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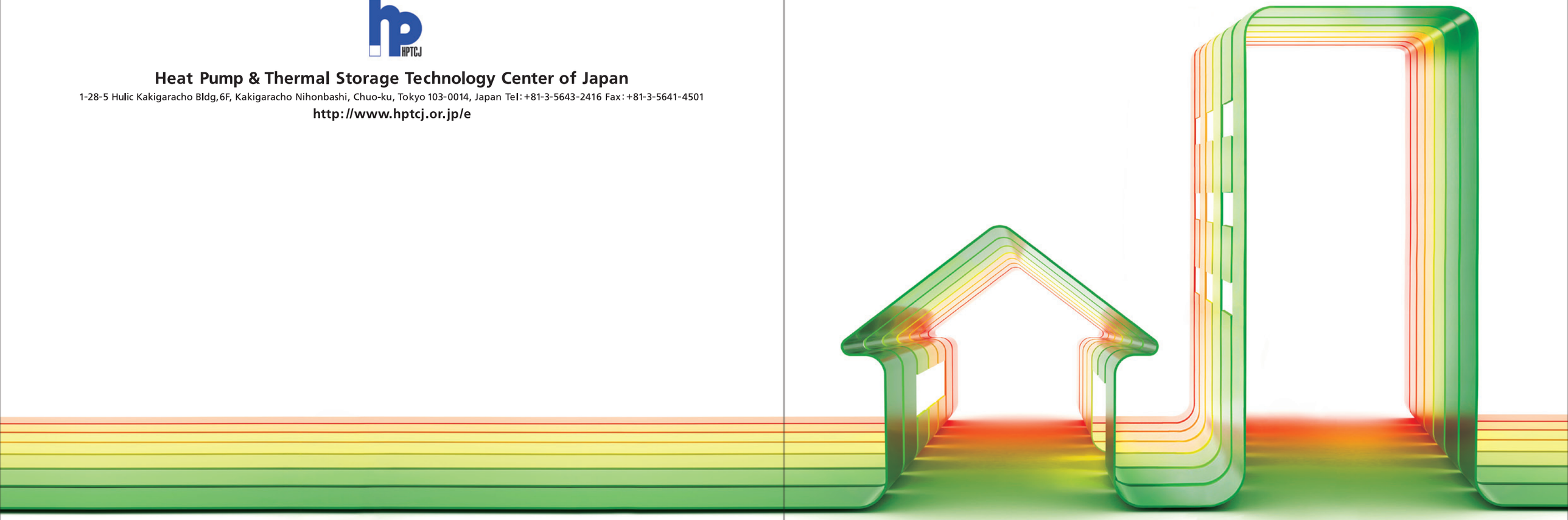
Heat Pump Style

Towards the emissions reduction goal in 2050

References

IEA
- **Energy Technology Perspectives 2008**
- **Energy Technology Perspectives 2010**
- **Technology Roadmap** (Energy-efficient Buildings: Heating and Cooling Equipment)



Message from International Energy Agency

- Synergy between heat pump technology on the demand side and the de-carbonization on the supply side results in very significant CO_2 reductions.
- Wider use of heat pumps could result in 1.25 G-tons (Gt) of CO_2 reductions by 2050.
- Heat pumps are mature, highly efficient technologies that take advantage of renewable energy*.
- Thermal energy storage improves system efficiency, shifting demand and facilitating greater use of renewable energy.
- Half of all space and water heating systems will be combined with thermal energy storage by 2050.

*It is stated in the EU directive on the promotion of renewable energy that heat pumps are a technology that utilizes "renewable energy."

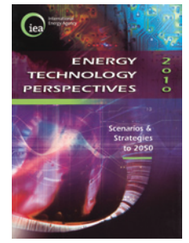
International Energy Agency (IEA)

IEA was established in 1974 after the first oil crisis as an organization within the framework of the Organization for Economic Cooperation and Development (OECD) with the aim of avoiding the crisis of oil supply in the member countries. Its present mission is to harmonize energy policies of the countries concerned, while maintaining a good balance between energy security, solution of global environmental issues, economic development and the efforts that involve the world as a whole. IEA has its secretariat in Paris and 28 member countries.

What is Energy Technology Perspectives ?

Energy Technology Perspectives

- Energy Technology Perspectives (ETP) is a report published every two years by IEA to provide decision makers with the information that is necessary for a future that is safer and emits less carbon.
- At the G8 Gleneagles Summit (Scotland, U.K.) in 2005, the G8 requested the IEA to develop scenarios and strategies to solve energy and global environmental issues. Based partially on this request ETP was developed.
- There are several analyses of scenarios (countermeasures, emissions reductions, costs, barriers to dissemination, etc.) in ETP. As for the major technologies mentioned in ETP, Technology Roadmaps are also prepared.



ETP2010

Technology Roadmap

- The roadmap clarifies a route for the advancement and dissemination of technologies from the present to 2050 and proposes research & development, demonstration, investment, policy, international cooperation, etc. that is needed to exploit the full potential of these technologies.
- The roadmap is provided as a reference for international organizations, including the United Nations Framework Convention on Climate Change (UNFCCC). It is also used by respective governments and companies as a tool to develop and implement energy strategy.

Technology Roadmap

ETP and Technology Roadmap–Key Points

July 2005	G8 Gleneagles Summit	IEA was requested to support a solution for energy and global environmental issues.
June 2006	IEA published ETP2006	ETP 2006 analyzed and reported on the current status and future of energy-related technologies through 2050, as well as the barriers to widespread use of such technologies and measures for removal of such barriers.
June 2008	IEA published ETP2008	ETP 2008 presented a scenario that could reduce global CO_2 emissions by half by 2050. ETP selected heat pumps as one of 17 technologies that are highly effective in reducing CO_2 emissions and a major technology in achieving the 2050 target.
July 2008	G8 Hokkaido Toyako Summit	The G8 praised IEA's reports (ETP 2008, etc.). IEA was requested to continue their work to in developing roadmaps for major technologies.
July 2010	IEA published ETP2010	The contents of ETP 2010 were updated, for example, by introducing heat pumps as a technology expected to provide multiple benefits by "reducing carbon on the supply side" and "raising efficiency of energy use on the demand side."
May 2011	IEA published Technology Roadmap Energy-efficient Buildings: Heating and Cooling Equipment	The Technology Roadmaps that have been developed to date concerning major sectors and technologies are as follows: Carbon capture and storage (CCS), cement, wind energy, nuclear energy, Solar photovoltaic energy, concentrating solar power, biofuels for transport, electric and plug-in hybrid electric vehicles (EV/PHEV), geothermal heat and power and smart grids

Drastic reduction in CO_2 emissions is required for the future

According to the BLUE Map scenario in IEA ETP 2010 and Technology Roadmap, halving energy-related CO_2 emissions by 2050 from 2007 levels is necessary to enhance energy security and economic development and to protect environmental sustainably. Using a combination of existing and new technologies makes it possible.

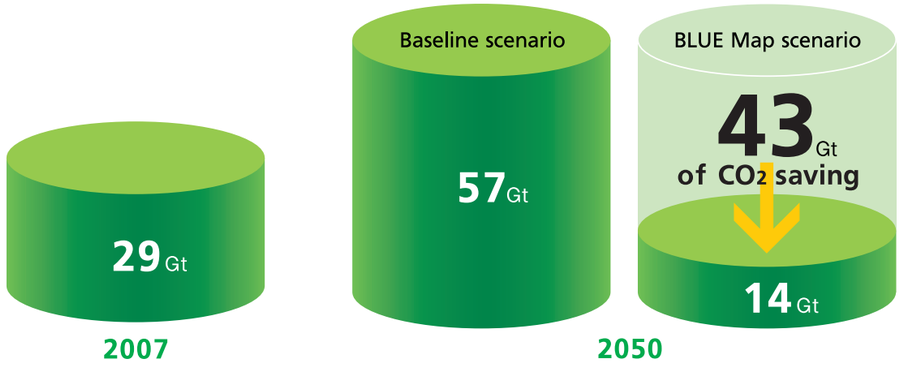


Figure 1 : Global CO_2 emissions

Baseline scenario : Baseline scenario assumes governments introduce no new energy and climate policies.

BLUE Map scenario : BLUE Map scenario is target-oriented : it sets the goal of halving global energy-related CO_2 emissions by 2050 (compared to 2007 levels) and examines the least-cost means of achieving that goal through the deployment of existing and new low-carbon technologies.

17 key technologies that are highly effective in reducing CO_2 emissions

To reduce the global CO_2 emissions by half by 2050, 17 highly effective technologies in reducing CO_2 emissions have been selected. Heat pumps are one of the technologies on the demand side.

Table1 17 key technologies for energy efficiency

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 combined-cycle 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-based reductions in CO_2 emissions (for space heating/cooling and hot water supply)

Highly efficient heat pump for space heating/cooling and hot water supply is a highly cost effective technology that has already been commercialized to reduce CO_2 emissions. According to trial calculations by IEA, CO_2 emissions reductions in space heating/cooling and hot water supply by 2050 will be projected at 2 Gt. Of this amount, reductions by heat pumps are assumed to be 1.25 Gt (63% of the total in space heating/cooling and hot water supply). As for reductions in other technologies, solar heat systems will account for 0.58 Gt (29% of the total) and CHP for 0.16 Gt (8% of the total).

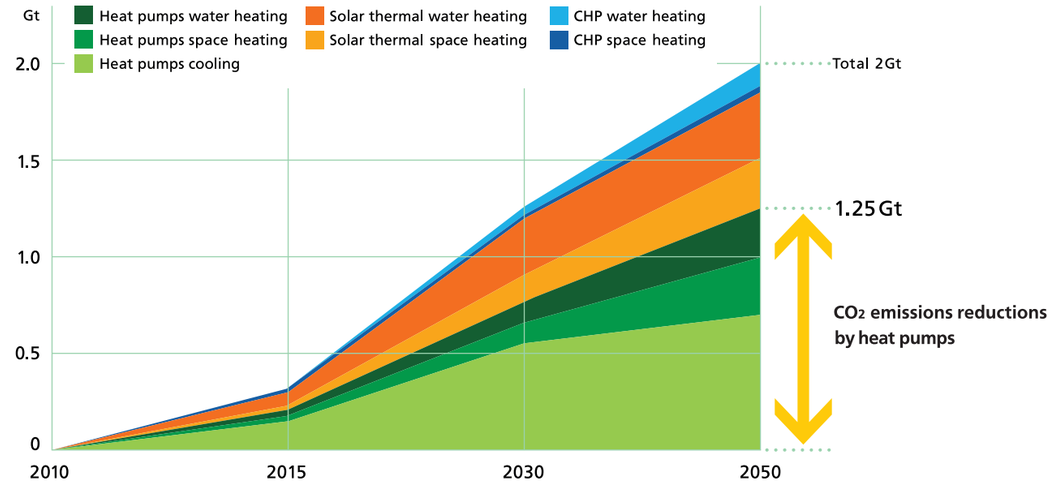


Figure 2 : Heating and cooling technologies' contribution to CO_2 emissions reduction

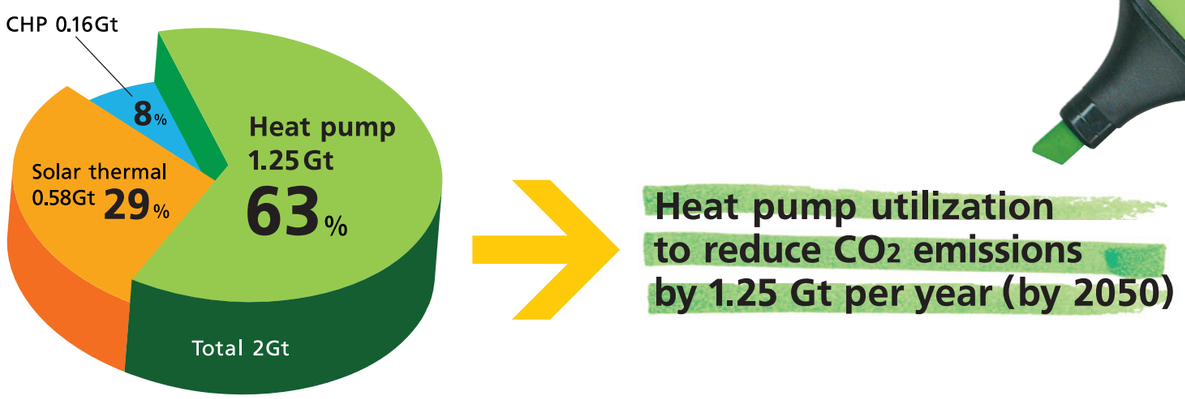


Figure 3 : CO_2 emissions reduction by effective technologies for space heating/cooling and hot water supply (2050)

Importance of measures for space heating/cooling and hot water supply

Buildings account for almost a third of final energy consumption globally and are an equally important source of CO_2 emissions. Currently, both space heating and cooling as well as hot water are estimated to account for roughly half of global energy consumption in buildings. Most of CO_2 emissions from space heating and hot water supply are caused by combustion of fossil fuels, and also the demand for cooling is rapidly increasing in emerging countries and others. Therefore, with space heating/cooling and hot water supply, using highly efficient heat pumps can reduce energy consumption and CO_2 emissions, as well as improve energy security.

Measures and dissemination targets incorporated by IEA to halve CO_2 emissions

Measures

ETP and Technology Roadmaps specially refer to heat pumps in the sections describing the measures to halve CO_2 emissions as follows:

●Dramatic increase in market share of space and water heating in the residential sector

The share of useful space and water heating demand met by fossil fuels will drop to between 5% and 20% (depending on region) from today's position of dominance and the total number of installed heat pumps in the residential sector for space heating and cooling, and hot water will reach almost 3.5 billion by 2050 (0.8 billion in 2010).

●Replacing boilers with heat pumps in a range of industrial applications

Recent technological advances that have enabled efficiency improvements, increases in capacity and output at higher temperatures offer the opportunity to replace boilers with heat pumps in a range of industrial applications. Using heat pumps can also cut energy costs, improve product quality and in some industries even shorten production periods.

●Increased deployment of thermal storage system

Thermal energy storage will be associated with half of all space heating and hot water systems by 2050. When combined with thermal storage, heat pumps could also help reduce the costs in the BLUE Map scenario of integrating a high share of intermittent renewables into the grid by enabling loads to be shifted out of peak periods.

●Mature and highly efficient technologies taking advantage of renewable energy

Heat pumps use renewable energy* from their surroundings (ambient air, water or ground) and "high-grade" energy to raise the temperature for heating or to lower it for cooling. In the BLUE Map scenario, the buildings sector deploys heat pumps widely for space heating and hot water, and very high-efficiency heat pump systems for cooling. This, together with the de-carbonization of the electricity sector, results in very significant savings compared with the Baseline scenario.

Dissemination targets

According to the Technology Roadmap, heat pumps for residential use will amount, on an installed capacity basis, to 4,876 GW (1,300 GW of which is for hot water supply). That far exceeds the 3,743 GW of solar heating systems. So, the importance of the role to be played by heat pumps will further increase for space heating and hot water supply.

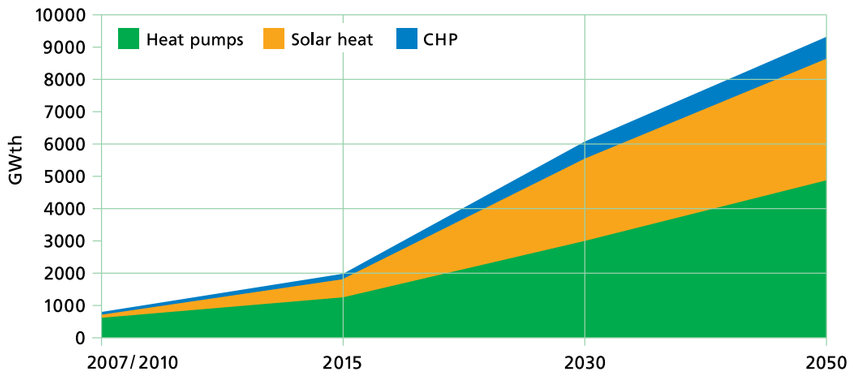


Figure 4 : Global deployment of energy-efficient and low/zero-carbon heating technologies in the BLUE Map Scenario, 2007/2010 to 2050 (GWth)

＊Definition of air source heat as renewable energy

In Europe, air source heat and others that are used by heat pumps are defined as renewable energy according to the "EU directive on the promotion of renewable energy," which went into effect in June 2009. Also in Japan, air source heat is defined as a renewable energy in the "Act on Sophisticated Methods of Energy Supply Structures," which went into effect in August 2009.

Expectations for heat pump technologies

Executive Director,
International Energy Agency (IEA)
(Sep. 2007 – Aug. 2011)

Mr. Nobuo Tanaka

Joined the Ministry of International Trade and Industry in 1973,
and then served as a Japanese Minister to the U.S.
and Director-General of Multilateral Trade System Department.
After serving as Director for Science, Technology and Industry at OECD,
he served as Executive Director of IEA
from September 2007 through August 2011.

When we think of the world in 50 years' time, we have to start new revolutions of energy technologies. If no additional policy is employed by 2050, the energy demand in the world as a whole will increase by 84%, and CO_2 emissions will double. To prevent global warming, it is necessary to halve CO_2 emissions by 2050 from the present level. For this purpose, it is required to mobilize all low-carbon and energy-saving technologies. Particularly, energy conservation on the demand side is the field that we should start working on first and foremost because it can enjoy merits that exceed investment costs.

In May 2011, IEA officially released "Technology Roadmap for Energy-efficient Buildings: Heating and Cooling Equipment." This roadmap shows that a very large reduction in CO_2 emissions by 2050 can be expected through the use of low-carbon and high-efficiency heating and cooling technologies such as heat pumps, thermal storage systems, solar water heaters and others. It estimates the amount of CO_2 emissions reduced through heating and cooling technologies at about 2 billion t-CO_2 (5% of the total reductions〈43 billion tons〉based on 450 ppm scenario) by 2050 and the amount of energy to be saved at 710 million oil equivalent tons (3% of 22.1 billion oil equivalent tons of primary energy to be supplied in 2050). This would have a very large positive effect. Of this reduction, heat pumps account for 63%, solar water heaters for 29% and CHP for 8%, according to trial calculations. We have high expectations for heat pump technologies to reduce CO_2 emissions.

If a system to successfully promote the wide-spread use of heat pumps is created, the effects would be large. In dissemination of heat pump technologies, for example, we need to take into consideration lifetime cost, not only initial cost. I think that a certification system should be created based on the cost required for the entire period of equipment operation. If the government presents an appropriate labeling system, consumers can make correct choices.

On the other hand, an additional research and development investment of 3.5 billion dollars is needed every year to realize these technologies, and it is shown that large positive results can be achieved, if technologies receive investment.

The government is expected to present roadmaps in consideration of actual future conditions, develop supporting measures and standards, and create an appropriate economic environment.