

(1) Aims

A great amount of energy is consumed for supplying hot water in the residential, commercial and industrial sectors. CO₂ emission from residential hot water supply systems only is estimated to be approximately 70 million tons-CO₂/year. Recently, heat pump hot water supply systems that may reduce CO₂ emissions significantly is in the process of propagation. Clarification of the roadmap of this technology will contribute to further progress of the heat pump technology, which is important to suppress global warming.

(2) Social and technical needs

Efficiency improvement and price reduction are common needs. In addition, size reduction, noise reduction, and improvement of performance in cold regions are also required. Multi-function products, including floor heating and central heating, snow melting products, direct hot water supply type products, small local hot water supply systems for lavatories, utilization of waste heat (such as remaining hot water after bathing), heat recovery systems (capable of simultaneous cooling and heating), hybrid products, commercial-use products, industrial-use products and other various products, are needed.

(3) Future directions for determining key mechanisms and parameters

There are many technical development elements, including refrigerant, compressors, heat exchangers, motor systems, recovery of coolant expansion energy, waste heat recovery technology, hybrid technology, and so forth. Parts of these technologies are described below.

(a) Refrigerant

Refrigerants currently in use are mainly classified as follows: Freon refrigerant and natural coolants. Various types of refrigerants were developed according to the uses and characteristics. The high temperature difference heating values at 65 °C differ with the coolant types, while the theoretical COP is 12.9. That of CO₂ is 11.5, which is the highest, that of R410 is 9.1, and those of other Freon coolants and hydrocarbon coolants are about 8. It is expected that efficiency will be improved via circuit designs appropriate to the coolant characteristics and

advanced coolant control.

(b) Hybrid technology

There are two types of main hybrid technologies: utilization of boilers for industrial use and large-scale users, and utilization of solar heat (solar panels) and ground heat. In terms of system configurations, the parallel systems mix heat produced by solar panels and heat pumps in storage tanks or at the outlets, while the integrated systems (installed on roofs, porches or walls) incorporate solar panel evaporators, or decompressed-boiling solar panel evaporators in heat pumps. Solar heat hybrid systems are expected to have remarkably improved efficiencies. If they are used decompressed-boiling solar panel evaporators, the efficiency of heat pumps using butane refrigerant may possibly be improved by about 80%.

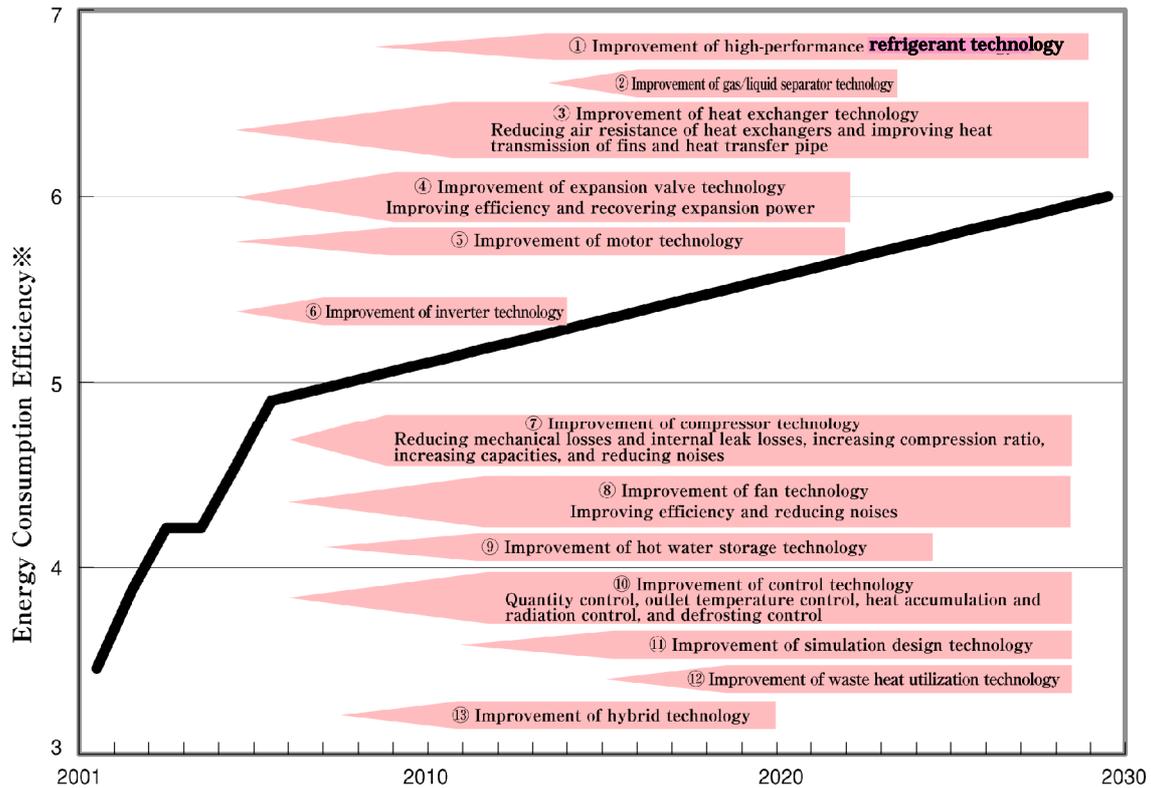
(c) Noise reduction

Noise reduction technology is important, since hot water storage type heat pump supply systems run at night. The noise level has reduced in the past five years from 45 dB to 38 dB owing to vibration reduction, suppression of noise transmission in solid matter, and noise quality improvement. Higher-speed rotation of compressors and fans is expected to further improve efficiency and reduce the size. Thus, noise reduction technology including noise quality improvement design and inverter technology should be improved.

(4) Contributions to society

Reduction of hot water needs by using high-performance insulating materials, improvements in efficiency of the heat pump hot water supply systems, and power decarbonization by increasing the renewable energy power generation ratio and CCS (carbon dioxide capture and storage) are three major elements. In the long term, the synergy effect of these three elements will reduce CO₂ emissions in the hot water supply industry. The quantity of residential heat pump hot water supply systems will increase up to 20 million or so by 2030. The expected CO₂ reduction in 2030 including residential, commercial and industrial facilities, will be 29 million tons in Japan. Besides, export to overseas countries will increase, since Japanese manufacturers are good at these technologies.

Social & Technical Needs	
2001 ~ 2010	<ul style="list-style-type: none"> • CO₂ reduction in hot water supply industry ↕ • Improvements in efficiency of hot water storage systems • Noise reduction • Performance improvement for cold regions
2010 ~ 2020	<ul style="list-style-type: none"> • Direct hot water supply systems • Size reduction (Storage tank integrated type) • Water heaters for snow melting • Middle-size hot water storage systems for commercial and industrial use ↕ • Hybrid systems (boilers)
2020 ~ 2030	<ul style="list-style-type: none"> • Hybrid systems (solar and ground heat) • Larger-capacity hot water supply systems ↕ • Double-bundle condenser hot water supply systems ↕ • Performance improvement for very cold regions • Recovery of hot water supply waste heat (remaining hot water and waste hot water) • Waste heat recovery type small-size local hot water supply systems
2020 ~ 2030	<ul style="list-style-type: none"> • Small-size direct hot water supply systems using water as heat sources • Large-size systems for industrial use (heavy use) • Vapor generation heat pumps • Very small-size and high-efficiency type products



2001 ~ 2010	<ul style="list-style-type: none"> Development of hot water supply systems with CO2 coolant ④ High-efficiency ejector cycles ⑤ Optimum design of high-efficiency, small-size DC motors ⑥ SiC power devices ⑨ Vacuum heat insulators ⑬ Utilization of underground heat
2010 ~ 2020	<ul style="list-style-type: none"> ① High-efficiency coolant circuit design technology ⑥ High-efficiency matrix converter ⑫ Exhaust heat recovery ⑩ Load forecast control ⑬ Using solar heat panels together ① Advanced coolant control technology ② Further size reduction using surface tension ③ Micro-channel type heat exchangers ④ Power recovery compressors with integrated expanders ⑬ Solar heat pressure reduction boiling panel evaporators
2020 ~ 2030	<ul style="list-style-type: none"> ① Development of new coolant ⑤ Next-generation sensor-less PM motors ⑨ High-density heat accumulation and latent heat accumulation ① Water coolant double-bundle hot water supply systems ⑫ Heat recovery from wastewater

Changes in Society and Markets	
2001 ~ 2010	<ul style="list-style-type: none"> Number of shipped heat pump hot water supply systems increased by 50% or more every year. Eco Cute subsidy system 50% or more increase Approx. 20 companies entered heat pump hot water supply system market. Number of products reached 1 million (2006). First promise period in the Kyoto Protocol (2008) Number of products will reach 5.2 million (2010).
2010 ~ 2020	<ul style="list-style-type: none"> Second promise period in the Kyoto Protocol (2013) Total number of homes will stop at 50 million. Consumption of electric power of new energy: 16 billion kW (2014) Average people per family will lower below 2.5. Japanese influences upon the LNG market will lower (from about 50% down to 19%).
2020 ~ 2030	<ul style="list-style-type: none"> Average people per family in Tokyo will be below two first in Japan. Peak of traditional petroleum consumption Progress of de-carbonization of electric power Energy consumption in Asian countries will be doubled in comparison with that in 2004. Number of products reached about 20 million. (30 years)

※ Coefficient of Performance (COP)=Output of heat/Input energy