Annual Report 2004

2004

HEAT PUMP PROGRAMME

Implementing Agreement for a Programme of Research, Development, Demonstration and Promotion of Heat Pumping Technologies

IEA
OECD

International Energy Agency

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** concluded in 2004*

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

2004

International Energy Agency

The International Energy Agency (IEA) was founded in November 1974 as an autonomous body within the Organization for Economic Co-operation and Development (OECD) to implement an international energy program. Membership consists of 25 of the 29 OECD member countries.

Activities are directed towards the IEA Member countries' collective energy policy objectives of energy security, economic and social development, and environmental protection.

One important activity undertaken in pursuit of these goals is a programme to facilitate co-operation to develop new and improved energy technologies and introduce them into the market. Activities are set up under Implementing Agreements, which provide the legal mechanism for establishing the commitments of participants and the management structure to guide the activity.

Implementing Agreements are independent bodies operating in a framework provided by the IEA, and hence take full responsibility for their work programmes and publications.

There are more than 40 currently active Implementing Agreements encompassing activities relating to fossil fuels, renewable energy, efficient energy end-use, fusion power and information dissemination. This publication concerns the "Implementing Agreement for a Programme of Research, Development, Demonstration and Promotion of Heat Pumping Technologies", more commonly known as the IEA Heat Pump Programme.

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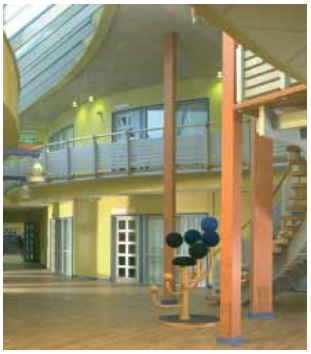

IEA Heat Pump Programme

Heat Pump Centre
The Heat Pump Centre is the central information activity of the Programme

The Centre links people and organisations worldwide in support of heat pumping technologies and communicates through National Teams in its member countries.

Organised under the umbrella of the International Energy Agency in 1978, the IEA Heat Pump Programme is a non-profit organisation funded by its member countries. The scope of the Programme covers heat pumps, air conditioning and refrigeration. The participating countries are:
Austria, Canada, France, Germany, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, the United States.

Mission

The Programme develops and disseminates factual, balanced information to achieve environmental and energy efficiency benefits through deployment of appropriate high quality heat pump, refrigeration and air-conditioning technologies.

The Programme serves the needs of policy makers, national and international energy and environmental agencies, utilities, manufacturers, designers and researchers. It also works through national agencies to influence installers and end-users.

Strategic Objectives

Environmental
To quantify and publicise the environmental and energy efficiency benefits of heat pumps.

Market and Deployment
To develop and deliver information to support appropriate deployment.

Technology
To maintain and develop international technical RD&D collaboration that furthers the environmental and market objectives.

Information Management
To provide effective collaboration and flow of information to, from and between stakeholders and other relevant bodies.

Activities

The activities of the Programme include an information service, the Heat Pump Centre, international collaborative projects, so-called Annexes, workshops, analysis studies and a triennial international conference.

In 2004 there were:

- Two meetings of the Executive Committee:
  – May 11–12 in Montreal, Canada
  – November 9–10 in Paris, France
- One meeting of the National Teams
  – April 19–20 in Borås, Sweden

Chairman's Statement 2004

I have been acting as Chairman of the Heat Pump Programme only since the end of November 2004, and so the success of activities carried out in 2004 and the impacts achieved are due to my predecessor, Roger Hitchin from the United Kingdom, who played a leading role for 18 months. We owe him a debt of gratitude not only for the leadership he showed during that time, but also for agreeing to share his experience as Assistant to the Chairman in 2005.

The main highlight of 2004 was definitely the transfer of the Heat Pump Centre to SP Swedish National Testing and Research Institute. Monica Axell and her team carried out their role, completing the new web site, distributing the Newsletter electronically and organizing a meeting of the National Teams in Borås, Sweden. We are able to count on their support and dynamic spirit to make sure that the Heat Pump Centre remains very active.

Other events during the year included the forging of closer ties with the IEA secretariat, the associations (EHPA, IIR), and the other Implementing Agreements (IAs), in particular Energy Conservation in Buildings and Community Systems (ECBCS) and Energy Conservation through Energy Storage (ECES). In conjunction with the Executive Committee meetings held in Montreal in May and in Paris in November, two workshops were organized to present the respective national programs in the heat pump field, and one workshop was organized in cooperation with the ECES Executive Committee delegates in Montreal.

The coming into force of the Kyoto Protocol and the context of sustainable development create a very favourable situation for the implementation of heat pumping technologies. By providing opportunities to reduce energy consumption and peak loads, they can play a key role in helping to achieve greenhouse gas emission reduction objectives. In addition to overcoming technical challenges, the role of the IEA Heat Pump Programme will be to remove economic and market barriers. Several collaborative projects (Annexes) in this vein are already in place or in preparation.

The Heat Pump Programme is now very active in the building sector; one of the new challenges will be to extend the scope of the Programme in the coming years to other sectors, such as industry and transport. In these sectors, too, heat pumping technologies may have significant impacts.

Sophie Hosatte
ExCo Chairman

Highlights of 2004

SP Swedish National Testing and Research Institute

New Operating Agent of the Heat Pump Centre

The Operating Agent of the Heat Pump Centre has been taken over by SP, the Swedish National Testing and Research Institute, since January the 1st 2004. The new operating agent continues the work performed by SenterNovem, but has also introduced some new activities. The main new items are: the publication of a new website, the launch of a publication data base and the introduction of an e-newsletter.

National Team Meeting in Borås

A National Team meeting held in Borås on April 19–20 proved very successful. Ten out of twelve countries were represented, several by more than one delegate. The first day was devoted mainly to country presentations. The situation in each member country was described, i.e. market trends, policies, research and work within the Heat Pump Programme.

Day two was devoted to discussing the activities within the Heat Pump Programme and the Heat Pump Centre. A number of suggestions for new Annexes were discussed, as were the topics and sessions for the 8th Heat Pump Conference in Las Vegas, 2005. The National Teams also presented their opinions on the work of the Heat Pump Centre. New activities and changes to the current activities were suggested.

Altogether the meeting was a success, providing the Heat Pump Centre with valuable information and closer contacts with the National Teams.

Workshops with National Industries held in Montreal and Paris
In connection with the Executive Committee meetings in Montreal, Canada, and Paris, France, workshops (on May 10 and November 8 respectively) were organised where the IEA country representatives were given the opportunity to learn more about the situation for heat pumping technologies in Canada and France respectively. In addition, the workshops also gave the industry representatives the chance to express their needs and expectations in respect of the Heat Pump Programme.

Joint Meeting with the "Energy Conservation through Energy Storage" Implementing Agreement
A joint meeting between the Executive Committees of the Heat Pump Programme and the Energy Conservation through Energy Storage Implementing Agreement was held in Montreal on May 13. The purpose of the meeting was to discuss topics of common interest. Fields of interest that were identified included ground-source heat pumps and supermarket refrigeration. These are both fields in which the ground or phase-change materials can be used for energy storage.

Newsletters 2004
Four newsletters were issued in 2004 and are available at the Heat Pump Centre web site. The topics for the Newsletters are:

1. Natural working fluids
2. Residential heat pump systems
3. Supermarket refrigeration
4. Heat pumping technologies in new markets

8th IEA Heat Pump Conference – "Global Advances in Heat Pump Technology, Applications, and Markets"
The programme for the conference to be held in Las Vegas May 30–June 2, 2005 was agreed on during the year. The first day of the conference will feature two half-day workshops for ongoing Annexes 28 and 29. The remaining three days will include nine technical sessions and two technical tours. The sessions will cover regional reports on the status and trends for heat pumps in North America, Europe and Asia/Pacific divided into:

- Energy and environment
- Heat pump applications
- Ground- and water-source heat pump systems
- Integration of heat pumps in cooling, heating and power systems
- Advanced concepts – components
- Advanced systems and equipment
- Experience with alternate refrigerants
- Country research program overviews

Programme Achievements 2004

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The Heat Pump Centre

Participating countries: Austria, Canada, France, Germany, Japan, the Netherlands, Norway, Spain, Sweden (Operating Agent), Switzerland, United Kingdom and the United States.

Activities

The Heat Pump Centre is the central activity of the Heat Pump Programme. The aim is to disseminate factual and balanced information about heat pumping technology and promote the activities performed within the IEA Heat Pump Programme. In addition, the Heat Pump Centre provides support to Operating Agents of annexes and to the Executive Committee.

One of the main activities is to publish the Heat Pump Centre Newsletter. The layout and structure of the electronic newsletter have been changed in order to make it more readable as well as suitable for printout in black and white. In addition, a new feature has been added, under the title of the Columnist, where an invited person gives his or her views on a specific topic.

In addition to the full newsletter, a short e-Newsletter has been developed. This e-Newsletter, which is distributed by e-mail, highlights the most interesting news and summarises all the articles. The aim is to reach a larger number of readers and to provide an extra service. The e-Newsletter also provides a means of easily spreading information about, and promoting, the Heat Pump Programme. Based on the contents of the e-Newsletter, readers will be able to decide whether they want to read the full version. On the practical side, particular attention has been paid to ensure that the short version is easily readable on the screen. In addition, readers can subscribe to the e-Newsletter via the web site.

Another important activity is the web site, which has been given a new layout and structure. The aim has been to enhance the structure and layout in order to make it easier to find relevant information and also to make it easier to find updates of the web site. These changes were made in order to make the web site user friendly for both first-time visitors as well as frequent visitors. All Heat Pump Programme and Heat Pump Centre publications are now fully searchable via a new data base on the web site.

International Collaboration

The Programme has collaboration agreements with the International Institute of Refrigeration (IIR) and the European Heat Pump Association (EHPA). Close links are also forged with the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) and the United Nations Environment Programme (UNEP).

New Publications Launched in 2004

Selected Issues on CO_2 as a Working Fluid in Compression Systems (Annex 27)

- Workshop Proceedings, Trondheim, Norway (CD ROM)
- Final Report (CD ROM)

Annex 27

Selected Issues on CO_2 as Working Fluid in Compression Systems

Participating countries: Japan, Norway (Operating Agent), Sweden, Switzerland, (United Kingdom, partly for 2001) and the United States.

The main objective of Annex 27 was to bring CO_2 heat pumping technology closer to commercialisation, by addressing issues of both basic and applied nature. The scope of the work included compression heat pump, refrigeration and air conditioning systems and components. Each of the contributing research teams conducted individual projects.

The projects were grouped in six different categories:

- Literature survey;
- Systems;
- Heat transfer;
- Compressors;
- Safety issues;
- CO_2 as secondary refrigerant.

One project evaluated the use of a compact CO_2 cooler in a standard freezer with thermosyphon evaporator and condenser, while another project explored the feasibility of transcritical CO_2 systems in mobile space conditioning. CO_2 heat transfer phenomena were analyzed in three experimental studies. As a result, a new correlation of heat transfer coefficient was proposed and another correlation for supercritical CO_2 was developed. Heat transfer and pressure drop phenomena were also studied in a multi-port extruded aluminium micro tube configuration. In addition, flow vaporization phenomena and two-phase flow patterns were studied.

The Annex included design, manufacturing and performance testing of a small oil-fee CO_2 compressor, a promising alternative to oil-lubricated compressors in automotive air conditioning, domestic water heating and applications in food industry.

A major safety issue for CO_2 is related to the high operating pressure leading to the study of explosion energies. For supermarket refrigeration, CO_2 is a promising alternative to artificial refrigerants. From the analysis it is clear that using CO_2 in supermarket refrigeration does not introduce health risks for people in the shopping area.

The projects show that CO_2 is a very promising refrigerant candidate in a series of application areas. It is the hope of the participants that Annex 27 has contributed to filling some of the holes in the CO_2 technology.

The Annex was concluded in 2004 and the following publications can be ordered from HPC:

- Selected Issues on CO_2 as Working Fluid in Compression Systems (final report)
  Order No.: HPP-AN27-2; Published May 2004.
- Selected Issues on CO_2 as Working Fluid in Compression Systems – Workshop Proceedings, Norway.
  Order No.: HPP-AN27-1; Published February 2001.

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Annex 28

Test Procedure and Seasonal Performance Calculation for Residential Heat Pumps with Combined Space and Domestic Hot Water Production

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Participating countries: Austria, Canada, France, Germany, Japan, Norway, Sweden, Switzerland (Operating Agent), the United States.
The heat demand for domestic hot water heating compared to space heating is growing steadily. The overall efficiency for both functions is decisive for heat pump systems with combined space and water heating. However, existing test procedures are restricted to separate space heating (or cooling) and separate water heating. Annex 28 has investigated the testing of the most common integrated heat pump systems.

There are two objectives. The first objective is to establish a test procedure, which yields the necessary data in order to calculate the overall Seasonal Performance Factor of such heat pump systems with a minimum requirement for testing equipment and testing time. The second objective is to work out an easy method to calculate the Seasonal Performance Factor for integrated heat pump systems.

The Annex has been structured around three tasks:

Task 1 – Systems investigation
Task 2 – Developing a test procedure
Task 3 – Developing a calculation method for the overall Seasonal Performance Factor

The main objectives in 2004 were the development of the calculation method for the seasonal performance factor, and the linked test procedure for combined operating heat pump systems in the national projects based on the state-of-the-art survey carried out in 2003.

Besides semi-annual ExCo status reports, a comprehensive interim report on the results of the state-of-the-art survey was delivered in March 2004. As conclusion of the results, it was agreed that the test procedure should be an extension of existing standards, and that calculation should be performed on the basis of a bin methodology.

Interim results were presented and discussed at the 3rd working meeting of Annex 28 which took place at TEPCO R&D Centre in Yokohama, Japan, in June 2004, and national approaches for the test procedure and the calculation method were also coordinated.

As the results of Annex 28 are intended as recommendations for standardisation committees, external liaisons with the CEN/TC 113, Technical Committee for the testing of heat pumps, and CEN/TC 228, Technical Committee for the calculation of heating systems, have been established. Interim results of the work of Annex 28 have been continuously transferred to the respective CEN working groups, and the heat pump calculation approach of Annex 28 has been integrated in a draft standard in the framework of the Energy Performance Directive of Buildings (EPBD).

A website of the Annex 28 was established in the spring of 2004 (www.annex28.net). The site gives an overview of the objectives, activities, participants, the national projects of Annex 28 and additional information on the standardisation of heating systems.

The work of Annex 28 was presented at two workshops, one in connection with the 3rd working meeting in Yokohama, Japan, in June 2004 and one in connection with the ExCo autumn meeting in Paris, France, in November 2004. In addition, an overview of Annex 28 was presented at the ZEN Status seminar at ETH Zurich, Switzerland, in September 2004 in connection with presentation of the Swiss national project.

Annex 29

Ground-Source Heat Pumps Overcoming Market and Technical Barriers

Participating countries: Austria (Operating Agent), Canada, Germany (tentatively), Japan, Norway, Sweden (tentatively) and the United States.

Three Annexes on ground-coupled heat pumps have been carried out within the framework of the IEA Heat Pump Program: Annex 2, Vertical Earth Heat Pump Systems; Annex 8, Advanced In-ground Heat Exchanger Technology for Heat Pump Systems; and Annex 15, Heat Pumps Systems with Direct-Expansion Ground Coils. Annex 13, Design, Construction and Maintenance of Underground Thermal Energy Storage (UTES) Wells and Boreholes, has been carried out by the Energy Conservation through Energy Storage Implementing Agreement.

This topic has become increasingly important with respect to energy efficiency and the reduction of greenhouse gas emissions. Additionally, the demand for cooling and air conditioning is increasing significantly, especially in the developing countries, and in Europe.

Annex 29, which started in September 2004, will investigate ideas and – depending on climate and application – will identify systems that could improve the performance and market attractiveness of ground-source heat pump systems. The objective is to demonstrate the economic and environmental benefits of ground-coupled heat pump systems.

A kick-off meeting, attended by 17 participants from eight countries, was held at Arsenal Research in Vienna, Austria, in September 2004, at which an overview of the activities in the different countries was presented. The work programme was decided in the discussion. The main steps are:

- State of the art
- Market analysis
- Matrix of systems under different conditions
- Improvement of components and systems
- Overcoming legal barriers
- Increasing acceptance
- Overcoming economic barriers
- Products.

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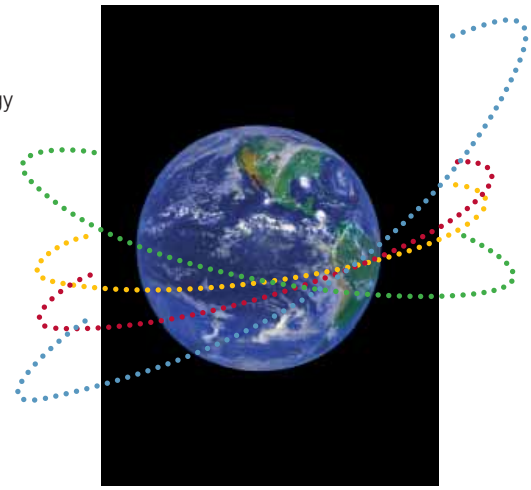

Summary of Annexes

Annex		Operating Agent	Participants	Completed
1.	Common Study of Advanced Heat Pumps	Germany	Austria, Belgium, Canada, Denmark, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, United Kingdom, the United States	1980
2.	Vertical Earth Heat Pump Systems	Sweden	Austria, Canada, Denmark, Sweden, the United States	1983
3.	Heat Pump Systems Applied in Industry	Belgium	Austria, Belgium, Canada, Denmark, Finland, Germany, Italy, Japan, the Netherlands, Sweden	1984
4.	Heat Pump Centre	Germany	Austria, Belgium, Canada, Finland, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the United States	1990
5.	Integration of Large Heat Pumps into District Heating and Large Housing Blocks	Sweden	Denmark, Germany, Italy, Sweden	1986
6.	Study of Working Fluid Mixtures and High Temperature Working Fluids for Compressor Driven Systems	Sweden	Austria, Denmark, Finland, Germany, Japan, the United States	1986
7.	New Development of the Evaporator Part of Heat Pump Systems	Sweden	Canada, Denmark, Finland, Norway, Sweden	1989
8.	Advanced in-ground Heat Exchange Technology for Heat Pump Systems	Canada	Canada, Germany, Switzerland, the United States	1992
9.	High Temperature Industrial Heat Pumps	Belgium	Belgium, Germany, Finland, Japan, the Netherlands, Sweden, Switzerland, the United States	1990
10.	Technical and Market Analysis of Advanced Heat Pumps	the United States	Sweden, the United States	1991
11.	Stirling Engine Technology for Application in Buildings	the United States	Japan, Sweden, the United States	1989
12.	Modelling Techniques for Simulation and Design of Compression Heat Pumps	the United States, Italy	Austria, Belgium, Germany, Italy, Japan, Switzerland, the United States	1992
13.	State and Transport Properties of High Temperature Working Fluids and Non-Azeotropic Mixtures	Sweden	Canada, Germany, Japan, Norway, Sweden, the United States	1992
14.	Working Fluids and Transport Phenomena in Advanced Absorption Heat Pumps	Japan	Belgium, Denmark, Germany, Japan, Sweden, the United States	1991

Annex	Operating Agent	Participants	Completed
15. Heat Pump Systems with Direct Expansion Ground Coils	Canada	Austria, Canada, Japan, the United States	1993
16. Heat Pump Centre	the Netherlands	Austria, Japan, the Netherlands, Norway, United Kingdom, the United States	2003
17. Experiences with New Refrigerants in Evaporators	Sweden	Canada, the Netherlands, Norway, Sweden, Switzerland	1993
18. Thermophysical Properties of Environmentally Acceptable Refrigerants	the United States	Austria, Canada, Germany, Japan, Sweden, United Kingdom, the United States	1999
19. Cancelled			
20. Working Fluid Safety	Belgium	Belgium, Japan, the Netherlands, Norway, Switzerland	1993
21. Global Environmental Benefits of Industrial Heat Pumps	the United States	Canada, France, Japan, the Netherlands, Norway, Sweden, United Kingdom, the United States	1996
22. Compression Systems with Natural Working Fluids	Norway	Canada, Denmark, Japan, the Netherlands, Norway, Switzerland, United Kingdom, the United States	1999
23. Heat Pump Systems for Single-Room Applications	Canada	Canada, France, Switzerland, Sweden, the United States	1999
24. Ab-Sorption Machines for Heating and Cooling in Future Energy Systems	Sweden	Canada, Italy, the Netherlands, Norway, Japan, Sweden, United Kingdom, the United States	2000
25. Year-Round Residential Space Conditioning Systems using Heat Pumps	France	France, the Netherlands, Sweden, the United States	Ongoing
26. Advanced Supermarket Refrigeration/Heat Recovery Systems	the United States	Canada, Denmark, Sweden, United Kingdom, the United States	2003
27. Selected Issues on CO_2 as Working Fluid in Compression Systems	Norway	Japan, Norway, Sweden, Switzerland, United Kingdom, the United States	2004
28. Test Procedure and Seasonal Performance Calculation of Residential Heat Pumps with Combined Space and Domestic Hot Water Heating	Switzerland	Austria, Canada, France, Germany (partly), Japan, Norway, Sweden, Switzerland, United Kingdom, the United States	Ongoing
29. Ground Source Heat Pumps – Overcoming Market and Technical Barriers	Austria	Austria, Canada, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, the United States	Ongoing

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