



Heat Pumping Technologies

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A HEAT PUMP CENTER PRODUCT

National Market

Japan: Heat Pump Market Report

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Given Japan's hot and humid summers, heat pumps, particularly inverter air conditioners for both cooling and heating, have been extensively adopted since early on. Heating usage is prevalent across the country, barring the colder northern regions where combustion heating remains prevalent. Moreover, stringent energy-saving regulations for heat pump equipment have consistently driven down power consumption for air conditioning and domestic/commercial hot water supply.

Introduction

Figure 1 illustrates the average temperature deviation in Japan [1]. In 2023, the deviation from the reference value (a 30-year average from 1991 to 2020) for Japan's average temperature was +1.29°C, marking the highest recorded since statistics began in 1898, surpassing the figures of 2020. Over time, Japan's annual average temperature has shown an upward trend, albeit with fluctuations. Long-term data indicates a rise of 1.35°C per century, with a notable increase observed since the 1990s, marked by several years of elevated temperatures.

In Japan, eight regional classifications are defined, as shown in Figure 2. Generally, regions 1 to 4 are often defined as cold regions. [2], [3]

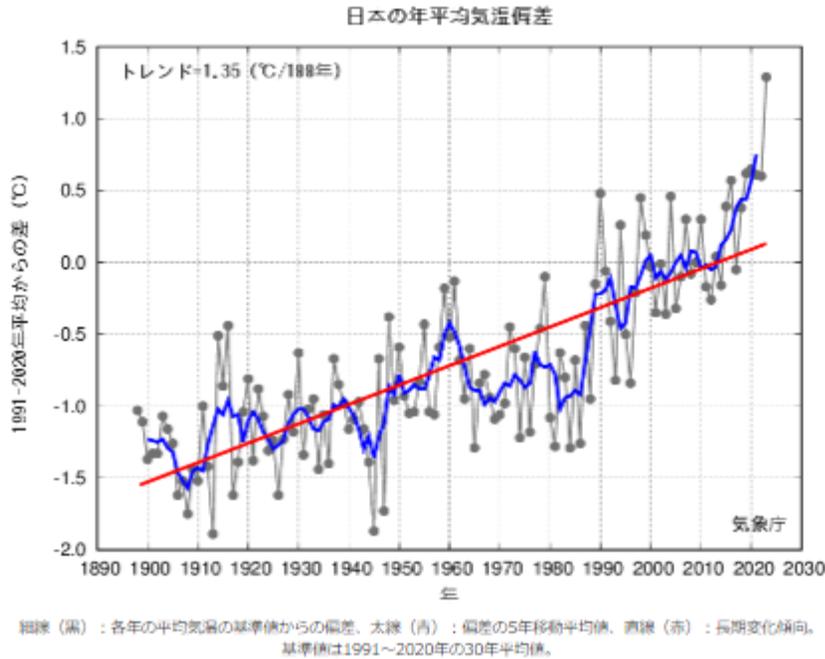


Figure 1: Average temperature deviation in Japan

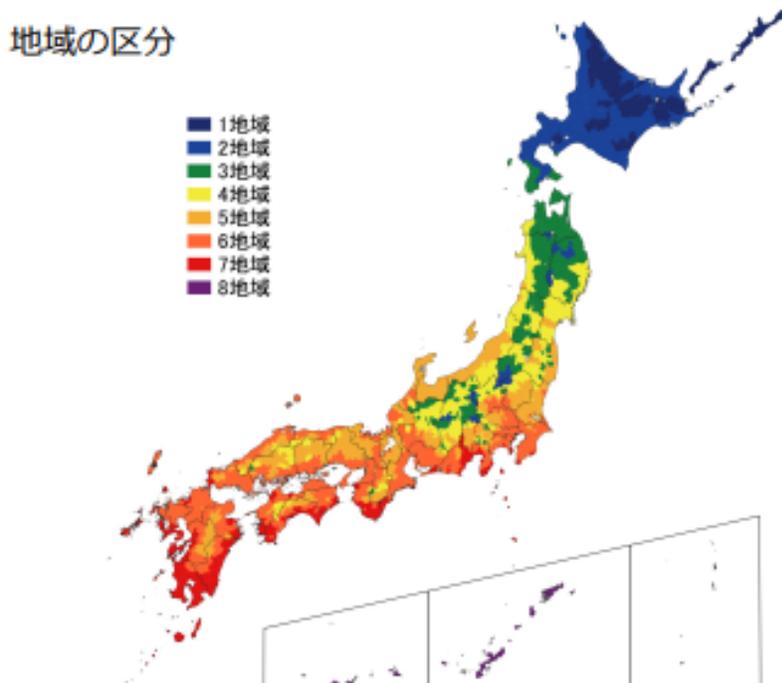


Figure 2: Definitions of Regions in Japan

In accordance with the Japanese climate of high temperature and humidity, the spread of heat pumps as cooling equipment was preceded. In the Japanese residential market, inverter air conditioners, which can switch between heating and cooling, account for almost 100% of the market. However, the ratio of combustion-type heating is still high in cold

regions. The heating performance and defrosting control of air conditioning equipment continue to improve thanks to the technological development efforts of manufacturers.

For domestic hot water supply, the government subsidy policy and electric power companies have cooperated to promote the popularization of heat pump by domestic hot water supply equipment "EcoCute". It is a domestic hot water heat pump using a CO₂ refrigerant. It is characterized by a large hot water storage tank that stores hot water at night using inexpensive late-night electricity and is suited to Japanese bath conditions.

In order to reduce power consumption, the government has been eliminating low-efficiency heat pump equipment from the market by establishing energy-saving regulations based on APF: Annual Performance Factor for residential air conditioners, commercial air conditioners, and hot water supply equipments. This energy-saving measure has greatly improved the energy efficiency of heat pump equipment in Japan over the past decade.

Room air conditioner and package air conditioner

As shown in Figure 3 and Figure 4, the shipment volumes of room air conditioners and package air conditioners are almost flat, and the Japanese market is mainly driven by replacement demand. [4]. As mentioned above, heat pump technology spread mainly in cooling equipment in Japan and was later applied to heating. Air-conditioning equipment manufacturers are working on the development of equipment specialized for improving heating efficiency for cold regions, and are also making efforts to popularize heat pump equipment in cold regions, including hot water supply.

In cold regions where the outside temperature is below freezing, the heating efficiency of heat pumps is certainly lower, but they are still two to three times more efficient than oil or gas heating systems. On the other hand, regarding low-GWP refrigerants, the heat pump industry is cautious about selecting standard refrigerants because the optimum refrigerant selection has a significant impact on the energy efficiency of equipment and its cost.

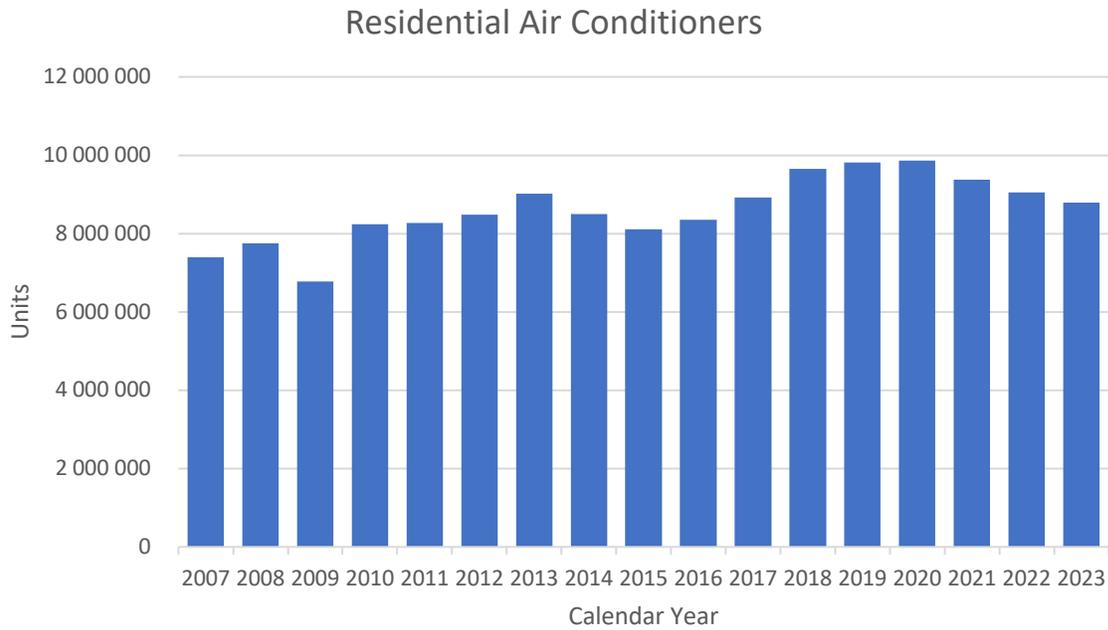


Figure 3: Shipment volumes of Room Air Conditioners

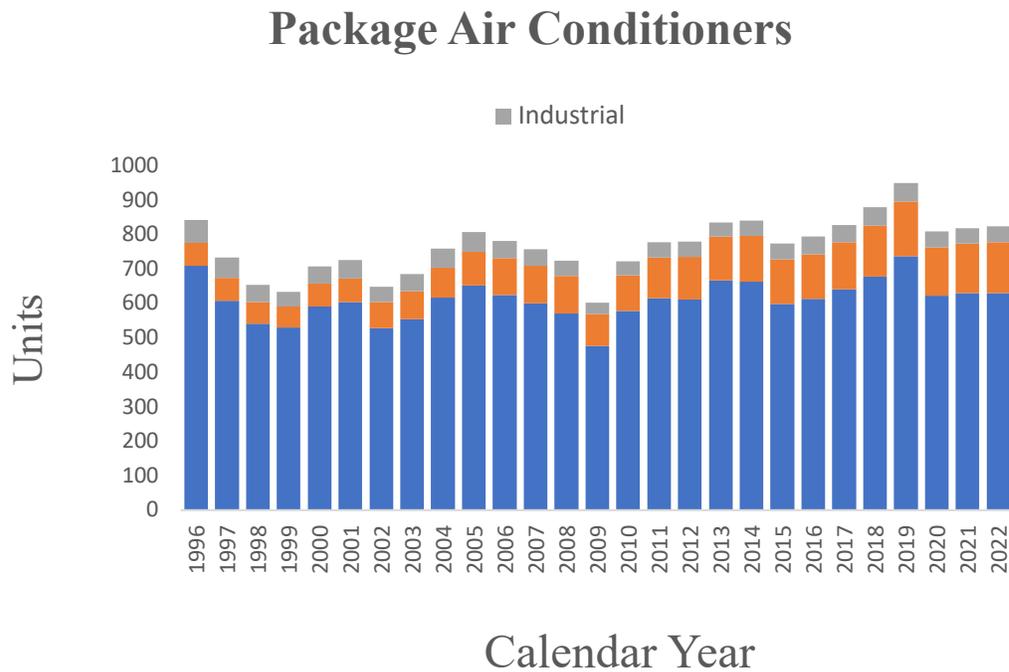


Figure 4: Shipment volumes of Package Air Conditioners

Domestic hot water heatpump “EcoCute”

Japan's CO₂ hot water supply technology, which can raise the water temperature from 10 °C to 90 °C at once, can contribute to the European market depending on how it is used. On the other hand, the refrigerant pressure is high, and the installation cost of the

equipment is much higher than that of combustion equipment. Therefore, it is needless to say that the introduction support of the government is an issue. In addition, there is a problem in terms of reliability related to water quality when expanding overseas.

Figure 5 shows the number of units shipped from EcoCute [4].

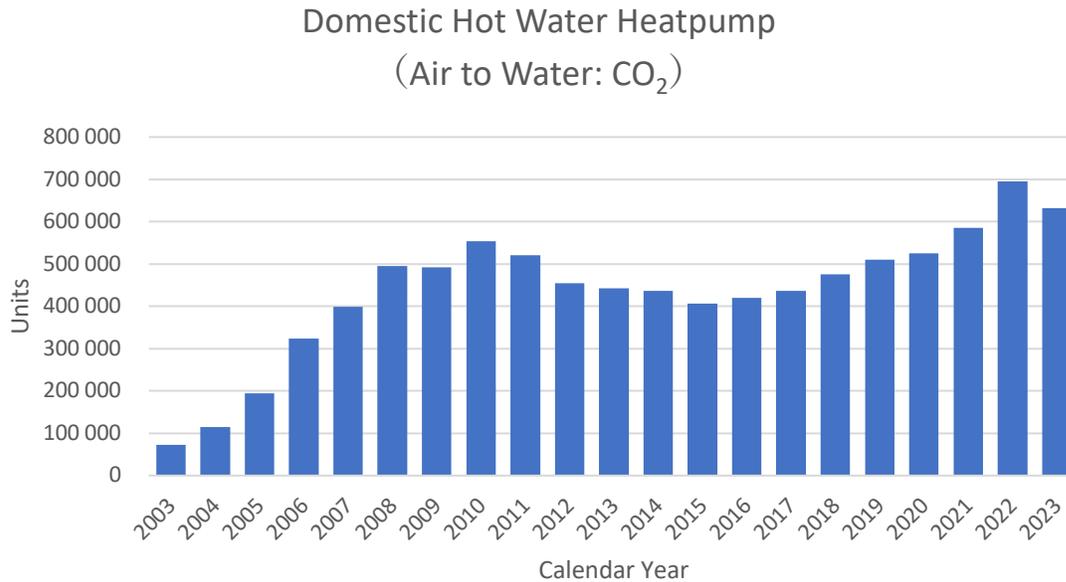


Figure 5: Shipment volumes of Domestic Hot Water Heat Pump “EcoCute”

Central air conditioning

Air-cooled chillers and water-cooled chillers

In Japan, air-cooled modular chillers, which are modular types capable of generating cold and hot water, have variable connection capacities and are equipped with inverter-driven compressors, are becoming increasingly popular. In addition to the ability to control the number of operating units, the compressor is inverter-driven on a module-by-module basis, making it possible to realize efficient operation of the entire system. Although the initial investment for the equipment is somewhat large, the system is superior in terms of energy saving and maintenance cost, and each manufacturer is gradually expanding the system to overseas markets.

Figure 6 shows the statistical data of chiller shipments excluding centrifugal chiller and absorption-type chillers [4]. Compared to 10 years ago, the market estimates that the total capacity of refrigeration tons has increased, as the number of units shipped has leveled off while the refrigeration capacity per unit of module chiller has increased.

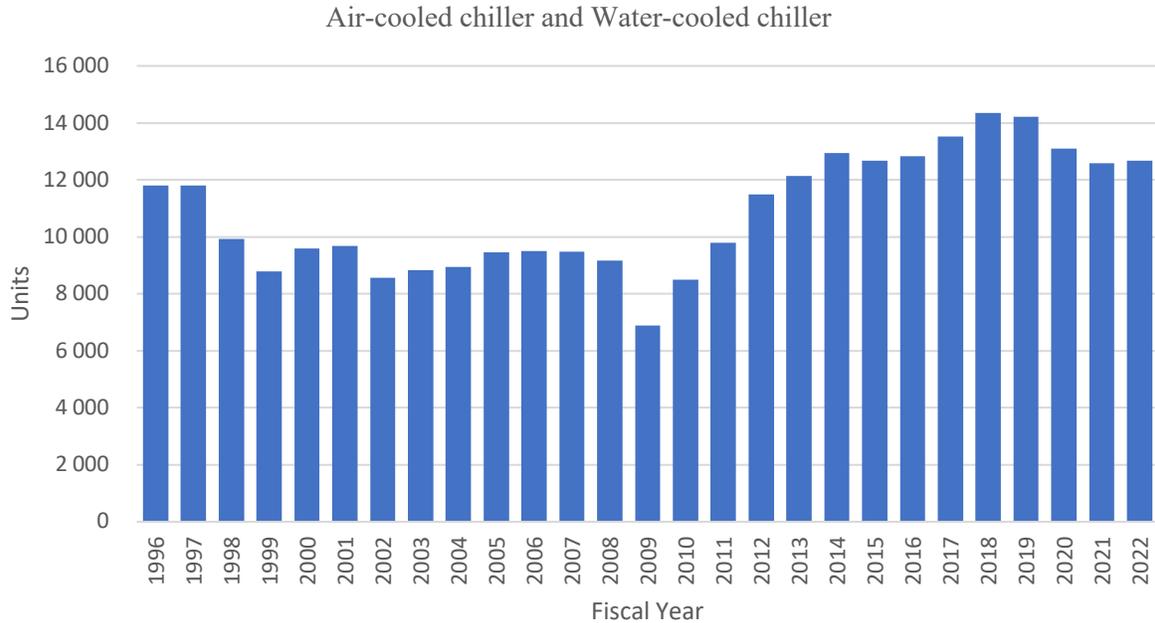


Figure 6: Shipment volumes of Air-cooled chillers and Water-cooled chillers

Central air conditioning, centrifugal chiller and absorption chillers

As shown in Figure 7, while shipments of centrifugal chillers have been flat, shipments of absorption-type chillers, regardless of type, have decreased by more than half from 20 years ago [4].

These data suggest that small-scale absorption-type chillers have replaced high-efficiency chillers, given the flat market size.

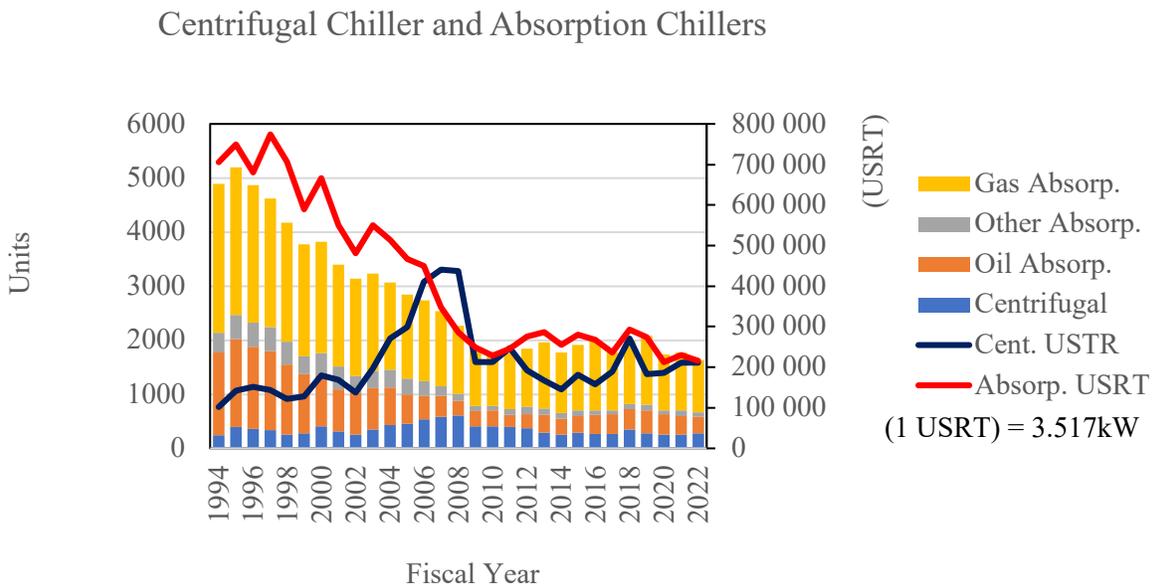


Figure 7: Centrifugal Chiller and Absorption Chillers

Industrial waste heat recovery

In industrial applications, the development of heat pump application systems that can recover waste heat from various industrial processes and waste heat recovery technology has been progressing in response to the need to reduce energy consumption. These systems will play an important role in supporting Japan's future renewable energy. At the same time, in industrial applications, there are great expectations for high-temperature heat pump technology, but there are still many problems with refrigerants and compressors, and we are still on the way.

Issue of heat pumps as a renewable energy source

As described above, the diffusion of heat pump air conditioning systems, mainly cooling systems, and the adoption of inverters are extremely high in Japan, and energy-saving regulations are also advancing. On the other hand, unlike in Europe, the government is cautious about including heat pumps in the statistics as renewable energy.

However, according to the actual energy supply and demand in Japan, the amount of renewable energy used by heat pumps is estimated to be about 16% of the total amount of final energy consumption in the consumer and industrial sectors [5]. Here, the amount of atmospheric heat for cooling in this trial calculation is calculated on the assumption that 100% of the heat supplied for cooling is atmospheric heat. Therefore, it is also a numerical value to raise the energy self-sufficiency rate, and the effect of the popularization of heat pumps on the energy supply is very large.

In Japan, policy decisions to support the diffusion of heat pump equipment are made on a policy-by-policy basis in light of the objectives of the policy. In some cases, heat pumps, including atmospheric heat, are supported as "low-carbon products." On the other hand, in some cases, atmospheric heat pumps are excluded from the measures to support the introduction of natural heat utilization facilities. Along with the reduction of resource energy and the improvement of the renewable energy rate, the energy policy is discussed from the viewpoints of the high-efficiency utilization of energy and the efficiency of final energy utilization equipment.

In discussions on the definition of renewable energy and decarbonization, renewable energy and energy conservation should be pursued in tandem to bring about fruitful results.

Conclusions

The heat pump technology stands as both an energy-saving and renewable energy utilization innovation, contributing to heat recycling efficiency. Now is the opportune moment for industry and government collaboration to position Japan as a global leader in heating, cooling, and hot water supply through its advanced heat pump technology.

While concerns have been raised about the potential increase in total energy consumption from widespread heat pump adoption without careful consideration, it's important to recognize that higher utilization rates of heat pumps in essential energy consumption



sectors lead to reduced fossil fuel consumption. Our ongoing efforts focus on advancing decarbonization through the widespread adoption of heat pumps.

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