The Future of Energy Policy after the Great East Japan Earthquake

July 27, 2011 (Wednesday)

The Institute of Energy Economics, Japan

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1. Short-Term Agenda
(1) Response to the NPP Accident ①

1) Stabilization of Fukushima Daiichi NPP and

- Installed capacity of Fukushima Daiichi is 4,696MW, while that of Fukushima Daini is 4,400MW.
- The recovery work continues at the Fukushima Daiichi Nuclear Power Station. Step 1, for attaining stability in cooling operations and the reduction of radiation dose, was completed on July 17. Step 2, for bringing the reactors to cold shutdown and the implementation of measures for preventing the dispersion of radioactive materials, has started and is expected to continue for the next three to six months.
- As of July 2011, there are 54 nuclear reactors in Japan: 16 in operation and 38 either under periodic inspection or shutdown, and another 2 under construction. Total installed capacity is 48,960MW. Nuclear energy accounts for 25% on an installed capacity basis and 30% on a power generation basis.
- The implementation of a "stress test" has become one of the conditions for permitting the restarting of a plant that has been shut down for a scheduled outage. Unless the reactors resume operation after planned outages, there will be serious energy shortages throughout Japan. Thus, steady restoration of NPPs is essential. Otherwise,...

1. Short-Range Challenges
(1) Actions against accidents at nuclear power plants ②

- Step 1 (completed by July 17)

The following tasks, defined at the beginning during the preparation of the roadmap, have been completed:

  - Attaining stability in the cooling of reactors and spent fuel pools
  - Lowering radiation dose at the boundary of the premises (to the level of 1.7Sv/year at the maximum)
  - Prevention of hydrogen explosion (by injecting nitrogen into the containment vessel

- Step 2 (requires three to six months for completion)

Targets and major tasks:

  - Bringing the reactors to the state of cold shutdown: startup of the systems for water circulation/injection and purification
  - Reducing the amount of water held in buildings: starting up decontamination facilities and safe storage of contaminated water, etc.
  - Preventing the dispersion of radioactive materials: installing covers on buildings, removing debris, etc.
  - Decontamination of a wide area around the site including the area covered by evaluation programs

- Mid-term challenges (require up to about three months for completion)
  - Starting the removal of spent fuel
  - Starting up full-fledged water treatment facilities
  - Treatment of contaminated soil (solidification, etc.)

It is important that local communities and utilities make active interchanges, by collecting knowledge and information and calling for the support of relevant organizations in Japan and abroad, to make all-out efforts to restore the environment at and around the Fukushima site.

1. Short-Term Agenda
(1) Response to the NPP Accident ③

2) Response to compensation issues

- Amount of compensation is estimated to reach ¥3 – 5 trillion.

(According to some press reports, the cost is expected to be 10 trillion yen.)

- Prompt actions are necessary after the compensation scheme is finalized.

3) Response to harmful rumors

- Import restrictions on Japanese products (agricultural, fishery and industrial products), and drastic decline of foreign tourists to Japan.
  (The statistics for the April-to-June period of 2011 reported a 50% drop from the same period of the previous year.)

- At least the following 4 responses are necessary:
  a. Provision of detailed information
  b. Issuance of product safety certificates by the Japanese Government, etc. ,whenever necessary
  c. Explanation of the current situation by the Japanese Government
  d. Giving publicity the safety of Japan by visiting foreigners

1. Short-Term Agenda
(2) Response to the Electricity Shortage ①

◆ **Outlook for electricity supply this summer**

TEPCO will maximize the interchange of electricity with Tohoku Electric. As a result, TEPCO's supply capacity is projected to be 53,800MW (end of July) while that of Tohoku Electric is expected to be 13,700MW (end of August)

Since the Kansai Electric Power Co. Inc. also began to face difficulty in having a clear vision about the restarting of its nuclear power plants after outages, the reserve capacity dropped by - 6.2% to - 3.9%. This prompted the company to call for the saving of power by 10%.

	Tohoku Electric		TEPCO		Kansai Electric	
	End of July	End of August	End of July	End of August	Operation of the Misumi Thermal Power Station	Stopping of the Misumi Thermal Power Station
Forecasts for electricity supply	12,800MW	12,300MW	56,800MW	55,500MW	30,150MW	29,430MW
Amount of electricity interchange	+1,400MW	+1,400MW	▲1,400MW	▲1,400MW	—	—
Electricity supply after interchange	14,200MW	13,700MW	55,400MW	54,100MW	—	—
Demand projection	14,800MW	14,800MW	60,000MW	60,000MW	31,380MW	31,380MW
Reserve capacity ratio	▲4.1%	▲7.4%	▲5.3%	▲7.5%	▲3.9%	▲6.2%
Power saving target	▲15%	▲15%	▲15%	▲15%	▲10%	▲10%

1. Short-Term Agenda
(2) Response to the Electricity Shortage ②

◆ Target reduction in demand: 15% in all areas covered by TEPCO and Tohoku Electric

(1) Large lot customers (business operators whose contract demand is 5,000MW or more)
—Eleclicity Usage Restriction
— 637 companies are participating in the voluntary action plan led by the Japan Federation of Economic Organization (end of April)

(2) Small-scale customers (business operators whose contract demand is less than 5,000MW)
— Establishment of voluntary restraint programs
— Announcement of "Standard Format for Energy Conservation Action Plan"

(3) Household customers
— Announcement and promotion of "Measures for Energy Conservation in Households"

Note: Establishment of energy conservation programs by the national government, incorporated administrative agencies and public interest corporations

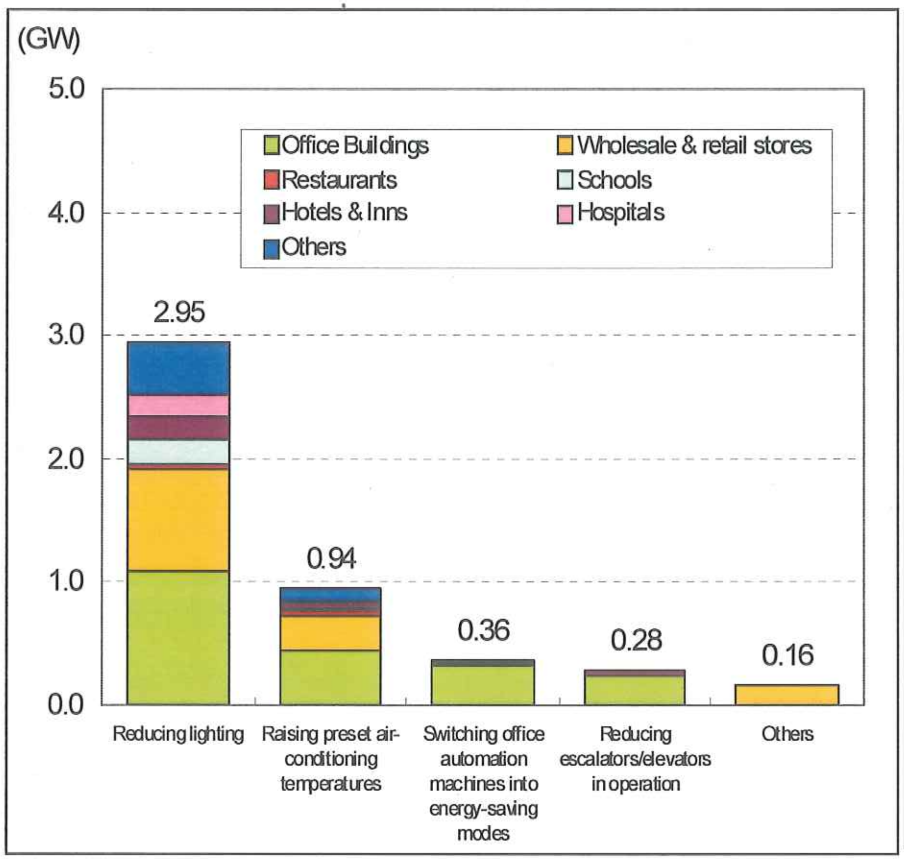
◆ Power saving target for the Kansai area

Based on the efforts continued at prefectural and municipal levels, attempts are made to save power by 10% or more.

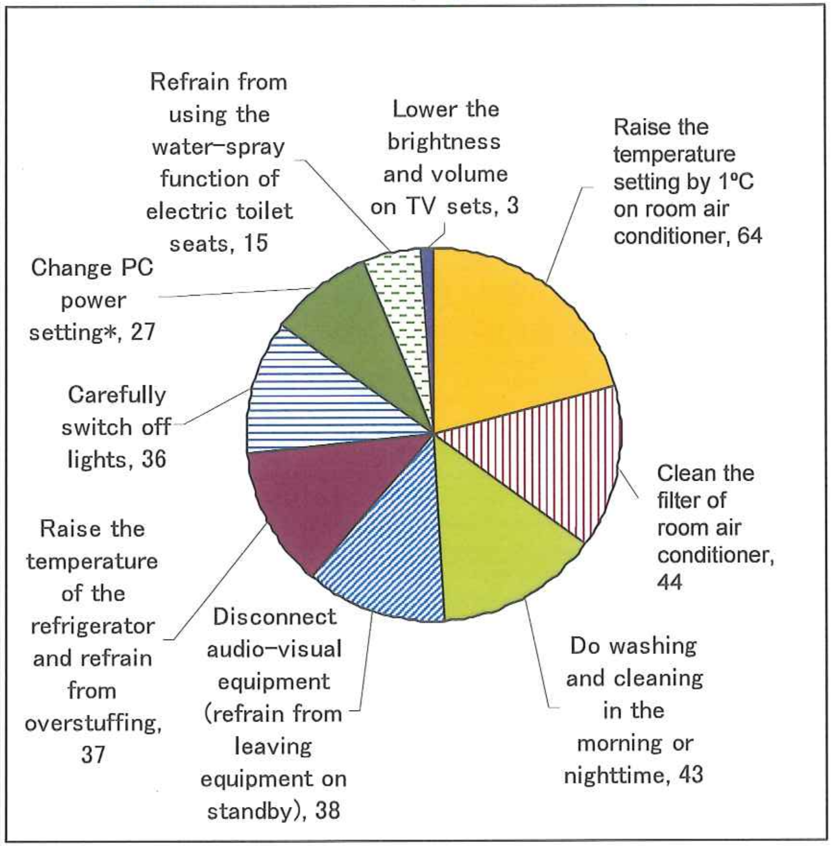
1. Short-Term Agenda
(2) Response to the Electricity Shortage ③

◆ Energy conservation by industry and households

Power saving by energy conservation measures taken by office and commercial buildings in TEPCO's area (estimated maximum: 4,000MW)



Power saving by energy conservation measures taken by household customers in TEPCO's area (estimated maximum: 2,500-3,100MW)



Both figures are based on estimations by the IEE.

1. Short-Range Challenges
(2) Coping with power shortages ④

◆ Assuming that the presently shut-down reactors, as well as the reactors which will soon enter scheduled outages, will not resume operation . . .

(1) The supply and demand for electricity will be very tight in the summer of 2012, possibly affecting employment.

•The gross generation capacity of electric utilities in Japan will be at least 7.8% lower than the peak electricity demand. If the utilities are to maintain at least a 5% reserve capacity ratio, it will be necessary to reduce electricity consumption by as much as 12.4%.

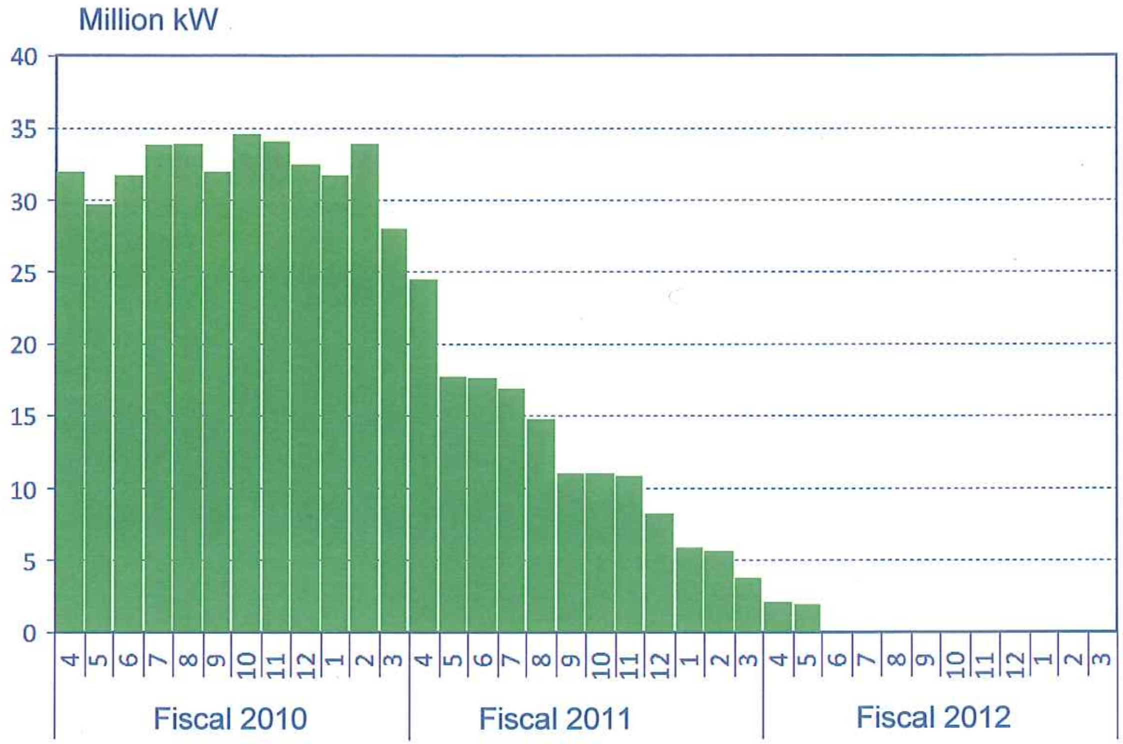
(2) Major increase of fuel cost

* If the reduction in output is to be compensated by thermal power plants, the fuel costs including coal, LNG and petroleum, will increase from the 2010 level by 3.5 trillion yen. If this is directly charged to power consumers, the electricity price will increase by 3.7 yen/kWh. For an average household, the electricity bill will rise by 1,049 yen (18.2%) per month, and the rate for industrial consumers by 36%.

(3) Major increase of energy-derived CO_2 emissions

* The increased use of fossil fuel will cause the CO_2 emissions in 2012 to rise to 1.26 billion tons, up 18.7% from the 1990 level.

Reference: Outlook for the Operation of Nuclear Power Plants in Japan (worst-case scenario)



◎ In the worst-case scenario, supposing long delays in starting up nuclear power plants after scheduled outages, the gradual loss of generation capacity will make it difficult for the utilities to cope with peak electricity demand in the summer and winter of 2011, seriously affecting industrial activity, etc.

Reference: In-house Power Generation

Some people consider that the efficient use of in-house power generation systems may prevent shortfalls in the supply and demand for electricity this summer. However, such systems are generally designed to use most of the output in-house and sell the rest to utilities. In the Kanto area, more than 40% of the output from these systems has already been sold to utilities, so there is little extra capacity that can be tapped.

Note: The total additional capacity in Japan is reported to be about 1.6 million kilowatts.

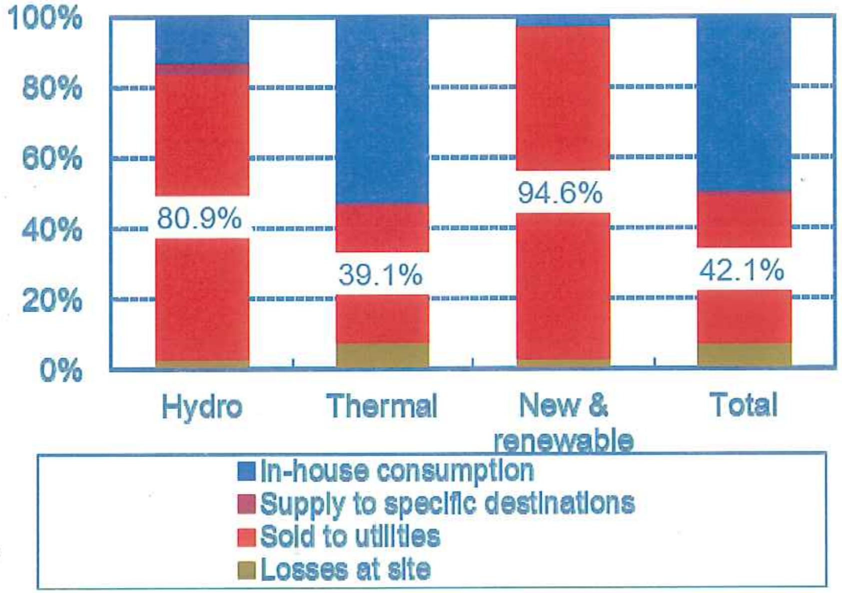
In-house power generation in Kanto

	Installed capacity	Generated power	Utilization factor
	x 10000 kW	x 0.1 billion kWh	%
Hydro	104.2	22.6	49.6%
Thermal	1,516.7	316.7	47.8%
New & renewable	18.9	1.5	18.0%
Total	1,640	341	47.6%

Note: The figures are based on statistics for the first half of fiscal 2010 (April to September).
Source: "Electric Power Statistics" of the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry

★ The total in-house power generation capacity in Japan is 54.07 GW.

Utilization factors of generation options



1. Short-Term Agenda

(3) Measures for demand/supply balance of oil and gas ①

◆ **Impact on worldwide demand/supply of oil and gas**

- Reducing factors
  - ◇ Reduction of demand due to slowing down of economic growth, general decline in industrial activity

- Growth factors (expected to have a larger impact)
  - ◇ Additional operations of oil- and gas-fired thermal power plants by TEPCO and Tohoku Electric
  - ◇ Additional demand by other electric power companies
    - ○ Possibility of delay in restarting units after periodic inspection
    - ○ Increase of in-house power generation
  - ◇ The increment for fiscal 2011 is given as a ratio of increase from fiscal 2010.
    50-210 thousand B/D of oil and 11-15 million tons of LNG.

- Supply of both oil and LNG seems to be assured as a whole.
  - ◇ Extra supply is available on international markets.
  - ◇ Can use various procurement channels.
  - ◇ However, there are some restraints on supply/demand (especially LNG).
  - ◇ Regarding LNG, another concern is a lack in transportation capacity.

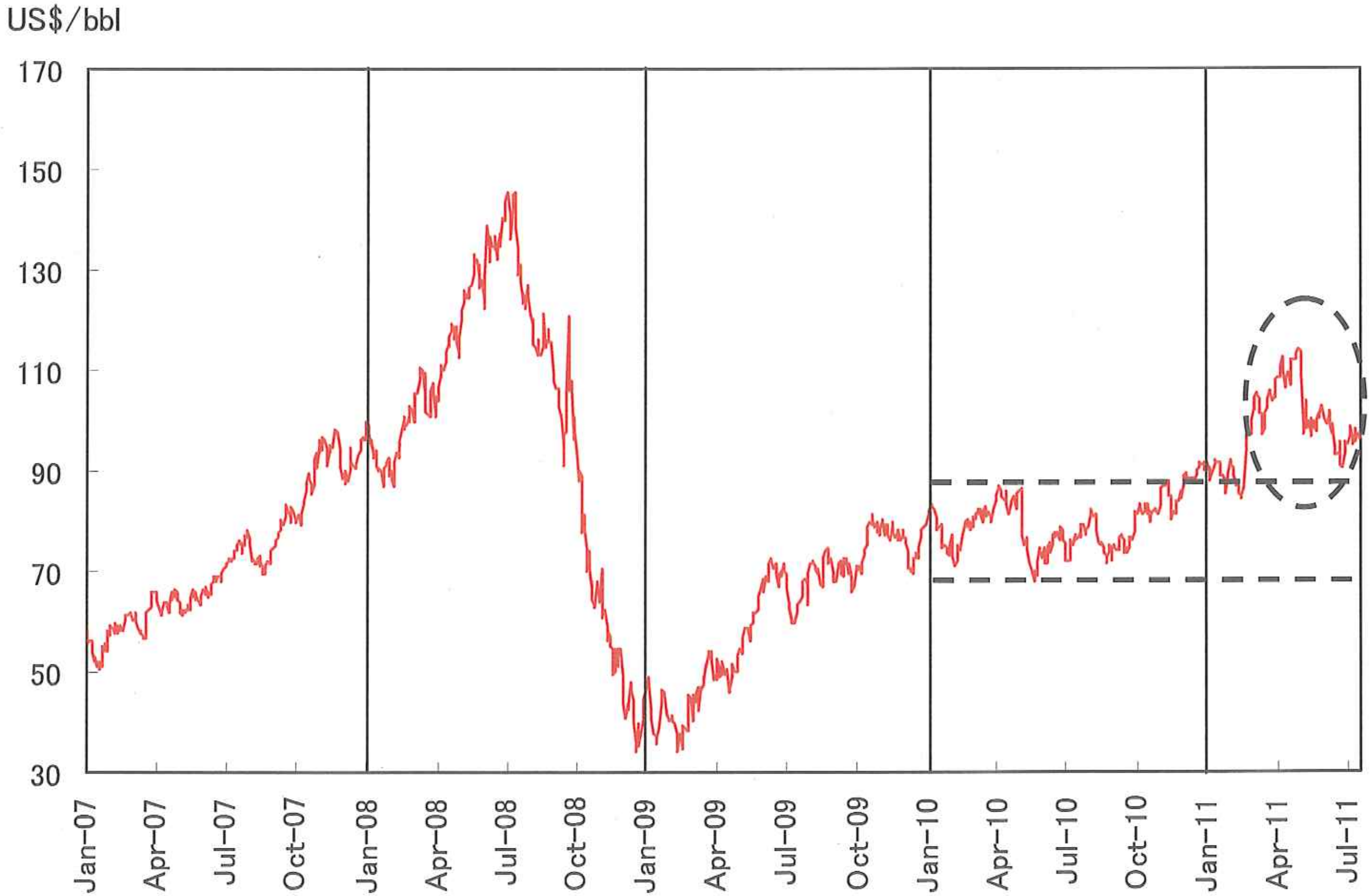
1. Short-Range Challenges
(3) Actions on supply and demand for petroleum and gas ②

○ Volatility in North Africa and the Middle East

- Egypt - Crude oil production: 0.74 million B/D (Jan. 2011). Export of gas (by pipeline and as LNG): 18.3 billion m^3 (2009). Geopolitically important location near the Suez Canal.
- Libya - Crude oil production: 1.58 million B/D (Jan. 2011). Export of gas (mainly by pipeline): 9.9 billion m^3 (2009). Exported mostly to Europe.
- Algeria - Crude oil production: 1.27 million B/D (Jan. 2011). Also produces NGL. Export of gas (by pipeline and as LNG): 52.7 billion m^3 . Exported mostly to Europe.
- Oman - Crude oil production: 0.89 million B/D (Jan. 2011). Export of LNG: 11.5 billion m^3. Exported mostly to Asia.
- Yemen - Crude oil production: 0.26 million B/D (Jan. 2011). Export of LNG: 0.4 billion m^3.
- Iran - Crude oil production: 3.66 million B/D (Jan. 2011). The second-largest producer of oil among OPEC countries. Exported mostly to Asia.
- Saudi Arabia - Crude oil production: 8.60 million B/D (Jan. 2011). The largest oil producer in terms of production quantity, export quantity and surplus production capacity.

1. Short-Range Challenges
(3) Actions on supply and demand for petroleum and gas ②

- Crude oil futures prices at WTI have risen sharply, but prices are falling as strategic reserves are released to the market.



Graph based on materials from NYMEX, etc.

2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ①

(1) Current Basic Energy Plan (2009-2030)

- Double the self-sufficiency of energy supply and independent development rate of fossil fuel.
  Increase the self-sufficiency rate of energy supply* from 38% to 70%.
  *Take into consideration the independent development of resources in addition to the conventional self-sufficiency of energy supply (domestically produced energy + nuclear energy).
- Raise the rate of zero-emission power sources from 34% to 70%.
- Decrease CO2 emissions from "daily life" (residential sector) by half.
- Maintain and enhance the world's highest energy efficiency in the industrial sector.
- A group of Japanese companies to achieve top share in the international energy products market.

↓

① Assure energy security to protect the Japanese people.
② Achieve low-carbon type economic growth, which can be a model for the world.
③ Reform "daily life" that Japanese people can be aware of.
④ Contribute to global CO2 emissions reductions and attract foreign investment to Japan.

↓

- Decrease CO2 emissions from energy production by at least 30% by 2030 compared with 1990, by thoroughly promoting the policies of this plan.
- This is a very ambitious goal, corresponding to approximately half of the CO2 emissions reduction target of 80% by 2050 from the 1990 level.

Reference: In Northeast Asia, Korea and Japan are energy midgets, China is a giant

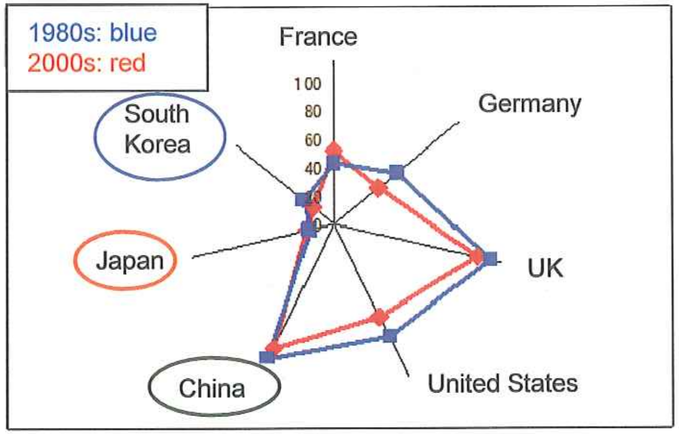
(1) Primary energy self-sufficiency ratio = Gross domestic production of primary energy / Gross primary energy supply x 100 (Note that nuclear power is counted as primary energy.)

Country	1970s			1980s			1990s			2000s		
	Self-sufficiency	OECD ratio	Score	Self-sufficiency	OECD ratio	Score	Self-sufficiency	OECD ratio	Score	Self-sufficiency	OECD ratio	Score
France	25.7	38	2.5	42.5	55	3.8	52.2	69	4.6	51.3	72	4.9
Germany	52.4	78	5.1	56.2	73	5.0	44.5	59	3.9	40.0	56	3.9
UK	62.7	93	6.1	112.5	146	10.0	112.9	149	10.0	103.7	145	10.0
United State	83.3	124	8.2	87.2	113	7.7	80.6	107	7.1	72.3	101	7.0
China	101.9	152	10.0	104.9	136	9.3	101.2	134	9.0	95.9	134	9.2
Japan	10.5	16	1.0	16.6	22	1.5	19.5	26	1.7	18.9	26	1.8
South Korea	29.0	43	2.8	27.1	35	2.4	16.7	22	1.5	18.6	26	1.8

Self-sufficiency ratios of major primary energy options (for comparison)

Country	Crude oil				Coal			
	1970s	1980s	1990s	2000s	1970s	1980s	1990s	2000s
France	1.7	3.6	3.5	1.7	57.0	45.2	34.4	7.4
Germany	4.9	5.6	3.6	3.8	104.3	99.9	86.6	67.6
UK	20.4	135.9	122.7	115.1	100.0	95.8	73.8	39.2
United States	67.3	66.4	49.1	37.8	111.6	113.4	110.6	102.2
China	109.6	121.5	100.5	64.4	100.7	101.9	102.8	105.3
Japan	0.3	0.3	0.4	0.3	28.2	13.7	4.2	0.4
South Korea	0.0	0.0	0.1	0.5	82.2	46.5	13.0	3.1
OECD mean	37.6	53.4	49.1	45.5	99.8	99.1	96.5	88.9
Country	Natural gas				Uranium (for comparison)			
	1970s	1980s	1990s	2000s	1970s	1980s	1990s	2000s
France	40.8	19.4	8.2	3.1	-	53.9	16.6	0.8
Germany	45.2	31.3	22.9	19.3	-	151.1	15.0	2.7
UK	93.6	78.3	97.7	100.0	-	0.0	0.0	0.0
United States	96.5	95.0	88.4	84.5	-	73.9	12.7	5.7
China	100.0	100.0	105.1	104.5	-	-	263.2	71.4
Japan	25.0	6.1	3.9	3.9	-	0.1	0.0	0.0
South Korea	0.0	0.0	0.0	0.6	-	0.0	0.0	0.0
OECD mean	97.2	88.5	83.2	77.2	-	76.1	37.7	37.5

Self-sufficiency ratio in the 1980s and 2000s



The self-sufficiency ratios for fossil fuel depend largely on the availability of fossil fuel resources in the given country. Even with limited availability, the primary energy self-sufficiency ratio could be high thanks to the large contribution of nuclear power to the gross primary energy supply.

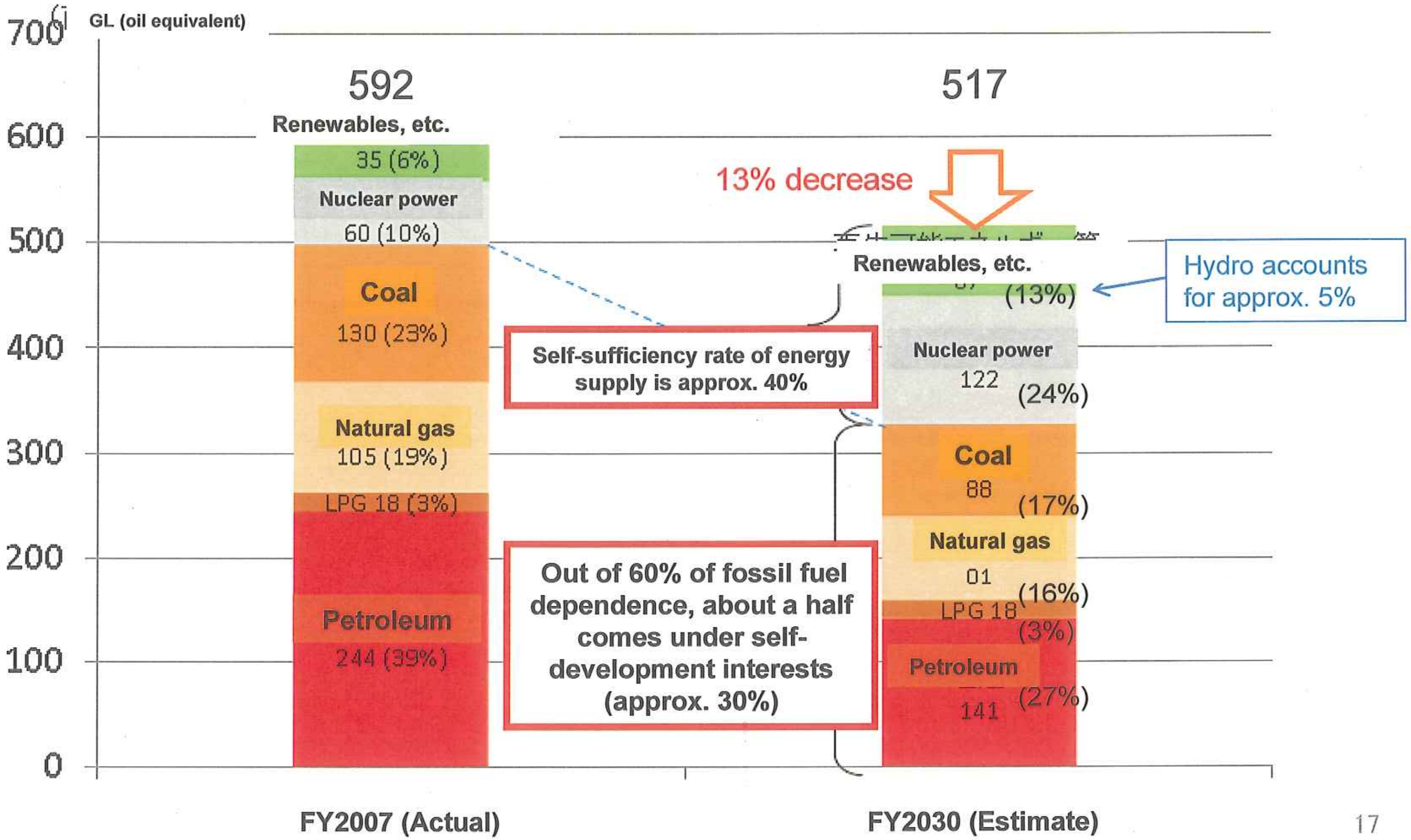
France, Japan and South Korea have few fossil fuel resources, yet France has a higher self-sufficiency ratio because of its greater contribution of nuclear power.

The UK has improved its self-sufficiency ratio by developing the North Sea oil fields.

Reference: Basic Energy Plan: Energy Composition

○ **Raise self-sufficiency of energy supply (self-sufficiency + independent development) from 38% to 70%.**

○ **Reduce CO2 emissions by 30% from 1990 level.**

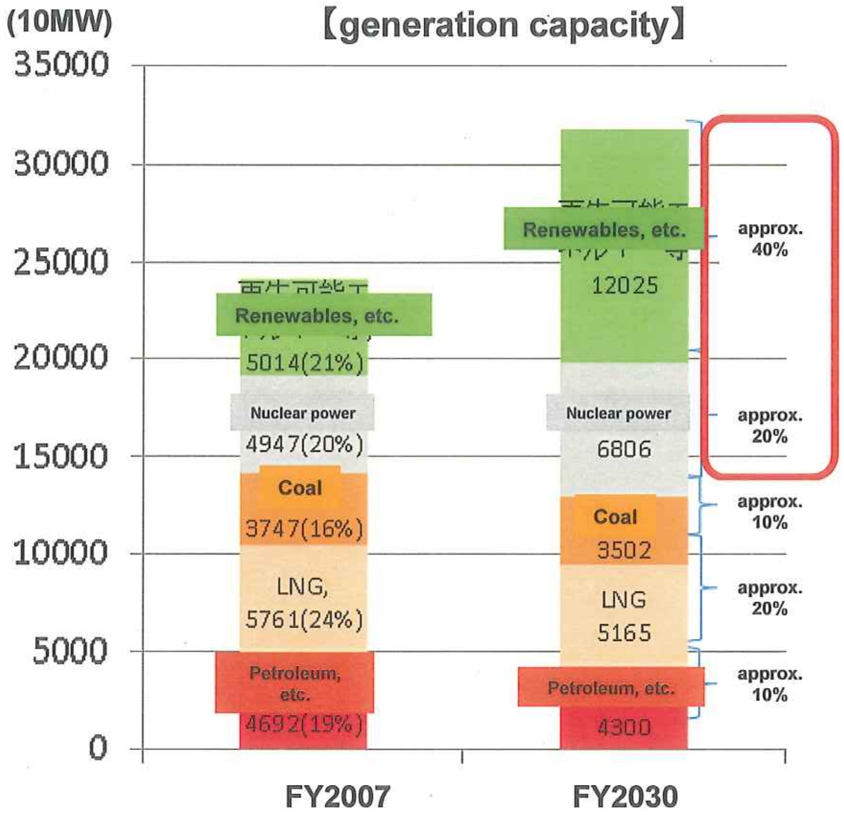


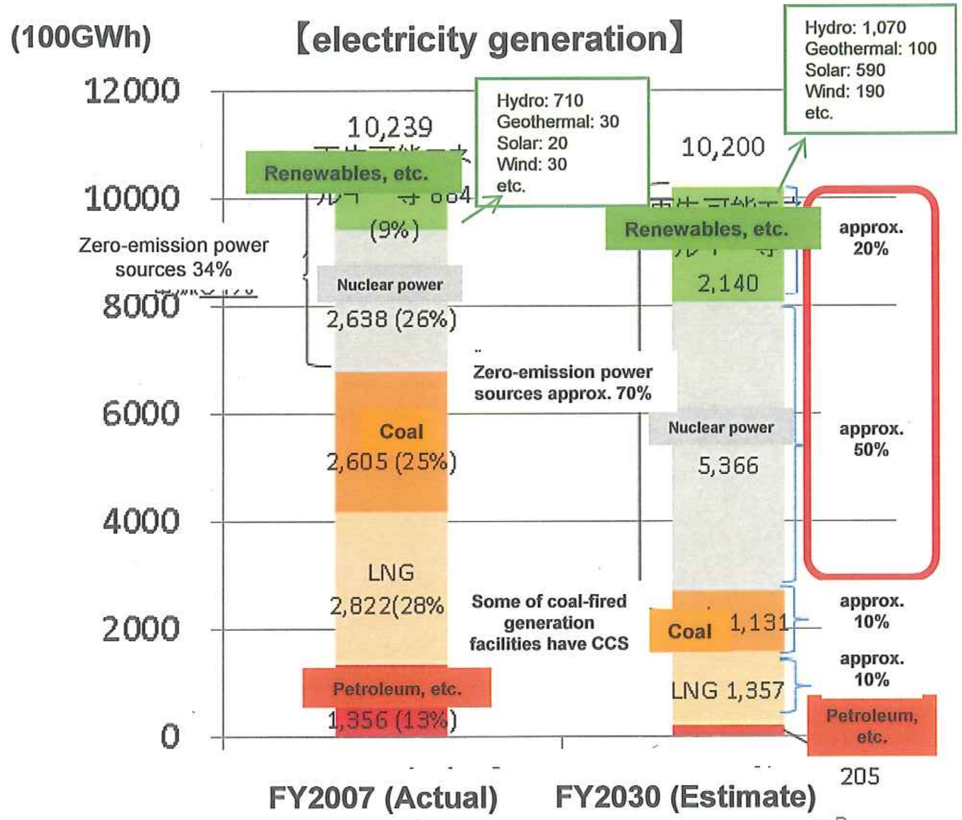
Reference: Basic Energy Plan: Composition of Power Sources

○ New construction and extension of 14 nuclear reactors; raise the operating rate from 60% to 90%.

○ Introduce renewable energy to 2.4 times the current level (15 times excluding hydropower).

○ Raise the share of zero-emission power sources from 34% to 70%.





2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ②

(2) Basic principles

- Importance of a comprehensive perspective
- Comprehensive perspective
  - a. Standpoint of security
  - b. Standpoint of global warming
  - c. Standpoint of costs
  - d. Standpoint of available potential reserves/energy density, etc.
- Unfortunately, there is no energy which can satisfy the first four standpoints.
  - ◇ Oil has problems concerning all of a, b and c.
  - ◇ Gas is superior to oil concerning a and b, while it is related to oil concerning c.
  - ◇ Coal is superior to oil concerning a and c, but has significant problems concerning b.
  - ◇ Photovoltaic power has advantages concerning a and b, but problems concerning c and d.
  - ◇ Wind and geothermal power, etc. have advantages concerning a, b and c, but problems concerning d.

Note: Photovoltaic power requires a land area equivalent to that inside the Yamanote Line in order to generate 1 million kW of electricity.
Wind power requires 3.5 times more land area than photovoltaic power.

2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ③

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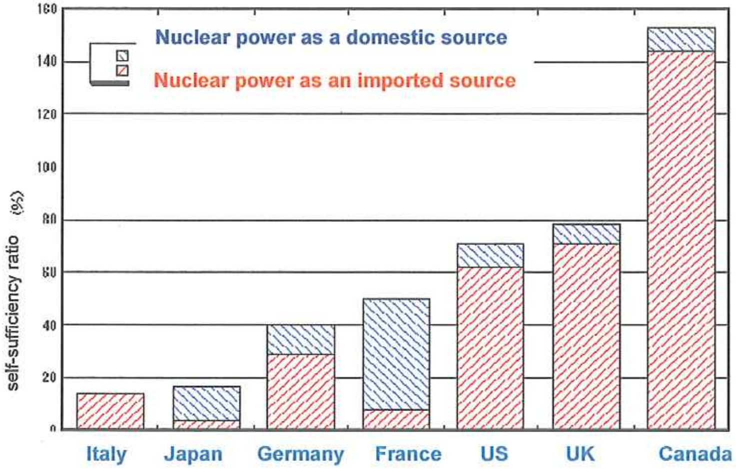
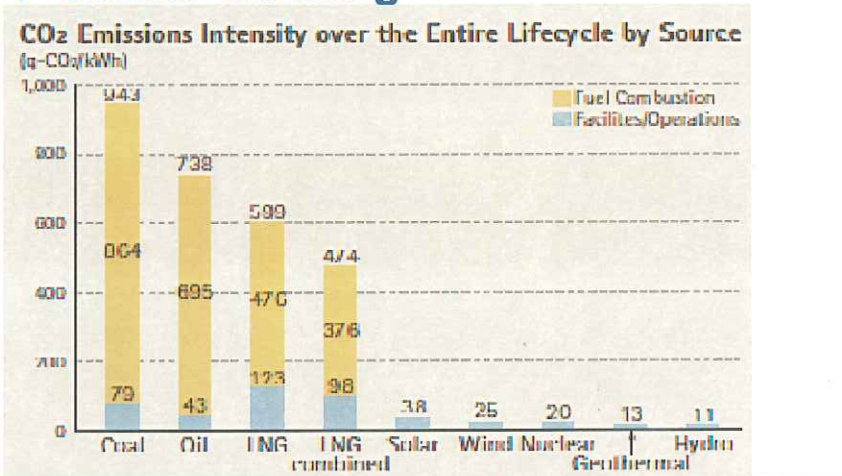
◆ Security



Energy White Paper

◆ Global warming



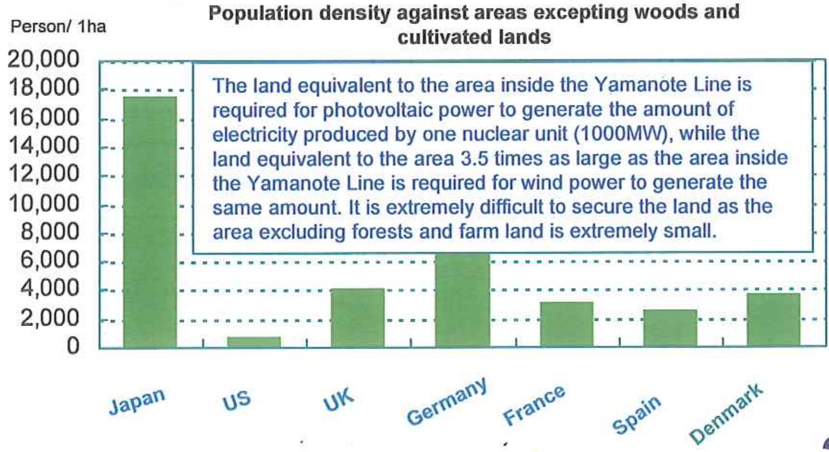
Source: Report of the Central Research Institute of Electric Power Industry, etc.

◆ Costs

Power Source	Generation Cost (yen/kWh)	Capacity Factor (%)
Hydro	8.2~13.3	45
Oil	10.0~17.3	30~80
LNG	5.8~7.1	60~80
Coal	5.0~6.5	70~80
Nuclear	4.8~6.2	70~85
Solar	46	12
Wind	10~14	20

Source: White Paper on Energy, METI

◆ Energy density



Prepared by IEE

2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ④

(3) Nuclear energy policy

- Four comprehensive standpoints: Nuclear energy has advantages concerning all of a to d.

- However, all possible safety measures must be taken to achieve safer nuclear energy.
  - A meticulous study to identify the cause of the current accident (earthquake, tsunami or other factor?) is essential.
  - Safety must be secured through international cooperation. Best practices must be shared among operators.

- Global perspective is also important.
  - How and on what grounds does each country implement respective policies?

- Risk management
  - Must assume unexpected problems.

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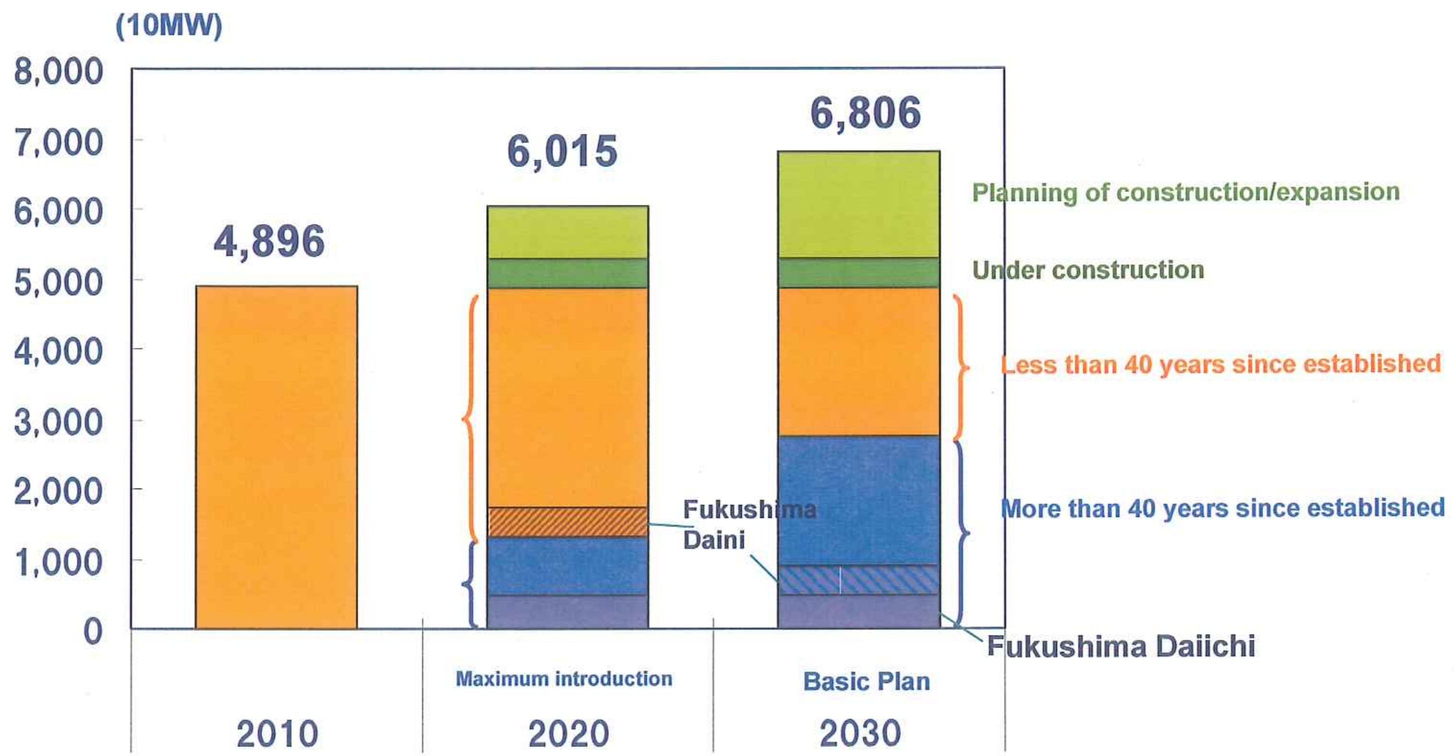
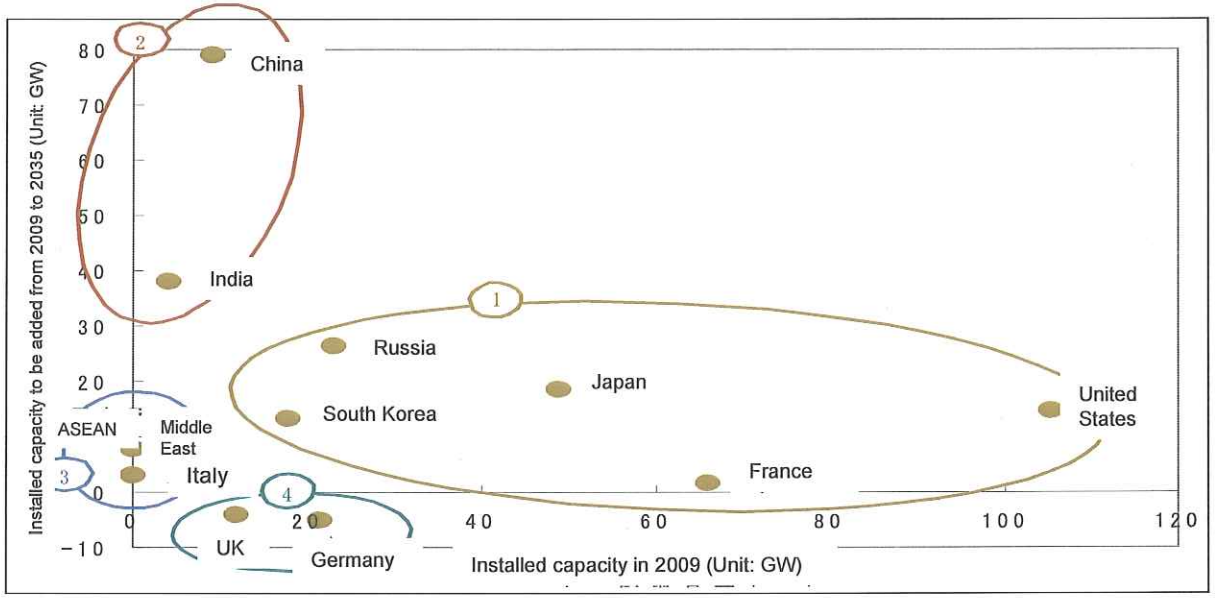
Reference: Installed Capacity of Nuclear Energy



	2010	2020	2030
Planning of construction/expansion		741	1532
Under construction		414	414
Less than 40 years since established	4,896	3,555	2,122
Fukushima out of above	910	440 (Daini)	0
More than 40 years since established		1,305	2,738
Fukushima out of above		470 (Daiichi)	910 (Daiichi and Daini)

Reference: National Policies on Nuclear Power since March 11



① Countries promoting nuclear power: These countries have been actively supporting the development and utilization of nuclear power within their territories and have also sought involvement in nuclear generation projects in other countries to improve the energy self-sufficiency ratio or as a part of strategic industrial development. The number of new commercial reactors planned for domestic construction varies from country to country, but for all of them, the nuclear power industry remains strategically important.

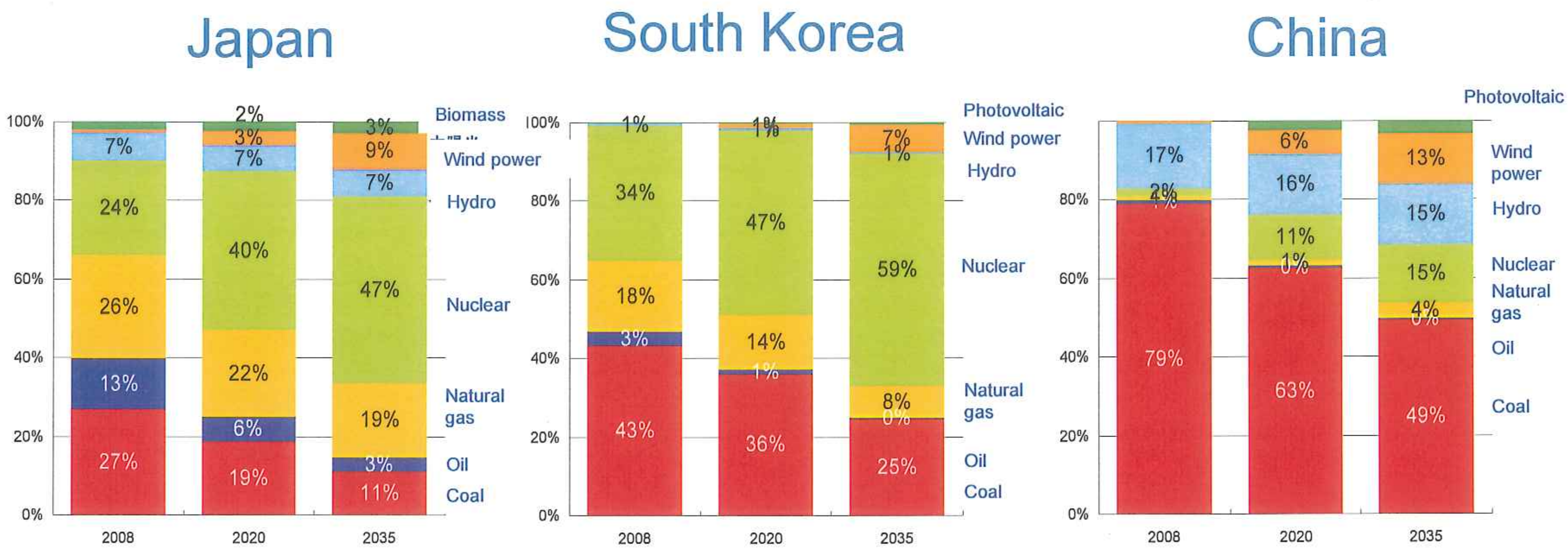
② Fast-growing nations relying on nuclear power: These countries will require major projects for constructing nuclear power plants to meet the growing demand for energy.

③ Countries planning to introduce nuclear power: In the past, the energy situation in these countries has not required reliance on nuclear power. However, these countries anticipate developing nuclear power to meet the growing demand for energy and to reduce dependency on fossil fuel.

④ Countries shifting away from nuclear power: These countries already have nuclear power in their energy portfolios but have no imminent need to expand. In the UK, the present government intends to support nuclear power.

Reference: Generation Mix in Countries of Northeast Asia (Current Status and Outlook)

Technology Development Case



* Scale of nuclear power generation

- China will be the greatest in Asia in terms of the scale of nuclear power generation.
- South Korea will have the highest share of nuclear power in the generation mix.
- Japan is expected to review its policies on nuclear power.

Reference: Scenarios Concerning Nuclear Power Generation in Asia

Installed capacity of nuclear power generation in Asian countries (Unit: GW)

	2009	2020		2030	
		Reference case	Technology development	Reference case	Technology development
China	9	48	80	90	130
Japan	49	62	62	68	68
Taiwan	8	8	8	6	8
South Korea	18	27	32	30	46
ASEAN	0	0	0	4	18
India	4	20	26	33	85
Asia	85	165	210	224	366

- Asian countries with nuclear power plants today are: Japan, South Korea, China, Taiwan, India and Pakistan, while Vietnam, Indonesia and Thailand are considering constructing nuclear power plants in their energy strategies.
- The gross installed capacity of nuclear power generation in China is expected to reach 80 million kW by 2020 assuming the technology development case. China will then have the largest installed capacity of nuclear power generation in Asia. Installed capacity in South Korea is expected to rise 80% by 2020 (assuming the technology development case).
- Installed capacity in India will also grow quickly as the existing heavy water reactors are complemented by imported light water reactors.

2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ⑤

(4) Energy conservation policy 1

- Four standpoints: This policy has advantages concerning 3 standpoints except d) potential reserves.

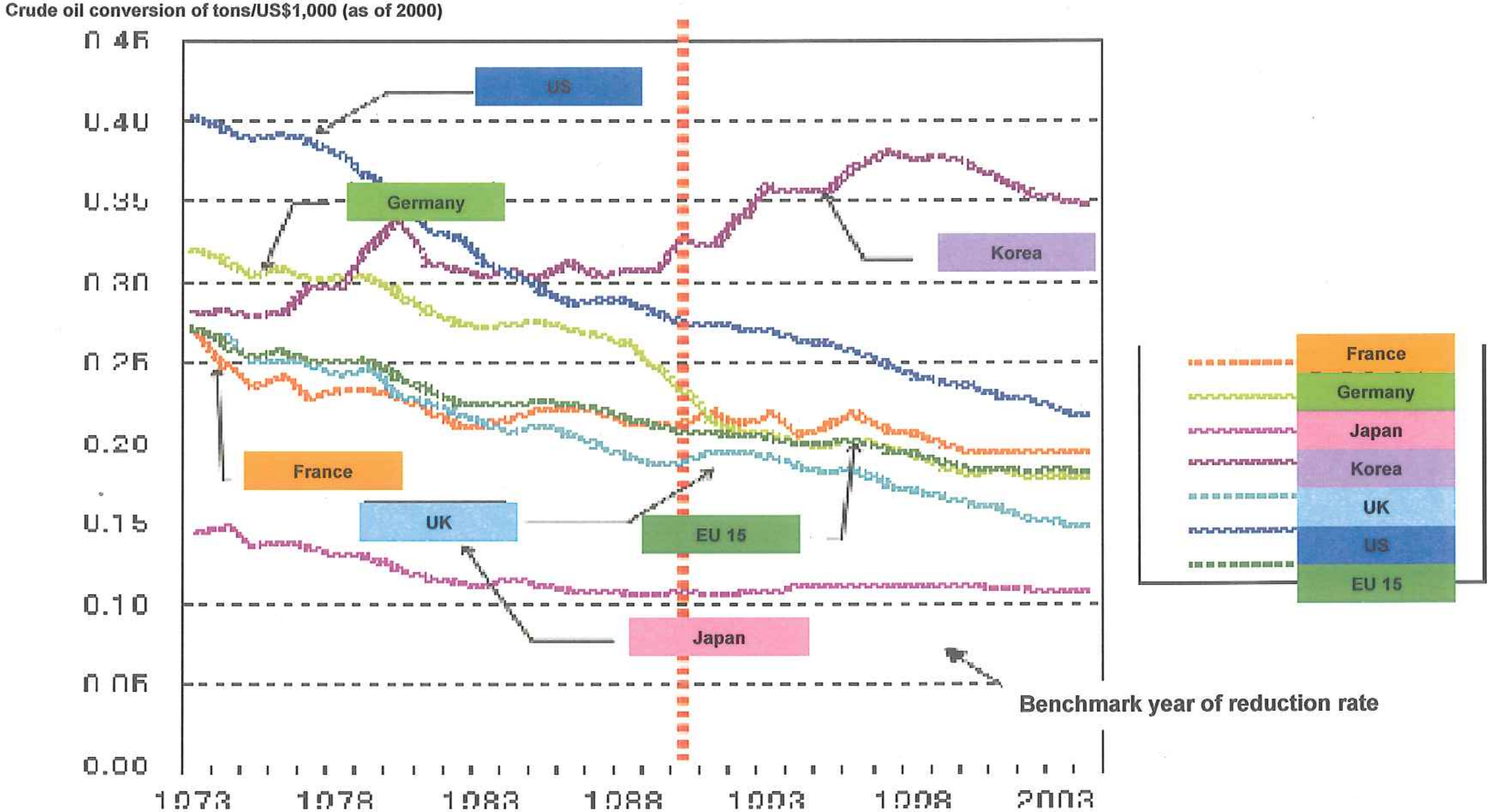
- Make Japan's advantages even stronger. (see next page)
  A 10% electricity saving is equivalent to 13,500MW of nuclear power and 95,000MW of photovoltaic power.
- Especially, there is still huge scope for conserving energy in households and workplaces, which will also boost industrial competitiveness.
  (High performance, new materials, new products)
- But there may be limits on energy conservation by industry as it has already made the greatest progress.
- It is also important to convert the industrial structure, and to change life styles and work styles.
  (The current energy conservation efforts will serve as a trigger.)

2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ⑥

(4) Energy conservation policy 2

Trend of energy consumption intensity by country

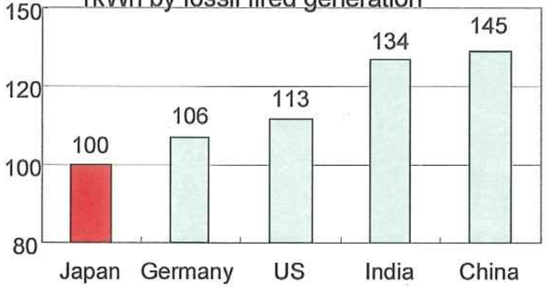


Source: Website of Agency for Natural Resources and Energy

Reference: Energy Utilization Efficiency by Sector

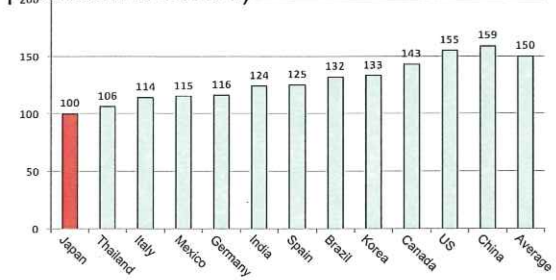
- Different sectors of the manufacturing industry in Japan have achieved world-leading energy efficiency thanks to energy-saving efforts.

Comparison of the index value of energy required to produce 1kWh by fossil fired generation



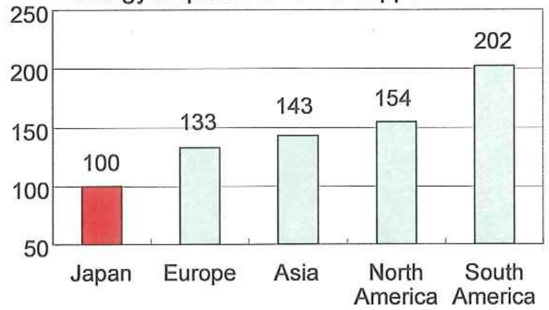
[Source: ECOFYS (Netherlands)]

Comparison of the index value of energy required to produce one ton of clinker (intermediate product in the production of cement)



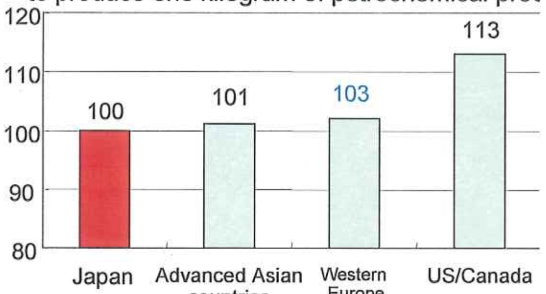
(Source: IEA "Energy Technology Perspectives 2008")

Comparison of the index value of energy required to refine copper



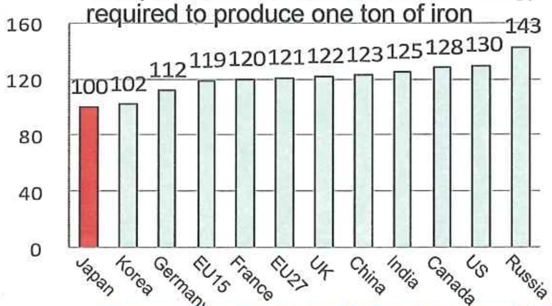
(Source: Japan Mining Industry Association)

Comparison of the index value of energy required to produce one kilogram of petrochemical proc



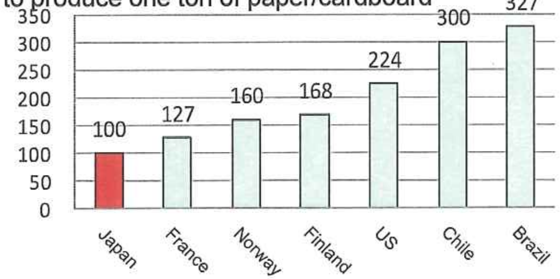
(Source: Solomon Associates)

Comparison of the index value of energy required to produce one ton of iron



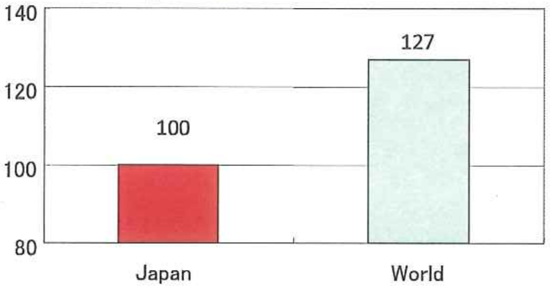
(Source: Estimation by RITE using a model, 2005)

Comparison of the index value of energy required to produce one ton of paper/cardboard



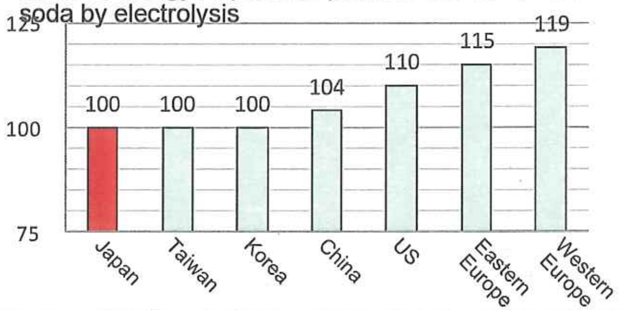
(Source: IEEJ, 2007)

Comparison of the index value of energy requir... for rolling aluminum sheets



(Source: International Aluminum Institute, etc.)

Index of energy required to produce one ton of caustic soda by electrolysis

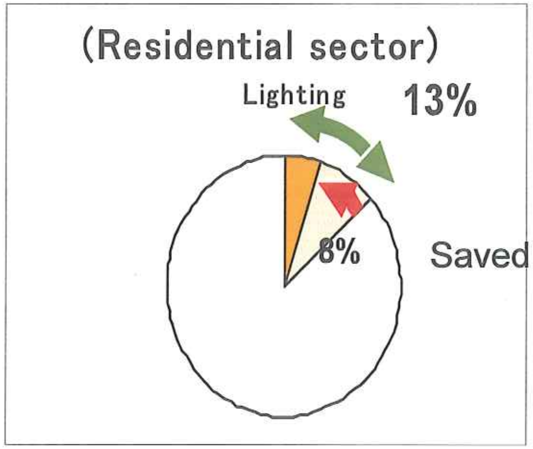


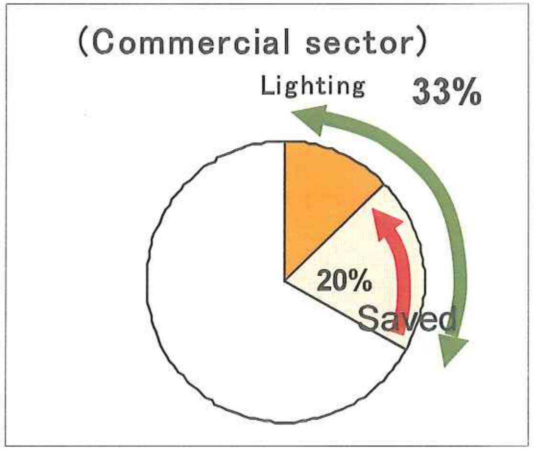
(Source: SRI Chemical Economic Handbook and Soda Handbook 2004)

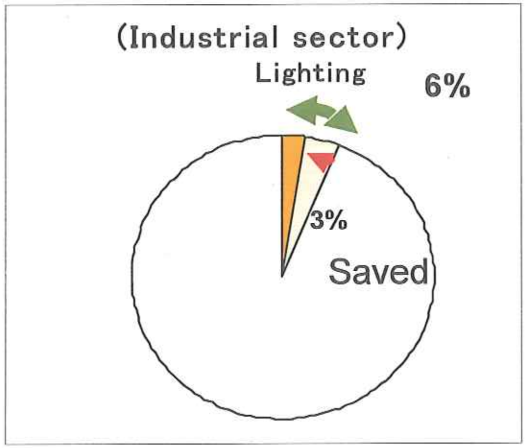
Source: Nippon Keidanren, with reference to the following materials, for example:
- Voluntary Action Plan on the Environment (against global warming)
- Fiscal 2008, an overview of reports on follow-ups

Reference: Benefits of LED Lighting

- LED lighting can replace incandescent lamps, providing the same brightness while cutting the electric power consumption to 1/8.
- Using LED lighting to replace all other types of lighting apparatuses in Japan would cut the gross electric power consumption by 9%.
- The initial investment required would be 15.7 trillion yen, which could be paid off in one or two years in the case of replacing incandescent lamps, or in about 10 years in the case of replacing fluorescent lamps.







2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ⑦

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(5) Renewable energy policy

- Maximum introduction of especially photovoltaic power, wind power and geothermal power is necessary.

- Comprehensive perspectives: c) costs and d) energy density are challenges to be solved.

- How much renewable energy can be stably supplied to the grid and by how much can costs be reduced by systems such as storage batteries, smart grids and mega solar systems?

- How to deal with the physical limitation concerning the relation between c and d?

Reference: Impacts of a 1GW Nuclear Unit

Impact of 1GW power station
- Nuclear v.s Renewables-

		Capacity factor (%)	power generation, GWh	CO2 reduction (Mt)	Initial cost (Billion JPY)	power generation cost (JPY/kWh)	To replace 1GW nuclear power plant, capacity (GW)	Area
PV	1GW	12.0	1,051	0.7	520	49.5	7.1	67 km2
WIND (onshore)	1GW	20.0	1,752	1.1	190	10.8	4.3	235 km2
WIND (offshore)	1GW	30.0	2,628	1.6	250	9.5	2.8	
Small Hydro	1GW	80.0	7,008	4.3	1,600	22.8	1.1	
Geothermal	1GW	70.0	6,132	3.7	850	13.9	1.2	
Nuclear	1GW	85.0	7,446	4.5	300	6.5	1.0	
(Thermal Power Generation)								
LNG	1GW				164	7.5		
Coal	1GW				272	5.8		

Energy conservation in the Demand side

Energy conservation (10% electricity saving) equal: Nuclear: 13.5GW
PV: 95GW

Reference: Outlook for Renewable Energy (Corresponding to the Basic Plan)

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	2008	2020	2030	ISEP 2020
PV	Capacity 2.14GW	27.6GW	55.9GW	81GW
	Residential use	16.6GW	39.4GW	—
	Non residential use	11GW	16.5GW	—
Wind	Capacity 1.86GW	5GW	10GW	40GW
	On-shore:1.86GW	5GW	8GW	—
	Off-shore:0GW	—	2GW	—
Geothermal	Capacity 0.53GW	0.7GW	1.65GW	3.4GW

Outlook of ISEP: from "Unplanned blackout" to "Strategic energy shift", on May 6, 2011

Reference: Installation of Photovoltaic Power Generation by Households (Corresponding to the Basic Plan)

- It is estimated that 12 million households will install photovoltaic power generation systems.
- It is estimated that photovoltaic power in non-residential facilities will increase to 55 times the current level.

1. Potential for installation

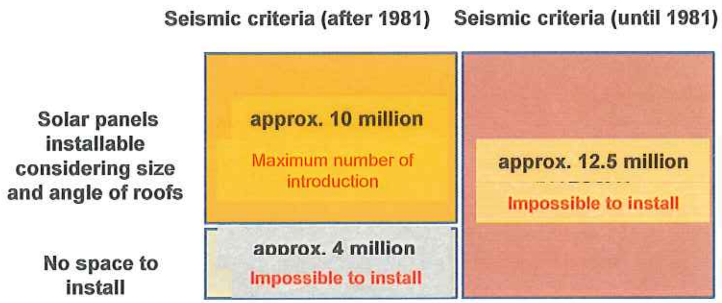
- According to the "PV Roadmap toward 2030+ (PV2030+)" by NEDO, there is potential of 54,000MW to 200,000MW for Japan as a whole.
  According to the Ministry of the Environment (in FY2010), the potential for non-residential facilities is estimated to be 59,000MW to 150,000MW.
- The number of detached houses which could install solar panels is a maximum of 10 million (35,000MW – 40,000MW) in view of seismic standards, installation locations, etc.
- Considering solar water heater units too, the limit will be even smaller.

2. Pace of installation

- At the pace of 150,000 houses in FY2009.
- Although the surplus electricity purchase price system is in place, it is necessary to install PV systems in 550,000 houses per year to reach 12 million houses by 2030. This means that PV systems must be made mandatory for all new houses.

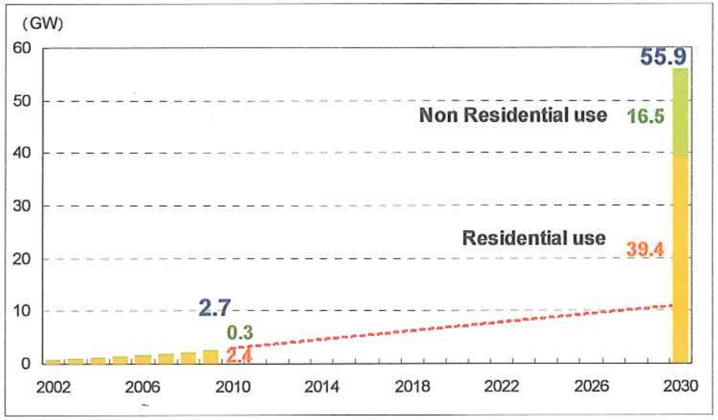
Reference: Limit on installing PV power generation systems for detached houses

Total number of detached houses: approx. 26.5 million



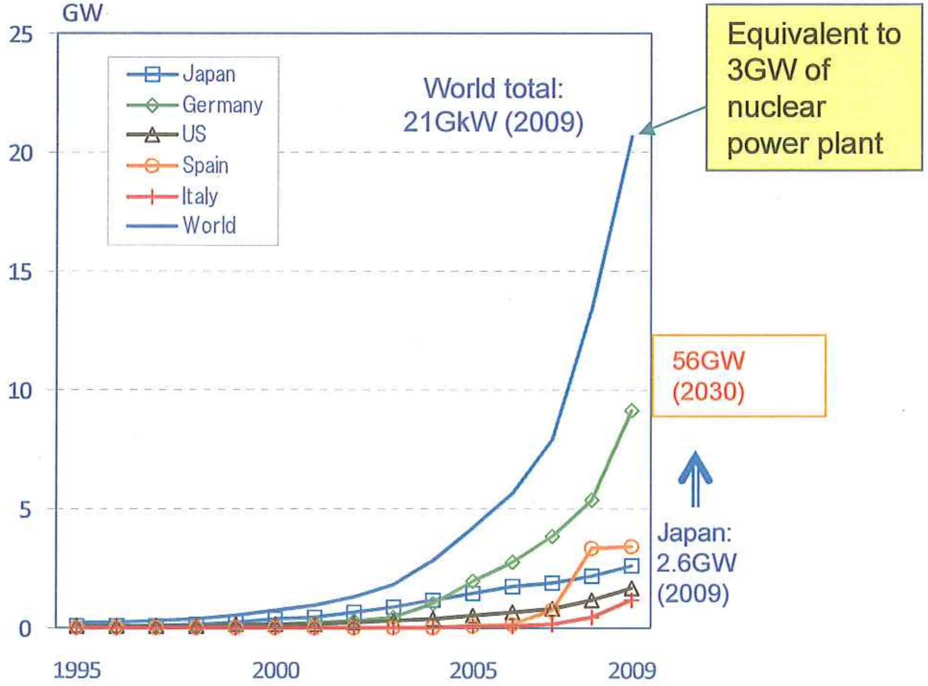
(Analyzed by Prof. Yuhara of Tokyo University, Member of Mid-Term Target Investigation Committee)

< Cumulative Installation of PV >



Reference: Installation Status of PV Power Generation

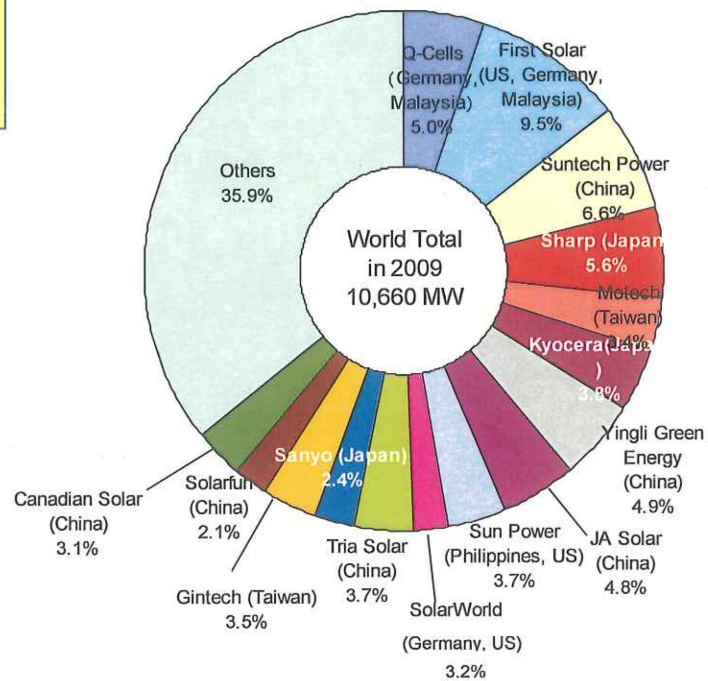
Installation status of PV power generation in the world



Note: The "world" means all countries participating in IEA-PVPS.

Source: IEA-PVPS "Trends in Photovoltaic Applications – Survey report of selected IEA countries between 1992 and 2008"

PV power generation module manufacturers in the world (2009)



Source: IEA "Trends in Photovoltaic Applications – Survey report of selected IEA countries between 1992 and 2008"

- The total cumulative installed capacity in the world is 20,630MW. Japan ranked top in the world until 2004 by cumulative installed capacity. However, following the introduction of the Feed-in Tariff (FIT) system, Germany and Spain are now first and second.
- Japanese companies produced almost half of all solar power generation panels up to 2005, but the share has gradually declined and German, Chinese and U.S. manufacturers have increased production.

Reference: Installation of Wind Power Generation (Corresponding to the Basic Plan)

▪Installing 10,000MW by 2030

1. Potential scale of installation
   - The potential for constructing onshore wind power generation units is 6,400MW according to NEDO's estimation. Therefore, it is necessary to select large sites in nature parks or offshore areas in order to install 1,000MW.
   - The construction potential assumed by the National Institute for Environmental Studies is considered to be excessive. For example, the Institute assumes that wind power units will be installed in woodlands while constructing access roads of up to 10km. Will such a program be permitted in terms of nature conservation?

2. Siting restrictions, etc.
   - There are issues to be solved such as preservation of natural landscapes, prevention of noises and bird strikes, etc. It is necessary to negotiate with local residents, so a rapid increase is difficult. Fishing rights is another issue concerning offshore wind power generation units.
   - It is estimated that planning to start of construction takes 6 to 9 years due to environmental assessments.
   - There are few suitable places for hosting wind power units due to geographic and wind conditions. Therefore, investigation of installation potential based on the natural conditions in Japan is necessary.

Estimated wind power generation potential

(MW)

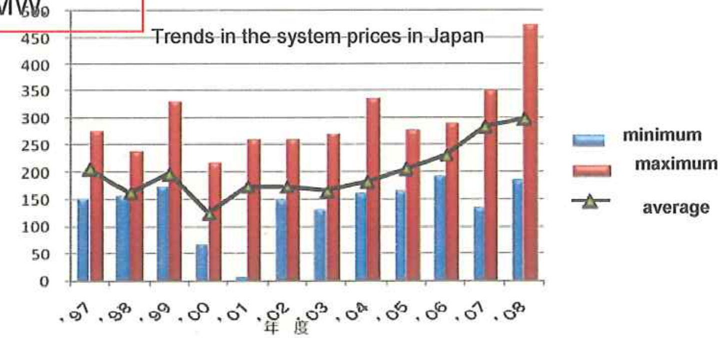
	JWPA	MOE
Onshore	168,900	300,000
Offshore(bottom-mounted)	93,830	310,000
Offshore(floating)	519,490	1,300,000
Total	782,220	1,900,000

Maximum capacity is estimated to be 5 million MW.

Source: White Paper on Renewable Energy Technologies published by NEDO

3. Cost of installation
   - Although onshore wind power generation costs are already globally competitive, system costs are rising as suitable locations decrease due to the rapid increase in worldwide demand and facility installation.

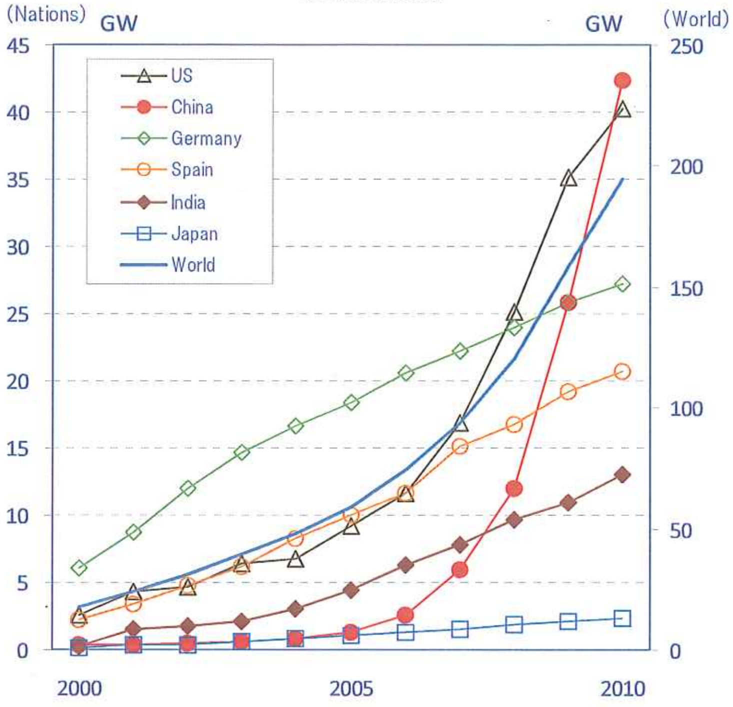
4. Other challenges
   - Due to volatility, the same as for PV power generation systems, Japanese electric utilities place an upper limit on the interconnection capacity of the wind power generation system. Measures to upgrade interconnection capacity is a significant challenge for the future.



Source: New and Renewable Energy Subcommittee of the Advisory Committee for Natural Resources and Energy

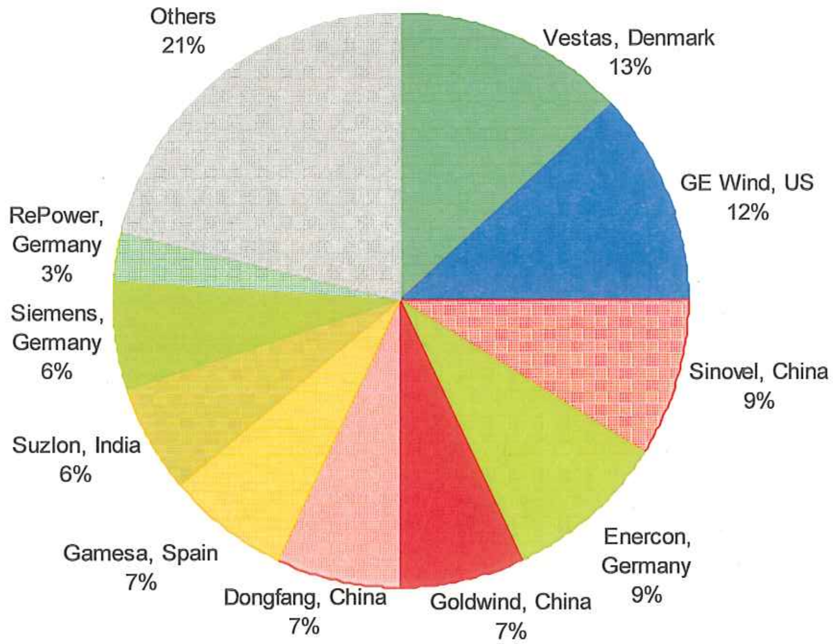
Reference: Installation Status of Wind Power Generation

Installation status of wind power generation in the world



Source: Global Wind Energy Council "Global Wind Report" 2010

Share of wind power generation units in the international market (2009)



Source: REN21"RENEWABLES 2010 GLOBAL STATUS REPORT"

- The global cumulative installed wind power capacity as of the end of 2009 was 158.500MW, up 32% from a year ago. The U.S., Germany and Spain have been active, but now China and India have been significantly expanding installed capacity.
- Although Vestas (Denmark), GE Wind (U.S.) and Gamesa (Spain) accounted for 50% of global wind power generation units in 2008, Chinese manufacturers grew strongly in 2009. Among Japanese manufacturers, Mitsubishi Heavy Industries has expanded its share in both the domestic and U.S. markets.

Reference: Installation Status and Production Trend of Geothermal Power Generation System

■Installation has been expanding in the U.S., Indonesia, etc.

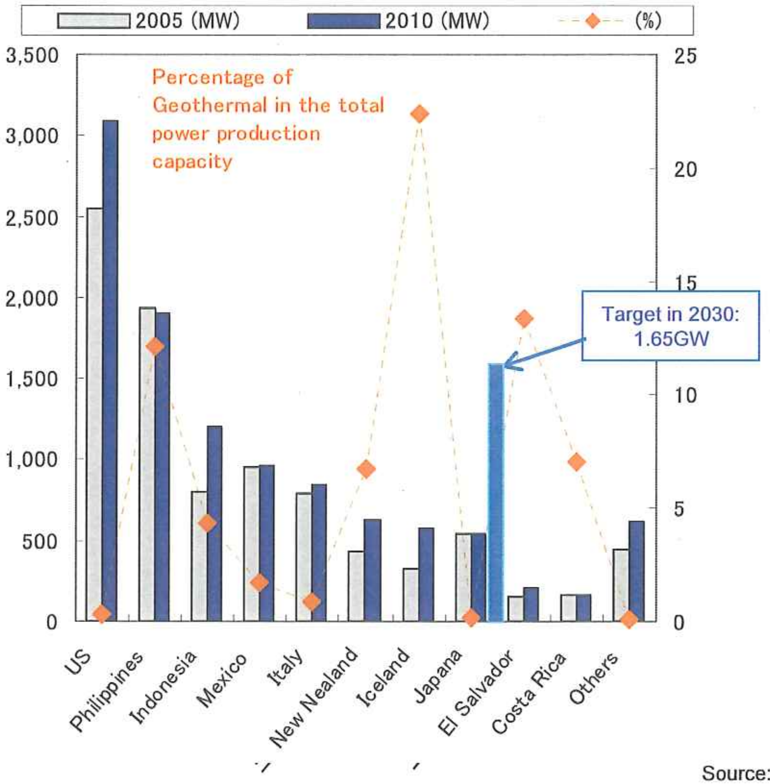
■Challenges for installation in Japan

- Although current installed capacity is 530MW, the corresponding Basic Plan assumes a cumulative capacity of 1,650MW which is perhaps the upper limit of the potential in 2030. However, there has been no new development in the last decade.
- Development risk is high due to the need for confirming the underground heat source by boring tests.
- There are siting restrictions due to conflicts of interest with national parks and utilization of hot springs.

■Japanese manufacturers have a large share in the world market.

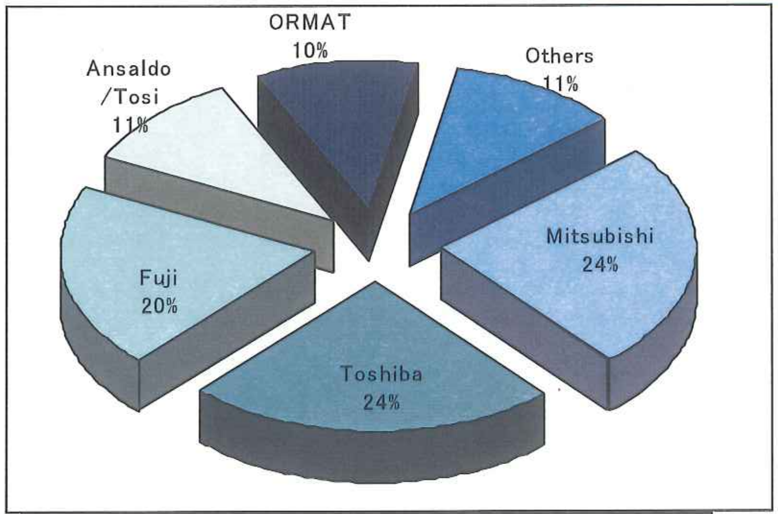
Installation status of geothermal power generation

(Note) Total power generation



Major manufacturers of geothermal power generation system

Cumulative value



Potential of geothermal power generation

Cost of power generation Up to ¥12/kWh: 1,100MW

Cost of power generation Up to ¥15/kWh: 1,460MW

Cost of power generation Up to ¥20/kWh: 1,650MW

Source: Prepared based on the "Study on the Low-Carbon Electricity Supply System"

Reference: Lesser-known Examples of Renewable Based Generation Technologies

◎ Mini Hydro

- Mini hydro generation facilities are installed using unused water head and water channels.
- The scale and cost vary greatly depending on the siting.
- Typically, a mini hydro system costs about 1.6 million yen per kilowatt. In terms of investment per kilowatt, it is more expensive than larger generation systems.
- The gross installed capacity of mini hydro systems at the generation cost of up to 12 yen per kilowatt may rise to 1.32 million kilowatt; and at up to 20 yen per kilowatt, may rise to 6.15 million kilowatt.

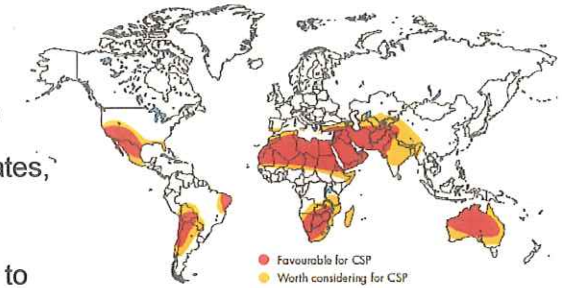
Mini hydro generation station in Kamimasiki-gun district, Kumamoto Prefecture

Photo from the New Energy Foundation

◎ Solar heat (Concentrated Solar Power - CSP)

- Thermal energy produced from concentrated solar radiation drives a turbine to generate power.
- There are few sites worldwide that can accommodate such CSP plants, but CSP plants are already in commercial operation in the United States, Spain, etc.
- There is a plan to build large CSP plants in North Africa for delivering power to Europe.
- Siting conditions are severe because of limited direct solar radiation.

Locations suited for CSP



Source: IEA "Energy Technology Perspectives 2008"

◎ Biomass

- A power plant may run on biomass only (mono combustion) or mix several percent of biomass with a conventional fuel such as coal (mixed combustion).
- Biomass generation may stimulate local economies but the cost and supply quantity of biomass fuel depends largely on the type of biomass and the manner in which it is used.
- The total supply of biomass fuel may increase to the equivalent of 14 million kL of petroleum. Even assuming that all is used for power generation, biomass power will not exceed 30 billion kWh (3% of today's gross electricity demand).

Biomass generation plant in Noshiro City, Akita Prefecture

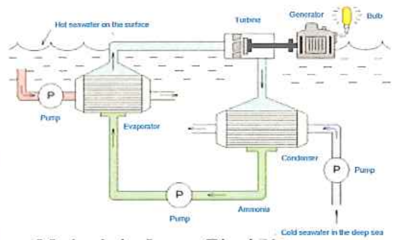
Photo from Sony website

◎ Wave/tidal energy, etc.

- Researches are being conducted on using tidal movement, tidal energy, ocean currents, seawater temperature gradient, salt concentration gradient, etc., as sources of power.
These technologies are at an earlier stage of development than other generation technologies. 10.5

Concept of tidal power generation

Principle of using seawater temperature difference for power generation



Sources: Materials from Chubu Electric Power and Saga University

2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ⑧

6) Fossil Fuel Energy Policy

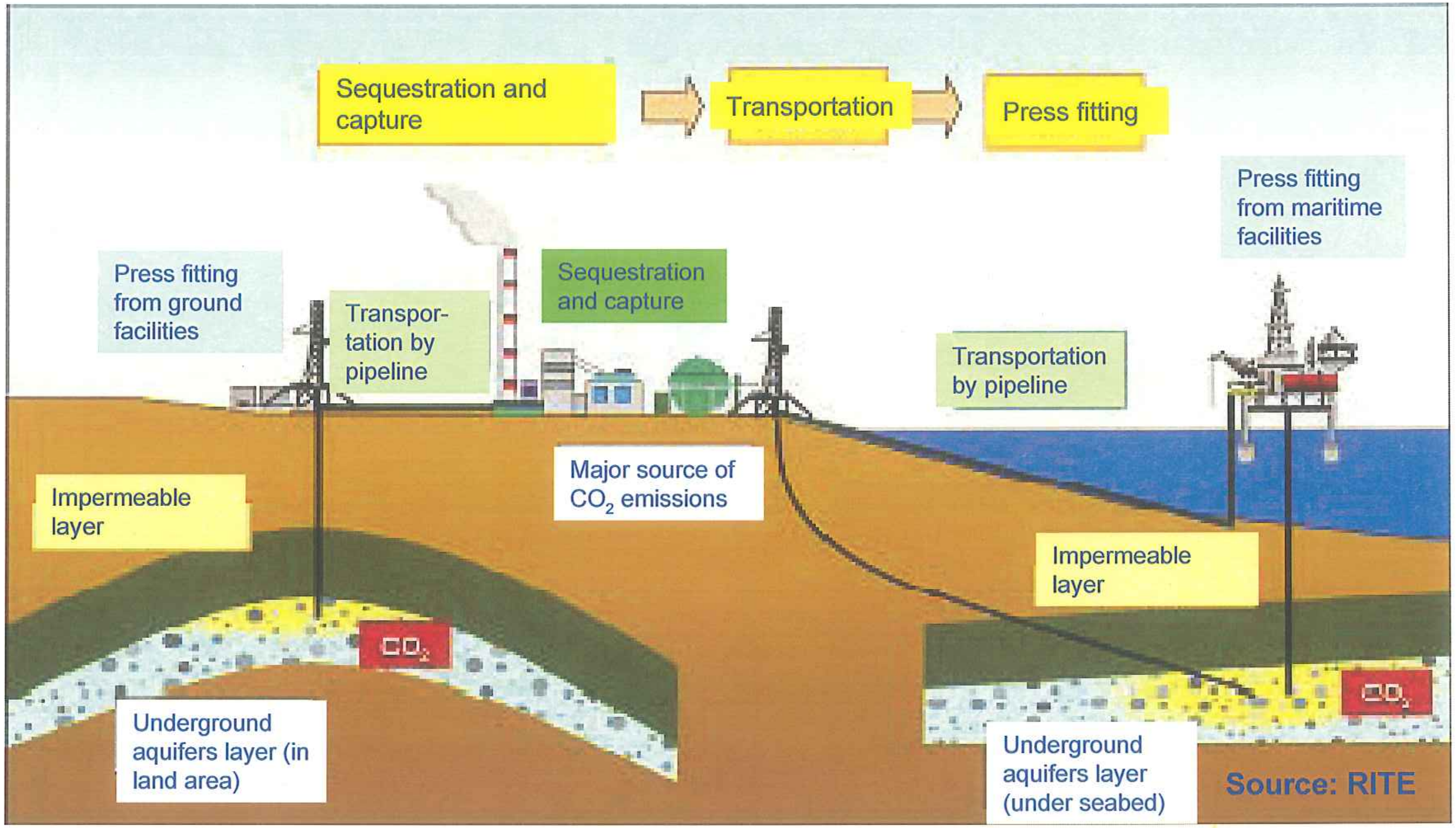
- Comprehensive perspective: It has problems concerning a, b and c (security, warming and costs).

- Among fossil fuels, the problems of natural gas are relatively small, but the problems of global warming gases cannot be avoided.

- It is necessary to accelerate the development of CCS, but:
  - There are little suitable sites in Japan.
  - Transportation by ship is essential. -> higher cost

- Idea of CCU (Carbon Capture and Use) is also important.-> maximum efforts are needed
  (Note: Remark by Dr. Eiichi Negishi)

Reference: Illustration of CCS



2. Medium- to Long-Term Agenda

○ Review of the Basic Energy Plan ⑨

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7) Important points

(1) The starting point should be the recognition that Japan has few energy resources, and that no elecricity supply network is available beyond border

(2) Comprehensive studies are essential to resolve the following four challenges:

a. Security : Independently developed energy or not

b. Global warming : Amount of CO2 emissions

c. Costs : Effects on industrial competitiveness

d. Available reserves/energy density : Physical limit

(3) There is no perfect energy which can replace nuclear energy. It is necessary to diversify energy sources and to promote technological development based on safety.

(4) It is important to mix safer nuclear energy, cheaper renewable energy and cleaner fossil fuels (especially, natural gas and clean coal) and to promote energy conservation.

(5) It is essential to internationally standardize the safety criteria and to share best practices through international cooperation for assuring the safety of nuclear energy and risk management.

2. Medium- to Long-Term Agenda
○ Review of the Basic Energy Plan ⑩

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8) An image of policy review

(1) Electricity composition in 2030
- Whether or not we keep 70% for zero emission energy to combat C.C.
- Stable and sufficient supply of electricity at reasonably low rate is indispensable to avoid the hollowing out of Japanese manufacturing industry

(2) Maximum promotion of renewable energy and energy conservation
- Two types of introduction are possible : linkage with centralized grid through smart grid and independent supply in principle from the grid with battery and/or fuel cell
- Energy conservation is possible by visualization through smart meter primarily at homes and offices

(3) Cleaner fossil fuels seem to have limitations for the next two decades because of very high cost of CCS

(4) Stable supply of electricity may not be possible without nuclear energy even with smaller share than 50%
- the premise is ensured safety and restored confidence among people

Thank you for your attention!

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