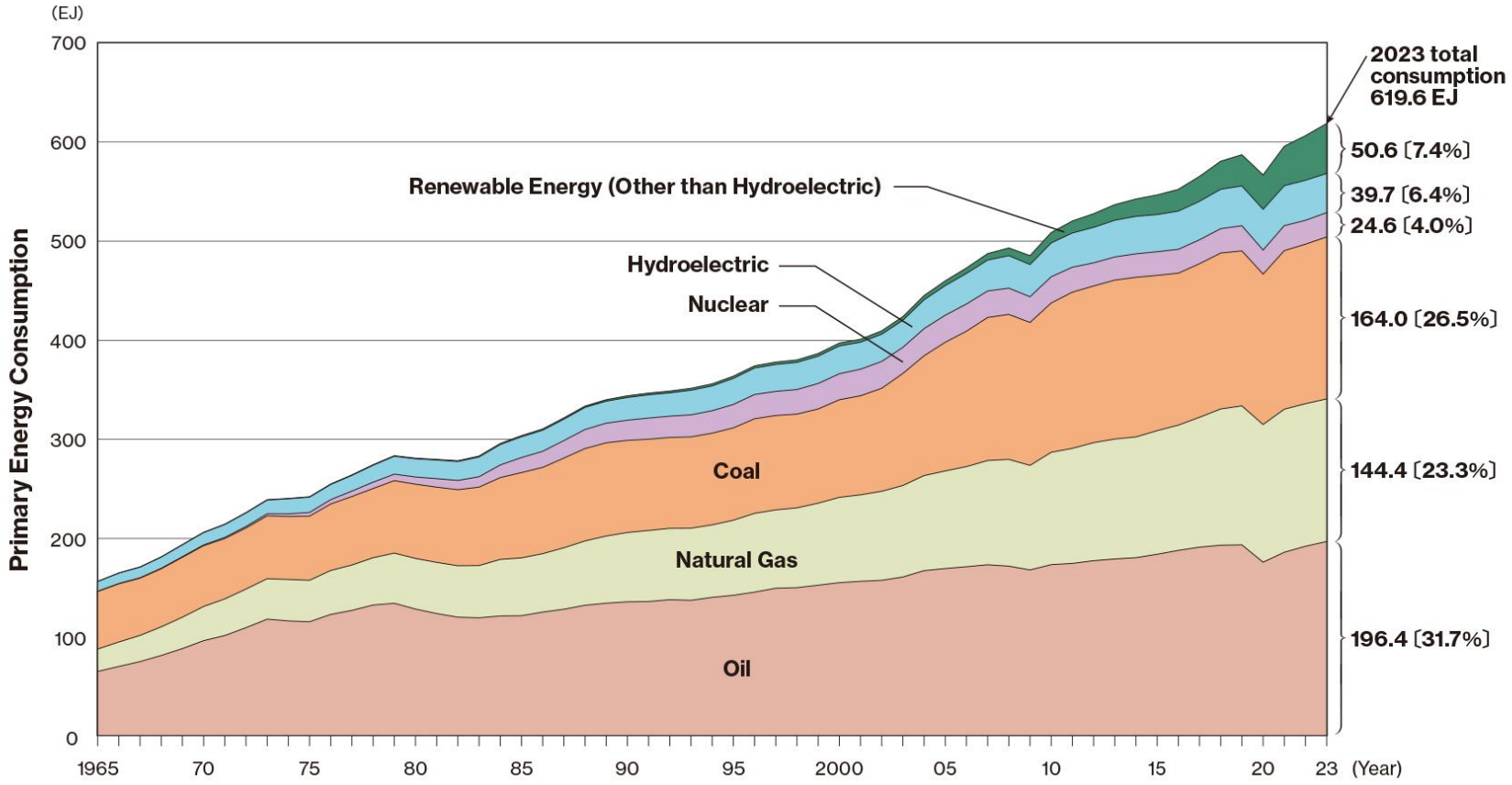
Environment and Ecology

Energy supply and consumption

The World's Primary Energy Consumption



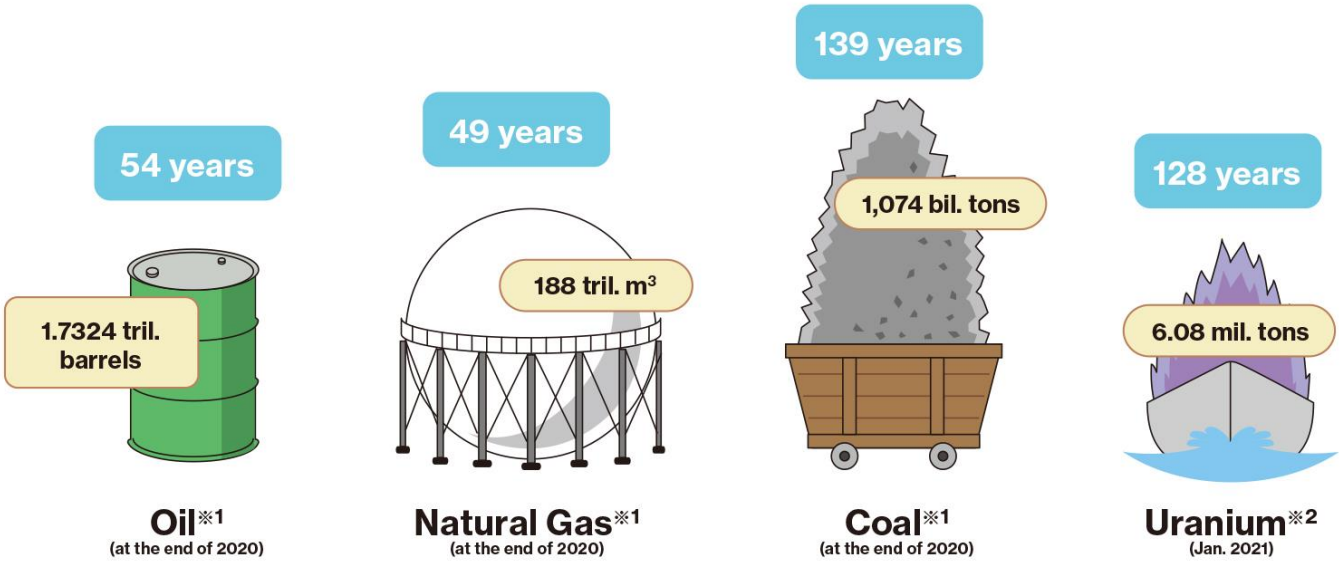
(Note) Figures may not add up to the totals due to rounding. The figures in parentheses are the share of the total.
1 EJ (=10^{18} Joules) is equivalent to the amount of heat from approximately 25,800,000 k ℓ of crude oil (EJ: exajoule).

1-1-7

Source: 2024 Energy Institute Statistical Review of World Energy

In the past, availability of energy resources was people's main interest.

Proven Reserves of Energy Resources

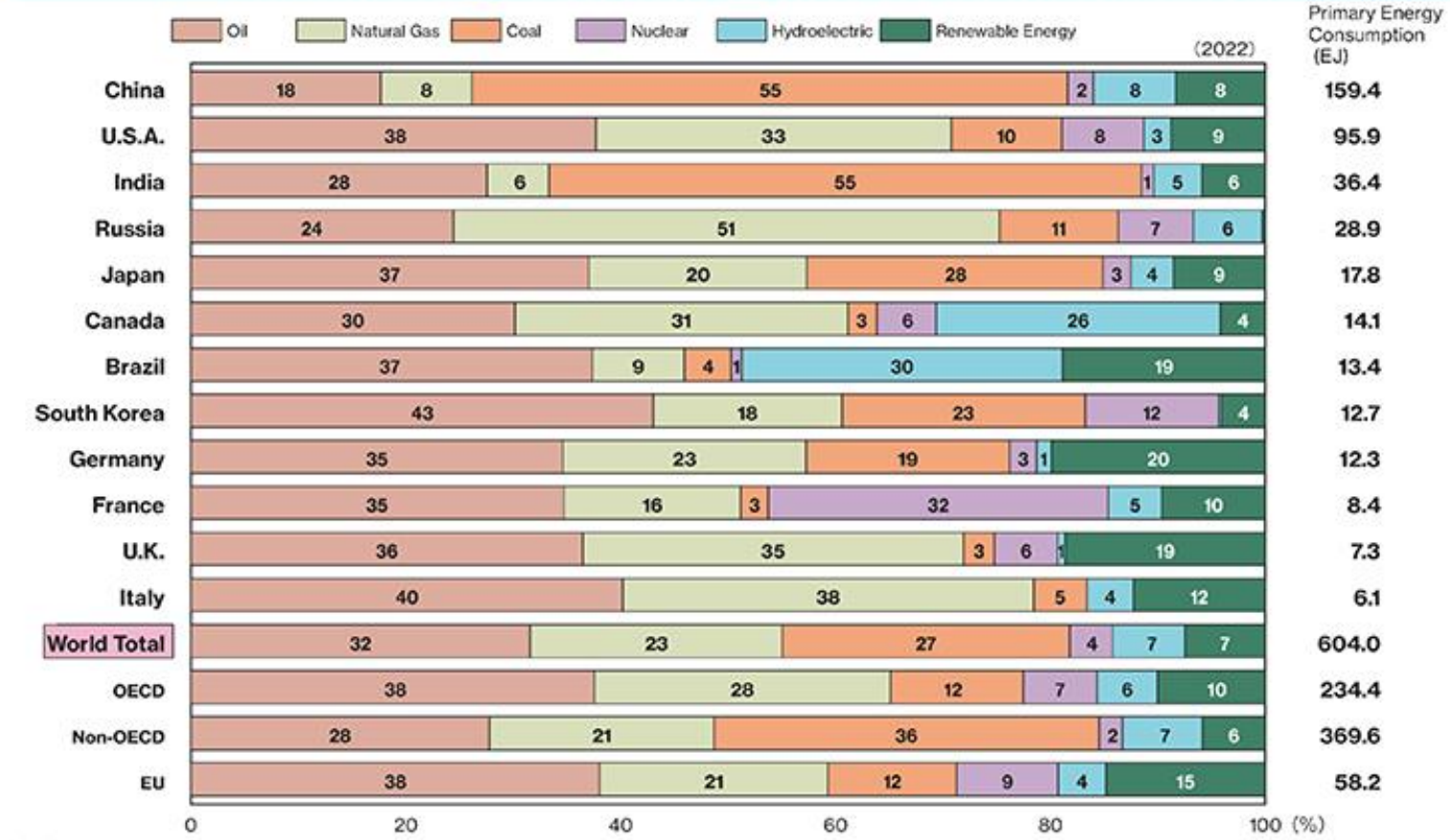


(Note) Reserves-to-production (R/P) ratio = Proven Reserves / Annual Production
RAR (reasonably assured resources) of uranium is estimated at a production cost less than USD 130/kgU.

1-1-6

Source: ※1 BP Statistical Review of World Energy 2021 ※2 OECD/NEA,IAEA, Uranium 2022

Primary Energy Consumption in Major Countries

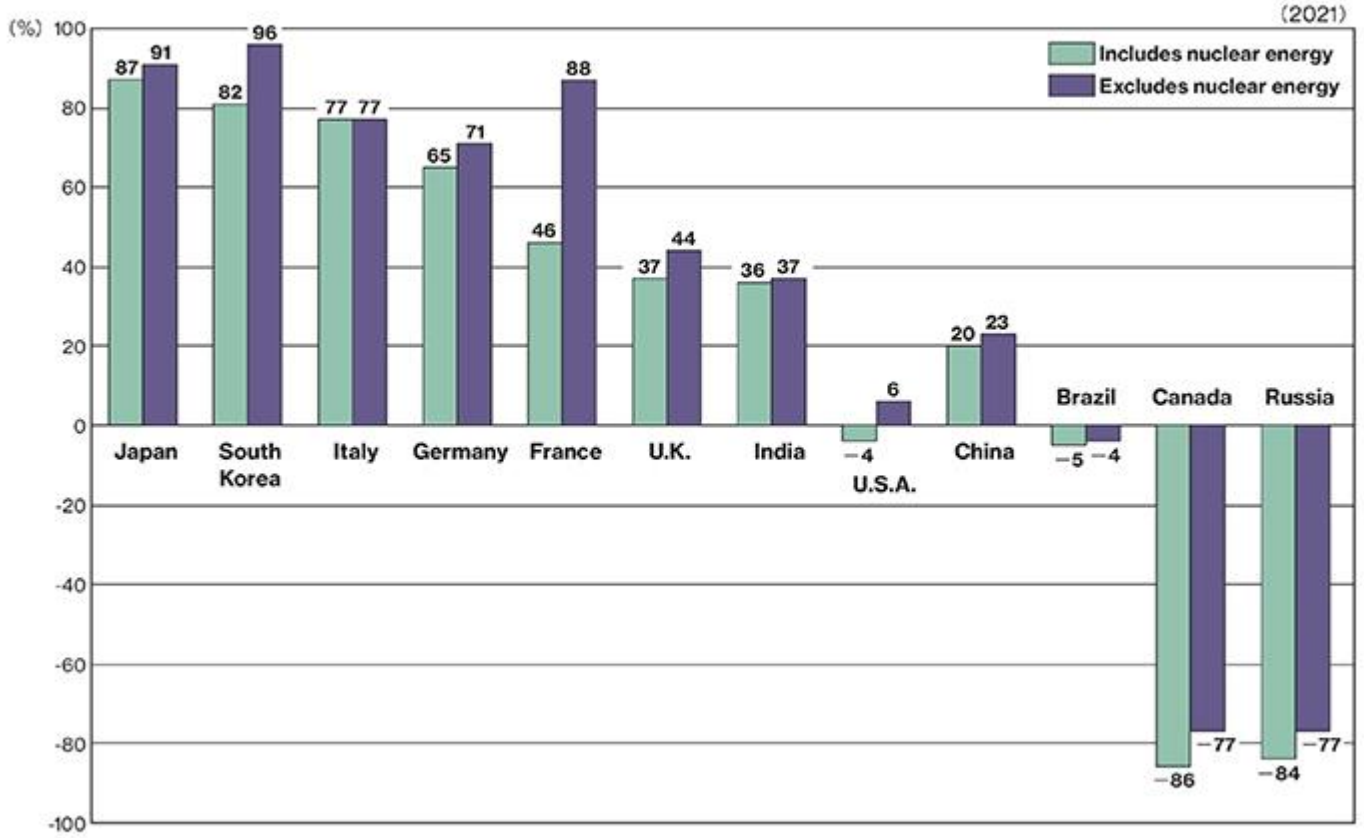


(Note) Figures may not add up to the totals due to rounding.
1 EJ (=10^{18} Joules) is equivalent to the amount of heat from approximately 25,800,000 kℓ of crude oil (EJ: exajoule).

1-1-8

Source: Energy Institute Statistical Review of World Energy 2023

Dependence on Imported Energy Sources in Major Countries



(Note) Canada and Russia are net-exporting countries.

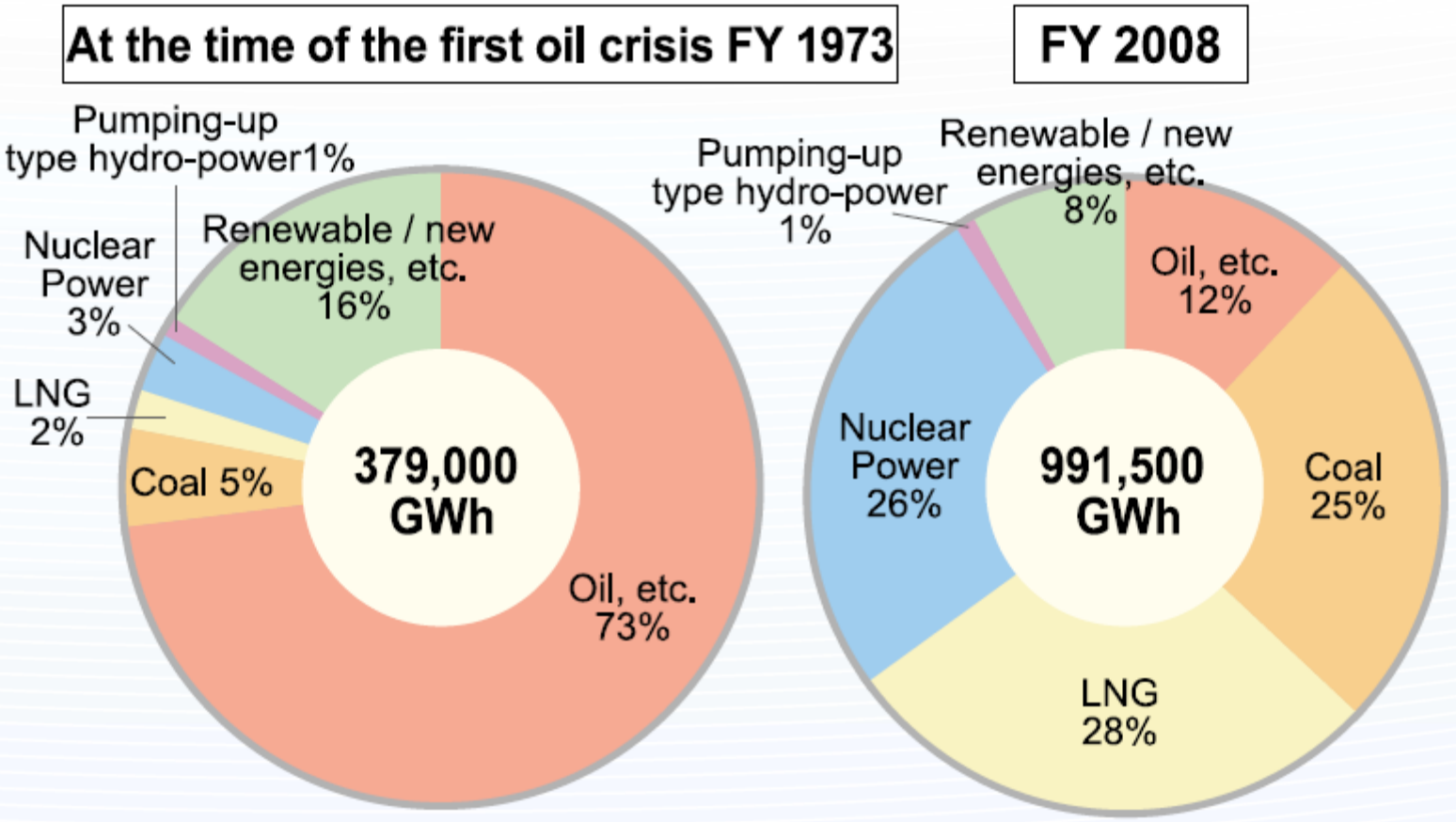
1-1-11

Source: IEA, World Energy Balances 2023

Shift in power source to nuclear power and other non-oil sources

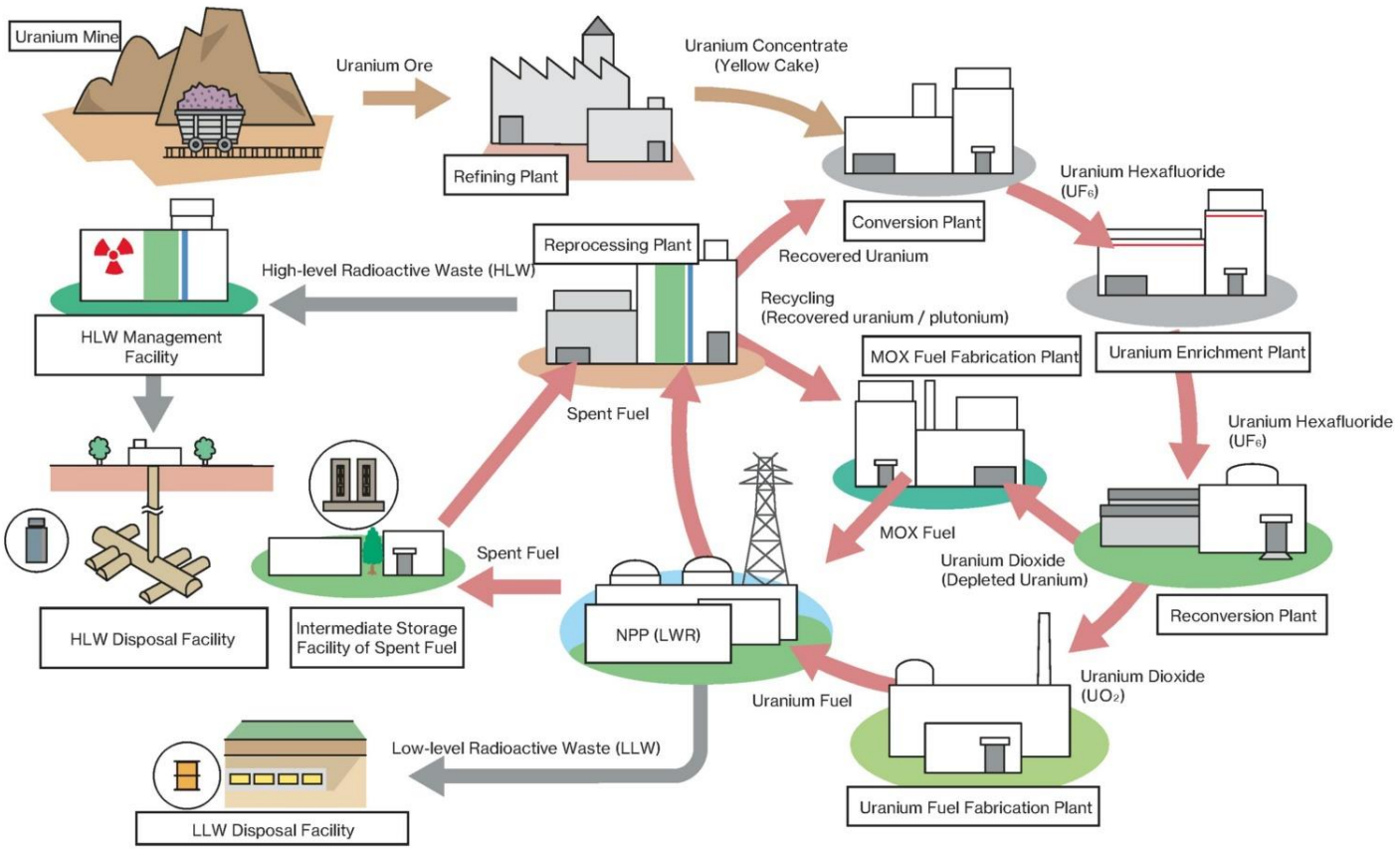
■ **Changes in the amount of power generated by power source (for general electricity business) (Figure 25)**

Source: Agency for Natural Resources and Energy,
"Outline of Electric Power Source Development"



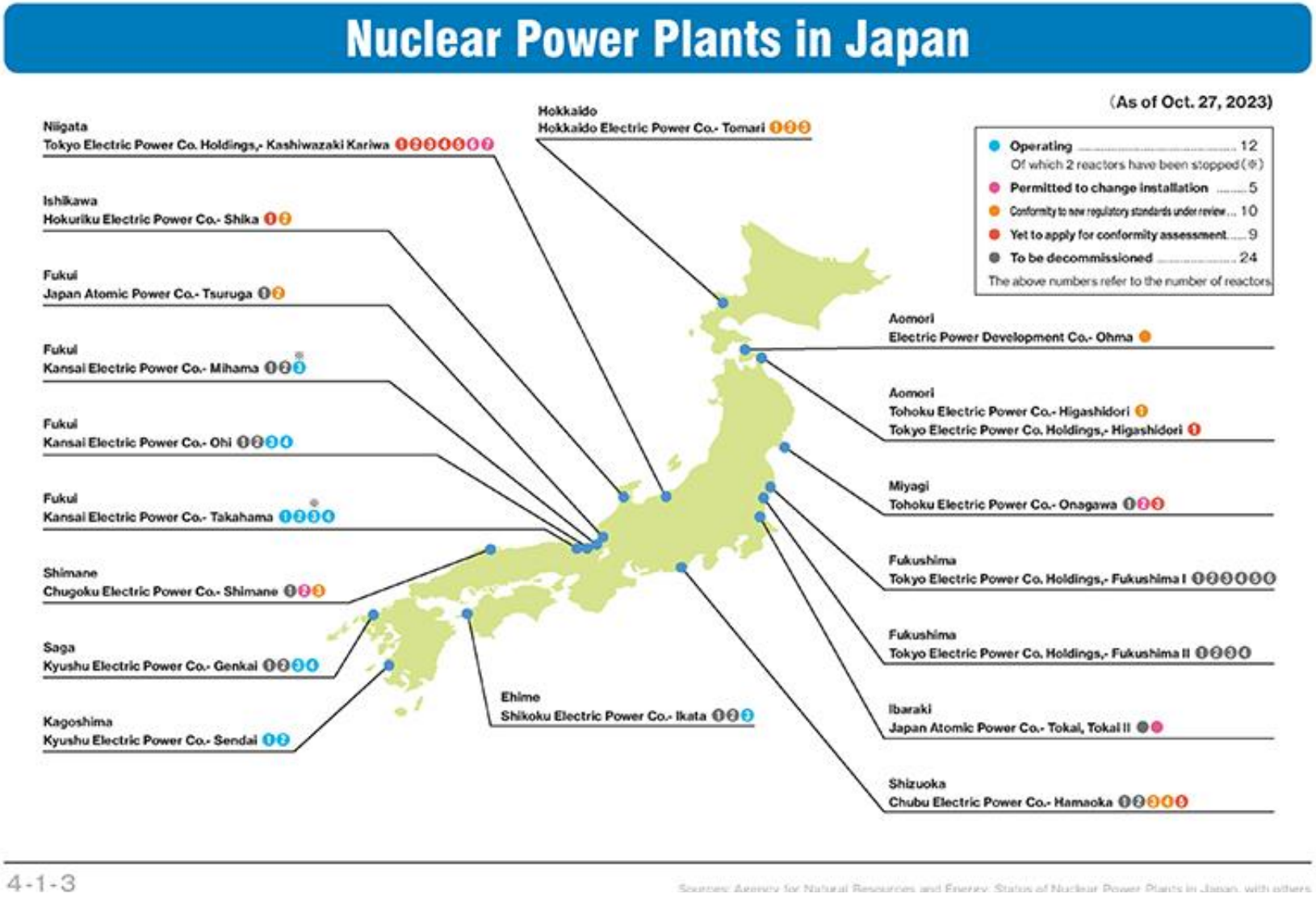
Energy in Japan 2010, Agency for Natural Resources and Energy

Nuclear Fuel Cycle



(Note) MOX Fuel: Uranium-Plutonium mixed oxide fuel

7-2-1



In many cases, nuclear power plants were constructed in areas that were depopulating and had very little tax base.

People's main interest is shifting toward the reduction of CO_2 emission.

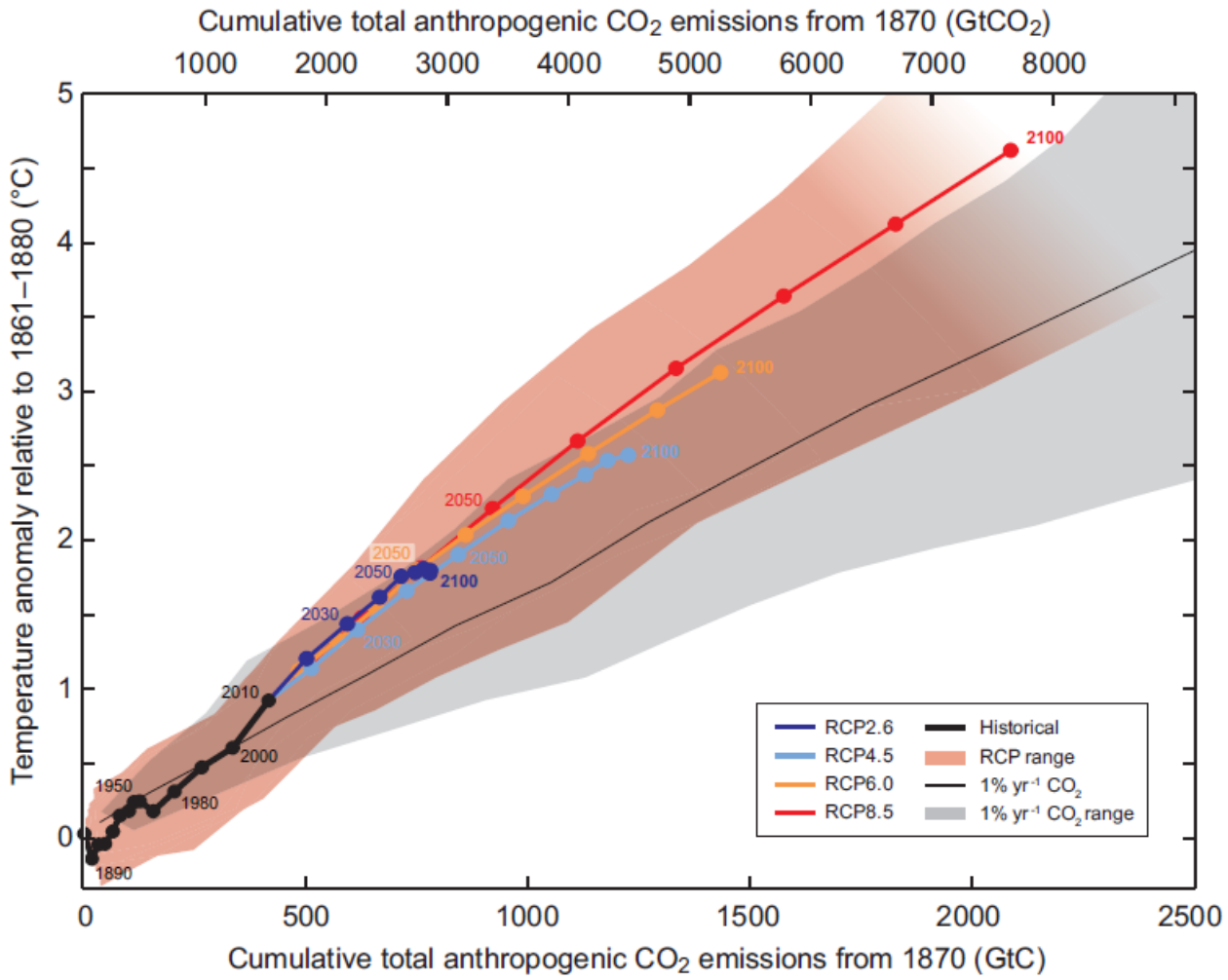
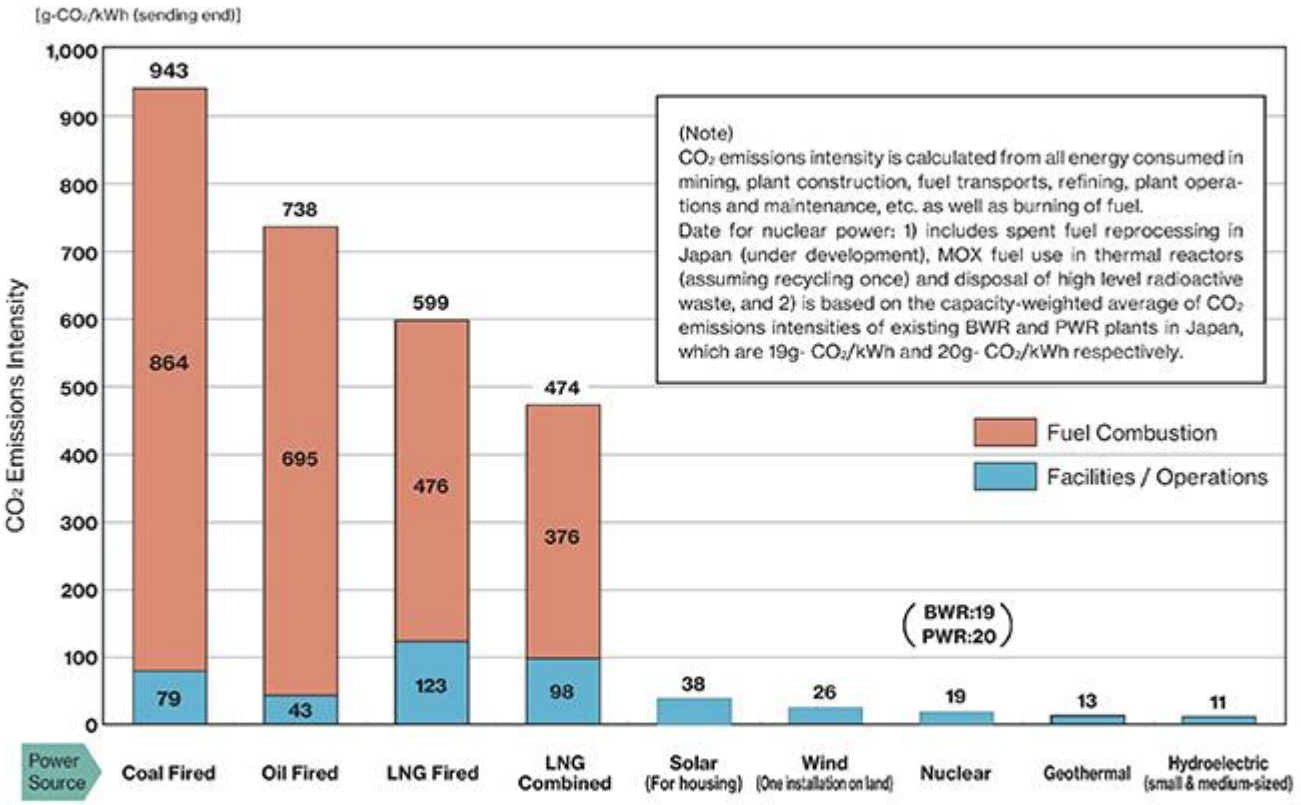


Figure SPM.10 | Global mean surface temperature increase as a function of cumulative total global CO_2 emissions from various lines of evidence. Multi-model results from a hierarchy of climate-carbon cycle models for each RCP until 2100 are shown with coloured lines and decadal means (dots). Some decadal means are labeled for clarity (e.g., 2050 indicating the decade 2040–2049). Model results over the historical period (1860 to 2010) are indicated in black. The coloured plume illustrates the multi-model spread over the four RCP scenarios and fades with the decreasing number of available models in RCP8.5. The multi-model mean and range simulated by CMIP5 models, forced by a CO_2 increase of 1% per year (1% yr^{-1} CO_2 simulations), is given by the thin black line and grey area. For a specific amount of cumulative CO_2 emissions, the 1% per year CO_2 simulations exhibit lower warming than those driven by RCPs, which include additional non-CO_2 forcings. Temperature values are given relative to the 1861–1880 base period, emissions relative to 1870. Decadal averages are connected by straight lines. For further technical details see the Technical Summary Supplementary Material. {Figure 12.45; TS TFE.8, Figure 1}

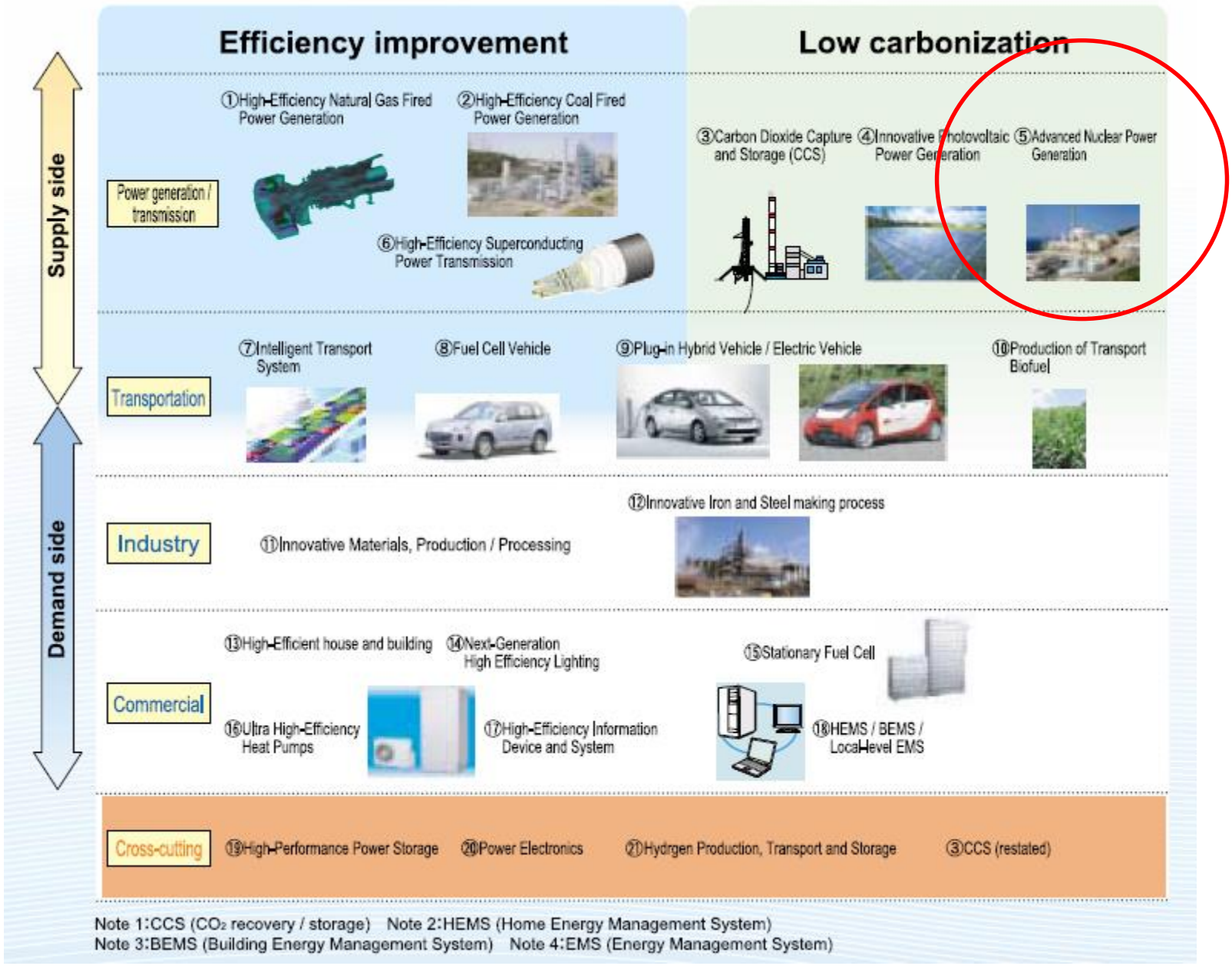
IPCC 2013

Lifecycle-Assessed CO_2 Emissions Intensity of Japan's Energy Sources



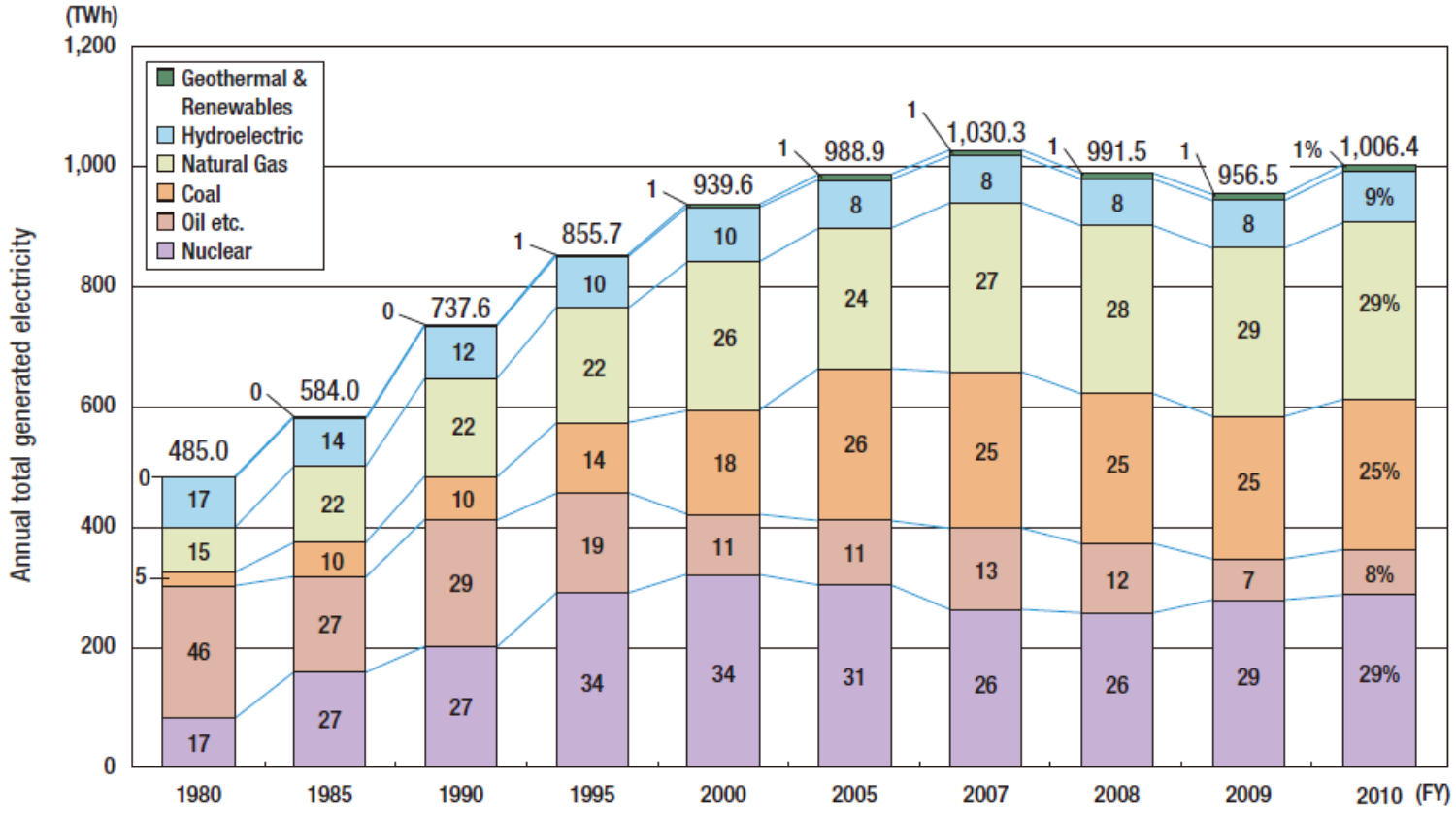
2-1-9

Source: Central Research Institute of Electric Power Industry, Comprehensive Assessment of Life Cycle CO_2 Emissions from Power Generation Technologies in Japan (July 2016)



Energy in Japan 2010, Agency for Natural Resources and Energy

Historical Trend of Power Generation Volume by Source



(Note) Oil etc. includes LPG and other gases.
Figures may not add up to the totals due to rounding.
Total of 10 electric power companies and power purchased.
Figures within the graph represent the composition ratio.

1-2-7

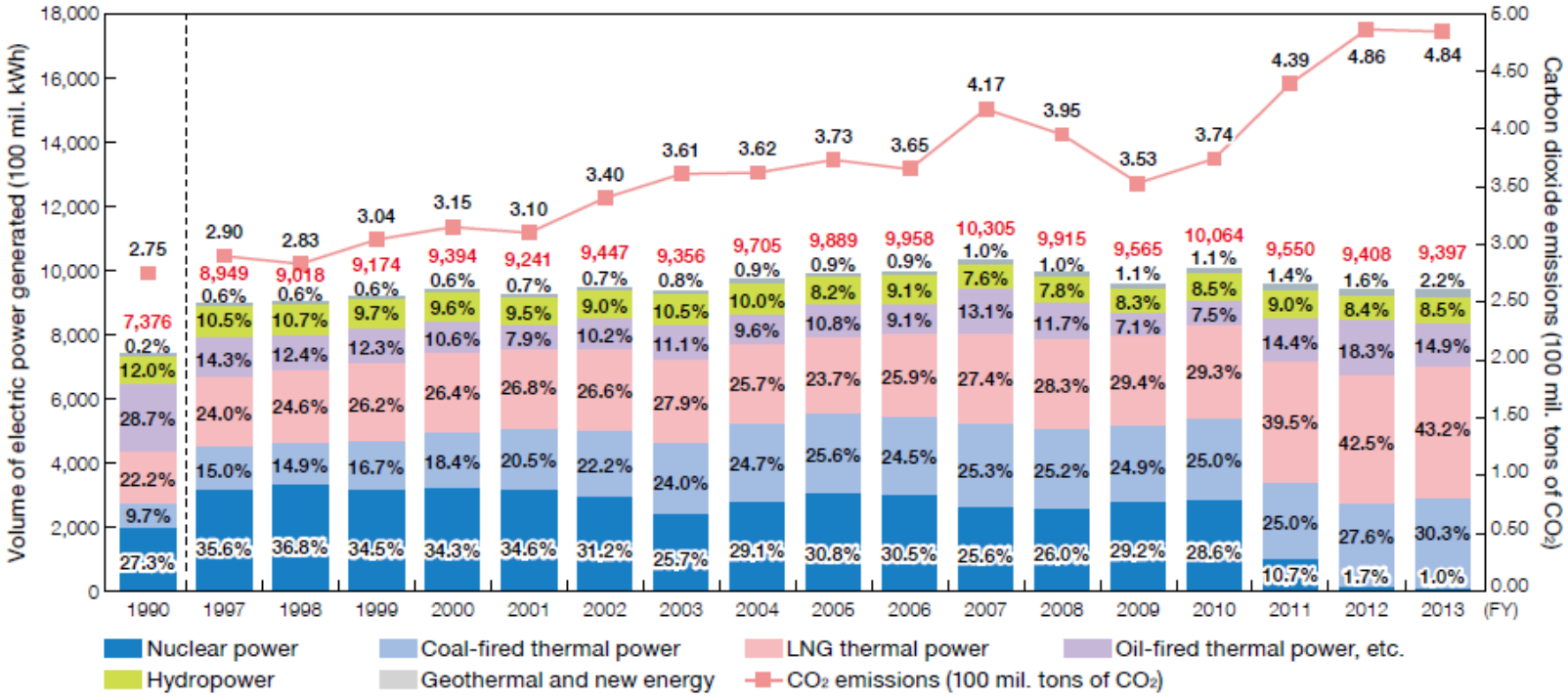
Source: The Federation of Electric Power Companies

2011. 3. 11

Tōhoku earthquake and tsunami
東日本大震災

Damage of the Fukushima Daiichi Nuclear Power Plant
福島第二原子力発電所事故

Changes in volume of electric power generated by type of power source and carbon dioxide emissions

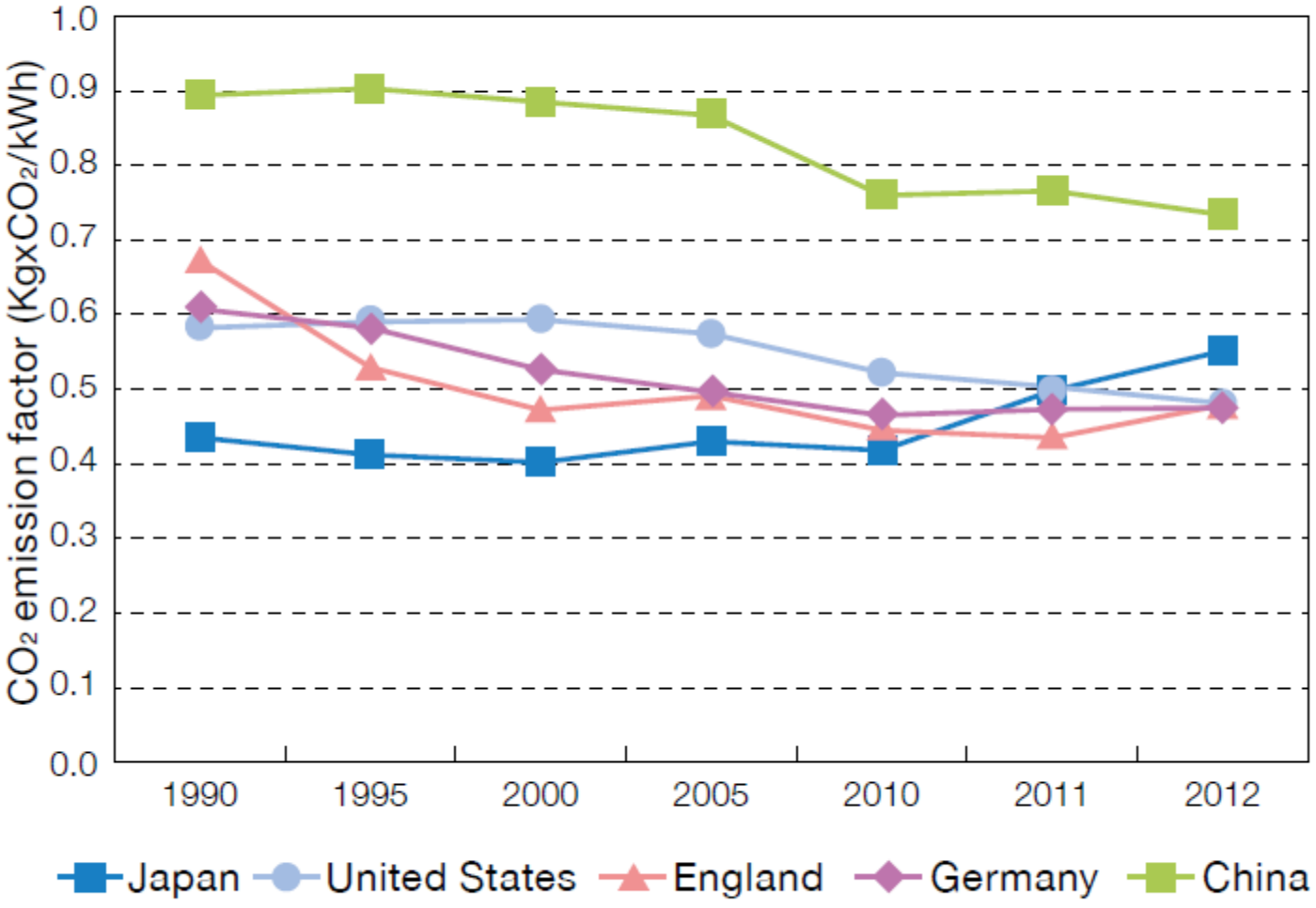


Note: Total for 10 general electricity utilities

Source: (Electric power generated by type of power) "Overview of Energy Development," Agency for Natural Resources and Energy; "Fiscal 2013 Comparison of Electric Power Generation Mix by Type of Power Source" and "Environmental Action Plan by the Electric Power Industry," the Federation of Electric Power Companies of Japan (Carbon Dioxide Emissions) "Global Warming Countermeasures by the Electric Power Industry" and "Environmental Action Plan for the Electric Power Industry," the Federation of Electric Power Companies of Japan

Annual Report on the Sound Material-Cycle Society, and Biodiversity in Japan 2015

Changes in CO_2 emission factor from electric power sector in major countries



Source: "CO_2 Emissions from Fuel Combustion 2014," IEA

Annual Report on the Sound Material-Cycle Society, and Biodiversity in Japan 2015

Key word

Renewable energy

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.

https://en.wikipedia.org/wiki/

Renewable energy

Wind power

Solar energy (Photovoltaics (PV) Solar heat)

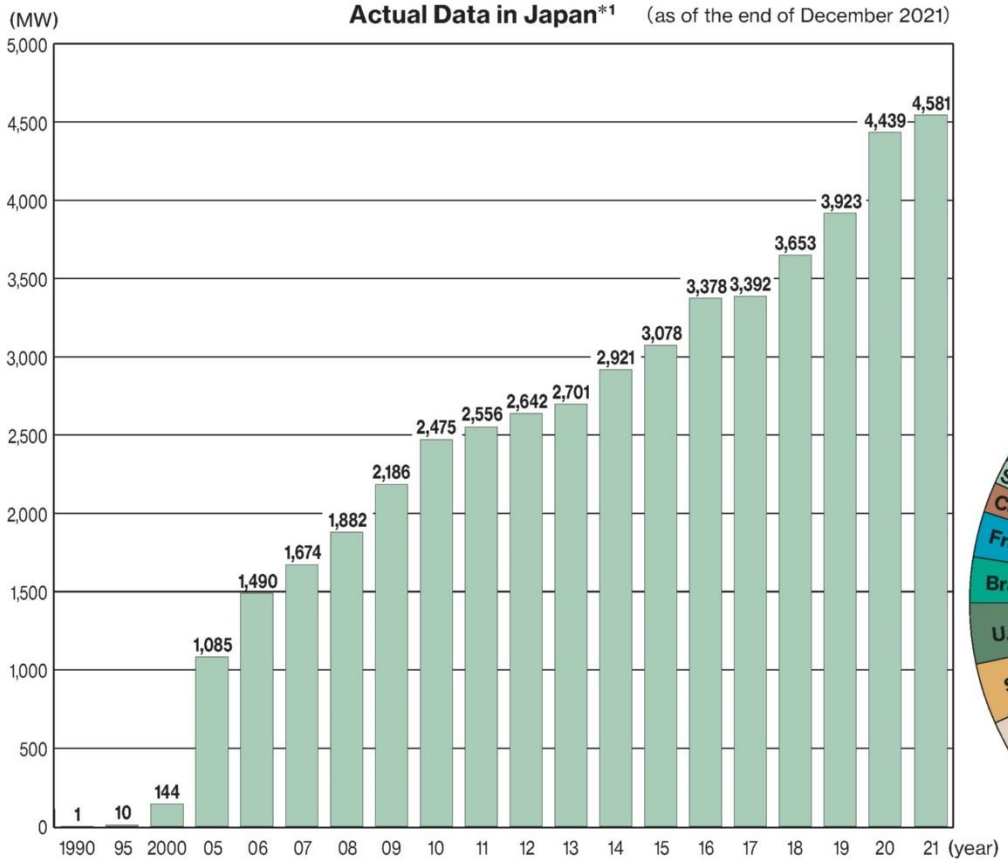
Hydropower

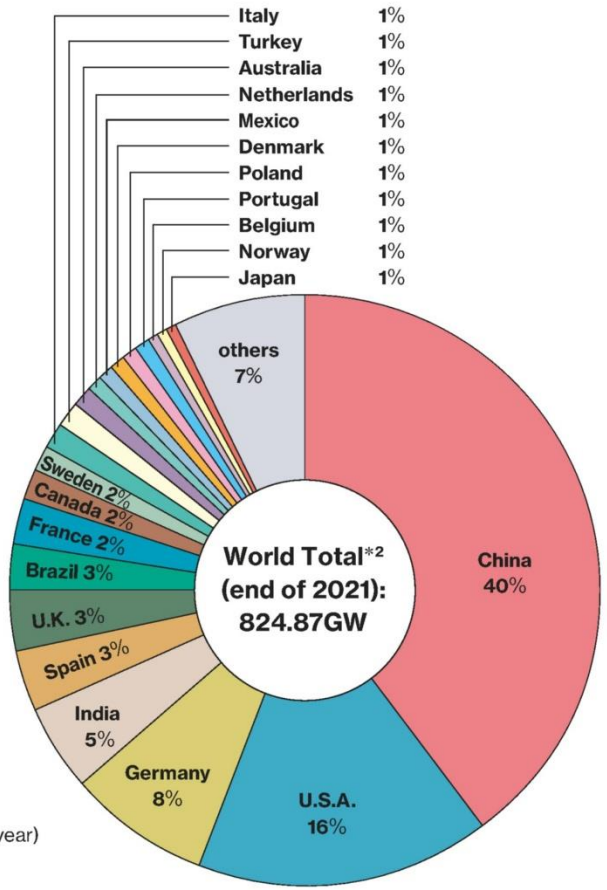
Geothermal energy

Biomass energy

Others (tides, waves etc.)

Wind Power Generation Capacity in Japan and the World





(Note) Figures may not add up to the totals due to rounding.

3-1-5

Source: *1 Agency for Natural Resources and Energy, Energy White Paper 2023 (Made with data of NEDO before 2003 and JWPA after 2004),
*2 IRENA (2022), Renewable Capacity Statistics 2022

Demerits of wind power

Fluctuation in power generation

Threat to birds（bird strike）

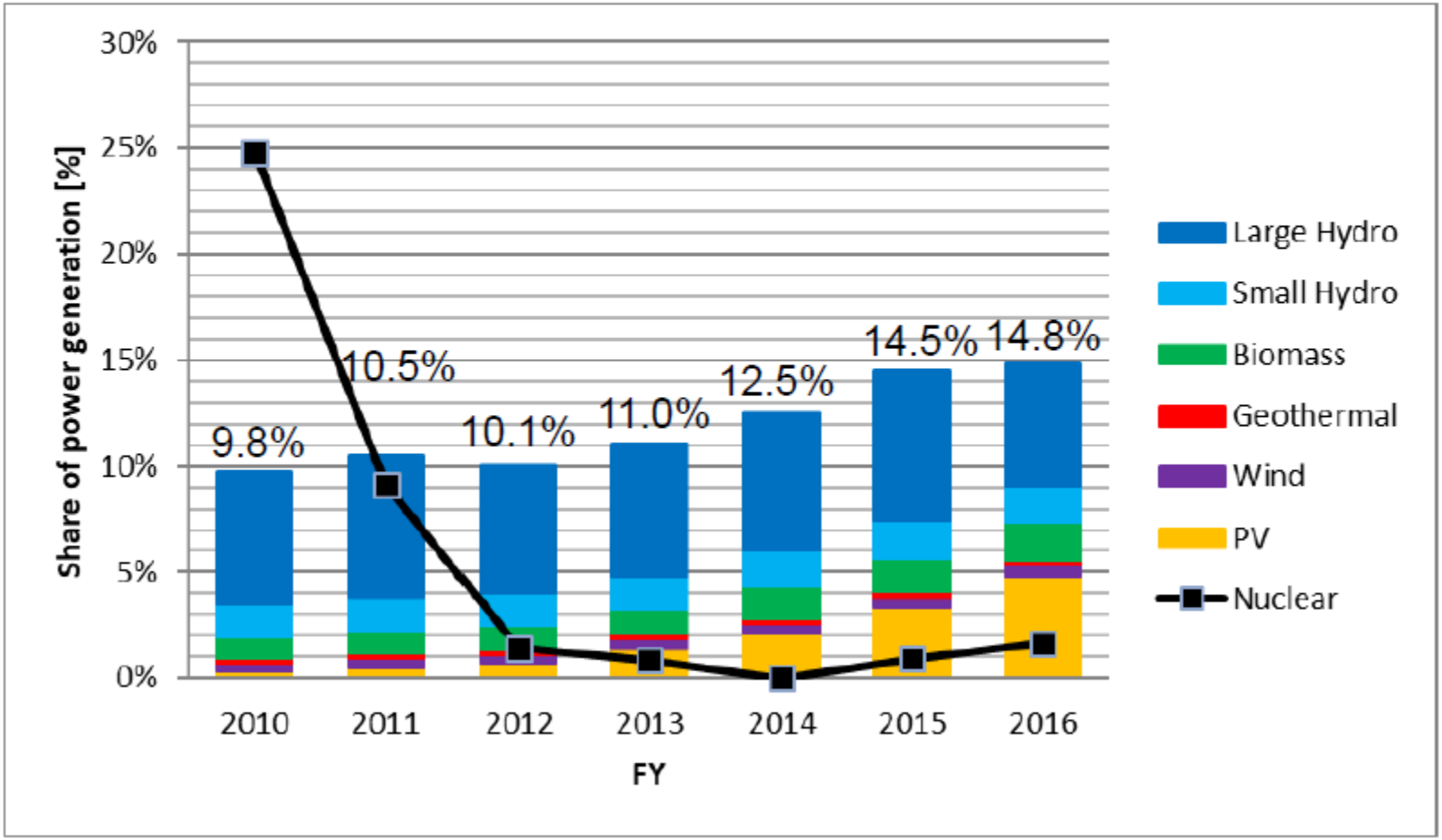
Negative impact on landscape

Noises

Others: deterioration over time etc.

Trends of Renewable Power Generation in Japan

Share of renewable energy power generation increased to 14.8% in FY2016.



Source: METI, ISEP(Renewables Japan Status Report)

Merits and demerits of geothermal energy

Merits:

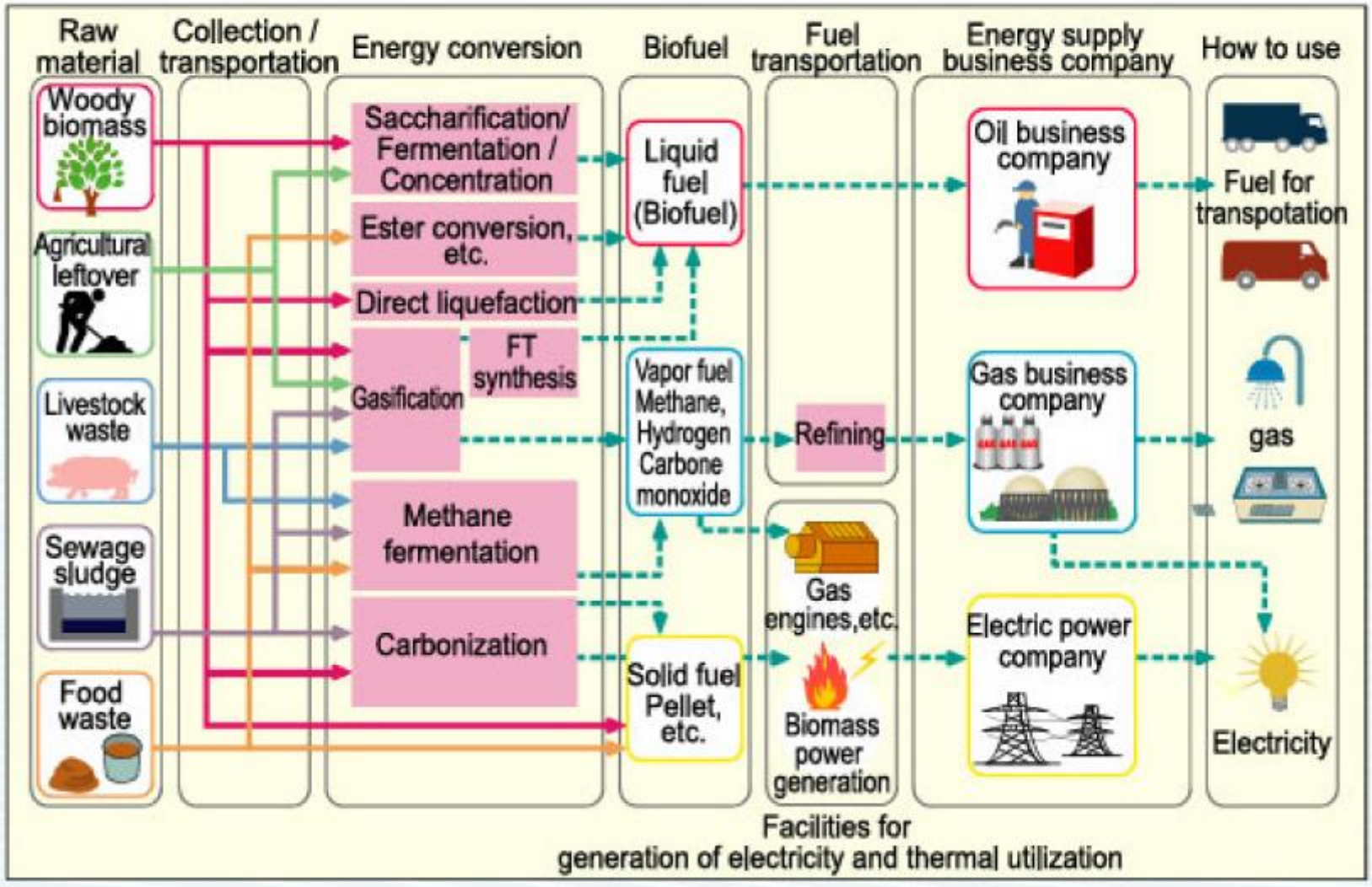
- Purely domestic
- No fuel for power generation
- Renewable energy
- No CO_2 emission in the process of power generation
- Stable without diurnal fluctuation

Demerits:

- Difficulty in the construction of large power plant
- Negative impact on landscape

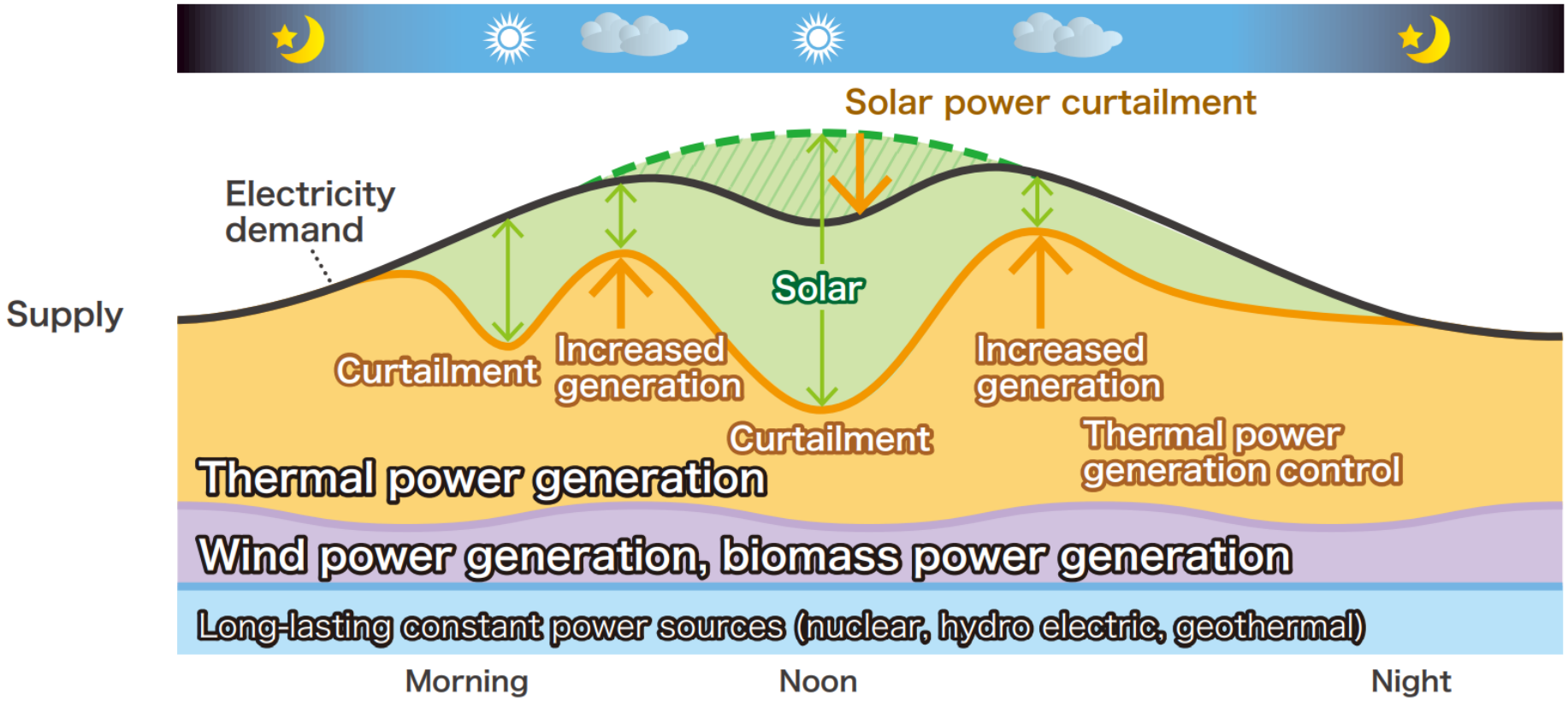
How to use biomass is various ways

■ Flow from the collection of the raw materials of biomass to the energy supply (Figure 41)



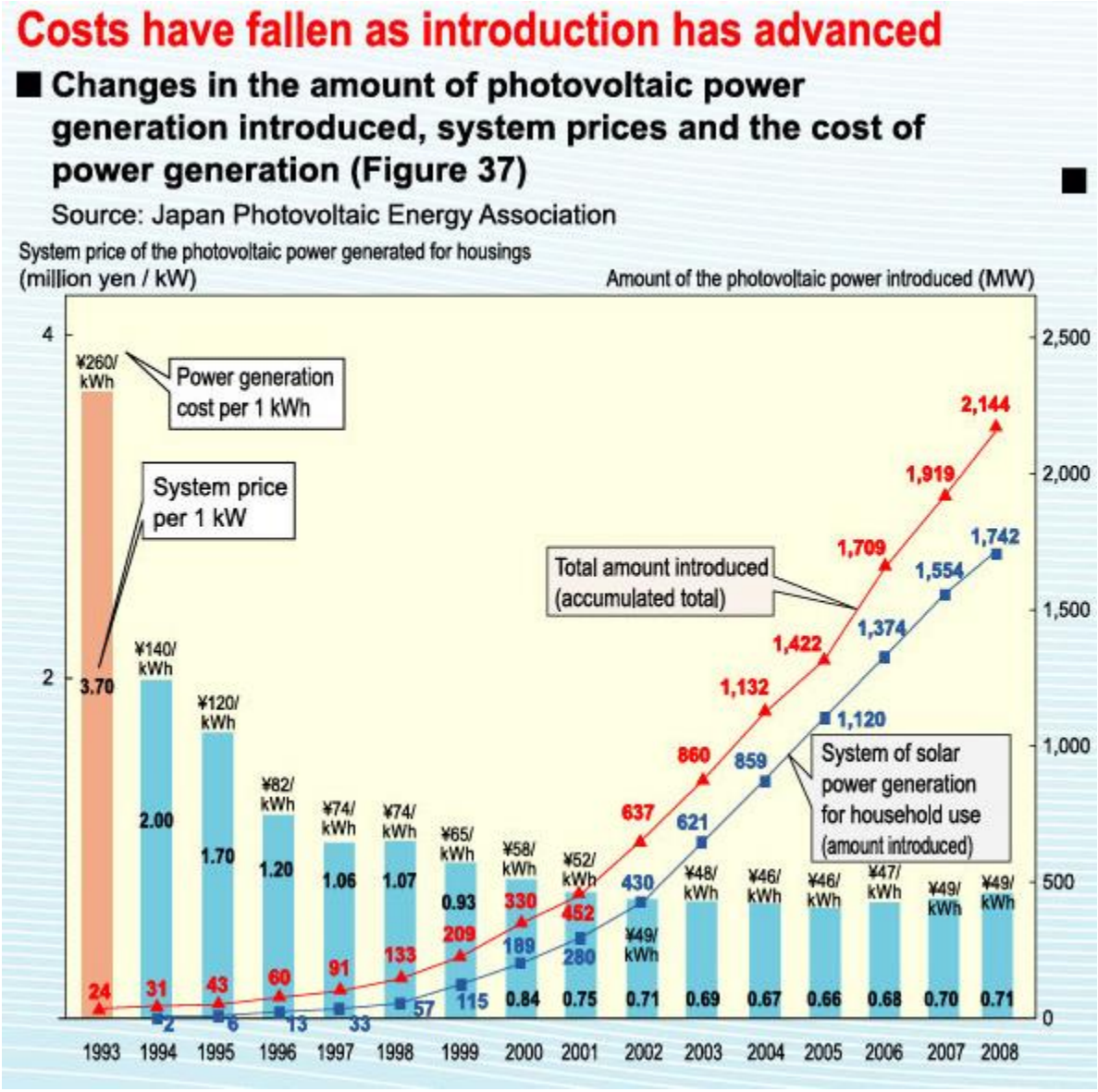
Energy in Japan 2010, Agency for Natural Resources and Energy

Image of supply/demand situation on the lowest demand day (such as a sunny day in May)



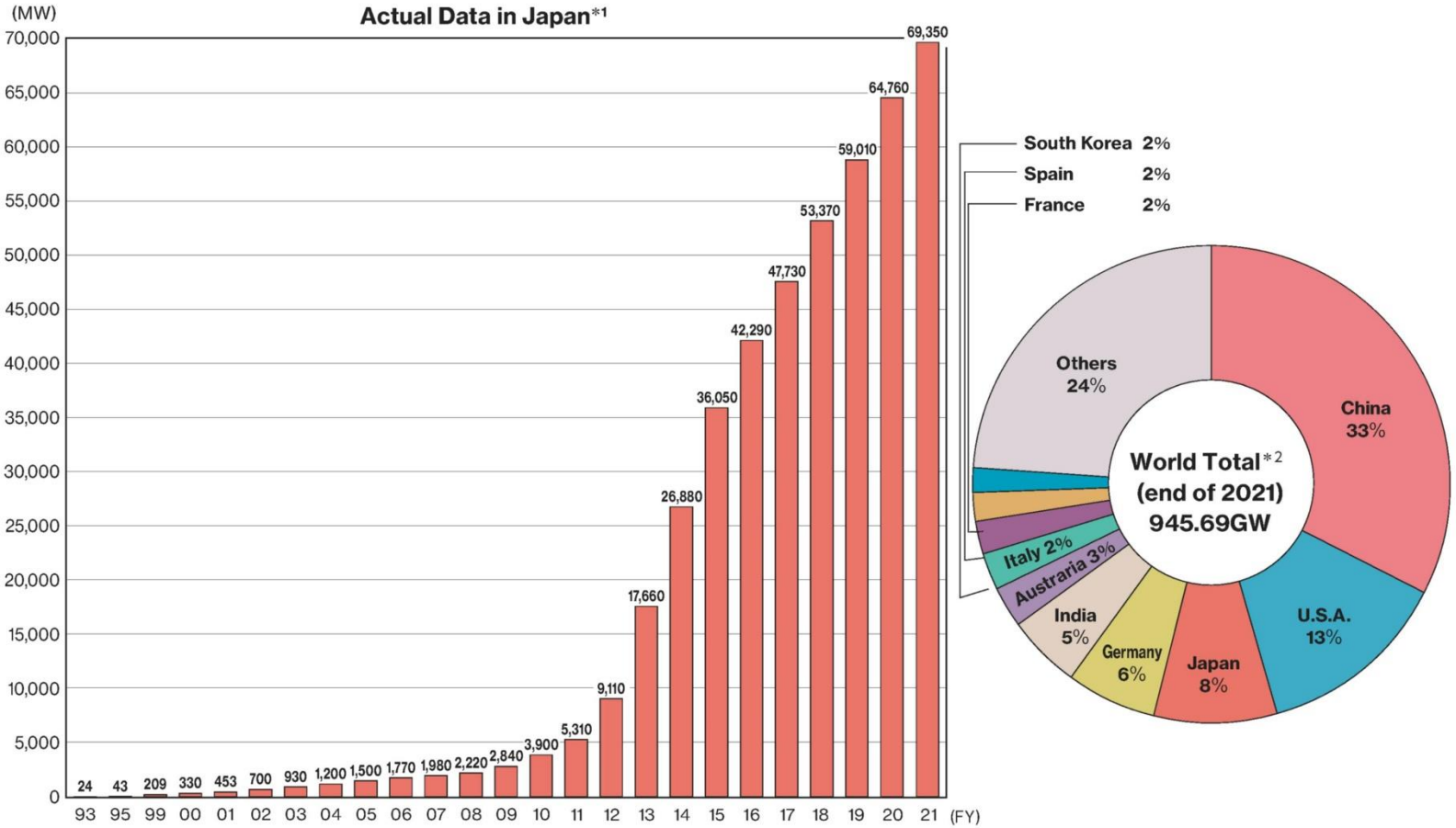
It is necessary to maintain a balance between generation (supply) and consumption (demand) so that consumers can have stable access to electric power. To this end, flexible power sources such as thermal power generation are used to compensate for fluctuations in renewable energy out put.

JAPAN'S ENERGY 2019, Agency for Natural Resources and Energy



Energy in Japan 2010, Agency for Natural Resources and Energy

Solar Power Generation Capacity in Japan and the World



(Note) Figures may not add up to the totals due to rounding.

3-1-4

Source: *1 Agency for Natural Resources and Energy, Energy White Paper 2023, and *2 IEA, TRENDS 2022 IN PHOTOVOLTAIC APPLICATION · Photovoltaic Power Systems Programme(PVPS)」「2022 Snapshoto of Global PV Markets」

Evaluation & Problems of New Energy

	Solar Power	Wind Power	Waste Power (Biomass Power)
Merits	○No fear of exhaustion ○Emits no CO_2 or other gases in the process of power generation ○Due to neighboring the demand area, there is no transmission loss ○Generate at daytime when the demand rises	○No fear of exhaustion ○Emits no CO_2 or other gases in the process of power generation	○No additional CO_2 emission by power generation ○Continuously supplied stable power source among new energies
Demerits	○Due to low energy density※1, it needs much larger area than thermal and nuclear power generation for the same amount of power generation ○Unstable due to no generation at night and low power output in rainy or cloudy days ○High costs on facilities	○Due to low energy density, it needs much larger area than thermal and nuclear power generation for the same amount of power generation ○Unstable due to occasional and seasonal volatility in wind directions and speed ○Makes noises when windmills rotate ○Locations where the wind situation is good are unevenly distributed ○High costs on facilities	○Low generation efficiency ○Needs further environmental burden reduction measures such as dioxin emission control measures and ash reduction
Necessary Site Area※2	To substitute for a 1,000MW-class nuclear power plant		
	Approx. 58 km², almost the same as the area inside the Yamanote Line (Tokyo Loop Line)	Approx. 214 km², approx. 3.4 times larger than the area inside the Yamanote Line	
Load Factor	12%	20%	

※1 Energy density: the amount of power generation possible per the size of the space (area) used to generate it, expressed as a number.
※2 Figures from the Study Group on Low Carbon Power Supply System (July 2008)

Key word

FIT

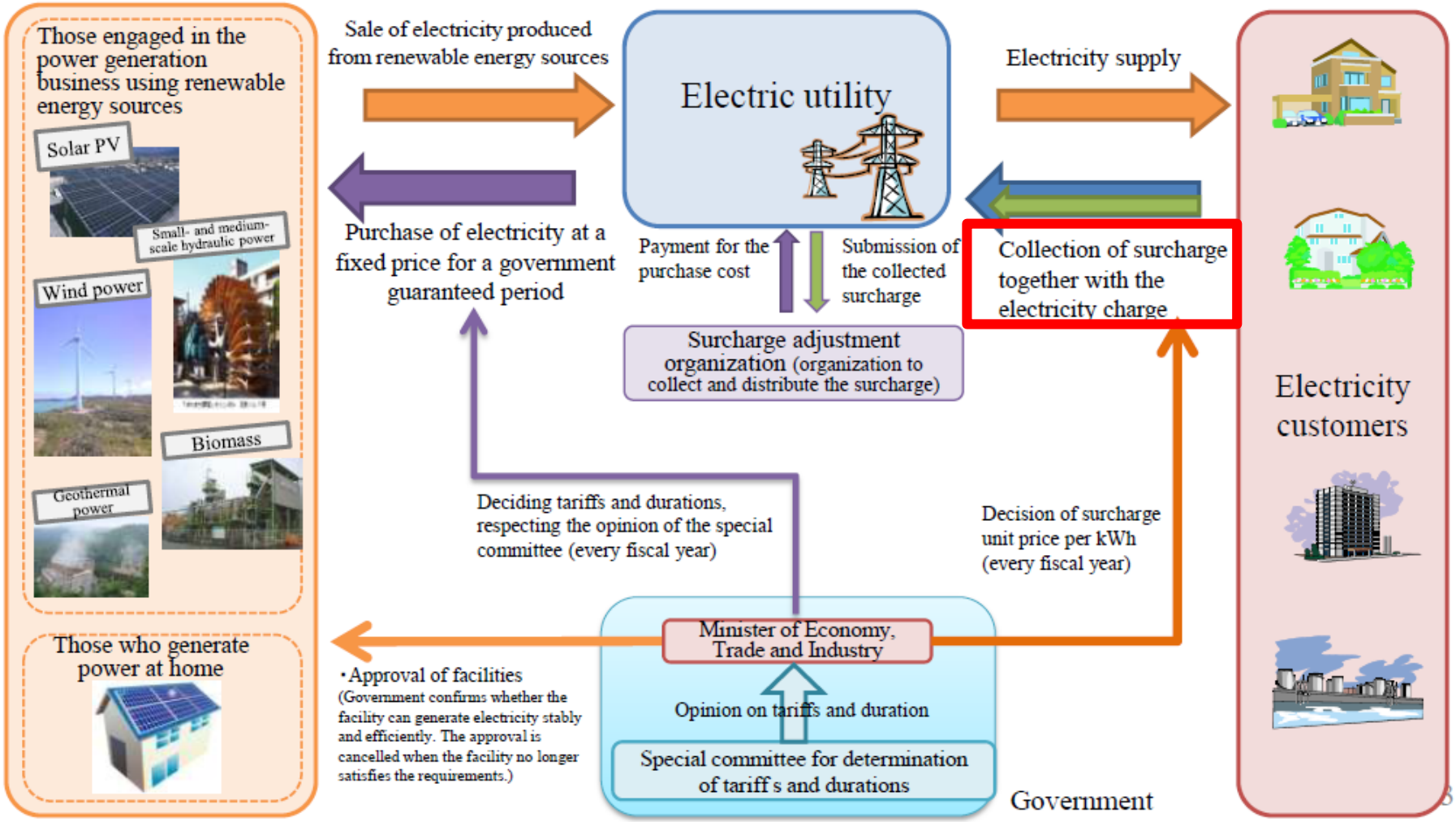
The feed-in tariff (FIT) guarantee purchase of all renewable energy regardless of cost.

The surcharge is collected from electricity customers together with the electricity charges.

Basic Mechanism of the Feed-in Tariff Scheme

M E T I
Agency for Natural Resources and Energy

■ Under the feed-in tariff scheme, if a renewable energy producer requests an electric utility to sign a contract to purchase electricity at a fixed price and for a long-term period guaranteed by the government, the electric utility is obligated to accept this request.



The purchase price differs depending on the type and scale of the renewable energy source.

Tariffs and Durations (PV, Wind, Geothermal and Hydro)

M E I I
Agency for Natural Resources and Energy

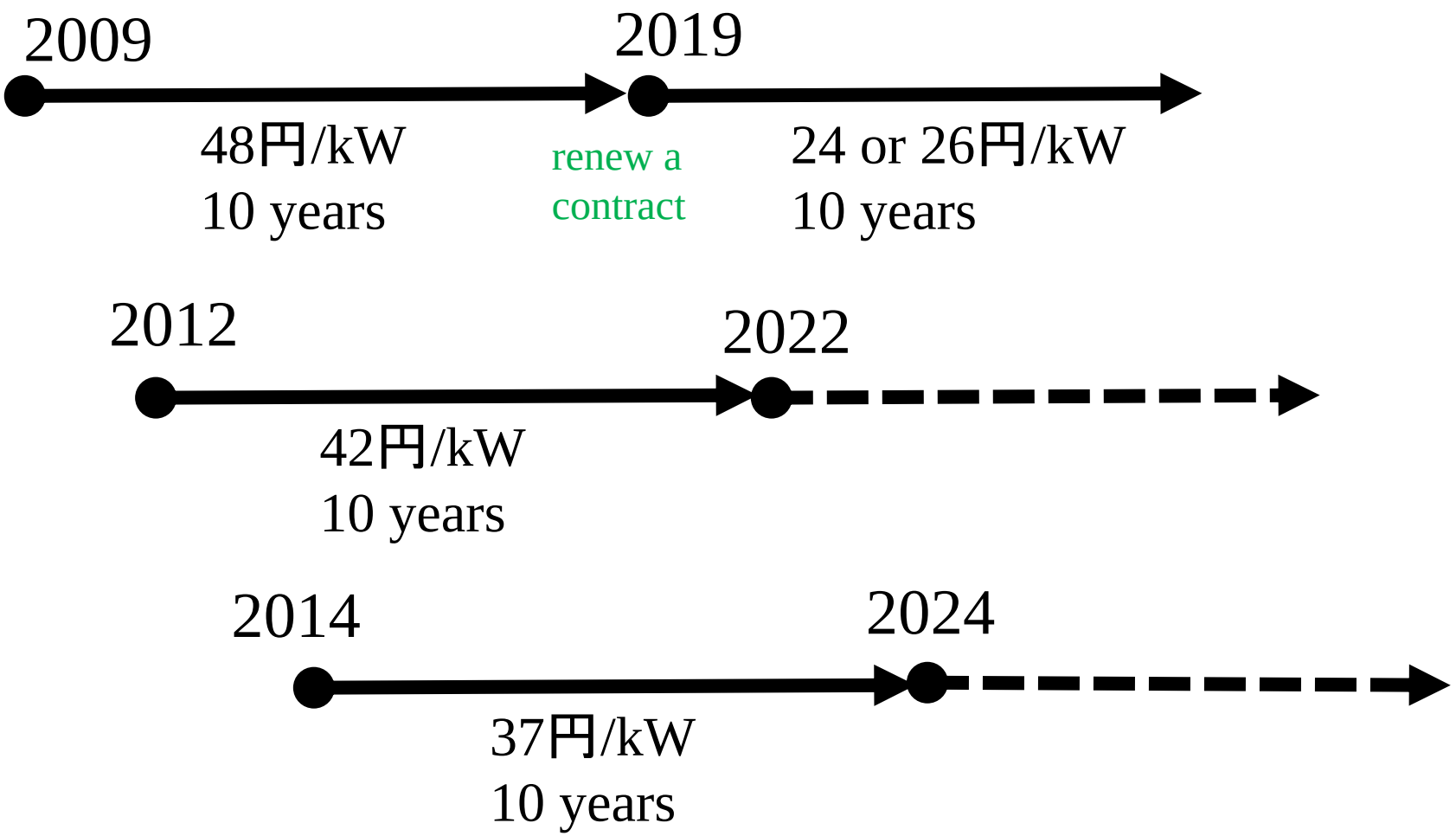
Energy source		Solar PV		Wind power		Geothermal power		Small- and medium-scale hydraulic power		
Procurement category		10 kW or more	Less than 10 kW (purchase of excess electricity)	20 kW or more	Less than 20 kW	15MW or more	Less than 15MW	1MW or more but less than 3MW	200 kW or more but less than 1MW	Less than 200 kW
Cost	Installation cost	325,000 yen/kW	466,000 yen/kW	300,000 yen/kW	1,250,000 yen/kW	790,000 yen/kW	1,230,000 yen/kW	850,000 yen/kW	800,000 yen/kW	1,000,000 yen/kW
	Operating and maintenance costs (per year)	10,000 yen/kW	4,700 yen/kW	6,000 yen/kW	–	33,000 yen/kW	48,000 yen/kW	9,500 yen/kW	69,000 yen/kW	75,000 yen/kW
Pre-tax IRR (Internal Rate of Return)		6%	3.2%(*1)	8%	1.8%	13%(*2)		7%	7%	
Tariff (per kWh)	Tax inclusive (*3)	42.00 yen	42 yen(*1)	23.10 yen	57.75 yen	27.30 yen	42.00 yen	25.20 yen	30.45 yen	35.70 yen
	Tax exclusive	40 yen	42 yen	22 yen	55 yen	26 yen	40 yen	24 yen	29 yen	34 yen
Duration		20 years	10 years	20 years	20 years	15 years	15 years	20 years		

(*1) Solar PV power generation using systems for residences
The price for solar PV power generation of less than 10 kW is seemingly the same as that for solar PV power generation of 10 kW or more. However, considering the subsidy of 35,000 yen per kW (FY2012) granted for power generation using systems for residences, the price will be 48 yen in effect.

(*2) IRR for geothermal power generation
Given that about 4.6 billion yen is required for site development, including surface surveying and exploration well drilling, and that the rate of successfully starting practical operation is low (about 7%), the IRR (Internal Rate of Return) for geothermal power generation is set higher than that of the other energy sources, at 13%.

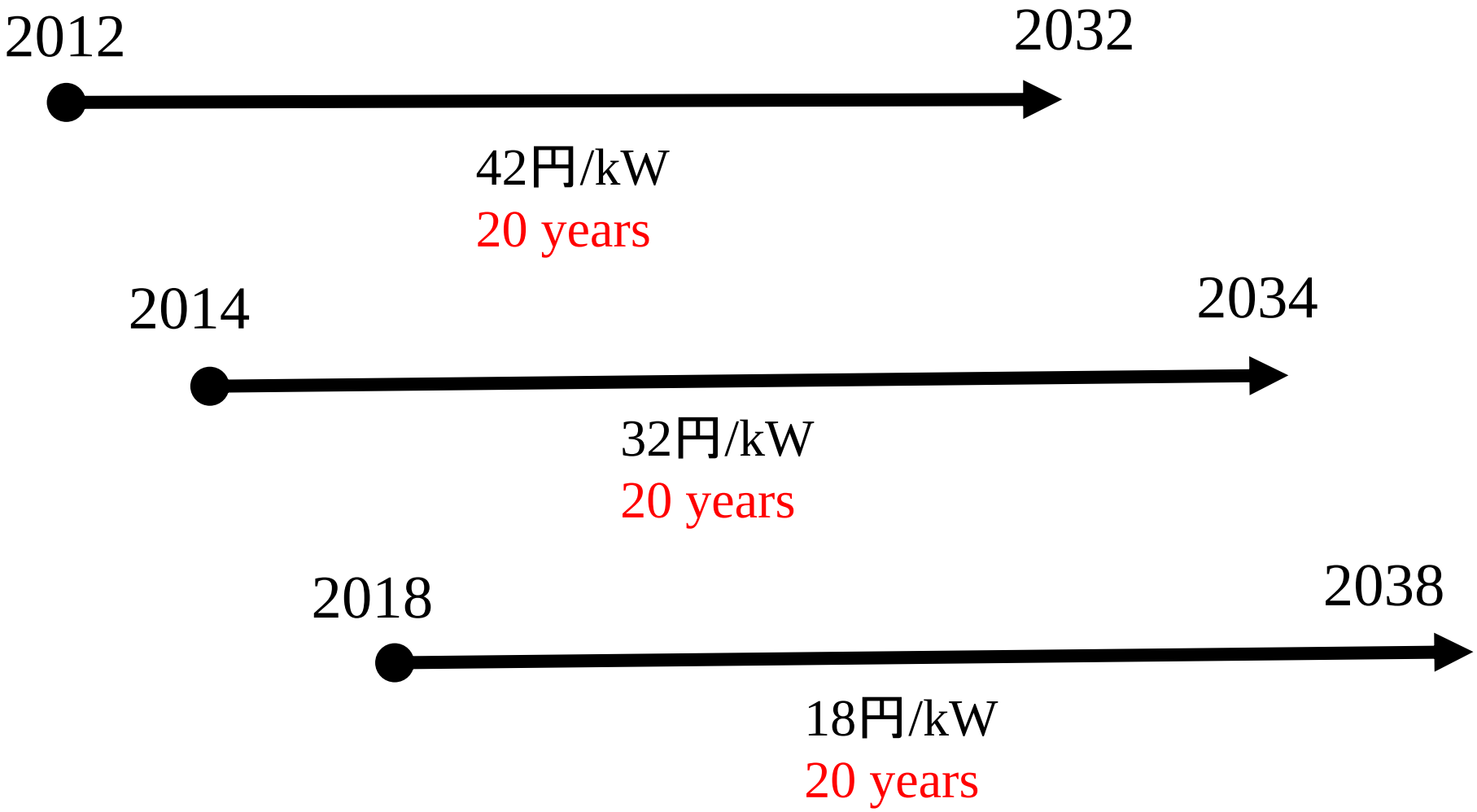
(*3) Treatment of consumption tax
With regard to consumption tax, both the tax-inclusive price and the tax-exclusive price are indicated, assuming that the tax rate may change in the future. However, the tax-inclusive and tax-exclusive prices are the same for the purchase of excess electricity produced from solar PV, which is mostly intended for general consumers.

Case 1: Solar PV less than 10kW (purchase of excess electricity)



Case 2: Solar PV 10kW or more

(mega solar power generation etc.)



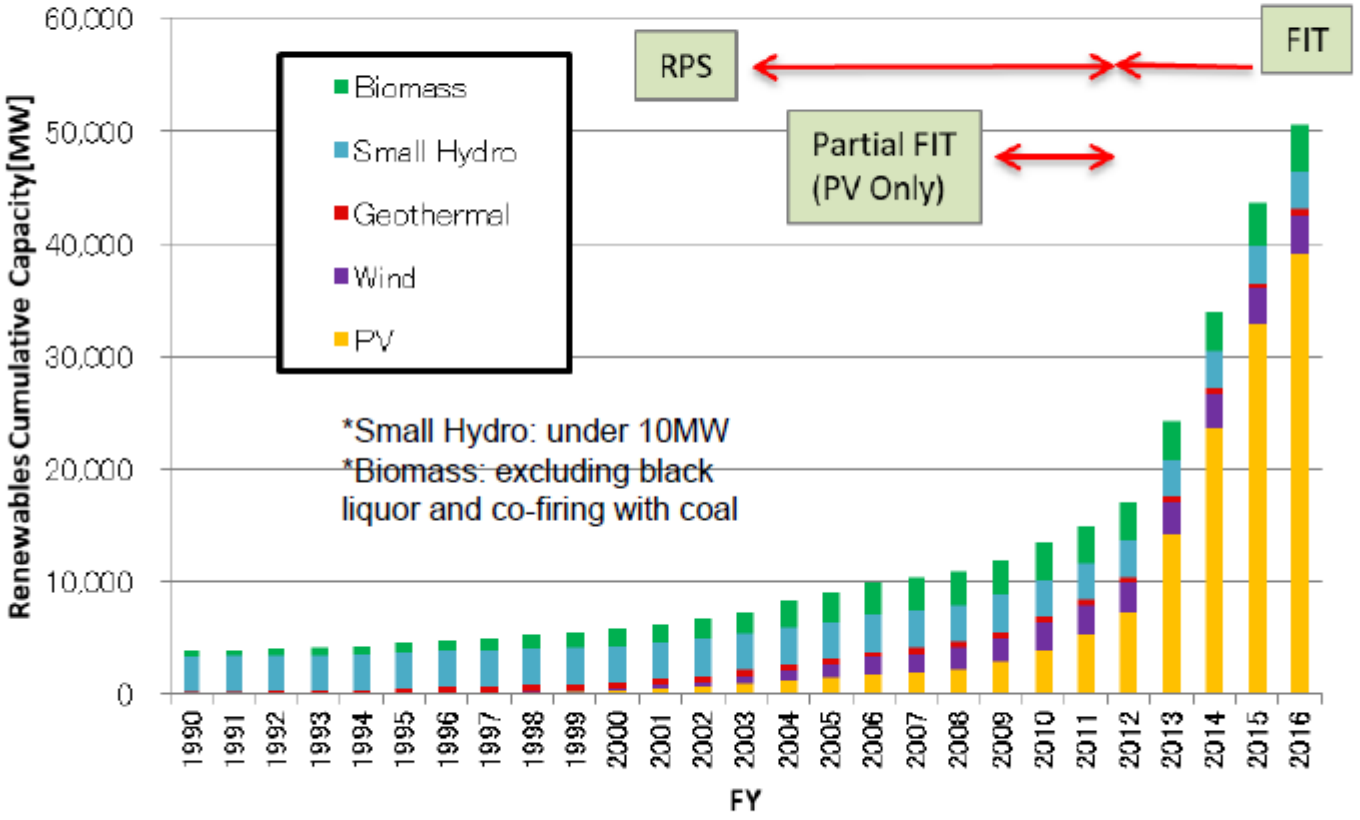
Key word

HEMS
(Home Energy Management System)

HEMS is a technology that promotes energy saving actions by making energy supply and energy consumption visible in an operating panel.

Trends of Renewable Energy Capacity in Japan

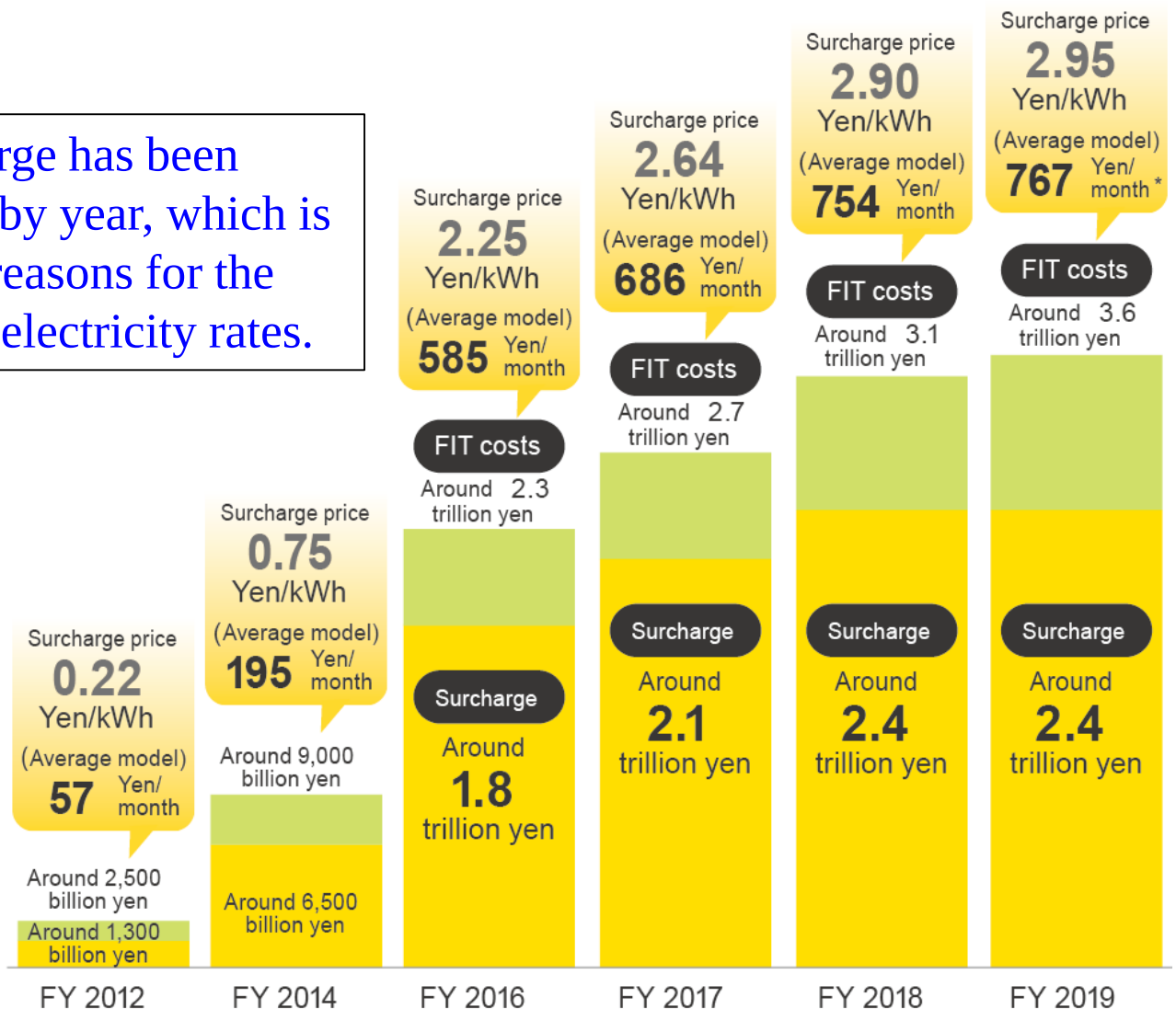
Trends of Renewable Energy Capacity in Japan(excluding large hydro): 50GW(FY2016)



Source: Renewables Japan Status Report (ISEP)

Trends in Surcharge after Introducing the FIT

The surcharge has been rising year by year, which is one of the reasons for the increase in electricity rates.



*Average model: Model with monthly electricity usage of 260kWh as posted on the websites of the Tokyo EPC and the Kansai EPC

https://www.enecho.meti.go.jp/en/category/special/article/energyissue2019_01.html

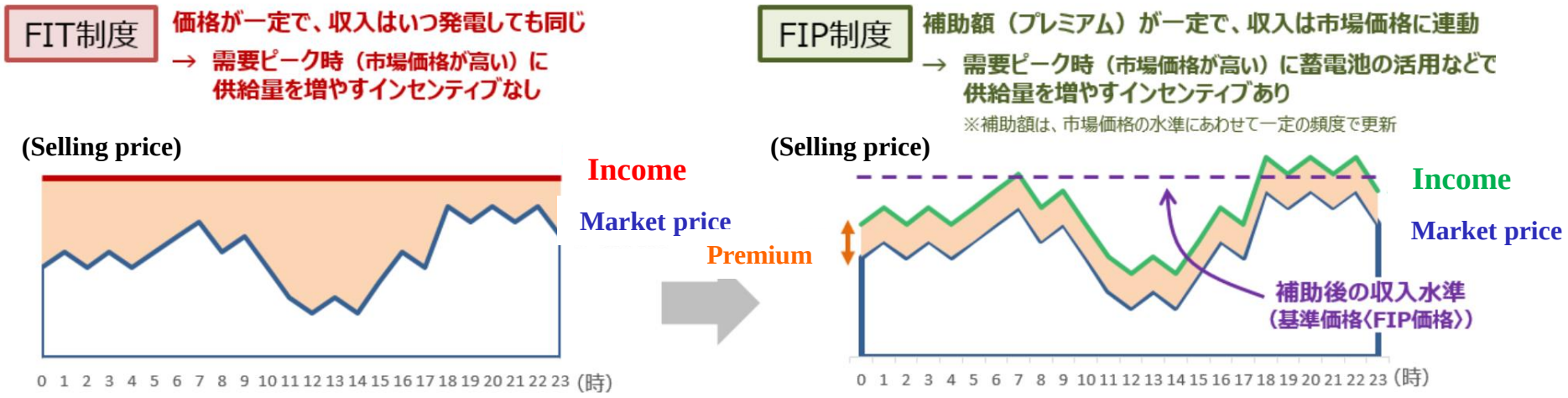
Key word

FIP (Feed-in Premium)

Under a feed-in premium (FIP) scheme, electricity from renewable energy sources (RES) is sold on the electricity market and RES producers receive a premium in addition to the market price of their electricity production.

April 2022 -

FIP (Feed-in Premium)



https://www.enecho.meti.go.jp/about/special/johoteikyo/fip.html

Japan's target was to reduce greenhouse gas emissions by 26% in 2030 in comparison to the 2013 level.

Country	Comparison to 1990	Comparison to 2005	Comparison to 2013
Japan	▲18.0%	▲25.4%	▲26.0% (by 2030)
USA	▲14～16%	▲26～28% (by 2025)	▲18～21%
EU	▲40% (by 2030)	▲35%	▲24%
China	• Reduce greenhouse gas **emissions by 60 - 65% per unit of GDP by 2030 compared with 2005 levels.** • Reach peak greenhouse gas emissions in or around 2030.		
South Korea	• Reduce emissions by 37% by 2030 compared to expected 2030 levels with no measures taken.		

Reduction target

Reduction target

Reduction target

Source: Comparison of pledges from major countries (targets for reduction of greenhouse gas emissions (Ministry of Economy, Trade and Industry created)
https://www.enecho.meti.go.jp/en/category/special/article/energyissue2019_01.html

The Government of Japan determined to reduce greenhouse gas emissions by 46% in FY 2030 from its FY 2013 levels, while continuing strenuous efforts in its challenge to meet the lofty goal of cutting its emission by 50% (announced in April 2021)

The Government of Japan formulates the Strategic Energy Plan to show the direction of Japan's energy policy under the Basic Act on Energy Policy.

The Cabinet approved the Sixth Strategic Energy Plan on October 22, 2021.

Points of outlook for energy supply and demand in FY2030 (1)

- In the light of new GHG emission reduction target in FY2030, this outlook shows **energy supply and demand on the ambitious assumption that various challenges in both aspects of supply and demand** in promoting thorough energy conservation and expansion of non-fossil energy **will be overcome**.

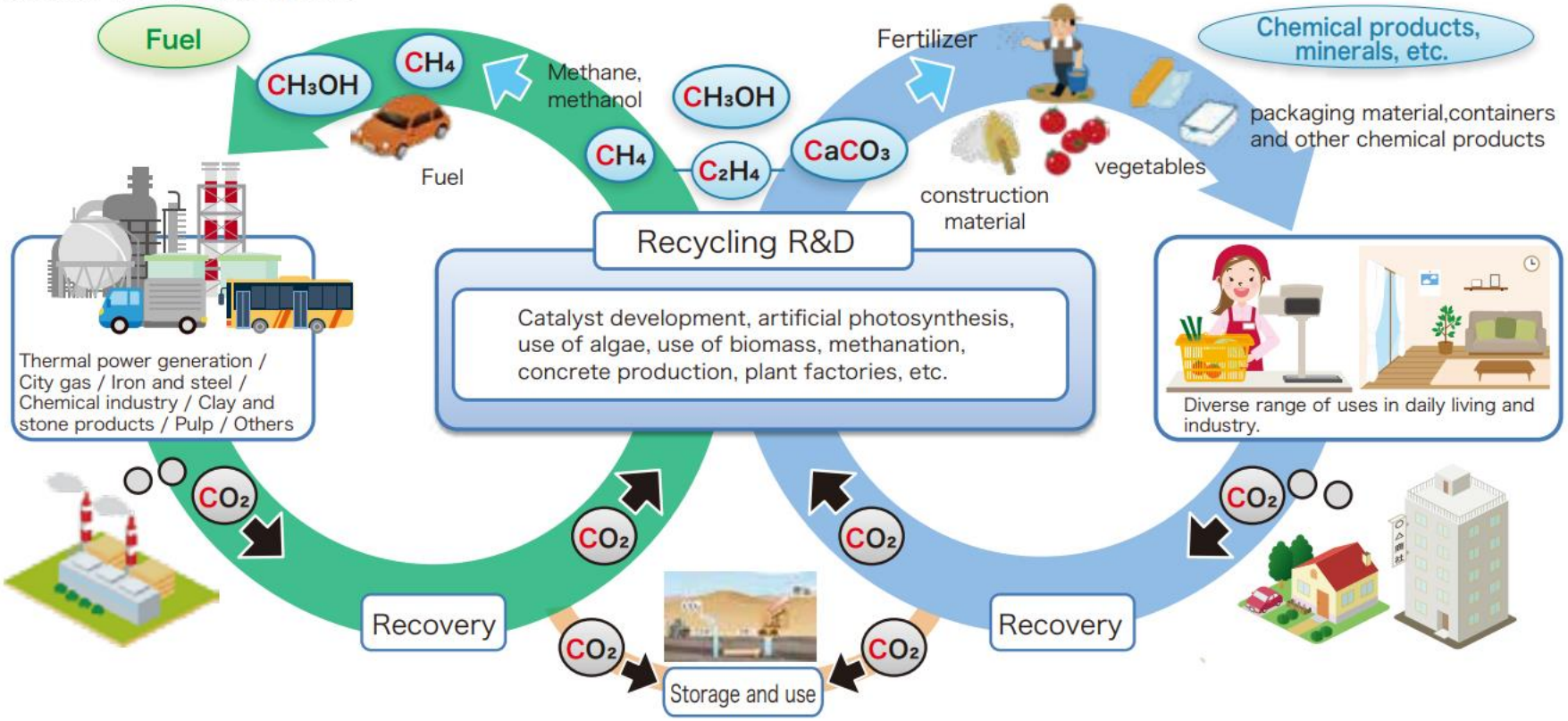
- In implementing the measures towards this ambitious outlook, **degree and timing of implementation of the measures need to be carefully considered for stable supply of energy not to be impaired.** (e.g. If fossil fuel power sources are immediately curtailed at a stage prior to full introduction of non-fossil fuel power sources, stable supply of electricity can be impaired.)

		(2019 ⇒ previous energy mix)		**Energy mix in FY2030 (ambitious outlook)**	
Energy efficiency improvement		(16.55 million kl ⇒ 50.30 million kl)		**62 million kl**	
Final energy consumption (without energy conservation)		(350 million kl ⇒ 377 million kl)		350 million kl	
Power generation mix Electricity generated: 1,065 TWh ⇒ Approx. 934 TWh	**Renewable energy**	(18% ⇒ 22-24%)	solar 6.7% ⇒ 7.0% wind 0.7% ⇒ 1.7% geothermal 0.3% ⇒ 1.0~1.1% hydropower 7.8% ⇒ 8.8~9.2% biomass 2.6% ⇒ 3.7~4.6%	**36-38%** ※If progress is made in utilization and implementation of R&D of renewable energy currently underway, 38% or higher will be aimed at.	
	Hydrogen/Ammonia	(0% ⇒ 0%)		**1%**	
	Nuclear	(6% ⇒ 20-22%)		**20-22%**	(details of renewable) solar 14~16% wind 5% geothermal 1% hydropower 11% biomass 5%
	LNG	(37% ⇒ 27%)		**20%**	
	Coal	(32% ⇒ 26%)		**19%**	
	Oil, etc.	(7% ⇒ 3%)		**2%**	
(+ non-energy related gases/sinks)					
GHG reduction rate		(14% ⇒ 26%)		**46%** Continuing strenuous efforts in its challenge to meet the lofty goal of cutting its emission by 50%	

https://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/6th_outline.pdf

Carbon Recycling (reuse of CO_2)

This is technology used for capturing CO_2, and utilizing it as a raw material resource in concrete or plastic, thereby controlling CO_2 emissions into the atmosphere.



JAPANS'S ENERGY 2019 Agency for Natural Resources and Energy

NEDO and the OSAKI CoolGen Corporation Started demonstration tests for oxygen-blown integrated coal gasification combined cycle technology with CO_2 capture.

大崎クールジェン株式会社ウェブサイト　https://www.osaki-coolgen.jp/project/

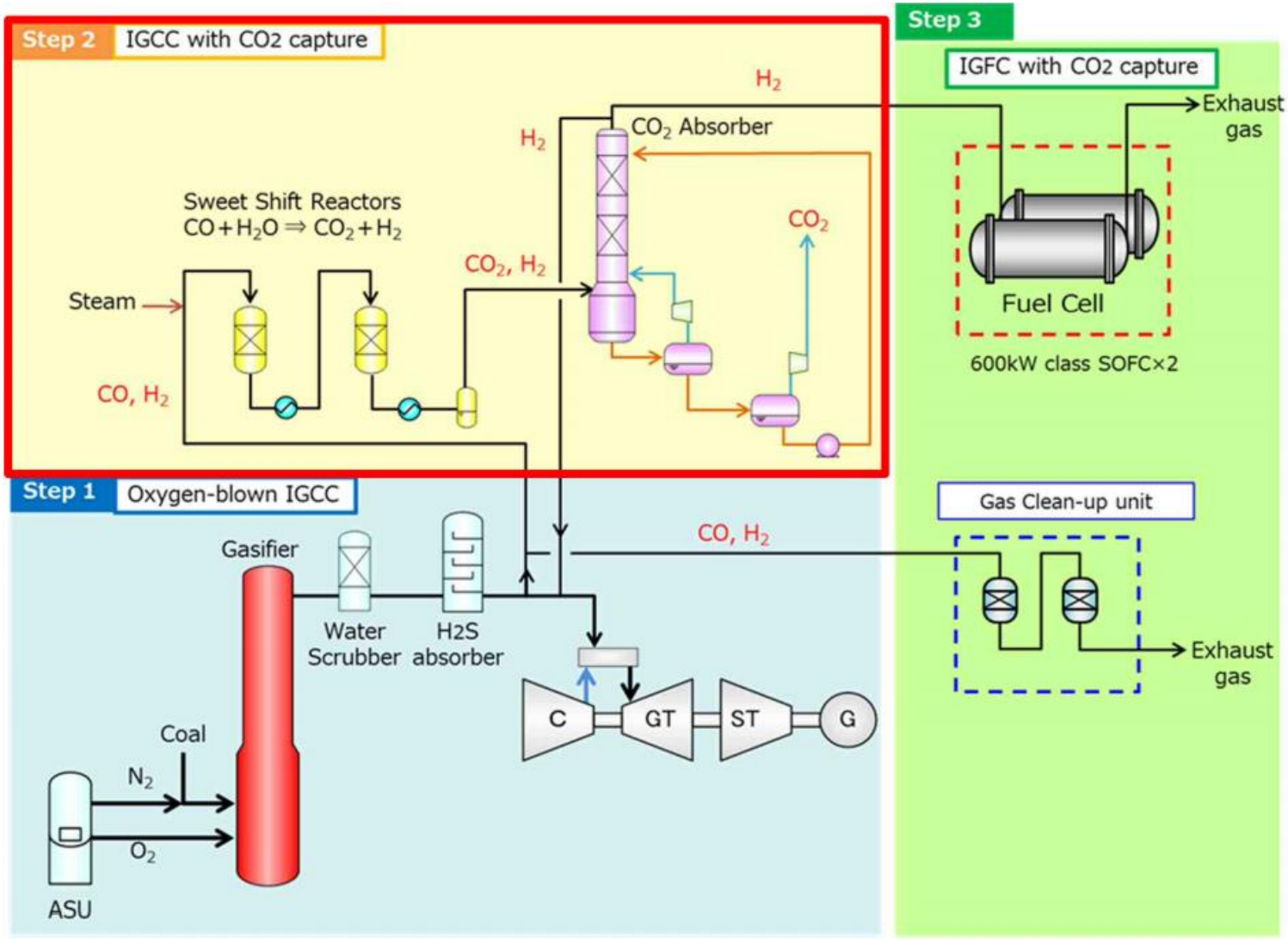


Figure 2: Outline of demonstration test system

https://www.osaki-coolgen.jp/en/news/pdf/20200204.pdf

The project aims to achieve a 90% capture rate of CO2 and a net thermal efficiency of 40% at commercial power plants

Programs for creating a hydrogen-based society

The use of hydrogen is being promoted in a wide variety of fields, including fuel cell vehicles and household fuel cells, through the construction of supply chains aimed at enabling large-scale hydrogen supply and international trade in hydrogen.

Production

Overseas unused energy

Brown coal → Gasification → CCS

Byproduct hydrogen

Overseas renewable energy → Water electrolysis

Renewable energy

Solar power, Wind power → Water electrolysis

＊Use of hydrogen as a means of energy storage (absorbing fluctuations in renewable energy output)

March 2020 demonstration project for large-scale hydrogen production using renewable energy - aiming for use during the Tokyo Olympics
(Namie Town, Fukushima Prefecture)

Transport and supply (supply chain)

Nationwide promotion of hydrogen stations
(160 stations in 2020, 320 in 2025)

Large-scale network for maritime hydrogen transport
Launching ceremony for liquefied hydrogen pilot carrier

Use

Transport sector

Fuel cell vehicles (FCV, FC buses, etc.)

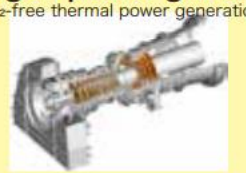
Power generation sector

Fuel cell cogeneration (ENE-FARM, etc.)

Modification → ENE・FARM

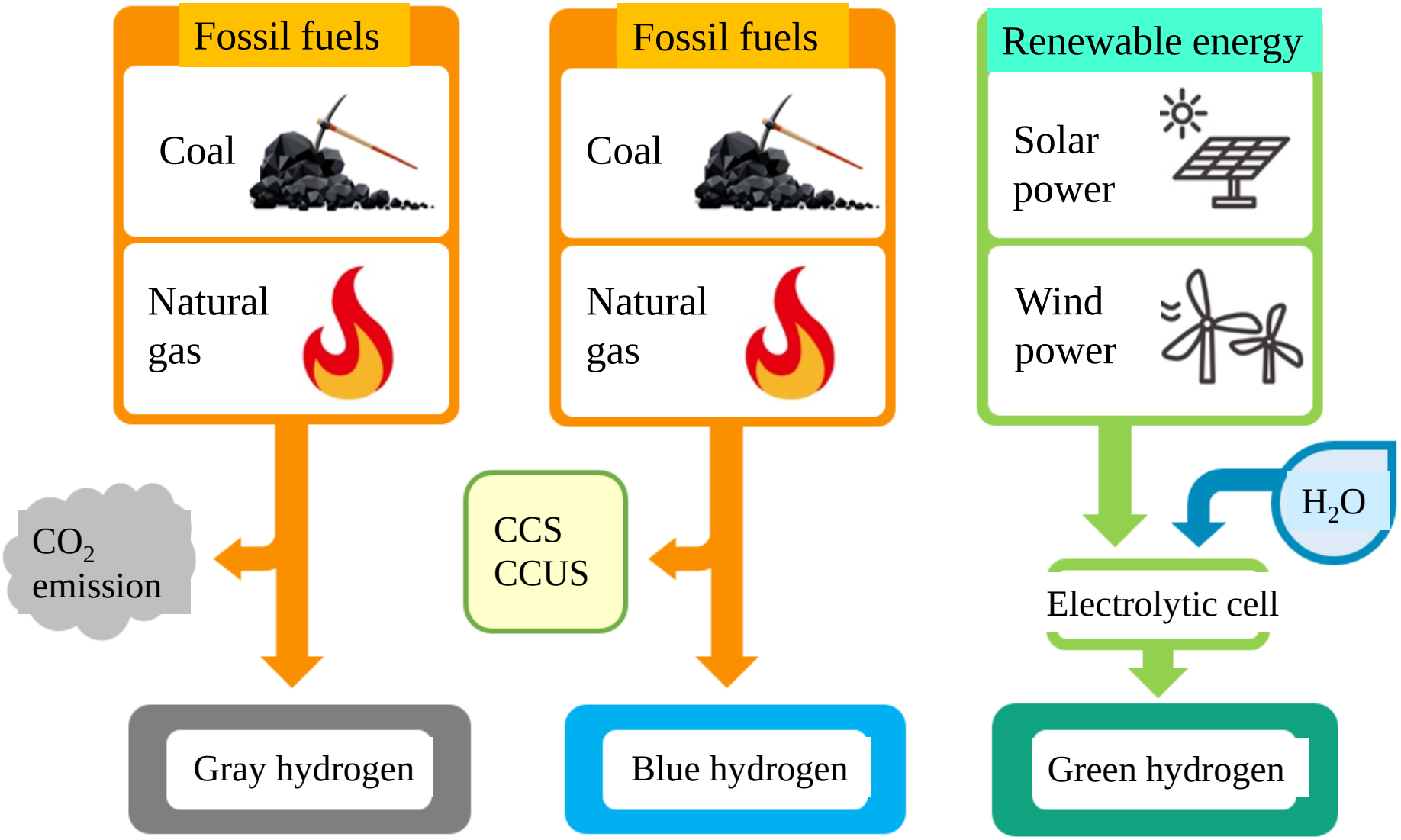
Fuel cell combined power generation system
[HYBRID-FC]

Hydrogen power generation
(CO_2-free thermal power generation)



Others
Use in the industry sector (Power-to-X)

JAPANS'S ENERGY 2019 Agency for Natural Resources and Energy



Agency for Natural Resources and Energy Website
https://www.enecho.meti.go.jp/about/special/johoteikyo/suiso_tukurikata.html

■ Energy Conservation Labeling System (Figure 58)

With a view to providing information on the energy-conserving property of the electric home appliances and promoting the dissemination of products with high energy conservation effect, the energy conservation labeling system has been implemented.

■ Examples of display on the energy conservation label

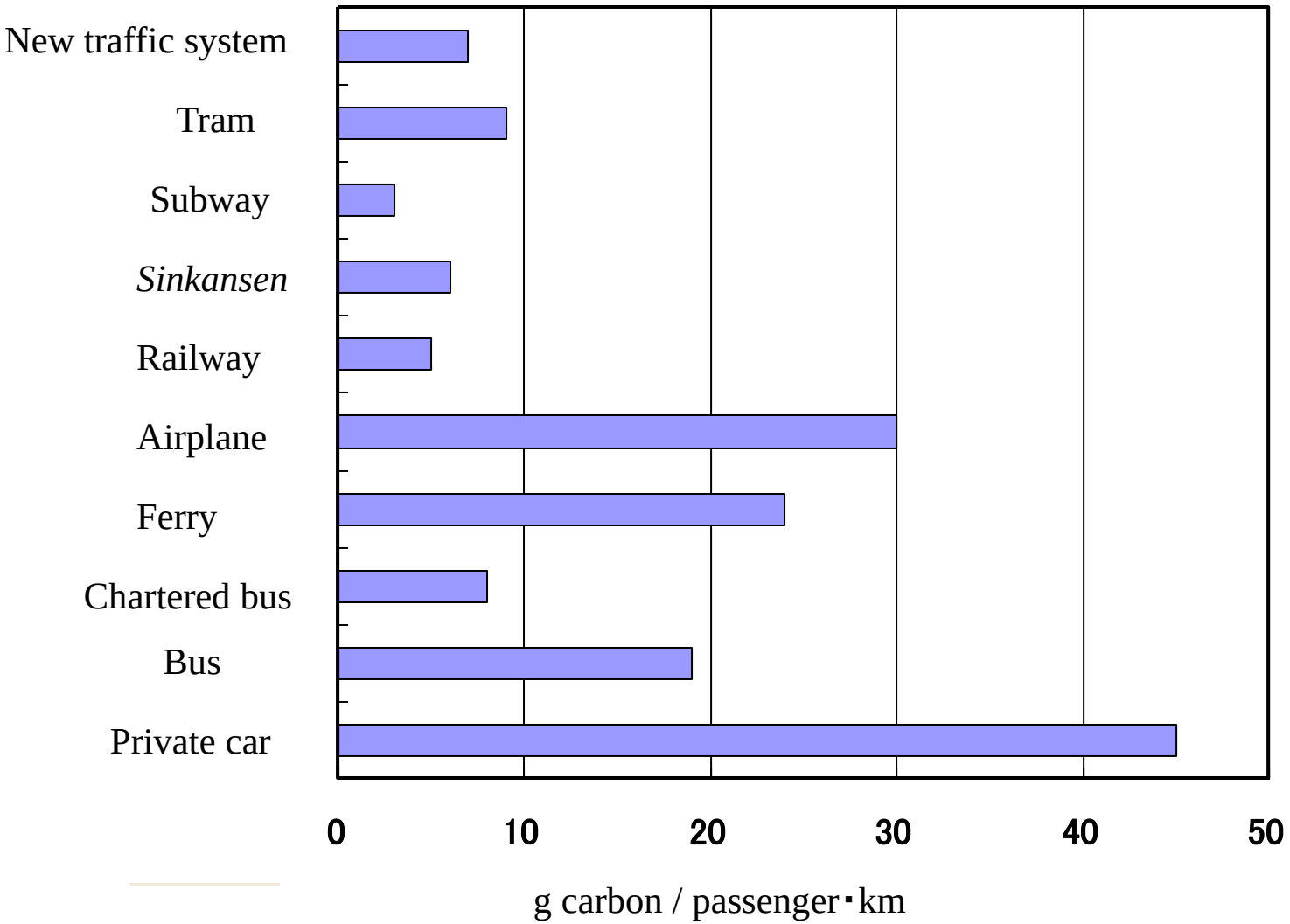
	Achievement rate of energy conservation standards	Annual power consumption amount
Target fiscal year: FY 2006	**108%**	**175**kWh / year

	Energy conservation standard achievement rate	Annual power consumption amount
Target fiscal year: FY 2006	**91%**	**206**kWh / year

Label to be pasted on the product itself

[As of February, 2010 – 16 items, namely air conditioner, refrigerator, fluorescent lighting fittings, television, stove, gas cooking appliance, gas water heater, oil water heater, electric toilet seat, electronic computer, magnetic disk, transformer, jar rice cooker, microwave and DVD recorder]

Energy in Japan 2010, Agency for Natural Resources and Energy



Carbon emission from transportation facilities

（平成12年度版環境白書より）