Annual Report 2013

HEAT PUMP PROGRAMME

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

International Energy Agency

Contents

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

International Energy Agency

The International Energy Agency (IEA) is an autonomous agency established in 1974. The IEA carries out a comprehensive programme of energy co-operation among 28 advanced economies, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The aims of the IEA are to:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

To attain these goals, increased co-operation between industries, businesses and government energy technology research is indispensable. The public and private sectors must work together, share burdens and resources, while at the same time multiplying results and outcomes.

The multilateral technology initiatives (Implementing Agreements), supported by the IEA, are a flexible and effective framework for IEA member and non-member countries, businesses, industries, international organisations and non-government organisations to research breakthrough technologies, to fill existing research gaps, to build pilot plants, to carry out deployment or demonstration programmes – in short to encourage technology-related activities that support energy security, economic growth and environmental protection.

More than 6 000 specialists carry out a vast body of research through these various initiatives. To date, more than 1 300 projects have been completed. There are currently 41 Implementing Agreements (IA) working in the areas of

- Cross-Cutting Activities (information exchange, modelling, technology transfer)
- End-Use (buildings, electricity, industry, transport)
- Fossil Fuels (greenhouse-gas mitigation, supply, transformation)
- Fusion Power (international experiments)
- Renewable Energies and Hydrogen (technologies and deployment)

The Implementing Agreement for a Programme of Research, Development, Demonstration and Promotion on Heat Pumping Technologies (Heat Pump Programme) belongs to the End-Use category above.

The IAs are at the core of a network of senior experts consisting of the Committee on Energy Research and Technology (CERT), four working parties and two expert groups. A key role of the CERT is to provide leadership by guiding the IAs to shape work programmes that address current energy issues productively, by regularly reviewing their accomplishments, and suggesting reinforced efforts where needed. For further information on the IEA, the CERT and the IAs, please consult www.iea.org/techagr.

www.iea.org

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, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, South Korea, Sweden, Switzerland, the United Kingdom, 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 2013

It is once again my great pleasure to write the Chairman's Statement for the IEA Heat Pump Programme (HPP) Annual Report. In 2013, Denmark joined the HPP, which brings the member countries to 15. Two new Annexes (43 and 44) have been recently approved, giving ten ongoing Annexes. This is an exceptional number: the situation reveals the high current interest for heat pumps in member countries and more generally worldwide.

Two HPP Executive Committee meetings were held in 2013; one in Oslo in May, and one in Tokyo in November. In conjunction with these meetings, workshops were organised by Norway and Japan respectively, to present their national heat pump activities and gather more information on the HPP. A working meeting and a National Teams' meeting to discuss future activities and proposals were held in October, in Nuremberg, Germany, in conjunction with the European Heat Pump Summit. This event was also an opportunity to promote the Programme. HPP was also present at international events, such as the IEA Building Coordination Group meeting in Paris in January. HPP also held regular meetings with the European Heat Pump Association.

HPP worked closely with the IEA and provided them with updated information on heat pumps to be incorporated in the Energy Technology Perspective 2014, to be published in 2014 by the IEA.

2014 will be marked by the 11th IEA Heat Pump Conference, that will be held in May in Montreal. Current status shows a high level of interest and participation with more than 300 abstracts submitted. The conference will consist of oral presentations and posters, and will address state-of-the art technologies, applications, markets and policies in heat pumping technologies. This is a unique forum for discussions and exchanges, and to learn about the most recent developments related to heat pumps.

I look forward to meeting you in Montreal!

Sophie Hosatte
ExCo Chairman

Programme achievements 2013

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New publications 2013
The publications published during 2013 included
- Annual Report 2012
- Four Newsletter issues.

In addition, work was initialised with publications for the Montreal conference in May 2014.

HPP publications can be downloaded from the Heat Pump Centre website.

Heat Pump Centre

The Heat Pump Centre (HPC) plays a central role in the IEA Heat Pump Programme (HPP), disseminating factual and balanced information on heat pumping technologies and promoting HPP activities. SP Technical Research Institute of Sweden has been appointed to manage the HPC.

New member countries: contacts and discussions regarding membership are underway with several countries, including e.g. Russia, India, Latvia, as well as the European Union.

HPC Newsletter

One of the main activities is 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. Individuals in non-member countries can subscribe to the newsletter.

In 2013, the series of national market report articles was continued, as was the Strategic Outlook article series.

A short version of the newsletter, an e-newsletter, is available free of charge to all countries, either by e-mail subscription or by downloading from the HPC website. The number of subscribers to the e-newsletter increased slightly, by approximately 3 % compared to 2012. In addition, the newsletter is also disseminated through national teams in the member countries.

Website

Another important activity is the development and maintenance of the website, which is continuously updated with news, events, press releases 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 database.

Updates during 2013 include, for example, information on the Heat Pump Conference in Montreal (May 2014), and ideas and proposals for new Annexes.

Questionnaire

A questionnaire was distributed among our Newsletter subscribers, in order to improve the work of the programme. This was a follow-up to our large survey in 2008. However, this time there were only multiple-choice questions, resulting in much shorter post-processing than for the previous survey. The answering alternatives were based on the answers in the previous survey. The questions covered issues such as what is the most important information channel from the HPP, how is the HPP useful, how can it be more useful, and reading frequency and general view of the Newsletter. Overall, the results were positive, indicating that the HPP is working with the right issues.

60 seconds

During 2013, the Heat Pump Centre has introduced the "60 seconds" e-mail. This is a monthly, brief, bullet-format information page, giving an overview of HPC activities during the last month. It is distributed to the ExCo, and those involved in Annexes and National teams.

Activity generation

The Heat Pump Centre is also involved in the establishment of new activities within HPP. For example, it publishes descriptions of project proposals on the website in order to encourage initiation of new Annexes. HPC also maintains regular contact with the Annexes' Operating Agents, supporting them with legal text, formal participation letters, etc.

Three new Annexes were initiated in 2013, and have held their kick-off meetings: "Heat pumps in smart grids" (Annex 42), "Fuel-driven sorption heat pumps" (Annex 43), and "Performance indicators for energy-efficient supermarket buildings" (Annex 44).

In October, a working meeting and National Teams' meeting was held in Nuremberg, Germany, arranged in connection with the European Heat Pump Summit (EHPS). The main focus of the meetings was to discuss and develop ideas for research projects within the programme. During the meeting, ideas for new Annexes were discussed: "Total Refrigerant Management System", "Heat pumps in District Heating and Cooling systems", "Market implementation of heat pumps", "Heat pump systems in multi-family buildings", and "Hybrid heat pumps with gas boilers".

Contributions/Support for IEA publications and activities

During 2013, the HPP was involved with two of the major IEA publications within the general area of heat pumps. The first one was "Transition to Sustainable Buildings: Strategies and Opportunities to 2050", which was released in June, while the second one, Energy Technology Perspectives 2014 (ETP 2014) will be released in 2014. In both of these, the HPP reviewed several chapters.

The work in order to compile high quality heat pump statistics was finalized. Barriers for obtaining detailed data were identified, and ways to overcome them were outlined. From 2014, HPC will compile and distribute a set of member country specific statistics, covering our member countries. The statistics will be accompanied by country-specific analyses.

Newsletters 2013

The four 2013 newsletters and e-newsletters are available on the Heat Pump Centre website.
The topics were:
1. Thermal energy storage
2. Heat pump performance monitoring and evaluation
3. Environmental evaluation of heat pumps as products
4. Heat pumps for cold climates

International collaboration and promotion

The Heat Pump Programme and the Heat Pump Centre have excellent relations with a number of national and international organisations, including EHPA, IIR, ASHRAE, AHRI/AHRTI and China Energy Conservation Association (CECA). Examples of interactions during 2013 was participation at the US HPP National Team's meeting in Dallas in January; attending a booth together with the EHPA at the ISH fair in Frankfurt in March; and participation and presentation at the 2nd Asian Air-Source Heat Pump Conference in June 2013.

www.heatpumpcentre.org

Discussions at the National Teams' meeting

Highlights 2013

Executive committee meetings

Two meetings of the HPP Executive Committee (ExCo) were held in 2013:

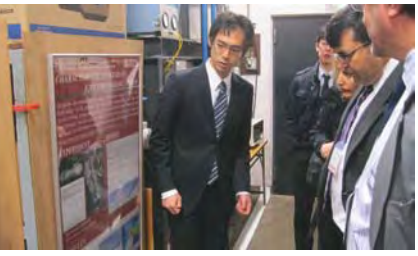
- May 28-29, in Oslo, Norway;
- November 14-15, in Tokyo, Japan.

In addition, meetings of the International Organization Committee (IOC) for the Heat Pump Conference in Montreal (May 2014) were held in connection with these ExCo meetings.

Workshops in Oslo and Tokyo

Workshops were held in Oslo on May 27, and in Tokyo on November 13, both in connection with an Executive Committee meeting. The objective of these workshops was to provide an overview of heat pump related activities in the host country, together with an international overview of policy and of innovative applications, as well as of more specific research and development. Presentations were also given of some Annexes and other projects closely related to the HPP. The workshop in Oslo also included a technical site visit to a heat pump central inside a new built hotel. At the Tokyo meeting, a guided tour of the Waseda University laboratories was held by Prof. Katsuta and Prof. Saito. The site and lab visits were both highly appreciated.

ExCo-meeting in Oslo, May 28-29



Guided tour during ExCo-meeting in Tokyo, November 14-15

Building Coordination Group meeting

The IEA Building Coordination Group (BCG) consists of representatives from all building-related IEA Implementing Agreements (IAs), and holds annual meetings. A meeting was held in January in Paris, with participation from the HPP.

The meeting focused on on-going work and achievements by the different BCG participants, including on-going and upcoming activities by the IEA. Another meeting focus was on improving co-operation. High priority areas for improvement included the role of the BCG, interactions with the IEA, and ways to improve communications among the Implementing Agreements (IAs), and between the IEA and the IAs. Discussions also focused on ways in which administrative and communicative tasks could be improved. Further, future plans regarding the ETP publications series for 2014 and beyond were discussed.

Future Buildings Forum

The HPC participated in the 3rd Future Buildings Forum in Netherlands in April 2013. This is a strategic planning effort, to plan research activities for the building sector by 2050. It was initiated by the IEA and is held once every five years. A total of 35 experts from 13 countries discussed how the built environment could be transformed into a zero-energy and low emission state.

The discussion was structured into three main themes Energy use reduction, Energy storage and management, and Energy production. For the Energy use reduction theme, these were among the main subject areas identified where R&D will be required:

- new, cost effective technologies with the aim to improve systems, not products;
- system integration on several levels, including monitoring and control;
- metrics on real data validation and standardised protocols, including user behaviour;
- knowledge on operation of different building types concerning building/user system interactions;
- knowledge of user behaviour, smart meter experience, and in-house display impacts; providing education to users and appropriate support media.

Monica Axell at the European Heat Pump Summit 2013

European Heat Pump Summit Symposium

The Heat Pump Programme attended and gave presentations at the EHPS in Nuremberg, Germany in October. The HPP also had a well-visited booth at the EHPS. A large audience were given two days of presentations, including market overviews of heat pumps for Europe, Russia and India; overviews of the European Directives regarding Ecodesign, Energy labelling and F-gas regulations; a number of presentations on components and systems, as well as the current status of HPP and the Annexes 36, 38, 40, 41, 42 and 43.

Audience at European Heat Pump Summit Symposium

Annex 36 participants at EDF, France

Discussions at the ExCo-meeting in Oslo

Ongoing annexes

Bold text indicates operating agent

35	**Annex 35** Application of Industrial Heat Pumps	AT, CA, **DE**, DK, FR, JP KR, NL, SE
36	**Annex 36** Quality Installation/Quality Maintenance Sensitivity Studies	FR, SE, UK, **US**
37	**Annex 37** Demonstration of Field Measurements of Heat Pump Systems in Buildings	CH, NO, **SE**, UK Observers: AT, DE, DK
38	**Annex 38** Solar and Heat Pump Systems	**CH**, DE, FI, FR, UK
39	**Annex 39** A Common Method for Testing and Rating of Residential HP and AC Annual/Seasonal Performance	AT, CH, DE, FI, FR, JP, KR, NL, **SE**, US
40	**Annex 40** Heat Pump Concepts for Nearly Zero-Energy Buldings	CA**, CH**, FI, JP, NL, NO, SE, US
41	**Annex 41** Cold Climate Heat Pumps (Improving Low Ambient Temperature Performance of Air-Source Heat Pumps)	AT, CA, JP, **US**
42	**Annex 42** Heat Pumps in Smart Grids	CH, DK, FR, KR, **NL**, UK, US
43	**Annex 43** Fuel Driven Sorption Heat Pumps	AT, **DE**, FR, IT, UK, US
44	**Annex 44** Performance Indicators for Energy Efficient Supermarket Buildings	**NL**, SE

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

Annex 35
Application of Industrial Heat Pumps

Participating countries: Austria, Canada, Denmark, France, **Germany**, Japan, the Netherlands, South Korea, Sweden
and from IETS Implementing Agreement: Denmark, the Netherlands, Sweden

This joint HPP/IETS annex, focused on the reduction of energy costs, fossil energy consumption and CO_2 emissions in industrial heat generation by investigating applications of industrial heat pumps, was started in April 2010 with 15 participating organisations from nine member countries of the two Implementing Agreements. The following tasks form the framework of the programme:

1. Market overview and barriers for application
2. Modelling calculation and economic models
3. Technology
4. Application and monitoring
5. External communication

Work in 2013 was marked by two Annex meetings on 17th March in Gothenburg, Sweden, and on 14th October in connection with the European Heat Pump Summit 2013 at the Exhibition Centre in Nuremberg, Germany.

The Gothenburg annex meeting was attended by 13 participants, and the Nuremberg meeting by 15 participants, in each case from eight member countries.

An extension of the annex until 30th April 2014 was agreed at the Gothenburg meeting.

Tasks 1 (Market Overview), 3 (R&D) and 4 (Case Studies) are nearly completed, with contributions from the majority of member countries. The work of the Annex is still concentrated on Task 2 "Modelling calculation and economic models", to analyse and evaluate the possible contribution of heat pumps to energy efficiency and reduction of greenhouse gas emissions from industrial processes.

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A heat pump with an output temperature up to 140 °C, with water as its working fluid.

Annex 36
Quality Installation/Quality Maintenance Sensitivity Studies

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Participating countries: France, Sweden, the United Kingdom, **the United States**

This Annex is evaluating how installation and/or maintenance deficiencies cause heat pumps to perform inefficiently (i.e., decreased efficiency and/or capacity). Also under investigation are the extent that operational deviations are significant, whether the deviations (when combined) have an additive effect on heat pump performance, and whether some deviations (among various country-specific equipment types and locations) have greater impact than others. The focus and work undertaken by each participating country is provided in Table 1.

Improved understanding on how quality installation (QI) and quality maintenance (QM) impacts equipment performance will position program managers to better apply attention, resources, and effort on the important design, installation, and maintenance parameters that impact various utility and government incentive and energy conservation programs. Additionally, this improved understanding can help building owners/operators and homeowners to consider the full value-to-cost proposition, not merely the "first price", when making equipment purchasing, installation, and maintenance decisions. Ultimately, adherence to QI and QM practices will help customers achieve enhanced comfort, reduced energy usage, improved occupant productivity, and enhanced occupant safety.

During 2013, the Annex Participants focused on completing individual country contributions for this three year effort. In October 2013, the Annex held its third annual meeting (at the Electricité de France R&D facility Site des Renardieres near Moret sur Loing, France) to review progress. To permit the conclusion of some additional work by various Annex participants, a time extension through July 2014 was requested and granted. The Annex's final results are to be presented at a workshop held in conjunction with the 11th IEA Heat Pump Conference (Montreal, Canada, May 2014) with the formal report to be completed and submitted by July 2014.

Table 1: Focus areas and effort

Annex 36 participants	Focus Area	Work Emphasis
France	EdF – Space heating and water heating applications.	Field: Customer feedback survey on HP system installations, maintenance, and after-sales service. Lab: Water heating performance tests on sensitivity parameters and analysis.
Sweden	SP – Large heat pumps for multi-family and commercial buildings KTH/SVEP – Geothermal heat pumps	Field: SP – Literature review of operation and maintenance for larger heat pumps. KTH/SVEP - investigations and statistical analysis of 22000 heat pump failures. Modeling/Lab: Determination of failure modes and analysis of found failures (SP) and failure statistics (KTH/SVEP).
the United Kingdom	DECC – Home heating with ground-to-water, water-to-water, air-to-water, and air-to-air systems.	Field: Replace and monitor five geothermal heating systems Lab: Investigate the impact of thermostatic radiator valves on heat pump system performance.
the United States (Operating Agent)	NIST – Air-to-air residential heat pumps installed in residential applications (cooling and heating).	Modeling: Examine previous work and laboratory tests to assess the impact of ranges of selected faults covered augmented by seasonal analyses modeling to include effects of different building types (slab vs. basement foundations, etc.) and climates in the assessment of various faults on heat pump performance. Lab: Cooling and heating tests with imposed faults to model the performance of a heat pump operating under those faults.

Annex 37

Demonstration of Field Measurements of Heat Pump Systems in Buildings - Good Examples with Modern Technology

Participating countries: Norway, Switzerland, **Sweden**, the United Kingdom
Observers: Austria, Denmark, Germany

The aim of this project is to demonstrate and disseminate the economic, environmental and energy-saving potentials of heat pumping technology. The focus is on modern technology, using results from existing field measurements in order to calculate energy savings and CO_2 reductions. It should be possible to predict the most suitable heat source and heat pump system for particular applications in particular geographic regions. It is important that the quality of the measurements is guaranteed, and so the criteria for good and assured quality have been defined in the project.

Summary of task statuses

Task 1 A common template of what should be communicated has been developed.

Task 2 The criteria for good quality of field measurements have been agreed. This includes boundaries of the measured systems, number and location of measuring points within the building, and accepted measurement uncertainty. Additionally, the SPF limits for good heat pumps were set to 3.0 for air-source heat pumps and 3.8 for ground-source heat pumps.

Task 3 Results from field measurements on heat pump systems were collected. Each country has at least three sets of field measurements, but not all heat pumps meet the criteria decided in Task 2.

Task 4 Agreement has been reached concerning how to calculate the seasonal performance factor, energy savings and carbon footprints for field measurements with different measurement set-ups. These parameters will be compared with those for other heating systems.

Task 5 The field measurements will be presented on the HPC website and in a brochure.

Task 6 Information dissemination. At least three good examples from each participating country will be presented on the IEA HPC website. Guidelines for manufacturers and installers will be provided.

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One of the studied buildings, located in Sweden. The building is equipped with an air-source heat pump and solar panels for DHW production.

Annex 38
Solar and Heat Pump Systems

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SOLAR + HEAT PUMP

Participating countries: Switzerland, Germany, Finland, France, the United Kingdom **and from SHC:** Austria, Belgium, Canada, Denmark, Germany, Spain, Sweden, Switzerland, the United States

The objectives of this Annex are to assess performances and relevance of combined systems using solar thermal collectors and heat pumps, to provide a common definition of performances of such systems, and to contribute to successful market penetration of these new, promising combinations of renewable technologies.

The Annex considers solar thermal systems in combination with heat pumps, used for the supply of domestic hot water and heating in family houses. It is thus dedicated to small systems in the range of 5 to 20 kW.

Any type of solar collector can be considered: using a liquid heat transfer fluid, air, hybrid collectors, or even hybrid thermal and photovoltaic or photovoltaic-thermal (PVT) collectors. All of them can be glazed or unglazed.

Any type of heat source for the heat pump was considered: air, water or ground source. The main focus was on heat pumps driven by electricity, as these are the main types on the market since 2009.

The Annex was a joint effort of the Solar Heating and Cooling Programme and the Heat Pump Programme (HPP). It is Task 44 for SHC and Annex 38 for HPP. It ended in December 2013.

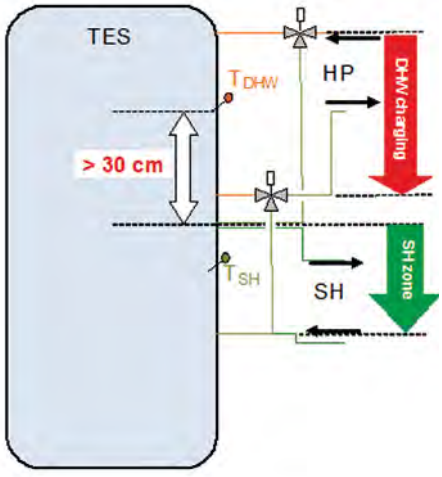
Subtask A of Annex 38 dealt with field test monitoring.

Several SHP systems have been monitored for one or two years, and the main results are available in technical reports. About 25 different SHP systems have been monitored during the duration of the work. A diagram of all observed seasonal performance factors (SPFHP+ as defined in Sub-task B) has been issued in Report A3. High performances have been measured in some cases, allowing Annex 38 to propose best practice recommendations in the final report of the Annex, to appear in 2014, edited by Wiley-VCH in Germany.

Annex 38 has developed a range of simulation tools to simulate all kind of solar and heat pump combinations. National teams have used these tools and the task framework to optimise several aspects of solar and heat pump combinations. One of these aspects concerns the heat storage, which is shared by the solar collectors and the heat pump in the most common parallel arrangement.

Recommendations derived from many simulations have been formulated in a Sub-task C report, available in March 2014.

Annex 38 published a third newsletter in February 2013, available on the Annex web site together with all final reports.



Recommendation on how to connect a combination heat store (TES) in a solar and heat pump installation

Annex 39

A Common Method for Testing and Rating of Residential HP and AC Annual/Seasonal Performance

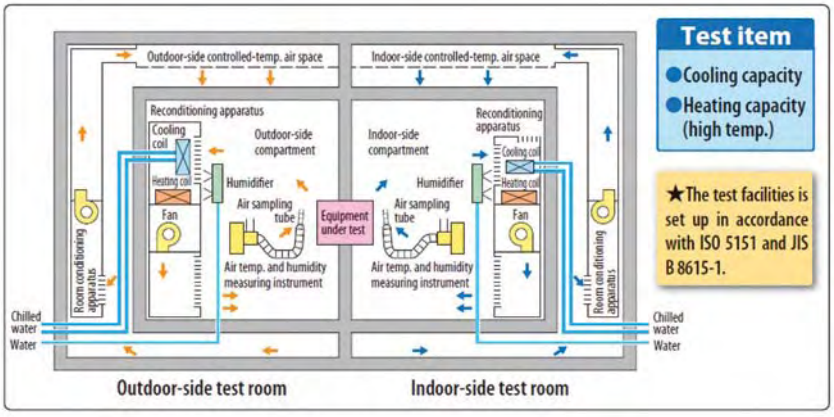
Participating countries: Austria, Finland, France, Germany, Japan, the Netherlands, South Korea, **Sweden**, Switzerland, the United States

The outcome from Annex 39 will be proposals for harmonization of SPF calculation methods for domestic heat pumps, including heating, cooling and domestic hot water production, as well as proposals for global harmonization of test points, to minimize testing efforts. The idea is to conduct pre-normative research, which later can be incorporated in standardization (ISO, CEN etc.).

The following task-sharing activities have been planned and initiated:
Task 1 Review and evaluation of existing test and calculation methods for SPF.
In task 1, a template for reporting has been developed, and the national methods are currently summarized.
Task 2 Development of a matrix defining needs for testing and calculation methods
Task 3 New calculation methods for SPF / commonly accepted definitions on how SPF is calculated
Task 4 Identification of improvements of existing test procedures
Task 5 Validation of SPF method
Task 6 Development of an alternative method to evaluate heat pump performance
Task 7 Communication to stakeholders

Two meetings were held in 2013, one in Brussels in parallel with the EHPA General Assembly, in which many of the participating members could join, and one in Tokyo before the HPP ExCo meeting. Information on national and international standards has been collected and analyzed, and a SWOT analysis of current standards has been made. In addition, Japan has compiled information on test laboratory accuracy which can serve as a benchmark for minimum requirements in testing. What is extra interesting is the detailed schematics of the set-up of the test equipment.

The project website can be reached via this link: http://www.heatpumpcentre.org/en/projects/ongoingprojects/annex39/Sidor/default.aspx.



Balanced ambient room-type calorimeter

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Annex 40

Heat Pump Concepts for Nearly Zero-Energy Buildings

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Participating countries: Canada, Finland, Japan, the Netherlands, Norway, Sweden, **Switzerland**, the United States

Political targets indicate that nearly Zero Energy Buildings (nZEB) are the next step of high performance buildings. Europe and the USA both foresee a substantial introduction of nZEB in the new building sector by 2020. In Japan, the projected target for the introduction of nZEB is 2030. However, although political targets focus strongly on nZEB, no consistent definition covering the various aspects of nZEB has yet been established.

Heat pumps are already well established as HVAC systems in nZEBs that have been built. However, current nZEBs are generally more or less prototypes, to prove the zero energy balance. Thus the objective of this Annex is to investigate and further develop customised heat pump system solutions for the particular requirements of nZEBs. Potentials are seen in building and system integrations, since the nZEB concept comprises renewable energy sources on site.

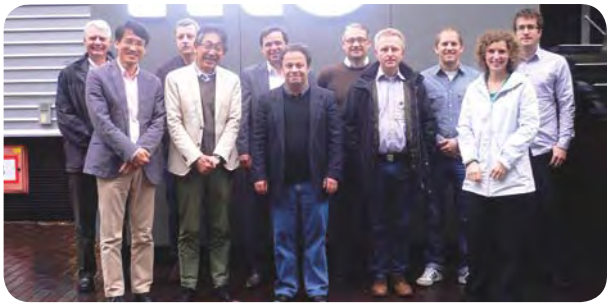
The principal objectives are:

- to improve and further develop heat pump systems for nZEBs
- to gather more field experience from operation of novel and existing heat pumps in nZEBs, and
- to produce recommendations and best practice systems for heat pump use in nZEBs.

The Annex has been structured into four tasks:

Task 1 State-of-the-art survey of nZEBs and applied technologies in nZEBs
Task 2 Optimisation of system concepts regarding performance and cost
Task 3 Technology development and field-testing of systems (in parallel with Task 2)
Task 4 Integration of nZEBs into the energy system (in parallel with Task 2).

In 2013, the IEA HPP project work started with state-of-the-art analysis of existing nZEB pilot and demonstration buildings in the participating countries. Results were discussed at a working meeting in May 2013 at SINTEF Energy Research, Trondheim, Norway. Central European countries and the US have already several hundreds of nZEBs, of which some have been monitored in detail. Heat pumps are very common for nZEB applications in Switzerland, being used in over 80 % of the installed systems.



Group photo from the 3rd working meeting held at the TNO in Delft, The Netherlands, in October 2013

The definition of nZEB for the work of Annex 40 has been fixed. Currently, work on Task 2, the system technology analysis for modelling nZEBs, and on Task 3, the development of heat pump technologies for nZEBs and the evaluation of field monitoring projects, is ongoing. Interim results have been presented and discussed at a working meeting at TNO in Delft, The Netherlands in October 2013.

Canada and Finland joined the Annex at the end of 2013, and Germany has announced that it is also interested in joining the Annex in 2014.

Task 4 is dedicated to the integration of nZEBs into the energy system, where aspects such as storage integration, control and the use of IC-technologies may become important. Interim results from IEA HPP Annex 40 will be presented at a workshop in connection with the IEA Heat Pump Conference in May 2014.

Annex 41

Cold Climate Heat Pumps (Improving Low Ambient Temperature Performance of Air-Source Heat Pumps)

Participating countries: Austria, Canada, Japan, **the United States**

Heat pump technology provides a significant potential for CO_2 emissions reduction. Annex 41 will revisit research and development work in different countries to examine technology improvements leading to successful heat pump experience in cold regions. The primary focus is on electrically driven air-source heat pumps (ASHP) with air (air-to-air HP) or hydronic (air-to-water HP) heating systems, since these products suffer severe loss of heating capacity and efficiency at lower outdoor temperatures. Thermally activated (engine-driven, absorption, etc.) ASHPs and ground-source heat pumps (GSHP) may also be included in individual country contributions, if desired. The main technical objective is to identify solutions leading to ASHPs with heating SPF ≥ 2.63 W/W, recognized as a renewable technology. The main outcome of this Annex is expected to be information-sharing on viable means to improve ASHP performance under cold (≤ -7°C) ambient temperatures.

The 1st working meeting of the Annex was held at Purdue University on July 1-2, 2013. Among the highlights to report is the fact that Austria announced just after the meeting its intention to become an official Participant in the Annex, joining Japan and the US. At the meeting the Japanese and US teams provided a number of presentations, describing technical progress and plans for the Annex work. Additionally, the Japanese and US teams submitted draft Task 1 reports. A common characteristic to note about all the various system configurations being investigated (analytically and experimentally) by the Annex Participants is the added complexity required in order to achieve significant improvement in low ambient temperature heating capacity (and efficiency) for an ASHP. Additional compressor capacity or novel compressor approaches, cycle enhancements (ejectors or vapor injection), or incorporation of supplemental renewable energy sources will be necessary. These capacity and efficiency enhancement measures will lead to more complex (and costly) systems compared to standard single-compressor ASHPs. A web site, http://web.ornl.gov/sci/ees/etsd/btric/usnt/QiQmAnnex/indexAnnex41.shtml, was established to collect meeting minutes and presentations as well as reports generated by the Annex.

After the meeting at Purdue, Austria and Canada joined the Annex in July and December, respectively. The next planned meetings of the Annex are a workshop and brief business meeting to be held at the 11th International Heat Pump Conference in Montreal. A final Annex meeting and workshop are planned for August 2015 in Yokohama, Japan, during the 2015 International Congress of Refrigeration. The Annex officially began in July 2012 and is expected to run through September 2015.

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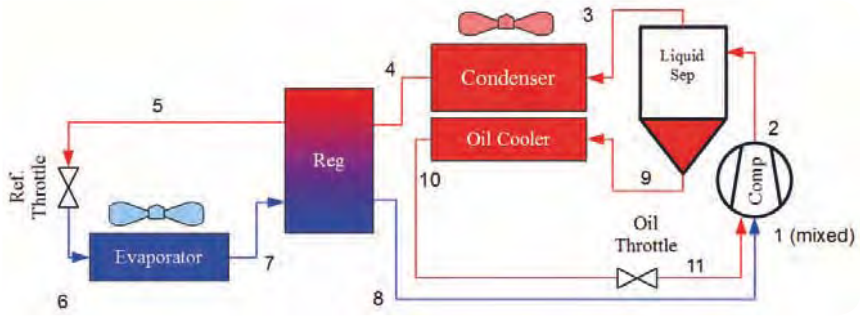

Oil-flooded compressor heat pump cycle concept to approach isothermal compression – schematic (top) and P-H diagram (bottom); test system under construction at Purdue.

Annex 42
Heat Pumps in Smart Grids

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Task structure
Task 1: Market overview, barriers for application;
Task 2: System aspects and opportunities;
Task 3: Modelling and technology;
Task 4: System technology and application;
Task 5: Communication

Participating countries: Denmark, France, **the Netherlands**, South Korea, Switzerland, the United Kingdom, the United States

Just like wind power, photovoltaic, solar heating, biomass and other renewable energy sources, heat pumps will become increasingly common in future energy systems in the built environment. It will therefore become more important to match user consumption to production from varying energy sources. Energy consumption will need to be aligned (in terms of time) with availability, instead of being called for at some random time chosen by the consumer/user. In addition to investigating the potential of heat pumps connected to smart grids for shaving peak loads on the electricity system, there is also a need to investigate how heat pumps can be implemented in smart cities or on local energy grids supplying smaller housing sectors or settlements, in parallel with district heating or other energy sources.

Objectives and scope: The objective of this annex is to help to reduce the use of energy and reduce greenhouse gas emissions by greater use of heat pumps (ground source, water source, air-to-water and hybrid types) in smart grids. See task structure in the left margin.

Deliverables: A summary report will be prepared for policy-makers, summing up the results from Tasks 1-3, including input from discussions in the working group. The ExCo and national policy-makers will be informed of the need for further projects or annexes on heat pump implementation in smart grids and in future smart cities.

Progress of the Annex: The Annex 42 group had its first meeting in May 2013 in Brussels, attended by country representatives potentially interested in participation in the annex: UK, the Netherlands, France, Germany, Sweden, Austria, South Korea and Denmark. The outline of a project structure, extracted from and in accordance with the legal text, was drafted and discussed at the meeting. This project structure formed the basis for a successful meeting in Nuremberg in October 2013, and progress on the annex became more visible.

At the Nuremberg meeting, progress was made on progressively consolidating the annex into a more defined shape. Task leaders have been appointed, with task descriptions, expected outputs, planning and a table of contents of the task report, subject to further discussions. This work was continued at the regular annex project meeting in February 2014 at EDF in France.

A growing number of countries - confirmed participants being the United Kingdom, the Netherlands, South Korea, the USA, Switzerland, France and Denmark, Sweden, Finland, Austria and Germany in the process of becoming fully fledged participants - are interested in joining the annex.

The Annex has a time frame of 36 months, from May 2013 until June 2016.

As Operating Agent, we will also participate in the triannual heat pump conference in Montreal in May 2014, including a workshop on heat pumps in smart grids, presenting a paper and presentation about heat pumps in future smart grids, accompanied by a regular Annex 42 project meeting.

Annex 43
Fuel Driven Sorption Heat Pumps

Participating countries: Austria, France, **Germany**, Italy, the United Kingdom, the United States

During the work in Annex 34 "Thermally Driven Heat Pumps for Heating and Cooling" there was a rising interest in the area of fuel driven sorption heat pumps, and more and more products came closer to market. Therefore a new Annex, "Fuel driven sorption heat pumps", was proposed to the ExCo in March 2012. After an Annex definition meeting, a Legal Text was written, and accepted as a draft by the ExCo, so Annex 43 started officially in July 2013 with a planned duration of four years. A kick-off meeting was held on 9-10 October 2013 in Freiburg, Germany, with participants from six countries. The main topics were the finalisation of the Legal Text and the work plan, as well as setting up the organisational framework.

Objectives: The scope of the work under this Annex will be the use of fuel driven sorption heat pumps in domestic and small commercial or industrial buildings and applications. If applicable, the additional possibility of supplying cold will also be considered. The main goal is to widen the use of fuel driven heat pumps by accelerating technical development and market readiness of the technology, as well as to identify market barriers and supporting measures. Further specification of tasks:

Task A- Generic Systems and System Classification
- Available sources and heating systems
- Existing market and regulatory boundary conditions
- Control strategies

Task B - Technology Transfer
- Link research to industrial development for faster market penetration of new technologies
- Novel materials (e.g. metal-organic frameworks (MOFs) for adsorption heat pumps)
- Novel components (integrated evaporators/condensers, compact heat exchangers)
- System designs (e.g. façade collector as heat source)

Task C - Field test and performance evaluation
- Measurement/monitoring procedures standardisation (e.g. how to cope with different fuel quality, system boundaries, aux. energy, etc.)
- Extend standards to seasonal performance factors at a system level

Task D - Market potential study and technology roadmap
- Simulation study to evaluate different technologies in different climate zones, different building types and building standards.
- Combine with market data and actual building stock for technology roadmap

Task E - Policy measures and recommendations, information
- Dissemination
- Workshops for planners, installers and decision makers
- Develop recommendations for policies, e.g., building codes and funding schemes

Within Task A, a template for the country report was prepared by ISE and send out to the participants. A presentation of the Annex was given at the Heat Pump Summit 2013 in October 2013 in Nuremberg, and an abstract was submitted to the International Sorption Heat Pump Conference in March 2014, in Maryland, USA.

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Group picture of the Kick-off meeting held in Freiburg, Germany, October 2013

Annex 44

Performance Indicators for Energy Efficient Supermarket Buildings

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Participating countries: the Netherlands, Sweden

Annex 44 was approved during 2013 and started with a kick-off meeting on June 27th in Stockholm. A second meeting was held in Utrecht (The Netherlands) on November 25th, and several teleconferences were held in between.

Objective

There is a clear trend for more and more monitoring systems, measuring parameters such as temperatures (typically to secure and validate food quality) and energy, to be installed in supermarkets. Measurements are taken and stored, and energy cost data is available, but still in many cases there is no knowledge of the supermarket's energy efficiency compared to other supermarkets in the same chain, or to competing supermarkets. This Annex will define performance indicators that will make it possible to evaluate energy efficiency of existing single supermarkets, supermarkets in a chain, supermarkets across different chains, and even supermarkets in different regions or countries.

Target audience

This will give supermarket organisations the ability to turn their available data into knowledge concerning the energy efficiency of their store(s), and use it for energy-related decisions and investments. Accurate energy consumption data for supermarkets can also be used at a national level to map energy use and benchmark best practices for supermarket buildings.

Work plan

The following tasks are defined in the Annex work plan:

1. Mapping existing energy systems in supermarkets and collection of monitored data from selected supermarket chains and individual supermarkets
2. Definitions & inventory of resources & System boundaries
3. Suggestions of suitable key performance indicators
4. Evaluation of existing monitoring methodology
5. Selection and refinement of selected key performance indicators
6. Evaluation (and validation)
7. Dissemination

Supermarket refrigeration installation.

Participation

The Annex was initiated in 2013, with Sweden and The Netherlands as participants. Other potential participants have been contacted, which has led to the expectation that at least one additional participant will join in 2014. The Annex is still open for new participants during 2014.

Image sources

Front page
Building in Tokyo, ExCo meeting, Oct 2013. HPC
Prof Saito, guided tour Waseda University, Tokyo, November 2013. HPC
Audience, European Heat Pump Summit Symposium, Oct 2013. NuernbergMesse/Frank Boxler
Tokyo city view, ExCo meeting, Oct 2013. HPC
Discussions at HPP National Teams' meeting, Nuremberg, Oct 2013. Johan Berg, HPC
Caroline Stenvall, HPC, National Teams' meeting, Oct 2013. Johan Berg, HPC

Programme achievements (p. 6-7)
Discussions at the National Teams' meeting, Nuremberg, Oct 2013. Johan Berg, HPC

Highlights (p. 8-9)
Tokyo City view, Tokyo. HPC
Group photo, ExCo meeting, Oslo, May 2013. Johan Berg, HPC
Prof Saito, guided tour Waseda University, Tokyo, November 2013. HPC
Audience at European Heat PumpSummit Symposium. Oct 2013. NuernbergMesse/Frank Boxler
Annex 36 participants at EDF, France, Oct 2013. Annex 36
Discussions at ExCo meeting, Oslo, May 2013. Johan Berg, HPC

Annex 35 (p. 11)
A heat pump with an output temperature up to 140 °C, with water as its working fluid. EdF R&D France

Annex 37 (p. 13)
One of the studied buildings, located in Sweden. The building is equipped with an air-source heat pump and solar panels for DHW production. Annex 37

Annex 38 (p. 14)
IEA Solar Heating and Cooling Implementing Agreement logotype. Annex 38
Recommendation on how to connect a combination heat store in a solar and heat pump installation. Copyright IEA T44A38. Annex 38

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Balanced ambient room-type calorimeter. Annex 39

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Prof Carsten Wemhöner, Heat Pump Summit 2011, NuernbergMesse /Frank Boxler
Group photo from the 3rd working meeting held at the TNO in Delft, The Netherlands, Oct 2013. Annex 40

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Van Baxter, IEA HPP Symposium, Chillventa congressing 2013. NuernbergMesse/Thomas Geiger
Oil-flooded compressor heat pump cycle concept to approach isothermal compression – schematic; test system under construction at Purdue. Purdue University

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Group photo. Annex 42

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Group picture of the Kick-off meeting, Freiburg, Germany, Oct 2013. Annex 43

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Supermarket refrigeration installation. Annex 44, v. d. Sluis

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