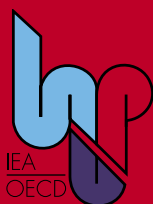
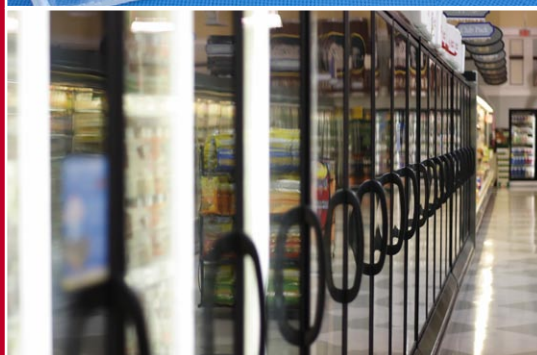
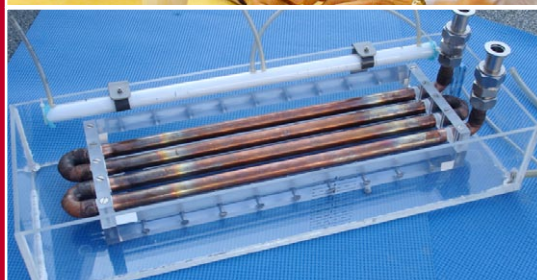


Annual Report 2009

2009



HEAT PUMP PROGRAMME

Implementing Agreement for a
Programme of Research, Develop-
ment, Demonstration and
Promotion of Heat Pumping
Technologies

International Energy Agency

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32	Annex 32 Economical Heating and Cooling Systems for Low Energy Houses	AT, CA, CH , DE, FR, JP, NL, NO, SE, US
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The IEA Heat Pump Programme participating countries are: Austria (AT), Canada (CA), Finland (FI), France (FR), Germany (DE), Italy (IT), Japan (JP), the Netherlands (NL), Norway (NO), South Korea (KR), Sweden (SE), Switzerland (CH), the United States (US). All countries are members of the Heat Pump Centre (HPC). Sweden is the Operating Agent of the Heat Pump Centre.

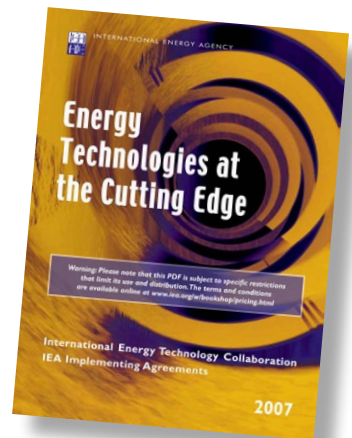
International Energy Agency

The International Energy Agency (IEA) acts as energy policy advisor for its 28 member countries as they work for reliable, affordable, clean energy for their citizens. Founded during the oil crisis of 1973–74, the IEA initially coordinated measures addressing oil supply shortages. Since then, evolving energy markets have brought new challenges. The IEA's portfolio now focuses equally strongly on climate change policies, market reform, energy technology collaboration and outreach to the rest of the world. Scenario analysis and roadmapping play a prominent part in the work of the IEA's teams of close to 200 staff. Energy experts and statisticians from member countries conduct a broad programme of energy research, data compilation, publishing and public dissemination of the latest energy policy analysis and good-practice recommendations. Following up on work for the G8, initiated in 2005, the IEA was entrusted at the 2008 G8 Hokkaido Summit in Hokkaido, Japan, with a second set of tasks for leaders of the world's major industrialised nations. These include:

- A commitment by G8 leaders to update their national commitments on energy security activities and provide them to the IEA for evaluation.
- A joint effort by the IEA and the International Monetary Fund (IMF) to carry out further analysis of real and financial factors behind the recent surge in oil and commodity prices, their volatility, and the effects on the global economy.
- A continuation of the IEA to enhance its work on voluntary sectoral indicators through improved data collection, complemented by business initiatives.
- A continuation by the IEA to further implement its 25 recommendations on energy efficiency.
- The assistance from the IEA, together with member countries, in the establishment of the International Partnership for Energy Efficiency Cooperation (IPEEC) to focus on joint efforts to accelerate the adoption of sound energy efficiency improvement practices.
- The establishment of an international initiative with the support of the IEA to develop roadmaps for innovative technologies and cooperation on existing and new partnerships, including carbon capture and storage (CCS) and advanced technologies.
- A strong endorsement of the IEA's position for the launching of 20 large-scale CCS demonstration projects globally by 2010, taking into account various national circumstances, with a view to beginning broad deployment of CCS by 2020.

For more than 30 years, IEA technology collaboration has been crucial in advancing more efficient, cleaner energy technologies. The collaborative vehicles are IEA energy technology R&D Programmes, or Implementing Agreements. These allow interested member and non-member governments to pool resources for R&D and deployment focusing on particular technologies. Operating within the standard rules and regulations of the "IEA Framework", these Implementing Agreement Programmes currently number 42. They cover the areas of: End-Use (Buildings, Industry and Transport); Fossil Fuels, Renewable Energies and Hydrogen; Fusion and Cross-Cutting Activities. The IEA Committee on Energy Research and Technology (CERT) and its Working Parties provide guidance and review the effectiveness, achievements and strategies of each Implementing Agreement.

This publication concerns the *"Implementing Agreement for a Programme of Research, Development, Demonstration and Promotion of Heat Pumping Technologies"*, known as the IEA Heat Pump Programme (HPP).



More information about the Implementing Agreements can be found on www.iea.org/Textbase/techno and in the publication *"Energy Technologies at the Cutting Edge"* (free to download from the IEA website)

IEA Heat Pump Programme

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Organised under the umbrella of the International Energy Agency since 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, commonly denoted as heat pumping technologies.

HPP member countries are:

Austria, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, South Korea, Sweden, Switzerland and the United States.

Vision

The Programme is the foremost worldwide source of independent information and expertise on environmental and energy conservation benefits of heat pumping technologies (including refrigeration and air conditioning). The Programme conducts high value international collaborative activities to improve energy efficiency and minimise adverse environmental impact.

Mission

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

Strategic Objectives

Energy and Environment

To quantify and publicise the energy saving potential and environmental benefits (local and global) of heat pumping technologies.

Market and Deployment

To develop and deliver information to support deployment of appropriate heat pumping technologies.

Technology

To promote and foster international collaboration to develop knowledge, systems and practices in heat pumping technologies through RDD&D (research, development, demonstration and deployment).

Information Management

To provide effective flow of information to, from and between stakeholders and other relevant entities.

Visibility and Status

To improve significantly the visibility and status of the Programme, and to be an outstanding Implementing Agreement within the IEA.

Activities

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

Chairman's Statement 2009

It is once again my great pleasure to write the Chairman's Statement for the IEA Heat Pump Programme Annual Report. In current energy and environmental contexts, heat pumps have a major role to play in providing heating, cooling and refrigeration with efficiencies greater than one. In this context, active support for the development and worldwide adoption of heat pumping technologies must continue to be the main focus of the Heat Pump Programme (HPP).

This year Finland joined the Heat Pump Programme. On behalf of the Executive Committee, it is my pleasure to welcome them. Their participation will help us to increase the Programme's development and influence.

Two HPP Executive Committee meetings were held during 2009, one in Amersfoort in the Netherlands in May, and one in Rome in November. In conjunction with these meetings, two workshops were organized by these countries to present their national heat pump activities and to obtain more information on the IEA Heat Pump Programme. A working meeting and a National Teams meeting were held in Borås, Sweden, to discuss future activities and proposals for new collaborative projects (Annexes). HPP was also present at international events such as the IEA Building Coordination Group meeting in Paris in January and the European Heat Pump Summit in Nürnberg, Germany, in October, which was an opportunity to promote the Programme. HPP also holds regular meetings with the International Institute of Refrigeration and the European Heat Pump Association.

During 2009, we worked closely with the IEA and provided them with updated information on heat pumps that will be incorporated in the following publications for release in 2010: the IEA Building Sector Book; the IEA Energy Technology Perspectives 2010; a roadmap on Energy Efficient and Low Carbon Buildings: Heating and Cooling. The roadmap is one of a series that the G8 has asked the IEA to develop in order to support the ambitious goal of halving global energy sector CO₂ emissions by 2050. A first workshop was organized by the IEA Secretariat in November in Paris, gathering heat pump experts to discuss the role of heat pumps for heating and cooling.

Under the theme "The Solution for a Low Carbon World", the 10th International Heat Pump Conference is now officially announced. This important event will be held in Tokyo on May 16 to 19. It is a unique forum for discussing the most recent updates and sharing information on the technology.

Five new Annexes (international collaborative projects) were approved by the HPP Executive Committee this year. Project kick-off meetings should be held in 2010. I encourage you to visit the Heat Pump Centre website to learn all about the activities and thus remain at the forefront of heat pump developments.



A handwritten signature in blue ink, reading "S. Hosatte".

Sophie Hosatte
ExCo Chairman

Programme Achievements 2009

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Heat Pump Centre

The Heat Pump Centre (HPC) plays a central role in the IEA Heat Pump Programme. It aims to disseminate factual and balanced information on heat pumping technologies and promote Programme activities. SP Technical Research Institute of Sweden has the mandate to manage HPC.

Activities

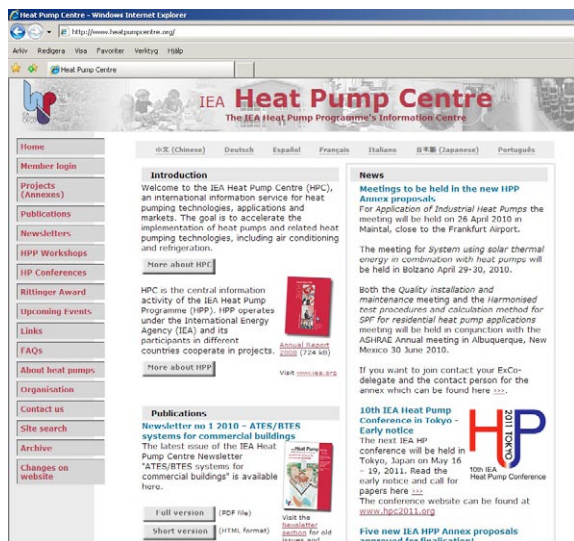
One of the main activities is the publication of the Heat Pump Centre Newsletter. Each issue covers a particular topic and contains articles, news and events, together with a contribution from a guest columnist. The newsletter is available free of charge from the HPC website to HPP member countries. Non-member countries can subscribe to the newsletter.

A short version of the newsletter, an e-newsletter, is available free of charge to all countries, either by email subscription or by downloading from the HPC website. The number of subscribers to the e-newsletter increased by over 30 per cent in 2009. In addition, the newsletter is also disseminated through the national teams in the member countries.

Another important activity is the website, which is continually updated with news, events and contact information. Descriptions of ongoing and completed HPP Annexes are also available on the website as well as HPP publications, which are accessible via a data base. The statistics of the website shows the same trends as previous years regarding which pages that are the most popular and which countries that are the most frequent visitors. As expected, the traffic to the website increases when newsletters are released. The entire website is currently being re-built resulting in a lot of improvements in the near future.

The Heat Pump Centre also works with the generation of new activities within HPP. For example, it publishes ongoing descriptions of project proposals on the website in order to stimulate the initiation of new Annexes. HPC has also compiled a report with information on research and development and market development in HPP member countries. The report is available to National Teams in the member countries. In September, HPC arranged a working meeting and National Teams meeting in Borås, Sweden. The main focus of the meetings was to discuss and develop ideas for research projects within the Programme.

During 2009, the Heat Pump Centre played a very active role in coordinating HPP's contribution to the IEA's coming publications, i.e. the roadmap for *Energy Efficient and Low Carbon Buildings: Heating and Cooling*, the report *Energy Technology Perspectives 2010* and the *IEA Buildings Sector Book*. For example, a survey was conducted during spring 2009 to gather data on market, performance and cost issues related to heat pumping technologies. Representatives of both national and international organisations were asked to deliver current statistics and trends, as well as



Website: www.heatpumpcentre.org

to reflect on the future outlook. Input regarding barriers to technology deployment, research status, good examples etc. were also requested.

HPC, together with representatives from HPP member countries, supported IEA in their arrangement of a workshop related to the publications in preparation. The workshop was held on November 9 in Paris, and representatives from both HPC and HPP participated.

The publications will be completed during 2010.

Additionally, the Heat Pump Centre works with general communication and information issues. In 2009 a proposal for a new HPP communication platform was produced. The platform includes a communication strategy and a communication plan.

Finally, HPC has a supportive function in assisting HPP Annex Operating Agents (project leaders) and the HPP Executive Committee in their work.

HPP publications can be ordered from the Heat Pump Centre.

International collaboration and promotion

The Heat Pump Programme and the Heat Pump Centre have good relations with a number of national and international organisations, including EHPA¹, IIR², ASHRAE³ and ARI/ARTI⁴. UNEP⁵ is another body that HPC/HPP exchange information with.

HPC promoted the Programme at different events. In August for example, HPC presented the Programme at gatherings in Finland held at the VTT Technical Research Centre of Finland and at SULPU, the Finnish Heat Pump Association. The meetings targeted both research organisations as well as industries associated with heat pumping. HPC was also present at the IEA Building Coordination Group meeting in Paris, France, in January.

In September, HPP was honorary sponsor of the European Heat Pump Summit in Nürnberg, Germany.

There are ongoing plans with two other Implementing Agreements on joint Annexes; one with the IA Solar Heating and Cooling (SHC) on a joint Annex about systems using solar thermal energy in combination with heat pumps and one with the IA Industrial Energy-related Technologies and Systems (IETS) on industrial heat pumps.

- ¹⁾ The European Heat Pump Association
- ²⁾ The International Institute of Refrigeration
- ³⁾ The American Society of Heating, Refrigerating and Air-Conditioning Engineers
- ⁴⁾ The Air-Conditioning and Refrigeration Institute/Air-Conditioning and Refrigeration Technology Institute
- ⁵⁾ The United Nations Environment Programme

Newsletters 2009

The four 2009 newsletters and e-newsletters are available on the Heat Pump Centre website.

The topics are:

1. Ground Source Heat Pumps
2. Heat pumps in year-round space conditioning system
3. Heat pumps are renewable
4. The role of heat pumps in future energy systems





Highlights of 2009

Contribution to IEA publications

– showing the potential of heat pumping technologies

There are three important IEA publications in preparation, namely:

- A roadmap for *Energy Efficient and Low Carbon Buildings: Heating and Cooling*, which will include scenarios for heat pumps for heating and cooling applications in the building sector until year 2050. This roadmap is one of a series that the G8 has asked the IEA to develop in order to support the ambitious goal of halving global energy sector CO₂ emissions by 2050. The goal of the roadmap is to guide governmental and industrial decision makers as they set priorities and accelerate efforts to develop and deploy technologies that will improve efficiency and reduce CO₂ emissions from the buildings sector. Workshops are arranged with experts in the field in order to discuss and agree on technology and policy issues having an impact on the scenarios.



Executive Committee meeting in Rome

- The report *Energy Technology Perspectives 2010 (ETP 2010)*, which will build on the publication *ETP 2008*, and include information from the above mentioned series of roadmaps.
- The *IEA Buildings Sector Book*, which is a new publication that will present the possibilities and difficulties with different technologies for heating and cooling purposes in buildings. The book will cover the state of the market, a technology discussion, an R&D discussion, techno/economic data and barriers to technology uptake.

During 2009, HPC together with representatives from member countries contributed to these IEA publications. A survey was conducted in order to collect valuable market, performance and cost data for heat

pumping technologies. The first workshop held on November 9 in Paris was attended by HPC and HPP representatives. HPP also supported the arrangement of the workshop, e.g. by identifying and inviting experts in the field.

The work will continue in 2010 and all publications are scheduled to be published during 2010.



Discussions in Amersfoort

Executive Committee meetings

Two meetings of the HPP Executive Committee were held in 2009:

- May 14–15, in Amersfoort, the Netherlands
- November 5–6, in Rome, Italy

The Amersfoort workshop

In connection with the Executive Committee meeting in Amersfoort, a workshop was held on May 13 to present ongoing activities in the Netherlands related to the heat pumping field, and where the role of heat pumps in the future energy systems was especially highlighted. Presentations on heat pump applications in low energy houses, greenhouses and industries were also given. Dr Sophie Hosatte spoke about the activities of the Heat Pump Programme.

The Rome workshop

In connection with the Executive Committee meeting in Rome, a workshop was held on November 4 to present ongoing activities regarding heat pumps in the Italian energy system, including current market and applications, as well as strategies and future developments. The presentations also dealt with gas fired, gas absorption and adsorption, as well as solar air conditioning, among other things. In addition, Dr Sophie Hosatte gave a presentation on the Heat Pump Programme and Dr Monica Axell presented the IEA publications in preparation (described on page 8).



National Teams meeting in Borås

Working meeting and National Teams meeting in Borås

On September 23, a working meeting was held in Borås, Sweden, with the main purpose of discussing proposals for new Annexes (projects) within the Programme. In particular proposals about field measurements for residential buildings, systems using solar thermal energy in combination with heat pumps, harmonised test procedures and calculation methods for SPF for residential heat pump applications, and applications of industrial heat pumps, were brought up.

In conjunction with the working meeting a National Teams meeting took place on September 24–25, with the main purpose of generating new activities in the Heat Pump Programme. Topics discussed were the role of heat pumps in future energy systems, how efficient heat pumps can be in heating and cooling applications respectively, and needs for research in the participating countries.



We welcome Finland as a member of the HPP!

The Heat Pump Programme had the pleasure of welcoming Finland as a new member country in 2009. The Finnish contracting party is Tekes, the Finnish Funding Agency for Technology and Innovation, designated by the Government of Finland.



HPP ExCo Chairman Dr Sophie Hosatte, the Finnish representatives Dr Arto Kotipeltö and Mr Jussi Hirvonen, and the HPC Manager Dr Monica Axell.

The Heat Pump Programme sponsored the European Heat Pump Summit

HPP was one of the honorary sponsors of the first European Heat Pump summit in Nürnberg, Germany, held on September 9–10. At the event 270 participants listened to a number of interesting presentations related to the whole range of heat pump applications. Visitors were also able to exchange information with over 20 exhibiting companies.


At the Chillventa trade fair in Nürnberg, in October 2010, heat pumps will be covered and the second European Heat Pump summit will be held in 2011.



Prof Hans-Jürgen Laue, IZW e.V., at Heat Pump Summit in Nürnberg (source: NuernbergMesse/Thomas Geiger)

IEA Building Coordination Group

In January, the Heat Pump Centre attended the IEA Building Coordinated Group's (BCG) annual meeting in Paris. This meeting is intended to inform IEA Implementing Agreements about each others' activities, and also to exchange information with IEA Headquarters. At this meeting the IEA publications described on page 8 were discussed in particular.



Highlights of 2009 *cont.*

Preparation for the Next Conference

– 10th IEA Heat Pump Conference 2011

Heat Pumps – The Solution for a Low Carbon World

The conference will be held in Tokyo, Japan, May 16–19, 2011.

The sessions at the conference will cover the following topics:

- **Environment-friendly Technology** – Advances in equipment design and development
- **Systems and Components** – Advanced electrically and thermally operated systems, and ground source systems
- **Applications** – Demonstrated energy efficiency and environmental advantages
- **Research and Development** – New developments and new refrigerants in heat pumping technologies
- **Policy, Standards, and Market Strategies** – Government, utility and professional society activities related on heat pumps
- **Markets** – Market status, trends and future opportunities
- **International Activities** – Discussion of actions in response to climate change initiatives

In association with the HPP Executive Committee, the conference is organised by the International Organising Committee (IOC) and the National Organising Committee (NOC). The Regional Coordinators are responsible for the conference's technical programme.

Increased market attractiveness of GSHP systems requires lower first cost

Overcoming economic barriers is the most important challenge in achieving a wider deployment of ground-source heat pump systems. HPP Annex 29, *Ground-Source Heat Pumps – Overcoming Market and Technical Barriers*, studied measures in different countries to lower first cost and to demonstrate the economic advantages of the systems. Measures include regulations such as the EU European Energy Performance of Buildings Directive (EPBD) and the EU directive on the promotion of the use of energy from renewable sources (RES Directive). Additionally, subsidies can be used to demonstrate the importance of the technology, to support industry efforts to become competitive and to support customers. Another method is the employment of contracting models covering ground heat source/heat sink systems, total heating systems, or total heat generation systems (as in the case of district heating systems). The Annex also investigated how to overcome legal barriers and increase the acceptance of GSHP systems.

Heat pumps – a good choice for existing buildings

The final results of Annex 30, *Retrofit Heat Pumps for Buildings*, will be published in 2010. The project comprised a detailed survey covering availability, technology, economy, ecology and possible R&D trends as well as case studies regarding the retrofitting of heat pump systems to provide low-energy, efficient space heating and cooling, and tap water heating in centralized and decentralized systems in existing residential buildings. It is clear that in many cases heat pumps already are, or will soon be, the preferred retrofit choice. The use of heat pumps is leading to drastically improved efficiency in heat generation together with reductions in the use of fossil energy and associated greenhouse gas emissions.

Final reports from Annex 29 and 30 will be available soon at www.heatpumpcentre.org.



www.hpc2011.org

Annex 31

Advanced Modeling and Tools for Analysis of Energy Use in Supermarkets

Participating countries: Canada, Germany, Sweden (Operating Agent), United Kingdom (partly) and the United States

Supermarkets are the most energy-intensive buildings in the commercial sector. It is estimated that 3–5 per cent of the total use of electricity stems from supermarkets in industrialised countries. In addition, it is estimated that annual refrigerant losses may be as high as 15–30 per cent of the total charge, thus making supermarkets the second largest emission source after mobile air conditioning, according to the most recent report from the UN Intergovernmental Panel on Climate Change. The supermarket sector has therefore a significant role to play, not only from an energy consumption point of view but also from the standpoint of refrigerant leakage impact.

The overall objective of Annex 31 is to provide new knowledge, methods and tools for enhanced energy efficiency in, and therefore reduced environmental impact from, supermarkets. The aim is also to share ideas and best practices among participating countries, as well as information on available tools for modelling and analysis, in order to further improve supermarket refrigeration systems. The Annex builds on experience and findings from Annex 26, *“Advanced Supermarket Refrigeration/Heat Recovery Systems”*.

In order to achieve the objectives of the Annex, the following task-sharing activities have been conducted:

- Task 1** Collection of available data from different supermarkets (benchmarking)
- Task 2** Development of performance indices for supermarkets
- Task 3** Development and validation of a model library for specific supermarket equipment
- Task 4** Development of whole-building simulation models
- Task 5** Comparison of the results obtained with the different whole-building simulation models for selected case studies
- Task 6** Future perspectives and possibilities
- Task 7** Deployment of the knowledge developed (indices, guidelines, papers, fact sheets)



A project meeting was held at the ASHRAE Winter Meeting in Chicago in January 2009. Annex 31 has now finished its activities and a draft report is being produced, but at this stage it is still missing the Task 5 comparisons. The report will include the findings from the work done by Annex 31 participants in the project activities. The report also summarises the challenges faced when performing some of the tasks in this Annex, which are mainly related to the differences in conditions, requirements, regulations and concepts in supermarkets in different countries. Hence, guidelines for simplifying similar tasks in the future have been suggested in the report.

Additional to the knowledge base developed during the work in this Annex, current and future trends in supermarkets in different countries were discussed.

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Annex 32

Economical Heating and Cooling Systems for Low Energy Houses

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www.annex32.net

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

Heat pumps are the only devices which can generate heating and cooling energy simultaneously. Multifunctional heat pump systems for space heating, domestic hot water (DHW) production, ventilation and space cooling may therefore be a cost-effective means of meeting all building needs with one integrated system.

The aim of this Annex is to investigate different system configurations of heat pump systems, including their respective energy sources and distribution systems, for application in low- and ultra-low-energy buildings. The principal objectives are:

- to improve and further develop multifunctional heat pump systems in terms of overall energy use, achievable comfort and costs,
- to gather more field experience from operation of installed multifunctional heat pumps, and
- to derive design guidelines for multifunctional heat pump systems and their control.

The Annex has been structured into four tasks:

Task 1 State-of-the-art survey of low-energy buildings and respective systems

Task 2 Assessment of system solutions and development of prototype systems

Task 3 Field testing of systems (in parallel with Task 2)

Task 4 Development of guidelines for systems and their control, and documentation of best-practice systems

The Annex started in January 2006 and was extended to cover a four-year working period, which finished at the end of 2009.

Activities in 2009 were dedicated to the conclusion of the national projects. National results, which are mainly related to prototype developments in Task 2 and extensive field testing in Task 3, were discussed at two working meetings during the year.

Developed prototypes of integrated heat pumps systems have an extended functionality, including (passive) space cooling and in one case also a dehumidification function to cover all building needs. Heat pumps using natural refrigerants were investigated in the project. Prototypes were lab-tested to identify the heat pump

characteristics for the implementation of the component in simulation tools. Simulations were carried out in order to evaluate system performance and control issues. Field tests of some of the prototypes are in preparation.

Field monitoring of more than 100 heat pumps installed in low energy houses covering the functions space heating, DHW, partly (passive) space cooling and ventilation were accomplished in Task 3. Field test results confirm a generally good performance of heat pumps in low energy houses, but also indicate prospects for further improvement of system performance.

Currently, final results are being collected and compiled into a final report, which will be available in 2010. Moreover, single field-monitored systems are documented as best practice.

It is intended to Present the final results at a workshop in conjunction with the 10th IEA Heat Pump Conference in Japan in 2011. Updated information is available on the Annex 32 website.



Participants of Annex 32 on a technical visit in Graz in March 2009

Annex 33

Compact Heat Exchangers in Heat Pumping Equipment

Participating countries: Austria, Japan, Sweden, United Kingdom (Operating Agent) and the United States

This Annex, which is now essentially complete with the final report to be delivered imminently, was directed at widening the use of compact heat exchangers (CHEs) in heat pumping systems. It is believed that these will improve efficiencies, minimize fluid inventories and reduce package size. The data collected during the Annex should allow potential users to quantify the possible benefits from CHE use, and also highlight any concerns. Ultimately, the use of compact heat exchangers should significantly improve the acceptability of heat pumps across all applications, by allowing improved COPs and reduced materials content.

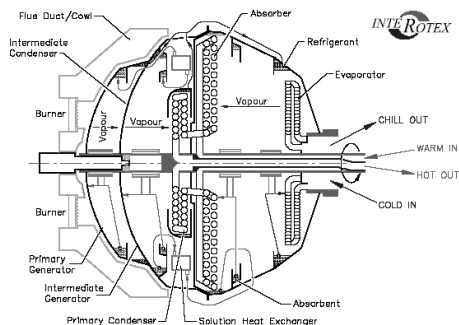
The principal objective of this Annex has been to present a compilation of possible options for compact heat exchangers, used as evaporators, condensers and in other roles in heat pumping equipment. The aim has been to minimize the direct and indirect effect on the local and global environment due to manufacture operation and final disposal of the equipment.

Specific technical goals involved identifying and documenting reasonably accurate methods of predicting heat transfer, pressure drop and void fractions in CHEs, thereby promoting their commercial use by heat pump manufacturers by simplifying the design and selection procedures. Integral with these activities will be an examination of manifolding/flow distribution in compact/micro-heat exchangers, in particular in evaporators. A guidance document on the types and uses in heat pumping systems of well-established as well as new types of CHEs (and some micro-heat exchangers) is incorporated in the final report.

Two Annex meetings were held in 2009. One was in Chicago in January and the final Annex meeting was in London (at Brunel University) in September.

The outcomes of the Annex consist of a wide variety of data ranging from fundamental research on boiling in narrow channels to guidelines for selecting and using CHEs in heat pumping systems. There are considerable market data available within the report and the cited references, and a number of novel heat exchanger concepts including the use of new materials and the application of process intensification methods, should allow equipment manufacturers in the future to achieve the Annex aim, as summarised above.

The scope has not been limited to heat pumps in buildings – the input from the UK has been particularly focussed on industrial heat pumps, where the potential for energy savings, assuming capital costs can be made attractive, is high.



An example of CHE use in heat pumping equipment is the plate heat exchanger used as a solution heat exchanger in the Rotex heat pump (now marketed by Rotartica as an air conditioning unit in Spain).

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Annex 34

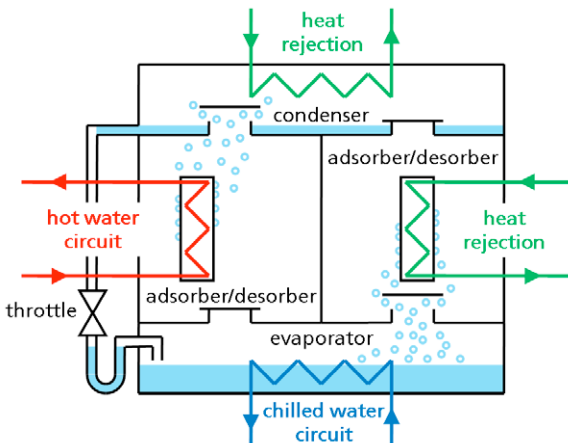
Thermally Driven Heat Pumps for Heating and Cooling

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¹⁾ The IEA Implementing Agreement Solar Heating and Cooling



Scheme of an adsorption chiller - the bubbles indicate the motion of the water vapour (heat transport)

Participating countries: Austria, Canada, Germany (Operating Agent), Italy, the Netherlands, Norway, Switzerland and the United States

Most heat pumps and chillers providing the building sector with heat or cold are driven by electricity. However, the substitution of the electrically driven compressor by a thermally driven one could lead to significant primary energy savings, especially if the heat is provided via solar or waste heat.

The goal of this Annex is therefore to reduce the environmental impact of heating and cooling by the use of thermally driven heat pumps.

One of the main objectives is to quantify the economic, environmental and energy performance of integrated thermally driven heat pumps in cooling and heating systems in a range of climates, countries and applications. From this, areas and applications with the greatest environmental benefit, the most favourable economics and the greatest market potential will be identified.

In 2009 France joined as a new Annex member, represented by Gas de France/Suez, since heat and gas-driven heat pumps have been identified as important technologies for France. This is very helpful because GdF/Suez played a substantial role in defining European standards for gas-driven heat pumps.

One of the mayor events in 2009 was the back-to-back meeting with SHC¹ Task 38, "Solar Air-Conditioning and Refrigeration", at Fraunhofer ISE in Freiburg, Germany, in April. In a full-day workshop, 95 participants discussed common problems and identified fields for further cooperation. In October a second expert meeting was held in Valladolid, Spain, since there are active institutions in Spain trying to join HPP in order to become official members of Annex 34.

Summary of task statuses and results of meetings:

Task A Market overview and state-of-the-art – A number of country reports have been compiled, showing a widespread use of thermally driven heat pumps and their different consideration in national funding schemes/building codes.

Task B Performance evaluation – The Austrian Institute of Technology (AIT) presented a proposal for the evaluation of performance standards for thermally driven heat pumps which will be discussed and tested for viability within the Annex 34 group. In Germany a directive (VDI-Richtlinie) is expected to be published in 2010.

Task C Apparatus technology – The sorption material database on the internal webpages has been updated with the first material data followed by the proposed measurement procedures. The round-robin test was extended to the property of heat conductivity since this is important for the power density of thermally driven heat pumps.

Task D System technology – A test lab to carry out tests on whole systems was set up at EURAC (Bolzano, Italy) and the first tests have already been conducted. A methodology of how to describe the systems, i.e. solar cooling/thermally driven heat pumps, was developed and agreed on with SHC Task 38.

Task E Implementation – Results from the first demonstration projects have been collected. The Technical University of Berlin has developed the first outline of the planned handbook, which will be harmonised with the SHC Task 38 handbook.

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, Sweden, 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

Summary of Annexes

Annex	Operating Agent	Participants	Completed
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
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	2005

Summary of Annexes

Annex	Operating Agent	Participants	Completed
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, Japan, Norway, Sweden, Switzerland, United Kingdom, (partly), the United States	2005
29. Ground Source Heat Pumps – Overcoming Market and Technical Barriers	Austria	Austria, Canada, Japan, Norway, Sweden, the United States	2009
30. Retrofit Heat Pumps for Buildings	Germany	France, Germany, the Netherlands	2009
31. Advanced Modeling and Tools for Analysis of Energy use in Supermarkets	Sweden	Canada, Germany, Sweden, United Kingdom (partly), the United States	Ongoing
32. Economical Heating and Cooling Systems for Low Energy Houses	Switzerland	Austria, Canada, Germany, France, Japan, the Netherlands, Norway, Sweden, Switzerland, the United States	Ongoing
33. Compact Heat Exchangers in Heat Pumping Equipment	United Kingdom	Austria, Japan, Sweden, United Kingdom, the United States	Ongoing
34. Thermally Driven Heat Pumps for Heating and Cooling	Germany	Austria, Canada, Germany, Italy, the Netherlands, Norway, Switzerland, the United States	Ongoing



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