COUNTRY REPORT JAPAN

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Abstract: In this paper, Japan's climate change in the situation in recent years, the demand side of CO_2 emissions and energy usage in a situation where there is an upward trend. Based on this situation, Global warming measures are urgently required in the circumstances. Japan's policy, the "Kyoto Protocol Target Achievement Plan" was issued in 2005, and a reduction in CO_2 emissions as one of the measures, the deployment of heat pump water heaters, high-efficiency air conditioning equipment expansion is the introduction of express. Energy Conservation low 2004 also began with "The Top Runner program" set by the air-conditioning system by the value of COP regulations, revised in 2006, has been more stringent, and change to the annual efficiency of energy consumption. Moreover, it introduces the policy of Japan that supports the technology development and the spread development of the heat pump.

Key word; CO₂ emission, Japan's policy, Energy Conservation, heat pump technology

1 INTRODUCTION

Global warming is progressing steadily.

Japan's Ministry of the Environment issued a white paper on the environment in the world's average temperature is rising and the average temperature difference between Japan's average annual trend seen in 1990 to ensure that the tendency to turn warm (**Figure 1**). And ecosystem impact of the abnormal weather phenomenon, not only in Japan, the world is faced with a problem.

Japan's energy consumption is increasing in number and CO_2 emissions in 1990, compared with +3.8% in the industrial sector, +4% in the residential sector and the increasing trend.

Japan, the "Kyoto Protocol", had promise to reduce 6% CO_2 emission compared in 1990, this means that Japan have to reduce 6% CO_2 emission with increasing amount. There is a rising trend of energy consumption in Japan is to reduce CO_2 emissions should be.

Like this in the alternative energy and energy conservation in Japan is aware of the urgent challenges. To create a sustainable society is essential for heat pump technology, and the break through technology of global warming.

In this paper, Introduce of Japan's policy, energy-saving efforts and the application of heat pump technologies. In addition air conditioning manufacturers face the increasing price of raw materials such as aluminum, steel, copper and plastics etc which are main components for air conditioners. This is a very big impact for the heat pump price.



Figure 1: Japan's average temperature rising



Figure 2: CO₂ emission by sector in Japan

2 R & D and Market situation

CO2 Heat Pump Water Heater

The first report is an introduction of the heat pump water heater that is changing the culture of supplying hot water in Japan.

Recently, the heat pump water heater using CO₂ refrigerant in Japan has developed rapidly as shown in **Figure 3**.

The Japanese Government drew great expectations to a drastic effectiveness of reduction of energy of a domestic supplying hot water by the spread of the heat pump water heater, and introduced the introduction subsidy system to aim at 5.2 million units total spread by fiscal year 2010 in 2001. COP=4.0 or more becomes an object, and 273Euro/Unit (165 JPY/Euro) for one unit as sbsidy in fiscal year 2007, and the introduction support that mounted up to 350 million Euro (58 billion yen) by present has been done in a domestic water heater. It was able to reach 1.24 million total sales as shown in **Figure 3** as a result.

On the other hand, the Japanese Government has installed a supplementary system of the energy conservation technology development support for energy conservation promotion. Because the energy conservation effect in the home is large, the development of the heat pump water heater is located with the emphasis countermeasure in the energy conservation technology development subsidy.

There is concretely a difficulty of the reduction in costs, the miniaturization of casing, and the cold district countermeasure, and each manufacturer is developing while receiving the support of the government. The improvement of COP was aimed at as shown in **Figure 4** every year, and it reached even COP 5.1 last year. There was an argument for the display of energy efficiency in full year, and it was changed to the APF (Annual performance factor) method in the heat pump water heater in 2008.

The business use is 20% in the percentage of the use of supplying hot water energy and 28% for the residential sector as shown in **Figure 5**.

This supplying hot water is the mainstream the water heater of the combustion type, and has demand of about 4 million a year or more in Japan. The conversion with the heat pump water heater using CO_2 refrigerant is from an angle of global warming to a big measure in the field of supplying hot water where this large percentage is occupied.



Figure 3: Water heater CO₂ Heat Pump (1,000 units)





Figure 5: Energy usage in Business and residential sector

Introduction of high-efficiency air conditioning equipment for business use

The Japanese Government announces "Kyoto Protocol Target Achievement Plan" in 2005, sets the spread desired value of highly effective air conditioning system for business use to 12,000 units (=1.4 million RT) as one of the measures of CO_2 reduction by 2010, (**Figure 6**), and be trying for the government to assist and to spread to CO_2 heat pump water heater in kind. The basis makes to the equipment whose cooling or heating capacity is 100kW or more, and has installed the criteria value of COP of each kind of the equipment as shown in **Table 1**. This is on plan according to result of 2007 sales.

Table 1; COP standard						
Category	COP					
Air Source (including water heater HP)	4.0~					
Water source Chiller (without centrifugal)	5.0~					
Centrifugal and other than above	6.0~					



Figure 6: Trend of High efficiency air conditioning equipment sales

Room air-conditioner (Top runner plan and market data)

The advantage point of energy conservation promotion in Japan is "Top Runner plan" of the Conservation of Energy Law that started in 2004. As for this "Top Runner plan", not only the air conditioner but also the car and the refrigerator, etc. are adopted. Energy Conservation Low was newly revised in September, 2006, and a new valuation basis and the division changed.

It divided into the division that prescribed the size and the free size division as shown in **Table 2**, and the APF (Annual Performance Factor) value that aimed at 2010 year respectively was provided. Moreover, it set up the labeling system in order to easy understand energy conservation performance of individual product for consumer. "Green mark" was displayed about the product that attained this Top Runner basis, and the product of the underachievement was displayed "Orange mark", and came to display the percentage achievement respectively. In the new product in 2008, the air conditioner that had already cleared the desired value in 2010 also began to appear. This technology is especially attained by development of the high efficiency compressor, highly effective developing of the power module of the inverter, and improving the heat exchangers.

Based on this Top Runner system, power consumption of the period of year has been improved dramatically as shown in **Figure 7**.

Cooling	Before			Oct 2006 ~		
Less than 4.0 _k W	Rating Cooling Cap	Target COP Cooling/Hea ting Ave.		Size division	Rating Cooling Cap	Target APF 2010
	~ 2.5 kW	5.27		Width less than	~ 3.2 kW	5.8
	~ 3.2 kW	4.9		800mm & Height less than 295mm	~ 4.0 kW	4.9
	~ 4.0 kW	3.65]	Size Free	~ 3.2 kW
			Other than above	~ 4.0 kW	6.0	

Table	2:	Тор	Runner	system
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Heat Pump split wall mounted (without Multi air-conditioner)



Figure 7: Trend power consumption for wall mounted type: 2.8kW (average power consumption within typical energy conservation model)

The demand for room air-conditioning changes by 7.0 - 7.5 million as shown in **Figure 8**, and in the future, will presume this trend to be will not changeable. It accounts for 99% in the heat pump, and most of compressor was changed to the DC inverter driving method in order to secure high energy conservation.

And variety of the unique products are appeared such as comfortable air distribution, the humidifier capability utilizing desiccant on heating mode, automatic filter cleaning mechanism for comfortable human life. The automatic cleaning function of the filter can contribute to the energy conservation on the substance use.



Package air conditioner

It changes by 750~800 thousand units about business use air conditioning system. 70% is composed of the heat pump, and the number of demand is situation of the level-off. (**Figure 9**) JIS (Japanese Industrial Standards) was revised in March, 2006, and it came to put the regulation of the annual energy efficiency. The display of APF in addition to the display of COP was used together in October, 2006.

Merchandise for the cold district began to appear from each company so for the demand expansion. Considering utilizing inverter technologies, or adopt the two stage compressor, or adding the injection cycle to refrigerant circuit by each company, it is improved heating capacity at low ambient temperature or improved quick supply of hot air by them.



Chiller

Electric chiller demand in Japan was about 10,000 units, mostly unchanged in recent years (**Figure 10**). 50% an application is for buildings for business, 50% is used for the factory. 80% for business purposes is used as air conditioning; factory-purpose of 50% is used as a production facility. It accounts for 70% of the entire chiller with the air source chiller, and the research of making to highly effective is performed. Merchandise that greatly exceeds COP=4 has developed by using the device of the inverter compressor with R401A refrigerant and developed making modulation of the casing, too (**figure 11**). Making to the inverter and the modulation are greatly improving technologies as for the part load performance. Furthermore, the chiller that exceeds COP=5 while using the water splay method to the outdoor heat exchanger appears, too.



Figure 10: Demand of Electric Chiller

Figure 11: Module chiller

Other Application

The heat pump has been widely applied to refrigeration, freezing, air-conditioning, and the current heating usage. However, it was newly adopted for the washing machine in Japan since 2005. It can have the expectation as a technology that effectively uses heating and the dehumidification of the heat pump in the future.

3 NATIONAL POLICY

3.1 National Policy

The energy policy in Japan describes the item that relates to the heat pump as follows.

- 1) In April, 2005: The Kyoto Protocol Target Achievement Plan
 - · CO2 heat pump water heater: 5.2 million (CO₂ 2,8 million ton reduction)
 - highly effective air conditioning system for business use: 12,000 (CO₂ 600 thousand ton reduction)
- 2) In May, 2006: New National Energy Strategy
 - In the energy conservation front-runner plan, the dissemination of the directional movement of development where a highly effective water heater, the freezer, and the air conditioning system are included as a next generation energy conservation device technology.
- 3) In March, 2007: The Energy Master Plan

The following have been described in the matter that relates to the heat pump.

- Effective management of the Top Runner standard is promoted as a countermeasure in the demand-side of energy in the public welfare division based on "Law pertaining to rationalization in the use of energy" (Energy Conservation Law).
- ·Comprehensible offer of energy conservation equipment information by labeling system

 \cdot Initial demand creation support of machinery and appliances with higher energy efficiency. (CO₂ heat pump water heater and latent heat collection type water heater, etc.). \cdot Approach of standby power requirement reduction

- 4) In April, 2007: The Energy Conservation Technology Strategy
- Five policy target is set, and the dissemination of a technological map and a technological road map of the technology that contributes to the improvement of the total energy efficiency that is one in that.
- •Road maps such as a highly effective heat pump, the ultra high efficiency heat pump, a highly effective heat pump water heaters, and the geothermal use heat pumps are descried. Moreover, the use of the thermal storage system and the road map of the energy conservation house and building are made.

Moreover, "Cool earth-energy innovative Energy technology Program" was made public by Ministry of Economy, Trade and Industry in March this year. It was specified for an energy innovative technique on which the technology of 21 had to work emphatically in that. The ultra high efficiency heat pump is taken up in the public welfare division in that.

The heat pump is a technology that can contribute to a low carbon social making in the demand-side.

3.2 Power Load Levering

Not only the improvement of the equipment efficiency of the air conditioning system to the reduction of energy consumption and CO_2 reduction in a business building but also introductions of the thermal storage air-conditioning system that maximum uses the heat pump are expected.

It is specified in "Kyoto Protocol Target Achievement Plan" for a power electric load leveling countermeasure to reduction of CO_2 emission. It will reach up to the peak shift of 1.66 million kW in 2006 like showing the consequence of the approach in Japan with **Figure 12**, and load factor is gradually improved and 64% in 2006. (**Figure 13**)







Figure 13: Annual load power factors in Japan

4 CONCLUSION

It is scheduled that G8 (summit) is held in Japan in July this year, and the argument for the scenario making for the energy efficiency improvement that was the difficulty of the Gleneagles summit in 2005 is scheduled. Consideration to the environment has risen gradually in Japan including media because it will be just before holding G8 called an environmental summit. The deployment planning of the high energy-saving technology that the heat pump has is planned, and the strategy that replaces the combustion system like the heat pump water heater is set up, too.

When the potential of the reduction of CO₂ emission with the heat pump is provisionally

calculated, it has the trial consequence of 130 million tons that can be reduced in Japan. This corresponds to 10% of all CO_2 emissions of Japan, and the great potential is understood. In other words, the introduction occasion of the heat pump is increased for the global environmental protection, and it is important to improve the energy conservation of the heat pump. The conversion to refrigerant with few global warming potentials is additionally important in the future with promotion of a thorough recovery of fluorocarbon and promotion of 3R (Re-use, Reduction, Recycle). The government, the university, and the institution and the manufacturer, etc. are under developing with cooperation.

For the prevention of global warming, the heat pump is key technologies to the further development.

So let's save the Earth with "Heat Pump"!

5 **REFERENCE**

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