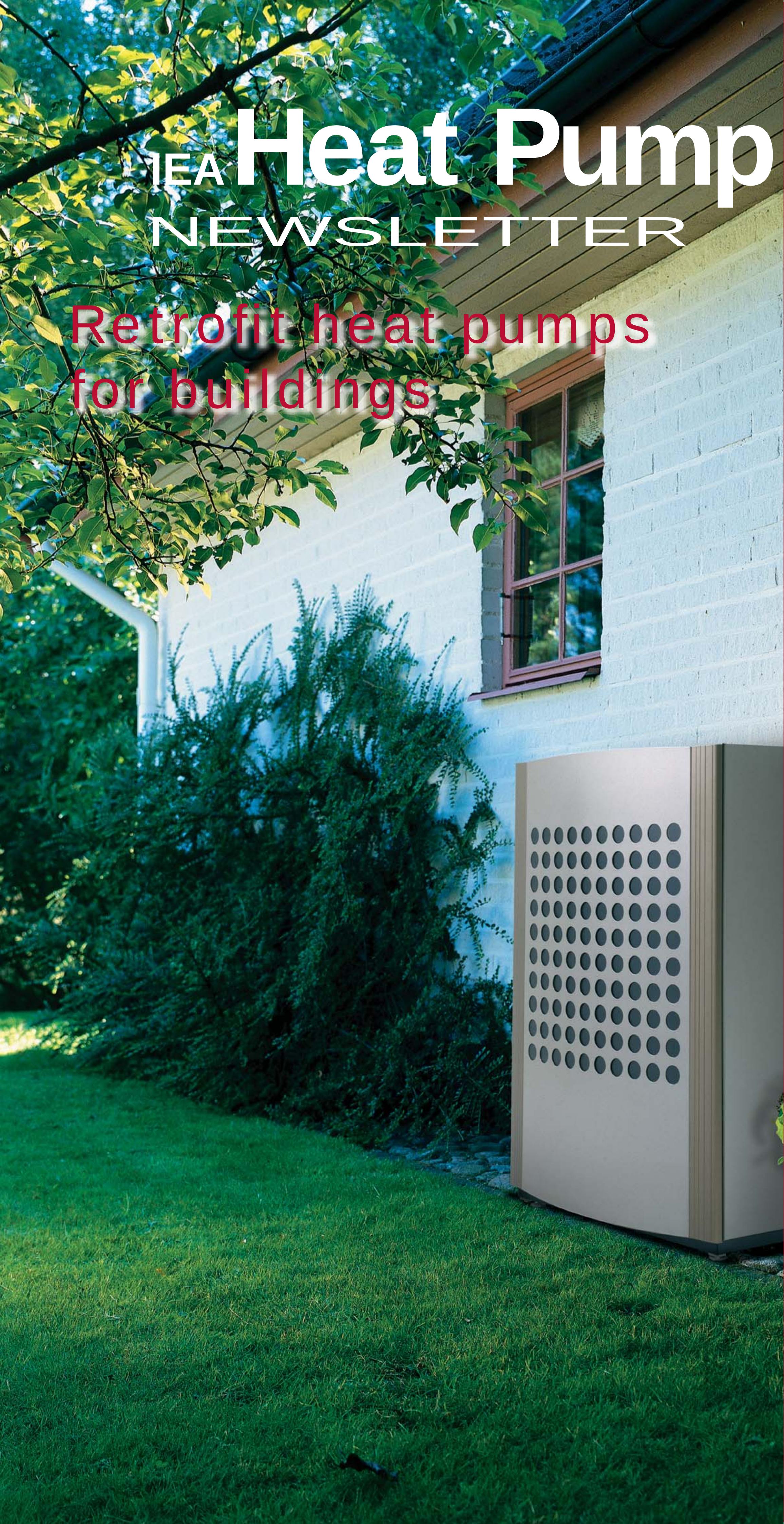

IEA Heat Pump CENTRE NEWSLETTER

Volume 24
No. 4/2006

Retrofit heat pumps for buildings

Fort Polk Installation Demonstrates Retrofit Potential of Geothermal Heat Pumps

High temperature heat pump for the retrofit market in France

Air-to-air heat pumps in Norway

IEA **Heat Pump** CENTRE
NEWSLETTER

Volume 24 - No. 4/2006

In this issue

Retrofit heat pumps for buildings

In this issue, a number of topical articles show examples on how heat pumps can contribute to less energy use in buildings. Not only the heat pump itself, but also the distribution system indoor is an important factor when a heat pump is replacing another heating system. This is exemplified in one of the topical articles.
Non-topical articles in this issue coves heat pumps in household tumble dryers as well as heat pumps in district heating systems.

Also take a closer look on the 9th IEA Heat Pump Conference that is announced in this issue and book May 20-22, 2008 in your calendars.

Enjoy your reading!

Roger Nordman
Editor

Heat pump news

Features

Topical article

Non-Topical article

COLOPHON

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Photo page 1: IVT optima, reproduced with permission by IVT

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Foreword

It is a pleasure for me to write the foreword for this last issue of the IEA HPP Newsletter for 2006.

After a break of several years, Germany is once again very active in the Heat Pump Programme, especially in the building sector and is the operating agent for Annex 30 "Retrofit Heat Pumps for Buildings".

Over the past years the IEA Heat Programme has mainly been concerned with the technical development of heat pumps for new buildings of different sizes with the aim to provide more energy-efficient heating and cooling systems.

Although, on the one hand, the market potential of heat pumps in new buildings is much smaller than in existing buildings, on the other hand the sales volume of heat pumps is much larger in new buildings than in existing buildings. For example, in Switzerland nearly 60% of all new one- and two-family houses are equipped with heat pumps, but only 5% of the heat pumps sold every year are installed in existing buildings. In the rest of Europe, heat pump markets also mainly concentrate on the new building sector. But, for all European countries, the retrofit market for the replacement of boilers is huge.

This provided a good reason for starting an international cooperation on retrofitting heat pumps in existing buildings. The main task of this cooperation project Annex 30 is to analyse the technical and market barriers of retrofit heat pumps and to consider technical solutions and the economic problems. Thus, Annex 30 should contribute towards overcoming the market barriers in this interesting sector.

The objective of the annex is to undertake surveys of the availability, technology, economy, ecology and possible trends of heat pump systems to replace energy-inefficient space and tap water heating systems in existing buildings.

The main barrier for the use of heat pumps for retrofitting is the high distribution temperature of conventional heating systems. This is too high for the present heat-pump generation with a maximum economical heat distribution temperature of around 55°C.

The annex takes into account different solutions:
- the application of available heat pumps in buildings which have already been renovated so that they have a reduced heat demand
- the development and market introduction of new high-temperature heat pumps
- the use of air-to-air units in buildings without central heating systems.

The objectives will be achieved by means of joint studies carried out by the participants for each country.

The programme is subdivided into 4 tasks:
Task 1 State of the Art, Market Analysis
Task 2 Matrix of Heat Pumps
Task 3 Overcoming Economic, Environmental and Legal Barriers
Task 4 Successful Factors for the Marketing of Retrofit Heat Pumps

Other participants in Annex 30 beside Germany, which is also represented by several German companies, are France, the Netherlands and Sweden represented by a German / Swedish company.

Five meetings have been held up till now. The Annex will be completed by the end of 2007 and a final report with case studies and demonstration projects, documentation of R+D projects, summaries of workshops and meetings as well as recommendations for future projects will be published.

Claus Börner
Executive Committee Delegate
Germany

Columnist

2006 The new beginning of the heat pump era

This year will probably be recognised as the year when heat pumps finally took off in Europe. Hitherto, heat pumps in Europe have been able to develop a self-sustaining market only in small countries such as Sweden, Switzerland and parts of Austria. 2006 has seen a significant growth in sales in Germany France, and Finland. Even countries such as the UK and Ireland are reporting a growing interest. The realisation that fossil fuels are running out is becoming widespread.

Existing directives on a European level are still not strong enough to have a real impact on the use of renewable energy sources. Much more is needed. Workers within the heat pump industry pay particular interest to the ongoing discussions on the Renewable Heating and Cooling Directive. The European paper on energy efficiency "Doing More With Less", published in June 2005, set the target that energy from renewable energy sources should account for 12 % of energy supply by 2010. However, major shifts in technology often require some sort of helping hand from the authorities. Tax incentives and different types of regulations have proven to be effective in many cases. As an example, it is worth mentioning the renewable energy regulation in Catalonia, Spain and a London borough. These local regulations set requirements on the use of renewable energy for buildings. In Sweden, heat pumps and biomass boilers have become the leading technologies in the residential sector solely due to economic benefits for the end users. Clearly, regulations are needed to speed up the inevitable introduction of renewable energy sources. This is the reason why the upcoming directive on renewable heating and cooling is so important to Europe. We believe that heat pumps will be one of the most important technologies for the European countries to meet their Kyoto commitments. ADEME in France has identified heat pumps as being the single most important technology for France to fulfil its commitments. The present market increase in Europe is only the beginning of the beginning. We believe that the European market for heat pumps will be ten-folded in less than ten years from now.

Martin Forsén
President, Swedish Heat Pump Association
Chair, Strategy Committee, European Heat Pump Association

IEA HPP Newsletter
The United Nations Climate change Conference

The 12th Conference of the Parties on Climate Change, which was also the 2nd meeting of the Parties to the Kyoto Protocol, took place in Nairobi, Kenya, on November 6-17, 2006.

These United Nations conferences are divided into two parts:
Preliminary discussions in subsidiary bodies on previously defined special subjects and the "high-level segment" at the end, during which the heads of delegations deliver their messages (Ministers of Environment, Directors of intergovernmental organizations, and Heads of non-governmental organizations).
Also, a lot of stands are run by various organizations, generally non governmental, and many side events are organized by countries and agencies.

The main challenges of this conference in Nairobi were the following: definition of a procedure for negotiations for the "post-Kyoto" period, i.e. after 2012, for which there are no official commitments in the present protocol; creation of an Adaptation Fund (there are already measures and funds for projects dealing with reduction of emissions of greenhouse gases, in developing countries, but nothing for adaptation to climate change, which will happen in any case and could increase flooding, desertification…).
These subjects were already presented at the previous conference in the high-level segment and several meetings were programmed in order to propose solutions. Progress has been made on the second point and the fund will probably be created next year. Nothing could be decided on the first point, but several declarations, especially during the high-level segment, show evolution for the future:

- nobody explained that climate change is uncertain and that we could postpone the implementation of measures, which was still the case previously according to certain countries;
- the goal of avoiding an increase in the global temperature of more than 2°C in 2050 now seems to have become a reference which needs a reduction in the emissions of greenhouse gases of 50% in 2050 at a global level.
- most European countries explained their willingness to do more. Several objectives were announced, especially by France, Germany and the United Kingdom: a reduction in the emissions by a third in the European Union in 2020 and by 60 or 75% in 2050 compared with 1990 levels.
- countries which did not ratify the Kyoto Protocol explained before that only voluntary measures should be taken and that they would not accept any constraints if no other countries accepted such constraints. For the first time, an emerging country, China, announced that it will reduce its emissions per unit GDP energy consumption by 20% before 2010 compared with 2005. Even if China will probably soon become the first emitter worldwide of greenhouse gases, ahead of the USA and even if this effort is not enough regarding the increase in the Chinese GDP, it could be a sign which could allow more negotiations involving USA, Australia and countries such as China, India, Brazil… The less developed countries, particularly African countries, which of course were well represented in Nairobi, are now no longer concerned by any commitments.

There are good signs for future negotiations, but not for immediate results (it is likely that no "after-2012" commitments will be decided before 2009).

Among the various subjects discussed, one must be mentioned: the production of HCFC22 produces HFC23 as a by-product. The Clean Development Mechanisms (CDM) finance the destruction of HFC23 which is a very potent greenhouse gas (GWP = 11 700) which indirectly encourages the production of HCFC22. It was impossible to find an agreement on such a little case.

However, we need to be prepared to implement new measures concerning refrigeration and air conditioning in the near future, both in developed and developing countries:

- a more rapid phase-out of HCFCs,
- equipment consuming less energy...

You will find hereafter the statement I delivered in Nairobi and also in New Delhi, India, where the 18th Meeting of the Parties to the Montreal Protocol took place (October 29-November 4, 2006). I particularly emphasized the need to ensure better coordination in the Montreal and the Kyoto Protocols and I hope, this will be taken into consideration. A seminar will be organized before the next United Nations Conference on the ozone layer in Montreal next September and this will probably be one of the issues discussed.

As I explained in the statement, the IIR already works on replacement of refrigerants and on energy efficiency all over the world. Heat Pumps are also an excellent solution for the future: all countries, particularly developed countries, have to put a lot of effort into reducing their emissions of greenhouse gases, and the easiest way to do this is to reduce energy consumption.

Our cooperation with the IEA Heat Pump Programme is a particularly appropriate way of addressing this challenge.

Didier Coulomb
Director of the International Institute of Refrigeration

Statement given by Didier Coulomb, Director of the International Institute of Refrigeration

November 2006

Mr. President, Dear Delegates,

Refrigeration is at the core of two major threats to the environment: ozone depletion and global warming. Both these causes of concern have led to two different protocols, the Montreal and Kyoto protocols, and both should be treated with greater international coordination; both are related, and what is done to alleviate the one has repercussions on the other, for better or for worse.

Refrigeration impacts on both these phenomena in two ways:

- Refrigeration uses refrigerants, some of which have a negative effect on the environment when emitted in the atmosphere, if the equipment is not sufficiently tight or if the refrigerants are not properly recovered when disposal of the equipment takes place:
  – CFCs and, to a certain extent, HCFCs, contribute to the depletion of stratospheric ozone;
  – CFCs, HCFCs and HFCs are greenhouse gases.
  However, natural refrigerants, (ammonia, CO2, hydrocarbons) that are gradually replacing them in many refrigeration units, do not have a significant direct impact.
- Refrigeration technologies are very energy-consuming, thus directly contributing to the emission of large amounts of CO2. When including air conditioning, they account for about 15% of worldwide electricity use. Typically, over 80% of the global warming impact of refrigeration systems is due to this electricity use. Energy efficiency, which varies according to units and refrigerants used, is therefore an essential element to take into consideration.

The benefits of refrigeration to mankind are considerable:

- refrigeration already plays an essential part in food and health-related issues; it is to become even more indispensable, as is shown by the increasing demand for air conditioning, caused by global warming;
- besides, refrigeration technology is necessary for the implementation of many future energy sources: the liquefaction of natural gas and hydrogen or thermonuclear fusion in particular, not to mention the liquefaction of CO2, in view of its storage.

In order to face increasing demand, while reducing its impact on the climate, stakeholders in the refrigeration field, and the International Institute of Refrigeration (IIR) in particular, are leading many actions:

- increasing research into refrigerants, in particular natural refrigerants;
- reducing refrigerant emissions thanks to better containment, reinforcing the monitoring of tightness, developing systems using less fluids;
- reducing the energy consumption of the units, with a view to bringing the figures down by a third before 2020;
- developing novel environmentally-friendly refrigeration technologies (magnetic refrigeration, solar-powered units in developing countries…).

The IIR is an intergovernmental organization. It brings together 61 developed and developing countries and countries with transition economies, which represent 80% of the global population. The IIR's mission is to promote and disseminate knowledge of refrigeration technology and all its applications. Thanks to the international scope of its network of experts, the IIR contributed to the success of the Montreal Protocol and is actively committed to the mitigation of global warming. A lot is still to be done for both these issues and the IIR invites all countries to join it in its task

General

Amendment to Canada's Energy Efficiency Regulations published

Amendment 9 of the Energy Efficiency Regulations was registered on November 2, 2006 and published in the Canada Gazette Part II on November 15, 2006. http://canadagazette.gc.ca/partII/2006/20061115/pdf/g2-14023.pdf (see pages 1784 to 1840 in html file and pages 138 to 194 in the .pdf file)

The amendment:

- updates the test method and increases the stringency of energy performance requirements for central air conditioners and heat pumps less than 19 kW (65 000 Btu/h). As a result, these regulations are harmonized with the required performance level of SEER 13 in the United States and the province of Ontario;
- increases the stringency of existing minimum performance requirements for three types of air conditioners used in the commercial/institutional sector. Packaged terminal air conditioners and heat pumps are heating and cooling assemblies mounted through the wall, and are often found in motel and hotel rooms. Large air conditioners and heat pumps and internal water-loop heat pumps are used for heating and cooling large commercial buildings;
- introduces regulatory requirements for minimum energy efficiency requirements for beverage vending machines and commercial reach-in refrigerators;
- introduces requirements for two new types of residential refrigerating appliances: chest freezers with automatic defrost, Type 10A, and automatic defrost refrigerator-freezers, with bottom-mounted freezer and through-the-door-ice service, Type 5A. The amendment ensures that minimum standard requirements and labelling are harmonized in Canada and the U.S. for these products;
- repeals the effective date for internally lighted exit signs. This change will broaden the coverage of the requirement to include all exit signs, regardless of the date of manufacture;
- repeals the effective date for fluorescent lamp ballasts and introduces ballast efficacy factors for energy-saving lamps. It also modifies specific exclusion criteria for certain ballasts, such as ambient temperature of operation and dimming capabilities. The amendment also allows for ballasts that operate a small subset of residential F32T8 lamps to operate at a lower power factor than specified in the current regulations;
- repeals the tap range exemption for dry-type transformers;
- repeals the requirement of Minister's recognition of certification bodies accredited by the Standards Council of Canada;
- addresses administrative items such as ensuring that the French and English versions of the Regulations are identical;
- updates the numbering system of items included in Part I of Schedule I of the Regulations. The amendment also updates the Regulations by adding references to the newly available French version of certain CSA standards, as well as updates the reference of the test method for dishwashers.

For further information relating to specific equipment, see our bulletins for these products:

- Air conditioners and heat pumps under 19 kW (65 000 Btu/h) – link to http://www.oee.nrcan.gc.ca/regulations/march2005-ac-heat-pumps.cfm?text=N&printview=N
- Packaged terminal air conditioners and heat pumps – link to http://www.oee.nrcan.gc.ca/regulations/ac-heatpumps-sept2004.cfm?text=N&printview=N
- Large air conditioners and heat pumps – link to http://www.oee.nrcan.gc.ca/regulations/ac-heat-pumps-bulletin2005.cfm?text=N&printview=N
- Ground and water source heat pumps and internal water loop heat pumps – link to http://www.oee.nrcan.gc.ca/regulations/jan2005_ground-water-heat-pumps.cfm?text=N&printview=N
- Refrigerated beverage vending machines – link to http://www.oee.nrcan.gc.ca/regulations/vending-machines_oct2005.cfm?text=N&printview=N
- Commercial refrigerators and freezers – link to http://www.oee.nrcan.gc.ca/regulations/reach-in-refrigerators-apr05.cfm?text=N&printview=N
- Self-contained commercial refrigerators and freezers - link to http://www.oee.nrcan.gc.ca/regulations/fridge-refrigerateur.cfm?text=N&printview=N
- Residential refrigerators/freezers – link to http://www.oee.nrcan.gc.ca/regulations/fridge-freezers05.cfm?text=N&printview=N
- Fluorescent lamp ballasts – link to http://www.oee.nrcan.gc.ca/regulations/fluorescent_may2006.cfm?text=N&printview=N
- Dry-type transformers – link to http://www.oee.nrcan.gc.ca/regulations/drytype-change-exemptions-oct2005.cfm?text=N&printview=N
- Energy performance verification program – link to http://www.oee.nrcan.gc.ca/regulations/energy-perform-sept2004.cfm?text=N&printview=N

Effective Dates

The effective dates of this amendment for the various products are as follows:

- Effective immediately:
  - o Air-conditioner and heat pumps under 19 kW (65 000 Btu/h);
  - o Package terminal air condition ers and heat pumps;
  - o Large air conditioners and heat pumps;
  - o Ground- and water-source heat pumps;
  - o Internal water loop heat pumps;
  - o Fluorescent lamp ballasts;
  - o Dry-type transformers
  - o Exit signs;

- o Residential refrigerators/freez ers; and
- o The changes to the criteria for energy efficiency verification or ganizations.
- Effective January 1, 2007:
  - o Refrigerated beverage vending machines.
- Effective April 1, 2007:
  - o Self-contained commercial re frigerators and freezers; and
  - o Commercial refrigerators and freezers.

This amendment to the Energy Efficiency Regulations was pre-published in the May 6, 2006 edition of Canada Gazette, Part I http://canadagazette.gc.ca/partI/2006/20060506/pdf/g1-14018.pdf for a period of 75 days, during which all stakeholders were invited to comment. Comments were received throughout this period, and there were some small changes to the amendment in response to stakeholder input.

Source: http://canadagazette.gc.ca

European Centre for Advanced Studies in Thermodynamics (ECAST) Ilya Prigogine Thermodynamics Prize, 2007

Call for applications

The Ilya Prigogine Prize awards an amount of 2000 Euros in addition to a diploma. The prize honours PhD theses or equivalent work carried out by young researchers, defended or published between January 2005 and January 2007. All aspects and branches of thermodynamics are considered, from applied and experimental work to the most theoretical aspects.

This prize, organized by ECAST, was established by the Nobel Prize laureate I. Prigogine personally, while he was alive. Every two years, it is awarded to a promising young researcher in thermodynamics for his/her PhD thesis, or for equivalent work. It was first awarded in 2001 in Mons, Belgium, during the JETC 7 (Joint European Thermodynamics Conference). The second time was in 2003 in Barcelona, Spain, during JETC 8, and the third time in 2005 at a thermodynamics workshop in Udine, Italy.

Applications will be examined by a selection committee of about ten scientists from different European countries, who will either act as experts themselves and/or will choose the best experts in the domains concerned. The composition of the selection committee will be made public.

The prize will be conferred solemnly during the JETC 9 meeting to be held in Saint-Etienne, France, June 11-14, 2007, when the recipient will give an oral presentation of his/her work. Candidates will be informed of the results by the end of April 2007.

Application: the following documents are required:
- two paper copies of the thesis or other work (which will be returned)
- a short English abstract (no more than two pages)
- the reports of the jury or the reviewers of the thesis, if any
- a CV of the applicant, in English
- a list of publications
- if the manuscript is not in English, a ”long” (20 pages) summary in English
- a CD containing pdf or Word files of all above documents

Deadline
February 14th 2007

Address for sending documents
Attention: Marie Blanchet, CERET,
ENSIC-INPL BP 451
1 rue Grandville,
FR-54001 Nancy Cedex,
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Marie.Blanchet@ensic.inpl-nancy.fr

Buildings of the future

The (German) “Energy-Optimised Construction” research programme has been modified, so that its objective is presented by the heading “Buildings of the future”.

For newly constructed buildings, topics such as halving of primary energy demand in accordance with EnEV 2006, up to “zero-emissions buildings” standards, are covered, as are various other requirements. To complement this, the programme also includes renovation. The new website for the EnOB projects and activities is introduced in a compact and concise form under the headings “New Building Construction” and “Renovation”, complemented by further relevant information and detailed scientific descriptions of projects.

The heading “New Materials”, introduces research projects, technologies and systems for building technologies, all of which have been tested under actual operating conditions.

All the material is described in German.

Source: energy-server newsletter Issue 61 2006/11/23

What’s hot when Swedes are looking for new houses

An investigation by the Swedish real estate broker Skandiamäklarna showed the following top priorities when people are looking for a new home:

1. Close to open water (74 %)
2. Large kitchen (74 %)
3. Good communications (71 %)
4. Open architecture (67 %)
5. *Ground source heat pump installed (66 %)*
6. Garage (66 %)
7. Wooden floors (63 %)
8. Close to recreation areas (58 %)
9. Large bathroom (53 %)
10. Fireplace(42 %)

Source: www.skandiamaklarna.se (In Swedish)

Germany’s EU presidency focuses on EE, RES and climate change

Energy efficiency, renewables and climate change will top the agenda of the German EU presidency. Germany will take over the EU presidency from Finland in January 2007. Ger-

man chancellor Angela Merkel announced that the German EU presidency will promote efforts to reach an agreement on what is to follow the Kyoto Protocol.
Source: www.europa.eu

ITER gets final go-ahead

The world's most expensive science experiment, the ITER project, aims to produce energy the way the sun does, via fusion.
The ITER fusion research project was officially signed by the seven partners committed to its construction - the EU, China, India, Japan, Russia, South Korea and the United States - on 21 November 2006.
Construction of the ITER reactor in Cadarache, southern France will start in 2007 and take at least ten years. The EU will contribute around 50 % of its total costs, estimated at EUR 10 billion, with the other partners contributing up to 10 % each. An experimental reactor could be fully operational by 2040.
Supporters of the project claim that nuclear fusion will result in an environmentally friendly, cost-effective and potentially inexhaustible supply of energy that will eventually replace oil and gas. They also expect the project to create some 10 000 new jobs.
Opponents say that it is a waste of money and fear that it will reduce funding for research on renewable energy sources, which are closer to breakthrough and could bring results sooner, while environmentalists argue that fusion is neither clean nor safe.
Source: Euroactiv Newsletter 2006-11-24

Substantial interest in EFFSYS 2

Sweden The Swedish Energy Agency has launched the EFFSYS 2 research programme. Building on the former EFFSYS programme, the new programme is aimed at making heat pumping and refrigeration technology more efficient. In this respect, both components and systems are meant to become more efficient. The total budget for this program is SEK 70 million, with SEK 28 million from government, and SEK 42 million from industry.
When the call was closed, more than 40 ideas had been submitted, with which the chairman of the programme, Professor Erik Granryd, was very pleased.
Source: Energi och Miljö #9, 2006 (in Swedish)

EU off track from Kyoto targets, says EEA

Europe With existing policies in place, only the UK and Sweden will be able to deliver on their pledge to reduce greenhouse gas emissions, according to new figures by the European Environment Agency (EEA).
EU-15 countries will need to step up their efforts if they are to meet their overall target to reduce emissions of global warming gases and meet their Kyoto commitments, the EEA warned on 27 October.
According to a new report by the Copenhagen agency, 'Greenhouse-gas emission trends and projections in Europe 2006', existing policies will have slashed greenhouse gas emissions in the EU-15 by only 0.6 % in 2010 - a far cry from the 8 % it committed to achieve by 2012.
Looking at national commitments - the individual share of the overall burden that EU countries have distributed among themselves - only Sweden and the UK are on track to deliver, the EEA said.
Source: EurActiv newsletter, 2 November 2006

Europe's plan to cut energy consumption by 20 % by 2020

Europe On 19 October, Energy Commissioner Andris Piebalgs presented his action plan to cut Europe's energy consumption by 20 % over the next 14 years. If successful, the EU could save more than EUR 100 billion per year. The plan would also help to cut the EU's CO2 emissions, and therefore contribute to reaching the Kyoto targets.
The Energy Efficiency Action Plan will be introduced over a period of six years. More than 75 actions were identified in ten priority areas:

- New energy performance standards for various product groups such as boilers, copiers, TVs, lighting (from 2007);
- new energy standards for buildings and for promoting low-energy buildings ("passive houses") (2008-9);
- making power generation and distribution more efficient (2007-8);
- possible legislation to limit CO_2 emissions from cars to 120 g/km by 2012 (2007);
- facilitate bank financing for investments in energy efficiency by SMEs and energy service companies (2007-8);
- boosting efficiency in new member states;
- coherent use of taxation with the preparation of a Green Paper on indirect taxation in 2007;
- awareness and education campaigns;
- improving energy efficiency in urban areas through a "Covenant of Mayors" (to be created in 2007), which will exchange best practices, and;
- international agreements to foster energy efficiency worldwide.

Source: EurActiv Newsletter: Energy

Will energy plan lead to less energy use?

The Energy Action Plan, set to be adopted on 19 October, foresees more than 75 actions to achieve a 20 % reduction of Europe's energy consumption by 2020. But several energy experts question whether higher energy efficiency automatically leads to less energy consumption.

Energy Commissioner Andris Piebalgs will present his long-awaited action plan on energy efficiency on 19 October, consisting of a catalogue of EU-wide measures to make Europe's economies more energy-efficient. The plan is a follow-up to the 2005 Green Paper, which started a stakeholder consultation on achieving the goal of reducing energy consumption in the EU by 20 % by the year 2020.

Energy efficiency has become one of the Commission's (and member states') answers to the double challenge of global warming and the EU's increasing energy dependency on oil and gas from the Middle East or Russia. In the United States, energy efficiency is much lower on the political agenda, because of US citizens' reluctance to reduce their "energy hunger".

Although energy efficiency has recently received more political attention, there are still questions over the effectiveness of particular policies. Several energy economists have questioned whether energy efficiency measures really do bring energy savings on a macro-economic scale. Building on the work of nineteenth-century economist Stanley Jevons, they have looked at the **"rebound" or "take-back" effects of energy efficiency policies**. This effect takes place when the energy savings produced by the measure are taken back by consumers in the form of higher consumption. Consider, for example, a household which has made big energy savings over the year. At the end of the year, it might decide to buy a new car with the money it saved. It is questionable therefore whether, on a macro-economic level, the household has contributed to less energy consumption.

A report produced in 2005 by the UK House of Lords' Science and Technology Committee as a response to the EU's Green Paper drew attention to this issue which, in academic circles, is also known as the "Khazzoom-Brookes postulate".

A 2005 study by the International Energy Agency looked at the energy efficiency critics and concluded: "Energy efficiency analysts who suggest that the rebound effect erodes some of the energy savings due to technical efficiency improvements do make a valid point, based on the empirical evidence. Some consumers and businesses will increase their demand for energy services as the cost of the service declines. But empirical evidence suggests that the size of the rebound effect is very small to moderate, with the exact magnitude dependent on the location, sector of the economy, and end use".

Although most experts now accept the existence of this rebound effect, the debate continues over its magnitude. In the UK, the Energy Research Centre (UKERC) is conducting an in-depth study of the magnitude and importance of the rebound effect of energy efficiency policies.
Commission officials working on the preparation of the action plan confirmed to EurActiv that they have looked into the possible rebound effects, and have calculated them into the 20 % target.
Source: EurActiv Newsletter

Corporate America gets hot on climate change

USA The Pew Center on Global Climate Change released its new study "Getting ahead of the curve: corporate strategies that address climate change" on 18 October.
"Climate change poses real risks and opportunities that companies must begin planning for today, or risk losing ground to their more forward-thinking competitors," Eileen Clausen, president of the Pew Center, argues in the foreword to the study.
The report includes a 'How To' manual for companies interested in developing effective climate-change policies. The authors of the report worked with companies such as Alcoa, DuPont, Shell and Whirlpool, and used their best practices to develop a handbook for other companies that want to start with effective policies.
The growing concerns of US companies about the impact of climate change stand in stark contrast to a number of European business leaders who are urging the EU to reconsider its world leadership position on the issue. According to many European CEOs, the European emissions-trading scheme is undermining industry's competitiveness.
US companies are not alone in not following the Bush administration's hesitation on climate change. More than 266 US mayors have signed the US Mayors' Climate Protection Agreement and, in California, Governor Arnold Scharzenegger recently signed a strong climate-change law for his state.
The American companies interviewed in the Pew study expect the next US government to produce new climate-change regulations by 2010. Eileen Claussen of the PEW Center does not believe that the US will join the Kyoto Protocol, but "it is likely climate change regulations in the US will go beyond Kyoto", she said.
Source: EurActiv Newsletter: Energy
ASHRAE forms sustainable metrics group
A new technical research group focusing on sustainable building guidance and metrics has been created by ASHRAE.
The group will develop design guidance, performance metrics and rating systems to integrate indoor environmental quality, energy efficiency and other aspects of sustainable building performance. It will work with other organizations to integrate HVAC&R systems with other building systems to enhance the effectiveness of total building design and integrated practice.
Source: ASHRAE Insights

Technology & Applications

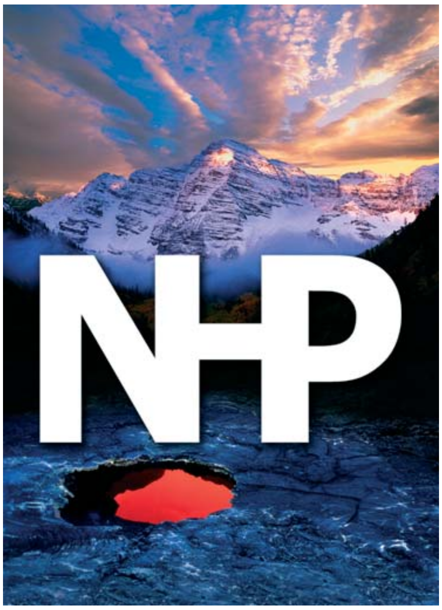
Research Lays Groundwork for More Efficient Air Conditioning System Designs Using Flattened Tube Heat Exchangers

Arlington , VA —Replacing traditional round tube heat exchangers with flattened tube technology may enable the air conditioning industry to provide comfort cooling using a new refrigerant, while increasing efficiency, but not the system's size.
A newly released Air-Conditioning and Refrigeration Technology Institute (ARTI) report characterizes how flattened-tube heat exchangers function under various environmental conditions and pressures.
To read the final report, "High Performance Heat Exchangers for Air-Conditioning and Refrigeration Applications (Non-circular Tubes)," go to http://www.arti-research.org/research/completed/finalreports/20021-final.pdf.
Contact: Colleen Hughes
ARI Public Affairs, 703-600-0331
Source www.ari.org

Dedicated brazed plate heat exchangers (CBE) for Heat Pumps

Sweden Swedish brazed plated heat exchanger (CBE) manufacturer SWEP International AB launch dedicated product range for heat pumps. Based on more than 15 years of experience working with dedicated heat pumps, SWEP launches the Nordic Heat Pump (NHP) product range. These heat exchangers are intended and dedicated for heat pump applications.

Recognizing the different operating conditions of evaporators and condensers, the NHP range consist of dedicated CBEs with different plate geometry and optimized distribution system to improve performance and cost-efficiency for both the evaporator and condenser function.
The NHP units have been verified in accordance with the European test standard EN14511:2004 in laboratory tests and real-life heat pump installations to ensure high reliability and seasonal performance.
The SWEP calculation program, SSP, is updated with the NHP product range and helps heat pump manufacturers to pinpoint the performance according to the market requirements.
For further information please contact SWEP or Product Manager NHP Adam Dahlquist (adam.d@swep.net)
Source: www.swep.net



Houses of the future to be 'self cooling'

A new study from Zurich Insurance, in conjunction with Arup Associates, has suggested that the homes of the future could pose a threat to the air conditioning industry.

The research claims that houses will be designed in such a way that they are able to self-cool, with pipes carrying cooled, recycled water into and around beams and ceilings.
Such an option could come into use to compete with the high levels of energy consumed by current cooling systems, meaning that air conditioning companies will need to develop more energy efficient units to remain competitive.
Air conditioning systems may also need to run on renewable energy supplies to make them competitive in the future, if Zurich's predictions are correct.
Zurich also claims that houses of the future will be self-heating, with solar panels and gas-filled triple-glazed windows providing warmth during the winter months.
Source: ACR news 15/12/2006

ASERCOM Energy Efficiency Award 2006

The ASERCOM Energy Efficiency Award 2006 granted for a new control of refrigerant flow.

Innovative developments for energy saving in the field of refrigeration, heat pumps and air conditioning, that promise to be successfully marketed, can be proposed for the ASERCOM Award.

The 2006 price-winning company is the Swedish Bubble Expansion Valve BXV(R) AB, for an innovative expansion device, effecting a better overall refrigerant heat transfer in the evaporator, and thus better system efficiency.

In small and medium-sized refrigeration units, a dry expansion system, controlled by a thermostatic valve, is common practice. This system requires that the vapour should leave the evaporator in a superheated state. This means that part of the evaporator is used to attain a dry, superheated condition, which reduces the overall heat transfer of this component. This drawback is not found with flooded evaporators, which are used in large industrial applications. In these types of systems, more liquid refrigerant is supplied to the evaporator than is evaporated in one pass. The surplus of liquid, not evaporated at the outlet, is re-circulated. These 'liquid overfeed' flooded systems show excellent refrigerant-side behaviour of the evaporator because the entire surface is working under boiling heat transfer conditions.
Expansion of the liquid refrigerant in these industrial units is controlled by a float valve, preventing liquid from accumulates in the condenser, and thus keeping the condenser internally empty.

The award-winning invention aims to extend the liquid overfeed system to small equipment as well. Expansion (throttling) is controlled by a valve, the position of which is derived from the condition of no liquid level in the condenser, similar to the float valve system described above. The new device allows liquid, together with a small amount of gas, to leave the condenser. This uncondensed gas 'slipstream', which of course must be low, is measured and provides a signal for the expansion valve. The new device incorporates an ejector for good fluid recirculation in the evaporator loop, a small drum to separate flash gas, and a unit to return oil to the compressor, heated by subcooling of the liquid from the condenser.

All these functions are integrated into a compact unit, which needs no electronic controls. In addition to the gain due to better use of the evaporator, the new device improves the performance of the condenser (no liquid build up), the pressure in which can vary with the seasonal and daily air temperature (floating pressure).

The energy savings depend on the type of equipment and whether or not electronic thermostatic expansion devices are used in the systems with which it is compared. However, energy savings between 10 and 20 % can be attained. In the light of these energy savings and the anticipated costs for the system, it is expected that the new system can, in several applications, compete successfully with the traditional dry expansion equipment with superheating controls.
Source: www.asercom.org

Transcritical CO_2 systems make their way to supermarkets

Sweden The Swedish company Friginor in Luleå has installed a transcritical CO_2 system in a supermarket in Luleå, Sweden. Even though high ambient temperatures are usually said to be difficult to transcritical CO_2 systems, the start-up of this run perfectly in 32 °C ambient conditions.

Friginor thinks that CO_2 is the future and says that, according to the Swedish refrigerant directive, one should choose systems that give the least environmental damage. The often-mentioned obstacle that components are not available is also exaggerated: the components are there, it's just a matter of finding them.
Source: Kyla #6, 2006 (in Swedish)

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, 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

IEA Heat Pump Programme participating countries: Austria (AT), Canada (CA), France (FR), Germany (DE), Japan (JP), The Netherlands (NL), Norway (NO), 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.

IEA Heat Pump Programme

GENERAL

The 9th IEA Heat Pump Conference

Early Notice – Call for Papers

May 20-22, 2008, Zürich, Switzerland

The Conference program will cover the following topics:

- Technology – advances in equipment design and development
- Systems - advanced electrically and thermally operated systems, and ground source systems
- Applications – demonstrated energy efficiency and environmental advantages
- Research and development – new developments in heat pumping technologies
- Policy, standards and market strategies - government, utility and professional society activities related to heat pumps
- Markets – market status, trends and future opportunities
- International activities – discussion of actions in response to climate change initiatives.

Papers: Papers will be presented both orally and as posters. If you are interested in submitting a paper, please contact your Regional Coordinator or see the conference website. Deadline for a 200-300 word abstract is April 30, 2007.

Workshops: There will be opportunities for organisation of workshops before and during the Conference. Interested organisations should contact one of the Regional Coordinators.

Exhibition: There will be an exhibition in connection with the Conference. For those interested in exhibiting, please contact your Regional Coordinators.

Web: For more information, please log on to the Conference website at: www.hpc2008.org

Regional Coordinators

For information on papers and workshops, conference program, etc., please contact the Regional Coordinator for your area:

- Asia and Oceania: Mr. Takeshi Yoshii, yoshii@hptcj.or.jp
- North America: Mr. Gerald Groff, ggroff2@twcny.rr.com
- Europe and Africa: Mrs Monica Axell, monica.axell@sp.se

Annex 33

Compact heat exchangers in heat pumping equipment

This Annex, which commenced activities in the autumn of 2006, is aimed at widening the use of compact heat exchangers (CHEs) in heat pumping systems. It is believed that these will improve efficiencies, minimise fluid inventories and reduce package size. The data collected during the Annex will, it is hoped, quantify the possible benefits from CHE use, and also highlight any concerns.

The objective of the Annex is to present a compilation of possible options for compact heat exchangers, used as evaporators, condensers and in other roles in heat pumping equipment. The aim is to minimise the direct and indirect effect on the local and global environment due to operation of, and ultimate disposal of, the equipment.

The activities will include market research, evaluation of the performance of compact heat exchangers relevant to heat pumps, evaluation of properties and operating limits of such equipment, and information dissemination. There will be opportunities for open meetings at which industry and academia can put forward their views and contribute to the project.

Operating Agent for the Annex is the School of Engineering and Design, Brunel University in London, UK, represented by Professor David Reay or Deputy, Dr. Peter Kew of Heriot-Watt University, Edinburgh.

The Vice-Operating Agent is the Royal Institute of Technology (KTH), Department of Energy Technology, SE-100 44 Stockholm, Sweden, represented by Professor Bjorn Palm, and the USA and Japan are also participating in the Annex.

Topics for the next year decided

The following topics have been decided for the Newslett
er next year:
March 2007: Industrial heat pumps
June 2007: Mobile air conditioning
September 2007: Development trends for heat pump components and control
December 2007: Combining heat pumps and other renewable technologies (solar, wood, fuel cells etc.)

All readers are welcome to submit articles on these topics. Contact the editor Roger Nordman for further instructions, roger.nordman@sp.se

The photo shows a compact heat transfer surface used in heat exchangers produced by Chart Energy & Chemicals, Inc.

Markets

Heat pumps now part of EU-25 energy statistics

Intensive information activities of EHPA representatives during the last months have helped heat pumps to be included in the EU-25 energy statistics for the first time. The EHPA highly welcomes this break-through.

The newly published EU-25 Energy Fiches (TREN C1) now lists the following RES Heat sources:

1. Biomass (thermal)
2. Solar heating
3. Geothermal (thermal, exclude heat pumps)
4. Heat pumps

Source:EHPA

Energy-saving-system: certified heat pump installer awarded with the Austria energy globe

The group picture shows Mr. Anschober – representative of the Upper Austrian Government, Mr. Mittermayr – a certified heat pump installer – a representative of the company Hauser and Mr. Windtner, managing director of Energie AG Oberösterreich.

Over 1400 participants attended the award show for the Austrian Energy Globe on 24th of November. The Energy Globe is awarded to projects from all over the world which make careful and economical use of resources and employ alternative energy sources. The winning projects are presented in the categories of earth, air, fire, water and youth at a TV gala, which is broadcast by international TV stations reaching 2.5 billion households.

Every year, about 700 projects from all over the world are submitted in the Energy Globe Award competition. Submitted projects are described in the Energy Globe data base, which is accessible in the near future for interested persons. It is today's most prestigious and acknowledged environmental award. The Energy Globe aims at informing the international public about as many sustainable and reproducible projects as possible.

The winners of the Fire category were the M-Tec Mittermayr GmbH and Hauser GmbH companies with their Energy Saving System (ES). This system uses the waste heat of cooling systems - which is normally not used – for heating. Additionally, at times of peak demand, the heat pump can provide indirect energy from geothermal sources. In summer, the system is perfect for efficient cooling of buildings. The heat is distributed via a floor heating system. Using the technology, 30 – 35 % of running costs could be saved. In addition, there are environmental benefits due to the fact that 30 % less refrigerant is needed, meaning that substantial CO_2 savings could be achieved. More than 30 supermarkets in Austria benefit from the system. The M-Tec company specialises in planning and installation of heat pump systems. Mr Klemes Mittermayr is also a certified heat pump installer.

For further information, please visit the following web sites:

M-Tec: www.m-tec.at
LGWA: www.lgwa.at
EU-Cert Projekt: http://eucert.fiz-karlsruhe.de/
Zertifizierte Wärmepumpeninstallateure: www.arsenal.ac.at
Klima:aktiv „wärmepumpe“: www.waermepumpe.klimaaktiv.at

For more information please contact:
The Austrian Heat Pump Association
Mag. Martina Höller
E: martina.hoeller@lgwa.at
T: 0043+ (0) 7229-70452

Fort Polk Installation Demonstrates Retrofit Potential of Geothermal Heat Pumps

Jeff Hammond, USA

A recent independent study prepared for the U.S. Department of Energy by Oak Ridge National Laboratory (Hughes, et al, 1998) demonstrates that geothermal heat pumps (GHPs) provide substantial benefits to the end user, the electric utility industry and the environment. A comprehensive 4,003-home retrofit project was conducted at Fort Polk, Louisiana where the existing heating and cooling systems (560 gas furnace/electric air-conditioner systems and 3443 air-source heat pump systems) were replaced by GHPs with desuperheater water heaters. In addition existing incandescent lighting fixtures were replaced by high-efficiency fluorescent or compact fluorescent fixtures, and existing shower heads were replaced by low-flow shower heads. Evaluation of this massive retrofit showed that it reduced electrical consumption in the 4003 residences by 26 million kWh (33%) while altogether eliminating consumption of 27,425,000 Mj of natural gas. Peak demand was reduced by 7.5 MW (43%), and the power factor was increased from 0.52 to 0.62 . Emissions of CO_2 have been reduced by an estimated 20,321,000 kg per year at the Ft Polk site. The GHPs alone are credited with 66% of the electricity savings and all of the natural gas savings (Hughes and Shonder, 1998) accounting for about 14,900,000 kg of the total annual CO_2 emissions reduction

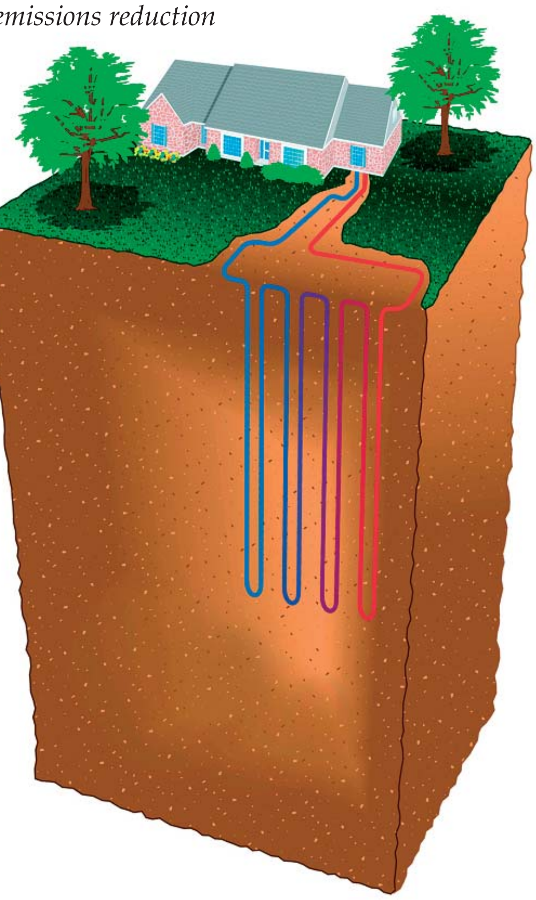
Introduction

Fort Polk, the world's largest installation of geothermal heat pumps, was funded by $18.9 million in private capital, with no investment by the U.S. federal government except for procurement and administrative costs. Private investors, through an ESCO (Energy Services Company), realized that GHPs inherently pay for themselves. The U.S. Army and the ESCO share the cost savings over the life of a 20-year contract, allowing Fort Polk to exceed the mandate for 35% reduction in energy use by 2010, outlined in the Energy Policy Act of 1992. With heating, air conditioning, and water heating responsible for 74% of residential energy use (and 50% of commercial energy use) on a national basis (in the U.S.), widespread use of GHP systems could generate significant savings for energy utilities and end users.

GHP systems consist of simple, proven components. The technology is not new. The first recorded system was shown in a 1912 Swiss patent. Ground water or "open loop" heat pumps have been used successfully since the 1930s. The Edison Electric Institute (EEI) sponsored closed loop research (like the Fort Polk application) in the 1940s and 1950s, although the lack of suitable material for closed loop piping slowed interest. U.S. researchers (Oklahoma State University, among others) began investigating geothermal closed loop systems again in the 1970s with the advent of polyethylene pipe, which is ideal for the application. GHP systems have been gaining in popularity every since.

GHP Systems

In general, GHP systems consist of three components, (1) a geothermal (or water source) heat pump, (2) a heat source/sink (closed loop piping system) and (3) a distribution system (forced air ductwork or hydronic piping). A geothermal heat pump "moves" energy to or from the ground, instead of to or from the air like traditional heat pumps, giving the GHP system the advantage of working with a very mild heat source/sink – the ground.



The heat source/sink consists of polyethylene pipe (usually 19mm or 25mm diameter), arranged according to the geography of the land. One loop piping system is not better than another; the loop is tailored to the available land space, with loop length adjusted accordingly (e.g. horizontal loops require more piping than vertical loops, due to the more shallow

1 Power factor is the ratio between power (in Watts) and V-A (Volt-Amps), which is important to the electric company, since the company bills for Watts, but supplies V-A to the customer. The closer the power factor is to 1, the less power factor correction is necessary via capacitors or inductors, thus lowering power generation and transmission costs.

burial depth). A water and antifreeze solution is pumped through the piping system. The water/antifreeze solution transfers heat from the earth to the heat pump refrigeration circuit (or from the heat pump refrigeration circuit to the earth), which transfers heat to or from the distribution system.

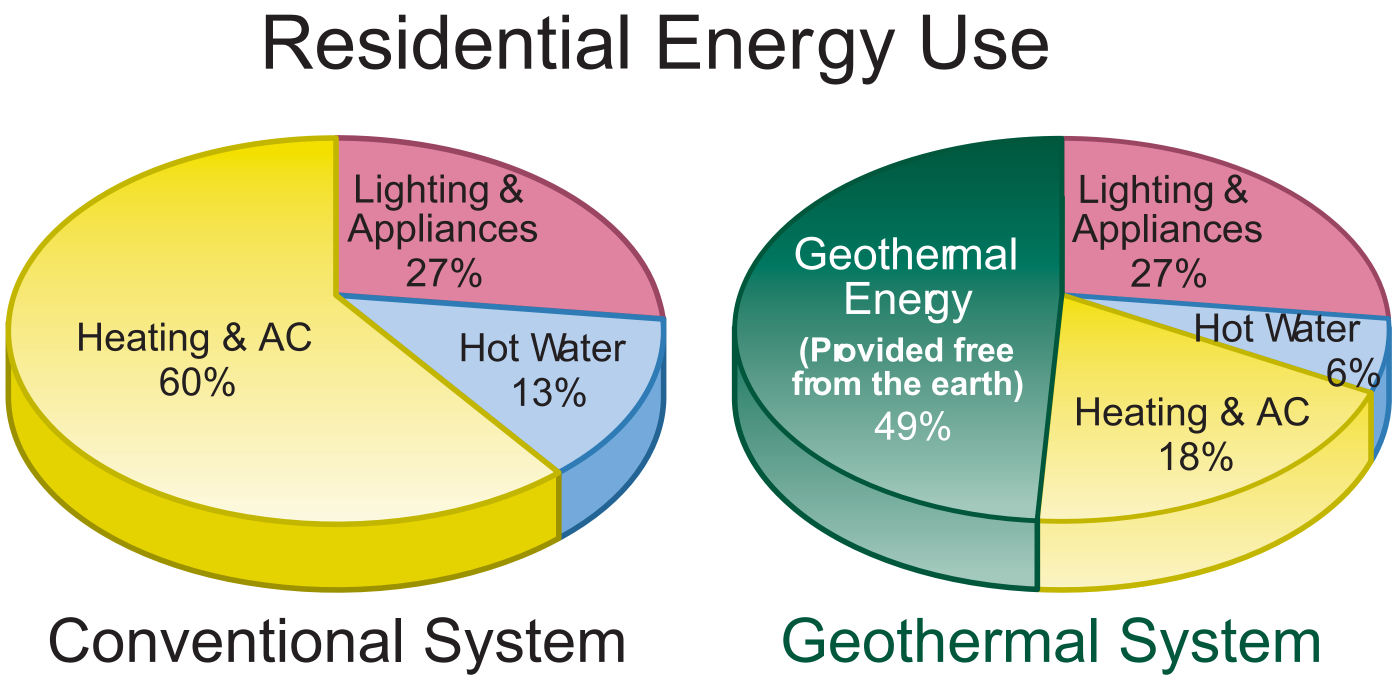
The distribution system consists of forced air ducting or hydronic piping. A forced air ducted system uses a fan and ductwork to deliver heated or cooled air via registers and grilles to the structure being conditioned. GHPs offer warmer air temperatures in heating for forced air systems than traditional air-source heat pumps due to the milder heat source they use. In cooling, GHPs provide excellent dehumidification and cool, refrigerated air. A hydronic distribution system may be used instead of a forced air system. Some examples include radiant floor heating, fan coil units and snow melt.

Diverse Applications for GHPs

Almost any building can benefit from a GHP system. Schools, assisted living communities, office buildings and residential homes are but a few examples. Any building that has an available space for loop piping of 0.1 to 0.3 m^2 per kW is a good candidate for a GHP system, even if the available space is under a parking lot or under the building. Where a retention pond is required for parking lot runoff, a GHP system can become not only the most efficient HVAC system, but may even be the lowest first cost (installed) system.

GHP systems can drastically reduce utility power generation requirements when compared to other systems. At Fort Polk, 0.32 kW peak demand reduction was realized for every installed kW of cooling capacity. This equates to peak demand reduction of 285 kW for every 9,290 m^2 building or for every 71 homes. If GHP systems were implemented on a widespread basis, power companies could avoid building new power plants. Using the figures from Fort Polk, a 400 MW gas turbine generator could be redirected for use elsewhere for every 99,500 homes or for every 1,400 buildings of 9,290 m^2 converted to GHP. In the past ten years since Fort Polk was started, heat pumps have become even more efficient, some with almost twice the efficiency, further enhancing generating capabilities (peak reduction). The increase in load factor with GHP systems helps level peaks and increase generating efficiency.

GHP systems are environmentally friendly. Based upon data supplied by the U.S. Department of Energy (NREL 1998), if just 100,000 additional homes in the US converted to a GHP system, CO_2 emissions could be reduced by over 200 million kg per year!



Residential GHP systems generally cost more to install than other HVAC systems. The additional cost is primarily the ground loop piping system, since the heat pump and distribution system are similar in cost to other technologies (e.g. furnace/air conditioner or air source heat pump). Initial cost for commercial GHP systems really depends upon a base system comparison. For example, GHP system initial cost is higher than a constant volume packaged rooftop unit, but the same or less than a 4-pipe VAV (variable air volume) system. Depending upon a base system comparison, peak demand and kWh savings will vary. However, GHP systems still have the most favorable operating cost and load profile of any HVAC system.

GHP systems have a proven track record for reducing operating costs for end users, lowering peak demand/improving load factor for utility companies and creating a more environmentally friendly heating and cooling system for society in general. The independent study of the Fort Polk GHP retrofit installation provides a benchmark for the endless possibilities of applying the technology on a widespread basis.

Conclusions

In conclusion, Fort Polk, the world's largest geothermal installation, demonstrates that retrofitting GHP systems makes economic sense, and also contributes to a better environment for future generations. In this study, the retrofit of 4,003 residences with geothermal heat pumps reduced electrical consumption for space heating, space cooling, and water heating by 17 million kWh per year. In addition, the GHPs eliminated consumption of 27,425,000 Mj/y of natural gas for space heating and water heating. The GHP retrofit has reduced CO_2 emissions by an estimated 14,900,000 kg per year.

References

Hughes, Shonder, White, and Huang. 1998. "Methodology for the Evaluation of a 4000-Home Geothermal Heat Pump Retrofit at Fort Polk, Louisiana," Oak Ridge National Laboratory, ORNL/CON-462 (March).

Hughes and Shonder. 1998. "The Evaluation of a 4000-Home Geothermal Heat Pump Retrofit at Fort Polk, Louisiana: Final Report," Oak Ridge National Laboratory, ORNL/CON-460 (March).

NREL 1998. "Environmental and Energy Benefits of Geothermal Heat Pumps," National Renewable Energy Laboratory (NREL), a DOE (U.S. Department of Energy) National Laboratory, DOE/GO-10098-653 (September).

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Air-to-Air Heat Pumps Evaluated for Nordic Circumstances

Fredrik Karlsson, Peter Lidbom, Monica Axell, Ulla Lindberg, Sweden

Twelve variable-speed capacity controlled air-to-air heat pumps have been evaluated by laboratory measurements and the results have been compared to similar investigations made in 2001 (variable-speed capacity control) and 1991 (single-speed compressors). The heat pumps were evaluated in terms of efficiency, performance of defrost system and ability to operate in a cold climate. The results show that heat pumps have become more efficient since 1991 and 2001. On average, the coefficient of performance (COP) has increased by 7-24 % since 1991. The defrost systems have also improved, although there are still systems that in practice operate under simple time control, and thus perform unnecessarily many defrost cycles, which reduces performance and probably also equipment life.

Introduction

Ductless split air-to-air heat pumps used for both heating and cooling are widely used all over the world, and the total market is estimated at 29 million units (JARN 2005). The majority of these units are used in areas where cooling is the dominating demand. However, over the last few years, the use of these heat pumps mainly for heating purposes has increased substantially in Sweden and Norway. The estimated number of units installed in Sweden in 2004 was 40 000 units, while 55 000 units were installed in Norway in 2003. Normal sales in Norway, before 2003, were about 1 000 – 2 000 units per year. An in-depth analysis of this market boom is provided by Aarlien et al., 2005. Although not as dramatic, the numbers of these units are substantially increasing in Sweden, too. The reasons for the increase are probably the increasing price of electricity and the common use of electric baseboard heaters in Swedish and Norwegian single-family houses, which were common due to the traditionally low price of electricity. Thus these buildings do not have any hydronic heat distribution system. To install a hydronic heating system is expensive, and so a change from base-board heaters to a hydronic based system (pellet burner, ground-source heat pump) is not normally a viable solution. However, installing an air-to-air heat pump is very simple, with low cost. As a consequence, even though the air-to-air heat pump must be backed up by a supplementary heat source, heat pumps are bought in order to reduce electricity use and to save money.

The increased demand for these products has drawn attention from a lot of manufacturers and marketing is fierce. In order to provide end-users with factual and independent information, the Swedish Consumer Agency and the Consumer Council of Norway together issued a laboratory test on air-to-air heat pumps. Eight units were tested by SP in 2004 (Karlsson 2004, Ebne 2004), and another four were tested in 2005 on behalf of the Swedish Consumer Agency. This article discusses the results from these two test series, and compares them with previous investigations from 2001 (Reis 2001) and 1991 (Fahlén and Johansson 1991).

Method

The heat pumps have been evaluated by laboratory tests and seasonal performance calculations. The ability to operate in cold climates and the defrost systems have been analysed from measurements and installed equipment.

Test procedure

The heating capacity and coefficient of performance (COP) was evaluated in accordance with the existing EN 14511 standard (for which SP is accredited), and the performance at part load was determined in accordance with CEN/TS 14825. The calorimeter room test procedure was used. The total uncertainty of measurement is within ±4.0 % for the heating capacity and the COP. For the electric power measurements the uncertainty is ±0.5 %. The heat pumps were tested at the outdoor air temperatures and capacities listed in Table 1, and the air temperature entering the indoor unit was +20 °C. The 75 % and 50 % part-load operation denotes the percentage of maximum heating capacity determined by the EN 14511 tests. These part-load operation points were performed such that the calorimetric chamber was cooled to get 75 % or 50 % of the capacity measured at the EN 14511 test point. Then the set value for the indoor air temperature was set to 20 °C, or a set value that gives 20 °C inlet temperature to the indoor unit, in the heat pump's control system. In this way, the heat pump's own control system adjusts the compressor capacity, such that the desired indoor air temperature is kept constant. The tests were performed for at least ten hours, maximum 24 hours, and analysed for a whole number of operating cycles with defrost, which means that the tests continued over a longer period of time than prescribed in EN 14511. The reason for this is to validate proper operation of the defrost system. The heating capacity should not continually decrease during consecutive defrosts.

The test from 2001 was performed in accordance with the former EN 255 European standard, and the part-load operation was performed as specified in CEN/TS 14825. A minor deviation is that the wet bulb temperature at the outdoor temperature of +2 °C was +1.5 °C in EN 255 and +1 °C in EN 14511. The tests from 1991 were performed in accordance with Swedish standard SS 2095 which, for air-to-air heat pumps, is similar to EN 14511. The only difference here is that the wet bulb temperature at +7 °C is +5.5 °C. Note that there were no variable-speed controlled heat pumps in the test from 1991. For all three methods, the evaluations were made for a whole number of operating cycles with defrost.

The sound power level was measured in accordance with ENV 12102 and ISO 3747.

Seasonal Performance Calculations

The seasonal performance calculations were performed for two buildings with energy demands of 11 000 and 20 000 kWh (space heating only) at an annual average outdoor air temperature of +6 °C. Based on the average outdoor air temperature, the duration curve can be calculated. Knowing the outdoor air temperature for each time step, assuming a constant indoor air temperature (20 °C in this case) and assigning a constant heat loss value to the building, the energy demand for heating can be calculated. As the heat pump capacity at different temperatures and loads is known from the measurements, it is possible to determine the capacity provided by the heat pump in each time step. The method is further described by Fehrm and Hallén, 1981 and Karlsson, 2003. The calculations are made in steps of 30 hours and the heat pumps are considered to operate down to -15 °C. Below -15 °C, the heat pump is switched off and heating is provided by an electric heater. A heating demand is present

Table 1.Test conditions; the figures within brackets are the wet bulb air temperatures

Outdoor air temperature (°C)	Capacity (%)
+7 (6)	100
+2 (1)	100
-7 (-8)	100
-15 (-)	100
+7 (6)	75
+7 (6)	50
+2 (1)	50

up to + 17 °C. The seasonal performance factor (SPF) is calculated as:

$$SPF = \frac{Q_{building}}{W_{heat\,pump} + W_{heater}}$$

where:
$Q_{building}$ = Energy demand by the building
$W_{heat\ pump}$ = Electric energy input to the heat pump
W_{heater} = Electric energy input to the supplementary heater

It is important to recognise that these calculations assume a perfect heat distribution, and thus give higher values of the seasonal performance factor than will be the case in an actual installation. In a real installation, the layout of the building will determine how well the heat is distributed. The efficiency of the installation will be higher for a building with an open layout, where the warm air can flow out into a large part of the building.

Results and discussion

The results from the previously described tests and calculations are discussed and analysed below. The discussion is divided into three different parts; energy efficiency, ability to operate in cold climates and performance of defrost systems.

Energy efficiency

The COP is the common measure for energy efficiency of heat pumps. From Figures 1 and 2 below it can be seen that the average efficiency of the heat pumps has increased since the tests in 1991 and 2001. The average increase for different outdoor air temperatures from 1991 to 2005 is summarised in Table 2. By far the best performance increase is for operation at -15 °C, where the minimum level has increased by 31 % since 1991, which is very favourable for operation in cold climates. From Figure 1, it seems as if the performance at +2 °C was poorer in 2001. However, for these tests, the wet bulb temperature was 0.5 °C higher than for the tests in 1991 and 2005, and so the water content of the air was higher which results in more frosting and therefore reduced performance.

Between 1991 and 2001, variable-speed capacity-controlled compressors became standard in air-to-air heat pumps. The use of capacity-controlled compressors provides opportunities for increasing the efficiency of heat pumps, mainly due to heat exchanger unloading, increased compressor efficiency and reduced need for defrosting (Karlsson 2003). As shown in Figure 3, the COP increases at part load for all except one of the evaluated heat pumps. Energy

Table 2 Average increase of COP between 1991 and 2005

Outdoor air temperature (°C)	Capacity (%)	Increase of average COP (%)
+7 (6)	100	12
+2 (1)	100	7
-7 (-8)	100	12
-15 (-)	100	24

savings in the range of 10-25 %, compared to fixed speed On/Off controlled heat pumps, have been reported (Tassou, Marquand et al. 1983; Marquand, Tassou et al. 1984; Bergman 1985; Miller 1988; Landé 1992). The performance at part-load operation has improved between 2001 and 2005, as shown in Figure 4, showing the COP at +7 °C and 50 % capacity.

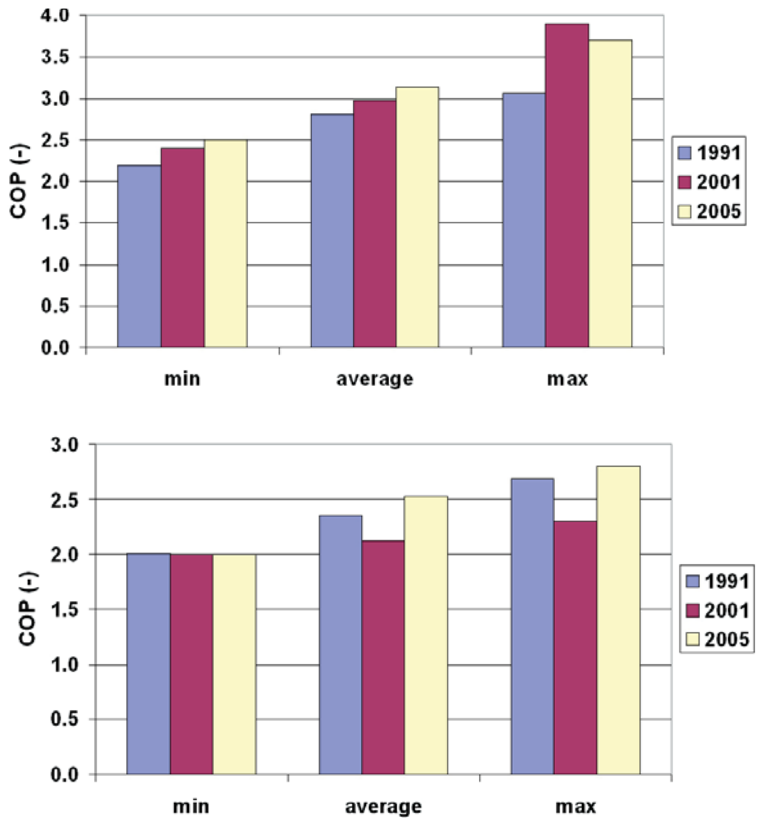


Figure 1. Minimum, average and maximum COP at +7 °C (top) and +2 °C (bottom) for air-to-air heat pumps evaluated in 1991, 2001 and 2005

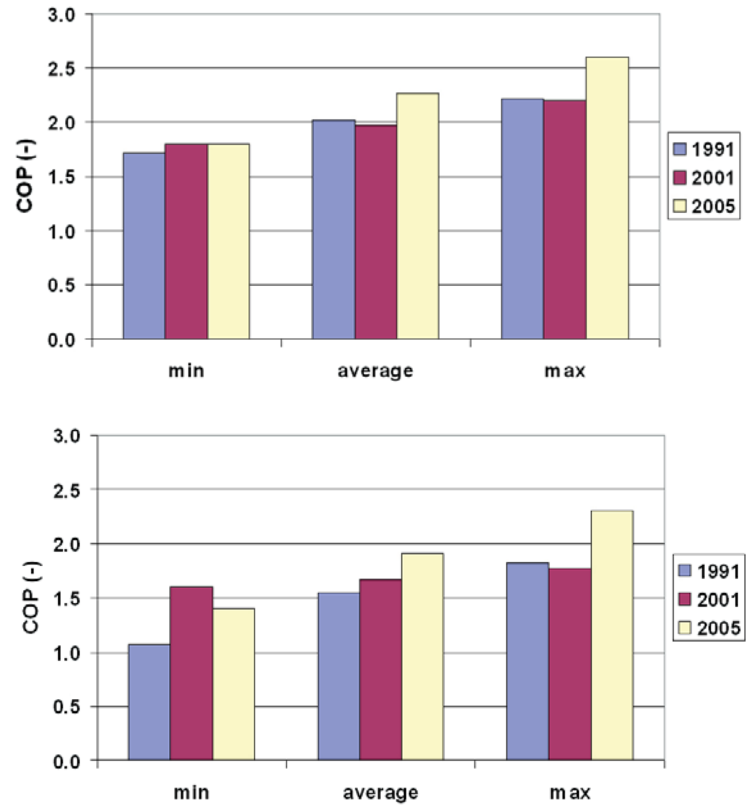


Figure 2. Minimum, average and maximum COP at -7 °C (top) and -15 °C (bottom) for air-to-air heat pumps evaluated in 1991, 2001 and 2005

Test results also show the importance of testing heat pumps at several operating conditions. A heat pump can be very efficient at +7 °C but still have a low COP at -7 °C, and vice versa. Figure 5 shows the COP for six different heat pumps from the 2005 test as a function of the outdoor air temperature. Considering heat pumps A and I, A is the most efficient at +7 °C, but has only the fourth best COP at -7 °C. The opposite is the case for heat pump I, which is fourth best at +7 °C but has the best performance at 15 °C. From this example, it is obvious that several operating conditions must be taken into account when comparing and labelling heat pumps.

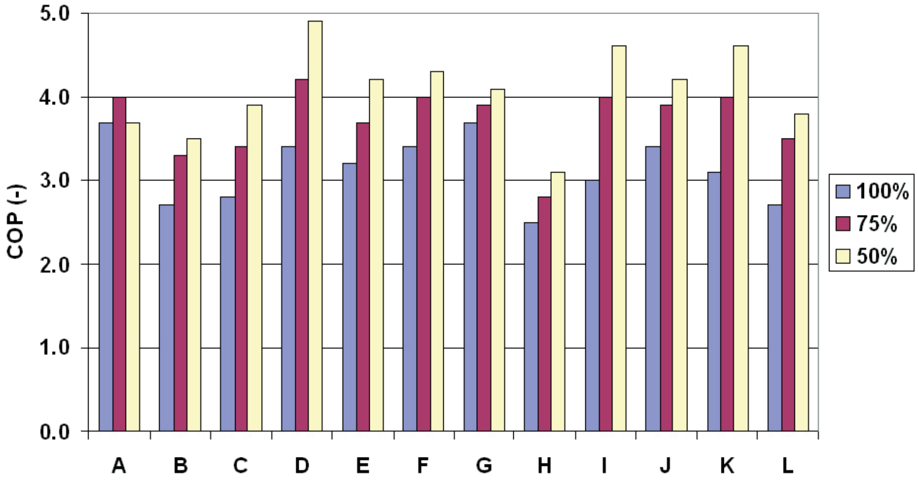


Figure 3. COP at +7 °C and different capacities for the heat pumps evaluated in 2005. In most cases, the COP increases as the capacity decreases

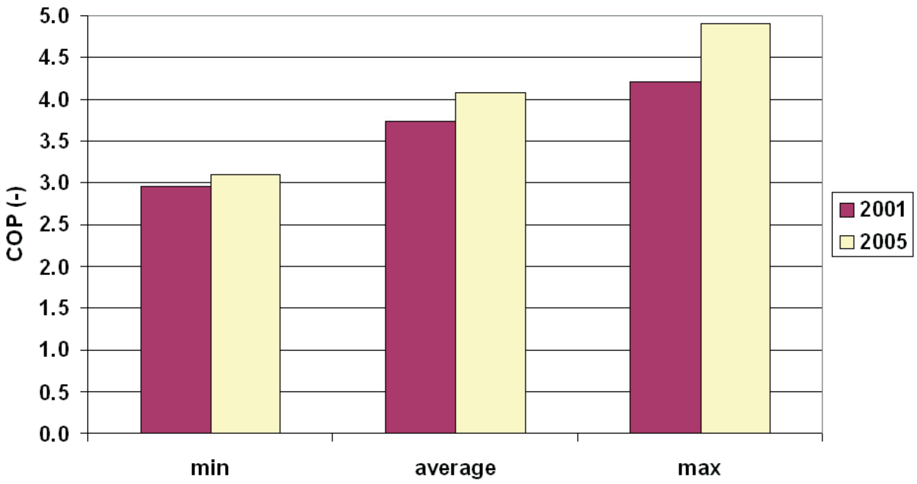


Figure 4. Minimum, average and maximum COP at +7 °C and 50 % capacity for heat pumps evaluated in 2001 and 2005

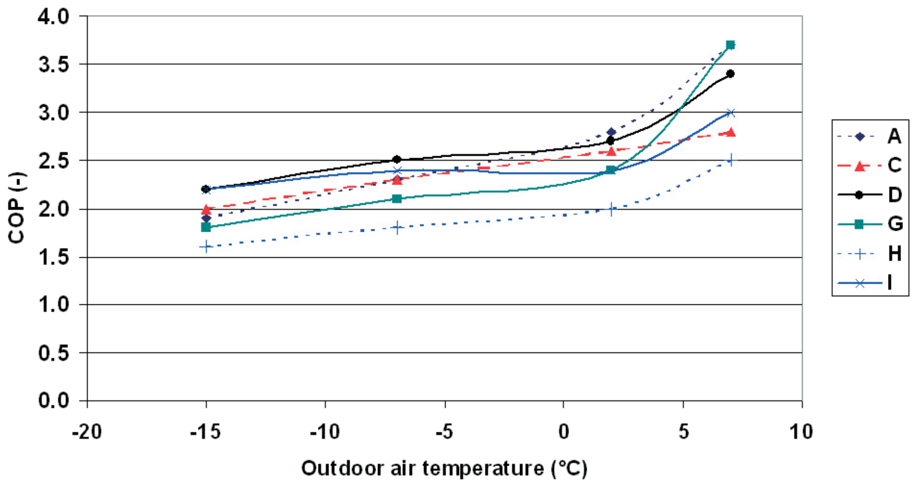


Figure 5. The diagram shows how the COP changes with outdoor air temperature for different heat pumps. The performance change differs quite considerably between the different heat pumps

Due to the differences in performance at different temperatures and part loads, calculation of the seasonal performance factor (SPF) is a good tool for comparing these heat pumps. The results from such a calculation for two different buildings are shown in Figure 6. The weakness of this comparison is that the heat pumps included in the test are not of equal capacity (see the right diagram in Figure 6) and thus cannot be directly compared, as the SPF value will depend on both capacity and efficiency. A large-capacity heat pump with a lower efficiency can have a higher SPF than an efficient low-capacity heat pump, which of course is relevant to include in an analysis as it is important properly to match the heat pump to the load. For the small building, heat pump D has the lowest capacity of the three heat pumps (D, E and K) with an SPF of 2.9, and can in one sense be considered as the most efficient. This is mainly due to a very good COP at part-load operation (see Figure 3). For the larger building, heat pump G shows to be the most efficient with an SPF of 2.3. Its capacity at +7 °C is the same as for heat pump D, but its capacity does not drop with lower temperature as much as does the capacity of for heat pump D.

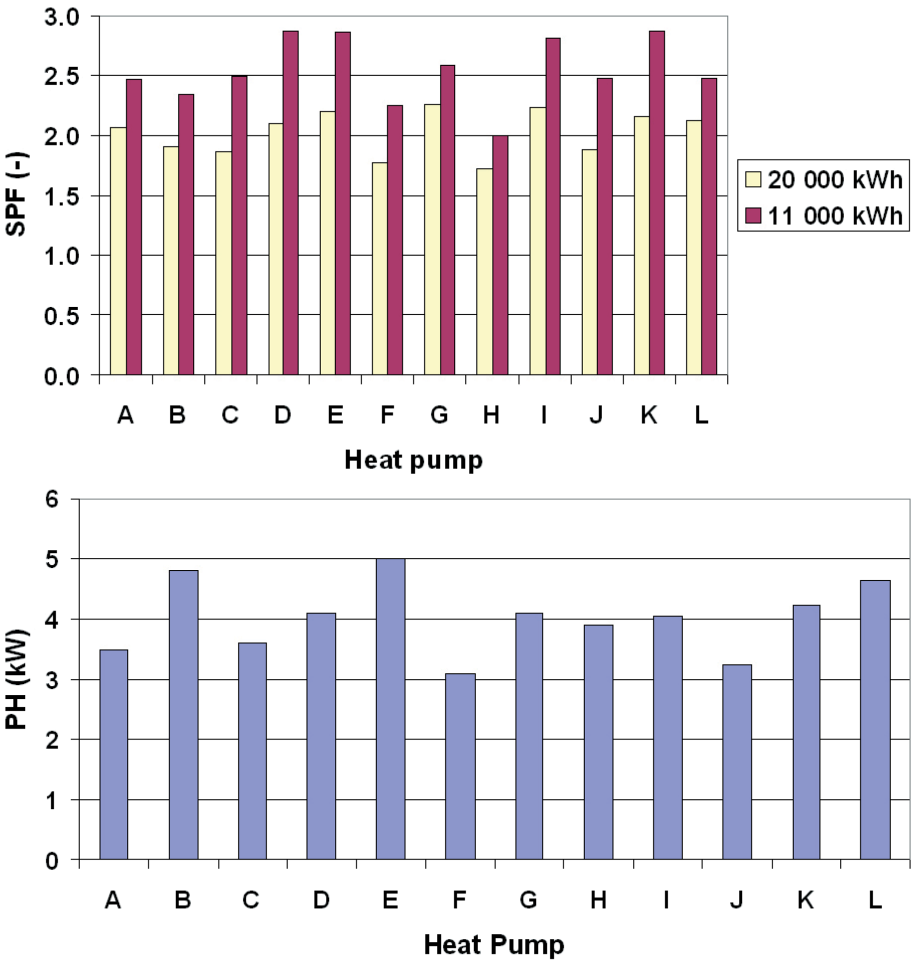


Figure 6. The top diagram show the SPF for the heat pumps evaluated in 2005 when used in two different buildings (calculated values). The bottom diagram show the capacity of the heat pumps at +7 °C and 100 % load.

Ability to operate in cold climates

As described above, the COPs at low outdoor air temperatures have increased substantially between 1991 and 2005. In our opinion, the following three components, in addition to a properly operating defrost system, are important in order to facilitate proper and reliable operation at low temperatures:

1. a crankcase heater to keep the oil warm when the heat pump is not in operation
2. a tray heater in order to prevent the drainage holes from freezing and causing excessive frost build up
3. a thermostat to switch off the heat pump when the outdoor air temperature is too low

If the defrost system operates properly, and the tray is well designed, with (for example) large holes placed to provide good drainage, it may be possible to do without the tray heater. The crankcase heater prevents the refrigerant from condensing and mixing with the oil in the compressor if the compressor is out operation at low outdoor temperatures. If the refrigerant mixes with the oil, there is a risk that it will quickly evaporate when the compressor starts and cause the oil to foam, which will drastically reduce the lubrication of the compressor and cause excessive wear or breakdown. The thermostat would switch the heat pump off when the temperature is below the operating range. If there is no thermostat function, the heat pump owner must turn the heat pump off manually.

Of the twelve heat pumps tested in 2005, only three had a crankcase heater and five had a tray heater. All three crankcase heaters were controlled such that they were operated only if the heat pump was not running and a certain temperature was below its limit value. Two of the tray heaters were not controlled, but were in constant operation. The others were switched on depending on one or more temperature limits.

As both the tray heater and the crankcase heaters are normally electric heaters and reduce the energy efficiency somewhat, they should be used as little as possible. Only one of the heat pumps had a thermostat that switched the heat pump off if the outdoor air temperature was too low.

Of the nine heat pumps tested in 1991, five had crankcase heaters and five had tray heaters. These numbers are higher than in 2005, and the question here is whether there has been a change in compressor design and operation that reduces the need for crankcase heaters or whether the machines are in fact less suitable for operation in cold climates. From contact with the manufacturers and retailers during the tests it seems as if they consider the heat pumps to be in more or less constant operation at low outdoor temperatures and thus a crankcase heater is not needed.

Performance of defrost systems

The defrost systems were found to work properly, in the sense that no ice build-up was noticed on the evaporators after several consecutive operating cycles. The cycle times (from initiation of defrost until initiation of next defrost) for the heat pumps in 1991 and 2005 are shown in Figure 7. In the report from 1991, the cycle times were considered short and the heat pumps were thought to defrost too often, thus reducing efficiency. The cycle time at +2 °C has not become longer in 2005 – on the contrary, it has actually become shorter (average cycle time in 1991: 76 minutes, and in 2005: 64 minutes). This implies that defrost strategies can still be improved. A major change though is the much longer cycle time at 7 °C, which is a major improvement. The water content in the air is much lower at 7 °C than at +2 °C and so, despite the lower temperature, frost formation is slower and the cycle times should be longer in order not to waste energy on unnecessary defrosts.

Generally the initiation of defrost is controlled on time and temperature for all heat pumps, and thus to some extent is demand-controlled. This can be based on several temperatures and times, e.g. 1) the outdoor temperature must have been lower than x °C for y minutes, while at the same time the temperature of the refrigerant leaving the evaporator must be below z °C, or 2) the heat pump has not defrosted for two hours. This was a simple example; several of the strategies are more sophisticated and include several more parameters, but the structure is the same. However, if condition 1) is not correctly formu-

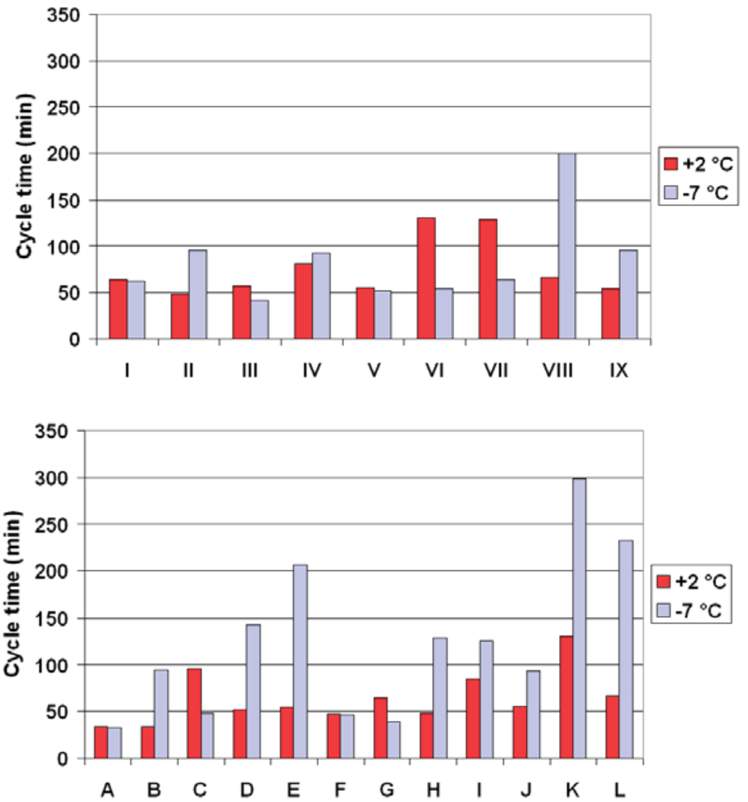


Figure 7. The diagrams show the cycle time for operation at +2 °C and -7 °C for the heat pumps evaluated in 1991 (top) and 2005 (bottom)

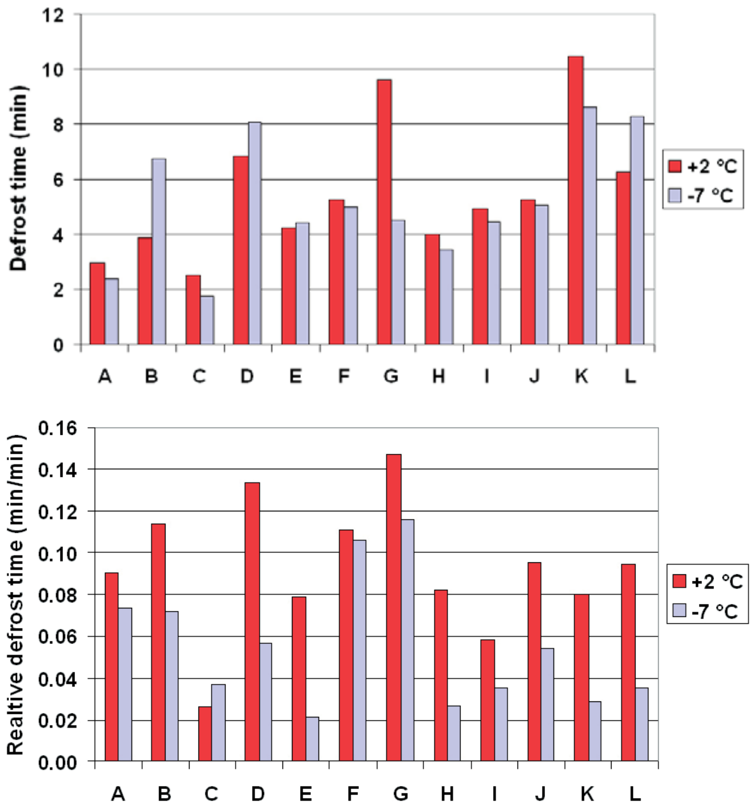
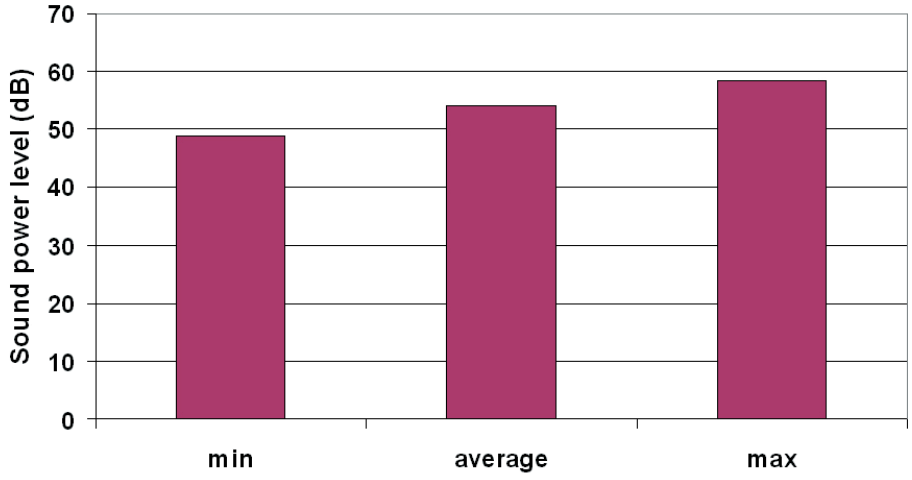


Figure 8. Defrost times (top) and relative defrost time, i.e. defrost time divided by cycle time (bottom) at +2 °C and 7 °C for the heat pumps evaluated in 2005

lated, the heat pump defrost may in practice be simply time-dependent. Comparing the cycle times for operation at +2 °C and 7 °C, as shown in Figure 7, the cycle times for operation at -7 °C are in most cases longer than for operation at +2 °C, and so the strategies in that sense work properly. However, the cycle time for heat pumps A and F is the same for the two temperatures, which means that, in practice, defrosting of these heat pumps seems to operate as simply time-controlled. It is also very interesting that for two of the heat pumps, C and G, the cycle time at 7 °C is shorter than for operation at +2 °C, which is the same strange pattern as was observed for several of the heat pumps in 1991.

Sound power level

The sound power level for both the indoor and outdoor units was measured in the 2005 test. The average sound power level for the indoor units is 54 dB, which is comparable to a kitchen fan. The difference between the highest and lowest sound power levels is almost 10 dB, which is perceived as a doubled noise level by the human ear. Note that the test is made with the fan on maximum speed, and that the actual sound pressure level will depend on installation conditions. The average value for the outdoor units was 60 dB. The Swedish Environmental Protection Agency prescribes that the sound pressure level at the garden boundary must be below 40 dB. This means that a heat pump outdoor unit with a sound power level of 60 dB should be placed at least 10 meters away from the neighbour's garden boundary.



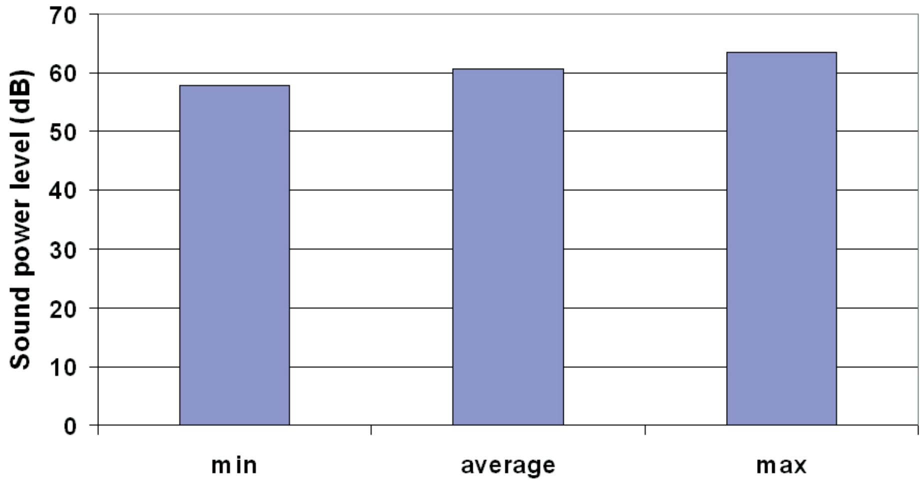


Figure 9. Minimum, average and maximum sound power levels for the indoor unit of the heat pumps evaluated in 2005 (top) and sound power levels of the outdoor units for the 2005 evaluation (bottom)

Conclusions

The air-to-air heat pumps evaluated in 2005 were more efficient than the heat pumps evaluated in 1991 and 2001. Prices have also fallen since 2001, and so the expected pay-back time is reduced by approximately 30 %. Even though the heat pumps have become more efficient on average, the spread is wider, i.e. the difference between the best and worst units is greater in 2005 than it was in 1991. It should also be noted that the performance of the defrost systems seems to have improved, but there are still opportunities for further improvements. There are still heat pumps which, in practice, operate defrost on time only instead of using a more efficient demand-based system.

The results also show the importance of measuring the performance at several different operating points and loads, as the performance changes with control strategy, components and dimensioning. A heat pump with top performance at +7 °C does not necessarily have best performance at 7 °C, so that it is not sufficient, and does not drive technology, to make decisions on information based on only one or two operating points. A better tool is to use the seasonal performance factor which, if based on performance at several operating conditions and loads, provides information about the performance over the entire heating season and also information about how well the heat pump is matched to the load.

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Retrofit heat pumps for buildings

Annex 30 of the IEA Heat Pump Programme

In the majority of European countries, the present heat pump market for space and water heating and cooling is largely concentrated on new buildings, particularly single- and two-family houses. However, there is a very large potential in the retrofit market for replacement of old conventional oil-, gas- and coal-fired heating systems with high energy-efficient and environmentally sound heat pumps (see Fig. 1).

The main barrier to the use of heat pumps for retrofitting is the requirement for high distribution temperature of conventional heating systems in existing residential buildings, with design temperatures up to 70 – 90 °C, which are too high for the present heat pump generation, which are suitable for use with a maximum, economically acceptable system distribution temperature up to 65 °C.

Annex 30 therefore supports the economic, ecological and energy-efficient use of heat pumps, considering three different solutions:

1. The application of existing heat pumps in already improved standard buildings with reduced heat demand, e.g. with thermal insulation of the building envelope and hence lower-temperature heat distribution systems.

2. The development and market introduction of new high-temperature heat pumps. Specific emphasis should be paid to higher heat distribution temperatures and environmental issues leading to lower greenhouse gas emissions, particularly through the use of low or zero GWP working fluids.

3. The use of reversible (heating-cooling) heat pumps (air-to-air or air-to-water), particularly in buildings without centralised heat distribution systems

Participants in the annex - which is operated by the German "Information Centre for Heat Pumps and Refrigeration – IZW e.V." - are six German companies, France and The Netherlands. Sweden is represented by a German/Swedish company.

The Annex started on 1st April 2005, and will run for two years until 31st March 2007. It is therefore already in its last year of operation and, depending on the status and results achieved, a possible extension of at least six months is at present being discussed.

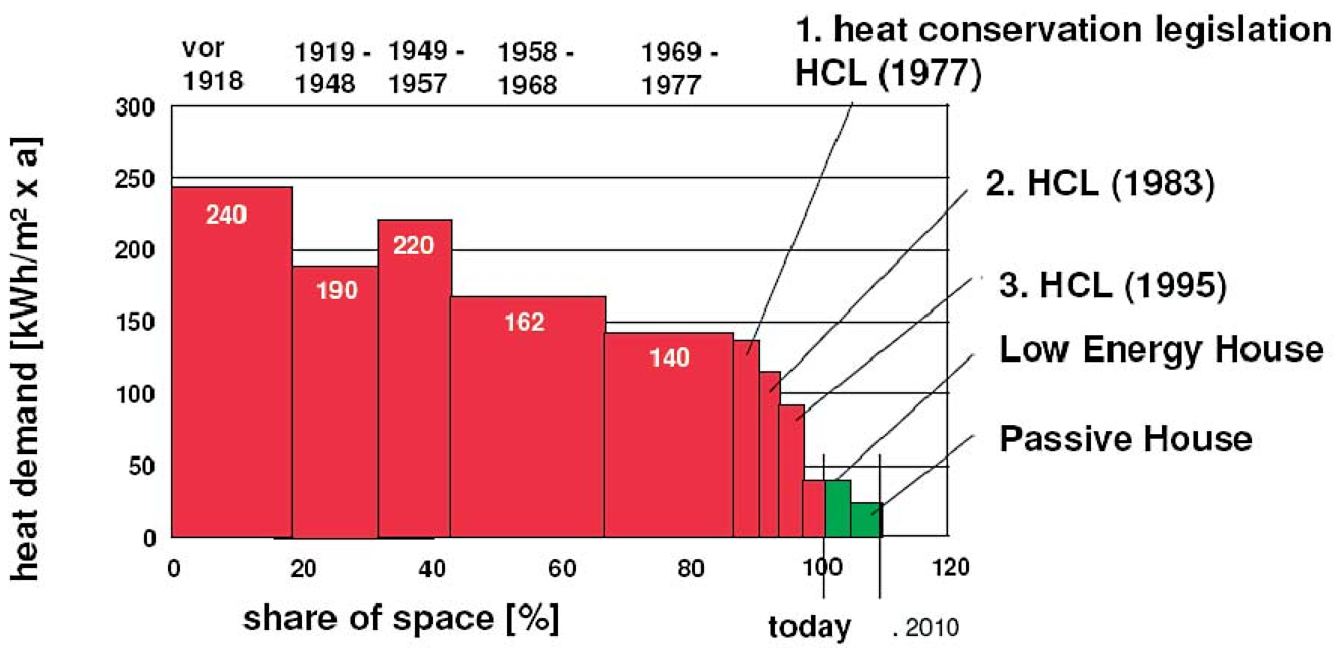


Fig. 1: Building stock heat demand - Germany

The programme is subdivided into four tasks:

Task 1: State of the art, market analysis
Task 2: Matrix of heat pumps
Task 3: Overcoming economic, environmental and legal barriers
Task 4: Successful factors for the marketing of retrofit heat pumps

The programme proposal was discussed, modified and the activities distributed between the participants at a first annex meeting on 12.05.2005 in Bonn. Detailed work started with Task 1: "State of the Art, Market Analysis". The participants have developed a matrix of information covering not only the current building structure but also the heating and cooling construction and design of different regions, depending on climatic and cultural aspects, type of power generation, legal aspects, support programmes etc., as well as on the type of heating systems, centralised or decentralised, water or air heat distribution systems, domestic hot water heating etc.

The results of Task 1 were reviewed at the second Annex meeting on 02.12.2005 in Bochum-Wattenscheid, and Task 2 "Matrix of heat pumps" - particularly with information on type and number of case studies and RD & D projects - was prepared.

Tasks 1 and 2 were finalised at the third meeting on 04.04.2006 in Aachen, and a first draft report of Task 3 "Overcoming economic, environmental and legal barriers" was presented, with a list of problems and barriers for the use of heat pumps in retrofitted buildings.

Further improvements of Tasks 1, 2 and 3 were discussed at the fourth Annex meeting on 01.06.2006 in Utrecht, and Task 4, "Successful factors for the marketing of retrofit heat pumps", was introduced. Specific aspects are analysis of existing Research, Development and Demonstration (RD&D) projects, and new concepts of heating/cooling systems, definition of heat pump systems and components for retrofit applications, cooperation with national / regional manufacturers, demonstration and prototype projects, and support of market introductions.

All four tasks were further improved at the Annex meeting on 17.10.2006 in Nürnberg, and the draft of the final report was discussed. It was agreed to organise a major symposium in Nürnberg in October 2007, not only to present the results of the Annex but also to provide a global overview of the present trends of retrofit heat pumps, as the highly promising heat pump market of the future and the most important contribution to reduction of CO_2-emissions in connection with the heating and cooling of buildings.

The common information source for the participants, with detailed protocols of the five Annex meetings and all attachments, as well as further necessary information, is on a password protected web site for the Annex, on the IZW web site: www.izw-online.de

H.J. Laue, IZW e.V.

High-temperature heat pump for the retrofit market in France

Sami Barbouchi and Jean-benoît Ritz, France

The retrofit of heating systems represents a significant market in France. Nowadays, high-temperature heat pumps make an interesting alternative to boilers, with real advantages in term of CO_2 emission and energy efficiency. Another advantage of heat pumps lies in the energy that can be saved over a year. The HSPF (heat seasonal performance factor) is therefore the most appropriate parameter for relating to actual heating energy bills. HSPF is the ratio of the total heat delivered over the heating season to the total energy input over the heating season. In the study, field test results on a French house will be presented, as results of simulations calculating the HSPF.

Introduction

EDF is concerned with energy savings and the environmental impact of energy production. The use of heat pumps represents a real advantage in terms of reduction of CO_2 emissions and improvement of energy efficiency.

This article first describes a field test of a French house equipped with a high-temperature heat pump, and concludes with a description of a method of calculating the HSPF (heating seasonal performance factor).

Figure 1: The field test house

Retrofit in France: single-family houses in France

It is estimated that there are 28 million homes in France, of which 14 million are single-family houses. The new building construction rate is only 1-2 % of new single-family houses, while 300 000 owners per year renovate their heating systems in existing single-family houses, so 180 000 boilers/year can be replaced by heat pumps (8.4 million oil or gas boilers). This means that the market potential of heat pumps for existing buildings is much greater than that for new buildings.

Heat distribution systems

60% of single-family houses in France have hydronic heating systems using radiators or floor heating.

Oil and gas provide 20 % and 40 % respectively of heating energy, mainly via hydronic systems. In most cases, due to the form of heat delivery system and the standard of building insulation, supply temperature may be up to 65 °C, with a heating requirement of 12 kW on the coldest days. Present-day heat pumps could not be used for retrofits for such buildings without changes to the heat delivery system and improvement of the building's insulation. A new generation of heat pumps - high-temperature heat pumps - is needed.

Field test

EDF R&D has selected a house and fitted it with a high temperature heat pump.

The field test was carried out on a house in Flers, in the north of Paris (Figure 1):
- Built in 1770
- Heat requirement, 12 kW at -15 °C
- Floor area, 125 m2
- Space heating (65 °C) and hot water production (55°C). (Parallel storage for heating water)
- Alternate production with priority for tap water (Design temperature T= -6 °C)

The heat pump used for the tests is a Viessman AWH110 [1] heat pump, having a compressor with a vapour injection port. The unit has been instrumented, and consumption and heating capacity of the heat pump have been measured (Figure 2).

Field tests conclusion:

During the heating season, the HSPF is equal to 2.95 with an indoor air temperature maintained at 20 °C. The lowest external temperature during the winter was -6 °C. Energy costs have been halved. The previous heating system was a propane boiler.
In term of comfort and energy, customer satisfaction is quite good, which is generally the case when the heat pump has been properly sized and installed. No problems were detected with the compressor or any components of the heat pump.
Finally, we can say that the high-temperature heat pump is a good product for heating and tap water production with high potential: relevant and reliable

Modelling the HSPF

The aim in this part is to model the house and the heating system and to simulate the behaviour of the heat pump during a heating season, i.e. from 1st October to 20th May. The weather is that of Trappes, a city near Paris (Figure 3).

Using data from heat pump manufacturers, it is possible to calculate the heating capacity and electrical input as functions of the outdoor air temperature and the temperature at the inlet of the heat pump [2]. The model also assumes that, for ambient temperatures below 5 °C, three stages of electric resistance heating will be progressively switched in as needed.

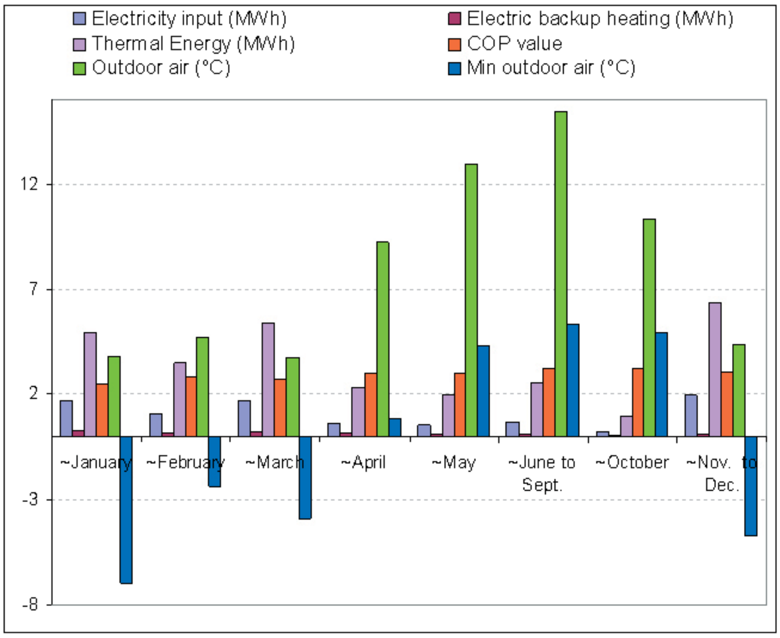


Figure 2: Data measurements for the field test year.

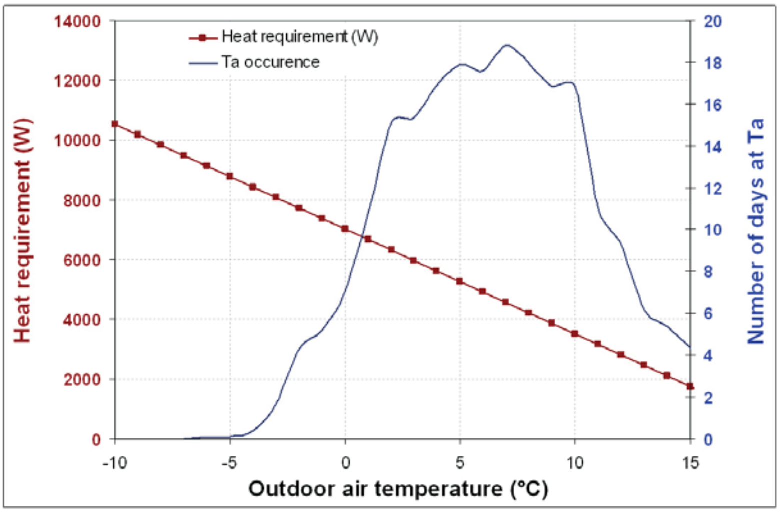


Figure 3: Thermal heat losses of a dwelling with GV=351 W/K.

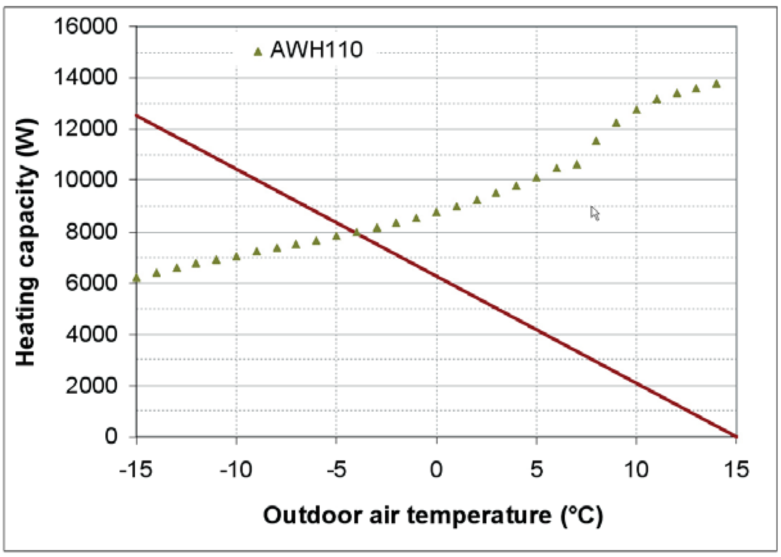


Figure 4: Heating capacity.

The COP and the heating capacity can therefore be calculated from the heat curve (Figures 4 and 5). The heat curve represents the temperature at the inlet or at the outlet of the heat pump as a function of the outdoor air temperature (Figure 6).

The simulation was carried out using Matlab, with data from the Simbad library. This is a library developed by the CSTB, which includes various models of houses and emitters. It is therefore possible to simulate heat pump behaviour over a heating season. The tap water consumption has not been taken into account.

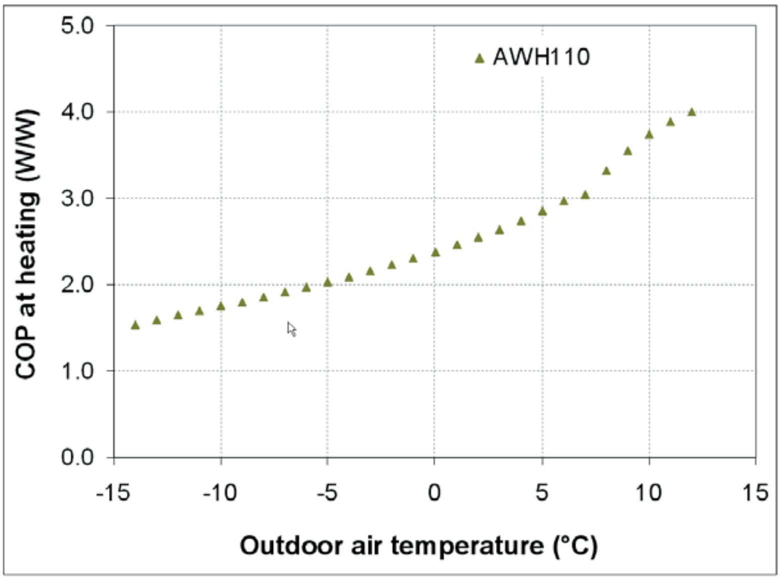


Figure 5: COP as a function of outdoor temperature.

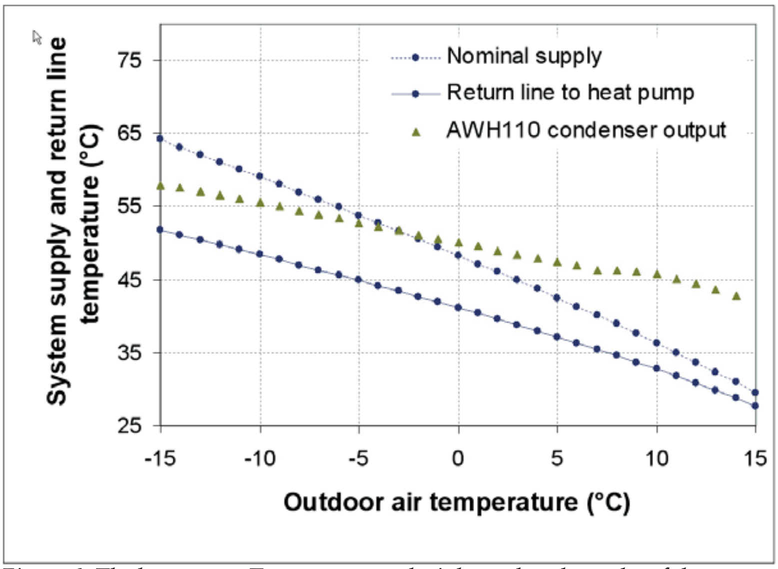
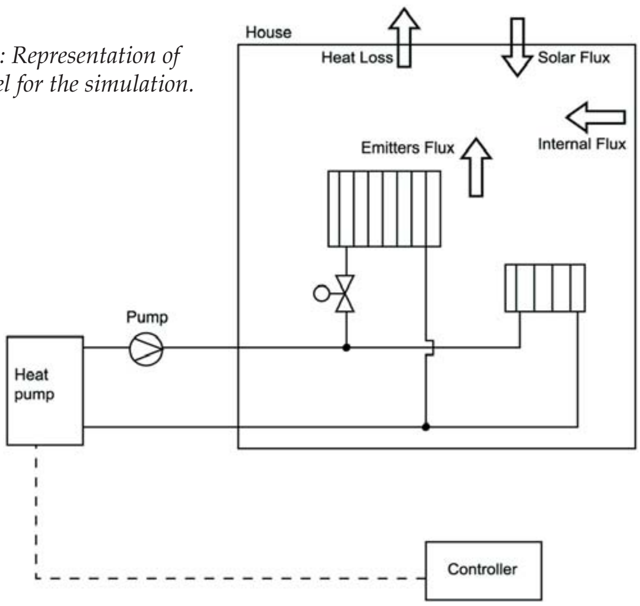


Figure 6: The heat curve. Temperature at the inlet and at the outlet of the condenser of the heat pump

Figure 7: Representation of the model for the simulation.



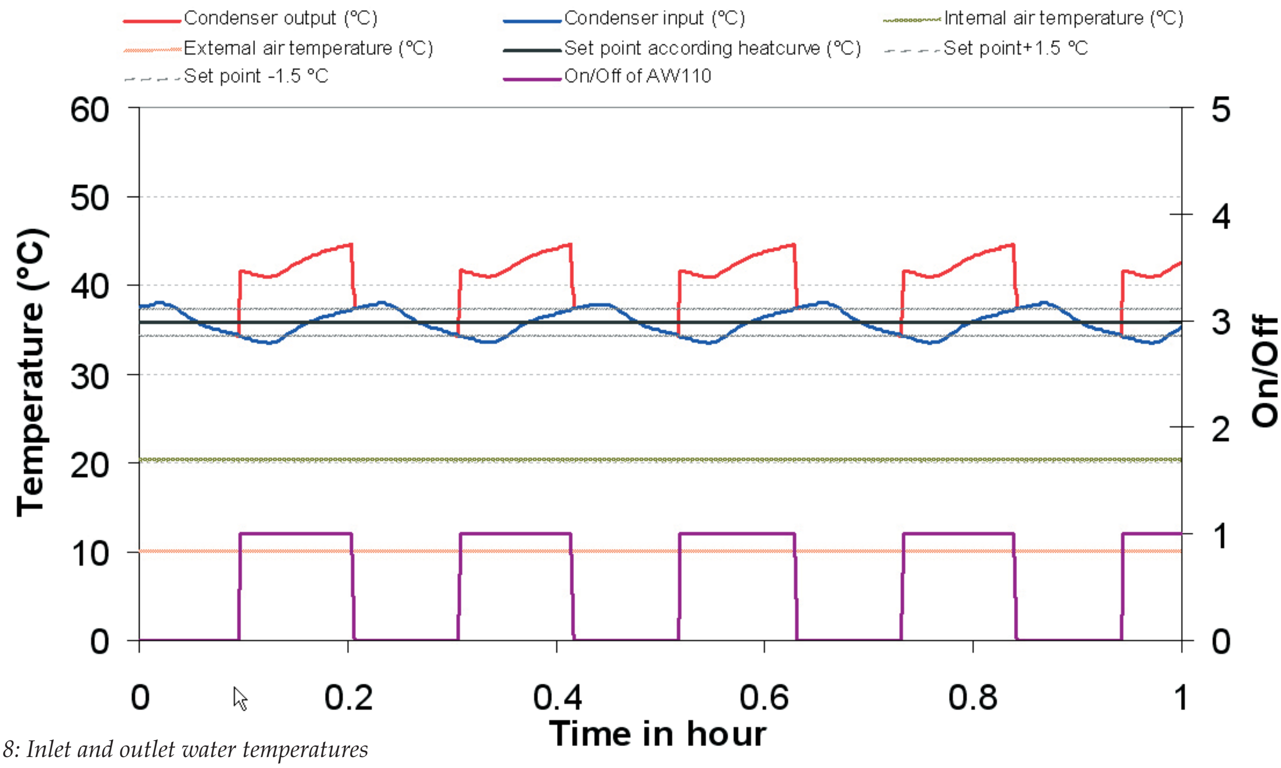


Figure 8: Inlet and outlet water temperatures at the heat pump during 1 hour.

In Figure 8 we can see the effect of the inertia of the hydronic heat distribution system. After the heat pump switches off, the water temperature at the inlet to the condenser continues to rise, correspondingly continuing to fall after the heat pump switches on. In this case, the volume of water in the heat distribution system is 70 litres, with a flow rate of 850 l/h. The results of the simulation are summed up in Table 1.

Table 1: Result of the simulation on a heating season

	HSPF	Heating capacity on the heating season	Mean internal air temperature
AW110	2.91 ±0.5%	27.3 MWh	20.14 ±0.4 °C

Evaluation of the CO2 emission of a heat pump compared to a conventional boiler

The TEWI (total environment warning impact) is an expression of the global impact on the green house effect. The TEWI is a relevant expression of the emission of CO_2. It takes into account the indirect and the direct emission of CO_2 of a frigorific system. The indirect emission is due to the emission of CO_2 to ensure the running of the frigorific system during its life cycle and the direct emission depends mainly on the mass of refrigerant released in the atmosphere.

$$TEWI = GWP\underbrace{\left[\dot{L}n_{year} + m(1-\alpha)\right]}_{\text{direct green house effect}} + \underbrace{n_{year}E_{input}\beta}_{\text{indirect green house effect}}$$

$\dot{L}$	Leakage ratio kg.year^{-1}
n_{year}	Life cycle of the devise year
m	Mass of the refrigerant in the devise kg
α	Percent of refrigerant recovered at the end of the life cycle
β	Emission of CO_2 per kWh of electricity
E_{input}	Consumption of electricity on a year kWh

Table 2: TEWI

Emission in kg of CO_2 per kWh	*0.18*
TEWI on 20 years	*36474*
TEWI on a year	*1824*
TEWI direct/indirect	*7.1%/92.9%*

Table 3: Emission of CO2 in g/kWh [3].

	Efficiency of the best technology	*Emission Of CO_2 in g/kWh*
Fuel boiler	*70 % 88 %*	*333*
Gas boiler	*70 % 92 %*	*250*
Heat pump	*1 kWh of electricity = 3 to 6 kWh heating*	*180*

Estimation of TEWI of a heat pump

With some hypothesis, it is possible to estimate the TEWI of a heat pump.
The hypotheses are the follow to calculate the TEWI:

- Heating energy on a year: 27300 kWh,
- Heating seasonal factor: 2.9,
- Mass of refrigerant: 5 kg,
- Life cycle of the heat pump: 20 years,
- Ratio of leakage: 1%,
- Ratio of recovery with a life cycle of 20 years: 70 %,
- Refrigerant R-407C, GWP: 1520,
- Emission of CO2 per kWh of electricity in France: 0.18 kg/kWh.

The results are presented in the Table 2.

Emission of CO2 per kWh of fuel, gas boilers and electricity for heating are presented in Table 3, the value are from a French governmental report [3].

Thus, it is possible to compare the emission of CO_2 over a year of the different heating systems, Figure 9. Compare to a fuel boiler, the emission of CO_2 by using a heat pump can be divided by six in France. Pointing out that the coefficient of emission of CO_2 per kWh of electricity is very small in France because an important part of the electric energy outcomes from nuclear energy.

Conclusion

The field test showed the relevance to use high temperature heat pump to replace boiler. Furthermore, the HSPF calculated is closed to the HSPF measured on the field test. In the simulation, the tap water consumption has not been taking into account, and the weather can differ a little. So, we have here an interesting tool to calculate the HSPF.

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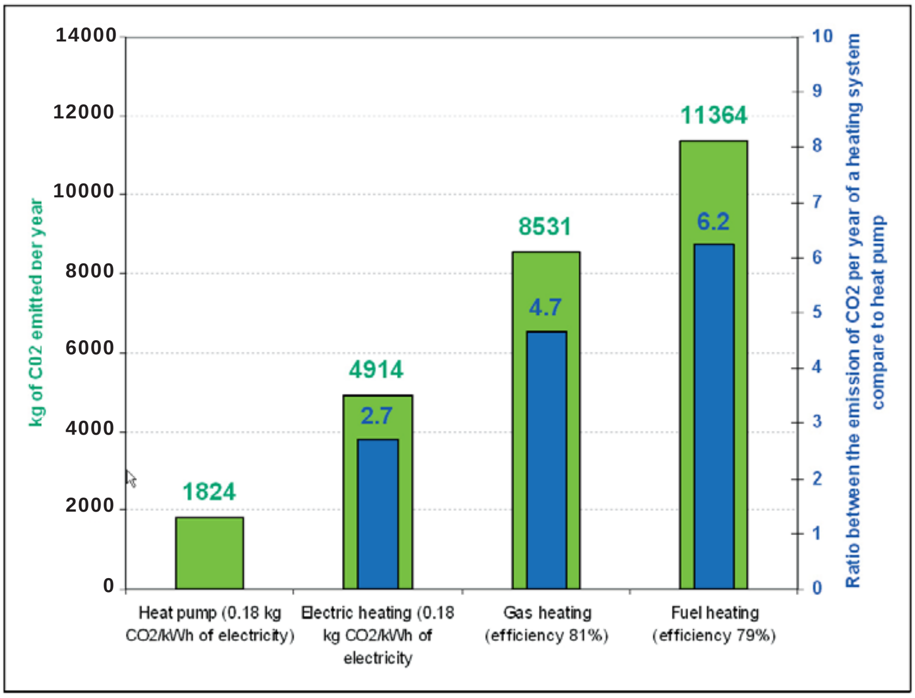

Figure 9: Emission in kg of CO2 for different heating systems on a year.

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Air-to-air heat pumps in Norway

Bård Baardsen, Norway

In Norway, air-to-air heat pumps have become the most popular way for house-owners to reduce their energy bills. By the end of 2006, heat pumps of this type will make up about 13 % of all those that have been installed, with almost all having been installed during the last five years.

Introduction

For many year, the Norwegian heat pump market remained stable at about 1000 units per year, with only modest interest in the technology among politicians and the public. The main reason for this was the low and stable price of electricity. The 1980s saw a government-funded programme to support the introduction of heat pumps, but its main emphasis was on large commercial heat pumps and industrial heat pumps.

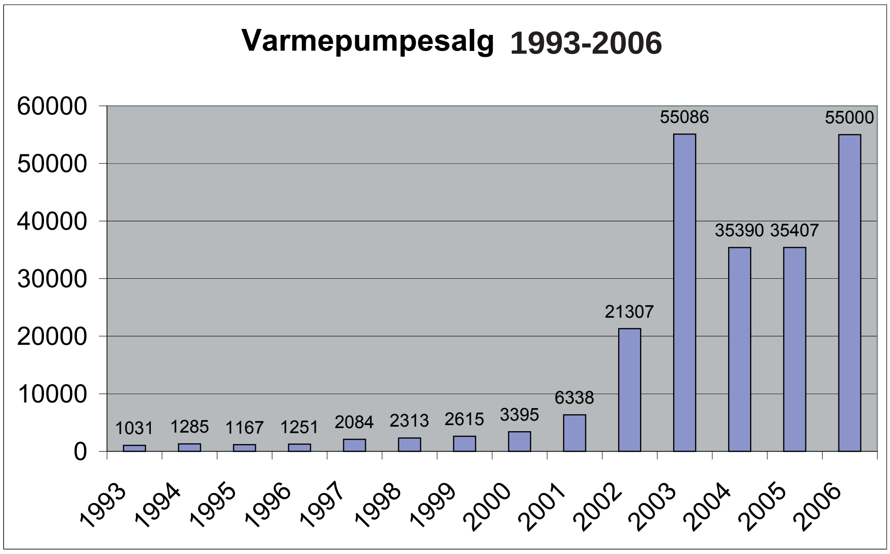

Figure 1. Heat pump market in Norway, 1993 – 2006(2006 estimated)

Electricity market in Norway

Due to an abundance of hydro power and a government determination to keep prices low through market regulation, electricity prices in Norway have been very low during the post-war period and up to the 1990s. In 1991, the government introduced the new Energy Act which deregulated the electricity market. As a result, electricity prices were now set by market factors, such as supply and demand. In 1996, Norway and Sweden established a common marked for electricity, which subsequently matured into a common electricity market for all the Nordic countries. The production of hydro power in Norway varies from 90 to 150 TWh per year, depending on weather conditions. Normal consumption is about 120 TWh. Electricity supply in Norway, with indigenous production dependent on weather conditions, benefits from connection to countries having power generation based on nuclear power, natural gas, coal or oil. The disadvantage for Norwegian consumers is that electricity prices rise significantly when it is necessary to import electricity. In 2002/2003, with a dry autumn and winter, prices rose to a maximum of up to about 250 % for electricity at peak load times.

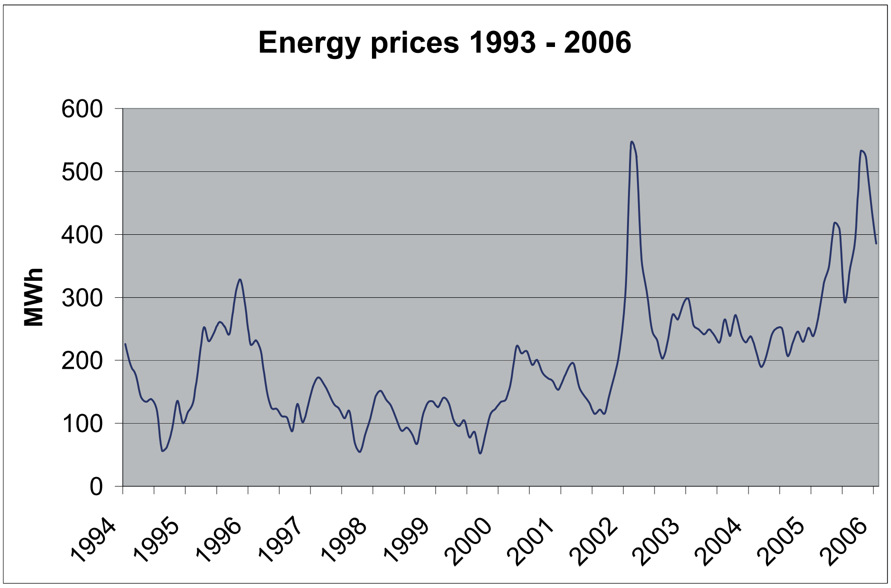

Figure 2. Electricity prices on Nordpool

Electricity used for heating purposes

Most families in Norway live in single-family houses, which have become significantly larger over the last couple of years. Most houses have been fitted with electric skirting heaters, which are cheap to buy and easy to use. Heating accounts for most of the energy use in a normal house, amounting to about 60 % of the total use of energy. In some parts of Norway, with a cold climate, there is a need for heating for about 300 days in a normal year. For Norwegian families living in single-family-houses, the best way to reduce energy costs is to use an alternative form of heating when electricity prices rise. As most houses do not have hydronic heating systems, the best alternative is an air-to-air heat pump.

Better equipment and increased competition

The shift from R-22 to R-410 in air-to-air heat pumps had a very positive result for heat pumps in cold climate. Air-to-air heat pumps with R-410 have fewer technical problems with defrosting etc. and are also more efficient than older models. The higher demand could have resulted in higher prices, but increased competition and higher volumes helped to reduce equipment prices for heat pumps.

Subsidy scheme from the government in 2003

The Ministry of Petroleum and Energy came under immense pressure to act in order to alleviate the situation for those suffering from economic problems as a result of high electricity prices in 2003. As one of several responses, the Ministry introduced an investment subsidy scheme - the Household Support Scheme - in order to support implementation of energy-efficient technologies. The scheme covered energy-saving control units for electric heaters, pellets-fired stoves, and heat pumps. Homeowners were eligible for a 20 % investment grant, up to a maximum of NOK 5000(~US$900). A total of almost 20 000 households (19,689) received the grant and installed equipment. Heat pumps were the most popular system, making up over 87 % of the total.

Increased media attention

Increased media attention was also a factor that contributed to the sales increase. Heat pumps were suddenly the theme of articles in all kinds of mass media. Newspapers ran heat pump advertisements daily, and even discussed heat pumps in articles several times a week. Radio and TV had programmes on the “energy crisis” several times a week, and heat pumps were often mentioned as a remedy.

Systematic efforts over a long time

Another reason for the increasing sales figures is probably the systematic long-term effort of many market actors over several years to establish the positive reputation of heat pumps as a reliable and energy-saving technology. The establishment (in 1991) and undertakings of the Norwegian Heat Pump Association in 1991, and its work, are particularly thought to have had a positive influence. Similarly, the activities undertaken by the regional energy conservation centres (established in 1994) and continued by Enova (2001) are also thought to have contributed to building a solid heat pump reputation. Typical activities for these organisations have included the provision of neutral and unbiased information, and of information to the public on demand, for example via free telephone enquiry lines.

Conclusions

The Norwegian market for heat pumps has experienced a tremendous growth over the last five years. The most popular type of heat pump is that which is more usually regarded as an air conditioner. Penetration among houses with direct electric heating is already high, and the strong market continues. Most people in Norway today are aware of heat pump technology, which is often mentioned by politicians when discussion efficient use of energy. For a normal household, an air-to-air heat pump saves 5000 – 8000 kWh every year, and has a payback time of three to six years. The residential sector in Norway uses 21 TWh electricity for heating purposes. The most important factor for future growth in the heat pump market is education and training of installers to ensure that customers remain satisfied when they invest in heat pump systems.

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Heat pumps for reduction of greenhouse gas emissions

Rune Aarlien, Norway

The Norwegian Commission on Low Emissions points to heat pumps as one of the technologies that could help cut Norwegian greenhouse gas emissions by 50-80 percent by 2050

This article is an excerpt of an article written by the Commission of Low Emissions. The full version and a full report can be found here: http://www.lavutslipp.no/article_1334.shtml

The Norwegian Commission on Low Emissions was appointed by the Norwegian government on March 11, 2005. The Commission has been charged with the task of preparing scenarios of how Norway can reduce its emissions of greenhouse gases by 50-80 percent by 2050. The Commission presented its final report to Minister of the Environment, Ms. Helen Bjørnøy, on October 4th, 2006.

Why should Norway cut greenhouse gas emissions by two-thirds?

Is it reasonable that Norway, which is responsible for less than two-tenths of a percent of global emissions, should worry about reducing its emissions? The Commission believes that the answer is Yes – for several reasons.

First, many countries have miniscule emissions when seen in a global context. The five countries that have the greatest emissions are responsible for about half of global emissions. If all the countries with relatively small emissions were to leave mitigation to the major emitters alone, we would never be able to get the climate situation under control.

Second, it is reasonable, as stated in the UN Convention on Climate Change, that rich countries should pave the way and reduce their emissions of greenhouse gases before countries with social and economic development needs are required to set climate targets. Norway is without doubt one of the countries which, from this perspective, should agree to restrict its emissions.

And finally, the Commission believes that the climate problem will make it necessary and desirable from a selfish perspective to reduce emissions sooner or later. The countries that develop the necessary climate-friendly technology early on will gain a competitive advantage in future industrial development, and will thus be able to position themselves favourably in a future market for such technology.

What can Norway do to cut emissions by two thirds?

The Commission has projected a scenario for how emissions growth might look in the future – a reference scenario. In it, greenhouse gas emissions in 2050 are about 70 million tonnes of CO_2 equivalents. About three-quarters of the emissions in this scenario are distributed fairly evenly between electricity production, process industries and transportation. The remaining emissions will come mainly from gas and oil activity, heating, agriculture, and waste disposal.

The Commission has identified 15 measures that together will ensure the necessary reduction in Norwegian emissions in a long-term perspective. The measures are mainly directed at specific and major emissions sources, with the exception of two basic measures that the Commission sees as prerequisites for the realisation of the other measures.

Basic measures

- Implementation of long-term national investment in climate information – a long-lasting climate awareness campaign. Dissemination of accurate and relevant facts about the climate problem and what can be done.

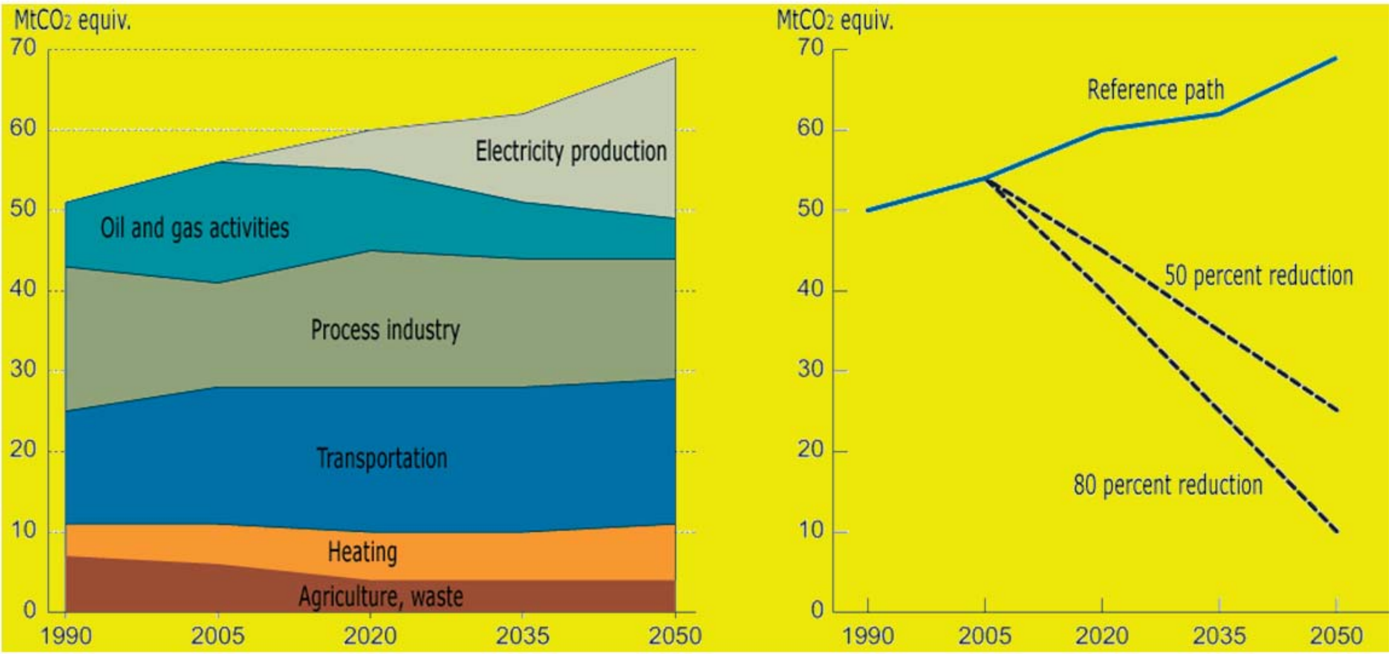
- Investment in the development of climate-friendly technologies through long-term and stable support for the Commission's technology package. This technology package emphasises technologies for carbon capture and storage, wind power (especially at sea), pellet and clean-burning wood stoves and fireplaces, biofuels, solar cells, hydrogen technologies, heat pumps and low-emission ships.

Transportation

- Phasing in of low- and zero-emission vehicles, such as hybrid cars, light diesel cars, electric cars and fuel-cell cars.

- Phasing in of CO_2-neutral fuels, such as bioethanol, biodiesel, biogas and hydrogen.

- Reduction of transportation demands through improved logistics and urban planning.



In the future, we expect emissions of about 70 million tonnes of CO2 equivalents. Historical and projected annual emissions of greenhouse gases are shown in the Commission's reference path. The low-emission goal for 2050 is also shown.

- Development and phasing in of low-emission ships.

Heating
- Increased energy efficiency in buildings through stricter building codes, eco-labelling and subsidies.

- Transition to CO_2-neutral heating through increased use of biomass, more efficient use of solar heat, heat pumps, etc.

Agriculture and waste disposal
- Collection of methane from manure pits and landfill, and use of the gas for energy purposes.

Process industry
- Implementation of carbon capture and storage from industries with large pulse emissions.

- Implementation of process improvements in energy-intensive industries.

Oil and gas activities
- Electrification of the continental shelf, and more facilities located on land.

Electricity production
- Expansion of "new renewable" energy through construction of wind and small hydro power stations.

- Implementation of carbon capture and storage from gas-fired and coal-fired power plants.

- Upgrading and improved efficiency of the electricity grid to reduce losses in the grid and give smaller power plants better access.

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18 MW heat pump system in Norway utilises untreated sewage as heat source

Svein Erik Pedersen, Jörn Stene, Norway

An 18 MW heat pump utilising untreated sewage as its heat source was put into operation in January 2006 by Viken Fjernvarme in Oslo, Norway. The installation costs for the plant were EUR 11 million, for an estimated annual heat production of about 85-90 GWh/year.

Introduction

A 2.2 MW heat pump was installed in 1983 in a 300 metre deep rock cavern at Skøyen Vest in Oslo, Norway. The plant utilised untreated sewage from the main sewage tunnel in Oslo as a heat source, and supplied about 9,5 GWh/year of heat to a district heating system. The CFC12 heat pump was equipped with a reciprocating compressor, and the maximum condensation temperature was about 80 ºC. The untreated sewage was filtered and sprayed over 80 open-type plate evaporators (3 x 1 metres). The evaporator design gave excellent heat transfer, and was insensitive to possible freezing of the sewage. However, the untreated sewage led to a number of operational problems, including clogging of the evaporator nozzles and fouling on the evaporator surface.

In 1998, the Skøyen Vest district heating system was connected to the Viken Fjernvarme district heat system. Due to operational problems of the relatively low-capacity heat pump, and the fact that the unit used CFC12 refrigerant, upgrading and retrofitting of the plant to HFC134a was considered to be unprofitable. However, in 2002, Viken Fjernvarme started to plan a new heat pump installation, with a contract being agreed in 2003-2004.

The existing CFC12 heat pump unit and all the auxiliary equipment was removed from the rock cavern. The approach to the cavern was down a 300 metre curved tunnel with rough walls, which limited the maximum size of the new heat pump equipment. Friotherm AG from Switzerland was selected as the supplier of a single R134a heat pump unit (Unitop 50FY), having a maximum heating capacity of 18.4 MW under design conditions.

40 bar centrifugal compressor

The heat pump unit is equipped with a 40 bar open-type two-stage centrifugal compressor, with both impellers on the same shaft, running at 9400 r/min. The second stage of the compressor is connected to an economiser (i.e. a vessel with three ports) operating at an intermediate pressure. The economiser increases the system COP and reduces the exhaust gas temperature from the second-stage compressor.

The capacity of the centrifugal compressor is controlled by inlet vanes on both stages. Capacity can be reduced down to 50% without by-pass operation, and from 50 to 25% with by-pass operation (less energy-efficient). The weight of the compressor is 22 tonnes. The water-cooled 11 kV motor has a nominal capacity of 7 MW, and runs at 1500 r/min. The weight of the motor is 23 tonnes.

The heat exchangers

The evaporator is a single-pass shell-and-tube heat exchanger with Cu/Ni tubes, where the filtered sewage water flows inside the tubes in the lower part of the evaporator and the working fluid evaporates on the shell side. The evaporator is 12 m long, the diameter is 1.7 m and the total weight is about 56 tonnes, including the working fluid charge. Under design conditions, the flow rate of the sewage is 2400 m3/hour, being cooled from 10 °C to 6 ºC. The water speed in the tubes under these operating conditions is 1.9 m/sec, and the pressure drop is about 0.8 bar.

The condenser is a 40 bar two-pass shell-and-tube heat exchanger with steel tubes. The water flow rate under design conditions is 540 m3/hour, and the total weight of the unit is 14 tonnes.

Since the heat pump unit is designed for a maximum delivery water temperature of 90 ºC, it is operating relatively closely to the critical point (R134a; 40.6 bar, 101.1ºC). In order to reduce the considerable throttling loss and increase system efficiency, the heat pump is equipped with a heat exchanger that sub-cools the liquid working fluid after the condenser. The sub-cooler covers about 25 % of the total heating capacity.

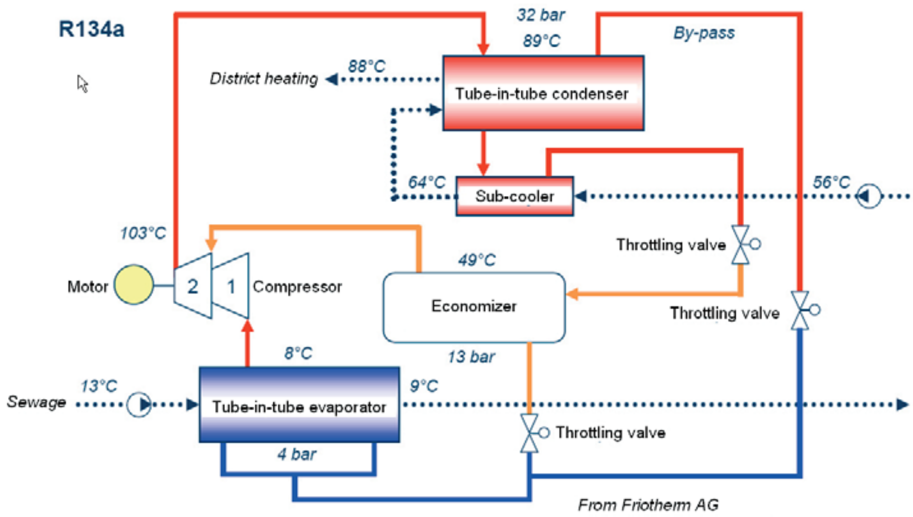
Main design data

The main design data of the heat pump unit are:

- District heating - supply/return temperature: 90/60ºC
- Sewage - supply/return temperature: 10/6ºC
- Condenser/sub-cooler - heating capacity: 18.4 MW
- Compressor - input power: 6.57 MW
- Estimated COP: 2.8

Measurements have shown that the actual heating capacity is between 19 and 19.5 MW under design conditions, which gives a COP of about 3.0. The sewage temperature varies, depending on the time of day: during the daytime, the temperature rises to about 12-13 ºC, giving a heating capacity of 21-22 MW and a COP of 3.3.

The estimated annual heat supply is about 85-90 GWh/year. The heat pump is intended to run at maximum capacity during the heating season, and the plant is shut down during the summer.



Advanced sewage treatment system

Since it is untreated sewage that is being used as the heat source for the heat pump unit, it was necessary to build two sewage reservoirs and filter stations inside the rock cavern. In each reservoir, a conveyor belt with grating (3 mm gap width) separates the solids from the water, and the solids are returned to the sewage tunnel. Centrifugal pumps pumping the sewage water through the shell-and-tube evaporator. In order to avoid clogging and fouling in the evaporator tubes, the flow direction of the sewage water is reversed once an hour by means of a tailor-made motorized four-way valve. The operation takes about 12 seconds, during which time the output water temperature from the heat pump condenser drops by about 3-4 ºC. In order to maintain a relatively constant evaporation pressure, the by-pass valve between the high-pressure and low-pressure side is opened to 60 % over a two-minute period.

The average water flow rate in the sewage tunnel is about 7200 m3/h during the heating season. However, during periods of cold weather without rainfall or melting water, the water flow rate between 05.00-06.00 a.m. can be relatively low, and lead to operational problems for the sewage pumps and the heat pump unit.

The sewage reservoirs with filter stations, channels and drains are covered by aluminium boards, and the exhaust air from the ventilation system is cleaned with highly efficient UV charcoal filters before it is discharged through an 800 m long duct.

Working fluid safety

The total R134a charge is about 8.4 tonnes. Six leak detectors with two-level alarm systems are mounted in the rock cavern. In the event of a fire alarm, the heat pump is shut down, and motor-operated valves in the suction and liquid lines section the evaporator from the rest of the plant. In the event of a working fluid leakage, fresh air is blown through the rock tunnel: due to the considerable charge, the emergency ventilation rate is as high as 20 000 m3/h.

Renewable energy

District heating systems supply about 35-40% of the total heating demand in the Nordic countries. Due to cheap electricity from Norway's very large hydro power production capacity up to the 1980s or so, Oslo is the only Nordic capital that did not have widespread district heating. However, due to the increasing focus on environmental protection, utilisation of renewable energy sources and energy conservation, the capacity of the district heating system has been considerably increased during the last 20 years. As a result, Viken Fjernvarme has become the largest Norwegian supplier of district heating, with an annual heat production of about 1 TWh/year, or about 25 % of the total heat production in Norwegian district heating systems. The new heat pump installation at Skøyen Vest increased the use of renewable energy in the district heating systems in Oslo from about 50 % to 70 %. Viken Fjernvarme has decided to install a 9 MW heat pump unit at Skøyen Vest.

The total installation costs for the heat pump plant at Skøyen Vest were about EUR 11 million. About 18 % of this was funded by ENOVA SF, and a further 11 % by Enøk Energy Conservation Fund in Oslo.

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Tumble-dryer with heat pump

Rainer Jakobs, Germany

The thermodynamic process of a heat pump is very suitable for drying processes. Simply by reducing humidity, water is absorbed from the laundry. Due to low temperatures, drying is gentle on fabrics and the energy demand is low.

Heat pumps have been used in this way for drying wood with good results for many years. The same procedure, for drying laundry, has also been well known for a long time.

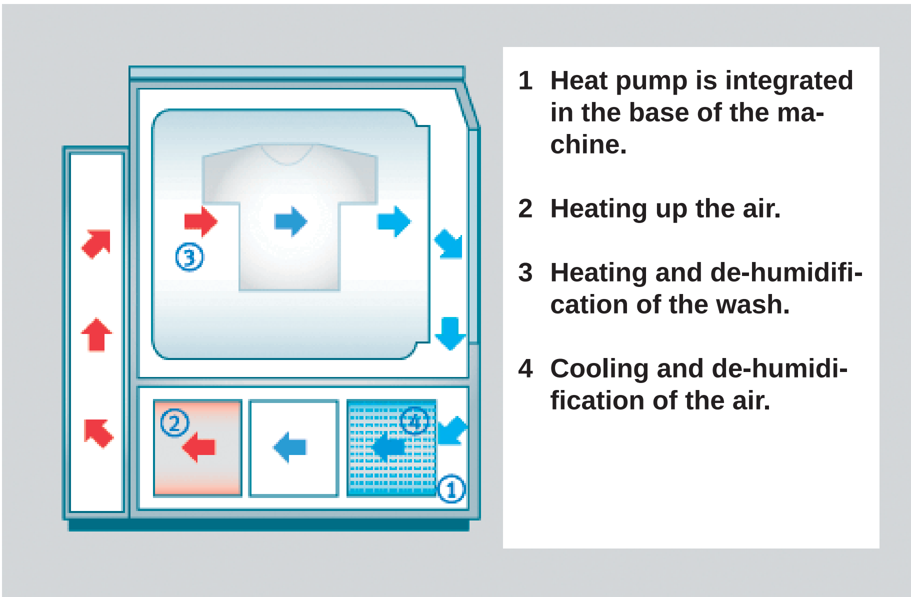
The function of the dryer can easily be explained: Air circulates through the machine and takes up the humidity of the laundry. The evaporator of the heat pump cools the air, condensing the water vapour, after which the air is reheated by the condenser. It becomes very dry and picks up more moisture in the laundry. The appliance needs only the operating power for the compressor of the heat pump.

These models take full advantage of modern heat pump technology, reusing the heat collected by the evaporator in a closed circulation system. The result is an energy saving of 40 – 50 % in comparison with ordinary tumble dryers.

Nowadays, at least three companies - AEG-Electrolux (D), Blomberg (D) and Schulthess (Switzerland) - offer dryers with energy consumptions up to 50 % less than that of a common dryer. Class A of the EU efficiency classification can easily be reached.

Machines of this type dry laundry with care thanks to low and constant temperatures. There is no need to sort fabrics which are sensitive to temperature. A drum of laundry is dry enough to put away in 60 minutes.

The prices for the appliances are higher, but overall running costs are lower for those who use the machines a lot.



Earlier technical problems have been solved. Careful design of the heat exchanger means that fluff balls scarcely cause problems, as simple cleaning is now possible. This intelligent technology will increasingly gain in market importance. The tumble dryers have been developed combining ideal energy efficiency, performance, laundry care and comfort.

Due to this technology, electricity consumption of a household can be reduced. This is a further example of how to save energy by an economical application of electricity without abandoning comfort. The heat pump reduces primary energy needs in this application area.

There are an estimated 15,1 million tumble dryers in Germany, representing only 38 % of the potential market in 2005.

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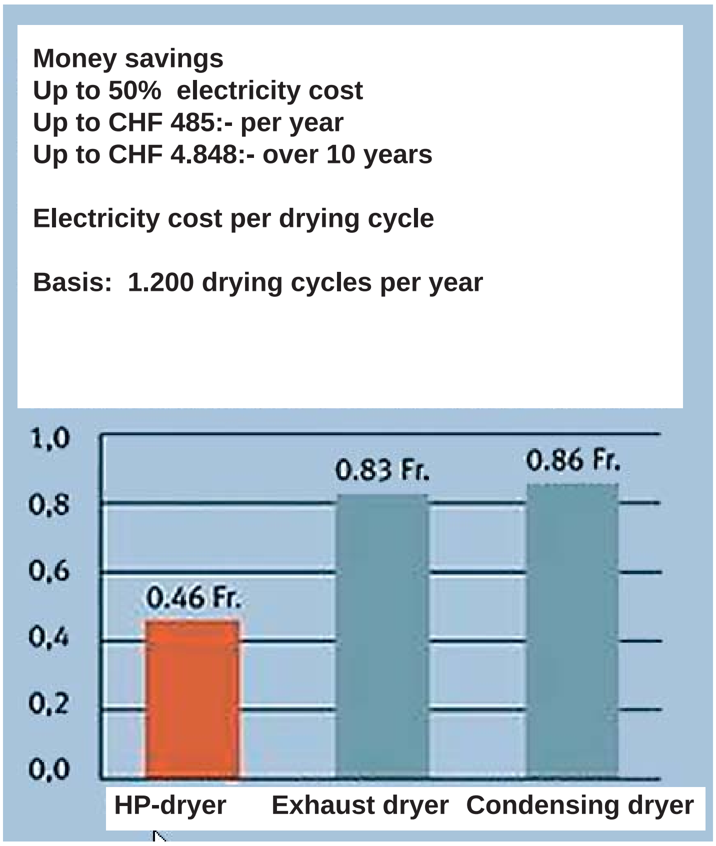

Books & Software

CO_2 Emissions from Fuel Combustion - 2006 Edition

In recognition of fundamental changes in the way governments approach energy-related environmental issues, the IEA has prepared this publication on CO_2 emissions from fuel combustion. This annual publication was first published in 1997 and has become an essential tool for analysts and policy makers in many international fora such as the Conference of the Parties. The twelfth session of the Conference of the Parties to the Climate Change Convention (COP 12), in conjunction with the second meeting of the Parties to the Kyoto Protocol (COP/MOP 2), will be meeting in Nairobi from 6 to 17 November 2006. The data in this book are designed to assist in understanding the evolution of the emissions of CO_2 from 1971 to 2004 for more than 140 countries and regions by sector and by fuel. Emissions were calculated using IEA energy databases and the default methods and emission factors from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.
Now available from the IEA Online Bookshop, www.iea.org

For more information:
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BP 586, 75739 Paris Cedex 15, France
Tel: 33 1 40 57 66 90
Fax: 33 1 40 57 67 75

2007

The 4th International Workshop on Energy and Environment of Residential Buildings (IWEERB2007)
15 - 16 January
Harbin, China
Contact: PhD Jianing Zhao
School of Municipal & Environmental Engineering
Harbin Instisute of Technology
Tel: 86-0451-88776496
Fax: 86-0451-6282123
E-mail: iweerb2007@hit.edu.cn or sky-lcy@163.com
http://indoorair.hit.edu.cn

Natural Refrigerant Heat Pumps Theory and design of CO2 systems
25 - 26 January
Lyon, France
E-mail: info@greth.fr
www.greth.fr

ASHRAE Winter Meeting
27 - 31 January
Dallas, USA
E-mail: jyoung@ashrae.org
www.ashrae.org

AHR Expo (in conjunction with ASHRAE winter meeting)
29 - 31 January
Dallas, USA
www.ahrexpo.com

2007 European Renewable Energy Policy Conference
29 - 31 January
Brussels, Belgium
conference@erec-renewables.org
http://www.erec-renewables.org/events/2007PolicyConference/default.htm

Cooling Technology Institute (CTI) 2007 Annual Conference and Exhibition
4 - 8 February
Corpus Christi, Texas, USA
http://www.cti.org/

Mechanical Contractors Assoc of America (MCAA) Annual Convention
25 February – 1 March
Orlando, Florida, USA
http://www.mcaa.org/education/mcaa/annualconvention/

European Energy Efficiency Conference
1 March
Linz, Austria
office@esv.or.at
http://www.esv.or.at/esv/index.php?id=1659&L=1#2545

ACCA Annual Conference and Indoor Air Expo
6 - 8 March
Orlando, Florida, USA
http://www.indoorairexpo.com/

IIAR 2007 Ammonia Refrigeration Conference & Trade Show
18 - 21 March
The international institute of ammonia refrigeration
Nashville, Tennessee, USA
http://www.iiar.org/f-conferences1.cfm

FBF Workshop on Feasible Sustainable Buildings and Communities
21 - 22 March
Finland

2nd International Conference on Magnetic Refrigeration at Room Temperature
11 - 13 April
Portoroz, Slovenia
info@thermag2007.si
http://www.thermag2007.si/

HEAT - SET 2007 Heat transfer in components and systems for sustainable energy technologies
18 - 20 April
Chambery, France
E-mail: info@greth.fr
www.greth.fr/heatset

ASHRAE Winter Meeting
19 – 21 April
Dallas, USA
www.ashrae.org

Ammonia Refrigeration Technology for Today and Tomorrow
27 – 31 April
Ohrid, Republic of Macedonia
Contact: Risto Cikonkov
Tel.: +389 2 3064 762
Fax: +389 2 3099 298
E-mail: ristoci@ukim.edu.mk
www.mf.ukim.edu.mk/web_ohrid2007/ohrid-2007.html

GAMA 72nd Annual Meeting
5 - 8 May
Gas Appliance Manufacturers Association
St. Petersburg, Florida, USA
http://www.gamanet.org/

Food Marketing Institute Show
6-8 May
Chicago, Illinois, USA
http://www.fmi.org/events/may/2007/

2007 Commercial Construction Show
15 - 17 May
Chicago, Illinois, USA
http://www.cc-show.net/

8e Colloque Interuniversitaire Franco-Québécois sur la thermique des systèmes
28 - 30 May
Montréal, Canada
Contact : Stanislaw Kajl
Tel : 1-514-396-8517
Fax : 1-514-396-8530
Stanislaw.Kajl@etsmtl.ca
http://www.cifq2007.etsmtl.ca/
The colloquium is held in French but open to everybody

CLIMA 2007 9th REHVA World Congress, endorsed by ASHRAE
10-14 June
Helsinki, Finland
E-mail: info@clima2007.org
http://www.ashrae.org/clima2007

Energy Efficiency in Motor Driven Systems
10-13 June
Beijing, China
eemods07@copper.org.cn
http://www.eemods.cn/

ASHRAE Annual Meeting
23 - 27 June
Long Beach, California, USA
http://www.ashrae.org/

22nd IIR International Congress of Refrigeration (ICR2007)
21 – 26 August
Beijing, China
Contact: Qiu Zhongyue
Tel: +86 10 6843 4683
Fax: +86 10 6843 4679
E-mail: icr2007@car.org.cn
http://www.icr2007.org
http://www.iifiir.org

10th International Building Performance Simulation Association Conference and Exhibition
3 – 6 September
E-mail: bs2007@tsinghua.edu.cn
http://www.bs2007.org.cn/

Fan Noise 2007
17 – 19 September
E-mail: info@fannoise2007.org.
http://www.fannoise2007.org/

For further publications and events, visit the HPC internet site at http://www.heatpumpcentre.org.

In the next Issue
Industrial Heat Pumps
Volume 25 - No. 1/2007

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 world-wide source of independent information & expertise on heat pump, refrigeration and air–conditioning systems for buildings, commerce and industry. Its international collaborative activities to improve energy efficiency and minimise adverse environmental impact are highly valued by stakeholders.

Mission

The Programme serves the needs of policy makers, national and international energy & environmental agencies, utilities, manufacturers, designers & researchers. It also works through national agencies to influence installers and end-users.
The Programme develops and disseminates factual, balanced information to achieve environmental and energy efficiency benefit through deployment of appropriate high quality heat pump, refrigeration & air-conditioning technologies.

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

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IEA OECD heat pump centre

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