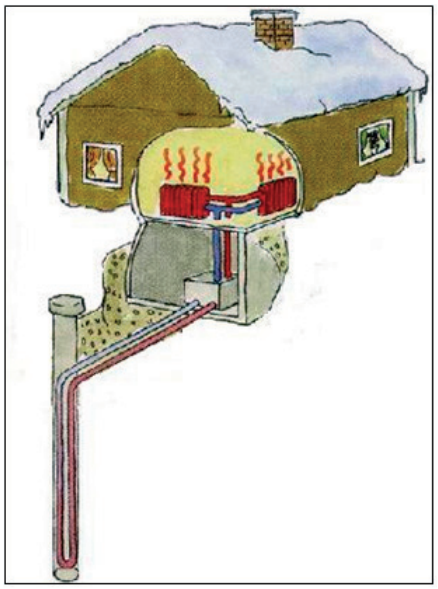
Ground source heating and cooling in Sweden

Olof Andersson, Sweden

Ground source heat pumps (GSHP) were appearing in Sweden by as early as the end of the 1970s as a contribution to reducing the country's dependency on oil. Horizontal and vertical closed-loop systems, together with a small number of systems extracting heat from ground water (open-loop systems) are currently replacing some 1.5 million m3 of oil annually. In recent years, there has been a steady growth in larger systems for combined heating and cooling, using the ground for seasonal storage of heat (UTES). These systems show a steady growth, due to their high potential for energy savings.

The most common closed-loop systems

Figure 1 is a schematic diagram of the vertical loop rock heat system, which is the type most commonly built in Sweden. A vertical borehole in the rock contains a heat exchanger (BHE) in the form of a single or double plastic U-pipe, through which a heat transfer fluid circulates. The fluid transfers heat from the rock to an electrically driven heat pump, the output temperature of which is suitable for space heating and domestic hot water production. In summer, the system can also be used for comfort cooling by circulating the heat transfer fluid through a simple air handling unit. Currently, there are some 250 000 of these installations in use, with numbers increasing at about 20-30 000 a year.



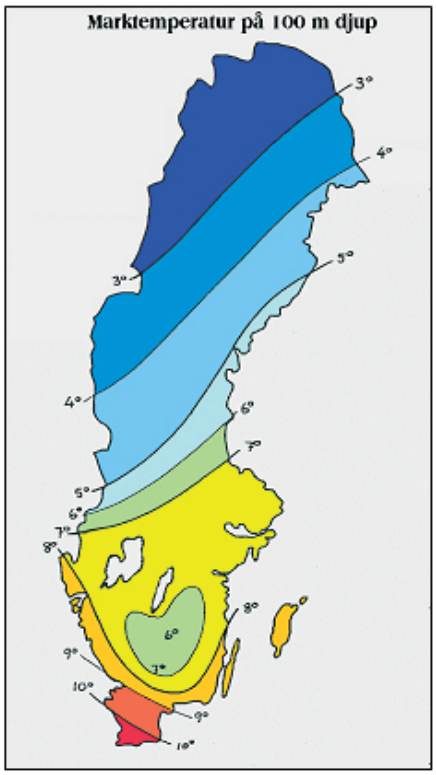


Figure 1. (a): Rock heat is typically used for single residences. Heat is extracted from a closed loop heat exchanger in a 100-200 m deep borehole.
(b): Rock temperature at a depth of 100 m varies between 10 °C and 3 oC.

The second most common system is that of surface earth heating. Figure 2 shows the typical arrangement of such a system, extracting heat via a plastic pipe laid at depth of approx. 1 meter. As in the case of rock heat, a fluid is circulated through the pipe, extracting heat from the soil. The difference is that the surface earth system is based on freezing the moisture in the ground. Heat is released when water turns into ice (phase change energy). Systems of this type therefore work best in a wet, fine-grained soil with high porosity. Currently, there are almost 100 000 of systems of this type in use in the country, with numbers increasing at around 5000 a year.

Groundwater used for both heating and cooling.

The temperature of groundwater is constant throughout the year, generally reflecting the average temperature in the atmosphere, see Figure 1. The constant temperature makes groundwater the most efficient heat source for heat pumps. In addition, the temperature is low enough to allow groundwater to be directly used for comfort cooling in all parts of the country. However, the use of groundwater is limited to only 10-15 % of the ground surface, and it is also strongly regulated. For these reasons, numbers of such installations are few, amounting to only about 5000. However, the size is commonly larger, and there are a number of plants in the industrial sector where the systems are used for process cooling.

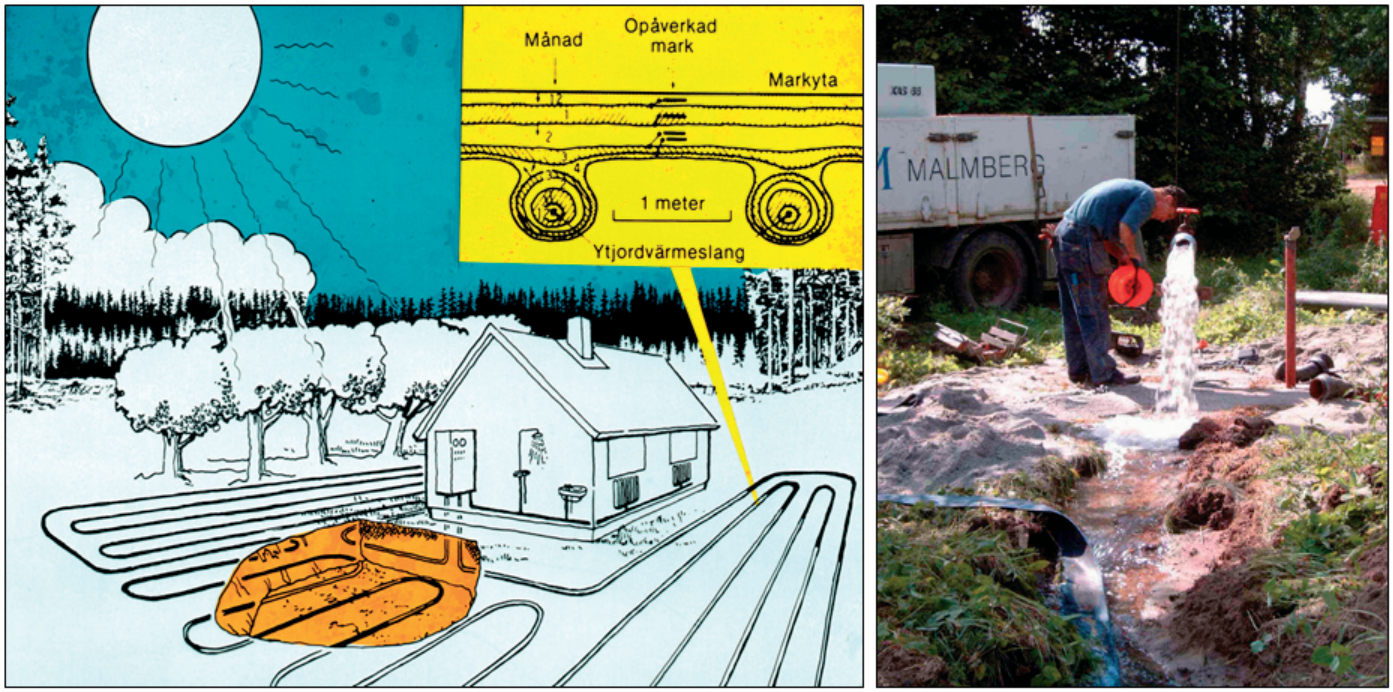


Figure 2. Surface earth heating, often for a single house in rural areas, abstracts heat from the soil. Groundwater heat is more efficient, and can also be used for direct cooling.

The advantages of groundwater are shown in Table 1, which summarizes some typical operational parameters of the different ground source applications used in Sweden.

"Working temperature" refers to the maximum and minimum fluid temperature on the evaporator side of the heat pump. The data in the table assumes a condenser temperature of +45 °C. The efficiency (SPF) is calculated by dividing the quantity of heat delivered from the condenser by the consumption of electricity for running the heat pump and other minor pumps belonging to the heating system. The payback time refers to replacing oil, natural gas or electric boilers.

Table 1. Typical operational and economic data for different GSHP systems in Sweden

Type of system	Working temp. (°C)	Efficiency (SPF)	Payback time (year)
Top soil heat	-5/+5	3,0-3,5	4-7
Rock heat	-3/+7	3,5-4,0	5-8
Groundwater heat	+3/+10	4,0-5,0	2-4
Ground source cooling	+3/+10	40-60	0-5

Environmental benefits.

It has been estimated that heat pump systems, mainly using ground source energy, contribute some 18 TWh/year to Swedish space heating demand (Nowacki 2007). Of this energy, approx. 6 TWh is electricity for running the heat pumps, while 12 TWh is extracted from the ground. This corresponds to about 15 % of the energy demand for space heating of all buildings in the country. Since the systems are used mainly to replace fossil fuel, geothermal heat represents some 1.5 million m3 of oil (9.5 million barrels) annually. Hence, the systems greatly decrease emissions of carbon dioxide and other environmentally harmful gases.

Systems for combined heating and cooling (UTES).

The systems described above are reheated in "passive" manners, mainly by energy exchange with the atmosphere but to a minor degree by geothermal heat flow from below (0.07 W/m2).

In UTES systems (Underground Thermal Energy Storage), thermal energy is actively stored in the ground by the system. In most cases, the storage is seasonal, meaning that heat is stored from the summer to be utilised during the winter. For cooling purposes, cold is stored during the winter, to be recovered during the summer. Most of the Swedish applications combine these two modes of operation. However, in special cases, only one or the other is stored, and there are also examples of short-term storage applications. Two commercial systems have been developed and introduced on the market: Aquifer Thermal Energy Storage (ATES) and Borehole Thermal Energy Storage (BTES). Figure 3 (Andersson 2005) shows schematic diagrams of the two.

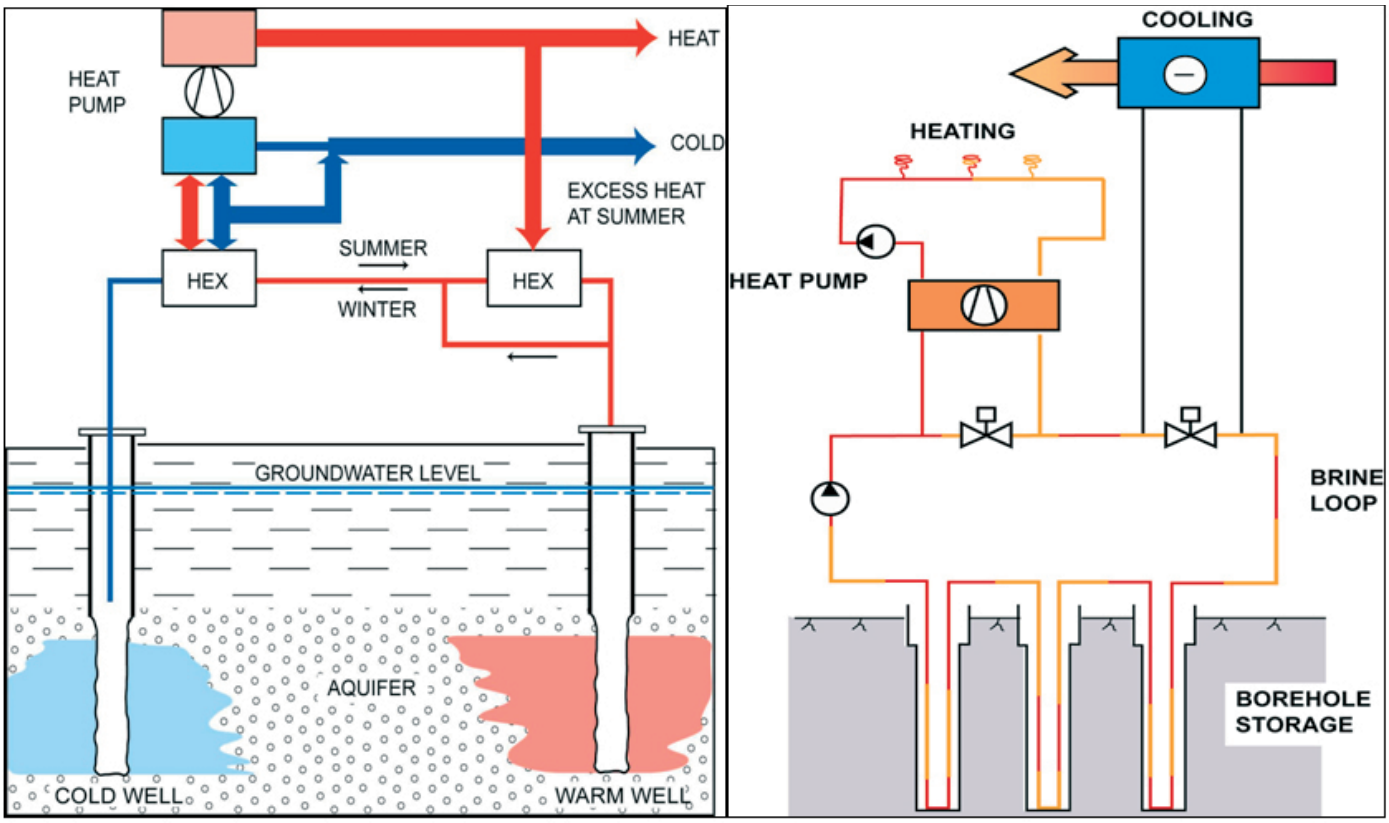


Figure 3. Schematic diagrams of the most common ATES (left) and BTES (right) systems

ATES- Efficient, but a technical challenge.

In ATES systems, groundwater is used to transport the thermal energy into and out of an aquifer. Wells provide the connection to the aquifer, and are normally designed with to serve both as production and infiltration wells. The energy is partly stored in the groundwater itself and partly in the solids that form the aquifer. There are two modes of operation. In winter, with a dominating heat demand, the warm wells are used as heat sources for the heat pump, with chilled return water being injected through the cold wells, with the result that cold is stored around these wells. In summer, the flow direction is reversed, and the cold is recovered and directly used for cooling. The waste heat from the cooling loop is then returned to the warm wells. The heat pump may be used for peak shaving of cold demand. If so, the condenser is chilled by the groundwater and the heat is stored in the warm side of the aquifer for the coming winter. Typical temperatures are 12-16 °C on the warm side and 4-8 °C on the cold side of the aquifer.

The systems are highly efficient, but not always applicable. One restriction is the need to find a proper aquifer at or close to the site. There are also legal obstacles that will be country-specific. Normally, there are substantial and time-consuming procedures to obtain permission to operate such a system, which involve extensive site investigations. In addition, there might be technical problems, related in most cases caused to water chemistry (Andersson 2006). For these reason, any new ATES project is a challenge.

Worldwide, there are more than a thousand ATES systems in operation, with the Netherlands as the main user. In Sweden, ATES was implemented in the mid 1980s, and currently there are about 100 larger plants with an average of capacity of some 2.5 MW. The rate of growth is currently estimated to some 5-10 new plants a year.

BTES – Less efficient, but easier to build.

BTES systems consist of a number of closely spaced boreholes, normally 50 – 200 m deep, which serve as heat exchangers to the ground, typically by means of a single or double U-pipe. In some countries the boreholes have to be grouted after the borehole heat exchanger (BHE) installation. In Sweden, no backfill is required unless the systems are located in groundwater protected areas. Instead, the boreholes naturally fill with groundwater. It is a well known fact that a water-filled borehole is more efficient than a grouted one, considering the Swedish geological conditions.
A heat transfer fluid containing antifreeze (water and ethanol) is circulated through the BHE to store or discharge thermal energy into or out of the ground. The process is mainly conductive, and the temperature change of the rock will be restricted to only a few meters around each of the boreholes. The rock temperature

will typically swing between +2 °C at the end of the winter and +8 °C at the end of the summer. The numbers of BTES plants are steadily growing, and it is estimated that Sweden has some 300 plants with more than 20 boreholes. These are typically intended for combined heating and cooling of commercial and institutional buildings, although cooling of electronic equipment in the telecom sector BTES is also common. Currently, there are some 10-20 new systems constructed per year.

In general, BTES systems are regarded as having a huge market potential, since they can be adopted practically anywhere, have a long lifetime (>50 years), and have a minimum of maintenance cost. In addition, the necessary site investigations are much less than for ATES and the permit procedure is simpler. This makes BTES a favourable option in the choice of system. Table 2 shows operating statistics of existing Swedish ATES and BTES systems used for combined heating and cooling.

Table 2. Typical operational and cost data for ATES and BTES systems in Sweden

Type of system	Fluid temp. (oC)	Efficiency (SPF)	Pay-back time (year)
Aquifer storage (ATES)	+6/+14	6-7	1-3
Borehole storage (BTES)	-2/+10	4,5-5,5	4-6

Market aspects of shallow geothermal heating/cooling.

Already today there are some 1.5 million shallow geothermal installations worldwide, with the USA and Canada representing half of these and Europe the other half. In addition to Sweden, the European systems are common in countries such as Germany, Switzerland, The Netherlands and Austria. However, in recent years, shallow geothermal technology has become an emerging technology in a number of other countries such as France, Great Britain, Ireland, Norway and Finland, as well as in some Mediterranean and Balkan countries, such as Spain, Italy, Turkey and Rumania.

One of the barriers for further growth is that the technology suffers from lack of awareness, knowledge and common standards and regulations. Fortunately, this barrier is currently being tackled by know-how transfer between countries in a training program for designers and drillers in an EU project, called GEOTRAINET. The project is also attempting to establish an EU-wide certification system for drillers and EU-harmonised legislations. The interest from the EU has also been shown by the forming a Geothermal Panel. The EU actions will provide political strength for market growth of ground source heating and cooling, especially in new countries.

Another barrier may be that the technology is not yet fully developed and therefore not technically mature. There are still a number of technical aspects that can be improved, such as drilling technology, borehole heat exchangers, well technology etc. These areas are under ongoing research and development by the International Energy Agency (IEA), and will gradually lead to more efficient and technically more robust systems. This research includes applications in different climate conditions, and so far it seems that shallow geothermal can be adapted to almost any climate zone, which means that ground source heating and cooling has a global market potential.

From an economic point of view, shallow geothermal heating and cooling systems have proven to be compatible with any other heating and cooling system on the commercial market. The relatively high investment cost may be an obstacle, but the savings of energy (compared to traditional systems) will in most cases make the systems profitable. Since the investment in the ground source system can be expected to have an extremely long lifetime, and the maintenance cost is commonly low, profitability improves with age. It has also been shown by experience that heat pumps connected to ground source systems have a longer life than air/air heat pumps, as the latter have to work with a wider range of temperatures that decreases not only the efficiency but also the lifetime of the heat pump.

Shallow geothermal systems are proven to have a very large saving capacity. With a performance factor in the order of 5-7 with heat pumps, and 40-60 without a heat pump in the system, there are few, if any, comparable alternative for cutting the emissions of environmentally harmful gases and substances. These environmental benefits, together with a sound cost basis, a high geographical potential and ongoing training of designers and drillers, indicate that a steady market growth can be predicted. It is also highly probable that countries not yet being part of this technology will recognise the advantages and adopt the geothermal solution as a way of defeating climate change. If so, we are only in the beginning of a geothermal boom, worldwide.

References

Andersson, O.2005. Ground-source thermal energy – More efficient than you would think. Swedish Research for Sustainability. Formas, No 1:05, 2005.

Andersson, O. 2007. Aquifer Thermal Energy Storage (ATES). In "Thermal energy storage for sustainable Energy Consumption", Chapter 6. Springer, 2007.

Nowacki, J-E., 2007. Heat pumps in energy statistics. Suggestions. Nowab AB, STEM ref no. 17-07-3884, 2007.

Web sites to visit for more information: www.geotrainet.eu, www.egec.org

Author contact information
Olof Andersson
SWECO Environment
P.O. Box 286
201 22 Malmö
Sweden
Phone: +46 (0)40-16 72 14
e-mail: olof.andersson@sweco.se

Heat Pump with Dehumidification Mode of Operation

Robert B. "Dutch" Uselton, USA

This article reviews the background and development of a split-type heat pump system with three operating modes: heating, cooling, and dehumidifying. An analytical method was developed to assess the effectiveness and operating cost of active dehumidification options. Several technologies were compared and contrasted using this evaluation tool. A split-system heat pump that flexibly controls both indoor temperature and humidity was built and tested. Laboratory and field performance results are discussed.

Introduction

Conventional vapor compression air conditioners and heat pumps provide cooling in response to a room temperature deviation from the thermostat set point temperature. Design practice has evolved over the years such that a reasonable amount of latent cooling is accomplished simultaneously with sensible cooling. In the US, Air-Conditioning Heating and Refrigeration Institute (AHRI) certification program rules limit the amount of indoor air circulation to 218 cubic meters per hour for each kW of delivered cooling (450 cfm/ton) as one way of forcing some dehumidification to occur at the rating point condition. Most residential heat pumps operate with a sensible heat ratio of 0.70 to 0.80, at rating conditions.

Current heat pump products generally do not actively control humidity during the cooling season. When moisture gains (from internal sources and infiltration) exceed the incidental moisture removal capability of the heat pump as it works to meet the sensible load, the indoor humidity can exceed desirable levels. This condition frequently occurs during the spring and autumn when there is a low sensible cooling load. It can also occur in humid climates all through the cooling season when the infiltration of humid outdoor air overwhelms the latent capacity of the heat pump. This condition can occur in spite of efforts by equipment specifiers to deal with the local climatic conditions by carefully selecting and commissioning equipment.

This article reviews the background and development of a split-type heat pump system with three operating modes: heating, cooling, and on-demand dehumidification. Several dehumidification technologies were compared and contrasted using an evaluation tool. Subsequently, a split-system heat pump was developed to flexibly control both indoor temperature and humidity. A new control algorithm was developed and implemented in a thermostat capable of sensing temperature and humidity. Some laboratory and field performance results from this system are presented in this article

Heat pumps in a humid climate

Seasonal simulation results for a residence in Houston, Texas

Results of these cooling season simulations are given using a psychrometric chart format. Each hour of the cooling season is plotted in Figure 1 as a temperature-humidity data point. For these simulations, the thermostat was set at 25C (77F). ASHRAE recommends limiting indoor RH to 60% but, for some people, health issues (allergies) argue for maintaining lower indoor humidity. In particular, limiting average indoor humidity to approximately 50% tends to reduce odors, and allergens.

The high-efficiency, two-stage heat pump modeled here reduces the cooling season electrical energy usage by 27%, compared to a 13 SEER (Seasonal Energy Efficiency Ratio, Wh/btu; 13 SEER is equivalent to a 3.81 SCOP, dimensionless) single-stage unit. The character of the indoor conditions are similar for single and two-stage systems as long as the indoor airflow is reduced, to maintain dehumidification, during low-stage operation.

Figure 1 shows good indoor temperature control by the two-stage heat pump but the humidity can be seen to float. Approximately forty percent of the cooling season hours are above 55% RH.

A recent innovation in the residential air conditioning market is the combination thermostat/humidistat. Some versions incorporate microprocessor-based logic that temporarily lowers the temperature setpoint under high humidity conditions. Figure 2 shows results of using one of these advanced thermostats with a high-efficiency, two-stage air conditioner. For these simulations, the cooling setpoint is 25°C and the humidistat is set at 50% RH. Up to 1.1°C overcooling is enabled when the indoor relative humidity is above setpoint. The difference between Fig. 1 and Fig. 2 is dramatic: the number of summer hours above 60% RH is considerably reduced.

The last psychrometric chart, Fig. 3, shows the seasonal operation of a high-efficiency, two-stage, split-system heat pump that has an enhanced dehumidification mode of operation. This mode uses condenser reheating of the supply air to shift the sensible-to-total heat ratio (S/T) down to 0.25 and lower. The control logic used is as described above except during high indoor humidity conditions, the enhanced dehumidification mode is used after the thermostat setpoint has been met. Again, there is a dramatic reduction in the number of summer hours with elevated humidity. Hours with humidity above 55% are greatly reduced.

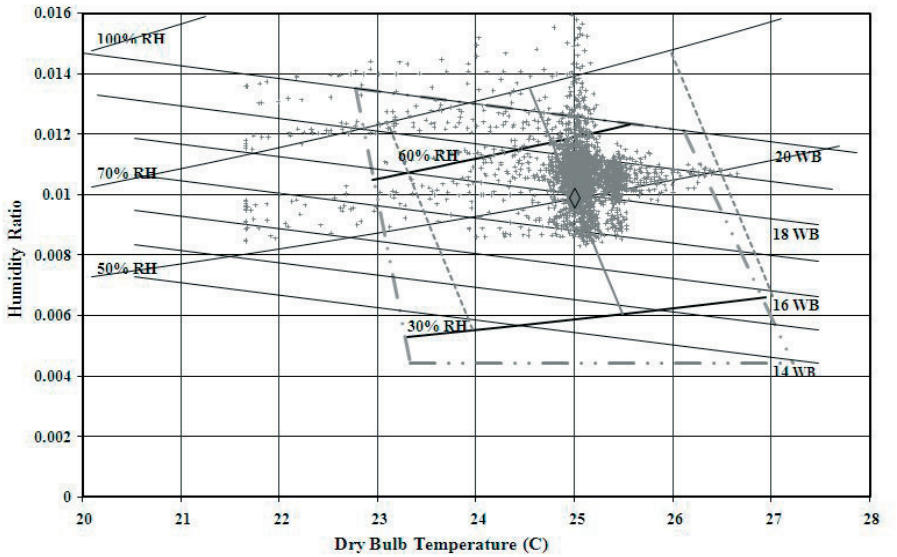


Fig. 1. Results for two-stage, high-efficiency heat pump

Testing in enhanced dehumidification mode

Figure 4 illustrates the system that was assembled and tested in a psychometric chamber. The diagram shows a typical heat pump system but with additional components that allow operation in an enhanced dehumidification mode. The system uses a refrigerant charge compensator (not shown) to store excess refrigerant during the enhanced dehumidification mode.

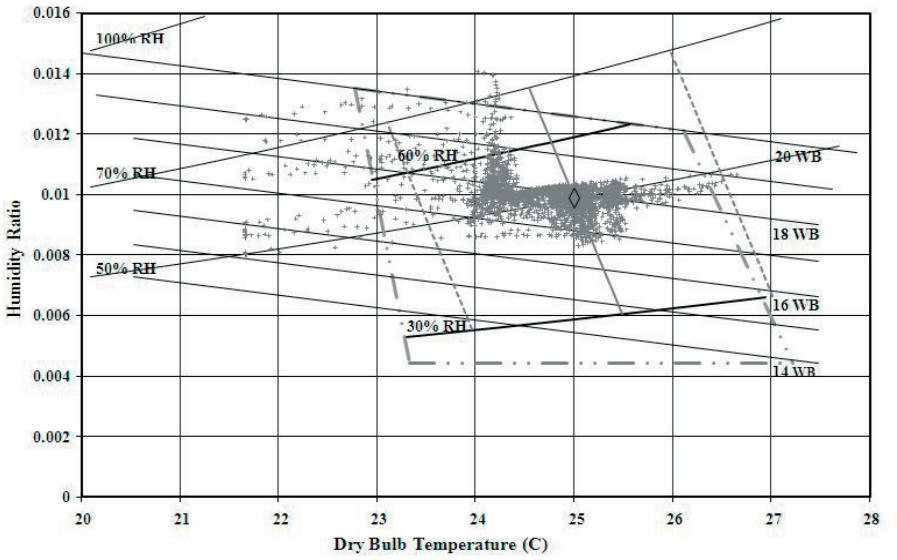


Fig. 2. Results for two-stage, high efficiency heat pump, 1.1° C overcooling allowed for dehumidification

The tested system had variable speed motors on both the outdoor and indoor sides of the system. The compressor had capability of operating at two capacity steps. During enhanced dehumidification operation, the compressor was at the high capacity step, the indoor blower was run at a reduced airflow, and the outdoor fan was operated at a reduced speed.

In this mode, refrigerant from the outdoor condenser coil is not completely condensed. The refrigerant completes condensation and is subcooled as it passes through the reheat coil. Indoor air first passes through the evaporator coil, and then is warmed as it passes through the reheat coil. Air supplied to the space has thus been dehumidified, but without a greatly reduced dry bulb temperature. The impact is to

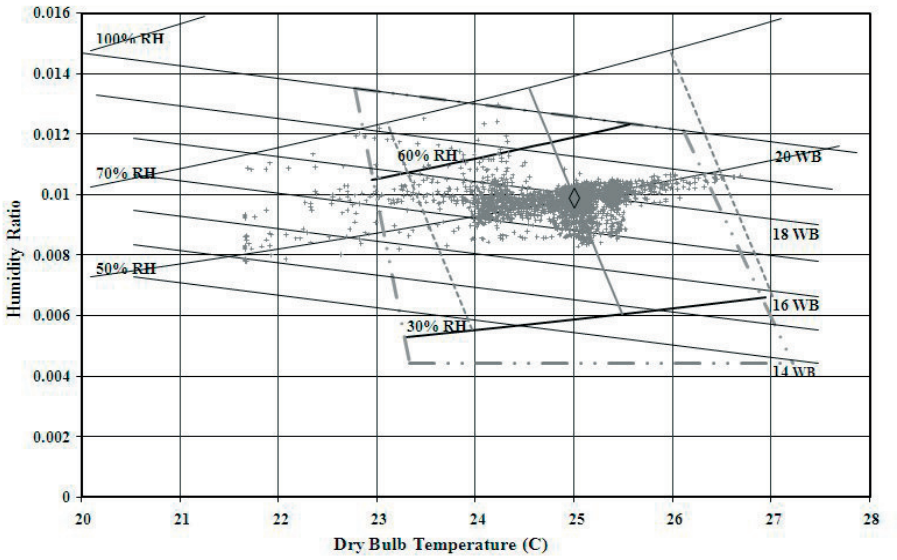


Fig. 3. Two-stage, high efficiency heat pump with condenser reheating, 1.1° C overcooling allowed

allow significant dehumidification of the space with minimal overcooling. This operating mode addresses loads that are primarily latent. The advantages of the system shown in Fig. 4, compared to a standard condenser reheat system, are that it is a "two-pipe" system (lending itself to residential "split" applications) and that it works on heat pumps as well as conventional air conditioners. This turns out to be important because, in the humid regions of the United States, heat pumps are very popular.

Figure 5 illustrates the performance of the system when there is a high latent load. The solid line shows sensible-to-total cooling performance for normal cooling mode. Shifting to dehumidification mode lowers the S/T. Adjusting the outdoor fan air volume (CFM) provides a range of S/T performance that can be tailored to the varying latent and sensible loads of the indoor environment.

Conclusions

The variable condenser-reheating enhancement to a conventional heat pump provides a new dimension in control of indoor humidity. This system was developed to be easily applied to a range of conventional heat pumps and to be compatible with regionally different heat pump installation customs. It integrates the dehumidification function into the central air circulation system of the home without undue complexity or cost. We have estimated the energy impact of tighter humidity control in a climate (Houston, Texas) that is known for persistent indoor humidity problems. It is possible to provide a greatly improved indoor environment and still use slightly less energy than a 13 SEER heat pump. The driver for enhanced humidity control can be comfort and/or the desire to retard unwanted odors, mold and allergen production. With the trend toward "tighter" home construction, the latent fraction of cooling load is likely to climb. This system addresses that potential problem.

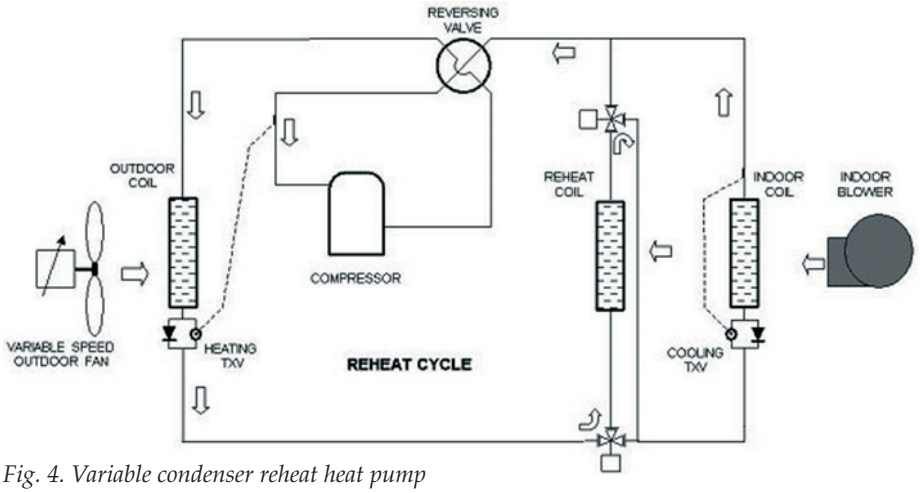


Fig. 4. Variable condenser reheat heat pump

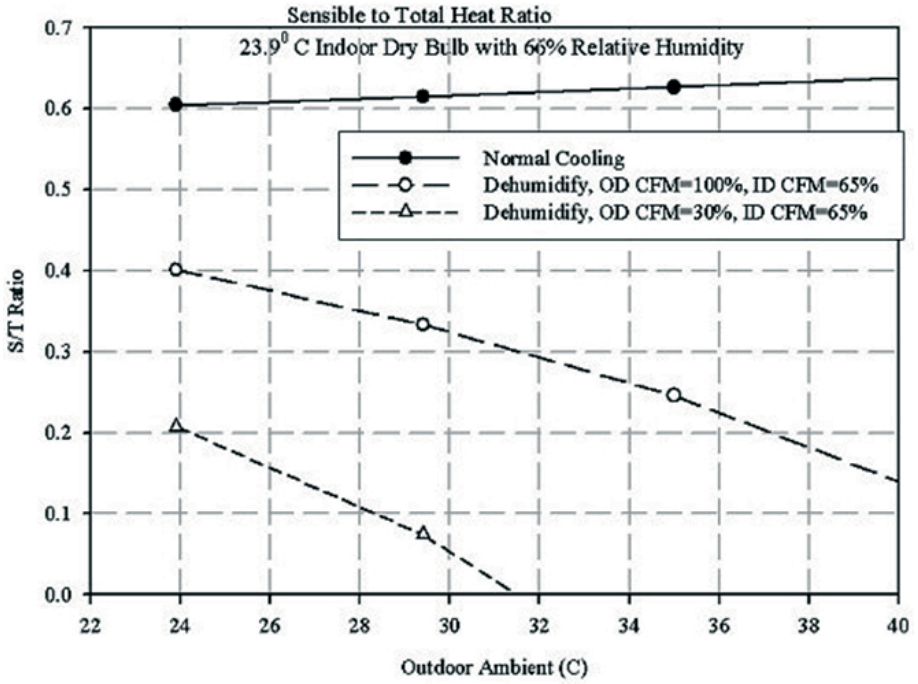


Fig. 5. S/T performance for heat pump cooling and dehumidification modes

References

[1] Hanson, O. W., Uselton, R. B., 2005. "Split-System Residential Heat Pump with Separate Dehumidification Mode". IEA Heat Pump Conference (Las Vegas)

Author contact information
Name Robert B. "Dutch" Uselton
Affiliation Lennox Industries Inc.
E-mail address dutch.uselton@lennox-intl.com
Phone number 972-497-7868

2009

14 - 16 November AHRI Annual Meeting
Scottsdale, AZ, USA
E-mail: ahri @ ahrinet.org
www.ahrinet.org

26 - 28 November RENEXPO® Austria
Messezentrum Salzburg, Austria
www.renexpo-austria.com

2 - 4 December 40th International Conference on Heating, Air Conditioning and Refrigeration
IIR-co-sponsored, Commissions B1, B2, D1, E1, E2
Belgrade, Serbia
E-mail: office @ kgh-kongres.org
http://www.kgh-kongres.org/content/view/108/105/lang,english

2010

23 - 27 January ASHRAE Winter Meeting
Orlando, USA
www.ashrae.org/events/page/562

25 - 27 January International Air-Conditioning, Heating, Refrigerating Exposition (AHR Expo)
Orlando, USA
Co-sponsored by ASHRAE and ARI
www.ahrexpo.com

1 February Interclima+ Elec Home & Building
Paris, France
www.interclimaelec.com

17 - 19 February 2010 International Symposium on Next-generation Air Conditioning and Refrigeration Technology
Tokyo, Japan
http://2010nextacr.com

14 - 17 March IIAR 2010 Industrial Refrigeration Conference & Exhibition
San Diego, CA, USA
https://www.iiar.org/conferences/exhibitinfo.cfm

22 - 26 March EU Sustainable Energy Week
http://www.sustenergy.org/tpl/page.cfm?pageName=home

23 - 27 March Mostra Convegno Expocomfort
Milan, Italy
www.mcexpocomfort.it/en/aspx/ShowFolder.aspx?idFolder=156

In the next Issue

Heat pumps are renewable

Volume 27 - No. 3/2009

International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among its participating countries, to increase energy security through energy conservation, development of alternative energy sources, new energy technology and research and development.

IEA Heat Pump Programme

International collaboration for energy efficient heating, refrigeration and air-conditioning

Vision

The Programme is the foremost worldwide source of independent information and expertise on environmental and energy conservation benefits of heat pumping technologies (including refrigeration and air conditioning).

The Programme conducts high value international collaborative activities to improve energy effi ciency and minimise adverse environmental impact.

Mission

The Programme strives to achieve widespread deployment of appropriate high quality heat pumping technologies to obtain energy conservation and environmental benefi ts from these technologies. It serves policy makers, national and international energy and environmental agencies, utilities, manufacturers, designers and researchers.

IEA Heat Pump Centre

A central role within the programme is played by the IEA Heat Pump Centre (HPC). The HPC contributes to the general aim of the IEA Heat Pump Programme, through information exchange and promotion. In the member countries (see right), activities are coordinated by National Teams. For further information on HPC products and activities, or for general enquiries on heat pumps and the IEA Heat Pump Programme, contact your National Team or the address below.

The IEA Heat Pump Centre is operated by

SP Technical Research Institute of Sweden

IEA Heat Pump Centre
SP Technical Research
Institute of Sweden
P.O. Box 857
SE-501 15 Borås
Sweden
Tel: +46 10 516 50 00
Fax: +46 33 13 19 79
E-mail: hpc@heatpumpcentre.org
Internet: http://www.heatpumpcentre.org

IEA OECD heat pump centre

National team contacts

AUSTRIA
Prof. Hermann Halozan
Technical University of Graz
Innfeldgasse 25
A-8010 Graz
Tel.: +43-316-8737303
Fax: +43-316-8737305
Email: halozan@tugraz.at

CANADA
Dr Sophie Hosatte
Natural Resources Canada
CETC – Varennes
1615 Bd Lionel Boulet
P.O. Box 4800
Varennes
J3X 1S6 Québec
Tel.: +1 450 652 5331
E-mail: sophie.hosatte@nrcan.gc.ca

FINLAND
Mr Jussi Hirvonen
Chair of the Board
Finnish Heat Pump Association SULPU ry,
Tel: +358 50 500 2751
Email: jussi.hirvonen @ ivt.fi
Internet: www.sulpu.fi

Dr Arto Kotipelto - Alternate
Senior Technology Advisor
TEKES (Finnish Funding Agency for Technology and Innovation)
PO Box 266
Yrjönkatu 20
FI-28101 Pori, Finland
Tel: +358 44 712 4138
E-mail: arto.kotipelto@tekes.fi

FRANCE
Mr Etienne Merlin
ADEME/DIAE
27 rue Louis Vicat
75737 Paris Cedex 15
Tel.: +33 1 47 65 21 01
E-mail: Etienne.Merlin@ademe.fr

GERMANY
Prof. Dr.-Ing. Dr. h.c. Horst Kruse
Informationszentrum Wärmepumpen und Kältetechnik - IZW e.V
c/o FKW GmbH
D-30167 Hannover
Tel. +49-(0)511-16 74 75-0
Fax +49-(0)511-16 74 75-25
E-mail: email@izw-online.de

Prof. Dr.-Ing. H.J. Laue - Alternate
Informationszentrum Wärmepumpen und Kältetechnik - IZW e.V.
Unterreut 6
D-76 135 Karlsruhe
Tel.: +49 721 9862 856
Fax: +49 721 9862 857
E-mail: laue.izw@t-online.de

ITALY
Dr Giovanni Restuccia
Italian National Research Council
Institute for Advanced Energy Technologies
(CNR – ITAE)
Via Salita S. Lucia sopra Contesse
5 - 98126 Messina
Tel.: +39 (0)90 624 229
Fax: +39 (0)90 624 247
E-mail: giovanni.restuccia@itae.cnr.it

Dr Angelo Freni - Alternate
Italian National Research Council
Institute for Advanced Energy Technologies
(CNR – ITAE)
Via Salita S. Lucia sopra Contesse
5 - 98126 Messina
Tel.: +39 (0)90 624 229
Fax: +39 (0)90 624 247
E-mail: angelo.freni @ itae.cnr.it

JAPAN
Mr Makoto Tono
Heat Pump & Thermal Storage Technology Center of Japan
1-28-5 Nihonbashi Kakigara-Cho Chuo-Ku,
TOKYO 103-0014, JAPAN
Tel: +81-3-5643-2404
Fax: +81-3-5641-4501
E-mail: tono.makoto@hptcj.or.jp

NETHERLANDS
Mr Onno Kleefkens
SenterNovem
P.O. Box 8242
3503 RE Utrecht
Tel.: +31-30-2393449
Fax: +31-30-2316491
Email: o.kleefkens@senternovem.nl

NORWAY
Mr Bård Baardsen
NOVAP
P.O. Box 6734, Rodeløkka
N-0503 Oslo
Tel. +47 22 80 5006
Fax: +47 22 80 5050
E-mail: baard.baardsen@rembra.no

SOUTH KOREA
Mr Seong-Ryong Park
Korea Institute of Energy Research
Department of Renewable Energy
71-2, Jang-dong, Yuseong-gu, Daejeon
Republic of Korea 305-343
Tel.: +82 42 860 3224
Fax: +82 42 860 3133
E-mail: srpark@kier.re.kr
http://www.kier.re.kr/eng/index.jsp

SWEDEN
Mr Mattias Törnell (Team leader)
Swedish Energy Agency
Energy Technology Department
Electricity production and Energy Use Unit
Kungsgatan 43
PO Box 310
SE-631 04 Eskilstuna
Tel.: +46 16 544 2169
Fax: +46 16 544 2099
mattias.tornell@energimyndigheten.se

SWITZERLAND
Dr Thomas Kopp
Hochschule Rapperswil
On behalf of the
Swiss Federal Office of Energy
Energy Renewable Division
Oberseestrasse 10
8640 Rapperswil
Tel.: +41 55 222 4923
E-mail: tkopp@hsr.ch

USA
Ms Melissa Voss Lapsa
Oak Ridge National Laboratory
Engineering Science and Technology Division
Bethel Valley Road
PO Box 2008
Oak Ridge, TN 37831-6054
Tel.: +1-865-576-8620
Fax: +1-865-576-0279
E-mail: lapsamv@ornl.gov