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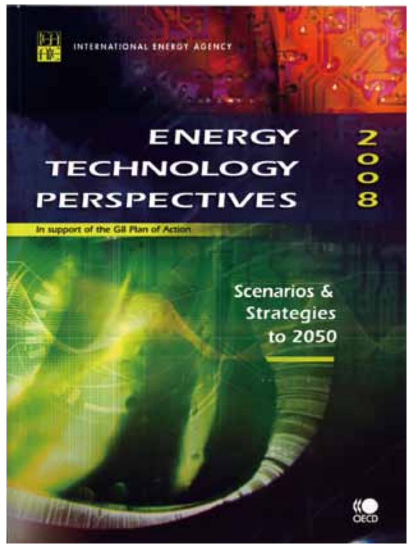
Annex
The Latest Topics

Energy Technology Perspectives (ETP) 2008



In 2008, International Energy Agency (IEA) launched "Energy Technology Perspectives (ETP) 2008" as reply to request by G8 Summit in Hokkaido for energy and environment policy scenario toward 2050.

ETP 2008, aiming realization of sustainable energy future with the challenging target of halving world's CO_2 emissions by 2050, offers a global energy scenario to attain this target. In this scenario, from energy efficiency, power generation and transport areas, 17 key technologies were expected to play the central role to mitigate CO_2 emissions. Heat pump is one of such important energy technologies including nuclear, CCS, photovoltaic, wind, electric vehicle, etc.

In ETP 2008, roadmap of each technology was also drawn to show the current technological development and provide the CO_2 abatement potential so as to deploy such technologies around the world.

Key Roadmaps in This Study

Supply side	Demand side
CCS fossil-fuel power generation	Energy efficiency in buildings and appliances
Nuclear power plants	**Heat pumps**
Onshore and offshore wind	Solar space and water heating
Biomass integrated-gasification combinedcycle and co-combustion	Energy efficiency in transport
Photovoltaic systems	Electric and plug-in vehicles
Concentrating solar power	H_2 fuel cell vehicles
Coal: integrated-gasification combined-cycle	CCS in industry, H_2 and fuel transformation
Coal: ultra-supercritical	Industrial motor systems
Second-generation biofuels	

Heat Pump and Renewable Energy

In 2007, EUROPEAN PARLIAMENT agreed that by 2020, (1) GHG emissions to be reduced by 20% in comparison to 1990 level, (2) EU targets for the overall share of energy from renewable sources in gross final consumption of energy as 20% and (3) reduction of gross final consumption of energy by 20% (so called "Triple 20").

In 2009, EUROPEAN PARLIAMENT adopted a directive, establishing a common framework for the promotion of energy from renewable sources. It sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy.

The Directive defines aerothermal, geothermal and hydrothermal energy captured by heat pumps as energy from renewable sources.(Annex VII to the Directive)

ANNEX VII

Accounting of energy from heat pumps

The amount of aerothermal, geothermal or hydrothermal energy captured by heat pumps to be considered energy from renewable sources for the purposes of this Directive, ERES shall be calculated in accordance with the following formula:

ERES = Qusable * (1 – 1/SPF)

where

— Qusable = the estimated total usable heat delivered by heat pumps fulfilling the criteria referred to in Article 5(4), implemented as follows: Only heat pumps for which SPF > 1,15 * 1/η shall be taken into account.
— SPF = the estimated average seasonal performance factor for those heat pumps.
— η is the ratio between total gross production of electricity and the primary energy consumption for electricity production and shall be calculated as an EU average based on Eurostat data.

By 2013, the Qusable and SPF guidelines of each heat pump technology should be established by taking into consideration differences in climate conditions.

By 1 January, 2013, the Commission shall establish guidelines on how member states are to estimate the values of Qusable and SPF for the different heat pump technologies and applications, taking into consideration differences in climate conditions, especially very cold climates.

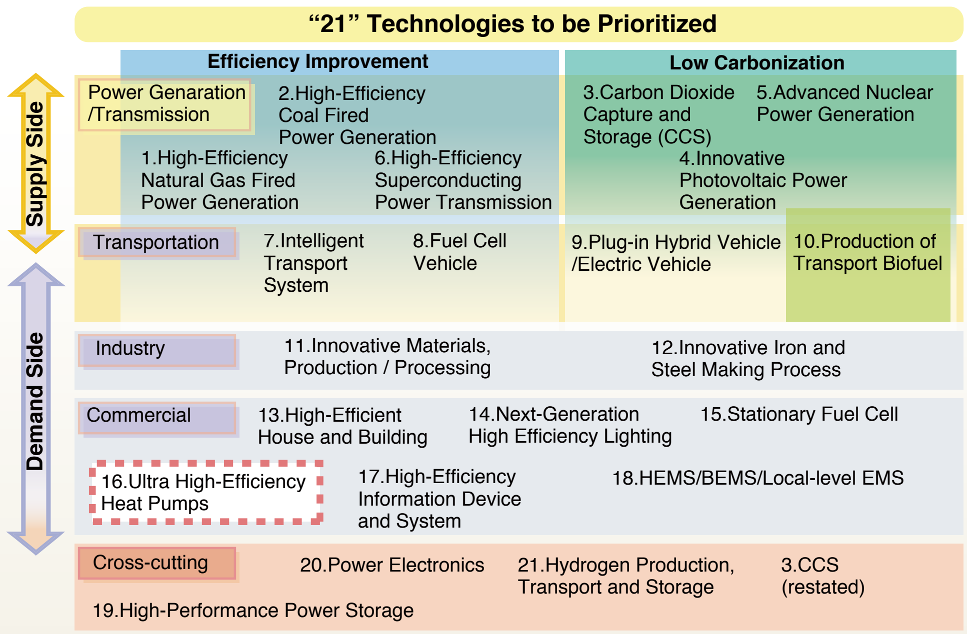
Following such European policy, the government of Japan begins to clarify the ambient heat captured by heat pumps as renewable energy in its energy policies and legislation.

Current Status of Heat Pumps in Japan

Japan's Ministry of Economy, Trade and Industry established the "Cool Earth-Innovative Energy Technology Program" in March 2008. In this strategic program toward 2050, the ministry selected the technologies that must be intensively addressed for the deployment to combat global warming. In this program, "ultra high-efficiency heat pump" was adopted as one of these important demand side energy technologies, particularly feasible and effective for the GHG reduction in the commercial sector. This program also drew the technology development roadmaps both to decrease the cost of heat pumps by half and to double the efficiency from the present level by 2050 through development of technological elements such as refrigerants and heat exchangers.

Based on this program, the ministry has started the advanced study of seeking such technological development toward next-generation heat pumps.

Japan's 21 Innovative Technologies for GHG Reduction



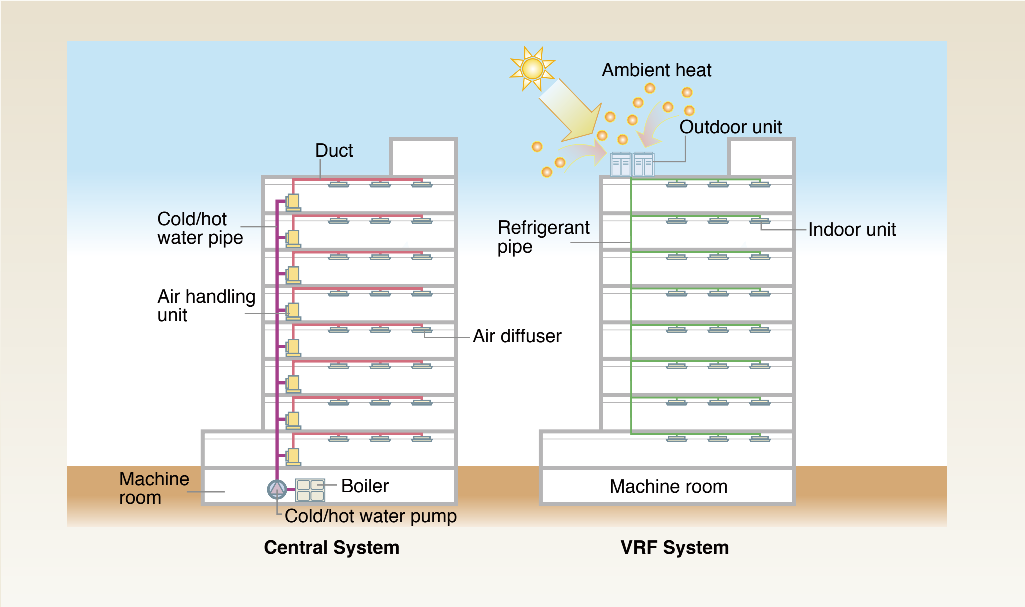
(Source : Cool Earth-Innovative Energy Technology Program 2008)

Variable Refrigerant Flow System

Central heating and cooling system, for which it is very common to apply duct-type appliance, usually accompanies auxiliary equipment such as air handling unit and cold/hot water pumps necessary to transport heat. In the actual situation, keeping the energy efficiency of such central system high is quite hard because of the difficulties to adjust its operation in accordance with the heat demand fluctuation of each room.

To overcome such barrier, VRF (variable refrigerant flow) heat pump heating and cooling system, which has been originally used for small-to-medium-size buildings, has been invented for large office buildings to replace central systems. VRF is now expanding its share because of its high efficiency, high energy-saving performance and low cost. Different from the duct-type air-conditioner, VRF has directly connected refrigerant pipes with one outdoor unit and two or more indoor units. VRF can substantially reduce the energy consumption to operate its system because it doesn't have auxiliary equipment and the inverter enables variable speed operation efficiently. Without the inverter, fixed speed of operation requires frequent starting and stopping of equipment and causes inefficient operations. In this consequence, the inverters enable drastic improvement in efficiency particularly of its partial load operation.

Furthermore, VRF can cope with a broad range of capacity from detached houses to large office buildings and hotels by connecting two or more outdoor units.



Heat Pumps for Use in Cold Climate Areas

In cold climate areas, air-source heat pumps which utilize ambient heat are less efficient than those in warmer areas. In the past, when the heat pump technology was not so advanced as today, the heating performance of some pieces of heat pump equipment drastically declined when the outside air temperature became low. Therefore, air-source heat pumps were rarely introduced for heating purposes, while fossil fuel combustion boilers were mainly used under such cold climate.

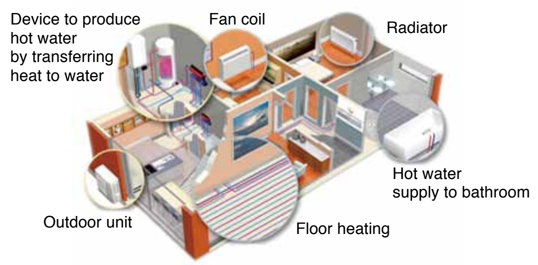
However, the performance of air-source heat pumps has been remarkably improved in recent years, and some products newly born have sufficient heating performance even at an outside air temperature of -25°C due to the enhanced performance of compressors and heat exchangers.

For example, an air-source heat pump water heating system for residential use that was invented by Daikin Industries, Ltd. in 2006 can supply sufficient heat in a climate below freezing point, and its specifications are reliable enough for use in cold climate areas such as Northern Europe. In 2007, approximately 10,000 units were shipped to Europe. At present, they are exported to China and North America in addition to Europe, and the annual shipment is more than 50,000 units.

Another air-source heat pump room heater and water heater that Mitsubishi Electric Corp. started producing in 2009 in the U.K. have also captured a new market. The expectations for air-source heat pumps are rapidly growing.

As it is easy to replace existing boilers with these air-source heat pumps, they foster the demand not only for new installation but also for the replacement of boilers.

Up to now, approximately 6 million boilers are sold annually in Europe. Air to water heat pumps are expected to account for about 1 million of these 6 million units in the coming years. Moreover, France and several other European countries are offering subsidies as an incentive to purchase heat pump equipment, which are providing a needed boost to heat pump water heating market expansion.



Example of installation of air-source heat pump room heater and water heater

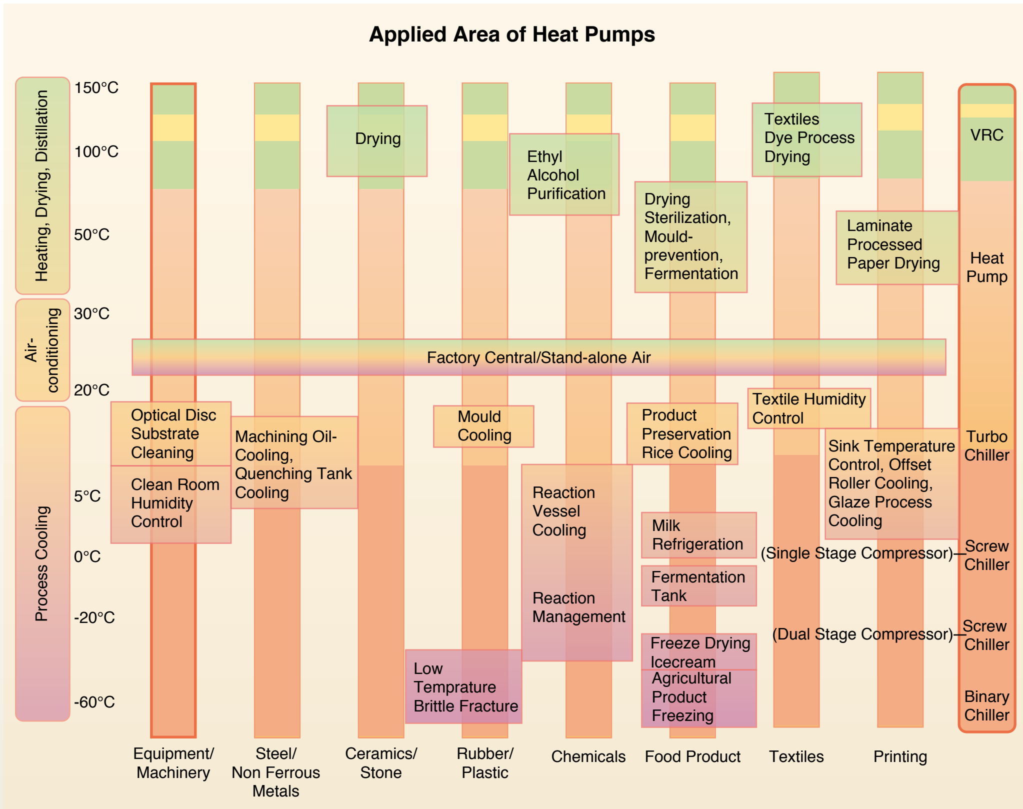
For reference, high-efficiency multitype air-conditioners with heat pumps for buildings, which were commercialized by Daikin Industries, Ltd. in 2007, achieved a level of COP3 or higher at an outside air temperature of -10°C.

Industrial Heat Pump Utilization with Technology Development

Heat pumps for industrial uses are now often found in various sectors with many different applications that range in temperature from tens-of-degrees below 0°C to over 100°C. The diagram below illustrates sample categories in which industrial heat pumps are used in each temperature range.

Heat pumps supplying heat at temperatures over 100°C, which had been almost impossible for conventional heat pumps, are being commercialized now. A Japanese heat pump manufacturer, Toyo Engineering Works, Ltd., began selling heat pumps in 2006, that utilize waste heat from brewery production process, etc. at 55-75°C, for the production of both steam at 100-120°C, as well as hot water at 60-95°C. And another Japanese manufacturer, Mayekawa Mfg. Co., Ltd., has developed heat pumps that can produce hot air at 120°C, even without utilizing waste heat.

These two products can reduce CO_2 emissions by more than 70% compared with fossil fuel combustion systems, according to the estimates. To expand the applied area, further research and development for higher temperature heat pumps is now proceeding by a number of manufacturers.



Heat Pump Reduces Heat Losses of Factory's Boiler

In order to reduce CO_2 effectively, it is quite necessary to focus on the actual performance of energy system. Today, steam supplied by combustion boiler with the long piping network is the main source of heat that is used for drying, washing and hot-water supply equipment, process machinery and heating machinery, etc.

According to the actual measurement of steam energy system in an automobile factory in Japan, only 26.6% of energy inputted into the steam system is used effectively. The rest of three quarters of the energy is dumped in the drain, leaked in the pipe and lost in the combustion process.

In other words, it should be noted that the steam system cannot be recognized as the only way to supply heat for manufacturing process without improving its efficiency.

Another solution which is getting more attentions from manufacturers is to improve energy efficiency and reduce CO_2 emissions with heat pumps. This is because they bring the following advantages that the steam systems are hard to obtain;

・Heat pumps should be located where energy is necessary.

・Heat pumps should produce heat at temperatures that is demanded.

・Heat recovery heat pumps should be adopted if possible.