Japanese Energy-Efficient Technologies

Progress of Energy Conservation in Japan

In the 1970s, Japan experienced what we call oil crisis and its industrial, commercial, and residential sectors suffered from oil shortage and soaring energy prices. However subsequently, the government, industries, companies and even people have committed to promote energy conservation and conversion activities and have vigorously worked toward energy innovations to develop technologies, devices, and systems with less energy consumption and higher energy efficiencies.

As a result, over 15 or so years since 1973, Japan more than doubled its GDP without increasing energy consumption to the level before 1973. Currently, Japan's GDP is 2.6 times as large as that of 1973 while the total energy consumption only grew 1.1 times. In particular, energy consumption in industrial sector has fallen by 0.7 times (see Fig. 1).

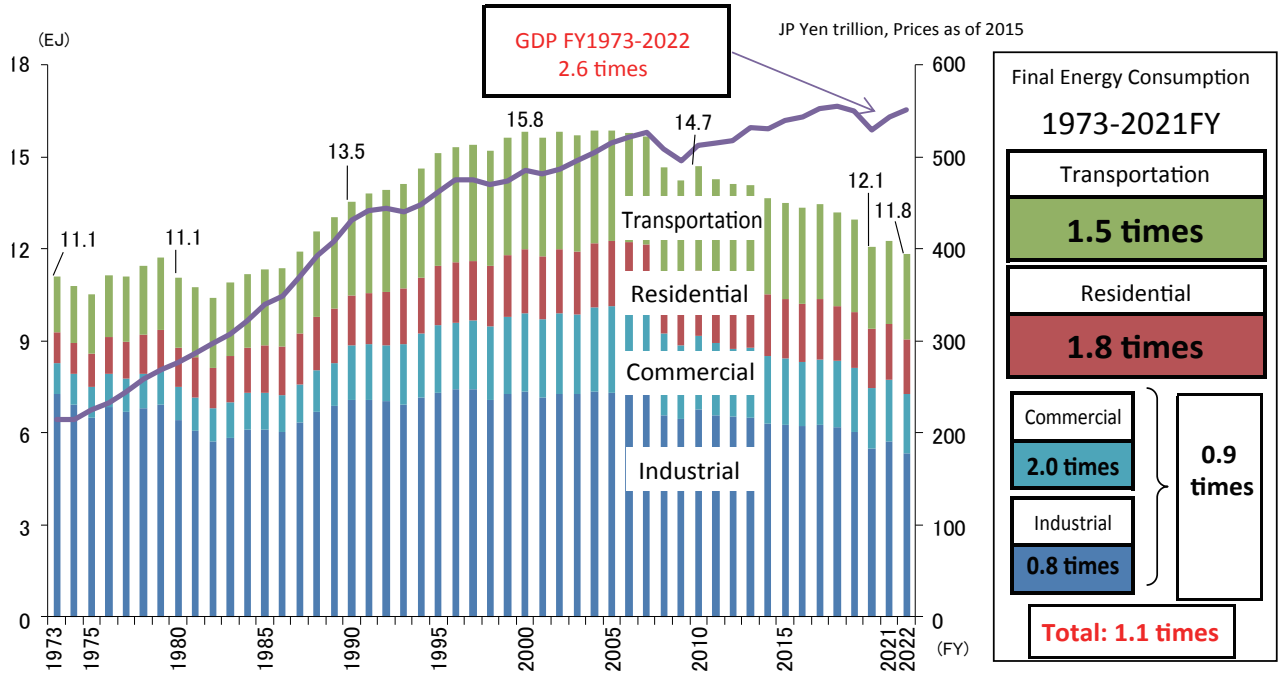


Fig. 1 Transition of Final Energy Consumption in Japan

Source: METI ANRE Energy White Paper 2024

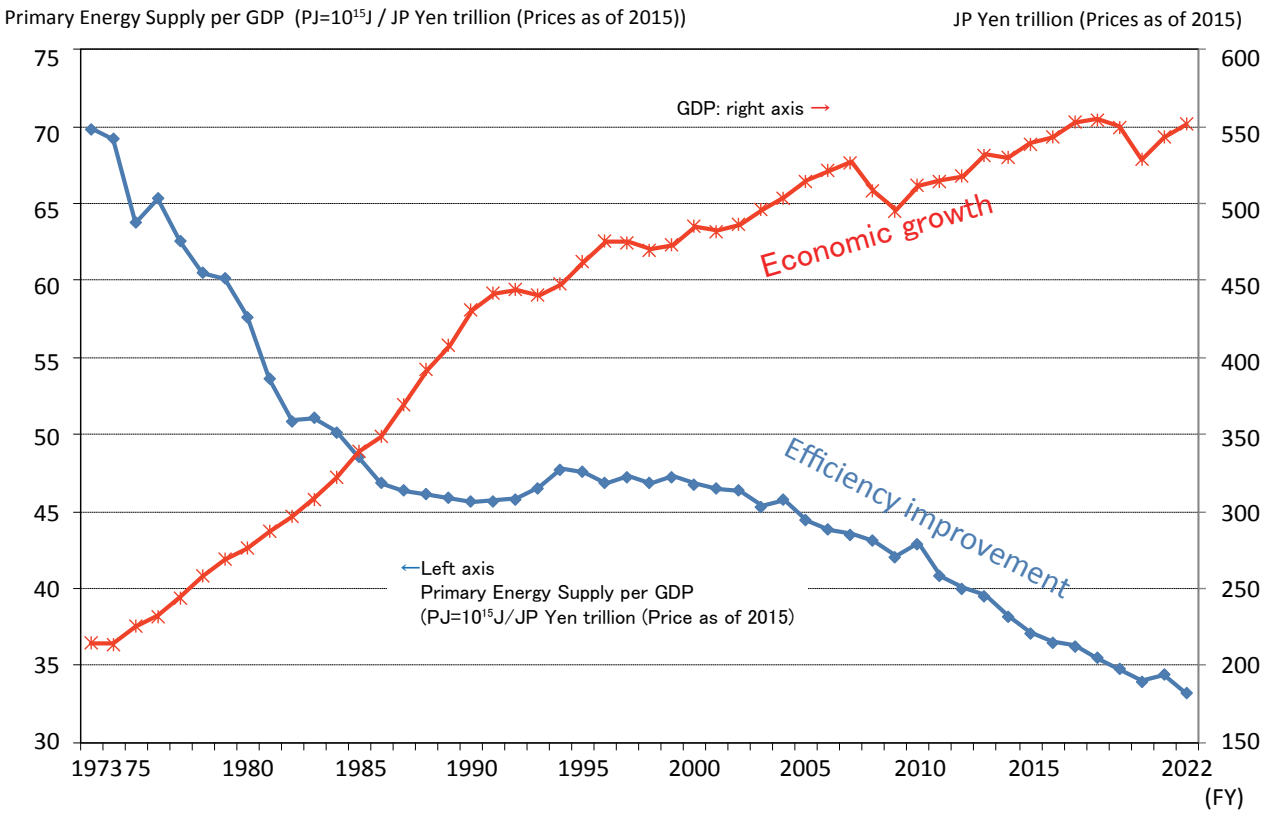


Fig. 2 Trend of Primary Energy Intensity per GDP in Japan
Source: METI ANRE Energy White Paper 2024

When the above circumstances are clarified in terms of the transition of Japan's GDP versus primary energy consumption, as presented in Fig. 2, improvement around 40% has been achieved since the oil crisis and energy-saving efforts continue to elicit better results while GDP is growing.

Global Energy-Efficiency Comparison

The rates of energy efficiency (Energy consumption /GDP) for various countries are compared in Fig. 3, and Japan ranks among the top in the world. The achievement of such higher energy-saving levels largely attributed to the emergence of more energy-efficient technologies, not only in the industrial sector but also in commercial as well as in residential fields.

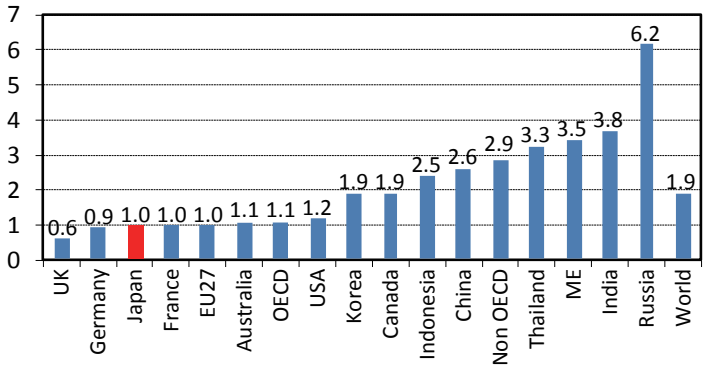


Fig. 3 Energy Efficiency (Primary Energy Consumption (toe) /GDP (US$)) 2021FY
Source: METI ANRE Energy White Paper 2024

One of the noteworthy initiatives introduced in Japan to rise energy efficiencies was the so-called "Top Runner Program", which has successfully led to improve energy efficiencies of various equipment.

This Program was firstly introduced in 1998 by revising the Energy Conservation Law and was intended to boost energy efficiency in the fields of transportation (vehicles) and home appliances. Under this scheme, the efficiency target is set to exceed the performance in the most efficient product made within a given number of years (from three to ten, depending on the circumstances and categories). Originally, 11 products categories were nominated (passenger vehicles, air conditioners, electric refrigerators, lighting, TV sets, etc.), and gradually expanded to others. As of 2023, 32 categories are covered, including thermal insulating materials, insulation sashes and multi-layered glazing for houses and buildings.

The categories are chosen based on the following criteria:

1. Products used for daily life.
2. Products with high energy consumption.
3. Products need to increase energy efficiency.

When the categorized products achieve their targeted efficiencies, Top Runner Labels which indicate their efficiencies met the targets are issued and the manufacturers can be attached these Labels on their products under the law. This labelling helps (environmentally aware) customers select products and incentivizes producers to develop more energy-efficient products.

Consequently, efficiencies of passenger vehicles, air conditioners and electric refrigerators were improved over 20% by the Program.

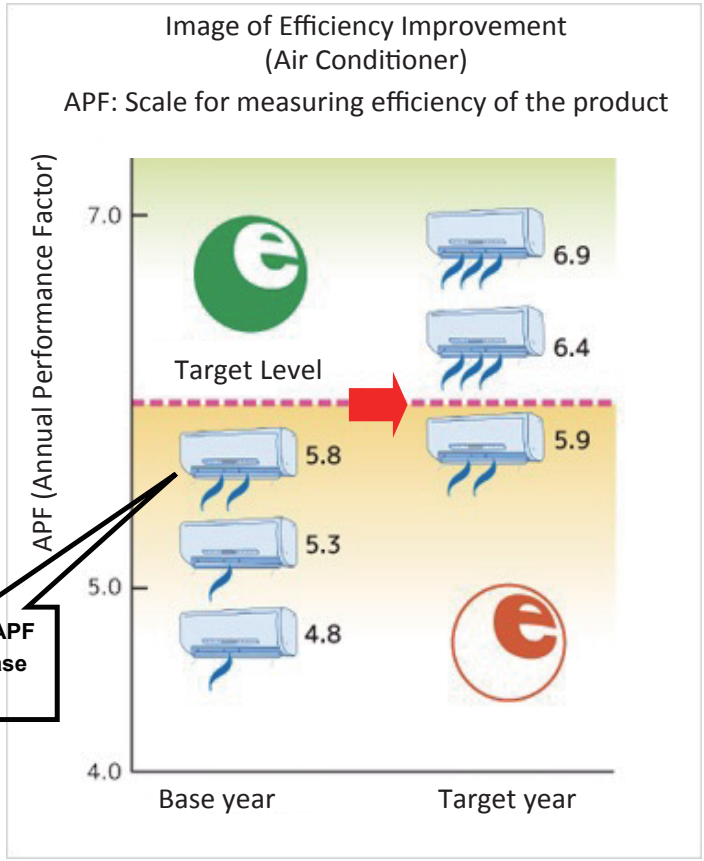


Fig. 4 Concept of the Top Runner Program
Source: METI ANRE Energy-saving website

Through these activities, energy conservation has been improved and GHG (CO_2) has been decreased in Japan, as shown in the following figure (Fig. 5). It is analyzed that progress of energy conservation is one of the main factors to lower CO_2. For example, during the period of 2013-2019, a reduction in GHGs of around 6% was achieved through the Top Runner Program, a figure which is set to rise to around 8% by 2030. *

*: Meeting material data of the 31st Energy Efficiency and Conservation Subcommittee (March 23 2021), Committee on Energy Efficiency and Renewable Energy, Advisory Committee for Natural Resources and Energy, METI

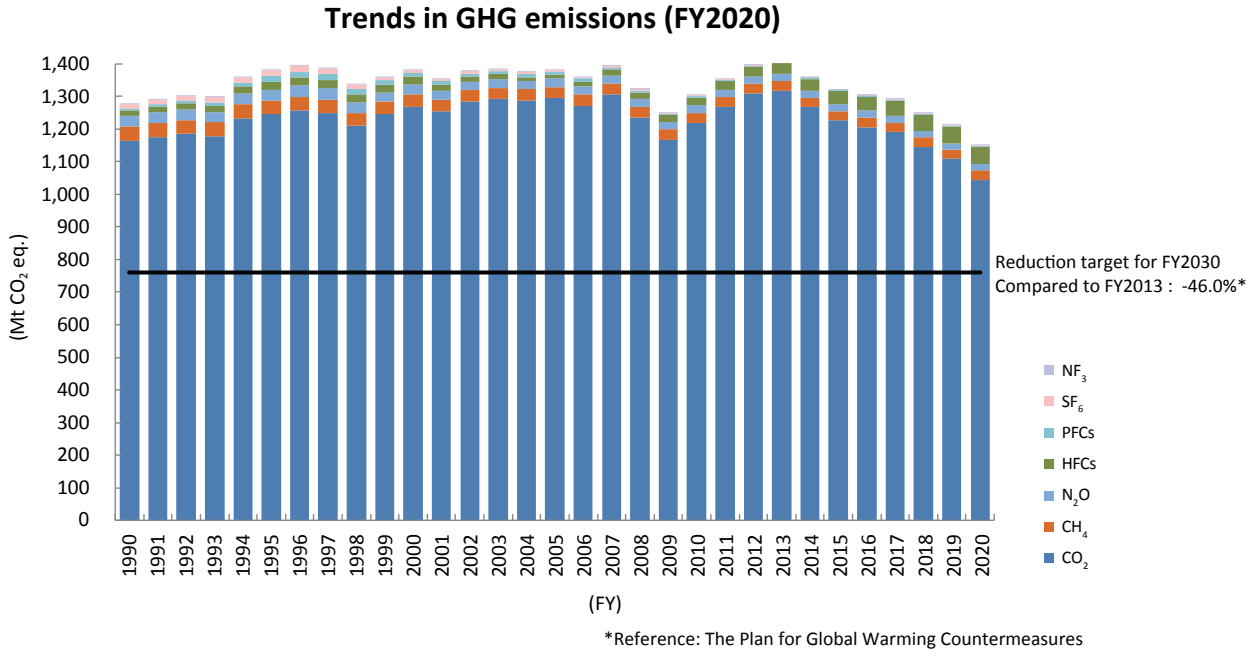


Fig. 5 GHG Emissions Trend (FY2020)
Source: National Institute for Environmental Studies,
Japan's National Greenhouse Gas Emissions in Fiscal Year 2020 (Final Figures) report April 15,2022

Japan's national target for GHGs reduction is -46% by FY2030 (compared to FY2013 levels) and it states to make further endeavors toward -50% by that period and finally to achieve carbon neutrality by 2050. To meet the goals, stronger policies and measures have been introduced.

In 2021 the 6th Strategic Energy Plan which was formulated and in the Plan the target of the energy saving amount was intensified to set to 62 million kiloliters of oil equivalent. It is to be achieved through the utmost efforts to reduce energy consumption and improve efficiencies in all sectors. Now the 7th Strategic Energy Plan is under discussion in the METI's Advisory Committee and it will be launched by the end of 2024.

Further, the Energy Conservation Law was revised and enacted in April 2023. The main points of the revision were: "revision of the definition of energy", "rationalization of energy use", "conversion to non-fossil energy" and "optimization of electricity demand". Non-fossil energy was to be dealt in the rationalization of energy use and the definition of energy was expanded by the revision.

Collaborations between countries are important as the carbon neutrality is a goal for the entire world. Japan is going to contribute to the net zero of other countries in particular in Asian region, where characterized by uneven distribution of renewable energy, underdeveloped grids with many islands, limited nuclear power generation, and increasing population and energy demand. To this

end, Japanese government has launched the initiative: Asian Zero Emission Community (AZEC) since 2021 to encourage cleaner energy transition and accomplish carbon neutrality of Asia in cooperation with other Asian countries. Based on this AZEC initiative, various specific activities and projects have been commenced under the cooperation between Japan and other Asian nations, utilizing both immediate and future technologies and means (energy conservation, renewable energy, biomass, ammonia, hydrogen, CCUS, and finance and credit systems).

Energy-Efficiency Topics in Industrial Sector: Effective Utilization of Thermal Energy

In the Japanese industrial sector, various efficient technologies have been developed to utilize thermal energy effectively, such as cogeneration, recovery of wasted thermal energy, high-efficiency furnaces and boilers, and facilities to use steam effectively. In industrial processes consuming fuel and thermal energy, given the considerable wasted energy, there is great potential for energy saving by leveraging technologies to reduce or recover wasted thermal energy. Such technologies usually also elicit other benefits, such as a cleaner environment and rapid progress has been made in their implementation. They can be applied to refine existing processes, as well as for newly built plants.

The features of cogeneration and its prevalence in Japan are shown in Figs. 6 & 7.

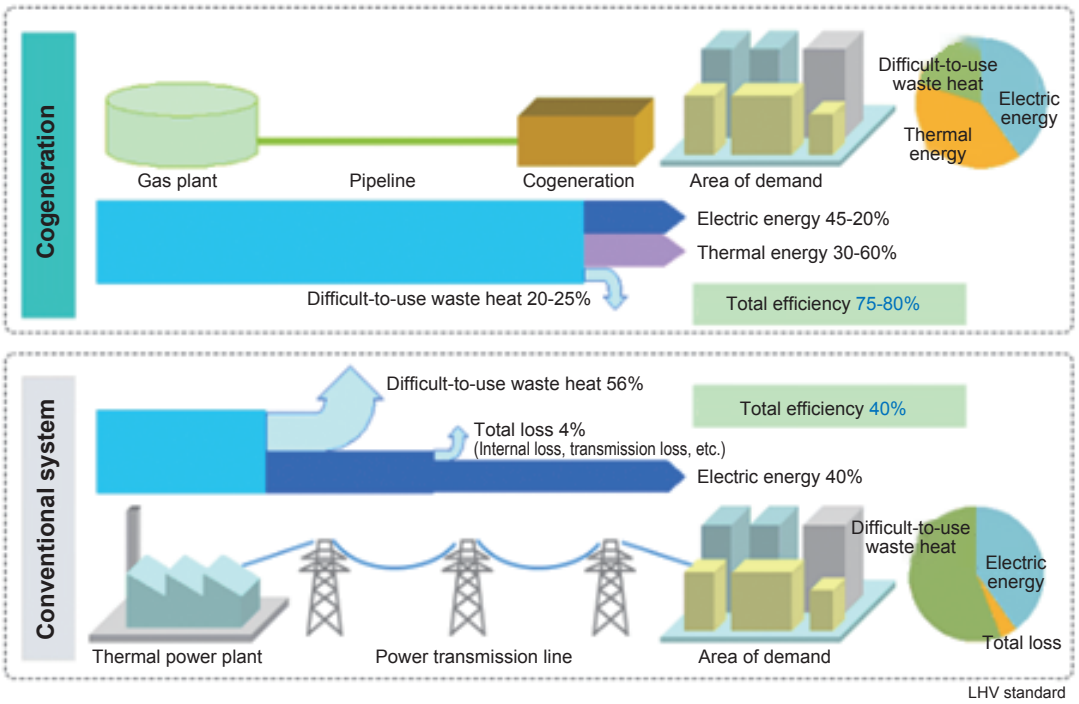


Fig. 6 Features of Cogeneration
Source: Advanced Cogeneration and Energy Utilization Center Japan (A.C.E.J) Website

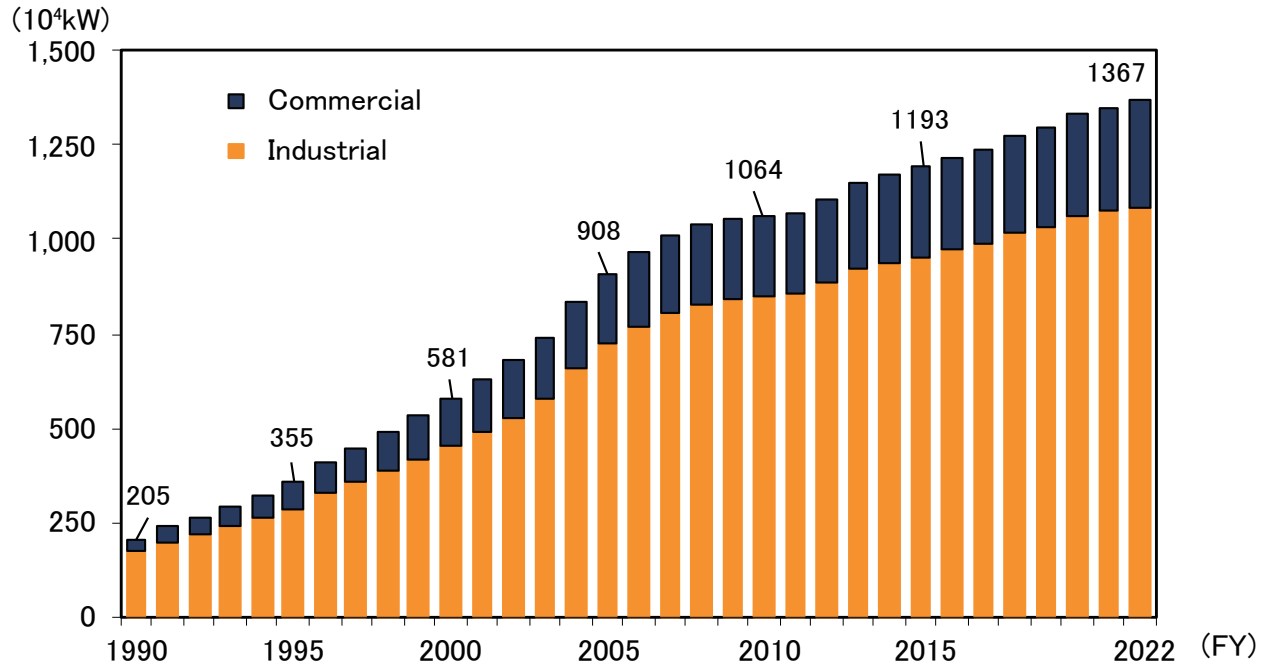


Fig. 7 Trend on Cogeneration Installation in Japan
Source: METI ANRE Energy White Paper 2024

Energy-Efficiency Topics in Commercial and Residential Sectors

As already seen in Fig. 1, Japanese energy consumption has steeply risen since mid-1980s in commercial and residential sectors, due to growing living standards across the country as well as commercial activities deployed in new sectors. The "Top Runner Program" was crucial to reducing energy consumption in these sectors, as highly energy-efficient electrical home appliances and office devices were developed and supplied to the domestic market. Thanks to these effects, growth of energy consumption in these sectors has been curbed for the past 15 years or so.

One key breakthrough within these sectors is highly refined thermal transfer technology for heating, cooling and refrigerating. It is sometimes referred to as "heat-pump" technology because it involves the transfer of heat energy and it has been applied to air conditioners, refrigerators, water heaters and other devices; combining not only thermal transfer technology but also highly efficient control technology based on inverter technology and environmental parameters, including temperature. This heat-pump technology has prevailed widely in Japan.

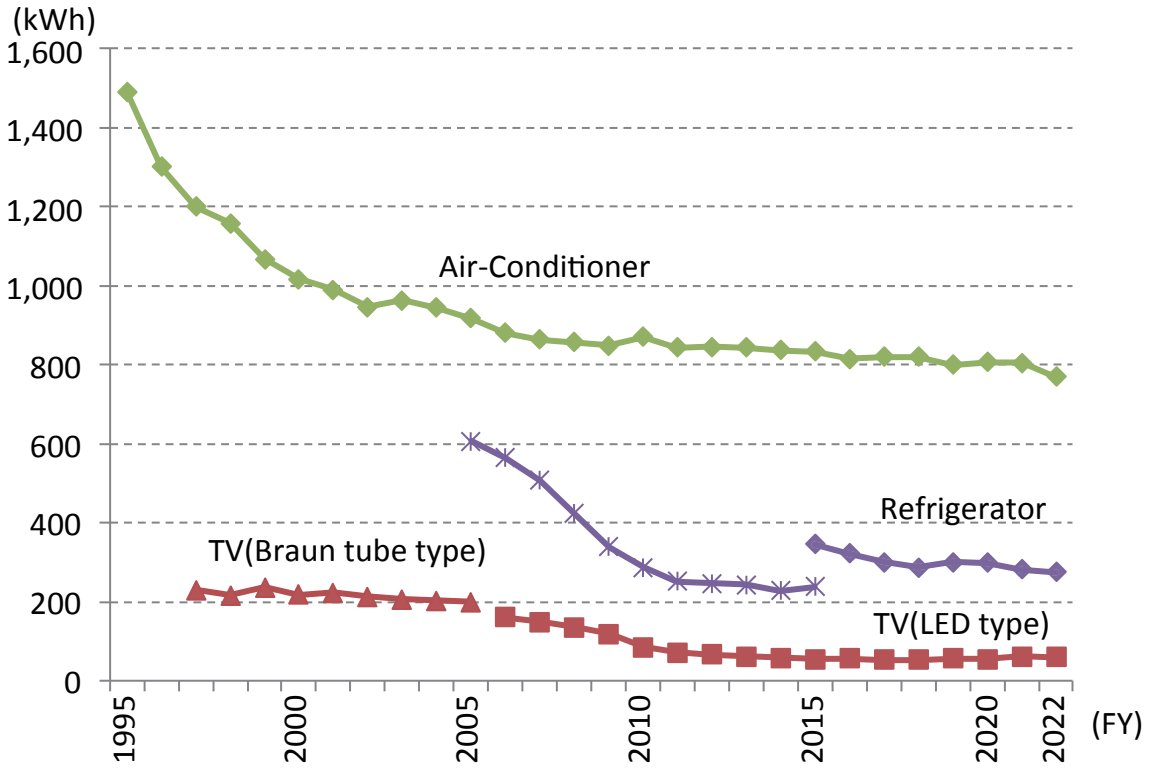


Fig. 8 Average Electricity Consumption of Air-Conditioner and Other Home Appliances

Source: METI ANRE Energy White Paper 2024

Note:

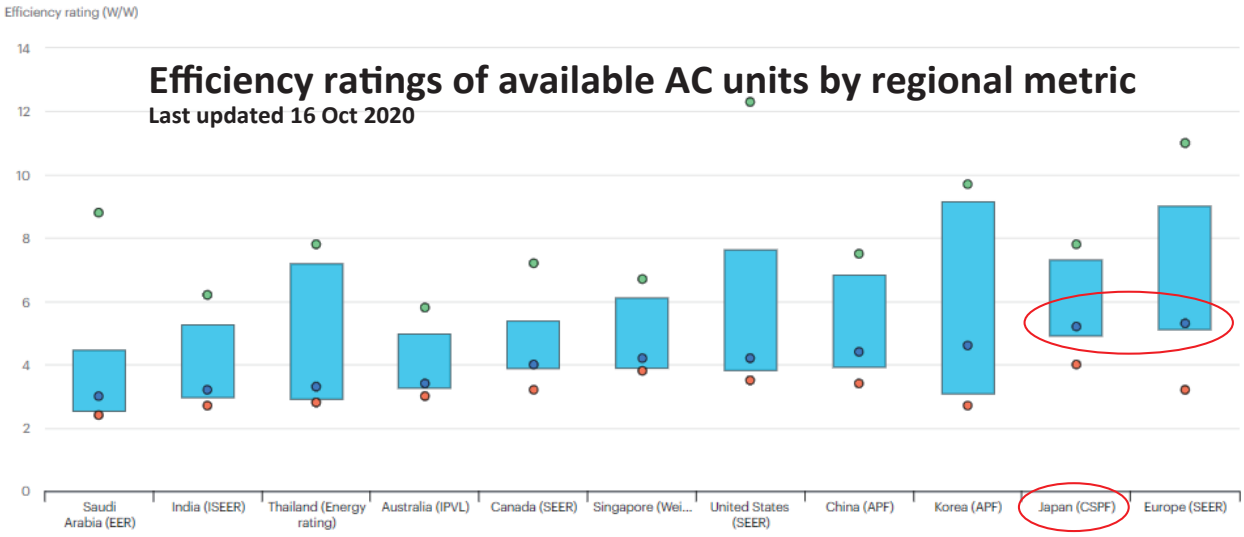
Air-conditioner; Wall mounted cooling and heating units with the cooling capacity of a 2.8kW-class model.

Simple average values for representative models of energy conserving-type products

Refrigerator; 400-liter type (average 401-500 liters).

Yearly electricity consumption (measurement method revised in 2015 (JIS))

LED TV; 32-inch, yearly electricity consumption



IEA、 The Future of Cooling, Efficiency ratings of available AC units by regional metric、 2020/10/16

Fig. 9 Comparison of Energy Efficiency Values of Air Conditioners by Area and Countries

Source: 4th Working Group on Judgment Standards for Air Conditioners and Electric Hot Water Appliances, Energy Conservation Subcommittee, Energy Conservation and New Energy Subcommittee, General Resources Energy Investigation Committee Oct. 18, 2021

In Japan, for air conditioners (all-season types: for cooling and heating) are concerned, COP (Coefficient of Performance) is one of the indices for measuring product efficiency, as well as the APF (Annual Performance Factor). Both COP and APF indicate the cooling/heating capacity (kW) values per 1 kW of power consumption. However, the latter takes power consumption at the rated time into account as well as load conditions such as buildings where air conditioners are used, the outside air temperature while cooling or heating and the efficiency of the air-conditioner depending on the differing capacities of inverter devices. This makes it possible to evaluate energy consumption performance regardless of utilization. There are many scales to evaluate performance of air conditioners, but APF is being introduced in foreign countries as a common benchmark to measure efficiency. The level of energy efficiency values for air conditioners in Japan is about same level as Europe area (top level), although differences in measurement conditions make direct comparisons difficult. (Fig. 9)

Energy-Efficiency Topics in Commercial and Residential Sectors: Zero-Energy Buildings (ZEBs)

When thinking about global energy consumption, buildings, especially in urban areas, consume vast amounts of energy, making this sector a crucial focus. Another important consideration is the lifespan of buildings. Buildings typically stand for 40 to 100 years or more, meaning that a building constructed today could still be in use in 2060. Therefore, immediate action is necessary to ensure a sustainable future. This has led to the emergence of the ZEB (Net Zero Energy Building) concept, which aims to achieve energy balance in buildings by incorporating energy-efficient and renewable technologies.

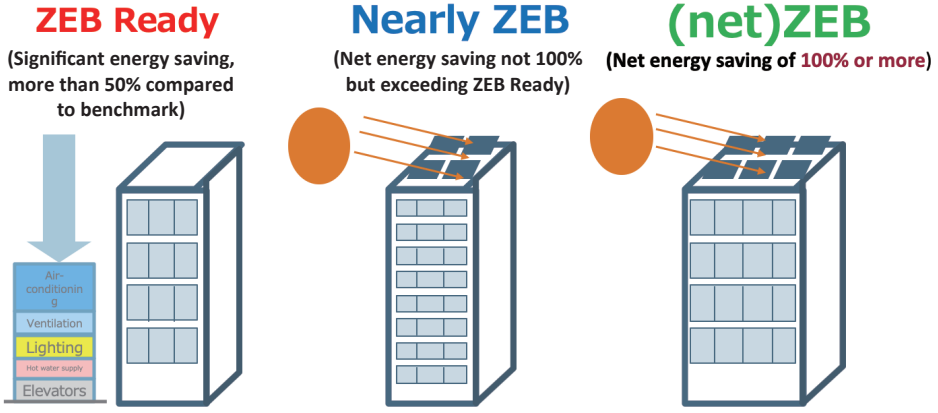
Before 2015, there were few Zero Energy Buildings in Japan, and most were experimental or prototypes. However, at the end of 2015, the ZEB Roadmap Examination Committee, sponsored by the Ministry of Economy, Trade, and Industry (METI), defined the concept of ZEB and outlined future promotion strategies. Since then, ZEB has gained significant attention.

The 6th Strategic Energy Plan which was approved by the Cabinet in October 2021, aims to:

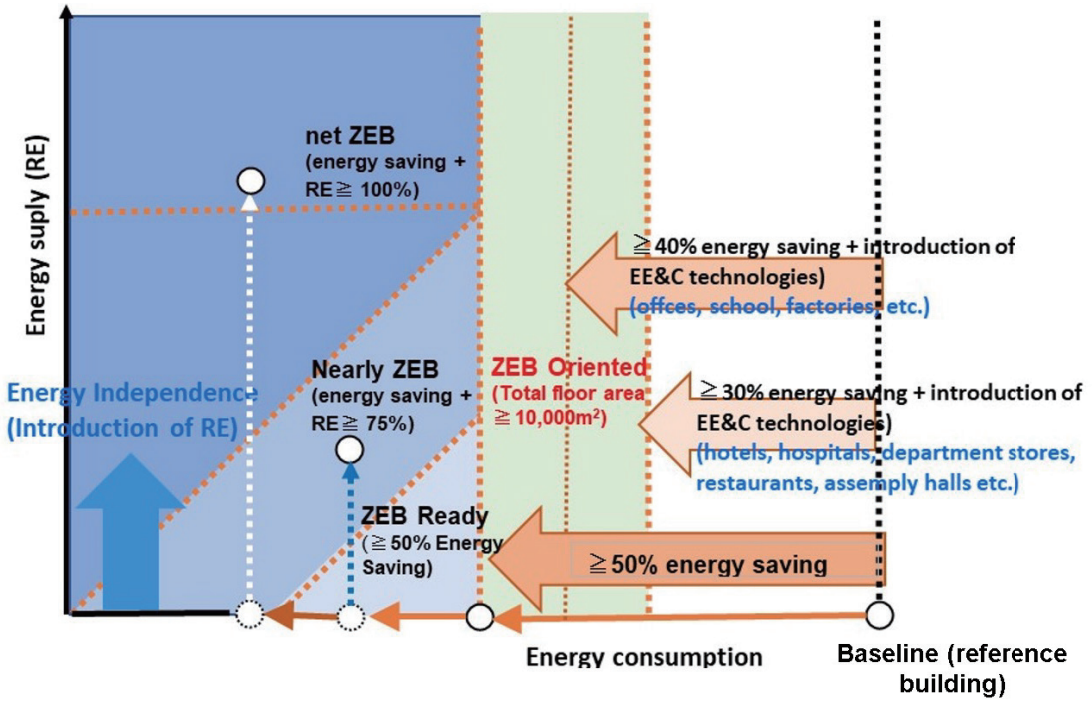
-Achieve energy-saving performance at the level of ZEB standard in the average stock of buildings in 2050.

-Achieve energy-saving performance at the level of ZEB standard for new buildings to be built in 2030 and later.

The ZEB Roadmap Examination Committee in Japan has started to examine (1) how ZEB is defined and evaluated, (2) the feasibility, and (3) measures to promote ZEB. and developed additional definitions for ZEB as follows:



Energy savings of at least 50, 75, or 100% earn ZEB Ready, Nearly ZEB, and (net) ZEB status accordingly.



In Japan, the definition of "ZEB oriented" was added to the ZEB series for buildings with total floors of 10,000 square meters or more in 2019 due to their lange energy consumption. In ASEAN, the ZEB Ready Award was introduced to the ASEAN Energy Awards in the same year to promote ZEB among ASEAN member states.

Now is the time to accelerate the promotion of ZEB in every country to dramatically reduce CO_2 emissions and mitigate climate change. To facilitate this, policies and supporting mechanisms that promote ZEB are crucial. In support of these efforts, ISO (International Organization for Standardization) published TS23674 in September 2021, titled "Methodology for achieving non-residential zero-energy buildings (ZEBs)". This standard is currently being updated and will be revised in 2025.

Malaysia has already introduced their guiding design document based on TS23764 and initiated voluntary ZEB certification. Beyond theoretical discussions, actual demonstration projects have commenced to retrofit existing buildings to ZEB standards.

Moreover, Thailand, the Philippines, Vietnam, and other countries have also launched their ZEB initiatives, making ZEB a prominent trend in Asian building industry.

Lastly, the Asian Zero Emission Community (AZEC) initiative aims to promote carbon emission reductions across Asian countries.

Roadmap for Worldwide Utilization

Highly developed energy efficient and renewable energy technologies can bring remarkable advantages to save energy. Currently, international efforts and activities have been made to prevail energy-efficient and renewable energy technologies. The purpose of this booklet is to help disseminate highly developed technologies in area of energy efficiency, renewable energy and decarbonization by showcasing relevant Japanese products & technologies and explaining their features and effects.

The products and technologies are listed in nine categories: “Factory,” “Industries,” “Office, Building”, “Residence”, “Construction, Transportation & Logistic”, “Power Generation & Distribution”, “Renewable Energy & Storage Battery”, “Energy Solution Service” and “Award Winning Technologies”. Also noted is the fact that all technologies in this booklet are environmentally friendly, given scope to lower energy consumption and even improve the environment directly. Moreover, the Japanese technologies in this booklet are also characterized as having “quality” and “durability,” which achieve lifetime impacts in the area of energy efficiency. This booklet also shows the contact points which help when studying feasibility and planning for adaptation.

The booklet also references companies and associations capable of integrated realization via the cited technologies or with scope to consult on overall energy reduction planning, basic designs of various plants or renovating for energy efficiency and renewable energy in the context of industrial estates.

Since the Paris Agreement came into force, many nations have set their greenhouse gas reduction targets called NDCs and started a lot of efforts toward net zero carbon. To achieve this globally, it is crucial to ensure the penetration and take-up of various tried and tested technologies, including energy saving and renewable energies, across the board worldwide. Amid growing global interest in the UN Sustainable Developing Goals (SDGs), Japanese companies are expected to continue actively engaging in climate change and carbon neutral measures and striving to expand various advanced technologies and products accumulated to date that will help save more energy and promote renewable energies and decarbonization to the rest of the world.

It is our hope that this booklet will help disseminate and leverage sophisticated technologies in the areas of energy efficiency, renewable energy and decarbonization throughout the globe.

(Written by JASE-W)