IEA **Heat Pump** CENTRE

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Concepts for Heat Pump Marketing

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Marketing MVR heat pumps in the chemical industry

Heat pump promotion by utilities in Switzerland

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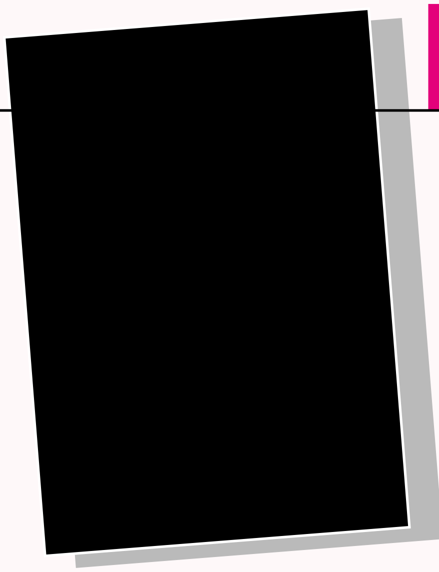

In this issue

Concepts for Heat Pump Marketing

In many countries heat pumps are known to be a way of achieving higher energy efficiency, reducing environmental problems and levelling the peak load. However, the diffusion of a new technology is not an easy process. The various parties in the market with an interest in an accelerated implementation of heat pumps have their own concepts for marketing heat pump technology. This issue describes the strategies and instruments used by governments and utilities.

Front cover:
This compilation represents several elements of heat pump marketing concepts.

COLOPHON

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TOPICAL ARTICLES

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Strategic heat pump marketing and the importance of the IEA Heat Pump Centre

The market for space conditioning heat pumps develops naturally in regions with a considerable cooling demand. This is the situation in Asia, the USA and to some extent southern Europe. In northern Europe heat pumps are mainly installed for space heating and domestic hot water, competing with conventional low-priced heating systems. Consequently, well-aimed policies are often required over a long period of time to attain a mature and stable heat pump market. The best example of this is Sweden, where extensive government heat pump support programmes were implemented from 1975-85. However, success in Sweden relied on the fact that politicians and decision makers were informed about the considerable possibilities of the heat pump technology. Today around 300,000 heat pumps supply 17 TWh of heat per annum, and more than 20,000 systems were installed in 1997.

The current Norwegian heat pump market is less significant, with 22,000 systems supplying 4.5 TWh heat annually. However, the potential is estimated at 15 to 20 TWh. Due to Norwegian membership of the IEA Heat Pump Centre (HPC), the Norwegian National Team has been able to carry out systematic information dissemination towards important target groups, including politicians, utilities, and environmental organisations. From being an almost forgotten technology, heat pumps are now regarded as an important instrument for energy conservation and reduction of greenhouse gases, according to the new government study entitled “The Norwegian Energy System Towards 2020”. The Parliamentary Committee for Energy and the Environment has also called on the government to establish a strategy plan for increased utilisation of heat pumps in Norway.

The Norwegian success would have been considerably more difficult to achieve without membership of the HPC. International heat pump collaboration has brought new knowledge, perspectives and inspiration in periods when energy conservation and application of renewable energy sources were less highlighted in the policies of the Norwegian government.

Due to the unique utilisation of renewable energy and waste heat, heat pumps should constitute an important part of any sustainable energy system. The Norwegian National Team believes that the reorganised HPC will attract new member countries, and therefore become an even more influential information centre in the years to come – which can only be beneficial to the environment.

Jørn Stene
Leader of the Norwegian National Team

Heat pump news

Heat pump quality label in force

Switzerland - After a two-year preparation period the heat pump quality label, an initiative of Austria, Germany and Switzerland, has now come into force. It was officially presented on 5 November 1998 during the heat pump Expo in Bern. The label will be valid in all three countries. The criteria for obtaining the quality label include:

- series production;
- measured performances in line with EN255;
- minimum measured COP of:
  - for air-to-water A2/W35: 3.0
  - for brine-to-water B0/W35: 3.5
  - water-to-water W10/W35: 4.1;
- electrical safety test;
- measured noise level;
- compliance with European conformity;
- minimum requirements for design sheets;
- minimum requirements for installation and operation manual;
- customer service covering the sales area within 24 hours;
- two years complete guarantee;
- ten-year spare parts guarantee.

The heat pump quality label is valid for a three-year period. The next step of cooperation between the countries will be a project to widen the scope of the criteria by creating a quality label for heat pump systems. This should ensure that the complete system complies with the latest technology standards and fulfils economical and ecological requirements.

Source: LGW Aktuell, 1/98

Electrical heating and cooling of residential buildings

United Kingdom - A study on how to transform the European market for electrical heating and cooling of residential buildings has been delivered to the Energy Directorate (DG XVII) of the European Commission in Brussels. A set of 22 recommendations have been made which could result in increased comfort and a substantial decrease in the environmental impact of one of mankind's basic needs.

The most sweeping recommendation is upgrading the thermal insulation of 9 million homes that are more than 50 years old, but whose fabric is basically sound, to a level close to current building standards. These homes should then be re-equipped with efficient electrical heating systems matched to the (reduced) heat loss of the home. The study identifies heat pump technology as the most efficient method of heating and cooling and makes some specific recommendations to increase their market penetration. It suggests that an annual installation target of one million heat pumps be set to encourage the industry to grow and concentrate on providing a full range of models for the European market. Other recommendations suggest that all types of heat pumps should carry an EU energy label, as well as the introduction of minimum standards following the introduction of labelling. A European heat pump association should also be set up to promote the technology and the market for heat pumps in Europe.

The study estimates that savings of 40 TWh of electricity could be made by 2010, thus contributing substantially towards the Kyoto target for reducing greenhouse gas emissions. An investment of ECU 20 billion by 2010 could be recovered within three years through avoided electrical capacity and reduction in electricity consumption.

More details on how to obtain the study can be found in the Books and Software section on page 31.

Source: Mr Rayner Mayer, Sciotech. Fax: +44-1252-873564

Standardising the monitoring of heat pump systems

The Netherlands - Now that the Dutch market introduction of heat pumps is growing in demonstration projects, questions arise about the real performance of heat pump systems. Procedures for monitoring currently differ from project to project.

To develop uniform procedures Novem and EnergieNed have requested TNO (Dutch Organisation for Applied Scientific Research) to develop a Standard Set Up for Monitoring heat pump systems (SOM-WP) for residential applications. SOM-WP is concerned with the entire system, unlike laboratory tests that often monitor the heat pump as a component. The main aim is measuring, registering and uniform analysis of the data regarding the energetic performance of the system. Customer satisfaction will also be analysed.

SOM-WP makes projects more comparable. The set up covers several phases; a preparation phase, measuring phase and an evaluation phase. The approach indicates which choices should be made at each stage of realising a residential building. Besides comparison with other projects, knowledge dissemination is essential to make use of the results. Depending on the needs of the parties involved, a basic monitoring procedure or an extended procedure can be chosen. Monitoring is an investment that can be seen as a pre-investment for future projects.

More information: L. Wijshoff
Tel.: +31-46-4202273
Source: Podium Warmtepompen, September 1998

European Heat Pump Network (HPN)

Germany - The European Commission’s White Paper for a Community Strategy and Action Plan entitled “Energy for the Future: Renewable Sources of Energy” has set the goal of doubling the current share of renewable energies by the year 2010. It suggests that the 60,000 currently installed geothermal heat pumps in the European Union be tripled, which would correspond to an installed capacity of 2.5 GWth. One of the key actions in this context is the systematic dissemination of unbiased and comprehensive information on all aspects of heat pump applications.

The Commission has supported the project “European Network on Heat Pumping Technologies” coordinated by the Fachinformationszentrum (FIZ) Karlsruhe, Germany with the co-contractors SINTEF Energy Research (Norway), A.D.P.M. (Association de Promotion de la Maitrise de l’Energie-Thermopompes et Machines à Froid, France) and Novem (the Netherlands). The results of this project included a European heat pump database, an Internet site (http://www.fiz-karlsruhe.de/hpn) and an analysis of the status and future trends of heat pump applications in Europe.

As a follow-up activity the project “Concerted Actions for the Promotion of Heat Pumps in Europe” has been proposed which is due to start by December 1998. In addition to the aforementioned partners, David Reay & Associates (United Kingdom) and the Leistungsgemeinschaft Wärmepumpe (Austria) have also joined the consortium. The tasks of the project are to:

- create a European Heat Pump Newsletter;
- regularly update the Internet page “European Heat Pump Network” and the heat pump database;
- study and organise a workshop on the current status of natural refrigerants;
- study and organise a workshop on heat pump training programmes for targeted groups.

To implement these activities and for the further long-term development of the European Heat Pump Network, close cooperation with the IEA Heat Pump Centre is required.

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The home page of the European Heat Pump Network.

International Standard adopted by ARI

USA - Taking a first step towards a transition to international standards, the water-source heat pump section of ARI has become the first product section to adopt an international standard and the first to use it as the basis for its certification programmes. On 1 January 2000 ISO standard 13256 “Water-Source Heat Pumps - Testing and Rating for Performance” will replace ARI standards 320 (Water-Source Heat Pumps), 325 (Ground Water-Source Heat Pumps) and 330 (Ground Source Closed Loop Heat Pumps). The new standard allows direct comparison of all three applications, and makes it easier to use data for energy analyses. Reasons for ARI to adopt ISO standards include the fact that the new standard provides credibility for worldwide acceptance of US water-source heat pump products as well as appreciation of ARI’s certification activities. ARI/ISO certification is expected to reduce export market entry barriers and associated costs for participating manufacturers.

Source: Koldfax, October 1998

The Norwegian Postal Administration is keen on heat pumps

Norway - In recent years, heat pumps installed in hydronic heat distribution systems have been the main heating alternative for the Norwegian Postal Administration. The operational experience has been very satisfactory with regard to profitability, energy efficiency and reliability.

In all new terminal buildings of 3,000 to 5,000 m^2 floor area, heat pumps in combination with hydronic floor heating systems are consistently selected as the main option. Heat pumps and floor heating systems are also being installed when existing terminal buildings are renovated. The first heat pump system was installed at a terminal building in 1994. The payback period for the heating-only heat pump was approximately three years. Since then, all new heat pump installations are providing both space heating and space cooling, and the profitability has been improved. The heat pumps are always designed to cover the maximum cooling load, and the capacity is then sufficient to cover 90-95% of the annual heating demand. The Norwegian Postal Administration has installed around 2,000 kW of heat pump capacity, and new installations are now being planned in several buildings.

Source: Jørn Stene, Sintef Energy Research / Norwegian National Team

Regeneration of geothermal heat exchanger fields for heat pumps

Switzerland - A recent study investigated the influence of regenerating small vertical geothermal heat exchanger fields using excess solar energy and summer cooling on the seasonal performance factor (SPF) of the heat pump and on the total costs. The computed estimates were made for a multi-family building with a low summer cooling requirement and for an office building with a high summer cooling requirement. The building was monitored by the HELIOS program and the geothermal heat exchangers by the EED program. The optimal regeneration case (a negligible heat transfer through ground water flows) was assumed for the heat exchanger field. Cooling mode was assumed for room temperatures above 26°C and heating mode for room temperatures below 20°C.

The multi-family building was studied for situations requiring summer cooling with a low and a high input of excess solar heat. In the case of the office building, the regeneration was effected only by using excess heat from cooling in the summer. Single and double row arrangements of geothermal heat exchangers with ”double U” heat exchangers were studied, for different spacing (5-18 m), different heat flow rate densities (35-75 W/mK) and heat exchanger lengths (65-200 m).

It was clearly demonstrated that for the multi-family building, regeneration of the geothermal heat exchanger field was both economically and energetically unfavourable. The cost for brine circulation exceeded the benefits gained from the slight increase in SPF. Taking into account the brine circulation with the regeneration of the heat exchanger field, the SPF is approximately identical with and without solar regeneration of the heat exchanger field.

However, for the office building, the heat drawn from the heat exchanger field with heat pump operation was in the same order of magnitude as that supplied for regeneration in summer through the room cooling. When room cooling takes place exclusively via the heat exchanger field, a slight increase in the SPF of the heat pump results after offsetting the energy required for circulating the heat carrier (mixture of water/ethylene glycol and pure water). Because this makes it possible to leave out an air conditioning unit, the study showed a 12% reduction in the overall costs compared to conventional room cooling using a refrigeration system. This cooling configuration results in a higher heat carrier temperature. Consequently, pure water can be used in the probe circuit instead of the usual water/ethylene glycol mixture. This is an energetic and ecological gain!

The generalised results of the study lead to the conclusion that active regeneration is only expedient when the following conditions are satisfied:

- the heat input in the year must attain the order of magnitude of the heat extracted by the heat pump;
- the geothermal heat exchanger field must have a configuration which approaches the function of a seasonal storage unit;
- with room cooling, the regeneration must lead to an increase in comfort and/or the removal of other equipment and machines;
- solar systems for hot water production contribute to natural regeneration by avoiding the extraction of heat from the probes in summer. On the other hand, direct summer charging of geothermal heat exchangers via hot water solar systems with degrees of coverage from 30-60% is energetically and economically unfavourable. A study of the benefits of regeneration is only worthwhile with very large-scale solar installations and regions with a high probe density.

The complete final report “Regeneration von Erdwärmesonden, Phase I: Potentialabschätzung” is available in German under ENET Number 9722601, and can be ordered from: ENET, Administration und Versand, Postfach 130, CH - 3000 Bern 16, Switzerland. Fax +41-31-3527756

Source and further information: Martin Zogg,
Swiss Federal Office of Energy (BFE).
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An air-to-water heat pump in a small-scale district heating system

Norway - The Norwegian Defence Construction Service (FBT), the largest building employer in Norway, administers properties with a total gross floor area of 5.8 million m^2. FBT has long traditions with heat pumps, and has been responsible for a number of installations in both large- and small-scale district heating systems, as well as in individual buildings.

In 1997 a 520 kW air-to-water heat pump was installed at a military camp in Stavanger situated on the western coast of Norway. Due to the relatively mild climate, ambient air was regarded as the most applicable heat source. The bivalent heat pump system consists of four HFC-134A heat pump units. Each unit has two tube-in-fin evaporators. The air-coolers, which have been optimised for cold climate operation, have a fin distance of 8 mm. This reduces the frost formation on the evaporator surface, and the evaporators are defrosted only once or twice a day at ambient temperatures below 4°C. The large evaporator surface ensures a low temperature difference in the evaporators and high energy efficiency. Since the ambient air has a high salt content (chlorine ions), the evaporators have been coated with epoxy.

The heat pump is designed for 50% of the maximum heating load, and oil-fired and electric boilers are used at peak load. During the year, the heat pump covers around 85% of the total heating demand in the camp (space heating, hot water heating and heating of ventilation air). The heat pump system is connected to a district heating system which serves 14 buildings. The supply temperature is kept constant at 66°C throughout the year.

The coefficient of performance (COP) for the heat pump system is 2.4 at 5°C ambient temperature. The total cost was USD 530,000, and the payback period is approximately six years when assuming an electricity price of USD 0.07 per kWh.

Source: Jørn Stene, Sinter Energy Research / Norwegian National Team

Study examines global warming implications of replacing ozone-depleting refrigerants

USA - The US Department of Energy and AFEAS (Alternative Fluorocarbons Environmental Acceptability Study) have jointly sponsored projects to identify the main applications of refrigerants worldwide and to examine the impacts of CFC and HCFC replacements on overall emission of greenhouse gases. The five main uses of refrigerants, based on refrigerant sales, are air conditioning for cars, supermarket refrigeration, unitary heat pumps and air conditioners, chillers for cooling large office and commercial buildings, and household refrigeration.

The study used the concept of total equivalent warming impact (TEWI), which was developed as a comparative index of global warming impacts of competing options for meeting a given end-use application. In most of the applications studied, the CO_2 emissions resulting from energy use dominate the results. Efforts to improve system efficiency and reduce CO_2 emissions will yield the greatest reduction in global warming impact. For supermarket refrigeration however, the level of refrigerant emissions is relatively high and changes in design or technology that reduce these emissions can make significant reductions in TEWI. Secondary loops or distributed systems have the potential to greatly reduce TEWI for supermarket systems using either fluorocarbon or natural refrigerants.

It was concluded that the TEWI index provides a useful tool to assess competing technologies, as specific chemical compounds are phased out under the Montreal Protocol. However, it is only one of the many factors that must be considered in evaluating the ‘best technology’ for any given application. Other factors include safety, health, costs, reliability, ease of maintenance and regional energy sources.

Source: Messrs Baxter, Fischer and Sand, ASHRAE Journal, September 1998

Swedish studies on hydrocarbons

Sweden - The Royal Institute of Technology in Stockholm has recently concluded a three-year project studying heat transfer characteristics of propane and propene in small brazed plate heat exchangers. In brief, the experimental results show that in evaporation the heat transfer coefficients will be higher with propane than with R-22 at a given surface heat flux and evaporation temperature. In the condenser the heat transfer coefficients were slightly lower with propane than with R-22. Both these results agree with theoretical predictions based on the thermodynamic properties of the fluids. The greatest difference between propane and R-22 was found when comparing the pressure drops, as the pressure drop of propane was about 40% lower than that of R-22.

At the same institute a second study has been carried out under the title ‘cyclopropane as refrigerant in small refrigeration systems’. Cyclopropane (RC-270) is compared with R-12 and R-600A. RC-270 has a vapour pressure curve similar to that of R-12, and the volumetric cooling capacity is about 20% higher than R-12. Application tests with freezers and refrigerators showed improved efficiency with cyclopropane compared to both R-600A and R-12. In the freezer tests the reduction in energy consumption was 10-15% compared to R-600A and approximately 2-5% compared to R12. The reduction is related to the favourable thermophysical properties of cyclopropane, which lead to a low pressure drop and high heat transfer coefficients. The stability issue has been studied, and experimental tests have not shown any decomposition.

Both study reports, in the form of a licentiate thesis, are available from the Royal Institute of Technology, Department of Energy Technology, Division of Applied Thermodynamics and Refrigeration, 10044 Stockholm, Sweden. Fax: +46-8-20 30 07

Source: Mr B. Palm and Mr J. Rogstam, Royal Institute of Technology, Sweden

European project on CO_2

Germany - Because of the positive characteristics of CO_2 as a working fluid such as non-flammability and non-toxicity, a European research project (COHEPs) has been started to develop CO_2 heat pumps. Heat production of CO_2 heat pumps takes place at temperatures of 60-90°C, which is higher than for conventional heat pumps. A relatively large pressure difference exists between the high-pressure side and the low-pressure side. Although this system is energetically efficient, several difficulties have been encountered in the development of suitable compressors. A prototype of a Danfoss research compressor has the advantage that capacity control is possible by changing the angle of the wobble plates used in this reciprocating compressor. This is energetically very beneficial, and so it would be useful if this could also be applied in heat pump compressors.

More energy savings that lead to an improved COP might be achieved through the application of an expansion machine rather than a valve. The expansion ‘work’ is used to compress the gas on the low-pressure side, so that there is less energy needed for final compression. Even with relatively low expansion efficiencies under 60%, this can result in a 20% improvement in the heating COP of the heat pump. New research has been started to develop a compression-expansion machine for CO_2 applications. As a final step, the CO_2 heat pump should, in cooperation with industry, be developed such that it is suitable for series production. This would mean an application with an environmentally friendly working fluid, whereby high heat-sink temperatures can be realised in an energetically beneficial way, which would make this type of heat pump suitable for retrofitting in buildings.

Source: Wärmepumpe, September 1998

Japan and US corporate alliance

USA/Japan - Carrier Corporation and Toshiba Corporation announced on 31 August 1998 the signing of a memorandum of understanding to form a strategic alliance. This alliance aims to combine the companies' complementary products and capabilities in technology innovation, manufacturing, quality assurance and sales and marketing. A joint venture, named Toshiba Carrier Corporation, will be established by 1 April 1999 with headquarters in Tokyo. The target sales will be around JPY 160 billion for the first year, and the company will employ around 2,200 staff. Carrier will own 40% and Toshiba 60%. Manufacturing joint ventures will be formed in the UK and Hong Kong, while sales and marketing joint ventures will be established in the UK, Thailand and Malaysia. Toshiba's HVAC sales organisations will be integrated by Carrier in Singapore, Hong Kong, France and Germany.

Source: JARN, September 1998

World air-conditioning study reveals massive regional differences

UK - The world air-conditioning market is experiencing a turbulent year in 1998. The total market is expected to fall 7% from USD 33.2 billion in 1997 to USD 30.8 billion in 1998, according to a market survey conducted by BSRIA/JARN as a joint project over the past year.

There has been a severe decline in the Far East and Oceania region. In 1997 this region accounted for 51% of the entire world market, but fell by 17% to 14.2 billion in 1998, with huge declines in five of the largest markets (Japan, South Korea, Malaysia, Thailand and Indonesia). However, many other parts of the world are experiencing high levels of growth, e.g. India, Latin America and Europe.

For unitary products, the USA is still the largest market in the world. This section includes mainly rooftops and ducted splits, with the US share around 80%. The US also has a 30% share of the world window unit market. In Japan, Asia and the Middle East the market is segmented into RAC minisplit units (specifically designed for residential applications) and PAC minisplit units, for the professional markets. The immense minisplit market is dominated by Japan, China and other parts of the Far East. Sales in the Far East being some 1.2 million units lower than 1997, the large number of high volume factories located in the region are looking for fresh markets to boost capacity. Japan, Korea and China are the largest markets for PAC minisplit units, followed by the UK market and, to a lesser extent, Italy and Spain.

For chillers, the world market was USD 4.0 billion in 1997, with the USA forming the largest market, accounting for 43% of centrifugal chillers. The world market for absorption chillers is even more concentrated, with nine countries controlling 99% of the value, 90% of which is in Japan, China, Korea and the USA. Reciprocating, screw and scroll form the fastest growing chiller market with a growth rate of over 4% per annum.

Source: BSRIA, fax: +44-1344-487575

New RAC models in Japan

Japan - Major Japanese manufacturers have released new products for the domestic market for the 1999 refrigeration year. Despite the difficult situation in the Japanese market, characterised by excessive production capacity and low prices, improvements in the products have been made, according to the manufacturers. The general trends are: higher performance resulting in lower energy consumption, finer air filtration and purification, adoption of HFC refrigerants, better thermal storage systems and stronger heating capability at lower outdoor temperatures. Considerable efficiency improvements were announced by Sanyo for its R-410A room air conditioner (RAC), which is said to have a heating COP of 4.83 resulting in 10% less power consumption than earlier models. Toshiba have announced a coefficient of performance of 4.90. When compared with the models of six years ago which had a COP of 2.82, it is clear that much progress has been made. All manufacturers have achieved similar improvements and power consumption has probably halved over this time period.

Source JARN, October 1998

Heat pump and kerosene heating hybrid air conditioner

Japan - Toshiba has released a new room air conditioner model with bivalent operation, suitable for operation in colder climates. The model is capable of automatically selecting either kerosene-fired refrigerant heating or the electric heat pump mode, according to the outside temperature or heating load. While shortening the warm-up period in heating mode and realising close temperature control according to a preset room temperature, it becomes possible to cut down on heating costs. Due to the adoption of the kerosene-fired refrigerant heating system, the model can produce enough heating capacity even in a cold district where the outside temperature in mid-winter reaches -20°C.

A kerosene-fired refrigerant heating operation is performed at the start of heating operation, and as the room temperature draws near the preset temperature, the electric heat pump operation mode is selected automatically. As a result, the warm-up period in heating mode can be reduced by 40% compared to the previous model, giving more comfortable heating with less room temperature fluctuations than the kerosene-fired refrigerant heating-only operation. The hybrid operation can realise around 16% cost reduction on the heating costs compared to kerosene-fired heating-only operation. Compared to electric heat pump heating-only operation cost reductions can be as much as 20%.

Source: JARN, October 1998

Two new Annexes started

USA - While three Annexes are nearing completion (Thermophysical Properties of Environmentally Acceptable Refrigerants - Annex 18, Compression Systems with Natural Working Fluids - Annex 22 and Heat Pump Systems for Single-Room Applications - Annex 23), two new Annexes were started, which will officially come into force on 1 January 1999.

Annex 27, entitled Selected Issues on CO_2 as a Working Fluid in Compression Systems is in many ways a continuation of one of the subject areas covered in Annex 22. Countries that expressed their interest included Austria, Belgium, Germany, Japan, Sweden, UK and the US. All countries were asked to confirm their participation with the Operating Agent (SINTEF Energy Research, Norway), by 1 January 1999.

The main objective of the Annex is to bring CO_2 heat pumping technology closer to commercialisation, by addressing critical issues of both a basic and applied character. It will be important to involve industry, particularly manufacturers, as well as research institutes in this process. The Annex is expected to continue into 2002.

Carbon dioxide technology will also be an issue in Annex 26, entitled Advanced Supermarket Refrigeration/Heat Recovery Systems. This Annex will make use of the results from Annex 22 regarding indirect refrigerating systems in supermarkets. The Annex was proposed by the US and attracted interest from several countries including Austria, Germany, the Netherlands, Norway, Sweden, Switzerland, UK and Mexico. All countries were asked to confirm their participation to the Operating Agent (Oak Ridge National Laboratory, USA) by 1 January 1999.

The objective of the Annex is to demonstrate advanced systems for food refrigeration, and space heating and cooling for retail food stores (supermarkets). The goals are to significantly reduce total refrigerant charge requirements (by at least one half), and to reduce total energy use for refrigeration and store heating/cooling by at least 15%, thus significantly reducing total equivalent warming impact (TEWI) of supermarkets. The Annex is expected to run until May 2001.

Source: IEA Heat Pump Centre

New strategy IEA Heat Pump Programme

USA - The Executive Committee (ExCo) of the IEA Heat Pump Programme (HPP) held its Autumn 1998 meeting in Syracuse, USA.

Significant progress was made on the new strategy for the HPP. After several meetings of the strategy working group over the past year, a new mission statement and newly formulated strategic goals were presented to the ExCo. The new mission statement is: "The IEA's Heat Pump Programme provides leadership in international information dissemination and networking, to enhance the acceptance of energy efficient and environmentally beneficial heat pumping technologies. The programme serves the needs of government policy makers, manufacturers, designers and researchers".

The HPP continues to widen its appeal, witnessed by the attendance of representatives from an increasing number of countries including Mexico, New Zealand and the European Commission (DG XVII). The ExCo welcomed Mexico as the 16th participating country in the IEA Heat Pump Programme. Unfortunately Spain withdrew from the Heat Pump Centre (HPC), but several other countries expressed interest in joining the newly structured HPC. The HPC was extended for a period of 3 years.

Source: Rebecca Jones, Technical Support Services Unit (TSSU)

Ongoing Annexes

Red text indicates Operating Agent. Japan is the Co-operating Agent of Annex 18.

Annex	Title	Countries
Annex 16	IEA Heat Pump Centre	AT, ES, JP, NL, NO, CH, US
Annex 18	Thermophysical Properties of Environmentally Acceptable Refrigerants	CA, DE, JP, SE, UK, US
Annex 22	Compression Systems with Natural Working Fluids	CA, DK, JP, NL, NO, CH, UK, US
Annex 23	Heat Pump Systems for Single-Room Applications	CA, FR, CH, US, SE
Annex 24	Ab-Sorption Machines for Heating and Cooling in Future Energy Systems	CA, IT, JP, NL, SE, UK, US
Annex 25	Development of Practical Concepts for Year-round Residential Space Conditioning and Comfort Control Using Heat Pumps	FR, NL, US

IEA Heat Pump Programme participating countries: Austria (AT), Belgium (BE), Canada (CA), Denmark (DK), France (FR), Germany (DE), Italy (IT), Japan (JP), Mexico (MX), The Netherlands (NL), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH), United Kingdom (UK), United States (US).

Concepts of heat pump marketing

An international overview

Hanneke van de Ven, IEA Heat Pump Centre

The marketing of heat pumps is a very diverse business. All parties have their own motivation for stimulating the use of heat pumps. The need for active marketing varies according to the maturity of the market. This article gives an overview of the main trends in the field of heat pump marketing over the past few years, showing the market status and barriers, as well as the instruments required to overcome these barriers. Finally, the market status in several countries is discussed in relation to their marketing activities.

In many countries heat pumps are seen as one of the technologies that should enable the goals for CO_2 reduction, set within the Kyoto Protocol, to be achieved. This is one of the most important reasons for governments to stimulate the use of heat pump technology. However, there are other environmental benefits of heat pumps related to this motivation, such as less production of waste heat, less use of depleting energy sources etc.

Another reason for stimulating heat pumps mainly occurs in countries with a more mature market situation where a cooling demand is present. The use of air-conditioners in summer causes high peak load, which leads to a deteriorating electricity load factor. Heat pumps, especially in combination with thermal storage systems, contribute to a better demand level. Both governments and utilities are concerned about this problem.

The last (but not least) reason for stimulation is an obvious commercial one: profit and an increasing market share. Manufacturers naturally benefit from increasing sales, and with the deregulation of energy markets, heat pumps are an important tool allowing utilities to offer additional services which stimulate customer loyalty.

Market status

The maturity of the market varies per country. In general there are six phases of development for heat pumps in buildings: research and development, prototype, field tests, demonstration project, small-scale production, and mass production. After each stage the status of the heat pump technology has advanced, as can be seen in **Figure 1**. The stages of development for industrial heat pumps are somewhat different, since this concerns often tailor-made applications. The article by Mr Kleefkens on page 21 gives a good example of a market strategy for industrial heat pumps.

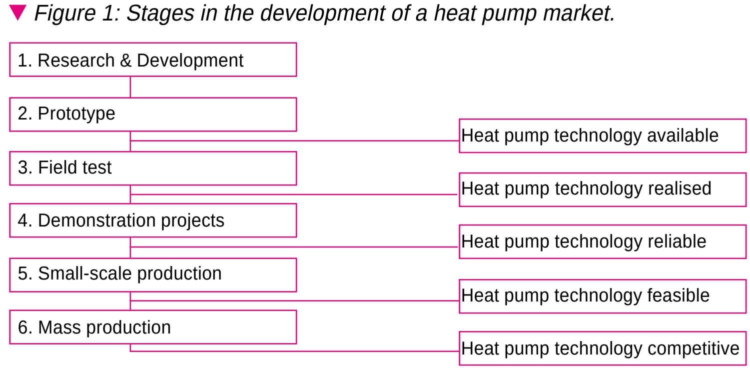
The role of the various parties differs according to the development stage of heat pump technology in a particular country, although within a country the heat pump market does not need to be homogenous. Different product/market-combinations, such as heat pump water heaters for residences or heat pumps for heating and cooling in commercial buildings, may be at completely different stages of development. Along with the market status, the instruments used for accelerating the penetration rate of heat pumps in the market also differ. It is difficult to give general guidelines for heat pump marketing concepts, although some elements can be identified that are present in many of the possible approaches. Depending on the context, a tailor-made marketing concept has to be designed for every situation. Fortunately, it is possible to learn from experiences in other countries or market segments. The following paragraphs give an overview of the existing market barriers and describe the instruments that might be used to remove those barriers. Promotion policies in the European Union (EU) and other countries are described in the final paragraphs.

Market barriers

A recent EU study identifies several barriers for energy-efficient technologies in general, which also apply to heat pumps. The barriers mentioned in the study include low energy prices, low level of awareness with the target group, large initial investment, lack of confidence and overestimation of risks.

Besides these market barriers several technical barriers also exist, including safety aspects, reliability and efficiency.

▼ *Figure 1: Stages in the development of a heat pump market.*



Instruments

Many types of instruments are used in heat pump marketing concepts, all aiming to remove one or more of the specific market barriers. Since higher investment costs still form one of the main barriers to further dissemination of heat pump technology, many instruments focus on the financial aspects. This is true for both utilities and governments.

Many governments stimulate or influence *RD&D projects*. This instrument is mainly meant to remove the technical barriers to a wider application of heat pumps. Governments, mostly apply this intrument when the market for a particular heat pump application is still in an early phase of development. One advantage is that national industries may benefit from government-sponsored research. However, it still seems difficult to introduce newly developed products/concepts onto the market. An additional instrument could then be targeted at the third and fourth phases (Figure 1), e.g. sponsoring of *demonstration projects* by the government or utility, to confirm the feasibility of heat pump concepts and simultaneously increase the awareness of potential users.

Another category of instruments consists of financial incentives used by both governments and utilities. These measures can really create a heat pump market. The disadvantage is that the market can be unstable and may collapse when incentives are withdrawn. Financial incentives can take the form of subsidies, special energy tariffs, an attractive lease construction, etc.

Promotion and information should reduce one of the main barriers (i.e. lack of familiarity and confidence in the technology) and can be aimed at specific target groups. In some cases utilities have been very successful in reaching end-users (mentioned later in this article). The disadvantage is that information alone will not create a heat pump market. To be effective this instrument should be combined with economic incentives.

▼ *Table: Measures to overcome market barriers.*

Technical measures	Financial measures	Other measures
Standards and codes	Fiscal incentives	Information dissemination
Regulations and directives	Public subsidies	Trade associations
Planning and guidance	Energy price controls	User associations
Support of R&D	Taxes	Emission controls

Governments can also influence energy prices with *taxes*, which can drastically influence the market opportunities for heat pumps. In addition, *regulations* enforced by the government can also have a strong impact. For example, they may require ventilation heat recovery, low-temperature distribution systems, or limit the use of air conditioners and the amount of cooling water in industry.

Certification or labelling of products is a tool which can be used to remove technical and market barriers, and improve characteristics of the heat pump such as safety and efficiency.

Lastly, additional instruments used by utilities include *reduced tariffs*, often given in exchange for the possibility to remotely switch off equipment during certain peak periods. Utilities sometimes provide attractive financing procedures, which make the financial burden for the consumer more bearable. *Heat (and cold) contracting* is another option, whereby the utility owns the heat pump installation which supplies one or more buildings. The utility is responsible for the operation and servicing, while the customer pays for the amount of heat delivered.

An important development is that the various parties interested in accelerating the market penetration of heat pumps are cooperating via an *'umbrella heat pump programme'*. These cooperative efforts can be seen in many countries with a mainly heating demand, both for more research-oriented umbrella programmes, as well as more market-oriented schemes.

The following paragraphs describe examples of the measures mentioned above, linking the market status and promotional activities for heat pumps within a region or country.

Asia

The government in Japan is continuing its support of ambitious RD&D programmes aimed at energy efficiency. The government also supports the Heat Pump Technology and Thermal Storage Centre of Japan (HPTCJ), which aims to stimulate both heat pumping and thermal storage technology.

A new development in the promotion of heat pumps is that utilities have now started their own programmes. Japan has a mature heat pump market, because of the coexisting heating and cooling demand and the widespread use of reversible air conditioners. Nevertheless, special attention is given to further marketing of two types of heat pump systems. The gas engine heat pump is stimulated by gas utilities and the heat pump in combination with an ice thermal storage system is mainly promoted by electric utilities. The main reason for this is the deteriorating load factor in the power supply. Reducing the peak demand by using different energy sources (in this case gas for the gas-fired heat pump) or applying thermal storage systems, is a priority for both utilities and the government. The instruments include information dissemination, subsidies and an adjusted tariff structure for electricity and gas prices. More information about the marketing aspects can be found in the article on page 19 and in the box on page 13.

In China the heat pump market is driven by the increasing demand for space conditioning. Because the promotion of heat pump technologies is not a government priority, there is no active stimulation policy. The South Korean government supports heat pumps as part of their energy efficiency policy. Projects and programmes that are currently in operation are in line with the government's five-year economic plan, which is in its final phase. Both the government and the utilities support RD&D projects in the heat pump field. The heat pump market in South Korea is growing rapidly as a result of increased space conditioning demands and support by the government and utilities.

USA

Government support in the USA with regard to energy savings concentrates on high efficiency equipment, including heat pumps. As a means to achieve this, RD&D projects are supported. In 1997 the US utilities offered several demand-side management (DSM) programmes. Financial incentives were used to stimulate use of heat pumps. Ground-source heat pumps receive increased attention in the USA. Other heat pump promoting bodies are the Geothermal Heat Pump Consortium and the regional heat pump associations. Sales in the residential and commercial sectors are steadily increasing, due to the climate conditions but also to the promotion efforts by the US government, utilities and the heat pump promotion consortia.

Canada

During the early 1990s DSM projects in Canada were also the principal tool for promoting heat pumps. By 1996 all DSM programmes had disappeared due to market conditions. The Canadian government is still actively promoting energy efficiency. In 1996 new heat pump programmes emerged, which included financial incentives by utilities and the foundation of the Canadian Heat Pump Council which should improve information dissemination. Up to 1995 the heat pump market there declined, but in 1996 there was a slight increase in sales of heat pumps.

Austria

Further to the deregulation of the electricity market, Austrian utilities have changed their attitude to how they operate. They have gone from being a supplier and distributor to being a seller of electricity. They have to be competitive and they are looking for electricity applications to meet the needs of their customers.

One segment of electricity utilisation is the space heating market and, in contrast to the past where direct electric heating was promoted, electric utilities have now entered the market of the hydronic heat distribution systems, currently dominated by oil- and gas-fired boilers. This market promises new customers through the use of heat pumps. Utilities have been active in the heat pump business, and the situation regarding the newly built single-family housing market looks promising for the future. Several marketing concepts are used by utilities that have started new heat pump programmes.

Subsidies, loans, reduced tariffs and other promotional activities are well-known measures, but they are usually not sufficient to create a stable market growth. The main task is to create a climate of confidence for the customers, and to support them by supplying reliable systems.

Another concept is heat contracting, i.e. the utility owns a heat pump supplying one or more buildings; operation and servicing is carried out by the utility and the customer only pays for the heat used. In multi-family houses a proper heat source can become a problem due to high costs, because in many cases vertical ground heat exchangers are the only efficient heat source. Utilities can supply these heat source systems, and vertical ground heat exchangers (down to a depth of 240 m) are being installed at reasonable cost.

In some communities, small district heating systems based on biomass are popular. One reason for this is that subsidies are available from the European Union. However, to construct an efficient system, not everyone (especially those living in the outskirts) can be connected to the district heating line. These customers could also use heat pumps supplied via the electric grid and charged by the combined heat and power system. They pay for the heat supplied, at the same tariff as customers connected to the district heating system.

As one can see there are interesting ways to establish heat pump systems in the marketplace. Unfortunately, such programmes are only initiated by the electric utilities. Up to now, gas utilities, which have also been deregulated, have not yet discovered the heat pump.

Source: Austrian National Team

Scandinavia

In Sweden, the government does not provide incentives for heat pumps, but they support RD&D projects in various heat pump technologies. They cooperate with industry and utilities in the Climate 2000 programme, as described in the IEA Heat Pump Centre Newsletter, No. 3/Volume 16. A Swedish heat pump design competition was supported by the government in 1995. Two years later, this same instrument (heat pump system competition) was used for residences in the Netherlands.

In Norway, heat pumps have a relatively poor penetration in the market. In order to improve general acceptance of heat pump technology in Norway, the Norwegian National Team has systematically been providing unbiased and targeted information to cabinet ministers, politicians in general, government officials, environmental organisations, utilities and energy conservation centres, as well as a number of organisations and companies dealing with energy-related matters. Over a period of three years (1996-98) this marketing campaign has been successful in putting heat pumps back on the political agenda. However, no government subsidies for heat pump installations were granted during this period, but some energy utilities regard heat pumps as an interesting technology for energy conservation and peak shaving (demand-side management). From 1995 to the present, a few utilities have been offering 20-30% subsidies for heat pump installations in commercial and/or residential buildings, and more utilities are expected to follow in near future. More details on the Norwegian approach can be found in the box on page 15.

D-A-CH

In Switzerland heat pump promotion activities have taken place since 1991 as part of the ambitious energy efficiency programme Energy 2000. These activities were initiated by the government. Today the utilities also play a very active role in promoting heat pumps, as can be seen from the article on page 17. Utilities often cooperate with the local and federal government. These joint activities have resulted in a steadily growing

▼ *Figure 2: German support guidelines for electric-driven heat pumps for space and tap water heating as of 1 January 1997.*

- Government grant
  USD 180 / kW
  up to 15 kW heating capacity

  USD 60 / kW
  above 15 kW heating capacity
  maximum amount USD 12,000

- Conditions
  - refrigerant: H-CFC free
  - seasonal performance factors
    air/water systems:
    1997: above 3.2
    1998: above 3.3
    brine/water and water/water systems:
    1997: above 3.5
    1998: above 3.8

The seasonal COP is verified (certificate) by the installer.

Japan

Since the oil crisis in 1973 dealt a substantial blow to the energy supply in Japan, heat pumps have been promoted for space heating and cooling of residential and commercial buildings and for industrial use because of their energy conservation potential. Governments, as well as electric and gas utilities, have been involved in the development of advanced heat pump technologies. This resulted in considerable improvements in the performance and reliability of heat pump technologies, which in turn contributed to the growth of the heat pump market in Japan.

As far as promotion of heat pumps is concerned, the Japanese government used only limited incentives to promote large commercial and industrial heat pumps. These instruments included tax incentives for corporation tax and special depreciation schemes. The widespread use of air conditioning in summer caused a serious decline in the electricity load factor. This is a serious problem for the energy supply sector in Japan.

To cope with this issue, the government has promoted heat pumps with thermal storage and gas cooling systems in summer, while gas and electric utilities have developed a special electricity and gas tariff structure.

The most important current government support is a subsidy for the installation of heat pumps with ice thermal storage systems, gas engine heat pumps and gas cooling systems for small commercial buildings, which became available in July 1998.

Source: T. Yoshii and K. Yamazaki, Heat Pump Technology and Thermal Storage Centre

The Netherlands

Marketing heat pumps is a complicated business, since purchasers differ from heat pump to heat pump. As heat pumps are not uniform products they have different types of buyers with differing needs.

The government's energy policy makes it clear that the number of heat pumps in the Netherlands should increase, mainly because of the energy that can be saved with heat pumps. Novem implements this policy, and the promotion of heat pumps is targeted towards energy saving. On the other hand, energy prices are relatively low, giving a negative impact on the payback periods of heat pumps.

Taking into consideration four aspects of marketing (product, place, promotion and price), the major spearhead in marketing strategies is price reduction. The government offers a tax reduction for investments in heat pumps, which results in a net profit (around 15%) on the investment costs.

Energy distribution companies have their own subsidies to promote the implementation of heat pumps. These vary from company to company, but are around USD 500 per heat pump system. Manufacturers in the Netherlands have founded the Dutch Heat Pump Association, which actively promotes heat pumps and focuses on removing market barriers.

It is important that the promoting parties emphasise the benefits of heat pumps that fulfil the needs of the buyer. For some commercial segments of the market, i.e. offices and swimming pools, the heat pump is already selling itself on its own merits. However, in the residential sector these qualities are not clear enough for clients to justify the high price. Therefore the heat pump should be promoted as a high comfort heating system, as the successor of the currently used gas-fired condensing boiler. More in-depth information on marketing of industrial heat pumps can be found in the article on page 20.

Source: Bram van Straalen, Dutch National Team

Figure 3: Financial measures and conditions for heat pump promotion by RWE Energie AG Essen, Germany.

Special contract for electric heat pumps:

- Electricity tariff
  - reduced fare: USD 0.05/0.07 per kWh
  - rating and switching price: USD 43 per year
- Utility grant
  - one- or two-family houses:
    USD 1,200 heating only
    USD 1,800 heating + tap water
  - multi-family houses (per apartment):
    USD 600 heating only
    USD 900 heating + tap water
- Conditions
  - refrigerant: CFC or H-CFC free
  - seasonal performance factor: above 3.2
  - centralised heat distribution system
  - certificate according to EN 255

residential market, with the well-known figure of one-third of newly built residences being equipped with a heat pump. However, the commercial market is rather low and fluctuating. Several efforts have been made in cooperation with Germany and Austria. Since October 1998 the heat pump quality label has been available in all three countries. In Austria electric utilities have discovered the heat pump market and developed heat pump promotion programmes. More details on the situation in Austria can be found in the box on page 23.

New government programmes in Germany were initiated in 1997. The subsidy scheme is shown in **Figure 2**. The government still supports research on heat pumps and the information centre IZW. Utility activities have increased over the past few years. Several utilities now promote heat pumps and the VDEW is also involved in strategic and operative heat pump marketing activities. The market has been steadily increasing since 1992, probably resulting from efforts by German utilities. An example is the RWE Energy Essen programme, which since the start of the support programme in 1993 has doubled every year the number of promoted heat pump plants from 25 in 1993 to 553 in 1997 using the subsidy programme described in **Figure 3**.

Switzerland

The Swiss Energy 2000 programme has achieved some remarkable improvements over the past eight years, including 4,300 new jobs, a reduction of USD 331 million in external costs and a 4% reduction in CO_2 emissions.

A total of 885 GWh_{th} of ambient heat was used in 1997. During the E2000 programme from 1990 on, an increase of 328 GWh_{th} could be achieved, mainly by using heat pumping technologies.. The E2000 programme will be completed by the year 2000, although an Agency for the Use of Renewable Energies is being founded to continue along this path. Funding could be achieved by a CO_2 tax of USD 0.04/kWh on non-renewable energy. However, this tax is still under discussion by the Swiss parliament.

The Swiss Association for the Promotion of Heat Pumps (FWS) achieved a 24% increase in heat pump sales by the end of 1997. The promotional activities that have been most successful include open days and a new programme known as "marketing coach". This free service by FWS is directed towards installers and electric utilities, where one-day workshops allow discussions of relevant topics such as:

- how do market changes influence our company ?
- do we know our strengths and weaknesses ?
- new marketing ideas.

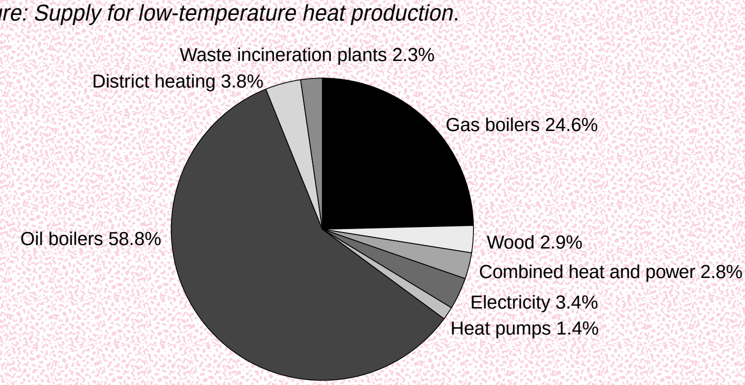
Together with the achievements of the heat pump test centre in Winterthur-Töss and the new Quality Label for Germany, Austria and Switzerland, quality assurance can now be given to the increasing number of heat pump users.

Electric utilities have also recently started to promote heat pumps. Two examples are described in the article on page 16. The Promopac programme in west Switzerland was also quite successful. In 1996 some utilities in the cantons of Vaud, Geneva, Fribourg, Neuchâtel and Wallis embarked on a programme to support heat pump installations in their regions. Heat pump contractors cooperating in this programme are very satisfied with its success. In November 1997, one year after the programme began, the aim of supporting 1,000 heat pump installations has already been reached. The programme had a total budget of USD 2.3 million and makes use of financial incentives as well as more general promotional activities. The subsidy (USD 140/kW thermal) amounts to at least USD 1,600 per heat pump.

Approximately 55,000 heat pumps are now installed in Switzerland, saving 100 million litres of oil, 700,000 metric tons of carbon dioxide and 600 metric tons of nitric oxide. However, there is still great potential for heat pumping technologies since, up to now, only 1.4% of low-temperature heat production is via heat pumps (see **Figure**).

Source: Thomas Afjei, Swiss National Team

Figure: Supply for low-temperature heat production.



UK

The UK government supports energy-efficient equipment and applications in general programmes, but there is no specific promotion programme for heat pumps, except for the Industrial Heat Pump Technology Forum. The aim of this forum is to promote industrial use of heat pumps, to transfer technology and to bring together interested parties. These parties include the government, utilities, manufacturers, academics and consultants. The Heat Pump Association (HPA) brings together utilities, manufacturers and trade associations to promote the benefits and proper use of heat pumps and heat pump technology. Only one gas utility has recently started to promote gas-fired heat pumps.

France

France has seen a significant improvement in the promotion of heat pumps and reduction of pollutant emissions by the government and utilities. In 1992 there were no heat pump stimulation programmes in France, but since 1996 there is one government programme which is part of a larger programme for reduction of pollutant emissions, mainly in industry. Financial incentives are used by the electric utility EDF. The gas utility GDF promotes absorption heat pumps.

The Netherlands

Heat pumps in buildings have not yet gained a substantial market share in the Netherlands. This is mainly caused by the high investment costs and the relatively low gas price which benefits competing systems such as gas condensing boilers. The main government instruments to promote heat pumps include financing R&D, tax reductions and demonstration projects. At the same time Novem and the Ministry of Economic Affairs are aiming to orchestrate an agreement between the various parties in the market and formalise this in a so-called ‘covenant’. This approach has been successful with, for example,

Norway

The Norwegian heat pump market has been rather invariable over the last five years, with an annual installation rate of approximately 1,500 units, corresponding to 0.2 TWh/year. However, in 1997 nearly 2,000 units were installed, representing a 30% increase compared with 1996. The improved market situation for heat pumps in Norway is due to a number of reasons, including a low interest rate (1997), favourable energy price level, incentives from certain market parties and a renewed awareness of the benefits of heat pumps by the government as well as by the HVAC/heat pump community in general. Besides the utility measures that are described in the main article, some of the regional energy conservation centres in Norway have also been marketing heat pumps (in combination with hydronic heat distribution systems) as profitable and environmentally benign heating systems for the future.

Periodic power shortages in the Norwegian hydropower system as well as national commitments to the Kyoto Protocol, have addressed the importance of renewable energy sources for electricity and heat production, as well as energy conservation in buildings and industrial processes. The efforts of the Norwegian National Team of the IEA Heat Pump Centre to put heat pumps back on the political agenda, were quite successful. In 1997 the White Paper from the Department of the Environment set specific plans for the future utilisation of bioenergy and heat pumps in Norway (goal: 5-10 TWh heat production over the next 10 years). Most political parties now consider heat pump technology as an important tool for energy conservation and reduction of greenhouse gas emissions. In 1998 the government granted USD 1 million to support new heat pump installations in combination with hydronic heat distribution systems. In April a parliamentary committee formally called on the government to establish a strategy plan for increased utilisation of heat pumps in Norway.

The strategy plan, entitled “The Norwegian Energy System Towards 2020” includes heat pumps as an important part of its energy conservation measures. Heat pumps are viewed as renewable energy. New and more extensive subsidies for renewable energy and energy conservation measures, including heat pumps, are expected in the 1999 state budget. New market stimulation programmes for heat pumps may also be introduced.

There are virtually no heat pump manufacturers in Norway. However, heat pump suppliers for the residential and commercial sectors have been marketing their products by focusing on the following items:

- profitability, via reduced annual energy costs. The payback period is 5-8 years for residential installations and 2-5 years for installations in commercial buildings;
- low maintenance costs and long economic lifetimes for geothermal heat pump systems due to the use of closed (indirect) evaporator systems in combination with low-temperature heat distribution systems (low-temperature lifts and very stable operating conditions), as well as (reliable) factory assembled heat pump units;
- improved indoor environment compared to direct electric heating when installing reversible air-to-air heat pumps with electrostatic filters for combined heating and cooling operation, or air-to-water and brine-to-water heat pumps in combination with low temperature hydronic heat distribution systems (radiators or floor heating systems);
- improved local environment (no emissions of particles) and improved global environment (no CO_2, SO_2 and NO_X emissions) when heat pumps are installed as alternatives to oil/gas-fired boilers, wood-fired systems or direct electric heating based on imported electricity from Sweden, Denmark or Germany (coal-fired power plants).

Source: Jørn Stene, Norwegian National Team photovoltaics. In the agreement manufacturers, government, utilities, research organisations, installers and representatives of the building sector will together develop measures for increased implementation of heat pumps.

In 1997 a heat pump competition was organised, which was described in the IEA Heat Pump Centre Newsletter, Vol. 15/03. The box on page 13 describes the situation in the Netherlands in more detail.

Conclusion

The descriptions of the approaches in different countries show that many parties realise the importance of using heat pumps to obtain a more sustainable energy supply. The boundary conditions of technical and economic feasibility of an increased number of applications are improved by the marketing efforts of manufacturers, utilities and the government. Technical barriers are removed by using standardisation, regulations and support of R&D, while economic barriers are being removed by tax reductions, subsidies, reduced tariffs and other financial incentives. Other market barriers, such as lack of awareness and perception of the technology by the target groups, are addressed by measures such as demonstration projects, information centres, quality labels, heat pump competitions. A new approach which is taken in the US, Sweden, Switzerland and the Netherlands, is establishing collaborations in which different parties cooperate to accelerate the implementation of heat pumps.

In spite of the many different approaches that have been taken, this has not resulted in a ready-to-use solution that can be applied in every case. A heat pump marketing strategy should be developed to remove barriers in a specific market situation. However it can be taken as a promising sign for the future that more and more parties are acknowledging the importance of heat pumps and that cooperation is improving.

Hanneke van de Ven,
IEA Heat Pump Centre

USA

The construction market in the United States has been on a long-term, record-setting trend. The residential construction and heat pump market have advanced along with the expanding economy. A record 257,000 heat pumps were installed in new single-family homes during 1997.

This growth is continuing, as seen in the Table below. US factory shipments of air-conditioners and air-source heat pumps in July 1998 represent a 35% increase over July 1997. The shipments in the first seven months of 1998 are 15% ahead of last year. Heat pump shipments in July 1998 were 129,164 units, which was a 23% increase over last July. Total 1998 shipments to date are up 10% compared to 1997.

The growth being experienced in the unitary heat pump market has come amid significant changes. Major utility incentives have declined. Some utilities have reduced or eliminated rebates and incentives altogether as they pass into a less regulated "competitive market" environment. This is likely to continue. On the other hand, consumers are better informed. They have the disposable income to afford the higher efficiency heat pump systems, but they demand cost justification. Consumers want to know the benefits and the value of high efficiency heat pumps to justify their purchase. Contractors have responded with much clearer manufacturer-supplied literature that displays the operational cost savings compared to other options. Contractors are also improving their communication skills, providing facts not only in a technical manner, but in a practical understandable way.

Another significant change is the consolidation being experienced throughout North American heat pump distribution channels. This is bringing a more efficient flow of equipment from the factory to the consumer. Many distributor/wholesalers have joined under one banner, and contractors/dealers (installers) are joining forces to form new corporations at an even greater rate to create streamlined multi-state operations to better meet consumer's comfort needs.

The future promises continued growth for heat pumps in North America.

Source: Dave Lewis and Jim Crawford

Table: US shipments of air conditioners and heat pumps for 1997 and 1998.

Systems	July 1997	July 1998	Jan-Jul 1997	Jan-Jul 1998
AC & HP	539,796	728,725	3,618,816	4,161,639
HP only	105,011	129,164	708,000	779,246

Note: Industry shipment information is based on ARI September 1998 News Release.

References:
[1] *Energy Technology: the next steps*, Directorate General for Energy (DG XVII) of the European Commission, 1997

[2] *Update of the heat pump status and policy review*, IEA Heat Pump Centre, due to be published February 1999.

[3] *Internet site of the European Heat Pump Network*, http://www.fiz-karlsruhe.de/hpn

Heat pump promotion by utilities in Switzerland

Alfred Bürkler and Willi Gassert, Switzerland

In Switzerland heat pump sales are relatively high compared to other countries. Around one third of the new houses are equipped with a heat pump (for space heating). Utilities have played an important role in promoting heat pumps. This article evaluates the policy of a utility from the eastern part of Switzerland, the St.Gallen-Appenzell Power Company Ltd (SAK). The last section briefly describes a different approach by a utility from the western part of Switzerland (Electric Utility of Fribourg; EEF).

Since its introduction in autumn 1993, SAK's promotion strategy for heat pumps has consisted of three parts: providing information, a customer service package, and improving the cost-effectiveness of heat pump systems. This policy was described in detail in an HPC Newsletter article in June 1994 "A Power Utility's Strategy for Heat Pump Promotion". It is summarised below, along with its strengths and weaknesses.

The first important aspect of the programme is to inform building owners and those responsible for the design of heating systems (architects, engineers and installers) of the advantages of using heat pumps. Secondly, SAK offers an extensive service package to reduce the risk of the building owner making a wrong decision. This means that SAK takes full responsibility for the heat pump system offered to a customer. The package includes the design of an optimum system, obtaining the permits, installation, user training and service support. Thirdly, measures are taken to improve the cost effectiveness of heat pumps. This is achieved in two ways: through an investment contribution of USD 190 per kW thermal capacity (maximum USD 4,800), and by offering a reduced electricity tariff in exchange for the opportunity to remotely switch off the installation during peak load periods.

SAK's strategy is targeted towards promoting heat pumps for space heating in new single-family houses and small multi-family buildings. Because of its high COP, the first heat pump considered should be the monovalent ground-coupled heat pump. Five years of promoting this heat pump has brought some excellent successes, but has also highlighted a few weaknesses.

Successes

A first indicator of the success of this strategy is that the market share for heat pumps in new single-family houses is almost 50% in certain parts of the three cantons covered by SAK. The company has installed 340 heat pumps with a total thermal capacity of 4 MW. Therefore the decline in electrical resistance heating has been compensated by installing new heat pumps. These figures refer only to the region in which SAK supplies equipment directly to its customers, i.e. around 20% of the three cantons. The rest of the region is supplied by resellers. Two-thirds of the installed heat pumps are air-to-water types, with the remainder being brine-to-water heat pumps with ground heat exchangers. In a few individual cases water-to-water heat pumps were installed, using ground or surface water.

Nearly half of the new heat pumps installed in the region since 1993 were sold by SAK. The comprehensive service package, from the consultancy phase to monitoring efficiency, was a determining factor in the success of this direct marketing campaign.

End-users and the main decision makers responsible for selecting heating systems were approached by using various marketing techniques. Concentrating these efforts proved to be successful.

In its supply region SAK enjoys a high level of acceptance and confidence, which has now been transferred to heat pumps. Customer surveys prove that extensive contact with customers, excellent service during installation and the after-sales service are in line with customer requirements.

This heat pump promotion strategy acted as an example to resellers in the supply region and the other canton suppliers. After some initial resistance, a heat pump tariff has been accepted by the resellers.

Although there is a lower tariff for equipment that can be switched off, the gross margin for the utility (e.g. a single-family house with heat pump and electric boiler) is still twice that of a comparable customer without a heat pump. This is due to the higher electricity consumption.

A positive external factor that contributed to the success of the promotion programme was that the prices for heat pumps and vertical borehole heat exchanger drillings have fallen sharply over the past five years. The seasonal performance factors of heat pumps have also continuously improved. Both items improve competitiveness.

Weaknesses

Some weak points have made the promotion difficult and sometimes hindered the campaign.

Firstly, heat pump promotion could only be implemented in regions where SAK supplies customers directly (20% of the supply region). In other regions, business is conducted and, in particular, tariff arrangements are left to the resellers. But customers do not find it logical that different conditions apply for neighbouring villages. SAK can only recommend that resellers promote the use of heat pumps in their area using identical or similar measures. Although this is time consuming work, initial successes have been achieved.

The proportion of heat pumps in new buildings is already significant. However, there is greater potential in renovating old buildings, though here the proportion is still low. Good technical and economic solutions for using heat pumps in renovation projects are still lacking.

The final obstacle is that the approval procedure is time consuming and costly, especially for brine-to-water heat pumps with vertical borehole heat exchangers or water-to-water heat pumps using ground water. For example, for each borehole drilling the services of a geologist are required. For using ground water, a concession is necessary and a charge is levied for each cubic metre of water, thus further impairing the cost-effectiveness compared to conventional heating systems. This partly explains why these systems are hardly ever used, in spite of their high coefficient of performance.

Outlook

Most energy in the domestic sphere is used for room heating and hot water production. Customers have a choice between systems fuelled by oil, gas or electricity. The competition in this market is strong. For the North-East Switzerland Power Company (NOK), the canton and local power supply companies, the income from the comfort heating market is very important. They have therefore jointly prepared a package of measures for expanding their market position in the heating sector throughout the entire region (total population of two million). The focal point of this package is heat pump promotion.

The promotion measures include image building, with a national campaign entitled “the heat pump is a non-smoker”, plus founding the North East Electric Power Information Centre as a starting point for customer information and distributing specialist information to decision makers.

Another measure was to harmonise the investment grants over the entire supply region. A grant of USD 180 per kW installed thermal capacity (to a maximum of USD 18,000) was agreed. Applications are submitted to the North East Electric Power Information Centre which pays the investment grants directly by cheque.

To stimulate the participating power companies, 474 in total, NOK is granting a peak load tolerance of 80% of the heat pump’s installed electrical capacity, thus substantially reducing the per kW peak load charge. However, the heat pump must be designed to be switched off at least twice a day for one hour during peak load periods.

The package is being expanded during the winter and a comprehensive product is being offered, similar to the SAK service package.

SAPAC

In the western part of Switzerland, the Electric Utility of Fribourg (EEF) took a different approach to promote heat pumps. In 1985 a new company, SAPAC (corporation for heat pump applications) was established by EEF, although its main aim was changed in 1993 to *production and promotion* of heat pumps as well as complementary electrical installations in buildings. The reasons for incorporating the production in SAPAC were to have everything in one place, keep production costs under control, and be independent of external suppliers. Additional shareholders joined later: two energy companies and an industrial services company. In 1996, in cooperation with two German firms, ERSET, an experienced French heat pump manufacturer, was acquired.

SAPAC offers several services to their customers free of charge, including the calculation of heat demand, planning and sizing of the heat pump, applying to canton offices for permission to drill the borehole of the vertical heat exchanger and estimating annual operating costs based on electricity tariffs. SAPAC also offers an automatic counter for energy consumption. This allows customers to compare the preliminary estimate with the actual operating costs.

This strategy should lead to a cleaner environment using heat pumps, and to a technological and market leadership for SAPAC, with further expansion into other parts of Switzerland.

Conclusions

Two different approaches have been taken towards promoting this technology. After five years of heat pump promotion SAK has incorporated its experience into a package for the entire region, while SAPAC’s policy is to integrate production, promotion and installation of heat pumps. Both methods indicate that heat pumps are being promoted in a new and future-oriented way. “Other heating systems have tradition, but the heat pumping has a future!”

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Heat pump and thermal storage promotion activities in Japan

Tetsushiro Iwatubo, Japan

Japanese electric utilities are facing the problem of a high peak demand in summer because of the electricity consumption of air conditioners. This has motivated the Japanese government, in cooperation with electric utilities and gas utilities, to start various activities promoting the use of thermal storage (in combination with heat pumps) and gas-driven heat pumps. These promotional efforts include subsidies which give clear cost benefits to the heat pump owner. This articles describes the background of these subsidy systems and practical activities designed to influence the market situation in Japan.

In Japan heat pumps have a high market penetration. Annual domestic shipments of residential reversible air conditioners amount to almost 8 million units with an electricity capacity of around 1 kW under average operating conditions. If we include the units for commercial applications, it is clear that the total electricity demand from heat pump technology is substantial.

Small decentralised systems, such as packaged air conditioners, are the most popular. Small packaged air conditioners were also recently installed in a large building (almost 5,000 m^2 total floor space). The use of smaller types is financially attractive because they benefit from mass production.

Electricity demand

Power consumption has increased steadily over the years. The peak demand in summer (of which air conditioning accounts for 40%), has also increased. To make matters worse, the difference between demand in peak periods and off-peak periods is still increasing, both for the daily and yearly demand curves. **Figure 1** shows the daily load curve in a peak demand day of each year. In 1966, the peak demand occurred in winter, but moved to summer after 1971. This peak demand became a very serious problem for Japanese electric utilities: the load factor reduced from 70% in the 1950s to below 55-60% in the 1990s (see **Figure 2**). This very low load factor is one of the reasons for the relatively high electricity price in Japan.

Promotion

The Japanese government formulated an energy policy which aims to “reduce the electricity prices to the same level as in the USA or Europe”. Two bodies were established as a result of this policy: the Energy Countermeasure Promotion Cabinet Council and the Electric Power Industry Council, Load Equalization Countermeasure Investigation Subcommittee. Both the council and the subcommittee have selected promotion of heat storage systems and gas-driven heat pumps for air conditioning as one of the measures for load factor improvement and load levelling. Various subsidies and support measures are provided for further diffusion and promotion of these systems.

Data on the promotion plans for heat pumps combined with thermal storage are summarised in **Table 1**. A distinction is made between existing (conventional) technology and new technologies. For conventional technologies mainly regulations (but no subsidies) are used to influence the market. An energy-saving law is now in force in Japan, not only because of the peak demand issue but also to achieve carbon dioxide emission reductions. The regulation of conventional technologies is not a marketing measure, but an effective measure to deploy energy-efficient heat pumps.

Government assistance

The government uses three supports systems: tax deductions, loans with very low interest rates, and subsidies to the system owner (see **Table 1**). In the past, tax deductions were preferred, but nowadays subsidies form the predominant method. The subsidy

▼ *Table 1: Measures for promotion of heat pump technology.*

Targets	Measures	By
Conventional technology	- Regulation by energy law	Governments
	- Tax deduction system for energy-saving system	Governments
New technology (small markets)	- Loan systems for ice-storage system and gas heat pumps	Governments
	- Subsidy system for ice-storage system and gas heat pumps (to system owner)	Governments
	- Subsidy system for ice-storage system (to manufacturers)	Electric utilities
	- Support system for gas driven heat pump	Gas utilities

system was started in April 1998. Similar measures were also taken for ice-storage and gas systems. For ice-storage systems the government will credit 50% of the difference between the purchase price of an ice-storage system and the market price of a conventional system. The budget for 1998 is USD 2.3 million for ice-storage and USD 1 million for gas systems.

Utilities

Electric utilities most important support system for ice storage consists of subsidies to manufacturers of small ice-storage systems. These measures were taken before the government subsidy system began. Electric utilities certify the systems and decide upon the size of the peak-shift in kW. Rates paid to the manufacturer vary from USD 230 to USD 380 per kW peak-shift. Gas utilities use various support systems for gas-driven heat pumps, such as certification and performance evaluation.

There should be little difference between the support of electric and gas utilities so that one technology is not favoured more than the other. This is important because electric utilities never sell heat pumps including an ice-storage system, while gas utilities sell not only gas but also gas equipment. Therefore gas utilities are in a strong position to market their gas-driven heat pumps.

A traditional problem when marketing heat pumps is that there will be no mature system designs without a mature market, but market sizes cannot be predicted without knowing the performance of the system. For the Japanese market in particular, competing systems (conventional heat pumps), are already cost-efficient due to mass production. The measures mentioned in this article are not only meant to stimulate the demand side of the heat pump market, but also to stimulate production investments by manufacturers. This is an important difference between the situation in Japan and that in some other countries.

Figure 1: Changes in daily electricity curves in peak demand day.

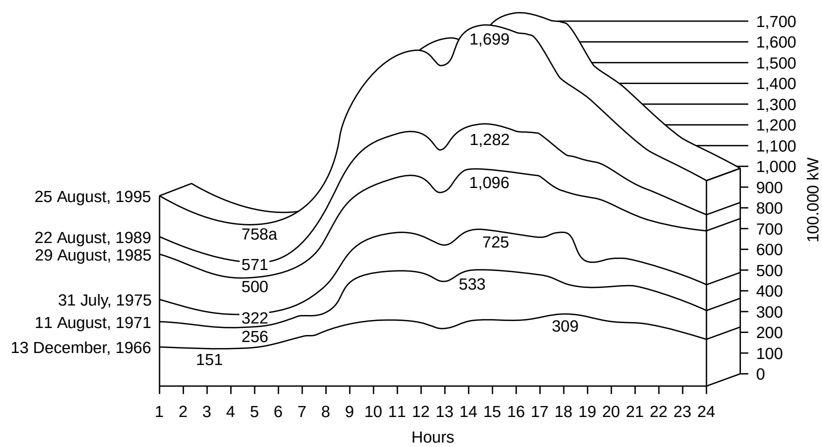
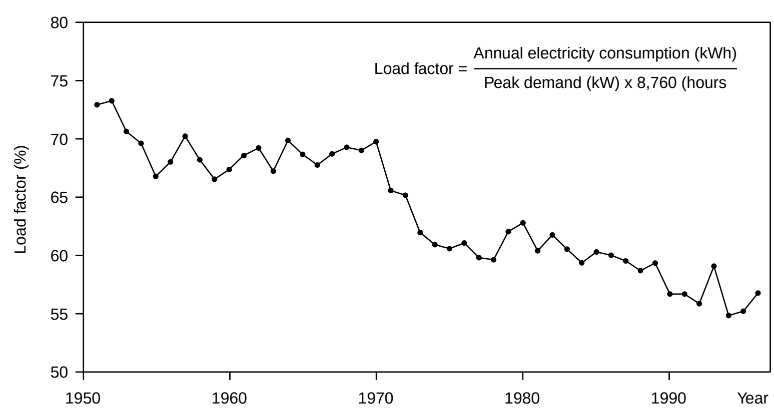


Figure 2: Trends of annual electricity load factor in Japan.



Conclusion

Because of the many problems concerning the peak demand issue, there are many different support systems for thermal storage and gas heat pumps in Japan. Not all information given will be applicable for other countries, due to the different market conditions. However, the Japanese promotion programmes for new technologies, such as thermal storage systems and gas-driven heat pumps, are a good example of an explicit promotion strategy for increased used of (specific types of) heat pumps.

This article gives only a few examples of supporting measures, although frequent changes in support systems occur. For more detailed information, please contact the Heat Pump & Thermal Storage Technology Center of Japan (HPTCJ), which deals with some of the measures mentioned in this paper (address on back cover).

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Marketing MVR heat pumps in the chemical industry

Onno Kleefkens, the Netherlands

A policy to increase the use of MVR heat pumps in industry can only succeed if both the supply and demand sides of the market are balanced. This balance does not exist, either in the Dutch market or in some other European markets. A survey undertaken by Novem (Netherlands agency for energy and the environment) among key players found that there is to a lack of supply/demand mechanism in the market. Manufacturers, consultants and contractors are not actively pushing the MVR (mechanical vapour recompression) heat pump concept, and users are not demanding heat pumps for their process plants. In order to stimulate the market the attractiveness of heat pumps needs to be increased. Government policy aimed at using more heat pumps to meet the targets set at Kyoto, should be aware of existing market mechanisms. Lessons from this study can also be applied to heat pumps in other sectors.

The marketing manager of a famous perfume once said “We don’t sell perfume, we sell beauty”. That is real marketing, because the product offers what people really want.

A marketing survey carried out for Novem by TSM Business School covered MVR heat pumps in the chemical industry. One of the main conclusions was that MVR is not a ‘real’ product, but rather a concept or an engineered solution. Both end-users and major consultancies perceive the MVR concept to be difficult and expensive, compared to other technologies. Marketing efforts need to move this perception towards a more positive attitude in a market which is not actively demanding heat pumps. The heat pump concept should focus on the needs of the customer.

Industrial market

The main parties in the industrial market for MVR systems are: suppliers, manufacturers, contractors, consultants, end-users and government. Heat pumps are not a ‘product’: important suppliers in the chemical industry are selling components (e.g. compressors or heat exchangers), which are tailor-made for the system by contractors designing the plant. Sometimes, mainly with new installations, the heat pump is part of a larger installation, such as a distillation column. The industrial heat pump market is not attractive to suppliers; their main business lies outside this market, so the supply mechanism is not optimal.

On the demand side, industrial end-users in the chemical industry are reasonably aware of heat pumps, though expectations that they are not economically attractive hinder implementation. Competing energy-saving technologies, such as combined heat and power (CHP) are not a part of the process, simple to design and install, and economically attractive in the existing tariff structure. CHP systems are also installed by utilities and financed under very favourable conditions for the end-user, giving lower variable costs and no problems. For existing installations in particular, the perception of expected difficulties in integrating heat pumps into the chemical process is considered too high.

Nevertheless heat pumps have been installed for chemical processes in the Netherlands, e.g. at Shell, Hoechst, ARCO and PURAC. These were mainly new processes for market innovators. Energy savings were not the main reason for heat pump installation. Aspects such as process improvement and full utilisation of capacity are also important considerations.

Decision process

The survey made several recommendations to balance the market for MVR in the chemical industry, by working on both the supply and demand mechanisms. End-users play a crucial role. An analysis of company decision processes showed that the basic factor which determines the success of a heat pump project is the payback period. There can be many side effects influencing the cost effectiveness of a project. These can be so important that a heat pump project does not even reach the financial decision phase.

Besides cost effectiveness, other important factors influencing the decision-making process are:

- *awareness*: to what extent is the user familiar with the latest technical details and solutions, potential benefits and risks, experiences, etc? Large companies score high on the awareness scale;
- *opportunity identification*: a pinch analysis was carried out for specific plants at most of the larger companies. However, the opportunities found were generally considered too small to warrant installing a heat pump;
- *technical feasibility*: this is considered in combination with the surrounding processes. The complexity of the heat pump solution and the associated risks involved are considered high, especially where heat pumps are considered in a retrofit situation. The estimated risks are mainly based on the perceptions of non-users;
- *availability of heat pump solutions*:

solutions are generally tailored to the industrial application. End-users consider the heat pump a speciality ‘for others’ but not for ‘their’ process;
- *non-economic aspects*: environmental aspects are increasingly important for heat pumps (reduced use of ground water for cooling, reduction of waste heat and noise). Other aspects involve public relations and long-term agreements on energy conservation between industrial sectors and the government;
- *decision-making process*: in large companies the process of making technical and economic decisions goes through many levels. The more levels are involved, the more difficult it will be for a complex technological solution to be chosen.

Strategy

If end-users are not willing to install heat pumps, should the government consider legislation to reach its energy targets? The social costs of heat pumps expressed in costs per ton of CO_2 emission reduction are relatively small compared to, for example, CHP or wind energy. However, due to the tariff structure of existing market prices for gas and electricity, CHP is far more attractive (economically) than heat pumps. This market imbalance cannot be corrected easily without threatening the competitiveness of the Dutch economy. The challenge for the government is how to reach its goals on industrial heat pumps, besides using legislation, without disturbing the market?

TSM Business School advised three general governmental market intervention strategies:
- reduce installation costs;
- give subsidies and grants;
- increase market pull.

Depending on the market development the government uses a flexible mix of intervention to achieve its goal of stimulating the heat pump market.

To illustrate how the supply/demand mechanism could be improved, the situation for MVR in new and existing processes is described below.

New installations

Installing a heat pump in a newly designed installation is not common practice for the majority of the market. Heat pumps are generally offered by the supplier as an optional add-on technology. Considering the extra costs the end-user often decides not to install a heat pump as his energy costs based on steam production by a CHP plant are relatively low.

The suppliers’ strategy could focus on integrating the heat pump into the installation or distillation process and emphasise advantages other than energy conservation. Thus a competitive, efficient and environmentally friendly process technology can be offered. Government strategy could focus on environmental aspects, such as lower production of waste heat. By comparing the proposed installation with the best available technology, guidelines can be given on which technology to choose. The government then becomes an important party in the market and a new market balance is created in which the demand for heat pumps will increase. However, due to a lack of existing legislation the government is not able to act in this way. Only tax reductions are currently being offered.

Retrofit

Existing installations are a difficult market segment for MVR heat pumps. They are only in the first phase of market implementation, so the target group consists of innovators. Important market parties on the supply side (consultants and contractors) should develop heat pump concepts in close collaboration with the innovators on the demand side.

The gains with MVR are considered too small to redesign the process to accommodate a heat pump. Yet installations are regularly overhauled and revamped, which gives suppliers and the government the opportunity they need. The direct costs of installing the heat pump are then integrated into the costs of the overhaul. As these installations are almost always tailor-made, further costs can only be reduced by standardising procedures in the preparation and contracting phase.

Instruments

Economic considerations on the demand side must include the effects of process improvement and full utilisation of capacity, while the reduction in cooling load is an important environmental aspect. A strategy should be developed to position the heat pump as a solution for the customer. Subsidies and grants are important direct governmental instruments to help the industrial heat pump climb this learning curve.

In the longer term, tax reductions are an important stimulus for the demand side. In the Netherlands these tax benefits are given for heat pumps and, together with soft loans, they can increase the internal rate of return (IRR) up to 40%. Financial constructions based on the loan principle are developed for those companies not paying tax in the Netherlands.

To increase market pull, new long-term agreements between industrial sectors and the government are important. These cover a 30% increase in energy efficiency in 2010, while industries also have to increase their use of renewable energy by up to 10%. Long-term agreements ensure an agreed commitment from a number of parties sharing a common goal. These agreements create new market circumstances which will automatically incorporate heat pumps as the next solution, even for existing installations, when other possibilities will have been used to their maximum.

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OKA heat pump programme - how to achieve a dominant market position

Hans Zeinhofer, Austria

Marketing heat pumps as a heating option occurs in a highly competitive environment: the space heating market is dominated by fossil fuels, mainly due to the recent price ratios. It requires a detailed marketing plan including a market analysis, definition of goals, a detailed planning process, a clear distribution policy and controlling measures to achieve a reasonable, let alone a dominant market position. The OKA marketing plan aims at a 25% market share of the residential segment of single- and two-family houses in its supply area.

In the late 1970s OKA began its first heat pump programme. In contrast to many other utilities in central Europe, OKA has identified heat pumps as a new segment in the electricity market, and not as a competitor to direct electric heating systems. Additionally, it is still an economic alternative to conventional systems using fossil fuels. Based on these considerations OKA has never reduced their electricity tariffs for heat pump operation, but has supported consumers with efficient and reliable systems.

Monitoring programmes were introduced to provide better information on heat pump systems. They have confirmed a steady increase in the efficiency of individual heat pump units and heat pump systems over the past 15 years.

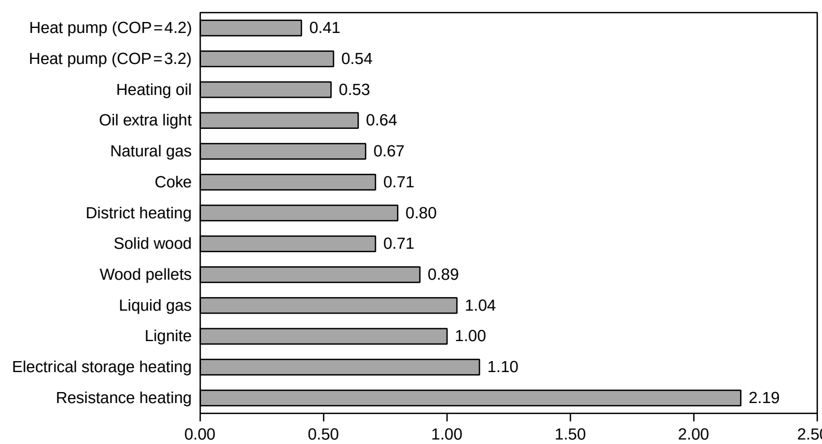
OKA decided to reinforce its heat pump installation programme by starting a new heat pump marketing plan, the so-called Kundenkontaktoffensive Wärmepumpe (customer contact campaign for heat pumps).

Market analysis

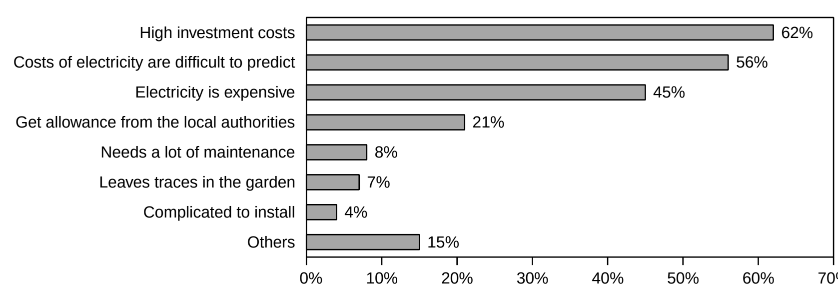
As a first step, a detailed market analysis has been undertaken. Questionnaires were sent out to all heat pump users, and the return rate was significantly high (61%). In addition, the energy price per unit of heat was determined for different heating sources, and sales figures and market shares were analysed.

The energy price per unit of heat shows a clear picture (see **Figure 1**) when only

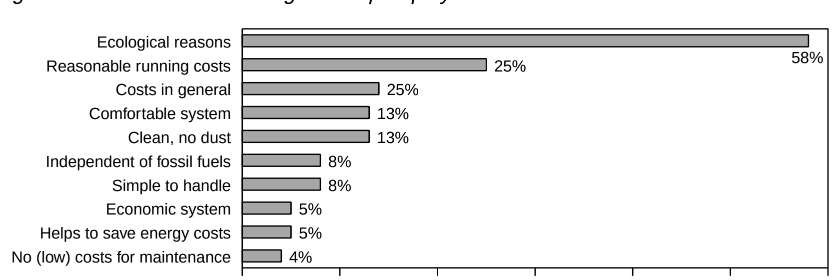
▼ *Figure 1: Prices per 1 kWh of useful heat.*



▼ *Figure 2: Valuated disadvantages of heat pump systems.*



▼ *Figure 3: Reasons for installing a heat pump system.*



the operating costs are taken into account: conventional direct electric heating systems are by far the most expensive and cannot be seen as competitive in this market segment. On the other hand, the lowest heat unit prices can be achieved by using electricity to drive a heat pump.

The sales figures for heat pumps in the OKA supply area show a stagnation, but at a relatively high level. Over the past four years there have been between 450 and 500 new installations per year, which means a market share of around 15% of the newly built single- and two-family houses. For the business year (1997/98) OKA hoped to achieve 600 new heat pump installations; up to the year 2000 the goal is set at 800 heat pump installations per year and a market share of 25%. This seems an ambitious goal, but experiences in other countries in central Europe have shown that this is feasible.

Customer survey

The most important experience gained from the market analysis was the customer research carried out during February and March 1997, involving all 4,800 customers using heat pumps as heating systems. The survey showed that the main disadvantage is the high installation cost compared to oil and gas boilers (**Figure 2**), followed by uncertainties concerning future electricity tariffs and the high price for electricity. But experience has shown that the latter was not a serious hindrance to the installation of heat pumps.

The survey also showed that the main reason for installing a heat pump was the ecological benefits for 58% of the customers (see **Figure 3**). Reasonable operating costs were given as a second reason, but this motive was far less strong.

Finally, the general acceptance and customer satisfaction with the system was really impressive: 49% of the customers stated that they were "very satisfied", while another 42% were "generally satisfied" with the performance of their heat pump. Only 2% seemed to have real problems (**Figure 4**).

Planning process

The planning process for this heat pump programme includes all the necessary measures to reach the market goals. The first step was an intensive training programme for employees responsible for customer service. This training programme focused on specifying the advantages a heat pump provides for potential customers. How to organise customer contacts was the second item in the training programme. The survey showed that this contact should be made as early as possible, at the initial planning stage of a new house.

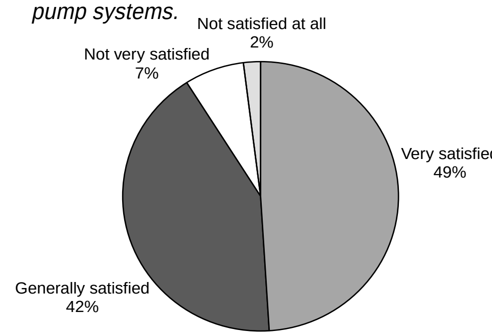
A well organised cooperation with market partners is probably the key factor that decides whether the programme will be successful or not. As OKA does not install the systems directly, it needs to attract competent installers as partners. OKA has achieved these partnerships in Upper Austria: competent manufacturers and installers specialising in heat pumps and heat pump systems, are achieving relatively high and stable sales figures, which guarantee a high quality level. At the moment OKA is expanding this network of competent market partners, which has grown over the years, by motivating additional installers to become "quality partners".

As a result of the customer survey the OKA management decided to give their customers an additional subsidy for installing a heat pump. From May 1997 customers receive a refund on the interest paid for a 10-year loan of USD 1,700 to 2,600. This, combined with the subsidy granted by the Federal State (USD 2,600 per heat pump), should compensate for the higher installation costs of heat pump systems.

Dissemination policy

The next step in the marketing plan is implementing the measures planned. This means that the OKA employees act as heat pump system "sellers" by contacting as many potential customers as possible. It also means informing important target groups, using communication instruments such as printed information, direct mail, participation in local trade fairs, as well as information campaigns via printed media, radio and television.

▼ Figure 4: Customer satisfaction of heat pump systems.



In addition to the OKA programme a nationwide information campaign in the printed media has been initiated by the VEÖ, the Austrian Utility Association, to raise public awareness of the environmental advantages of heat pumps.

Quality control as a marketing tool is not described in detail. OKA now has all necessary information available on the quantity and quality of their heat pump programme. Per customer, this information includes name and address, size, type and brand of the heat pump installed and the name of the installer. This data will enable OKA to run a consistent quality control and complaint management programme to support their customers.

Summary

OKA is promoting the heat pump as an ecologically advantageous heating system, which is also economically viable from the customer's point of view. OKA believes their goal can be achieved: to become a really dominant player in the space heating market for their supply area.

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Energetic life cycle analysis of heat pumps

Gerdi Breembroek, IEA Heat Pump Centre

Heat pump technologies offer a distinct advantage over conventional heating equipment in terms of CO_2 emissions. In collaboration with ARGE Wärmetechnik, Austria, the HPC recently performed a review study to assess the benefits of heat pumps in mitigating global warming. The study also included the environmental impact of cooling and refrigeration equipment.

The study *Environmental Benefits of Heat Pumping Technologies (HPC-AR6)* identifies new developments since the publication of HPC Analysis AR01 *The impact of heat pumps on the greenhouse effect* in 1991. It reviews 21 new studies and provides extensive emission data of heating and space conditioning equipment. Thirty-four heating-only heat pumps (including three gas-fired heat pumps), 18 gas- and oil-fired boilers and seven reversible heat pumps were analysed in detail. Data on chillers and commercial refrigeration systems were also included. This renders the report a useful data source for policy makers, environmentalists and all those involved in heat pump promotion. This article provides an overview of the scope of the report and highlights some conclusions.

Energetic life cycle analysis

Emissions of greenhouse gases not only occur during the operation of heating equipment, but also during transport and distribution of the energy source, and even after the effective lifetime of the equipment (disposal). Emissions from the complete energy chain can be distinguished according to their origin:

- operation energy (white energy): for electric heat pumps, numbers for this emission source mostly refer to emissions at the power station; for fossil fuel-fired boilers, it refers to emissions from operating the boiler;
- upstream and downstream energy: this involves all emissions, primarily during mining and transport, that occur up to energy conversion (upstream) and between energy conversion and end use due distribution losses (downstream);
- grey energy: this usually includes the energy used to manufacture and maintain the equipment, and possibly as 'second-level grey', the energy required to manufacture and maintain power stations/refineries etc;
- refrigerants: including annual losses and losses at disposal of the installation.

Many new studies take all steps into account, although emission data per step is often not specified. This shows that energetic life cycle analysis has become common practice over the past few years.

Greenhouse gases

Emissions can be expressed in different ways. Extensive databases such as GEMIS, the VDEW database in Germany and the Ecoinvent database in Switzerland, often provide data on emissions of numerous substances including CO_2, CH_4, CO, dust, etc. from various types of equipment. Of these emissions, CO_2 contributes most to the greenhouse effect. Other studies express all data in CO_2 equivalents, and recalculate emissions of refrigerant and CH_4 to this one dimension. The first method has the advantage of clarity, while the second allows easy comparison using a single dimension. Emissions are expressed per kWh useful heat or as a total for the entire lifespan (TEWI, total equivalent warming impact) of the equipment. The studies in the report use all these methods, and there is no tendency towards a specific method.

Electricity generation

The CO_2 emissions of electricity generation, together with the seasonal performance factor of the heat pump, determine the emissions from operating energy of electric heat pumps. It is well known that emissions from electricity generation differ widely between countries (see **Table 2**), and sometimes also between seasons. Specification of the CO_2 emission from electricity generation is essential to allow comparison of heat pump emission data in different countries.

Heating equipment

The efficiencies of the heating equipment form a most relevant parameter when assessing the environmental impact of heat pumping technologies. The efficiencies used in the studies reviewed differed widely, see **Table 1**. However, the minimum value assumed for the efficiency of electric heat pumps and gas-fired boilers has increased since 1991, while the efficiency of oil-fired boilers has remained the same.

▼ *Table 1: Efficiency ranges of heating equipment in the reviewed studies.*

	SPF (electric heat pumps); PER (thermal-driven heat pumps); efficiency (gas- and oil-fired boilers/based on LHV) *all excluding distribution efficiency within the building*	
Heating equipment	**minimum**	**maximum**
Air-source electric heat pump	2.25	3
Water-source electric heat pump	2.8	4.42
Ground-source electric heat pump	2.8	4.5
Thermal-driven heat pumps	1.4	1.6
Oil-fired boiler	0.6	0.94
Gas-fired boiler	0.6	1.08

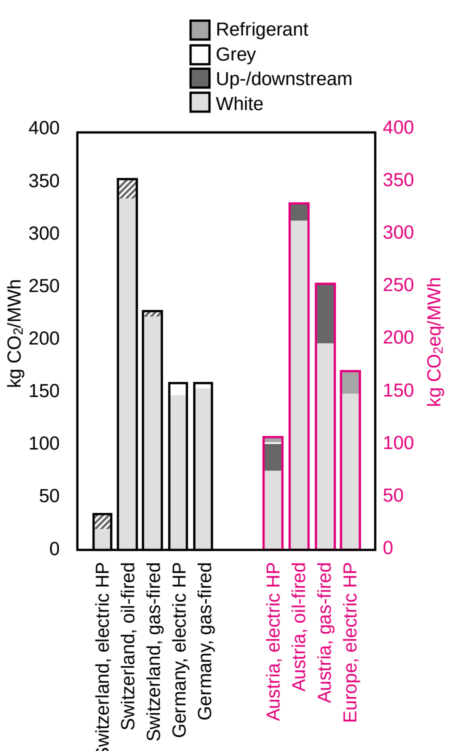
▼ *Table 2: Assumptions for analysing CO_2 emissions of heating equipment.*

	Dimension	Electricity (kg CO_2/MWh)	Details energy chain analysis: Up-/downstream	Grey	Refrigerant	SPF and efficiencies generation: elect. heat pump	oil-fired boiler	gas-fired boiler
Switzerland	CO_2	25.9	incl. in grey energy	includes up-/downstream	not incl.	3.5	0.9	0.97
Germany	CO_2	600	incl. in white energy	incl.	not incl.	4.0		1.08
		(kg CO_2eq/MWh)						
Austria	CO_2eq	294	incl.	incl.	incl.	3.1	0.94	1.04
Europe (US study)	CO_2eq	470	not incl.	not incl.	incl.	3	–	–

The energy chain **Figure 1** shows four examples of emissions from electric heat pump systems and five examples of emissions of fossil fuel-fired boilers. All these heat pumps use R-22, except the German (R-1270). The assumptions for the calculation of CO_2 emissions are summarised in **Table 2**.

Comparison of the data in the figures shows that the CO_2 emissions of heat pumps are generally lower than those of fossil fuel-fired boilers. The heat pump reduces CO_2 emissions by more than 50% in Austria, and by more than 80% in Switzerland. In Germany, however, emissions of new gas-fired condensing boilers and electric heat pumps are approximately equal. The CO_2 emission of the Swiss heat pump is exceptionally low, because of the low CO_2 emissions for electricity generation in that country.

▼ *Figures 1: CO_2 emissions and CO_2 equivalent emissions of various heating equipment.*



Up- and downstream energy use is a substantial part of the total emissions. The average contribution is around 16% for all heating equipment studied (highest for gas-fired boilers and lowest for oil-fired boilers). Grey energy is a smaller amount, except for the Swiss heat pump in Figure 1, where grey and up-/downstream energy together cause more than 50% of the CO_2 emissions. If this specific case is excluded, the average contribution from grey energy is only 5% for heat pumps and even lower (around 1%) for fossil fuel-fired boilers. CO_2 equivalent emissions from refrigerants constitute 2-10% of the total CO_2 equivalent emissions in Figure 1. On average, emissions from refrigerants constitute 7% of the total CO_2 equivalent emissions of heat pumps.

Air conditioning

Studying the environmental impact of heat pumps as heating devices essentially means comparing them with boilers of the same capacity. This comparison is difficult for cooling and refrigeration since there is no conventional solution, except in certain cases of cooling with ground or sea water. Assessing the environmental impact of cooling and refrigeration equipment can therefore only compare various heat pumping equipment. The extensive US TEWI study which carried out this work is also reviewed in this Analysis Report.

Other heating technologies

Some of the studies also addressed the CO_2 emissions of several other technologies, including district heat with combined heat and power (CHP), combinations of CHP with electric heat pumps, and solar collectors.

The percentage of grey energy in the emissions of the combination solar collectors/gas-fired boilers is much larger than for conventional boilers and heat pumps. In Germany, the country where the analysis was performed, the cumulative CO_2 emissions of such a solar collector system, local district heat and heat pumps are all about the same.

Conclusions

Heat pumps reduce CO_2 emissions, especially in countries with a low CO_2 emission for electricity generation (reductions of 50% in Austria, 80% in Switzerland). Recent studies which compare the environmental impact of various equipment mostly analyse the complete energy chain, including operation energy, up- and downstream energy, grey energy and emissions from refrigerants. Consideration of up- and downstream emissions is particularly important, because these constitute a substantial part (around 16%) of the total emissions.

The analysis study "Environmental Benefits of Heat Pumps" which is summarised in this article will be available in early 1999 and can be ordered from the IEA Heat Pump Centre.

Gerdi Breembroek, IEA Heat Pump Centre

High temperature heat pump combines compression and absorption technology to upgrade industrial waste heat

Helge S. Baksaas and Svein Grandum, Norway

The Institute for Energy Technology in Norway is researching a high-temperature heat pump that combines absorption and compression technology, to reach temperatures of 115°C at the heat sink. The heat pump is designed for upgrading waste heat from industrial processes, for which absorption/compression heat pumps are well suited. The ability to deliver heat at high temperatures, together with the high temperature lift, makes it applicable where conventional vapour-compression heat pumps have reached their limitations. This article describes the system design and application areas.

Waste heat with a typical temperature of 30-50°C is available in large quantities in, for example, Norwegian petroleum industries. Upgraded heat can either be used within the industrial process, and thus reduce the primary energy con–sumption, or it can be utilised for other purposes requiring high temperatures, such as drying or evaporation processes located close to the waste heat source. A 60 kW laboratory-scale absorption/compression heat pump using NH_3/H_2O as working fluid pair has been designed and built to evaluate the performance and long-term operation consequences (see photograph below).

System design

The small-scale experimental plant works with an oil-lubricated reciprocating compressor and is equipped with standard plate-type heat exchangers, even for the absorption and desorption processes. Computer simulations of the heat pump process show optimal reuse of waste heat when the temperature is upgraded from 53°C to 117°C. This temperature lift results in a coefficient of performance (COP) of 3.8.

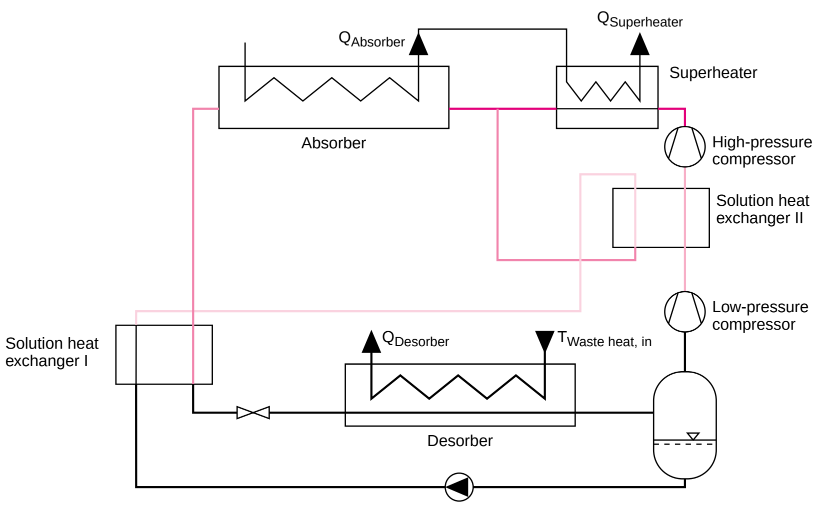
An absorption/compression heat pump is a combination of a vapour compression-type heat pump and an absorption-type heat pump. The system layout is shown in **Figure 1** while the process flow sheet is presented in **Figure 2**. This process is not new, and the first reference goes back to 1895. The reason why this process has not been studied thoroughly up to now is probably due to the problems that occur when converting theory into practice. One of the main problems when considering long-term operation of the heat pump is assumed to be the oil-lubricated compressor. It is impossible to avoid some water content in the ammonia vapour at the compressor inlet, and this will be mixed with the lubrication oil in the compressor. Water mixed with oil will probably cause reduced lubrication by the oil, so there is reason to believe that long-term operational problems might occur. However, system tests have so far shown no damage to the compressor at all.

Advantages

In an absorption/compression type heat pump, the working fluid is a non-azeotropic mixture containing two or more components. The process has several advantages compared to the conventional vapour compression-type heat pump.

▼ *Figure 1: Photo of the Laboratory Plant at the Institute for Energy Technology.*

▼ *Figure 2: Principal sketch of the heat pump.*



A first advantage is that higher heat sink temperatures can be achieved. In ordinary compression-type heat pumps, the condensing pressure usually becomes high, even at temperatures below 100°C (ammonia at 40 bar pressure con-denses at 77°C). If ammonia is absorbed in a NH_3/H_2O solution, the pressure is reduced considerably (ammonia absorption in a solution of NH_3/H_2O containing 33.8% ammonia results in 117°C at 19 bar).

Secondly, the process has temperature glides for heat exchangers both at heat source and heat sink. This results in a higher efficiency.

Finally, changing the mixture's component composition can easily change the process temperature during operation. The process can therefore be easily adjusted to variations in the temperature of the heat source and to variations over time of the temperature demanded at the heat sink.

The construction of the experimental apparatus for an absorption-/ compression heat pump at the Institute for Energy Technology began in 1996. If standard components are successfully implemented, the process can be realised more easily in industrial applications. The reasons why this process is considered particularly interesting is due to:

- the advantages compared to ordinary vapour compression-type heat pumps;
- the phasing out of CFC and HCFC working fluids requires the development of efficient heat pumps utilising natural refrigerants;
- by utilising well-known oil hydraulic technology the compressor lubrication problems can be solved;
- by utilising compact heat exchangers the total heat pump size will be smaller. The few known laboratory-scale plants built so far have used shell and tube heat exchangers.

Applicability

Preliminary tests of the heat pump have been carried out, but a few modifica-tions were necessary to achieve optimum system performance. The absorption/compression heat pump is designed for quite a large temperature glide in the absorber and desorber, in order to maximise the COP. To match the heat pump's temperature glide, the most feasible processes for implemen-tation of this heat pump will be ones containing single component fluids with no phase change and ones containing multi-component fluids (with phase change) where the boiling points differ significantly.

Many industrial processes have heating demands in the temperature range of 100-120°C. In order to evaluate the applicability of this type of heat pump, a preliminary process study has been performed. The study aimed to find feasible processes and locations for implementing the heat pump into Statoil's gas terminal at Kårstø, Norway. This particular process plant consists mostly of extraction and fractionation columns. Due to the light hydrocarbons involved, evaporation and condensation occur at nearly constant temperatures. Directly implementing this heat pump into the process is therefore not preferable. However, it is suitable for connection to the utility system. Preheating of condensed steam (initially 93°C) before it enters the boilers for high-pressure steam generation, is most applicable. Simulation results for a process using waste heat from sea water coolers (at 50°C) for upgrading to the heat sink at a target temperature of 105°C achieved a COP of 3.2. Since the investment cost for the heat pump is comparable with conventional heat pump technology, economic considerations will be very similar.

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New 'absorption' type heat pump tested

G.J.M. Ruijgers, the Netherlands

Over the past few years international literature has given some attention to a new working principle applicable to thermal-driven heat pumps, which may be an alternative to the well-known absorption process. This new process is referred to as the 'reverse rectification' process. In theory it has certain advantages over the standard absorption processes, for which the working pairs ammonia/water or lithium-bromide/water are usually used. This article describes the principle of this process, its advantages and the results of the first testing experiments.

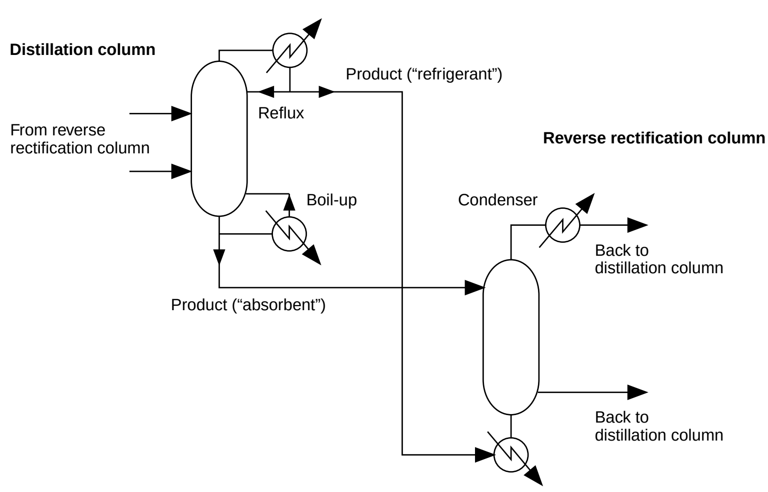
A much wider choice in working fluids and the separate occurrence of heat and mass transport are the most remarkable features of the reverse rectification process. Substantial cost reductions can be achieved by incorporating these features into the design of a small thermal-driven heat pump. If these expectations are met, this new type of heat pump has the opportunity to cause a breakthrough in the domestic heating market. To study this the Dutch company SLE, in cooperation with the Delft University of Technology and sponsored by the natural gas utility Gasunie, has constructed a test model.

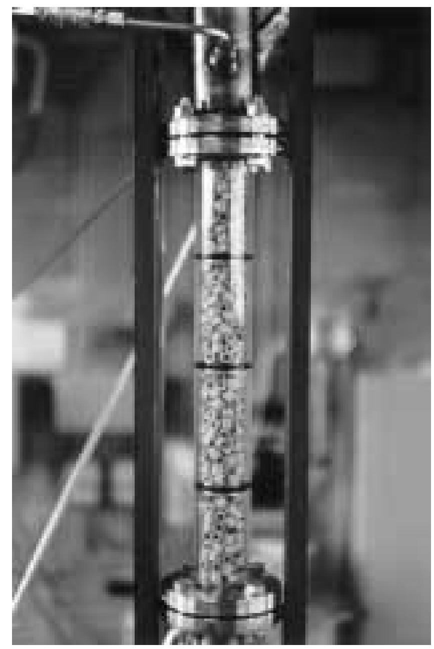
Reverse rectification

The principle of the reverse rectification process is the separation and mixing of two working fluids. The accompanying heat effects are used to create a heat pump [1]. The only condition that the process imposes on the working fluids, is that they are separable by way of distillation. The process diagram of reverse rectification is shown in **Figure 1**.

However, there are a number of additional requirements to create a well-functioning heat pump: the working pair should result in a high efficiency, i.e. a high primary energy ratio (PER), and should be nonpoisonous, noncorrosive, not harmful to the environment etc. These are general requirements imposed on any type of heat pump. The much wider choice of working fluids which the new working process allows, makes it possible to choose a mixture that fulfils a number of important requirements. Selecting mild pressures and standard components and materials will allow a simple construction. Another factor that leads to a simple construction is that heat and mass transfer take place separately. No part of the machine is comparable with the traditional absorber.

▼ *Figure 1: Reverse rectification process.*





▲ *Figure 2: Close-up of a mass transfer unit, height = 50 cm.*

There were plenty of reasons to test the new process in practice. The advocate of this new process, Prof. P. le Goff from Nancy, France, was mainly interested in the working of the reverse rectification column. A matching distillation column had never been built, and therefore no real heat pump had been created. Whether later researchers were deterred by the large degrees of freedom that also characterises the process, or by the original outline, which may evoke serious questions, is not known, but to date no results of any further research have been published.

However, the company Second Law Engineering concluded, after thorough studies of the theory, that it would be possible and useful to build a small heat pump test model. This decision was supported by the natural gas utility Gasunie.

Test model

The aim in designing a test model was to evaluate whether the characteristics of a heat pump working according to the reverse rectification scheme are consistent with the advantages that may be expected in theory. The final goal is the construction of a domestic heat pump, so easily handled working pairs were required, which also promised a fairly high PER. Isobutane-cyclopentane gas was chosen, as these two substances are already being used extensively in the manufacture of domestic refrigerators (isobutane as a refrigerant and cyclopentane in insulation foams), so there should be no restrictions for using these in a heat pump.

Calculations show that a PER of 1.55 can be achieved with this working pair, giving a temperature lift of 50 K. This corresponds with a coefficient of performance (COP) of 4.0 for an electric-driven compressor-type heat pump (assuming an electric power generation efficiency of around 38%).

With the reverse rectification process it is easy to add a second stage, lifting the PER of such a double-effect system to 2.0 (this corresponds with a COP of 5.1 for an electric system).

The test model is designed to deliver 1 kW of heating, of which 350 W is taken from the environment. This rather modest capacity limits the dimensions of the main components: heat exchangers and mass transfer units need about 0.02 m^3 of space. The working pressure in both columns is kept at 2.6 bar.

Test results

After a first series of measurements it can be concluded that the process works satisfactorily. The following conclusions can be drawn:

- the process flows are commensurate with theory. Unexpected phenomena have not been observed;
- the amount of heat taken from the environment approaches the design value;
- working pressures are well inline with calculated values.

The predicted value of the PER cannot yet be confirmed because the test model has no insulation, and heat losses are relatively large because of the small capacity of the model.

Future research

The research programme for the test model will be extended. The initial phase showed that no practical barriers were found in the design of a small thermal-driven heat pump according to the principle of reverse rectification. The aim for the next phase is to establish the PER and temperature lift, and to study the dynamic behaviour of the heat pump.

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Reference

[1] P-M. Ranger, H. Matsuda and P. Le Goff; *Modelling of a new type of absorption heat pump combining rectification and "reverse-rectification"*; Journal of Chemical Engineering of Japan, vol. 23 no. 5, pp. 530-536; 1990.

Electrical heating and cooling of residential dwellings
Available from: Sciotech, 9 Heathwood Close, Yateley, Hampshire, GU46 7TP, United Kingdom, fax: +44-1252-873564. Published in 1998, 76 pages. Price: GBP 15, or ECU 25. A 4-page summary is available free-of-charge.
This report concerns a study on transforming the market for energy-efficient electrical heating and cooling appliances, that was made within the scope of the SAVE programme of the European Commission. The study identifies heat pump technology as the most efficient method of heating and cooling and makes some specific recommendations to increase their market penetration.

Handbook industriële warmtepompen (Handbook for industrial heat pumps)
Available from: Kluwer, PO Box 23, 7400 GA Deventer, the Netherlands.
Tel.: +31-570-673555, fax: +31-570-632411. Dutch language only. Published in 1998, 231 pages. ISBN 9055761397. Price: NLG 89.
This handbook describes the technological aspects of industrial heat pumps in detail, considers heat pumps as part of an industrial process and gives guidelines for several phases of application. These phases include feasibility studies, design stage and exploration phase. Furthermore it describes applications of heat pumps in different types of industrial processes.

Government strategies to phase out ozone depleting refrigerants: four case studies from the Nordic countries
Available from: SMI Distribution Services Ltd., PO Box 119, Stevenage, Hertfordshire SG1 4TP, UK. Fax: +44-1438-748844. Published July 1998. Price: USD 40.
This book describes the experiences of government and industry in four Nordic countries (Denmark, Sweden, Finland and Norway) in designing and implementing regulatory and voluntary measures to phase out ozone depleting refrigerants controlled under the Montreal Protocol.

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Compression Systems with Natural Working Fluids
Annex 22 Workshop Proceedings, January 1998. Order No. HPP-AN22-3.
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Organised by the International Institute of Ammonia Refrigeration.
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Attn. Chris Combs.
Fax: +1-202-2234579
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1999 International Sorption Heat Pump Conference
24-26 March 1999 / Munich, Germany
Contact: Dr Martin Hellmann, ZAE Bayern, Walther-Meissnerstrasse 6, D-85748 Garching, Germany.
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World Sustainable Energy Trade Fair Clean Energy for the 21st Century
25-27 May 1999 / Amsterdam, The Netherlands
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Paper abstracts due December 1998

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Technical visits on 3 June 1999
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Session 1: Opening plenary session
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Session 3: Technology
Session 4: Heat Pump Systems
Session 5: Applications
Session 6: Market Strategies
Invited speakers and call for posters
Information is also available from the Heat Pump Centre

Next Issue

Ground-source heat pump systems
Volume 17 - No.1/1999

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 cooperation 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

Set up by the IEA in 1978, the IEA Heat Pump Programme carries out a strategy to accelerate the development and use of heat pumps, in all applications where they can reduce energy consumption for the benefit of the environment. Within the framework of the programme, participants from different countries collaborate in specific heat pump projects known as Annexes.

IEA Heat Pump Centre

A central role within the programme is played by the IEA Heat Pump Centre (HPC), itself an Annex. 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

Novem

Netherlands agency for energy and the environment

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