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IEA HEAT PUMP CENTRE

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Heat Pumps - A key technology for the future

Energy Technology Perspectives 2012

IEA Heat Pump CENTRE
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Volume 30 - No. 4/2012

In this issue

Heat Pump Centre Newsletter, 4/2012
This issue's topic is *Energy Technology Perspectives 2012* (ETP 2012), referring to the publication published by the IEA that aims to demonstrate how technologies can make a decisive difference in achieving the climate and energy security objectives of our society. The three topical articles give insights from Japan and from China, as well as from a Smart grids' perspective. We are also planning for an additional article on the ETP 2012, for the next issue, with a more general view.

Further in this issue you will find a market report from Canada.

The Heat Pump Centre wishes you all a Merry Christmas and a Happy New Year!

Enjoy your reading!

Johan Berg, Editor

Heat pump news

Topical articles

Regulars

COLOPHON

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Energy Technology Perspectives 2012: Pathways to a clean energy system

Markus Wråke
Project leader Energy Technology Perspectives
Head of Unit
Energy Supply Technology, IEA , France

Energy Technology Perspectives (ETP) is the IEA's most comprehensive and ambitious publication on energy technology. It demonstrates the role and limits of technology in achieving the objective to limit global average temperature rise to 2° C while enhancing energy security. ETP 2012 presents scenarios and strategies to 2050 and beyond, with the aim of guiding decision makers to what needs to be done to build a clean, secure, and competitive energy future.

The analysis is built around three core scenarios with a projected global temperature increase of 2° C (2DS), 4° C, and 6° C, respectively. It is clear that decisive policy action will be necessary to transform the energy system if the 2DS goal is to be met. The future energy system needs to be smarter, more decentralised and highly integrated. Action is needed in all sectors: power generation must be decarbonised; industry needs to become more efficient and deploy carbon capture and storage (CCS); energy efficiency and better heating and cooling technologies are needed in the buildings sector; in transport, fuel economy can deliver great savings in the short term, with increased use of biofuels and electric vehicles (EV) playing a larger role in the long term. Government targets must be backed by credible policies. At the moment, industry projections of EV sales are far lower than national targets, illustrating a common discrepancy in what governments aspire to and what industry is planning for.

Three high level recommendations to governments are formulated:

1. Create an investment climate of confidence in clean energy, most importantly by getting prices to reflect the true cost of energy;
2. Unlock the incredible potential of energy efficiency – the "hidden" fuel of the future;
3. Accelerate innovation and public research, development and demonstration (RD&D).

As a main incentive for this to happen, it is shown that although the investments in clean energy are huge, they will pay off - even economy-wise.

ETP 2012 has been substantially updated compared to previous editions. It has a stronger focus on near-term policy recommendations based on the long-term outlook; energy systems thinking runs as a theme through the analysis, it presents detailed scenarios for nine world regions, and it analyses options to eliminate energy-related CO_2 emissions by 2075. Moreover, the 2DS scenario differs slightly from the BLUE Map scenario of ETP 2010, due to, for instance, changes in current and projected costs for fossil fuel and deployment of renewables, and novel research in climate science.

Thus, the "Buildings" technology area will need significant action to get on the right track. Heating and cooling account for 46 % of global energy use, and their huge potential for GHG abatement is often neglected. Policy action is urgent as we are currently locking ourselves into inefficient infrastructure that will make future energy efficiency gains much more costly. Specifically for heat pumps, more efficient building shells that reduce energy demand for heating would greatly facilitate tapping into the potential of the technology. Other opportunities for heat pumps are the future low carbon electricity ("greening of the grid"), use of low-temperature waste heat from thermal power plants, and that a large share of the building stock that will exist in non-OECD countries by 2050 has not yet been built, opening up for promotion of heat pumps through building codes that incentivise energy efficiency.

The ETP series is published every second year. The IEA looks forward to working on the next publication in the series, ETP 2014, together with the Heat Pump Programme!

Please visit http://www.iea.org/etp/ There you can find data visualisations, background documents, presentations and more. You can also order the book there.

Column

The creation of the French National Heat Pump Institute

David Canal
ADEME
(Environment & Energy Management Agency)
France

The National Heat Pump Institute (Institut National des Pompes à Chaleur; INPAC) is a network of French research actors in the field of heat pumps. Established at the end of 2010, the Institute consists of the following members: BRGM (geological and mining research office), CEA (French Alternative Energies and Atomic Energy Commission), COSTIC (scientific and technical committee of climatic industry), CSTB (scientific and technical building centre), EDF (French energy company), GDF SUEZ (French gas company) and Mines Paris Tech (French school of engineering).

INPAC provides a forum for its members to exchange information, to discuss their own consultative research program, to maintain contact with other French partners or international partners, and to keep up to date with scientific and technical information on heat pumps for those involved in the field.
Every year, INPAC organises the French Heat Pump Congress, presenting the results of research and development projects, together with INPAC members' and partners' work on progress reports. The congress provides an opportunity to discuss essential working areas for improving heat pump performance, combination with other energy sources, or optimised use in the buildings or industrial sectors.

Currently, some of the main development studies in France are:

- Micro-channel evaporators for carbon dioxide heat pumps, carried out by CEA
  This technology is well-suited to CO_2 transcritical heat pumps in particular, because of such heat pumps' high working pressure. CEA has built a prototype, which has utilised the results of tests that have been carried out since 2006 in the dedicated micro-channel CO_2 evaporation test bench, to deliver a good design of evaporator in the CO_2 heat pump.
- A horizontal geothermal heat exchanger model optimised for short cycle heat pump operation has been constructed by BRGM. *In a low-heat-demand building, the heat pump operating time is short compared to the average dwell time of the fluid in the geothermal heat exchanger. The BRGM experimental platform investigates the development and validity of new superficial geothermal exchanger models (horizontal, vertical and compact).*
- An ammonia/water absorption machine: modelling, design, characterisation and optimisation carried out by CEA. *Development of an absorption machine based on thermodynamic cycle modelling for the design of different components.*

ADEME (the Environment and Energy Management Agency) and its Renewable Energy Department will support INPAC in 2013 in the establishment of a national research program for the heat pump technology. Identification of the main advances in heat pump research will provide valuable information to identify areas in which national research is needed, so that ADEME can formulate the goals and contents of a research program. Some of the main priorities in France include:
- The problem of the consumption peaks in the French electricity network: how can heat pumps help to balance production and demand, or help in peak shaving?
- The construction of a high-temperature/high-capacity heat pump for waste heat recovery in industry.

IEA Heat Pump Programme News

Denmark joins HPP!

The Heat Pump Programme is very happy to welcome Denmark as our latest member country!

The Heat Pump Programme now has 15 member countries. As a member country, all Danish people can now access our full newsletters free of charge. Organisations, such as industry, research institutes and universities in Denmark, can also join current Annexes or start new ones.
Once again, we welcome Denmark in the HPP!

IEA Heat Pump Conference 2014: Address from the HPP Chairman

As the chairman of the International Energy Agency Heat Pump Programme, it is my great pleasure to invite you at the 2013 International Heat Pump Conference that will be held in Montreal, Canada.
This conference will be the 11th in a series of triennial conferences on heat pumping technologies, organized under the auspices of the IEA Heat Pump Programme (HPP). Previous conferences were held in Graz, Austria (1984), Orlando, Florida, USA (1987), Tokyo, Japan (1990), Maastricht, Netherlands (1993), Toronto, Canada (1996), Berlin, Germany (1999), Beijing, China (2002), Las Vegas, Nevada, USA (2005), Zürich, Switzerland (2008), and Tokyo, Japan (2011). This event aims at providing the most recent developments as well as offering a forum for exchanging about heat pumping technologies in the whole innovation chain.
In addition to the conference several workshops will take place to present the work performed under the Annexes, the international collaborative projects managed by the Heat Pump Programme. Also, the prestigious Ritter von Rittinger awards will be given. These awards recognize deserving individuals or teams that have distinguished themselves in the area of heat pumping technologies.
The potential of heat pumps to valorize renewable energy, coming from the air, the ground, the sun or waste heat give them high efficiencies and make them technologies of choice. In the current energy and environmental contexts, they are unavoidable options to provide energy savings and reduce GHG emissions for heating, cooling and refrigeration applications.
I look forward to meeting you in Montreal for this event!

Sophie Hosatte
IEA Heat Pump Programme Chairman

Call for papers to 11th IEA HP Conference

The call for papers is now open! Submit your paper for the 11th International Energy Agency Heat Pump Conference before April 15, 2013.
This Conference will be an excellent opportunity for heat pump stakeholders from all over the world to meet and discuss the current state of the heat pump industry. Research and development activities, policies, environmental issues are commons themes which will also lead to many discussions about the industry's future.

More than 200 addresses, keynote presentations and papers are usually presented during the IEA Heat Pump Conferences with participants from over 25 countries.

Abstracts (200-300 words max.) must be submitted through the conference website by April 15, 2013:
http://www.iea-hpc2014.org/
Submitted abstracts will be analyzed by members of the international organizing committee to ensure presentations will stimulate discussions, complement invited papers and provide regional balance. Authors will be advised of acceptance by August 31st, 2013. Full papers will be required by January 31 2014.

The CGC, Canadian Geo Exchange Coalition, is the host organization for the International Energy Agency Heat Pump Conference 2014 which will be held downtown Montréal (Québec, Canada) on May 13-15, 2014 at the Fairmont Hotel - The Queen Elizabeth.

General

Energy groups share tips on best practices for better statistics

Representatives of twenty organisations that track energy statistics shared how they are using newly agreed-upon definitions of energy products and flows when they gathered last week at the IEA for the sixth meeting of the InterEnerStat initiative. InterEnerStat, or International Energy Statistics, was launched in 2005 to increase international co-operation on energy statistics.
Source: http://www.iea.org

Policy

AHRI meets with Canadian counterpart to discuss standards

AHRI meets with Canadian counterpart to discuss standards
The AHRI of US and the Heating, Refrigeration, and Air Conditioning Institute of Canada (HRAI) held one in a series of meetings on October 1 to provide cross-border coordination on several policy and technical issues, and to prepare for a meeting with the Canadian Standards Association (CSA).

A major topic of discussion was the divergence of U.S. and Canadian testing and rating standards. The divergence raises questions about future recognition of AHRI Certified products in Canada, and about the cost to manufacturers of additional testing in Canada. Both agreed this is an un-healthy trend and needs to continue to be addressed with CSA and Natural Resources Canada (NRCan).
Source: http://www.ahrinet.org, October 18, 2012

EPA issues final version of residential water heaters specification

The US Environmental Protection Agency (EPA) has issued the final Version 2.0 specifications for the ENERGY STAR Program for residential water heaters. A major change in the new version is the addition of requirements for "Light Duty EPACT-Covered Gas Water Heaters" which covers gas storage water heaters (20 and 100 gallons) with input rates between 75,000 to 100,000 Btu per hour. The Version 2.0 specifications become effective on July 1, 2013, meaning any water heater within the scope of this document that is manufactured and labeled as ENERGY STAR must meet Version 2.0 requirements by that date. Manufacturers also may elect to have their eligible products certified to the Version 2.0 requirements immediately.
Source: http://www.ahrinet.org, October 25, 2012
Specifications: http://newsmanager.commpartners.com

Working fluids

Vietnam gets support to phase out ozone-depleting substances

World Bank approved a US$9.76 million grant from the Multilateral Fund for the Implementation of the Montreal Protocol to support Vietnam's efforts in phasing-out hydrochlorofluorocarbons (HCFCs) between January 1, 2013 and January 1, 2015. This initiative builds on an existing program in addressing other ozone-depleting substances.

Designed to help Vietnam reduce its consumption of HCFCs in the polyurethane (PU) foam sector, the Vietnam HCFC Phase-out Project Stage I will introduce the most current technologies to phase out about 1,275 metric tons of HCFC-141b in 12 large foam production enterprises; and supports policies and regulations and technical assistance activities to curb HCFCs consumption.
Source: http://www.worldbank.org

British Refrigeration Association issues guide to flammable refrigerants

A guide to flammable refrigerants, prepared by Cool Concerns Ltd at the request of the Council of the British Refrigeration Association, seeks to provide impartial information about the flammability issues associated with hydrocarbons and flammable HFC refrigerants to end users, specifiers, building owners, manufacturers and contractors. The publication, covering the use of flammable refrigerants in new, specially designed systems, is an introduction to flammable refrigerants and signposts where interested parties can obtain more detailed information.
The guide can be downloaded from *http://www.feta.co.uk*

German car manufacturers told to respect European law

The German government is lining up against its car manufacturers who are considering defying the MAC directive by refusing to move away from the refrigerant R134a. Dr Lutz Knopek of the liberal Free Democratic Party (FDP) and member of the German parliament's environment committee, has backed calls from Germany's Federal Motor Vehicle Office to respect the European law.
Following its own crash tests with the proposed replacement R1234yf, Daimler had indicated that it would continue with R134a on safety grounds. Some other German car manufacturers were also reported to be concerned about the flammability of 1234yf but Knopek pointed out that the law was clear that all vehicle manufacturers were under obligation to use only low GWP refrigerants.
Source: http://www.acr-news.com

CO_2 as automotive refrigerant: SAE offers collaboration

In response to a recent press statement from Germany that "CO_2 is the right refrigerant," SAE International President Frank O. Klegon invites all automobile manufacturers to join in an industry collaborative effort to fully evaluate the technical aspects of the use of CO_2 as an automotive air conditioning refrigerant.
Source: http://www.sae.org

Markets

Turnaround of market for gas-engine driven heat pumps in Japan

After having declined steadily between 2006 and 2010, Japan's market for gas-engine driven heat pumps showed 26 % growth in 2011, compared with 2010. Japan has experienced electricity shortages since the earthquake, tsunami and nuclear crisis last year, and this has sparked new interest in gas-fired systems, including air-conditioning systems, which consume less electricity than electrically driven systems.
Source: JARN, August 25, 2012

High-efficiency boilers: increased consumer interest

The new residential boiler efficiency standards went into effect in September, with gas-fired hot water boilers now having to be a minimum of 82 percent AFUE (Annual Fuel Utilization Efficiency). Other changes include elimination of a standing pilot. Many in the industry are welcoming these modifications, noting that sales of higher efficiency boilers have been trending up, so homeowners are already expressing interest in better efficiency.
Source: http://www.achrnews.com

ENERGY STAR: "Most Efficient" criteria released

US EPA recently issued the final criteria for ENERGY STAR Most Efficient 2013. For a product to qualify for Most Efficient, it must be certified as ENERGY STAR by an EPA-recognized certification body, such as AHRI, and meet certain requirements.
Source: http://www.ahrinet.org , November 29, 2012

Europe's smart home market is growing

Europe's smart home market is still a niche market, despite the continuous development over the past ten and more years, but there is growing interest with an upward trend seen in the market size, a new study from British building environment market intelligence provider BSRIA has found.

Home control can be traced back to the 1980s with controls on electrical equipment. The smart - or intelligent - home has been in development for over 10 years, but awareness by consumers of smart home products and systems remains low. However, in the last year, more people from the industry have started talking about the smart home, due to the interest in energy conservation in the home.

Source: http://www.bsria.co.uk

The Emerging Canadian Heat Pump Market

Denis Tanguay, Canada

Canada is endowed with abundant energy sources and is one of the most energy intensive countries in the world. This explains some historical choices for heating equipment. However, as the energy transport and distribution infrastructures are in need of major investments over the next decades, energy prices will increase consequently. Customers will have to explore new options for heating and cooling services. From the current low penetration rate (less than 10 %) heat pumps will likely play an increasingly important role in the future.

Introduction

The market for heat pumps has never really taken off in Canada. In the residential sector, heat pumps account for less than 3 per cent of heating equipment. Although we currently do not have statistics in this regards, the proportion is likely not much bigger in the commercial and institutional sectors. There are a number of reasons for this.

Canada has traditionally been very well endowed in energy sources of all kinds: hydro, oil, natural gas, nuclear, wood, to name a few. The wind and solar industries are also emerging in many parts of the country as well as biomass for electricity generation at a larger scale. In such a wealthy energy environment, with close to world record low energy prices, the efficiency advantage provided by heat pumps has never been a huge concern for Canadians.

Constitutional framework

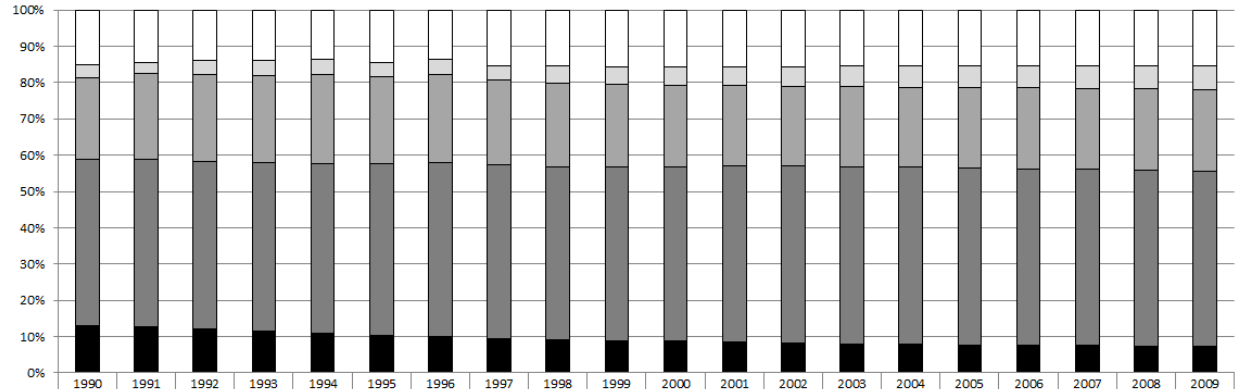
Under the Canadian Constitution, energy production and distribution is of provincial jurisdiction. Canada is also a heating dominant country so the choice of fuel for heating – not electric cooling – dictates most of the heating equipment stock. Finally, energy resources endowment, on a provincial basis, is yet another important factor influencing the selection of heating equipment.

As we see in charts 1 and 2[1], the type of heating equipment varies enormously from one province to another. In Alberta and Saskatchewan for example, huge natural gas resources are reflected in heating equipment stock. In Québec, with large hydro-electric production and very cheap electricity, electric resistance systems dominate the market place throughout the period.

With this in mind, it is very difficult to establish one national energy policy that would work for all provinces. Although the federal government may get involved in the promotion of renewable energy, at the end of the day, each provincial government takes its own decision according to its priorities.

Central government can play a pivotal role in terms of standards development by developing national standards for energy efficiency. But once again, each province has the freedom to adopt these standards or not. To make things even more complicated, the federal government is responsible for international trade issues as well as interprovincial trade issues. For example, the importation of heat pumps in Canada must follow the Canadian Energy Efficiency Regulation. Heat pump efficiency standards are therefore set by the federal government.

Chart 1
Heating Equipment Stock - Single Family Dwelings
(thousands of units - Canada)



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Other	888	865	854	873	871	930	898	1014	1035	1061	1082	1093	1105	1120	1135	1147	1153	1166	1183	1201
Heat Pumps	199	193	245	250	268	270	270	262	318	335	353	370	389	409	428	447	465	484	503	523
Electric (resistance and central)	1330	1416	1464	1510	1547	1548	1596	1566	1556	1546	1546	1550	1565	1594	1610	1637	1688	1708	1728	1750
Natural Gas	2675	2780	2844	2914	2987	3063	3146	3178	3218	3266	3320	3381	3454	3518	3584	3632	3662	3713	3750	3775
Heating Oil	764	766	738	715	693	672	665	627	606	610	614	607	593	576	574	574	573	575	574	576

However, a Canadian manufacturer located in any one of the provinces will not be subject to the Canadian Energy Efficiency Regulation as long as its products are only sold within the province.

Market and policy challenges

Let's take an example to see the effects of these issues on heat pump promotion. In the past three years in the province of Ontario, electricity prices increased dramatically from about 12 cents / kWh to over 22 cents / kWh (note: Canadian cents; at the moment approximately equal to US cents). There are a number of reasons for this which are very specific to the province. At the same time, in the neighbouring province of Québec, thanks to its huge endowment in hydroelectric power, electricity prices are around 8 cents / kWh. Additionally, both provinces have essentially no natural gas resources but can count on a very developed pipeline network which can bring gas from anywhere in North America. Aside from transportation and distribution charges, the price of natural gas itself is more or less the same in both provinces. In the past four years, natural gas prices have declined by about 70 % throughout the continent and now stand at historical lows. Some experts predict that relative energy prices will be favourable to natural gas for another ten years.

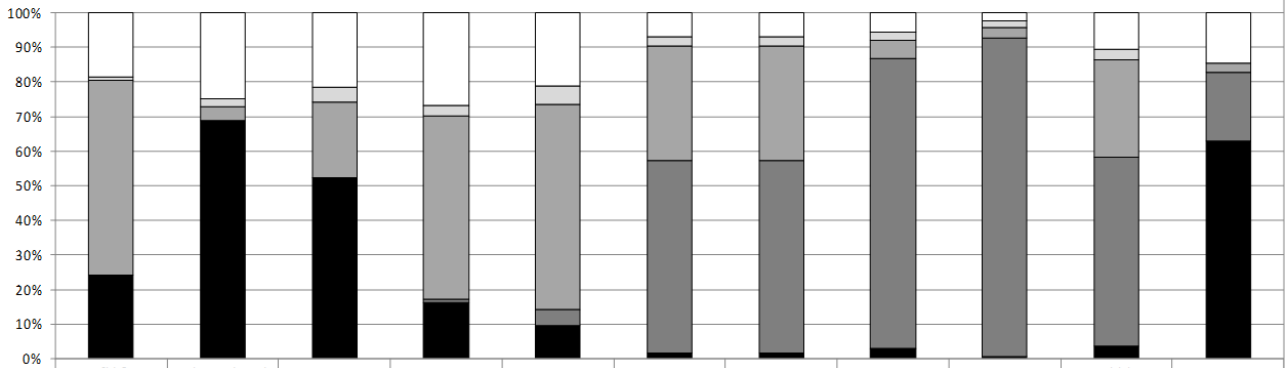
Four years ago, in the province of Ontario, the choice of a ground source heat pump for a residential application made a lot of economic sense when compared to natural gas. Today, four years later, even considering the high SCOP of GSHP, the business case is in favour of natural gas. The price difference between the two systems is too high to be recovered by expected savings over the lifetime of the equipment.

Some argue that if cooling loads are considered, the GSHP option would still be an option. Not quite so for residential. In most cases, heating loads are way more important than cooling loads. Therefore, the increased use of electricity to run the GSHP for both heating and cooling would still cost more than the natural gas option for heating and a window air conditioner. In the meantime in Québec, because relative energy prices are still somewhat favourable to electricity, heat pump options (whether ground source or air source) can be promoted and implemented more easily.

However, we are then faced with another set of constraints. To promote efficiency in Québec, the government could provide direct financial assistance for the installation of heat pumps. This can also be done under the leadership of the electric utility, Hydro-Québec, which holds a monopoly over electricity distribution within the province. To promote heat pumps, however, the electric distributor needs to go before the Québec Public Utilities Board and get any program approved under the provision than the program meets the requirements of Total Resources Cost Test. Currently, the distributor claims that high free ridership rates make the promotion of heat pumps through financial assistance programs uneconomical.

Meanwhile, the Government of Québec has a policy of promoting renewable energy, as well as an energy efficiency policy. As such, they provide financial assistance for the installation of heat pumps but only in retrofit applications and only for customers who are currently heating with any fuel but natural gas or electricity. The government chose not to extend its financial assistance program to areas and technologies that are otherwise supported by energy efficiency program from natural gas or electricity distributors. This complicated reality found in each Canadian province, makes it extremely difficult to put in place a national scheme to promote heat pumps.

Chart 2
Heating Equipment Stock - Single Family Dwelings
% per Province - 2009



	Nfld & Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Québec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Territories
Other	18,6	24,9	21,6	26,8	21,2	7,0	7,0	5,7	2,3	10,5	14,5
Heat pumps	1,0	2,1	4,1	2,9	5,3	2,7	2,7	2,2	2,0	3,0	0,0
Electric (resistance and central)	56,1	4,1	22,0	52,9	59,3	33,1	33,1	5,3	3,1	28,3	2,6
Natural gas	0,0	0,0	0,0	1,0	4,5	55,6	55,6	83,9	92,0	54,5	19,9
Oil	24,3	68,8	52,3	16,3	9,6	1,6	1,6	2,9	0,6	3,7	63,0

Canada is a long standing contender to be one of the most energy intensive nations in the world. Canadians are just starting to realize how they have been blessed with cheap energy for generations. But the paradigms are changing and the economic reality of resource depletion combined with rising cost to maintain and expand energy transportation and distribution networks are having a significant impact on energy consumers. It is estimated that over $400 billion will be required in the next 20 years just to upgrade the existing electricity transportation and distribution infrastructure in Canada. Regardless of low energy prices, the rising costs of infrastructure alone are leading to continuous increases in overall energy costs.

In this infrastructure discussion, Canadian municipalities and provinces are only beginning to adopt district energy. The discussions around this topic curiously validate ambient-temperature alongside high temperature systems, leading to a bright possibility for heat pump technology. Additionally, large office buildings with cooling dominant loads and at-times complex zone controls each running with electricity provide markets openings for sophisticated professional suppliers and contractors.

It is in this context that there is a clear future for heat pumps, even in a country such as Canada, rich in energy infrastructure and supply of all sorts. The reality is catching up. The situation is particularly important in the commercial and industrial sectors where all costs of doing business are important, including energy spending. Differences in heating and cooling loads from one building to another and the varying cost of equipment including the space needed for mechanical rooms are other factors that could make the increased use of heat pumps economical.

Conclusions

The next step for Canada is to educate decision makers to the advantages of adapting heat pumping technologies. The role of heat pumps in increasing the value of energy services (heating and cooling) is clearly misunderstood in Canada. We are used to thinking about large scale centralized energy production facilities located at great distance from consumption areas rather than smaller scale, decentralized or dynamic systems where heat pumps can play a key role in moving energy around. The discussion about integrated community energy solutions and recovering heat from industrial processes and from sewage is only now beginning for example.

Canada has a relatively underdeveloped heat pump market. While this may be seen as negative, it should rather be seen as a huge opportunity for the technology. The low penetration rates for the technology means there is a near pristine market of millions of potential customers who will increasingly be interested in heat pump options.

References

[1] Natural Resources Canada, Office of Energy Efficiency. Historical Database, November 2011.

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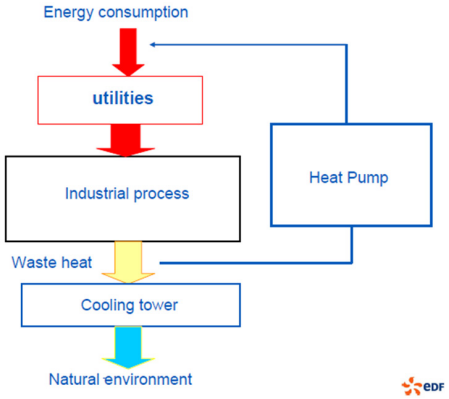
Annexes, ongoing

IEA HPP /IETS Annex 35 / 13 Application of Industrial Heat Pumps

The Annex 35 / 13, a joint venture of the IEA Implementing Agreements "Industrial Energy-related Technologies and Systems" (IETS) and "Heat Pump Programme" (HPP) organized its annex meeting on October 10, 2012 in connection with the Chillventa - International Trade Fair for Refrigeration, Air Conditioning, Ventilation and Heat Pumps – and the IEA HPP Symposium at the Exhibition Centre Nuremberg/Germany. The Annex meeting was attended by 15 participants from 9 member countries.

The work of the Annex is still concentrated on Task 2 "Modeling calculation and economic models", to analyse and appraise the possible contribution of heat pumps to energy efficiency and reduction of greenhouse gas emissions in industrial processes.



Implementation of heat pumps in industrial processes
Source: DTI Denmark / EdF R&D France

The status of Task 2 has been discussed at a workshop "Application of industrial heat pumps", organized and led by Roger Nordman directly before the annex meeting on October 10, 2012 in Nuremberg.

IZW e.V. as operating agent of the Annex has analyzed in detail Task 2.

Four IZW notes were provided:

- 01/2011 Analysis of the Annex 21 IHP Screening Program
- 02/2011 Upgrade of the Annex 21 Screening program
- 11/2012 Some thoughts regarding Annex 35 /13 Task 2 report
- 12/2012 Integration of heat pumps into chemical processes: An outline of theoretical methods.

At the discussion it has been stated that the Annex 21 Screening program has to be updated, in particular the data base, as the data are too old and in many cases not longer relevant. The Swedish experts in charge of the Annex 21 screening program stated that in the present annex the resources are not available to gather all the new data needed. Therefore, for Task 2, this has to be done in another way, which is still in progress.
It was decided to ask the ExCo for an extension of the Annex 35/13 for one year up to the 30 April 2014. The ExCo agreed to the extension with the requirement for a working plan for this extension.

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IEA HPP Annex 36 Quality Installation / Quality Maintenance Sensitivity Studies

Annex 36 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 participants held the 2nd working meeting of the Annex at the National Institute of Standards & Technology (NIST, Gaithersburg, MD, USA) on 24-25 September, 2012. Day 1 was devoted to a number of presentations from US industry spokespersons on market forces and trends, from a US DOE spokesperson on current heat pump R&D priorities, and an overview of NIST and its R&D activities from Piotr Domanski. The industry presentations included summaries of HVAC installation issues from the perspective of practicing contractors, along with summaries of the US heat pump contractor accreditation program, the Air-Conditioning, Heating, and Refrigeration Institute's (AHRI) heat pump equipment certification program, and HVAC tech-

Annex 36 September 2012 meeting participants: front row, left to right – Kerry Norton (British Consulate office, Atlanta; UK), Kristin Larsson (SP; Sweden), Jean-Marc Lebreton (EdF; France); back row, left to right – Vance Payne (NIST; US), Van Baxter (ORNL; US), Piotr Domanski (NIST; US) Jan-Erik Nowacki (KTH/SVEP; Sweden), Hugh Henderson (CDH Energy; US), and Glenn Hourahan (ACCA; US).

nician training/certification through the North American Technician Excellence (NATE) program. Tours of two local residential ground-source heat pump installations and of the recently completed NIST net zero energy residential test facility (NZERTF) were included as well. Day 2 was devoted to presentations of work progress from each participant and to discussion of the final report preparation schedule. It was agreed that each participant would provide draft country reports (with executive summary) to the OA by 1 Sept 2013. The OA team will then assemble the reports into a rough draft final Annex report and transmit to the participants by the 3rd or 4th week of Sept 2013 for overall review.

An interim web meeting is planned for March/April 2013. A final working meeting is planned for October 2013 at EdF in France and will be primarily devoted to summarizing final results and finalizing the Annex report. The Annex is scheduled to run through November 2013.

NIST NZERTF – photo Piotr Domanski, NIST

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IEA HPP Annex 37

Demonstration of field measurements on heat pump systems in buildings – good examples with modern technology

The aim of the project is to demonstrate and disseminate the economic, environmental and energy saving potential of heat pumping technology. The focus will be on modern technology, and results from measurements on good examples will be used to calculate energy savings and CO_2 reductions. The results will be presented on the HPC website.

The project partners are Sweden, Switzerland, the United Kingdom and the newest partner Norway. Austria is participating in the annex as an observer. The operating agent at SP (Sweden) has been changed in the project: Pia Tiljander has been replaced by Marcus Olsson.

In the project, a template has been produced of what should be reported for each heat pump. Moreover, the limit criterium for a good heat pump have been decided: for GSHPs, the SPF should be at least 3.8 and for ASHPs at least 3.0. The criteria for good quality of field measurements have been determined, as well as important parameters for assured quality. Calculations of energy savings and CO_2 reduction are on-going. The calculations of CO_2 reductions are based on comparisons with the heat source that was replaced by the heat pump or the probable alternative to the heat pump in new productions.

The number of heat pumps included from each country will be 15 in Switzerland, 3 from Sweden and 2-4 from the UK. The number of heat pumps from Norway remains to be decided.

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IEA HPP Annex 38 Solar and Heat Pump Systems

The combined SHC Task 44 and HPP Annex 38 called "Solar and heat pump systems" is running its 3rd year out of the 4 foreseen.

The objective of this Annex is to analyze and compare the most common and promising combinations of solar and heat pumps for a single family house.

One achievement of 2012 was to gather the first monitoring results of systems in the field in several countries, and to analyze first simulation results with validated models for those teams who have reached this point.
Field results show that systems with ice storage recharged by solar during winter sunny days can perform quite well in terms of annual performance factor. Simulation of this type of system is underway and will deliver sensitivity analyses for all main factors.
Another achievement is a common definition of important seasonal performance factors (SPF) to be considered when comparing different systems of heat pumps combined with solar energy. All various system boundaries have been defined and SPF can then be calculated for each boundary. Environmental factors have also been defined in terms of a primary energy ratio and global warming potential effect. A report on these aspects is available.
http://www.iea-shc.org/task44

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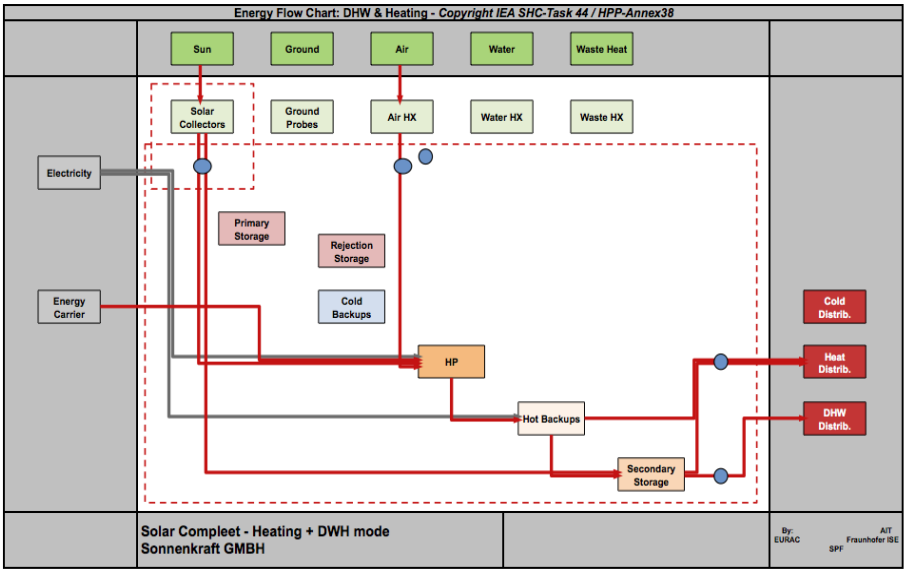

The "square view" representation of a solar and heat pump system as developed within Annex 38 can also be used to show energy flows in a monitored system out of an Excel table of data.

IEA HPP Annex 40 Heat pump concepts for Nearly Zero Energy Buildings

The IEA HPP Annex 40 dealing with heat pump concepts for Nearly Zero Energy Buildings (NZEB) was started in July 2012 with a Kick-off meeting in Rapperswil, Switzerland, where participants of the countries BE, CA, CH, DE, FR, FI, JP and SE attended. Meanwhile, the countries CH, NO, NL, JP, SE, US declared their definite participation in the Annex 40, further countries like AT, CA, DE, DK, FR, FI and KR also have interest in participation.

The Annex work has been structured in four tasks: Task 1 is dedicated to a state-of-the-art survey of building technology concepts installed in presently built NZEB.

In Task 2, detailed analysis and optimization of promising concepts are to be performed by system comparison and simulations, considering the system performance and cost as well as design and control issues. In parallel, in Task 3, a further development of system technology and field monitoring of NZEB technologies is to be accomplished.

Task 4 is dedicated to storage options for electricity and heat to enhance load match and interaction with energy grids, enabling thereby options for smart operation by enhanced IC-Technologies. These aspects will become important with a broad introduction of NZEB.

Presently, countries, who already declared their participation, are working on the state-of-the-art analysis in Task 1.

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IEA HPP Annex 41 Cold Climate Heat Pumps

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-to-air or air-to-water air-source heat pumps (ASHP), with air or hydronic 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 in the EU. 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.

A 2nd organizing meeting was held on October 10, 2012 in Nürnberg, Germany with representatives from Canada, Japan, and the US attending. Summaries of planned Annex contributions were presented by representatives from Canada (Natural Resources Canada), the Japanese Annex 41 national team (represented by Prof. Saito of Waseda University), and the US team (Purdue University and Oak Ridge National Laboratory). Currently Japan and the US (OA) are officially participating in this Annex. Canada is seeking funding for a national project; they will join when funding is received. In Nürnberg as well, Austria announced that they have submitted a project for funding and feel that chances were very good that it would be approved and Austria would join the Annex in early 2013. The Annex remains open to new members so other HPP member countries are strongly encouraged to join.

The Annex officially began in July 2012 and is expected to run through September 2015. A 1st working meeting is planned to be held in the US in mid-2013 with a 2nd meeting and open workshop planned for May 2014 at the 11th IEA Heat Pump conference in Montreal. The final

IEA HPP Annex 40 Kick-off meeting in July 2012 at HSR Rapperswil, Switzerland

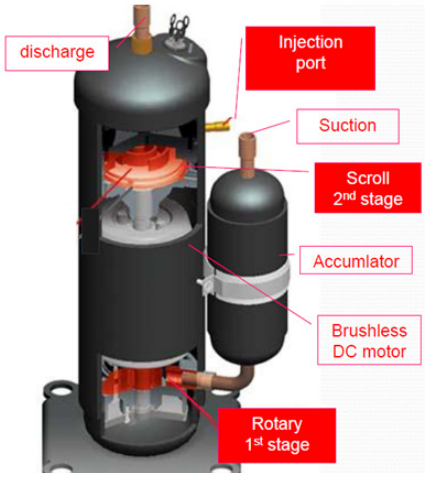

Diagram of two-stage (scroll+rotary) compressor – Diagram courtesy of Mitsubishi Heavy Industries, Japan

Laboratory prototype test system at Purdue University – Photo courtesy of Prof Eckhard Groll, Purdue University

Annex meeting is planned to be held in Japan in August 2015 in conjunction with the next IIR International Congress of Refrigeration.

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IEA HPP Annex 42 Heat Pumps in Smart Grids

After discussing this item as a potential subject for an Annex in fall 2011, the Legal Text was further developed in close cooperation between the IEA Heat Pump Centre in Sweden and the undersigned during summer 2012. Initial presentations at the HPP Symposium in Nurnberg in October 2012 about, at that time, the 'Proposed Annex' were received very well by delegates of the member states within the HPP.

During the National Teams' meeting, the member states gave their input for further detailing and elaboration of the Legal Text. The conclusion at the end of this meeting was that more or less 'a full house' of member states intended to join and support the Annex.

At the ExCo meeting in November in London, a final presentation and brief discussion of the proposed Annex led to a clear positive vote by the ExCo delegates. Commitment to the Annex 42 was expressed by, amongst others, Sweden, USA, Korea, Finland, Germany, The Netherlands, and Austria. Several other member states consider participating in this Annex 42 in due course as well.
Due to the upcoming new year, with the new budgets, this might take somewhat more time.

Status of activities:

- Template notification letters have been sent to the member states in which they can officially confirm their participation to the IEA office in Paris, HPP and the Operating Agent.
- The first version of a planning scheme is being drafted.
- An online project management tool in ActiveCollab is equipped to enable all participants from all over the world to cooperate within one single online project management environment.
- The first meeting of the Annex 42 project group is foreseen in March (During ISH 2013 in Frankfurt) or May 2013 (Parallel to EHPA General Assembly in Brussels), depending on the progress in the initial stages.

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Ongoing Annexes

Bold text indicates Operating Agent. ** Participant of IEA IETS or IEA SHC

Annex 34 Thermally Driven Heat Pumps for Heating and Cooling	34	AT, CA, CH, **DE**, FR, IT, NO, UK US
Annex 35 Application of Industrial Heat Pumps (together with Task XIII of "Industrial Energy-Related Technologies and Systems" (IEA IETS))	35	AT, CA, DK, FR, **DE**, JP, NL, KR, SE
Annex 36 Quality Installation/Quality Maintenance Sensitivity Studies	36	FR, SE, UK, **US**
Annex 37 Demonstration of field measurements of heat pump systems in buildings – Good examples with modern technology	37	CH, NO, **SE**, UK
Annex 38 Solar and Heat Pump Systems	38	AT**, BE**, CA**, **CH**, DE, DK**, ES**, FI, FR**, IT**, UK
Annex 39 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
Annex 40 Heat pump concepts for Nearly Zero Energy Buildings	40	CA, **CH**, FR, NL, NO, JP, US
Annex 41 Cold climate heat pumps	41	CA, JP, **US**

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

China Building Energy Efficiency Technology Roadmap

Xu Wei, China

Sustainability has long been a theme in Chinese energy policy. Already in the 1980s, national commitment to improving energy efficiency led to a long-term decline in energy intensity seen nowhere else. China has the potential to become much more efficient, and the mandatory targets of the country's Five-Year Plans (FYPs) provide guidelines for increasingly sophisticated measures.

With the rapid increase in the urbanisation rate, coupled with the country's strong GDP growth, living standards have risen in parallel, with the result that energy consumption in the built environment has grown rapidly in recent years. Since 2006, government has enforced strong policies to promote energy efficiency in the built environment, with remarkable achievements in the 11th Five-Year Plan (2006-2010).

The 12th FYP sets a target of reducing energy use per unit of GDP by 16 % in 2015, compared with 2010. A variety of programmes and regulations support this target. In 2012, the Ministry of Housing and Urban-Rural Development (MOHURD) promulgated the 12th Five-Year Building Energy Efficiency Plan, which covers the objective and all associated activities in the building sector.

This paper briefly describes the work that China has already done and will continue with in the building energy efficiency sector.

Background of Chinese building energy efficiency work

From 1989 until 2011, China's average annual GDP growth was more than 9 %. From 1978, the urbanisation rate has increased from 18 % at a rate of one percent per year, and has reached over 50 % by 2011. The effect of these two factors is that more and more energy is used to achieve higher indoor air quality.

Starting from the 1980s, the national commitment to improving energy efficiency led to a long-term decline in energy intensity (energy use per unit of gross domestic product [GDP]) seen nowhere else. China has the potential to become much more energy-efficient, and the mandatory targets of the country's Five-Year Plans (FYPs) provide guidelines for increasingly sophisticated measures.

The Ministry of Construction, now called the Ministry of Housing and Urban-Rural Development (MOHURD), has published the national Energy Conservation Design Standard for New Heating in Residential Buildings standard, which marked the beginning of China's building energy efficiency work. A series of plans, policies, regulations and codes followed.

Table 1. Key building energy efficiency policies and regulations

Year	Policies, regulations, codes, standards	Issuing authority
1994	Building Energy Efficiency 9th Five-Year Plan and 2010 Plan	Ministry of Construction
1999	Building Energy Efficiency Regulation in civil buildings	Ministry of Construction
2005	Building Energy Efficiency Regulation in civil buildings - Revised	Ministry of Construction
2005	Design standard for energy efficiency of public buildings GB50189-2005	Ministry of Construction
2006	Evaluation standard for green building GB/T50378-2006	Ministry of Construction
2008	Energy Efficiency Regulation of Civil Buildings	State Council
2008	Energy Efficiency Regulation of Institutional Buildings	State Council

Achievements during the 11th Five-Year Plan (2006-2010)

General situation

By the end of 2010, 95.4 % of new building work was complying with the building energy codes: 182 million m^2 of residential buildings in the northern part of China had been retrofitted with heat metering and energy efficiency improvements; 33 000 large government office buildings and public buildings had completed building energy statistics, with 4850 having undergone full energy audits, over 6000 building energy consumption data records were open to the public, and 1500 buildings had installed on-line energy consumption monitoring.

City-level dynamic energy monitoring had been started in nine pilot

provinces and cities and 72 energy-saving campuses. 386 renewable energy demonstration projects and 210 PV building integration projects had been finished. Central government was promoting renewable energy utilization in 47 cities and 98 towns, resulting in 1.48 billion m^2 of building floor space supplied by solar thermal energy, and 572 million m^2 of building floor space supplied by ground-source heat pumps. In rural areas, 342 401 houses were retrofitted for increased energy efficiency, and more than 600 central solar showers had been built.

Technology R & D Programs

In the 11th Five-Year Plan, the central government supports a series of R&D projects in building energy efficiency and green building sector.

Government subsidies

To promote policy and set up demonstration projects, the Ministry of Finance and MOHURD have provided a total of 15.2 billion RMB (2.44 billion USD) to support the work of energy efficiency improvement in government office buildings and large public buildings, energy-efficient retrofit for existing residential buildings in China's northern heating zone, demonstration of renewable energy application in buildings, and building-integrated photovoltaic and city-level demonstrations of renewable energy application. In addition, local finance has also been given substantial support: according to incomplete statistics, 6.9 billion RMB (1.11 billion USD) support was arranged by provincial government and 6.5 billion RMB (1.04 billion USD) support was arranged by city-level government for building energy efficiency.

Energy-saving achievements

4.85 billion m^2 of newly constructed buildings implement the building energy codes, saving 46 million tce (tons of coal equivalent). 182 million m^2 of residential building in 15 northern provinces have had heating system retrofits, saving 2 million tce. Utilisation of solar thermal and ground source heat pumps, using renewable instead of regular energy, save 20 million tce. With all the activities described above in 2.1 and 2.3, the building sector has achieved 100 million tce of energy savings in the last five years.

Table 2. Part of Objectives and achievements during 11th FYP of BEE

	Objective	Implementation
Building energy codes compliance	95%	95.4%
Energy-efficient retrofit of existing residential buildings in China's northern heating zone	150 million m^2	182 million m^2
Energy efficiency of government office buildings and large-scale public buildings	Kick-off for the work	33 000 building energy statistic
Renewable energy application*	200 pilot projects	386 demonstration projects and 210 PV building integration projects, 47 demo cities and 98 demo towns,

** in addition to the GSHP installations described above.*

Table 3. R&D program in building energy efficiency and green building sector in the 11th Five-Year Plan

R&D program	Leading organization
Research and demonstration of key technology on building energy efficiency	China Academy of Building Research
Key technologies of modern architecture design and construction	China Academy of Building Research
Research and development of environmentally friendly building materials and products	China Building Materials Academy
Research and demonstration of key technology on existing building retrofits	China Academy of Building Research
Research and demonstration of renewable energy building integration	Centre of Science and Technology Centre. MOHURD

Table 4. Government subsidies to promote building energy efficiency work

Government	Special Subsidy document	Central government	Provincial government	City-level government
Ministry of Finance and Ministry of Housing and Urban-Rural Development	Special subsidy for energy efficiency of government office buildings and large public buildings	2.44 billion USD	1.11 billion USD	1.04 billion USD
	Special subsidy for energy-efficient retrofit for existing residential buildings in China's northern heating zone			
	Special subsidy for demonstration of renewable energy application in buildings			
	Special subsidy for building-integrated photovoltaic systems			
	Special subsidy for city-level demonstration of renewable energy applications			

Building energy-efficiency roadmap during the 12th FYP

In 2012, the Ministry of Housing and Urban-Rural Development (MOHURD) published the 12th Five Year Building Energy Efficiency Plan. This section briefly describes the objective and some of the activities.

Objective

By the end of 2015, building energy efficiency should have a total energy-saving potential of 116 million tce. Of this, the development of green building and implementation of building energy codes could have a potential of 45 million tce, heating reform and residential building retrofitting could have a potential of 27 million tce, large commercial buildings and government office building energy efficiency retrofits, together with better management and operation, could have a potential of 14 million tce, with a further potential 30 million tce from renewable energy and building integration.

Activities

- More stringent building energy codes. By the end of 2015, more than 95 % of buildings in the cold and severely cold regions in the northern part of China, and in the hot-summer and cold-winter zone, will be required to apply the latest national building energy code for new building design. The required energy efficiency of new urban buildings will be more than 30 % higher than at the end of the eleventh five-year plan (2010). Megacities such as Beijing and Tianjin will apply higher-level building energy efficiency standards, with the building energy efficiency level of new buildings reaching or approaching those of the developed countries with the same climate conditions. Finally, a number of low-energy and extra-low energy demonstration buildings will be constructed. By 2020, green buildings will account for more than 30 % of new buildings, with the energy efficiency level of construction and operation reaching or approaching that of the developed countries current level.
- Expansion of existing residential building retrofits. In the northern part of the country, 400 million m^2 of residential building heating improvements and energy efficiency retrofits will be accomplished, accompanied by the introduction of metering and charging for heat. In the hot-summer and cold-winter zone, pilot projects of more than 50 million m^2 will be started. Establish and improve the large-scale public building energy efficiency supervision system. Determination of the energy consumption of large public building by metering and monitoring energy statistics, by energy audits and by monitoring of energy consumption. Determination of the baseline energy consumption of different types of public buildings, identification of key energy buildings and high-energy consumption buildings. Reduce the energy consumption of high-energy-consuming public buildings by ensuring that they operate efficiently. Retrofit 60 million m^2 of high-energy-consuming public buildings. Over the period of the 12th Five-Year Plan, this work could reduce energy consumption by 10 %, and that of large public buildings by 15 %.
- Speedier and wider application of renewable energy in construction. Further to promote different renewable energy utilisation systems, including but not limited to solar energy-integrated buildings, ground-source heat pump systems, subterranean water-source heat pump systems, seawater-source heat pumps, sewage-source heat pumps. By 2015, aim to increase the use of renewable energy in buildings to 2.5 billion m^2, saving 30 million tce.
- Large-scale implementation of green buildings. A total of 800 million m^2 of newbuild green buildings. In new towns, more than 20 % of new buildings should be green buildings.
- Government management. With the Energy Conservation Law and Energy Efficiency Regulations for Civil Buildings as the main basis, promote development of departmental regulations, local laws, local government regulations and normative documents to support Chinese building energy efficiency legislation and regulations. Improve standards covering energy-saving technology in buildings.

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Next-generation Heat Pump System Research and Development by NEDO and Implications of ETP2012

Toru Udagawa, Japan

NEDO is conducting research and development of next-generation heat pump systems based on Strategy for Energy Efficiency Technologies. These technology development activities will help to achieve a low-carbon society by utilizing waste heat and unused natural heat, as implied by the International Energy Agency's Energy Technology Perspectives 2012 (ETP2012).

Introduction

In September of this year, the Japanese Government announced a new energy strategy entitled "Innovative Strategy for Energy and the Environment". By 2030, this policy initiative is expected to result in an energy saving of over 72 million kiloliters of oil equivalent, as compared to 2010, on a final energy consumption basis. It is expected that details regarding technology development and methods to promote the dissemination of new technology, based on the government's strategy, will be announced in the near future. At present, the New Energy and Industrial Technology Development Organization (NEDO) is developing energy efficiency technologies based on its 2011 "Strategy for Energy Efficiency Technologies". This strategy, which contributes to the government's energy-saving targets, was developed in collaboration with the Ministry of Economy, Trade and Industry of Japan in 2011 and is subject to revision if needed.

The present article presents the background to NEDO's activities in connection with development of next-generation heat pump systems, and the status of heat pump systems as essential technology under ETP2012.

Outline of 2011 Strategy for Energy Efficiency Technologies

The 2011 Strategy for Energy Efficiency Technologies prioritises a wide-range of energy efficiency technologies, focusing on key technologies that can meaningfully contribute to Japan's energy-saving efforts. Key technologies cover the following:

1. Technologies that are expected to achieve significant energy-saving effects by 2030.
2. Systems that can be combined with other technologies or integrated into new concepts to achieve significant energy-saving effects.
3. Technologies that are expected to achieve significant energy-saving effects and are broadly applicable on a long-term basis.

When selecting a technology for classification as key technology status, it is evaluated to determine if it is suitably original and does not simply repeat existing technologies. Figure 1 shows thirteen key technologies selected on this basis. In particular, next-generation heat pump systems have been selected as a key technology, as the demand for such systems has expanded for various uses, such as air-conditioning, hot water supply systems, dryers, freezers and refrigeration systems, and automobile air conditioners.

In order to realize high-efficiency and low-cost heat pump systems, and to reduce carbon greenhouse gas emissions, the 2011 Strategy for Energy Efficiency Technologies also supports research and development of next-generation heat pump systems. Systemization technologies and innovative element technologies are being developed. In the area of systemization technologies, technologies for utilizing waste heat, collecting and storing high-efficiency heat (simultaneous cooling and heating), power recovery expansion, streamlining low load areas, non-fluorinated refrigeration and air-conditioning equipment and others are being developed. In the area of innovative element technologies, work is concentrated on technologies for high-efficiency refrigeration cycles, development of new refrigerants, high-efficiency heat exchange equipment, high-efficiency compressors and others items and processes (Figures 2 and 3).

As a result of NEDO's activities to develop systemization and element technologies for next-generation heat pump systems, it is forecast that, by 2030, the manufacturing cost of new systems will have been reduced by 25 %, and total efficiency will have improved by 50 % in comparison with present costs and efficiencies. The manufacturing cost is forecast to decrease a further 25 % as total efficiency improves by 50 % by 2050.

Implication from ETP2012

ETP 2012 points out that large quantities of waste heat exist in current energy systems. It also reports that cooling energy demand has increased due to a growth in incomes and urbanization in Asia and emerging countries. In addition, ETP 2012 notes that policy action is needed for effective use of waste heat through utilization and promotion of heat pump technologies, and that construction and expansion of district

heating network systems are needed for effective utilization of natural unused heat in various areas.
However, conditions and infrastructure for making effective use of natural waste heat which could be effective for achieving Japan's energy-saving targets have not yet been developed. NEDO has therefore been working on next-generation heat pump systems research and development as a national project since 2010. The goal for the project is to develop basic technologies for residential/commercial heat pump systems so as to achieve a total efficiency increase of 50 % in comparison with the present efficiencies. For all themes of the project, and especially that of heat pump air conditioning system development using groundwater sources with unused heat, which has already reached the testing phase, the goal is to achieve verification of a 50 % improvement in overall efficiency during winter and summer test operation by the end of 2012.
NEDO has already developed technologies to utilize heat from sewage effluent, which exists in large quantities in urban areas, as well as waste heat. Testing of these technologies started in March of this year and will continue throughout 2013.

Conclusions

NEDO will continue to undertake research and development of next-generation heat pump systems and other energy efficiency technologies, based on its 2011 Strategy for Energy Efficiency Technologies, while also promoting their widespread use. Through such efforts, NEDO will contribute to the target of achieving a low-carbon society as presented in the ETP/2DS scenario.

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Figure.1 Thirteen key technologies in the 2011 Strategy for Energy Efficiency Technologies

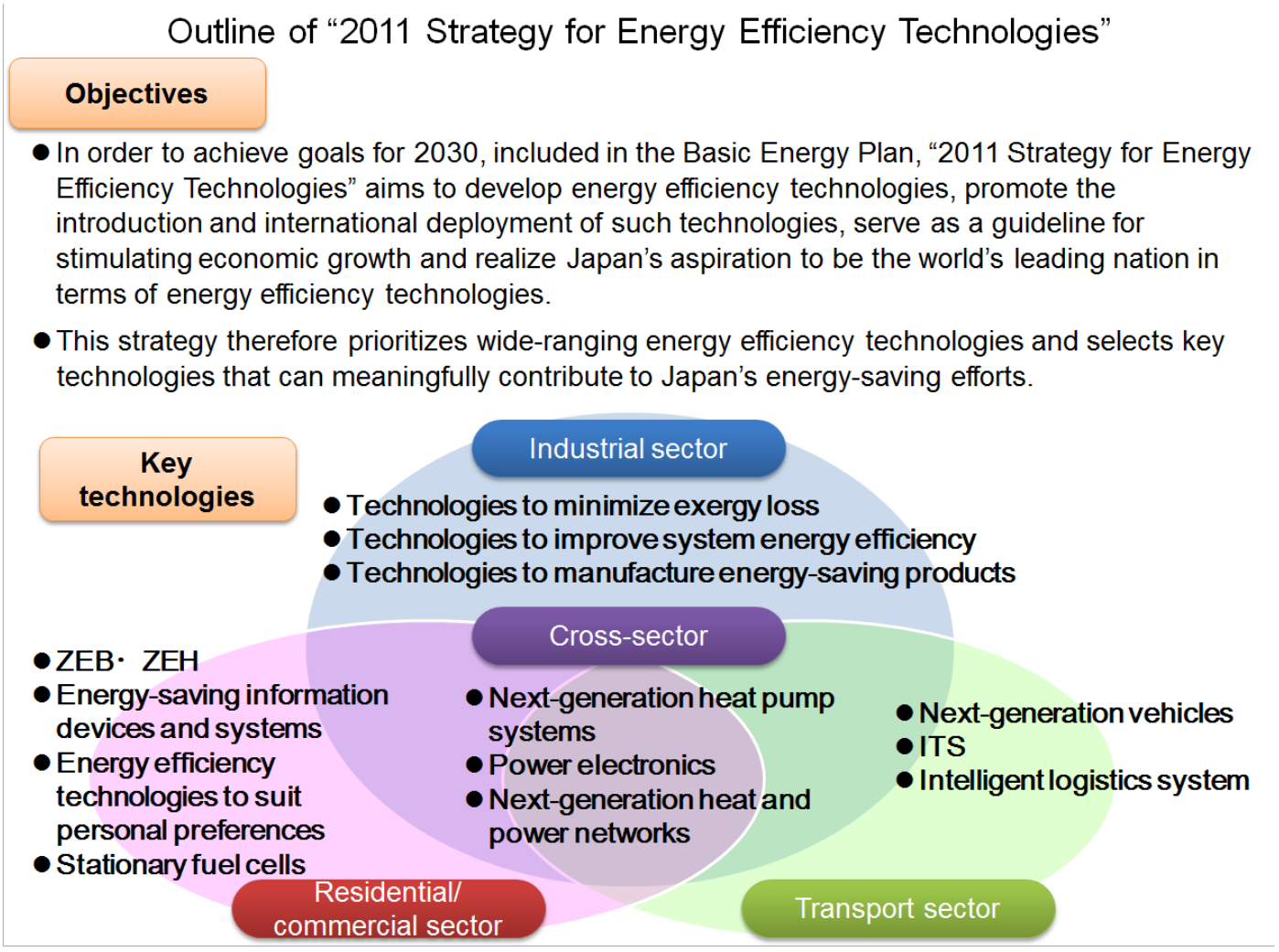


Figure 2. Targets of Next-generation Heat Pump System Research and Development in the 2011 Strategy for Energy Efficiency Technologies

【Cross-sector key technologies】
Next-generation Heat Pump Systems

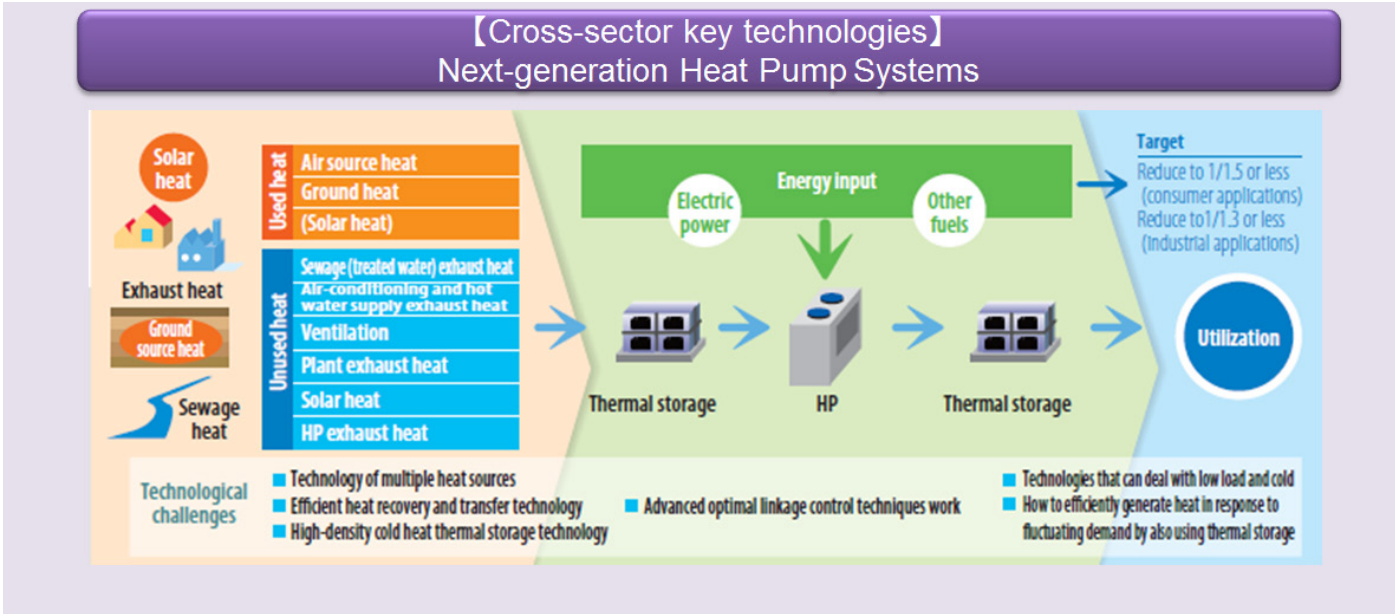
System to achieve high-efficiency, low cost heat pumps and reduce greenhouse gas emission by developing systemization and innovative element technologies for heat pump.

- Systemization technologies: Technologies for utilizing unused heat, technologies for collecting and storing high-efficiency heat, technologies for improved efficiency at low loads, etc.

- Innovative element technologies: Technologies for high-efficiency refrigeration cycles, development of new refrigerants, high-efficiency heat exchange equipment, technology for high-efficiency compressors, etc.

Examples:
- HPs for home, office buildings and factory air-conditioning
- HPs for car air-conditioning
- Industrial use HPs
- HPs for hot water
- HPs for refrigerators, freezers, etc.

Figure 3. Images of Next-generation Heat Pump System Research and Development in the 2011 Strategy for Energy Efficiency Technologies



Smart Grids in relation to ETP 2012

Peter Wagener, The Netherlands

In our highly technology-driven society, which is on the brink of significant steps on the path of electrification of the entire system, very few consider consciously the essential part played by electricity as a dominant energy carrier for our day-to-day life. Continuing to take it for granted is an untenable position, as the present affordability, availability and accessibility will continue only if we change our system dramatically. Managing our future energy systems will mean that they will have to become smart in every respect. Power generation, transportation, balancing of demand and production - all aspects will gradually adopt IT solutions to improve and maintain the manageability, adaptability and (particularly) the reliability of the system.
Electricity production from renewable sources is steadily increasing, and calls for a paradigm shift in the way we approach our major energy carrier. Electricity production, transportation, usage and pricing will all change significantly.

Introduction

One way or another, mankind seems to take services such as heating, cooling, lighting etc. as something obvious. Our society shows signs that this is gradually changing, although slowly, in terms of greater interest and awareness.

One of the main, constant energy users in our western society is the use of energy for heating, cooling and hot tap water production in the built environment: all regarded as essential conveniences to us nowadays. But the energy consumption of the technologies used to deliver these services is not something that can be disregarded but a growing strain, and there lies the future challenges and opportunities.

For an overview of energy consumption by region, see Figure 1.

For a significant part the energy system, the provision of space heating, cooling and hot tap water production in the built environment is very likely to undergo a gradual change from being mainly fossil-fuelled to provision by electricity. Since this change will and cannot happen overnight, the expected transition period will take several decades. At times, it will be difficult, but it will also provide many opportunities.

Electrification will bring us to a state where demand will increasingly have to follow supply, instead of the opposite as it is now. Increasingly, the use of renewable energy sources for electricity production will determine when (in terms of times of the year and times of the day) hat electricity may be used, until the day arrives that we can efficiently and cost-effectively store that electricity in very large quantities. This will not be in the very near future. It is therefore essential that smart grids should play a part, and especially in conjunction with heating solutions such as heat pumps. This not least because of the fact that utility companies seem already to have concluded that simply adding more copper to the network is an answer to this increasing challenge that will not do the job and is infeasible in terms of cost.

Flexibility in electricity systems

Analysis in IEA's Energy Technology Perspective (ETP 2012) of smartgrids' deployment up to 2050 shows that although the investments are steep, the benefits will outweigh the investment cost. The IEA modelled

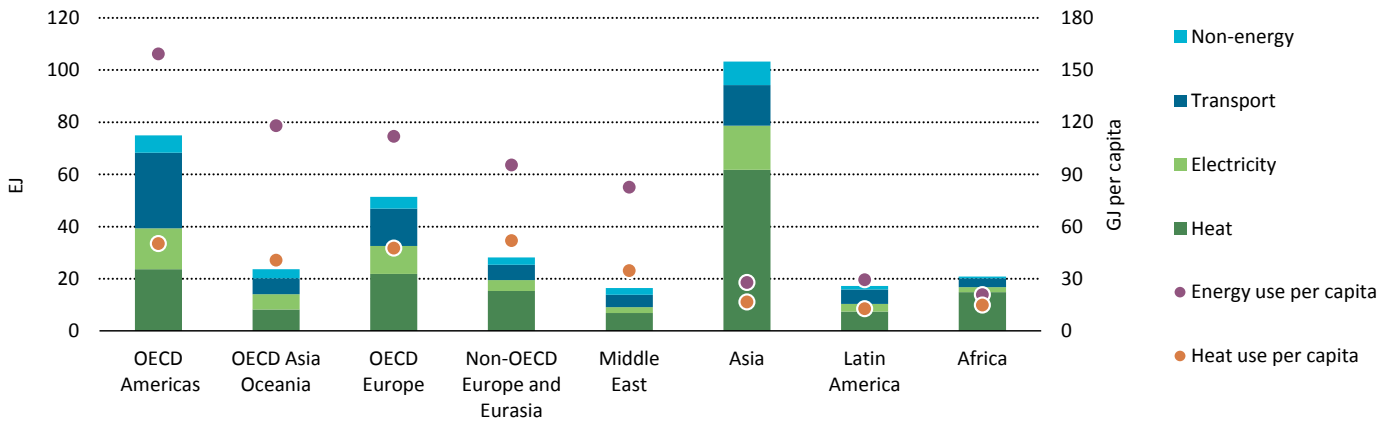


Figure 1. Total final energy consumption by region as electricity, heat, transport and non-energy uses, status 2009 (Source: Energy Technology Perspectives 2012 © OECD/IEA, 2012)

Smart Grids have become what is known as a 'container definition', which means that everybody knows the definition but also that there is a broad spectrum of perception of what this definition implies.
The term "smart grid" and its origin:
A smart grid is an electrical grid that uses information and communications technology to gather and act on information, such as information about the behaviours of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.
The term 'smart grid' has been in use since at least 2005, and had been used previously and may date as far back as 1998. There are many smart grid definitions; some functional, some technological, and some benefits-orientated.

A common element of most definitions is the application of digital processing and communications (ICT technology) to the power grid, making data flow and information management central to the smart grid. Electrical utilities now find themselves making three classes of upgrades:

- Improvement of infrastructure,
- Addition of the digital layer, which is the essence of the smart grid, and
- Business process transformation, necessary to capitalise on the investments in smart technology.

(Source: Amin and Wollenberg (2005)

five regions with such developments and concluded that smart grids permit cost reductions in power generation, transmission and distribution, retail operations, and in the overall system usage (ETP 2012, pp 216-218). Achieving the necessary low-carbon economy requires a clear transition from the existing mainly (fossil-fired) one-way-direction electricity system, in which generation follows demand, to one that optimises the use of all operational renewable resources (e.g. wind, solar photovoltaics [PV], wave, and tidal) available.
To date, too much attention has been concentrated on using only the existing generation infrastructure to provide the required system flexibility, while investment in other flexibility approaches has unfortunately been neglected. This development of other flexibility options will be needed in order to solve the long-term problems of the power system, as opposed to flexibility in known generation options, which is more short-term related.

The need for flexibility in the electricity system is increasing rapidly, as growing numbers of variable renewable generation options come onto the grid. Variable renewable generation sources are becoming a significant input to the electricity system, expected to reach 20 % and even up to 55 % of regional generation capacities by 2050 under the 2K temperature increase Scenario (2DS) of ETP 2012. Integrating variable renewable power generation supply to the grid requires an increasing demand for smart balancing tools to match this electricity flow to the volatility of power demand.

A substantial potential exists if the predictable but intermittent electricity demand can be matched to the less-predictable electricity supply. Facilitated by smart-grid technologies, demand response can technically provide between 50 % and over 300 % (depending on the region) of the regulation and load-following flexibility that will be needed in 2050. Demand response is less suitable for the scheduling time frame, but can still contribute.

In this load-following flexibility approach, heat pumps can play a very significant role. Heat pumps can use renewable energy from a variety of sources: not only ambient air, surface water or geothermal heat, but also heat from sewage effluent, exhaust air etc. etc.

However, combining heat pumps with storage options can offer the almost ideal disengagement option in the use of renewable energy sources.

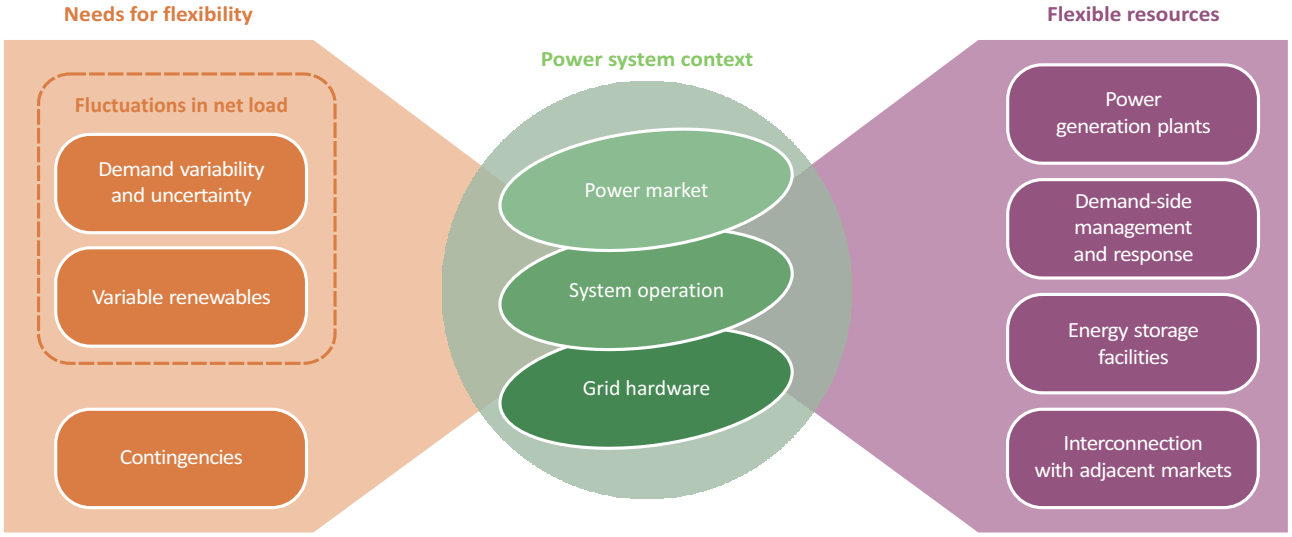


Figure 2. The need for flexibility, resulting from variable renewables, demand and contingencies, can be met by four flexible resources: generation, demand response, storage and interconnections. (Source: Energy Technology Perspectives 2012 © OECD/IEA, 2012)

By means of buffering of heat and/or cold we can break the link between the moment of availability and the moment of energy demand. But this also offers technical opportunities to use the electricity grid more efficient by lopping peaks and improving load balance in the network. All these systems require far more flexibility from all the stakeholders, and a more integrated approach of the solutions applied: the smart solutions.

In the end we shall see more complex systems which become more and more mutually connected. This mutual connection will be possible only if we can rely on sophisticated IT solutions in a 'smart' support structure.

Such a smart structure should offer the flexibility we need to handle all kind of load variations on the grid, with enough robustness to ensure the required reliability. See also Figure 2.

By managing the grid and its users in a smarter way we can retain energy security and obtain low-carbon energy for affordable costs. The latter is important, since for millions of households and businesses affordable energy bills are of utmost importance.

Fossil fuels will not disappear from our energy mix within a few years. But the low-carbon fossil sources such as natural gas are to be preferred to oil and coal. Let us use this fuel as a flexible transition solution on our way to a totally renewable energy system. Fossil fuel can be used in central power generation but also in many (decentralised) hybrid solutions. Gas-driven heat pumps are one example that we can see coming onto the market in a variety of solutions nowadays.

In addition to helping to time-shift the demand and use of energy, hybrid heat pumps and gas-driven heat pumps offer the opportunity of choice of the type of energy carrier. In the transition time frame that we are in at present, this is a welcome addition to the range of available options for smart grid management solutions.

The potential of heat pumps in conjunction with smart grids for their role in a route to a low carbon, energy-secure society is widely recognised, but until now has been less comprehensively investigated and reported. The Executive Committee of the IEA Heat Pump Program has recognised this need for gathering and disseminating knowledge, and approved establishment of Annex 42, 'Heat Pumps in Smart Grids' at the ExCo meeting in November 2012. The results of this annex will have to shine light on a variety of subjects related to heat pumps in smart grids, and will be achieved by a project in which a large group of IEA member states cooperates on accomplishing this knowledge gathering and dissemination process.

Conclusion

Electricity changes from a low-interest, low-cost convenient commodity into a valuable energy carrier which forms the foundation for our society due to its increasing reliance on electrification. Development of smart grids, including application of a variety of heat pumps, is essential for securing a reliable power grid.

References

Energy Technology Perspectives 2012 © OECD/IEA, 2012

Amin, S.M. and Wollenberg, B.F., Toward a Smart Grid, IEEE P&E Magazine 3, 34 (2005)

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Events

This section lists exhibitions, workshops, conferences etc. related to heat pumping technologies.

2013

26-30 January
ASHRAE Winter Conference
Dallas, Texas, USA
http://www.ashrae.org/membership--conferences/conferences/dallas-conference

5-7 February
Chillventa Rossija
Moscow, Russia
http://www.chillventa-rossija.com/en/

28 February – 1 March
GeoTHERM
Offenburg, Germay
http://www.geotherm-offenburg.de/en/geothermal_expo_congress

7-9 March
ACREX India 2013
Mumbai, India
http://www.acrex.in/

17-20 March
2013 IIAR Industrial Refrigeration Conference & Exhibition
Colorado Springs, Colorado, USA
https://www.iiar.org//index.cfm?

8-10 April
China Refrigeration 2013
Shanghai, China
http://www.cr-expo.com/EN/Index.asp

12-16 April
ISH 2013
Frankfurt, Germany
http://ish.messefrankfurt.com

2-4 April
2nd IIR International Conference on Sustainability and the Cold Chain
Paris, France
http://www.iccc2013.com

9-11 May
5th International Conference Ammonia Refrigeration Technology
Ohrid, Republic of Macedonia
http://www.mf.ukim.edu.mk/web_ohrid2013/ohrid-2013.html

14-15 May
EHPA General Assembly and Conference 2013
Brussels, Belgium
http://bit.ly/VlgJNr

3-7 June
European Geothermal Congress 2013
Pisa, Italy
http://www.geothermalcongress2013.eu/

7-8 June
15th European Conference - Italy
Refrigeration and Air Conditioning
Milano, Italy
http://www.centrogalileo.it/milano/congressodimilano2013english.html

16-19 June
CLIMA 2013
Prague, Czech Republic
http://www.clima2013.org/

22-26 June
ASHRAE Annual Conference
Denver, Colorado, USA
http://ashraem.confex.com/ashraem/s13/cfp.cgi

9-10 September
International Conference on Compressors and their Systems
London, UK
http://www.city.ac.uk/compressorsconference

25-27 September
5th International Conference Solar Air-Conditioning
Kurhaus Bad Krotzingen, Germany
http://www.otti.eu/event/id/5th-international-conference-solar-air-conditioning.html

3-4 October
7th CLIMAMED Mediterranean Congress of Climatization
Istanbul, Turkey
http://www.climamed.org/

2014

18-22 January
ASHRAE Winter Conference
New York, USA
http://www.ashrae.org/membership--conferences/conferences/ashrae-conferences

31 March – 3 April
2014 International Sorption Heat Pump Conference
College Park, Maryland, USA
http://www.ceee.umd.edu/events/ISHPC2014

12-16 May
11th International Energy Agency Heat Pump Conference
Montreal, Canada
http://www.iea-hpc2014.org/

28 June - 2 July
ASHRAE Annual Conference Seattle, USA
http://www.ashrae.org/membership--conferences/conferences/ashrae-conferences

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Heat pumps and thermal energy storage

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International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among its participating countries, to increase energy security through energy conservation, development of alternative energy sources, new energy technology and research and development.

IEA Heat Pump Programme

International collaboration for energy efficient heating, refrigeration and air-conditioning

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.

IEA Heat Pump Centre

A central role within the programme is played by the IEA Heat Pump Centre (HPC). The HPC contributes to the general aim of the IEA Heat Pump Programme, through information exchange and promotion. In the member countries (see right), activities are coordinated by National Teams. For further information on HPC products and activities, or for general enquiries on heat pumps and the IEA Heat Pump Programme, contact your National Team or the address below.

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