



*Japan, historical culture coexisting with high technology.*

# Inside view into the Japanese heat pump market

Known for its contradictory image between historical culture and high technology, Japan has been leading the world of innovation in numerous and various fields for decades. In order to understand the success of the Japanese economy, Government and manufacturers are always working very closely, joining their forces and efforts through various programs in order to achieve the best efficiency to ensure a better future. A concrete example in the field of heat pumps is the foundation of the Heat Pump and Thermal Storage Technology Center of Japan (HPTCJ) in 1986 by the Japanese Government. By gathering all actors of this industry, the country enhances technologies as well as end users awareness.

## Fukushima accident speeds up the development

Time has gone by since Tohoku earthquake in 2011, but some of its consequences might be unclear for our readers today. By the end of the 90's, the Japanese Government engaged a program to reduce their dependency on gas. Their idea was to strengthen electricity oriented consumption by simultaneously increasing electricity generation from nuclear power plants and strongly promoting energy efficient electrical solutions.

18 months after disaster, it is still difficult to determine a clear long term direction regarding nuclear power plants in Japan. **But for sure, in continuity with the implication of Japan in the Kyoto Protocol, energy efficient products are more than ever being promoted.**

## Structure of the thermal comfort market

In the field of thermal comfort it is obvious that markets are driven by climatic characteristics. In Japan, climate is predominantly temperate but strong variations can be observed: from humid continental in the north to subtropical in the south of the archipelago.

Both heating and cooling are necessary for end users. As a consequence, air to air reversible heat pumps are extremely popular, with yearly sales of more than 8.2 million units, especially considering a total amount of approximately 57 million dwellings.

This market has been established for many years, especially thanks to always increasing performances, but

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their products don't show big differences compared to the ones known in western countries such as on the North American market for instance.

Relating to its geopolitical strategy to reduce Japanese dependence on fossil fuel and to promote high energy efficiency systems, the government decided to study the potential impact of expanding heat pumps use to other fields. Two fields, which were dominated by non electrical appliances, were identified: domestic water heating all over the country as well as space heating for the coldest regions.

## Domestic water heating programme

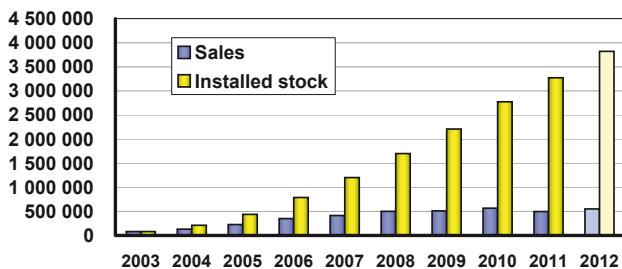
Back in 1995, the Central Research Institute of Electric Power Industry (CRIEPI) and TEPCO (Tokyo Electric Power Company) started a research of domestic water heating systems. Compared to the average Western European domestic hot water (DHW) usage, the average Japanese DHW usage is much higher in daily consumption. Japanese people's habit of taking hot baths, among others, brings the average consumption per dwelling and per day up to around 420 liters of DHW at 85°C. It represented about 34% of the total domestic energy consumption at that time.

An innovative solution was proposed to both ensure the necessary comfort and reduce the energy consumption significantly: utilizing CO<sub>2</sub> as a refrigerant for heat pumps.

The Japanese government, which was closely involved with this study since the beginning, decided to incorporate it into its CO<sub>2</sub> reduction program under the Kyoto Protocol. It was given the name of “Ecocute”, which means that it provides hot water (“cute” or “kyuto” in Japanese) in an ecological and economical way (“eco”).

It is important to underline that **this program focused on a full life cycle analysis from the beginning, instead of just concentrating on energy efficiency.** The result of this long term strategy is the choice of carbon dioxide refrigerant which was rarely commercialized back then, but proven as a greener choice. In addition of being natural, CO<sub>2</sub> is an ODP free (Ozone Depletion Potential = 0), low GWP (Global Warming Potential = 1) and neither toxic nor flammable refrigerant.

In 2001, the first “Ecocute” heat pumps were sold. As of today, **more than 3.5 million units have been installed in Japan**, while yearly sales have been constantly increasing, reaching more than 550 000 units sold per year, at an initial cost for end users of about 4 700€ (depending on the exchange rate). The equivalent CO<sub>2</sub> absorption of those installed units is more than 15 000 km<sup>2</sup> of forest.



Sales and installed stock of Ecocute (CO<sub>2</sub> heat pumps for DHW) in Japan since 2003.

### Ground source space heating heat pumps for colder regions

Last February, HVAC&R Exhibition took place in Tokyo. It provided a good opportunity to learn about the future of space heating heat pumps. Besides well-known air-air reversible heat pumps, some ground source heat pumps (GSHP) that were specifically developed for colder regions in Japan were presented. Considering the ever increasing energy efficiency of those systems, Japan has decided to push their developments and installations in colder regions. Being aware of the existing technologies around the globe, Japanese engineers have developed products adapted to their specific needs and constraints: smaller houses, cold outdoor temperatures, very high seasonal performance factor (SPF) and **very green and safe technologies.**

In parallel, they focus on improving current state of the art features in order to keep perception as a technological leader and environmentally conscious country that contributes to reducing CO<sub>2</sub> emissions. Interesting concepts have been brought to the market, some of which result from the previous Government program developments: by combining top of the class compressors, heat exchangers and intelligent thermodynamic loops, some manufacturers have managed to replace HFC with CO<sub>2</sub>, the final purpose being to propose the best SPF with a much greener refrigerant.

Again, Japan has decided to avoid focusing only on energy efficiency: it considers a full life cycle analysis in addition to regular comfort and cost considerations.

### Intelligent incentive schemes

History has proven through the Ecocute program that focusing on improvement of the full life cycle analysis of systems instead of their energy efficiency only brings the best possible products to the market. However, most importantly, before reaching high sales volumes and thus reducing their cost, intelligently defined incentives have been introduced to speed up the expansion of such environmental friendly technologies.

For instance, the Ecocute program related subsidy allowed to increase yearly sales up to more than 550 000 in 2010, starting from zero. In parallel, end users prices went down in order to reach an acceptable level for end users. As a result, this subsidy program ended successfully in 2010.

As it exists in some European countries, heat pumps are eligible for subsidies under a condition by meeting pre-defined level of efficiency. Additional tax rebates and incentives are provided for higher efficiency products (i.e. proving their savings in terms of energy and CO<sub>2</sub> emissions), ground source usage and heat pumps using natural refrigerants.

### Japan has an advanced vision of thermal comfort

Japanese industry has been leading the world of thermal comfort for decades. However, global competition is becoming tougher. In order to keep its number one position, it has developed a vision jointly with its Government: bringing to the market the greenest possible products. As part of this strategy, the full thermal comfort industry is now working jointly with electronics expert in order to set up standards for future smart homes. ☺