Market Report: Japan

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This article describes trends in the shipments of room air conditioners, commercial air conditioners, and domestic heat pump water heaters, which are typical products in the Japanese heat pump market, over the past 20 years. Recent product technology trends are also described. In addition, the trends in use of industrial heat pumps is overviewed based upon information obtained from HPT Annex 48 activities. Finally, the role of heat pumps in Japan's energy conservation policy and the direction of technology developments by sector in energy conservation technology development strategies are described.

Introduction

Japanese heat pumps have evolved as products that correspond to the Japanese climate, housing style, and lifestyle. There is growing use of room air conditioners that individually air-condition each room and can be used for heating and cooling, heat pump water heaters (Eco-Cute) using CO_2 refrigerant that can store hot water at high temperatures, and multi air conditioners for buildings that can be connected to many indoor units. In industrial use, the spread of industrial heat pumps is promoted by the energy conservation measures of the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, and future growth can be expected.

Japan's climate and heat pumps

Figure 1 shows the monthly average, maximum and minimum temperatures in Tokyo. The maximum summer temperature is about 32 °C and the minimum winter temperature is about 2 °C. A heat pump can be used for both cooling and heating, and a high COP can be secured in both uses. Therefore, room air conditioners that heat and cool have been developed and commercialized for a long time, and air conditioners for both cooling and heating became mainstream in the 1980s. In addition, as a technology to compensate for the imbalance between cooling and heating capacities, a variable speed technology for the compressor using an inverter, electronic expansion valve and optimal system control has been continuously developed. It is also applied to other heat pump products.

Market trends and features of each product

Representative heat pump products in Japan are described below. They include room air conditioners, commercial air conditioners, domestic heat pump water heaters and industrial heat pumps.

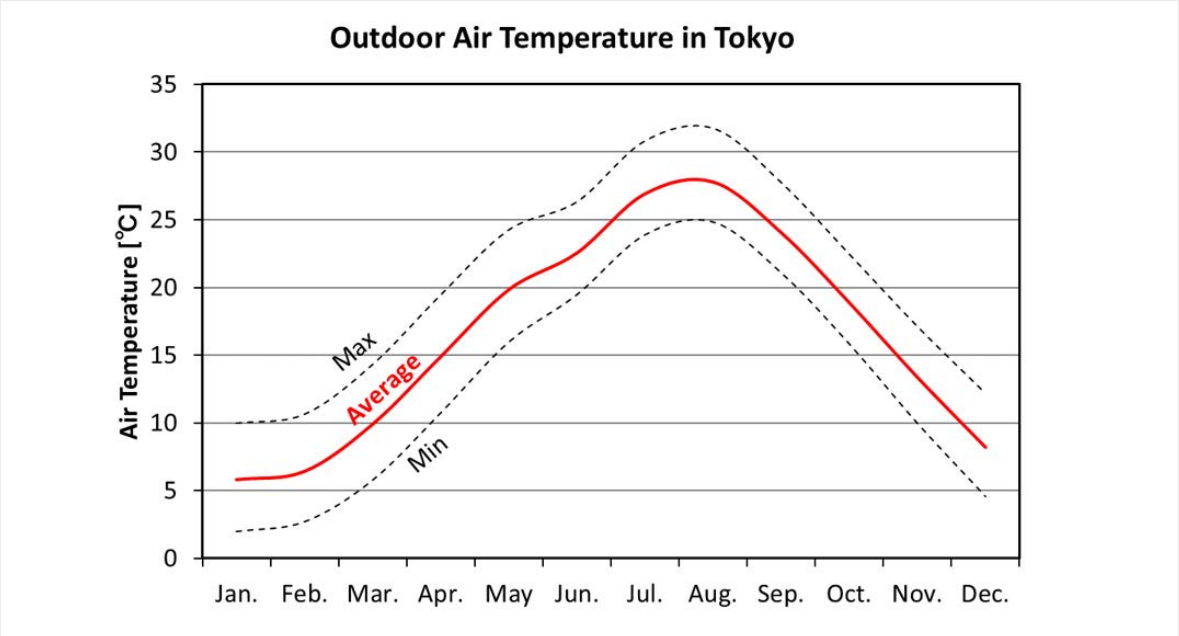

Fig. 1: Outdoor Air Temperature in Tokyo (Average of 2009–2018). Source: Aggregate JMA data [1]

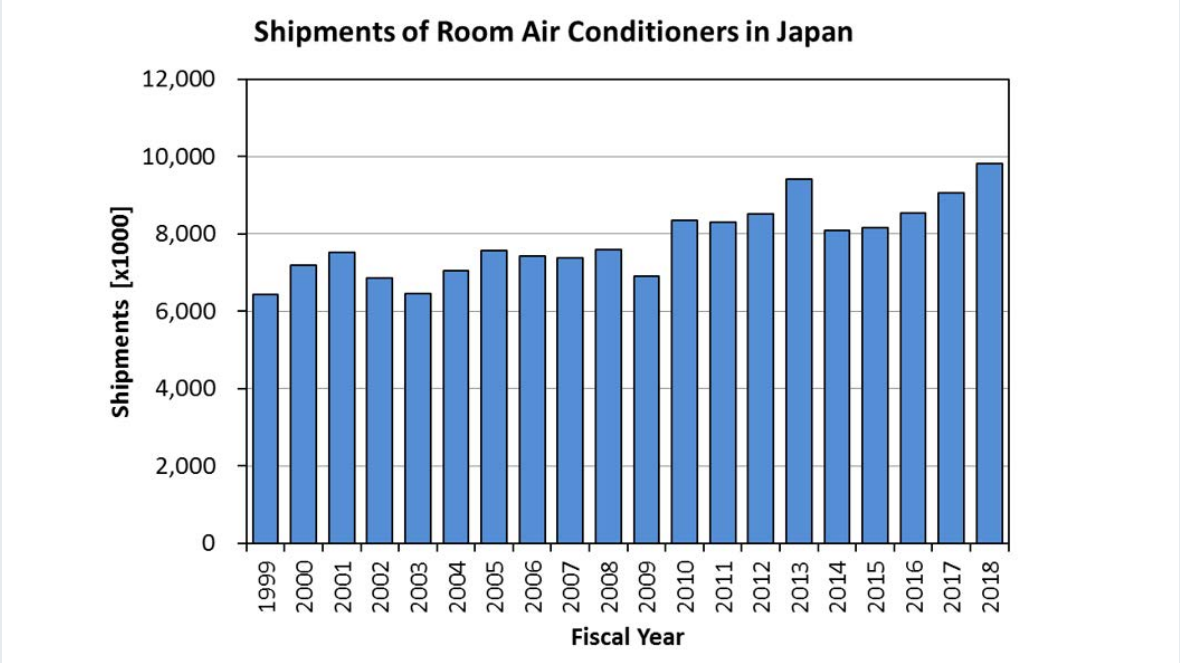

Fig. 2: Shipments of Room Air Conditioners in Japan. Source: Aggregated from JRAIA statistical data [3]

Room air conditioners

According to a survey conducted by the Statistics Bureau of the Ministry of Internal Affairs and Communications in 2014[2], the room air conditioner penetration rate in Japan was 90%, and the number of units owned per 1,000 households was 2,723 units. About half of the households have more than 3 room air conditioners (households of 2 or more people). The number of room air conditioners shipped is 9.8 million units per year (2018), as shown in Figure 2, and continues to rise moderately.

Since Japanese room air conditioners are often installed in each room after a house is built, separate units that do not affect the building during installation work and wall-mounted indoor units that do not affect the room layout are the mainstream.

The power consumption of room air conditioners has decreased significantly, due to the effects of the energy-saving Top Runner Program started in 1999. Power consumption has improved significantly between 1999 and 2009. However, the amount of improvement has slowed down during the last ten years. As for refrigerants, the conventional R410A was updated to R32, with one-third of the GWP value, from 2011 to 2013.

In addition to performance improvements, additional functions are also advanced. For example, some humidity controls have a function of dehumidifying without lowering the room temperature and a non-supply water humidifying function of absorbing moisture from the outside air to humidify the room. Also, many air conditioners have an air purifying function. In addition to the function of automatically cleaning the filter, a function of automatically cleaning the inside of the air conditioner has also been developed. Technology that detects people in the room and saves electricity by heating and cooling the necessary area only, and blowing technology that individually controls comfort, are also progressing. In terms of operability, the application of IoT technology has enabled remote operation with mobile phones.

Commercial air conditioners

Figure 3 shows the shipment volume of commercial air conditioners. Overall shipments declined after peaking at 1,050,000 units per year in 1991, and have been almost flat at around 800,000 units since 2011. By application, VRF building multi air conditioners have been increasing since 2000, and have been doubling over about 20 years.

R32 refrigerant has been introduced in commercial air conditioners since around 2014, following its introduction in room air conditioners. Commercial air conditioners use more refrigerant than room air conditioners, so there are more issues in applying mildly flammable R32 refrigerant, but the use of R32 refrigerant started sequentially from small-capacity models, and R32 had been adopted in about half of commercial air conditioners by 2017.

Domestic heat pump water heaters

As shown in Figure 4, shipments of heat pump water heaters have increased significantly since their release in 2001. Shipments reached 570,000 units per year in 2010, but decreased after the Great East Japan Earthquake in 2011. In 2015, the downward trend bottomed out and shipments increased again, and recently recovered to 480,000 units in fiscal year 2018 (1 April 2018 to 31 March 2019; FY2018). Total shipments reached 6.39 million units at the end of FY2018. The target for FY2030 is a total of 14 million units.

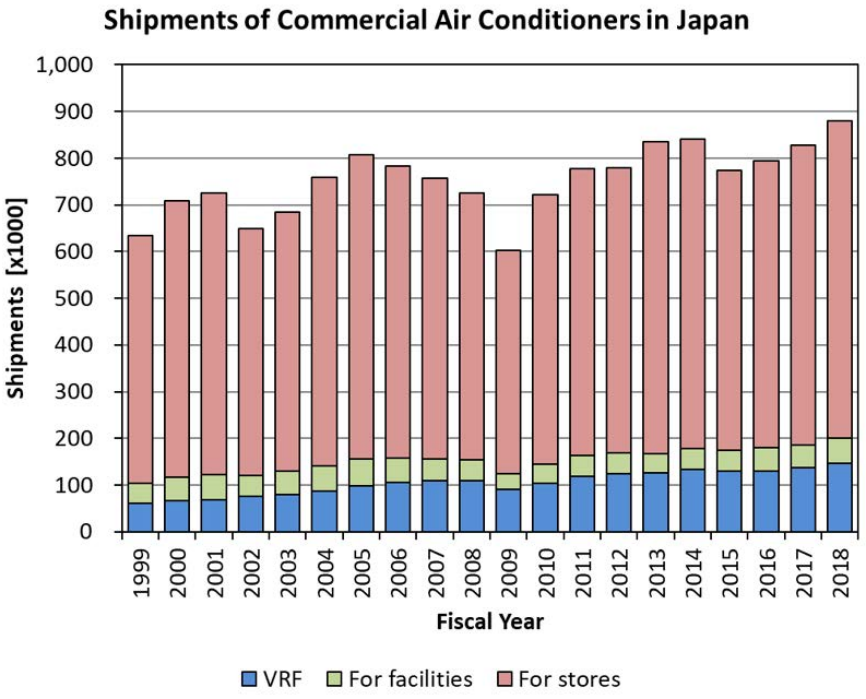

Fig. 3: Shipments of Commercial Air Conditioners in Japan. Source: Aggregated from JRAIA statistical data [3]

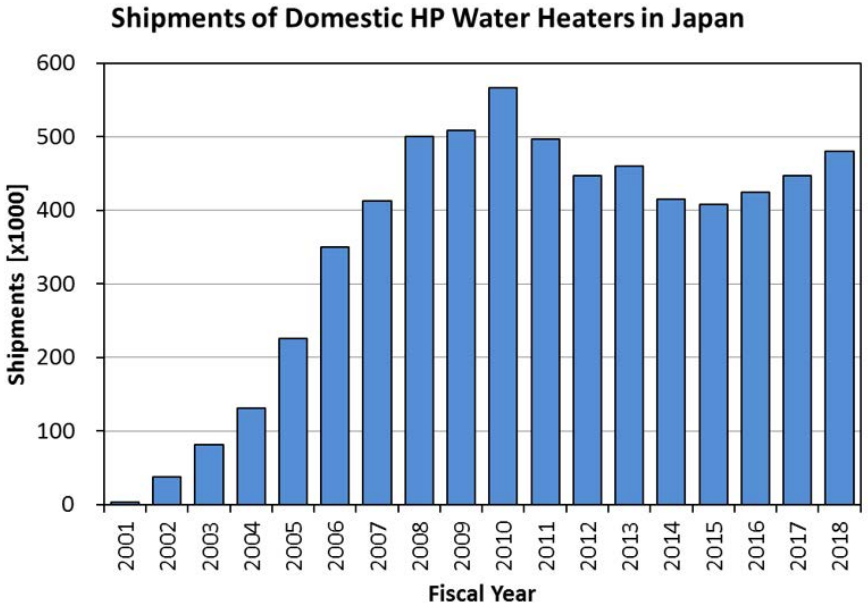

Fig. 4: Shipments of Domestic Heat Pump Water Heaters in Japan. Source: Aggregated from JRAIA statistical data [3]

Domestic heat pump water heaters have used natural CO_2 refrigerants since the initial product launch in 2001. CO_2, which has a lower critical temperature than conventional HFCs, has good performance for a single-pass temperature-rise heating operation that increases the temperature of the feedwater up to a high degree in one rush, and high-temperature hot water can be obtained. In Japan, CO_2 heat pumps that can store hot water (65 °C to 90 °C) are suitable because of the large amount of hot water used in bathtubs, and due to the fact that there are many soft-water areas and scaling due to mineral precipitation is unlikely to grow even at high temperatures.

In addition, the inverter and control technologies developed for room air conditioners realize stable tapping temperature control even within a temperature increase range of 50 to 80 °C.

In addition to performance improvements, functions that improve convenience have been introduced. Examples include a technology that uses microbubbles to improve the effectiveness of hot baths in bathtubs, as well as functions to clean piping using microbubbles, to increase shower pressure and to suppress the growth of bacteria in bathtubs using silver ions.

Industrial heat pumps

Industrial heat pumps have various applications, with a large span of temperatures. It is difficult to obtain statistics using specific indicators. As a result of a trial calculation in 2015 at the Heat Pump and Thermal Storage Technology Center of Japan [4] it was found that out of a total industrial boiler heating heat of 1,530 TJ (terajoules), about 440 TJ may be output by heat pumps.

At the current state of industrial heat pumps, the application of industrial heat pumps collected during the continuous efforts of IEA HPT Annex 48 [5] can be summarized as follows.

In Japan, industrial heat pumps are mainly used as equipment in production factories, and are applied to food, machinery, chemicals, electronics, agriculture/fisheries, and paper manufacturing in descending order of the number of applications. As for heat sources, air heat sources and simultaneous heating/cooling dual-use technology each occupy approximately one-third of the market. R410A, CO_2, and R134a dominate the refrigerants used. As an introduction result, the average primary energy reduction rate of the collected cases is 42% and the average CO_2 reduction rate is 49%, which indicates that there has been a great effect. Although the necessary supply temperature varies depending on the field and application, there are heat pumps that can generate steam at a maximum of about 120 °C.

Energy conservation policy and impact on heat pumps

In the energy conservation measures formulated by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, the target for energy conservation measures in FY2030 is set to 50.3 million m^3 crude oil equivalent compared to 2013.

Specific measures related to heat pumps include the introduction of high-efficiency air conditioning and industrial HP (heating and drying) in the industrial sector, the introduction of commercial water heaters and refrigerant management technology in the commercial sector, and the introduction of high-efficiency water heaters and the improvement of energy-saving performance of equipment by the Top Runner Program in the household sector.

In the energy-saving technology strategy, “next-generation heat pump systems” are positioned as a cross-sectional technology strategy for each sector of industry, domestic, commercial and transportation. The direction of heat pump development by sector has been proposed. As individual technology for each sector, higher efficiency of heat pumps and development of new refrigerants are promoted. By sector, the development of exhaust heat utilization systems and high-temperature heat pumps are being promoted in the industrial sector. In the domestic and commercial sectors, the performance of component device improvements, demand control and response functions, and equipment and systems for new refrigerants are being promoted. In the transportation sector, development of heat pumps for next-generation automobiles is being promoted.

Conclusions

Room air conditioners are improving year by year in terms of performance and functions as products suitable for the Japanese climate and form of housing. Shipments in 2018 have reached 9.8 million units and continue to grow moderately.

Commercial air conditioner shipments are around 800,000 units and are almost flat in quantity. In terms of applications, the building multi type has grown, and shipments have doubled over the past 20 years.

Domestic heat pump water heater shipments have reached 480,000 units (2018) and have been increasing since 2015. They are also listed in the Ministry of Economy, Trade and Industry's energy-saving policy, targeting a total of 14 million units in 2030.

Industrial heat pumps have the potential to produce heat pump output as high as 440 TJ as replacements for industrial boilers, and have application examples in industries such as food, machinery, chemistry, electronics, agriculture/fisheries, and paper manufacturing. They are listed in the Ministry of Economy, Trade and Industry's energy conservation policy, and future growth can be expected.

References

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https://doi.org/10.23697/nwk7-8f60