ANNUAL REPORT 2015

HEAT PUMPING TECHNOLOGIES

Technology Collaboration Programme on
Heat Pumping Technologies - HPT TCP

iea Energy Technology Network
International Energy Agency

IEA OECD
Technology Collaboration Programme
on Heat Pumping Technologies

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HPT TCP Annual Report 2015

www.heatpumpcentre.org

April 2016

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IEA
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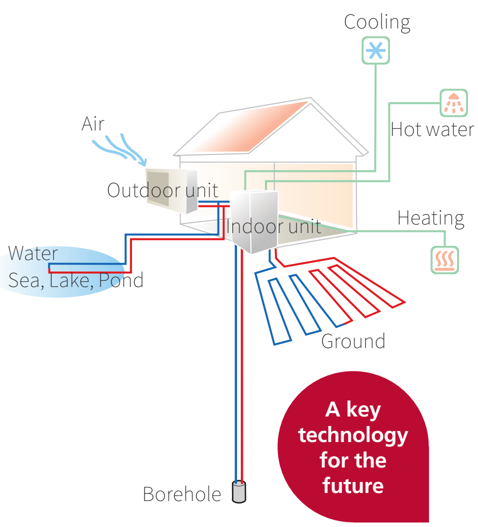
Technology Collaboration Programme on
Heat Pumping Technologies (HPT TCP)

Message from the Chairman



Heat pumps have reached a high state of technical development and are used in large numbers throughout the world as highly efficient heating or cooling systems. Besides room heating, domestic hot water heat pumps meet an increasing amount of sales. The necessity to reduce the carbon footprint of heating appliances and the trend to low temperature district heating systems open opportunities for large heat pumps. On the other hand, one can observe an increasing worldwide demand for air conditioning. The only single technology that can fulfil this is the heat pumping technology. Nevertheless, there are various challenges that have to be met and these lead to the demand for more research and development.

As the chairman of the Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP) it is my pleasure that with the work and the findings in our Annexes we can contribute to this development on an international basis and are present in all the promising fields. In 2015 we launched four new Annexes and another two are prepared to be launched in 2016. The new Annexes cover topics like Hybrid Heat Pumps, Heat Pumps for Domestic Hot Water, Heat Pumps in District Heating and Cooling systems and Industrial Heat Pumps. Ideas for new Annexes are developed in a first step during the National Teams' Meeting, which this year was held in Nuremberg, Germany.

The important work of international collaboration can only be done with a good cooperation among the participating countries and the contributions from the delegates. It is important to know that in both of the Executive Committee Meetings in 2015 all fifteen participating countries were represented by their delegates or alternate delegates. The first meeting was held in May in Aarhus (Denmark) and the second in November in Basel (Switzerland). In conjunction with these meetings, workshops were organised by the host countries. The workshops are an important opportunity to present the work of HPT TCP and learn more about the market situation and research and development projects in the organising country. During 2015, one new country decided to join the HPT TCP Agreement, and we are happy to welcome Belgium!

Dissemination of information about heat pumping technologies and the outcomes of our Annexes is an important task of HPT TCP. The Heat Pump Centre fulfils a significant part of this. One example is this annual report with the aim to inform in a concentrated manner about the targets and new developments in our work and most important findings from the Annexes. It is an ongoing duty to improve the means of communication. This is the reason why we developed an update of our communication strategy. A first result is the new format of the annual report.

Looking back to my first year as the chairman of HPT TCP I must say that it is a pleasure to collaborate with the delegates in the Executive Committee, to see the efforts of the Operating Agents and their teams in the Annexes, and to be supported in all fields of activities by the staff of Heat Pump Centre. Many thanks to all of them.

Stephan Renz, Chairman of the Executive Committee

International Energy Agency

Established in 1974, the **International Energy Agency (IEA)** carries out a comprehensive programme of energy co-operation for its 29 member countries and beyond by examining the full spectrum of energy issues and advocating policies that will enhance energy security, economic development, environmental awareness and engagement worldwide. The IEA is governed by the IEA Governing Board which is supported through a number of specialised standing groups and committees.

For more information on the IEA, see *www.iea.org*.

The IEA Energy Technology Network
The IEA Energy Technology Network (ETN) is comprised of 6 000 experts participating in governing bodies and international groups managing technology programmes. The *Committee on Energy Research and Technology (CERT)*, comprised of senior experts from IEA member governments, considers effective energy technology and policies to improve energy security, encourage environmental protection and maintain economic growth.

The CERT is supported by four specialised Working Parties:

- *Working Party on Energy End-use Technologies (EUWP)*: technologies and processes to improve efficiency in the buildings, electricity, industry, and transport sectors
- *Working Party on Fossil Fuels (WPFF)*: cleaner use of coal, improvements in gas/oil exploration, and carbon capture and storage
- *Fusion Power Co-ordinating Committee (FPCC)*: fusion devices, technologies, materials, and physics phenomena
- *Working Party on Renewable Energy Technology (REWP)*: technologies, socio-economic issues and deployment policies

Each Working Party coordinates the research activities of relevant IEA Technology Collaboration Programmes (TCPs). The CERT directly oversees TCPs of a cross-cutting nature.

The IEA Technology Collaboration Programmes (TCPs)
The IEA Technology Collaboration Programmes (TCPs) are international groups of experts that enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues, from building pilot plants to providing policy guidance in support of energy security, economic growth and environmental protection. The first TCP was created in 1975. To date, TCP participants have examined close to 2 000 topics. Today, TCP participants represent more than 300 public and private-sector organisations from over 50 countries. TCPs are governed by a flexible and effective *framework* and organised through an Implementing Agreement. TCP activities and programmes are managed and financed by the participants.

To learn more about the TCPs, please consult the short *promotional film*, the *Frequently Asked Questions* brochure, or the IEA website *www.iea.org/tcp*.

Technology Collaboration Programme on Heat Pumping Technologies



Organised under the umbrella of the International Energy Agency since 1978, the Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP) 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.

HPT TCP MEMBER COUNTRIES
Austria, Belgium, 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 significantly improve the visibility and status of the Programme, and to be an outstanding Technology Collaboration Programme within the IEA.

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

Highlights 2015

Executive Committee Meetings
Two meetings of the HPT TCP Executive Committee (ExCo) were held in 2015:

- May 5-6, in Aarhus, Denmark;
- November 10-11 in Basel, Switzerland.

Workshops in Aarhus and Basel
Two workshops were held in conjunction with the Executive Committee meetings, in Aarhus on May 4, and in Basel on November 9.

The objectives of the workshops were to provide an overview of heat pump-related activities in the host country, presentations of plans and progress of some of the HPT TCP Annexes, together with an international overview of policy, market, and innovative applications, as well as of more specific research and development.

Both of the workshops concluded with site visits; the Aarhus workshop with a tour of labs at the Danish Technological Institute (DTI), the Basel workshop participants visited the Energy Research Lab (ERL).

Building Coordination Group Meeting
The IEA Building Coordination Group (BCG) consists of representatives from all building-related Technology Collaboration Programmes (TCPs), and holds annual meetings. A meeting was held in January in Paris, with participation from the HPT TCP.

As at previous meetings, the meeting highlighted work and achievements by the different TCPs, including ongoing and upcoming activities by the IEA. Another meeting focus was on improving co-operation, both between the TCPs and the IEA secretariat and directly between the TCPs.

It was emphasized that cross-cutting contacts between TCPs are important. IEA representatives wanted to know what issues are missing at the IEA that the BCG group can address.

Further, the IEA pointed out that they need data regarding energy efficiency, in a format that can be used for their analyses, for instance for the ETP publications; HPC is in close contact with the IEA regarding this issue. Finally, the importance of awareness raising, especially directed towards policy makers was emphasized.

IEA Heat Pump Conference

12th IEA Heat Pump Conference 2017

At the fall ExCo meeting in 2014 the bid for the 12th IEA Heat Pump Conference in 2017 was awarded to the Netherlands. The Conference will be held at the World Trade Centre in Rotterdam from 15 – 18th May. The theme of the Conference is: '**Rethink Energy, Act NOW!**'

This is a time of **rethinking** or a paradigm change. The era of heat pumps and other renewables is inevitable. The main solutions and choices will not be made purely on economics, but more on expectations on future energy systems and infrastructures becoming dependent on insecure suppliers and on electricity from renewable sources. Ecological concerns become key drivers for policy makers and consumers alike, and their choices are fundamentally altering the energy business landscape.

Renewable energy is inevitable because we still use more and more energy based upon fossil fuels that is not sustainable. Thus, from an environmental point of view, it is necessary for us to increase our use of renewable energy, in order to stop 'the race to the cliff', as evidenced by *World Overshoot Day*.

The message of the Conference goes beyond the standard slogans like energy efficiency, renewables and environment.

In the area of heating and cooling systems, there is a great urgency to **act now**. Almost all current investments made in this sector will have a long-term effect on overall energy use. The renovation of a heating system will impact energy usage for the next 15 to 20 years. At the same time, almost all these measures to reduce energy emissions, whether implemented within the industrial, commercial or residential market, can be categorized as "no-regret options" and should be prioritized in a systematic policy approach.

Policy makers worldwide must give primary consideration to heating and cooling usage and look at the best available options. Here heat pumps play a key role as an already available and proven technology.

Progress in the Conference Organisation

The Conference is organized by the NOC in collaboration with the IOC. The International Organizing Committee has as chairman Mr Per Jonasson (Sweden) and two vice chairs, being Mrs Sophie Hosatte (Canada) and Mr Hiroshi Okumura (Japan). The National Organizing committee has a chairman, Mr Onno Kleefkens and vice chair, Mr Raymond Beuken.

An initial IOC meeting was held at the spring ExCo meeting in Aarhus and a second meeting at the fall ExCo meeting in Basel. All ExCo participating countries joined in the meetings. Good progress was made during these meetings on the development of the preliminary program for the Conference. This template program is used by the NOC as basis for the first Call for Papers which was opened on 1st December 2015.

Conference Program

The first day will start with the Annex related workshops. At the European Heat Pump Summit in Nuremberg the NOC-chair organized a special meeting for the Operating Agents of the Annexes. As the workshops on the first day of the Conference are an integral part of the Conference and marketed as such, an outline has been developed for the Annexes, where these will be presented as a coherent package. For example, HPT TCP Annexes with a focus on residential applications (Annexes 40, 45, 46, 47), those on industry and others like sorption. The Operating Agents from other IEA Technology Collaboration Programs have been invited to join, for instance Energy in Buildings and Communities (EBC). The NOC is looking into the possibility of having a workshop on heat pumps in combination with other technologies.

On the second day the Conference will be opened with a plenary opening session where high level speakers will give presentations in line with the theme of the Conference.

After the main plenary opening session the Conference will consist of three main sessions running in parallel tracks.

- **Residential heat pumps** focusing on: Nearly Zero Energy Buildings; Technologies for Renovation; Hybrid Heat Pumps; Domestic Hot Water Heat Pumps; Multi Family Buildings
- **Non-residential heat pumps** focusing on: Industrial Heat Pumps; Waste Heat Recovery; District Heating; Commercial Buildings; Greenhouses.
- **Innovation and R&D** focusing on technology topics like: Ground sources; Advanced storage systems; Working fluids; Combination with other renewable technologies; Sorption technologies; Non vapour Compression; Smart grids/energy; Cold climate heat pumps; Air Conditioning; Gas driven heat pumps

These topics are listed in the first call for papers where authors are asked in detail to specify their topic. This is in order to simplify the selection of papers on contents and to make sessions consistent.

Each session will be opened by an invited keynote speaker with the goal to place the topic of the session in line with the theme of the Conference. ExCo delegates are asked to propose these speakers.

Communication and Promotion Strategy

A Communication Strategy has been developed to market the Conference consisting of:

- **Conference Website**: The website (*www.hpc2017.org*) is the foundation for all promotional activities related to the meeting. It is custom designed to provide key information in a clear and concise manner, keeping potential participants updated and interested in all things connected with the conference. The website is optimized with Search Engine Optimization (SEO) to reach the highest possible ranking for searches on selected keywords in the leading search engines (Google, Yahoo and Bing) to gain high visibility on internet channels and reach a wide prospective audience.
- **Direct mailing** – A series of 12 direct e-mailings are foreseen where a list of 3650 addresses is used with an increasing number of subscribers to this mailing.
- **Promotion Material** – A first card has been printed and distributed at the European Heat Pump Forum in Brussels, the IIR Conference in Yokohama and at the European Heat Pump Summit in Nuremberg. A brochure designed for Abstract Submission has been printed as a flyer and distributed at the ASHRAE Winter Conference. A Sponsor brochure has been developed as an on-line document and sent to a number of potential sponsors.
- **Multimedia** – Videos and photos are particularly useful in attracting attention. Two videos of heat pump projects in Rotterdam are shown on the website and YouTube.
- **Promotion** – For the promotion of the Conference, partners are found in EHPA, IIR and other organizations.

Heat Pump Centre

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

As for new members, contacts and discussions regarding membership are under way with several countries, including China and Poland, as well as with the European Union. A Chinese delegation of fifteen people visited the HPC.

During 2015, the HPC has put significant efforts in developing a new communication strategy, re-considering both goals and means. This has included, for example, discussions with the Task Force Group and ExCo on communication, and distribution and compilation of a communication survey among the ExCo delegates.

HPC Newsletter

One of HPC's 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.

During 2015, the Newsletter has been available free of charge to HPT TCP member countries from the HPC website.

During 2015, a short version of the Newsletter, an e-newsletter, has been 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 by approximately 6 % compared to 2014. In addition, the Newsletter is also disseminated through national teams in the member countries.

Four articles from the Newsletter and the Conference have been re-published in a Chinese journal, "HVAC Special", which is a subsidiary of "Journal of HV&AC".

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 HPT TCP Annexes are also available on the website, as well as HPT TCP publications, which are accessible via a database.

Updates during 2015 include the addition of Final reports and two-page summaries for three Annexes (Annexes 35, 36, and 38), as well as two Annex Executive summaries (Annexes 35 and 36). Further, all Conference Proceedings Papers from the IEA Heat Pump Conferences in 2014, 2011, 2008, and 2005 have been made available for free downloading.

60 seconds

During 2015, the Heat Pump Centre has continued to distribute 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.

Newsletters 2015

The four 2015 newsletters and e-newsletters are available on the Heat Pump Centre website.
The topics were:

1. Quality installation / Quality maintenance
2. Space cooling
3. Ground source heat pumps
4. Innovative/alternative/non-conventional HP technologies

Activity Generation

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

The National Teams' meeting was held in Nuremberg, Germany in October, with high attendance. The main focus of the meeting was to generate new activities in the form of Annexes and Annex ideas, and to discuss research needs and trends in the member countries. At the meeting four Annex ideas were discussed, of which two were decided to be taken further: *Acoustic Signatures of Heat Pumps* and *Non-vapor-compression Technologies*. Another idea which attracted interest was *Ground Source Heat Pumps*, which may be taken further. One idea discussed will not be taken further at the moment: *Affordable, Reliable, Sustainable and Modern Energy for All*.

Three Annex proposals were discussed at the ExCo meeting in Basel in November, all of which may be approved in the near future. These are *Development of Precompetetive Open and Standardized Communication Protocols to Facilitate Commissioning and Re-commissioning* (continuation of Annex 36), *Heat Pumps in Multi-family Buildings,* and *Heat Pump Concept for Nearly Zero Energy Buildings* (continuation of Annex 40). Another Annex proposal discussed at the ExCo meeting in November was *Air conditioning*, which was decided to be taken further as a special task.

Finally, two new Annexes were started in 2015, *Hybrid Heat Pumps* (Annex 45) and *Heat Pumps for Domestic Hot Water* (Annex 46), and two more were approved, *Heat Pumps in District Heating and Cooling Systems* (Annex 47) and *Industrial Heat Pumps, Second Phase* (Annex 48).

Contributions/Support for IEA Publications and Activities

The IEA continues its series of publications Energy Technology Perspectives (ETP). This was previously a bi-annual publication, but is now published annually. The HPT TCP reviewed and commented on a draft of part of the ETP 2016, 'Building sustainable urban energy systems'. The HPT TCP also gave input to the outline of the ETP 2017.

International Collaboration and Promotion

The HPT TCP and the HPC 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 2015 include participation, by invitation, and presentations at the IEA Energy Conservation though Energy Storage (ECES) Greenstock conference (Beijing, China), at the 2015 China Heat Pump Alliance Annual Conference and 4th Asia Air Source Heat Pump Forum (both in Nanjing, China), and at the National Heat Pump Symposium organized by the Flemish Heat Pump Association (Belgium), and at the European Heat Pump Symposium (Nuremberg, Germany), as well as exhibition at the ICR2015 - the 24th IIR International Congress of Refrigeration (Yokohama, Japan).

Member Country Reports

Using the template that has been developed, and material received from the countries, member country reports or draft reports have been compiled for three countries.

Heat Pump Centre
www.heatpumpcentre.org

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Ongoing Research Projects

The projects within the HPT TCP are known as Annexes.

Participation in an Annex is an efficient way of increasing national knowledge, both regarding the specific project objective, but also by international information exchange.

Annexes operate for a limited period of time, and objectives may vary from research to implementation of new technology. Market aspects are other examples of issues that can be highlighted in the projects.

OUTLOOK IN THE FUTURE

For more information regarding *Annex proposals*, *Annex ideas* and *Special tasks*, see *Activity Generation* on page 12.

Ongoing Annexes

The Technology Collaboration Programme on Heat Pumping Technologies participating countries are: Austria (AT), Belgium (BE), 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 IEA Heat Pump Centre (HPC). Sweden is the host country for the Heat Pump Centre.

Bold text indicates Operating Agent

Domestic Hot Water Heat Pumps NEW	46	FR, **NL**, JP, KR, UK
Hybrid Heat Pumps NEW	45	FR, **NL**, DE, UK
Performance Indicators for Energy Efficient Supermarket Buildings	44	DK, **NL**, SE
Fuel-Driven Sorption Heat Pumps	43	AT, **DE**, FR, IT, UK, US
Heat Pumps in Smart Grids	42	AT, CH, DE, DK, FR, KR, **NL**, UK, US
Cold Climate Heat Pumps (Improving Low Ambient Temperature Performance of Air-Source Heat Pumps)	41	AT, CA, JP, **US**
Heat Pump Concepts for Nearly Zero-Energy Buildings	40	CA, **CH**, DE, FI, JP, NL, NO, SE, US
A Common Method for Testing and Rating of Residential HP and AC Annual/Seasonal Performance	39	AT, CH, DE, FI, FR, JP, KR, NL, **SE**, US
Demonstration of Field Measurements of Heat Pump Systems in Buildings	37	CH, NO, **SE**, UK

Demonstration of Field Measurements of Heat Pump Systems in Buildings

ANNEX 37

There is a need to be able to demonstrate the potential for energy savings and CO_2 reduction with heat pumping technology. There is also a need among the public for increased knowledge of the efficiency of heat pumps in real installations, especially concerning heat pump systems for combined operation including heating, cooling and domestic hot water production.

Demonstration of heat pump systems would be an efficient way of communicating the potential of the technology, promoting top-of-the-line heat pump systems and also improving existing guidelines for selection, design and installation of systems. Demonstration of best available heat pump technology is a way to achieve further acceptance for the technology and, in that way, to increase take-up in new markets.

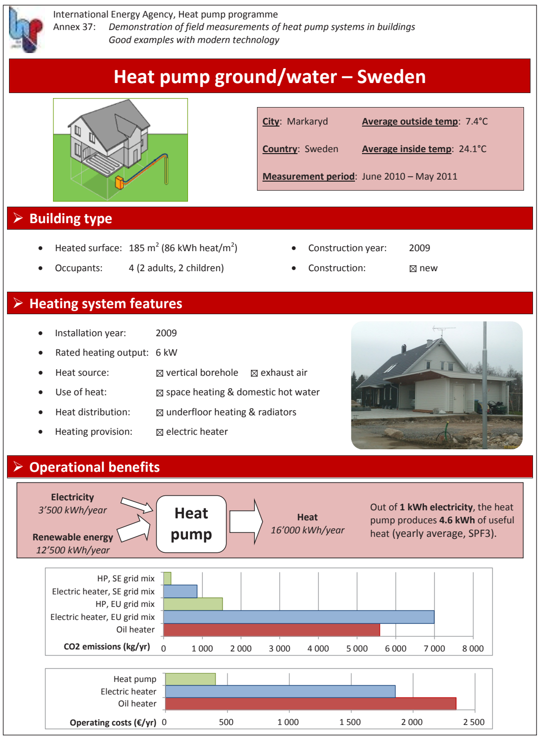

Figure 1. Site descriptions

> ***There is a need to be able to demonstrate the potential for energy savings and CO_2 reduction with heat pumping technology.***
>
> ***There is also a need among the public for increased knowledge of the efficiency of heat pumps in real installations, especially concerning heat pump systems for combined operation including heating, cooling and domestic hot water production.***

The aim of this project has been to demonstrate and disseminate the economic, energy and environmental potentials of heat pumping technology. The focus was on best available technology, and results from existing field measurements were used to calculate energy and cost savings and CO_2 reductions. In order to draw the right conclusions, it is most important that the quality of the measurements is assured to be sufficiently good. The criteria for good and assured quality of both the heat pump performance and field measurement installation were defined in the project.

OBJECTIVES

Therefore, Annex 37 was to present examples of domestic heat pump systems with good performance, and to give guidance on what could be considered good performance. The objectives of the Annex 37 were to:

» Demonstrate the potential with heat pumping technology for all types of domestic buildings from existing field measurements. The focus was on the best available technology. The electricity consumption and energy savings,

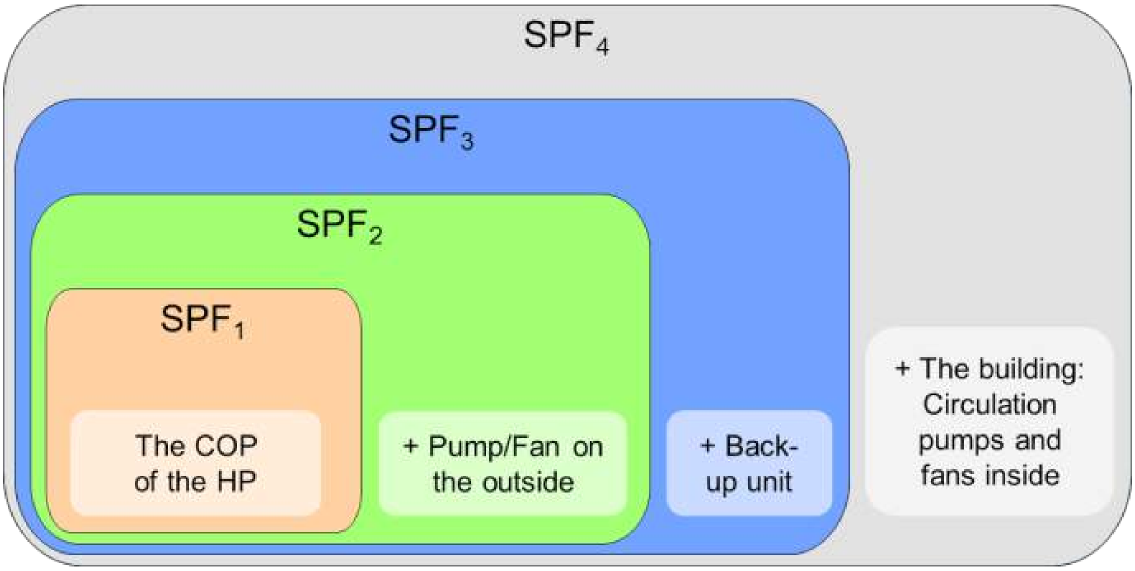

Figure 2. System boundaries for electrically driven heat pump systems applied in this Annex.

compared to alternative ways of heating, should be calculated.

» Improve the understanding of key parameters influencing the reliability and efficiency of heat pump systems.

HIGHLIGHTS from the Annex 37 deliverables

1. As one of the main conclusions from this project, air-source systems should be considered as good systems if they have an SPF_{H3} value (see Figure 2) of 2.8 - 3.2 and above. The corresponding values for ground source systems is 3.3 - 3.9 and above (see Table 1).

Table 1. Threshold values to be regarded as a good system.

	ASHP, new	ASHP, retrofit	GSHP, new	GSHP, retrofit
SPF_{H3}	3.2	2.8	3.9	3.3

2. It is important to clearly communicate system boundaries for the field measurement results. SPF_{H4} is probably the most relevant to house owners, but SPF_{H3} is the most relevant when comparing to other heating systems.

3. Heat pumps can reduce CO_2 emissions. In Sweden and Switzerland, where the carbon content of electricity is low (0.04 kg CO_2/kWh, 2009 figures), using a heat pump resulted in average CO_2 savings of more than 5 tonnes as compared to an oil boiler for the evaluated sites. In the UK, the default fuel is gas and the carbon content of electricity is considerably higher (0.49 kg CO_2/kWh), but the average saving was still 1.25 tonnes CO_2/year.

Project duration:
May 2011 – December 2015

Operating Agent:
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Participating countries:
Sweden, Switzerland, and the United Kingdom

Further information:
www.heatpumpcentre.org

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

ANNEX 39

In order to achieve an excellent working heat pump system, the right type of heat pump must be selected and installed with a matching heat distribution system. For this reason, it is important to have reliable information on both the heat pump itself and how it is influenced by the surrounding system and the climatic conditions under which it operates.

A common method for determining the Seasonal Performance Factor (SPF) would be important for a fair comparison between different types of heat pump systems, as well as for a fair comparison with other competing technologies, e.g. those using fossil fuels.

Presently a large number of national standards for both testing and calculation of SPF exist around the world. There is a request from manufacturers to have globally common testing methods and common SPF methods, since this would simplify the export of heat pumps to different countries. The question has been highlighted in the European countries after the RES Directive was approved. Also in Japan the existing standards need to be updated, and a common methodology is desired.

In order to achieve an excellent working heat pump system, the right type of heat pump must be selected and installed with a matching heat distribution system.

For this reason, it is important to have reliable information on both the heat pump itself and how it is influenced by the surrounding system and the climatic conditions under which it operates.

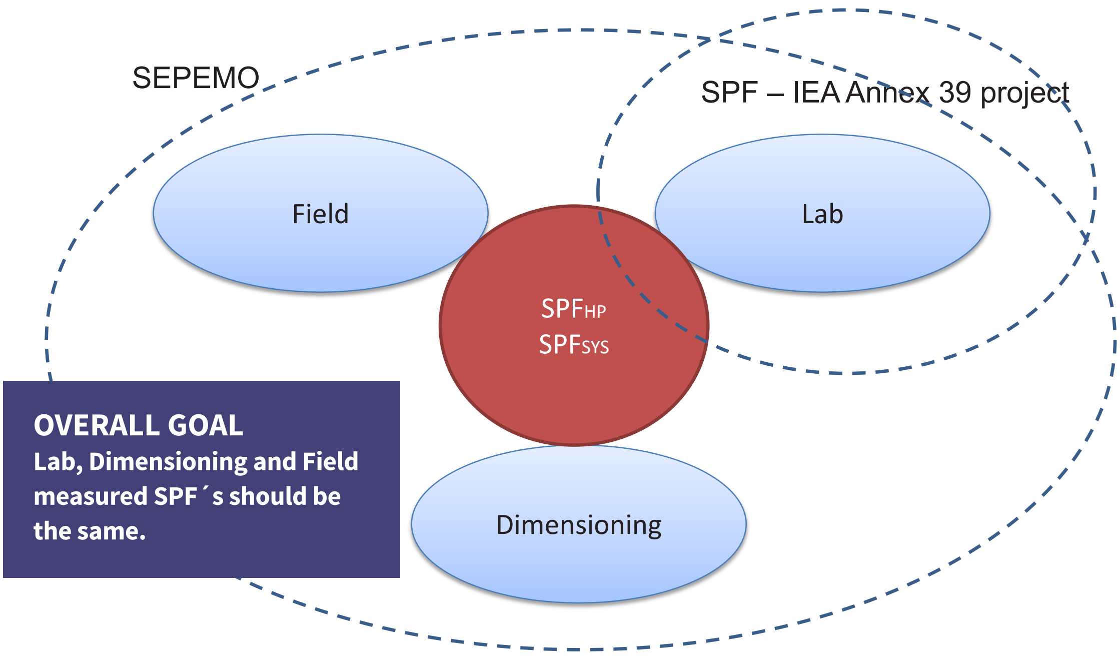

Figure 1. Scope for Annex 39, compared to the EU project SEPEMO.

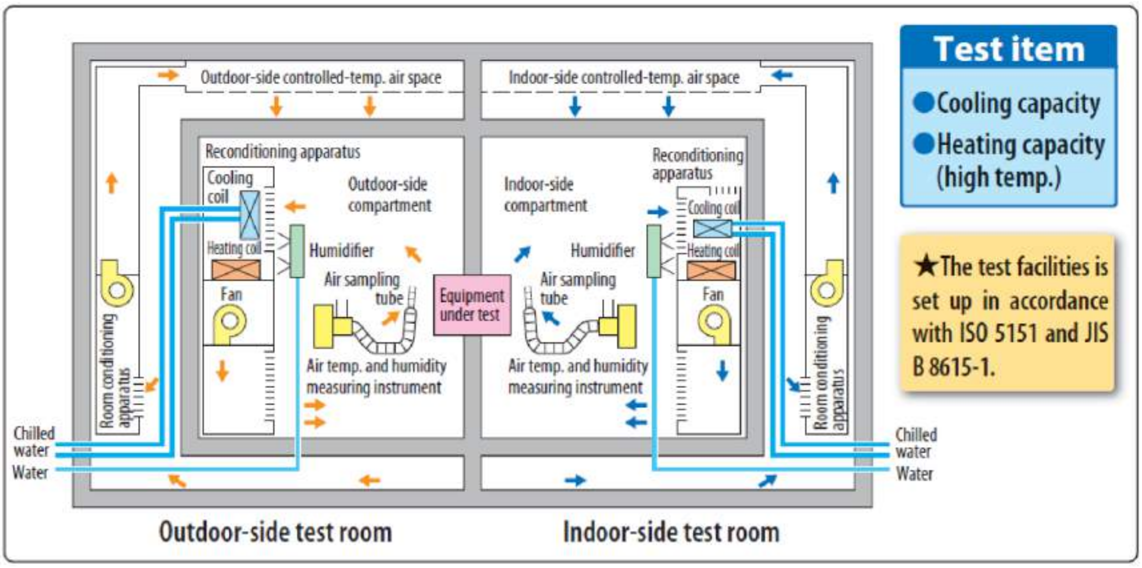

Figure 2. Balanced ambient room-type calorimeter.

OBJECTIVES

The objectives of the Annex 39 were to:

» Establish common calculation methods for SPF, using a generalised and transparent approach.

The focus is on a fair comparison between different heat pump types, but also on comparison between heat pumps and various competing technologies, such as pellet boilers, gas boilers, etc.

» Establish comprehensive test methods based on further development of existing test standards. The test standards should include test conditions needed for future SPF calculations.

» Develop a method to evaluate additional heat pump performance, e.g. Carbon Footprint, Primary Energy Savings or Energy Savings.

HIGHLIGHTS from the Annex 39 deliverables

1. Test points should be harmonised, so that a similar set of test points are tested in the test labs.

   There must be room for local (national, regional) variations, especially regarding climatic conditions and building demand profiles.

   Therefore, a matrix of test conditions could include the necessary test points, and voluntary test points that need to be tested for certain markets (e.g., in cold climates, one -15 °C point should be included).

2. As simulations become more and more accepted to define building integrated heating performance, there should be very transparent models for buildings, heating systems, as well as regarding climatic data.

   For each equation or other relation of a model, the operating range for each parameter should be clearly defined. Otherwise, there is a risk that the final performance numbers are compromised by uncertainties in simulations models.

Project duration:
September 2011 – December 2015

Operating Agent:
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Participating countries:
Austria, Finland, France, Germany, Japan, the Netherlands, South Korea, Sweden, Switzerland, and the United States.

Further information:
www.heatpumpcentre.org

Heat Pump Concepts for Nearly Zero-Energy Buildings

ANNEX 40

Nearly Zero Energy Buildings (nZEB) are the political target for new buildings after 2020. Even though the time schedule in the EU is quite tight, only a limited number of nZEB have been built so far, and no common definition of an nZEB is yet in place.

In order to achieve an nZEB consumption a good building envelope and on-site renewable energy generation are combined. In existing nZEBs heat pumps already play an important role in HVAC systems, since they have some favourable features for nearly zero energy buildings. They are highly efficient in combination with adapted systems of low supply temperatures, which can be installed in buildings with high performance envelopes and low space heating loads. Moreover, heat pumps offer multi-functional operation for different building services, and integration options of heat pumps with other building technologies can be a further advantage of the heat pump application in nZEB. Thereby, the energy demand is covered very efficiently,

> ***nZEBs are highly efficient in combination with adapted systems of low supply temperatures, which can be installed in buildings with high performance envelopes and low space heating loads.***

which reduces the need for on-site generation to meet the balance. On the other hand, by the on-site generation in nZEB, the building is no longer only a consumer, but becomes a prosumer. In this context, heat pumps enable local load management by storing electricity surplus from on-site generation as space heating and cooling energy in connection with storage, using the building´s thermal mass or in a seperate storage. In this way, heat pumps can link electrical to thermal infrastructure, a concept called *power2heat*. This aspect may become more important with a broad introduction of nZEB requirements in building codes intended for the years 2020 – 2030 in countries around the world.

Figure 1. First MINERGIE-A® certified building in canton Zurich with mixed residential and office use. The building has been monitored and optimized within the framework of Annex 40.

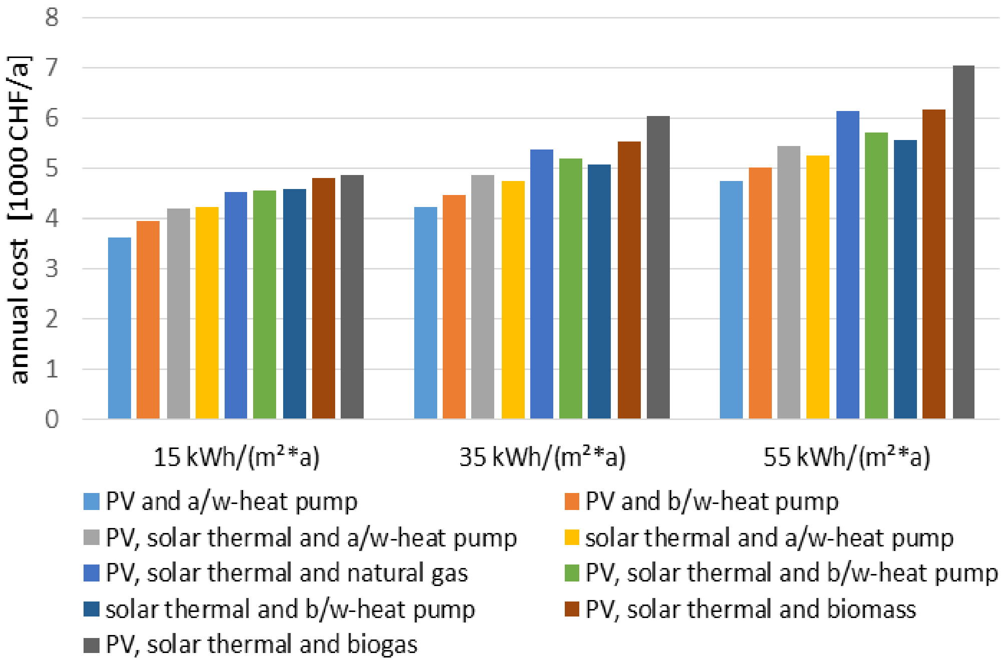

Figure 2. Case study of heating systems for nZEB in Switzerland. Heat pumps range among the most energy-efficient and cost-effective systems. Results of other case studies in Nordic countries in HPT TCP Annex 40 show similar results.

OBJECTIVES

Therefore Annex 40 was to assess and further develop heat pump concepts for nearly Zero Energy Buildings.

The objectives of Annex 40 are to:

- » characterise the state-of-the-art of the application of heat pumps in existing nearly Zero Energy Buildings and assess systems with heat pumps;
- » develop and lab-test new integrated heat pumps in the nZEB capacity range and combinations with other technologies, such as solar generators and storage;
- » evaluate the heat pump performance in nZEB by field monitoring in order to verify the nearly zero energy balance and characterise integration into the energy system.

HIGHLIGHTS from the Annex 40 deliverables

1. Case studies and technology comparison for HVAC systems in nZEB across different countries and regions in Europe, Canada and Japan regarding system performance and cost confirm that heat pumps range among the most energy-efficient and cost-effective system solutions.
2. Prototype developments of integrated heat pump solutions and combinations with other generators have been evaluated. Results include lab-testing and field monitoring of prototypes covering different building functions.
3. Field monitoring of heat pumps in nZEB confirm the good performance and remaining optimisation potential in true operation. Field monitoring results also comprise the first evaluations of heat pumps in Nordic nZEB, in Norway.
4. Demand-response has been evaluated in field monitoring of heat pumps for residential and office use with e-mobility. Evaluations show a reduction of grid-interaction by the load shift options with the heat pump.

Project duration:
July 2012 – December 2015

Operating Agent:
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Participating countries:
Canada, Finland, Germany, Japan, the Netherlands, Norway, Sweden, Switzerland, and the USA

Further information:
www.annex40.net

Cold Climate Heat Pumps

Improving Low Ambient Temperature Performance of Air-Source Heat Pumps

ANNEX 41

In 2012, Annex 41 was established to investigate technology solutions to improve performance of heat pumps for cold climates. The primary technology focus is electrically driven air-source heat pumps (ASHPs), with air or hydronic heating distribution systems. Some novel ground-source heat pump (GSHP) approaches are also being investigated by some of the participants. The main outcome of this Annex is expected to be information-sharing on viable means to improve ASHP performance in cold climate locations. For purposes of the Annex, cold climate locales are loosely defined as those with a significant number of hours having ambient temperatures < -7 °C. Availability of ASHPs with improved low ambient performance would help bring about a much stronger heat pump market presence in cold areas. Such areas today rely predominantly on fossil fuel heating systems or, where natural gas is not readily available, on propane or oil furnaces, conventional electric heat pumps or even electric resistance heating systems.

> ***The main outcome of this Annex is expected to be information-sharing on viable means to improve ASHP performance in cold climate locations.***

Electric vapor-compression cycle based ASHPs generally have the lowest installation cost of all heat pump alternatives. They also have the most significant cold climate performance challenges, given their inherent efficiency and capacity issues at cold outdoor temperatures. Traditional single-stage ASHPs suffer significant loss of heating capacity (and efficiency) as the outdoor temperature drops. Figure 1 illustrates the capacity problem. While the heat pump space heating capacity is falling, the building space heating load

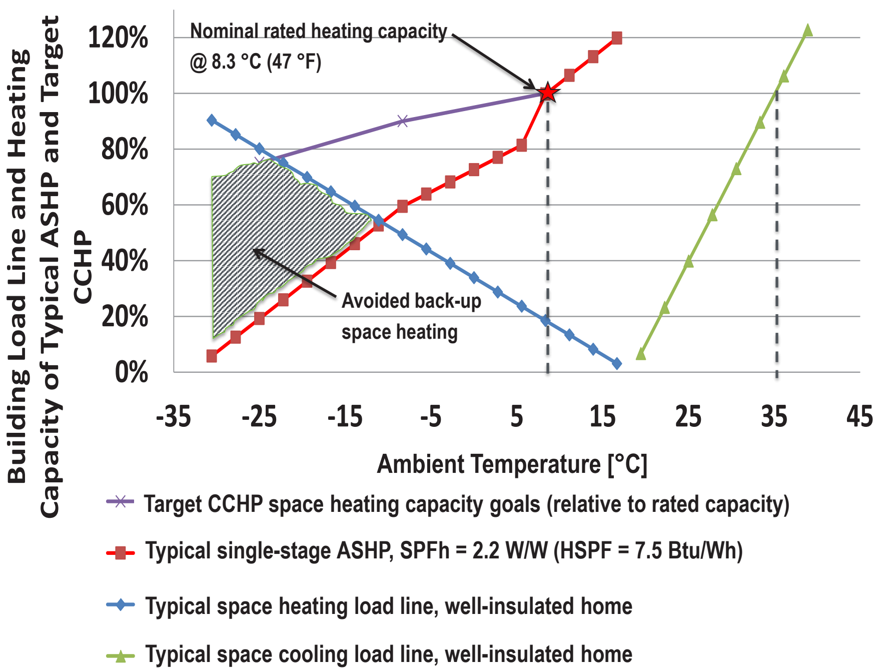

Figure 1. Space heating capacity vs. ambient temperature for target Cold Climate Heat Pumps (CCHP) and typical single-stage air-to-air ASHP compared to typical load lines for a reasonably well insulated house

it is required to meet is rising, causing the heat pump to rely on a backup system (usually electric resistance for air-to-air heat pumps using air distribution systems, or an electric or fuel-fired boiler for air-to-water heat pumps using hydronic distribution systems) to make up its capacity shortfall.

The figure also illustrates the impact that frosting and defrosting of the outdoor air heat exchanger (OHX) has on single-stage system heating capacity at moderately low outdoor temperatures (between about -5 °C to 7-8 °C; see the downward notch in the red curve).

One specific technical target for CCHPs driving the R&D of the Annex 41 members is to achieve ASHP solutions that have space heating capacity at -25 °C (-13 °F) ≥ 75 % of nominal rated capacity (e.g., the "Target" capacity line in Figure 1), thus greatly reducing reliance on back up heating (see the shaded area in Figure 1).

Another is to achieve an "in field" heating Seasonal Performance Factor (SPF_h) > 2.63 W/W (US Heating Seasonal Performance Factor or HSPF > 8.97 Btu/Wh).

PRINCIPAL ACTIVITIES

Principal activities being undertaken by each participant are as follow:

» Austria – analyses of alternative vapor compression cycle concepts for cold climate ASHPs, as well as experimental investigation of the frosting performance of advanced OHXs
» Canada – field tests of existing ASHPs in Canadian climatic conditions; evaluation of ASHP performance standards; lab/analytical investigation of novel direct expansion GSHP system using CO_2; lab/analytical investigation of solar assisted slurry-ice-source heat pump system
» Japan – lab/analytical evaluation of frosting phenomena on a range of OHX fin geometries; investigation of an Air Source Heat Pump Water Heater (ASHPWH) system concept using desiccant-coated heat exchangers to minimize frosting/defrosting impacts; development of heat pipe geothermal heat exchanger concept for GSHP systems
» U.S. – analyses and lab/field testing of improved vapor compression cycle ASHP concepts for cold climate applications, including single-stage, multi-stage, and oil-flooded compressor systems

A common characteristic to note about all the various system configurations is the added complexity required in order to achieve significant improvement in the low ambient temperature heating capacity and efficiency for an ASHP, compared to conventional single-capacity ASHPs. Additional compressor capacity (via a variable-speed drive, multiple compressors, or multi-stage compressors, etc.) or novel compressor approaches, cycle enhancements (ejectors or vapor injection), or incorporation of supplemental renewable energy sources may be necessary. These enhancement measures will come at the expense of more complex (and costly) systems, compared to conventional single-capacity ASHPs.

OBJECTIVES & DELIVERABLES

» Each participant completes surveys of previous R&D results and literature pertaining to cold climate heat pump applications
» Country reports and Annex interim and final reports covering analyses and evaluations of CCHP system design options (analyses and tests) and energy savings estimates
» Short summary document(s) for policy makers and technology stakeholders

PROGRESS TOWARD DELIVERABLES, TO DATE

» Prior literature and R&D survey reports submitted by all participants
» Interim report completed and posted to Annex web site
» Final report submission to ExCo expected by July 2016

Project duration:
2012 – 2016

Operating Agent:

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Van Baxter

Participating countries:
Austria, Canada, Japan, and the USA

Further information:
http://web.ornl.gov/sci/ees/etsd/btric/usnt/QiQmAnnex/indexAnnex41.shtml

Heat Pumps in Smart Grids

ANNEX 42

More widespread use of heat pumps in energy systems in the build environment will significantly increase the possibility to adjust user-consumption to production from varying sustainable energy sources. Besides investigating the potential of heat pumps related to smart grids with regard to equalizing peak loads in the electricity system, it is also necessary to investigate absorbing the electricity from intermittent sources into domestic housing.

Figure 1 shows the grid loads on the coldest day in 2013 and the coldest day in 2030 in an average Dutch municipality with 13 000 houses. What is visualized are the significant consequences for an electricity network when the numbers of heat pumps and electric vehicles are predicted to grow considerably during the coming years.

This growth in penetration of heat pumps and electric vehicles makes smart grids a necessity, but at the same time it offers an opportunity to absorb renewable electricity from intermittent sources.

OBJECTIVES & SCOPE

Annex 42 is to contribute to a reduction in the use of fossil energy and also a reduction of CO_2 emissions. These two goals will be met by increasing the implementation of heat pumps in smart grids while handling the increasing production of sustainable electrical power.

> ***More widespread use of heat pumps in energy systems in the built environment will significantly increase the possibility to adjust user-consumption to production from varying sustainable energy sources.***

DELIVERABLES

- » Knowledge dissemination between the participants;
- » Leaflet style 5-6 pages report for policy makers;
- » Scientific summary 2 pages;
- » Main summary of 40 – 50 pages, with as much visualized information as possible;
- » Background data and information: all the task and country reports preferably accessible online on the Annex 42 website.
- » The ExCo and national policy makers will be advised regarding the needs for further projects or annexes on heat pump implementation in smart grids.

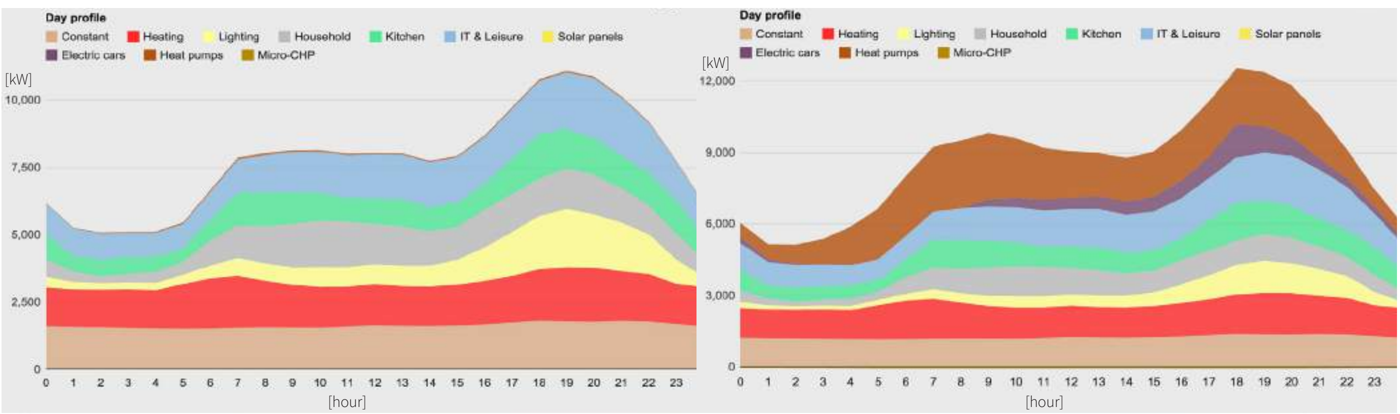

Figure 1. Grid loads on the coldest day in 2013 (left) and 2030 (right) in a typical Dutch municipality

PROGRESS OF THE ANNEX

During 2015 we have focussed on developing the approach of case scenarios and simulation (on flexibility, performance, comfort) programs to a further stage. Simulations should, where possible, including thermal storage options. Since it seemed very difficult to find a common approach for doing this, it was decided in 2014 that each country will do their own calculations or simulations in their own way.

Three main aspects and outcomes shall be used as a general guideline for all countries.

1. How large is the problem or challenge each country is facing?
2. How much of that problem can you solve with the various case scenarios?
3. What is the price to pay for this solution(s)?

In 2016, implementation barriers for implementing the suggested systems in the case scenarios will be the main subject of the group. Furthermore, a roadmap that tries to stipulate the challenges to be overcome will be drafted for smart connected heat pumps.

> *HORIZON 2020 – WORK PROGRAMME 2014-2015*
> The Technology Readiness Levels (TRL) – level 1 up to level 9 – as used within the Horizon 2020 program can be applied to the varying development stages of heat pumps in smart grids in the participants' countries. This ladder-wise approach gives a comprehensive overview of the current status of each country, and which technology readiness level, e.g. knowledge level, that can be expected.

MOST REMARKABLE NEWS/DEVELOPMENTS IN 2015

- **The Netherlands**: The introduction of flexible tariffs for end users, based on 15 min intervals, is to be tested soon. This development was expected as a rather far future development, but if the test runs successfully, it will become available nationwide in 2018.
- **Germany:** EEbus standards, as developed in Germany, can communicate with most other existing standards. Information can be found on EEbus.org.
- **The United Kingdom:** In Manchester a smart grid trial has been run, with 600 heat pumps, mostly all-electric, some hybrids. The district network operator wants to find out how much load can be shifted.
- **Switzerland:** The whole pool will respond to price as one entity if housings with a heat pump are connected to the grid by means of a virtual power plant (VPP). This means that the coincidence factor goes up, compared to heat pumps that are not pooled in a VPP. VPP responding to price is good for the end consumer, but bad for the grid load.
- **Switzerland and Germany:** There is a cultural aspect that beats any monetary based business case: the intrinsic thrive for autonomy. An individual house can fulfil its own energy need and become less dependent from the distribution system operator (DSO). This cultural aspect could be driven by the level of trust there is in the electricity grid of DSO's in general. In countries with a lower uptime of the e-grid, people will have higher interest in the possibility of autonomy.
- **Austria:** The project had a two step approach. Within the first step, an expanded model was developed for simulations of individual heat pump behaviour in a modelled house. A simplified model will be derived from this that will be used to make a pool of housings with heat pumps and which will simulate the behaviour of the whole pool.

Due to the availability of the results from the simulation studies, the Annex will run (inclusive production of the summary reporting) until December 2016.

Project duration:
May 2013 – December 2016

Operating Agent:
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Participating countries:
Austria, Denmark, France, Germany, the Netherlands, South Korea, Switzerland, the United Kingdom, and the USA

Further information:
http://www.annex42.nl

Fuel-Driven Sorption Heat Pumps

ANNEX 43

The heat pump market is dominated today by electrically driven compression technology. After a period of stagnation, thermally driven sorption technology was "rediscovered" at the end of the 20th century, mainly for thermally driven cooling. In recent years, gas fired sorption heat pumps were identified as an efficient solution for space heating and sanitary hot water preparation, mainly in existing buildings. Consequently, a number of products had already entered the market. These are seen as a complementary technology to electrically driven heat pumps with a potential to reduce the requirements on the electricity grid and to balance the overall energyconsumptioninafutureenergymixbyusing different sources (e.g. biogas, power-to-gas) and the existing infrastructure. The technology is efficient especially in existing buildings and is often seen as the next generation of efficient condensing gas boilers with a significant usage of renewable energy.

> ***The heat pump market is dominated today by electrically driven compression technology.***

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 as more and more products came closer to market. Therefore, a new Annex "Fuel-Driven Sorption Heat Pumps" started with the aim to support the technology at this early stage through the cooperation of experts from the industry and the academia. The Annex interacts with other stakeholders in this field like the working group "thermally driven heat pumps" of the EHPA.

Figure 1. Field test of a gas driven heat pump under cold climate conditions

SCOPE
The scope of the work is 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 cooling may be considered. The main goal is to extend 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.

DELIVERABLES

- A report on generic systems and a standardized system classification methodology.
- A report on state of the art in fuel driven heat pumps and novel materials, components and promising new system designs developed during the Annex.
- A market potential study and technology roadmap based on a simulation study
- A standard to monitor and measure performance of installed fuel driven heat pumps, taking into account different system boundaries, fuel quality and auxiliary energy consumption, field test reports.
- A comparision between different test standards on gas driven heat pumps and possibly propose a new one.

PROGRESS
In 2015, a first proposal for a standardised monitoring procedure for gas driven heat pumps was sent to the participants and is planned to be tested in the future.

Simulation models for gas driven heat pumps have been set up, boundary conditions for a simulation study have been discussed and first results showed promising performance for gas driven heat pumps under different conditions.

Several component developments (adsorbers, evaporators) have been performed in projects related to this annex and discussed with this group.

In September 2015 an international conference about sorption heat pumps with more than 100 participants from all over the world was organised by Annex 43 members in Milazzo, Sicily, Italy. The topics ranged from new working pairs for gas driven heat pumps over recent component development to field test results. A highlight was the session "Systems and applications" where four

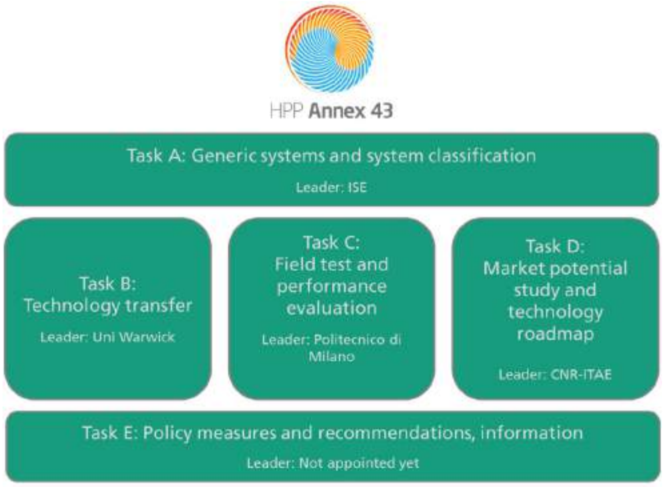

Figure 2. Annex structure.

companies gave an insight view of their plans for gas driven heat pumps. More information can be found at *www.sorptionfriends.org*

Furthermore, a full session on gas driven heat pumps was given by Annex 43 members at the "European heat pump summit 2015" October 20th in Nuremberg, Germany. In front of approx. 200 experts in the heat pumping business the state of the art of this technology was presented as well as recent news on performance evaluations, field test results and market expectations. Several questions from the audience showed the great interest in this technology.

A round robin test of a gas driven adsorption heat pump among for labs across Europe was started to compare different measurements procedures, e.g. (EN 12309 and VDI 4650-2) and their usability to calculate SPFs based on this measurements compared to field tests data. In the first lab a hybrid adsorption heat pump was tested according to EN 12309 and VDI 4650-2. These results will be compared to more laboratory tests in different partner countries in 2016.

Project duration:
July 2013 - June 2017

Operating Agent:
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Participating countries:
Austria, France, Germany, Italy, South Korea, the United Kingdom, and the USA. (*Observers:* Poland, Sweden)

Further information:
www.annex43.org

Performance Indicators for Energy Efficient Supermarket Buildings

ANNEX 44

There is a clear trend that more and more monitoring systems measuring e.g. temperatures (typically to secure and validate food quality) and energy are installed in supermarkets. Measurements are taken and stored, and energy cost data is available, but still in many cases there is no knowledge about the supermarket's energy efficiency compared to other supermarkets in the same chain, or to competing supermarkets.

Performance indicators are needed to transform available measurement data into knowledge of the energy efficiency of a supermarket building. Such indicators are e.g. the supermarket size, the opening hours, and the outdoor climate. When the energy use is related in the correct way to the supermarket size, its opening hours, and other performance indicators, it becomes possible to appreciate the energy use of the supermarket: is it relatively high, normal, or relatively efficient?

The results of this Annex are of particular interest to supermarket owners and supermarket chains, as well as to policy makers.

In this Annex, performance indicators are defined that will allow the evaluation of energy efficiency of existing single supermarkets, supermarkets within one chain, supermarkets across different chains and even supermarkets in different regions or countries. In the previous Annex 31, data

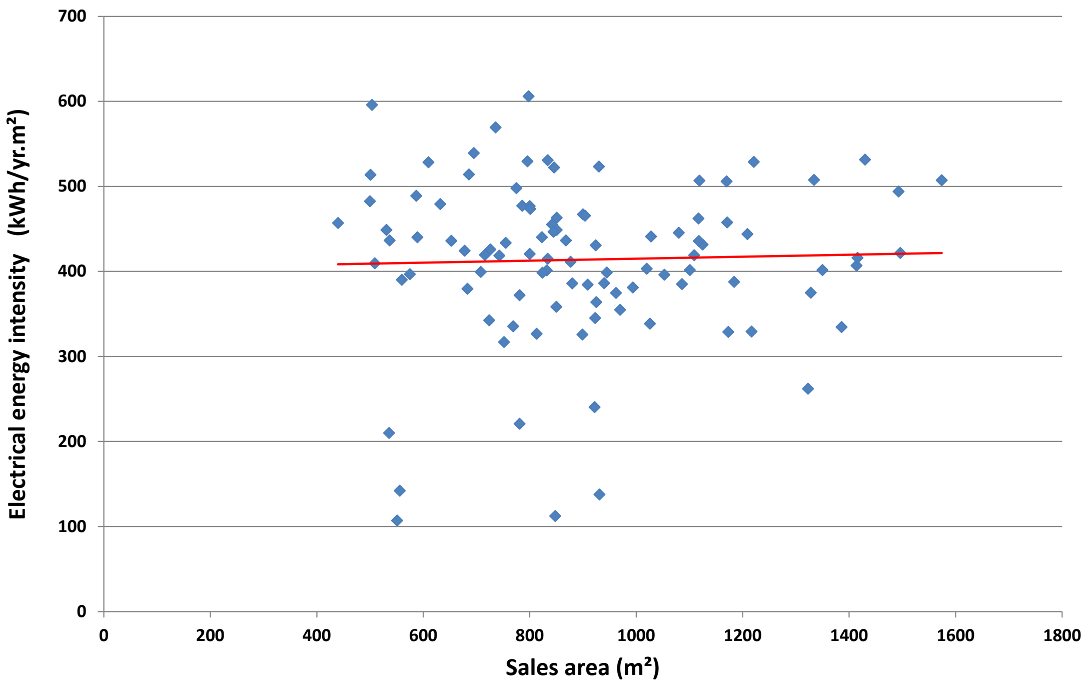

Figure 1. Data points for analysis of the annual energy consumption of 100 supermarkets from the Netherlands 2013, with electrical energy intensity (kWh/m^2) plotted against the sales area (m^2). Contrary to expectations, no dependency between energy intensity and sales area appears.

was collected and analysed for Sweden, USA and Canada; now data for the Netherlands has also been analysed.

The results of this Annex are of particular interest to supermarket owners and supermarket chains, as well as to policy makers

OBJECTIVES

The objectives of the work in Annex 44 are to:

- » Define system boundaries for evaluation of the energy performance of supermarket buildings;
- » Define performance indicators that will allow the evaluation of energy efficiency of existing single supermarkets as well as in relation to other supermarkets;
- » Describe monitoring systems for energy performance and related parameters currently used in supermarkets.

DELIVERABLES

The following deliverables are defined in the Annex work plan:

- » A mapping report on existing energy systems in supermarkets
- » An annex report containing suitable performance indicators
- » A methodology for evaluation of the energy performance of a supermarket building

PROGRESS

In 2015, the intermediate results of the Annex work were presented at an international conference in Yokohama, Japan.

The result of the work so far is that conventional parameters such as sales area cannot fully explain differences in energy intensity. Therefore there has been a shift of attention to include a new area of non-conventional performance indicators, such as staff training and system dynamics.

In the course of the year, Denmark has joined the Annex, and an extension of the Annex duration by one year has been granted.

During the course of 2015, the following meetings have been held for Annex 44:

- Project meeting in Stockholm, Sweden in February
- Annex 44 workshop (open to interested 3rd parties) in Yokohama, Japan, in August
- Project meeting in Stockholm, Sweden, in October.

Project duration:
2013 – 2017

Operating Agent:
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Participating countries:
Denmark, Sweden, and the Netherlands

Further information:
www.heatpumpcentre.org

Hybrid Heat Pumps

Heat Pump and Fossil Fired Boiler as Hybrid Heat Pump Systems

NEW

ANNEX 45

Retrofit and boiler replacement markets are the most important markets for heating and domestic hot water (DHW) production in the residential and light commercial sector in Europe at this moment, due to the low level of new construction. The technical lifespan of heating devices is 15-20 years, as an average. In many cases, no changes on the heat distribution system are made and frequently high supply temperatures (> 50 °C) are needed.

Insulation measures retrofitted during the lifespan of the building allow a decrease in the heating supply temperature, which makes such buildings interesting for an efficient implementation of heat pump technology for a substantial part of the heating season, since heat pumps function optimally at low supply temperatures.

On the other hand, both installers and customers seem to be rather conservative and reluctant to change with regard to the energy carrier they are used to – in many markets this is natural gas or even oil. In this context, heat pump and gas/oil boiler hybrid systems can, beside solar thermal and photovoltaic power generation (PV), be introduced and quickly increase the usage of renewable energy in strongly conservative markets.

> ***The Annex will show a perspective on the possibilities for implementation of hybrid heat pumps in potential markets.***

An example of how the penetration of heat pumps, including hybrid heat pumps, can develop in a country such as the Netherlands is shown in Figure 1.

Accordingly, this offers a chance to increase CO_2 emissions reduction. Not least through the 'hybridizing' of running installations by adding a heat pump to an existing boiler, which can help

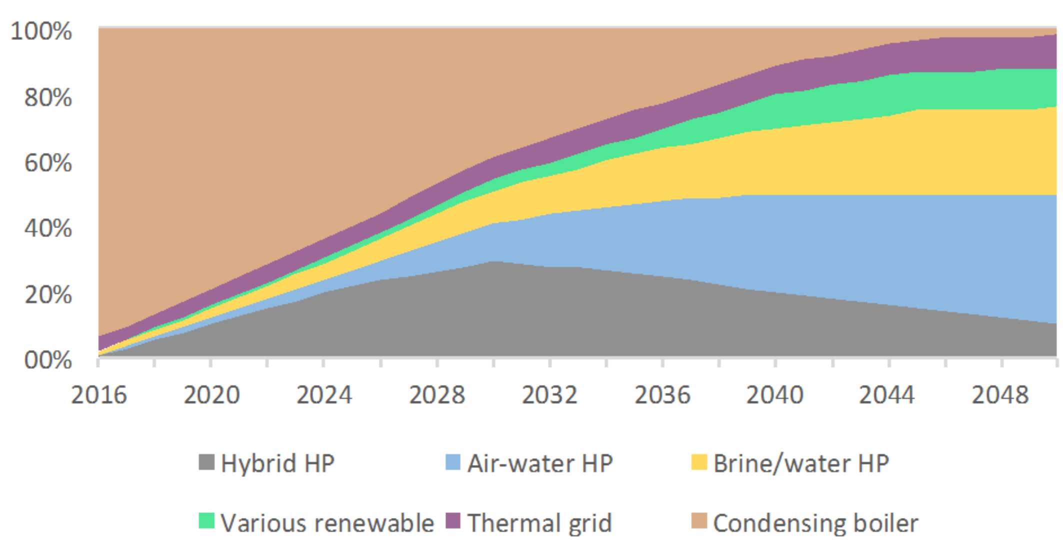

Figure 1. Spread of technologies - Annual numbers installed. Development scenario for heating devices in the Netherlands (Source: DHPA, BDH)

open up hidden opportunities for a far more significant usage of renewable energy. An increasing number of companies already offer hybrid systems – mainly consisting of a combination of a condensing gas boiler and an air-source heat pump. One would assume that this type of heat pump already would have found its way to a broad market usage, but reality proves differently. A whole array of issues remain to be addressed before we can speak of a technology strong and mature enough to run on its own.

SCOPE

The Annex will show a perspective on the possibilities for implementation of hybrid heat pumps in potential markets, and will focus on combinations between the (electrical or gas driven) heat pump (air, ground, water, exhaust air) and fossil fuel driven boilers (oil or gas) in the residential sector and light commercial sector, packaged in a configuration or integral unit.

STRUCTURE OF ANNEX 45

Task 1: Market overview and system classification

- » Country Reports: Market structure, market players, products, available systems and configurations, legislation, energy supply scenarios etc.;
- » Product (system) analysis and classification;

Task 2: Performance evaluation and quality assessment

- » Assessment and further development of laboratory test methods at system level;
- » Package solutions or which type of system configuration;
- » Comparison of testing experience among participants;
- » Technology comparison with other heat pump configurations on the market;
- » Recommendations for quality insurance measures;

Task 3: Modelling and simulation of components and systems

- » Collection of existing and development of new models (validated, where possible);
- » Definition of standardised boundary conditions;
- » Simulation of various systems in a wide range of operating conditions (climates, applications, energy scenarios etc.);
- » Sensitivity analysis and application matrix.

Task 4: Standardized field test procedures and evaluation

- » Development of a standardised monitoring/field test procedure;
- » Reach a common definition on system boundaries and performance evaluation figures;
- » Collection and analysis of measurement data;
- » Definition of best practice.

Task 5: Knowledge dissemination and market support

- » Provide information to a broad audience spectrum on the results;
- » Website and dedicated Wikipedia page;
- » Workshops for target groups such as installers and planners;
- » Final report.

TARGET AUDIENCE

The target audiences of this Annex are the manufacturers of hybrid heat pumps, engineers, planners, housing corporations, installers, (governmental) policy makers, research scientists, and normative bodies.

Project duration:
September 2015 – July 2018

Operating Agent:
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Participating countries:
Austria, France, Germany, Italy, the Netherlands, and the United Kingdom.
Still open for new additional participants

Further information:
www.annex45.com

Peter Wagener

Domestic Hot Water Heat Pumps

ANNEX 46

Domestic Hot Water Heat Pumps (DHW HPs) are heat pumps designed for the production of hot water only, traditionally used for bath/shower and kitchen. These types of heat pumps have been a growth engine for the European heat pump market during the last two years, growing to the tune of 30 % per year against a trend of slight decline in the wider heat pump market. While the residential market may be satisfied with standardised products and installations for space heating, this is not the case for Domestic Hot Water. Within a growing market in many of the IEA countries for Domestic Hot Water Heat Pumps, there is still a large potential for energy optimisation, conservation and reduction of CO_2 emissions, which are overlooked in policy papers and do not get market attention.

In combination with solar photovoltaics, DHW HPs are overtaking and out-phasing the market for solar thermal systems in Germany. However, for low energy housing, solar thermal systems can be excellently combined with DHW HPs. In the domestic space heating and cooling market, the combination with DHW in one combi heat pump is a state of the art application in Europe. In these cases it is not a question of an individual DHW HP, but of a combi heat pump with a storage tank.

> ***While the residential market may be satisfied with standardised products and installations for space heating, this is not the case for Domestic Hot Water.***

In choosing the right DHW system, a high performing and efficient hot water generator is the basis. However, the overall system efficiency depends on more than the efficiency of the generator alone. Especially in multi-family buildings and district heating systems, the heat distribution system traditionally gives high losses, while excellent innovative domestic hot water heat pumps are available to avoid these.

OBJECTIVES & SCOPE

The objective of the Annex is to analyse the information on DHW-heat pumping technologies and structure it to the market - ranging from end user to consultant, building constructor, and policy maker - in a way that leads to better understanding of the opportunities, and implementing them in order to reduce the use of primary energy consumption and CO_2-emissions and lower energy costs.

DELIVERABLES

In addition to a validated modelling tool, one of the important deliverables will be a reference guide describing presently available domestic hot water heat pump systems together with their applications; also software tools, their application and users' experience.

PROGRESS IN THE ANNEX

After the Annex had been agreed upon by the ExCo in October, a Kick-Off meeting was held in Nürnberg with the participation of 18 participants from 10 countries. In the first stage after the meeting, four countries sent in their participation letters. In the Kick-Off meeting at least seven other countries announced their interest in participation, these being the United Kingdom, Sweden, Switzerland, Germany, Canada, Austria and China. These potential participants are invited to all meetings in the first year of the Annex as observers.

The Operating Agent has been actively increasing the number of participants at the start of the Annex through face to face meetings with potential participants in the United Kingdom and Sweden and has planned to do so also for the Asian participants (South Korea, Japan and China).

A first working meeting has been planned (and held) in February 2016 where the Tasks were discussed and Task Leaders appointed. The main first body of work will focus on Task 1 and Task 3, where a special meeting is planned.

The primary goal of Task 1 is to obtain insights in the differences in the energy systems of the different countries and to set potential CO_2 reduction goals when implementing DHW heat pump systems. The analyses under Task 1 will generate future energy scenarios for DHW Heat Pumps in the energy transition model. The goal is to have a presentation at the 12th IEA Heat Pump Conference in Rotterdam 2017.

The goal of Task 3 is to simulate the further development of the market by modelling this technology. In modelling, stratification in the tank is the core of the process, where several models exist. Participation of experts in this field is still being sought.

TASK STRUCTURE

- » Task 1 – State of the art market overview
- » Task 2 – Systems and concepts in comparison to alternatives
- » Task 3 – Modelling calculation and economic models
- » Task 4 – R&D
- » Task 5 – Example projects and monitoring
- » Task 6 – Communication and training

Project duration:
January 2016 – July 2018

Operating Agent:
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Participating countries:
France, Japan, the Netherlands, South Korea, and the United Kingdom.
Still open for new additional participants

Programme Contacts

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