Present Situation and Issues on New Energy

May 2003

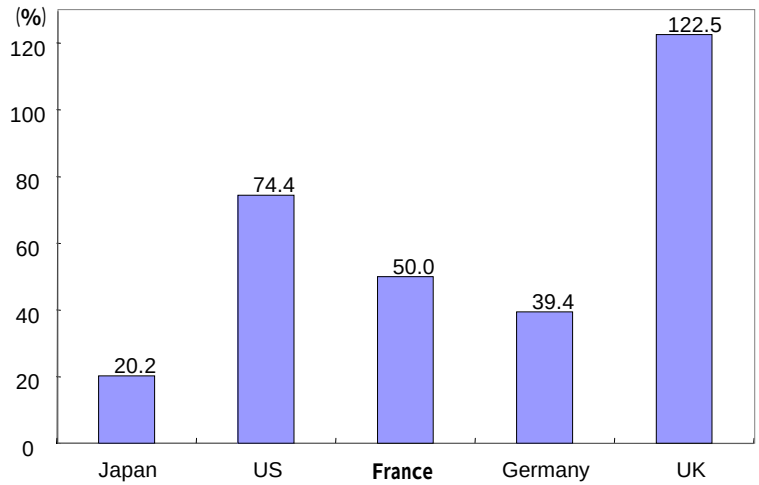
New and Renewable Energy Division
Agency of Natural Resources and Energy

Japan's Energy Situation Compared with the World

Characteristics

- Japan has worked **to promote energy conservation and the introduction of oil-alternative energy, such as nuclear power, since the two Oil Crises**, resulting in a reduction of oil dependency to about 50%.
- However, **the energy self-supply rate of Japan**, which does not have much energy resources within the country, **is still very low, at about 20%, compared with other major countries**.
- Especially compared with the West, **Japan's oil dependency continues to be high, and dependency on the Middle East for oil is high. As such, Japan's energy supply structure is relatively weak.**

【Energy self-supply rates in various countries (1999)】



Source: IEA "ENERGY BALANCES OF OECD COUNTRIES 1998-1999"

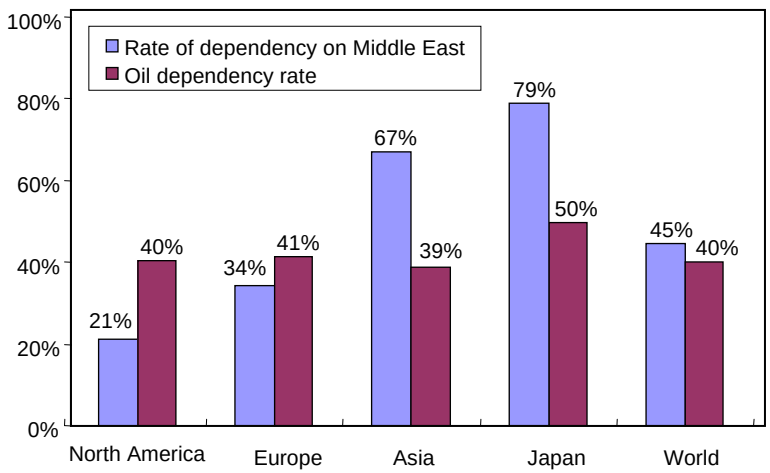
【Primary energy supply and the ratios in major countries (1999)】

(%)

	Japan	US	France	Germany	UK
Primary energy supply (million tons of oil equivalent)	515	2270	255	337	230
Coal	17	24	6	24	15
Oil	52	39	35	40	36
Natural gas	12	23	14	21	36
Nuclear	16	9	40	13	11
Hydro	1.4	1.1	2.4	0.5	0.2
Renewable energy, etc.	2	4	5	1	1

Source: IEA "ENERGY BALANCES OF OECD COUNTRIES 1998-1999"

【Rates of oil dependency on Middle East and oil dependency rates (2000)】



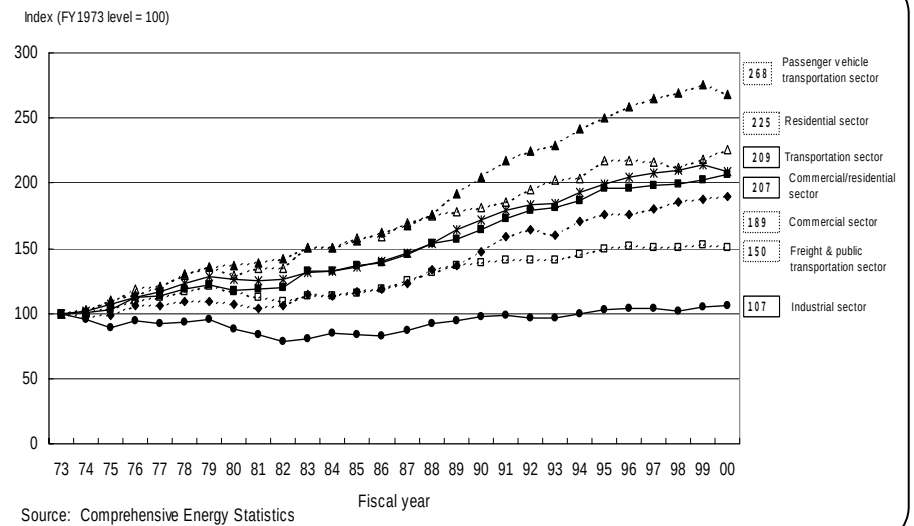
Source: BP Statistic 2001

Japan's Energy Demand Trend

Characteristics

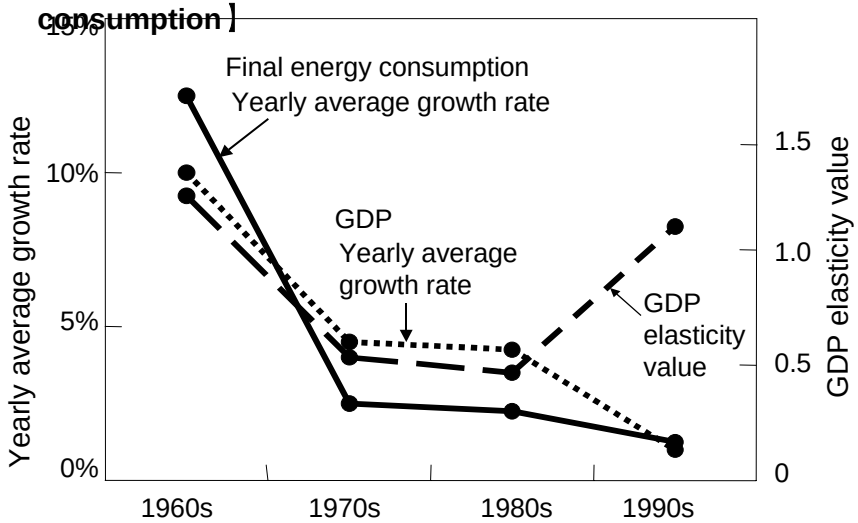
- Energy consumption, which is essential for economic activities, **greatly increased in association with high economic growth** in the 1960s.
- In the 1970s and 1980s, **energy conservation and economic growth were simultaneously achieved through energy-conservation efforts, centered on the industrial sector**, and by every class of citizens, after two Oil Crises in the 1970s. (The GDP elasticity value for energy consumption was about 0.5. In particular, consumption in the industrial sector stayed lower than at the time of the first Oil Crisis.)
- In the 1990s, when Japan faced a sluggish economy, energy consumption growth stayed low in association with economic growth, but it exceeded the GDP growth rate (the GDP elasticity value for energy consumption was 1.14). **Due to the spreading of lifestyles that pursue comfort and convenience, and for other reasons, energy consumption greatly increased consistently, centered on the commercial/residential and transportation sectors.**

【Change in the final energy consumption by sector】



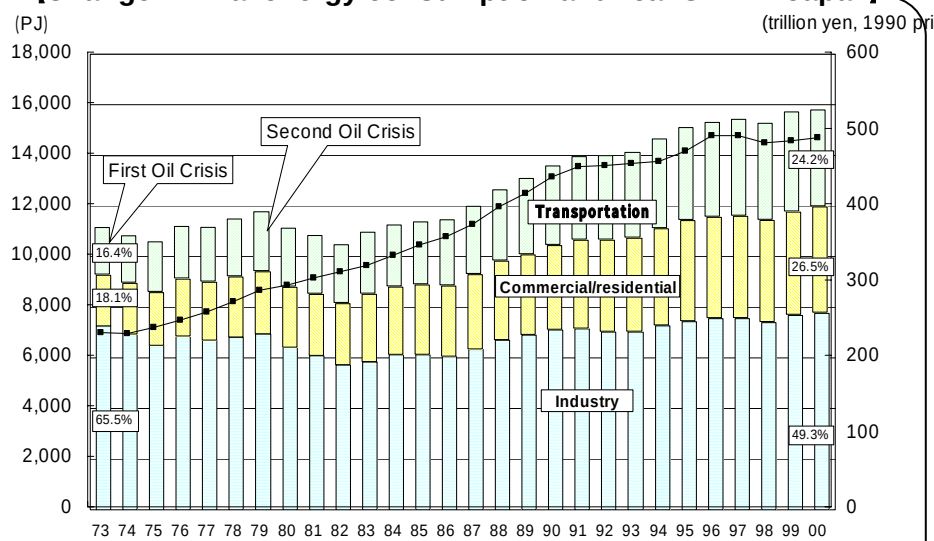
Source: Comprehensive Energy Statistics

【Relation between GDP and final energy consumption】



. Source: Surveyed by the Agency of Natural Resources and Energy

【Change in final energy consumption and real GDP in Japan】



Source: Comprehensive Energy Statistics, preliminary figure for FY2000

Japan's Energy Supply Trend

Characteristics

- As to Japan's energy supply, domestic coal lost competitiveness in the 1960s, **which was substituted by oil, and oil accounted for the majority of primary energy supply, at 80%.**
- After the two Oil Crises in the 1970s, **introduction of oil-alternative energy**, such as foreign coal, natural gas, and nuclear power, **under an oil-alternative policy, was promoted, and oil dependency significantly decreased, to about 50%** (from 77% in FY1973 to 52% in FY2000).
- In the 1990s, needs for higher efficiency in energy supply increased, but due to restricted supply of nuclear and renewable energy, **the majority of energy supply necessary for economic growth was still fossil fuels**.

Fossil fuel dependency rate: 85% (FY1990) to 83% (FY2000)

GDP elasticity value of fossil fuel supply volume: 0.4 (1980s) to 0.9 (1990s)

【Change in primary energy supply】

(%)

	FY1973	FY1990	FY2000
Primary energy supply (million kl of crude oil equivalent)	414	526	604
Oil	77	58	52
Coal	15	17	18
Natural gas	2	10	13
Nuclear	1	9	12
Hydro	4	4	3
Geothermal	0	0.1	0.2
New energy, etc.	1	1	1

Source: Comprehensive Energy Statistics

【Relation between GDP and primary energy supply】

Period	Yearly average growth rate (%)				Primary energy supply versus GDP elasticity value	Fossil fuel supply versus GDP elasticity value	Energy-originating CO_2 emissions versus GDP elasticity value
	Primary energy supply	Fossil fuel supply	Energy-originating CO_2 emissions	GDP			
1960～1970	12.2%	14.0%	-	10.0%	1.2	1.4	-
1970～1980	2.2%	1.8%	1.9%	4.4%	0.5	0.4	0.4
1980～1990	2.0%	1.6%	1.3%	4.2%	0.5	0.4	0.3
1990～2000	1.4%	1.1%	1.0%	1.3%	1.1	0.9	0.7

Source: Surveyed by the Agency of Natural Resources and Energy

【Change in electric energy generated by electric sources in Japan (for general electric industry)】

(%)

	FY1973	FY1990	FY2000
Generated electric energy (1 billion kWh)	379	738	940
Oil-fired power	73	29	11
Coal-fired power	5	10	18
LNG-fired power	2	22	26
Nuclear	3	27	34
Hydro	17	12	10
New energy	–	–	0.2

Source: Electric Power Supply Plan

Energy-Originating CO_2 Emissions

Characteristics

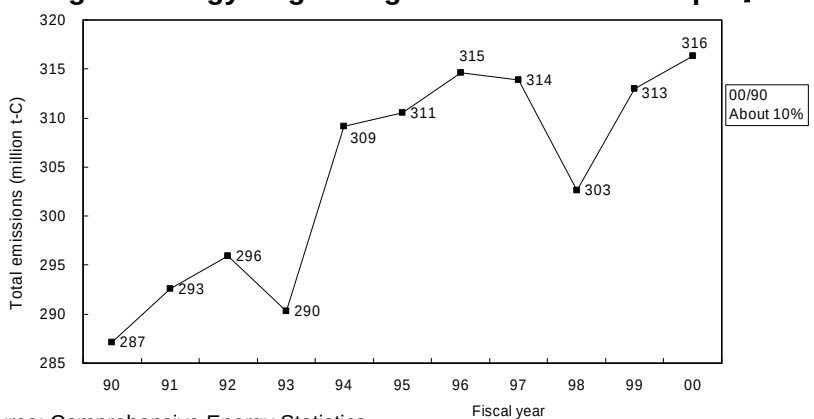
- Energy-originating **CO_2 emissions consistently increased in accordance with the expansion of energy consumption**. **Even in the 1990s, when economic difficulties were faced, emissions increased by about 10%.** While energy consumption in the industry sector, mainly in manufacturing, leveled off, **emissions remarkably increased** in the fields of passenger vehicle transportation and traveling, and **in the commercial and residential fields**, with lifestyles pursuing prosperity in the background.
- **If expansion of energy consumption continues** with no effective measures taken, **energy-originating CO_2 emissions in fiscal 2010 are prospected to increase by over 20%, compared with the 1990 level.**
- On the other hand, **to achieve the 6% reduction target in the Kyoto Protocol, it is necessary to reduce energy-originating CO_2 to the 1990 level**, and, energy consumption, centered on the commercial/residential and transportation sectors, must be further rationalized in the future.

【Change in energy-originating CO_2 emissions in Japan】

Fiscal year	90	91	92	93	94	95	96	97	98	99	2000	00/90
Total emissions (million tons – CO_2)	1053	1073	1085	1065	1133	1139	1154	1151	1110	1148	1160	10.2%
Total emissions in terms of carbon	287.1	292.6	295.9	290.3	309.1	310.5	314.6	313.8	302.6	313.0	316.3	
(Rate compared with the previous year)		1.9%	1.2%	-1.9%	6.5%	0.5%	1.3%	-0.3%	-3.6%	3.4%	1.1%	
Per-capita emissions (million tons – CO_2)	8.52	8.65	8.72	8.53	9.06	9.07	9.17	9.12	8.77	9.06	9.13	7.2%
Per-capita emissions in terms of carbon	2.32	2.36	2.38	2.33	2.47	2.47	2.50	2.49	2.39	2.47	2.49	

Source: Surveyed by the Agency of Natural Resources and Energy

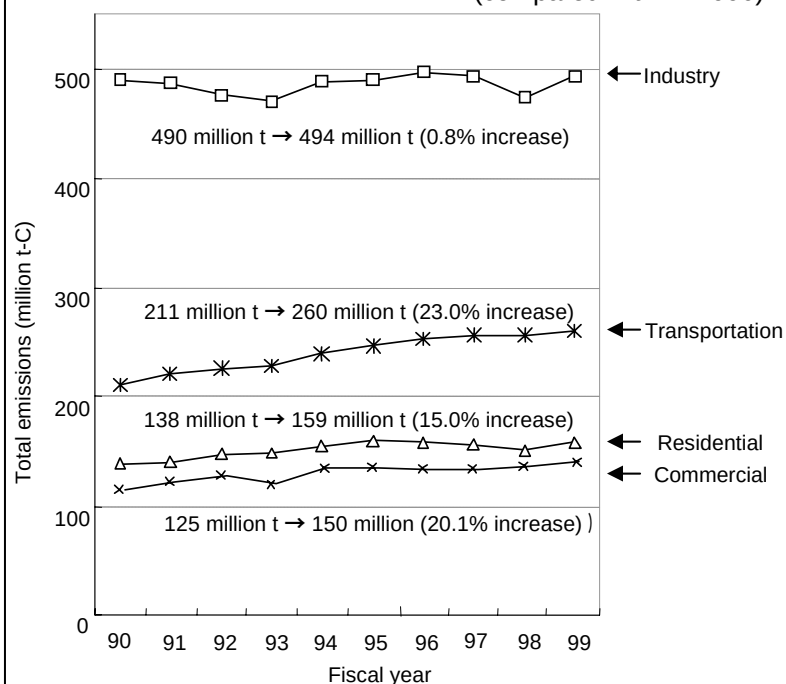
【Change in energy-originating CO_2 emissions in Japan】



Source: Comprehensive Energy Statistics

【Growth of emissions till FY1999 by sector】

(compared with FY1990)

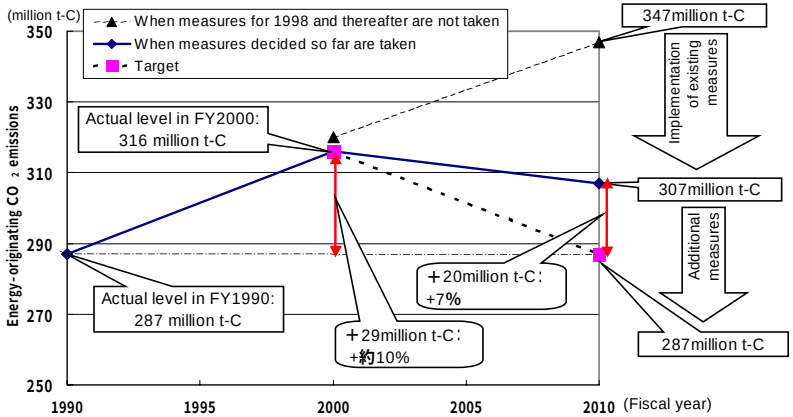


Source: Cabinet Meeting Regarding Protection of Global Environment (July 10, 2001)

Reduction of Energy-Originating CO_2 Emissions and Energy Supply Outlook

Goal — **About 90% of emitted greenhouse gas is energy-originating carbon dioxide. The goal is to reduce CO_2 emissions to the 1990 level, by fiscal 2010 (Global Warming Measures Promotion Outline)**

Problems — **[Demand aspect] Consistent growth mainly in the commercial/residential and transportation sectors**
[Supply aspect] Prolongation of the nuclear power plant establishment project



- Energy conservation / new energy measures
- Implementation of Keidanren's independent action plan
- Promotion of nuclear power policy, etc.

Energy conservation:
- 6 million t-C
New energy:
- 9 million t-C
Fuel change, etc.:
- 5 million t-C
Total: - 20 million t-C

Target of greenhouse gas measures

(Point)

Reduction of energy-originating CO_2 to about 287 million t-C (FY1990 level)

▲2.5%	Reduction of emissions of CO_2, methane, and dinitrogen monoxide
	(Among them) ±0%: reduction of energy-originating CO_2
	If no additional measures are taken (simple maintenance of present measures) Exceeds by about 20 million t-C ← Measures: Energy conservation: ▲6 million t-C; New energy: ▲9 million t-C; Others (fuel change, etc.) ▲5 million t-C
▲3.9%	Change of land usage and absorption by forest activities
+2.0%	Reduction of emissions of CFCs substitutes (HFC, PFC, SF6)
Remains (or Rest) ▲1.6%	Joint measures and use of emission permit transactions, etc.

Primary energy supply outlook

(Point)

Oil dependency rate: reduction to about 45% by FY2010

Item \ Fiscal year	1999 (composition ratio)	1999 (composition ratio)
Oil	52%	About 45%
Coal	17%	About 19%
Natural gas	13%	About 14%
Nuclear	13%	About 15%
Hydro	4%	About 3%
New energy	1%	About 3%

Outlook on electric energy generation (electric enterprises)

(Unit: 100 million kWh)

Fiscal year	1999		2010	
Electric energy generated	9176		About 9970	
By power source	Actual number	Composition ratio (%)	Actual number	Composition ratio (%)
LNG	2405	26.2	About 2549	About 26
Coal	1529	16.7	About 1599	About 16
Oil, etc.	1129	12.3	About 533	About 5
Nuclear	3165	34.5	4186	About 42
Hydro	893	9.7	962	About 10
Geothermal	34	0.4	37	About 0.4
New energy	21	0.2	115	About 1
CO_2 emission basic unit (g • C/kWh)	89.9		About 73.6	

Definition of New Energy

What is new energy?

As to new energy, “use, etc., of new energy” is stipulated in the Special Measures Law on Promoting Use of New Energy, which was enforced in 1997, and new energy is positioned as something that Japan should aggressively promote introduction of, as policy support, as follows:

(1) among manufacturing, generation, use, etc., of oil-alternative energy,
(2) energy that is not being spread due to economic restriction,
(3) energy that especially contributes to the promotion of oil-alternative energy.

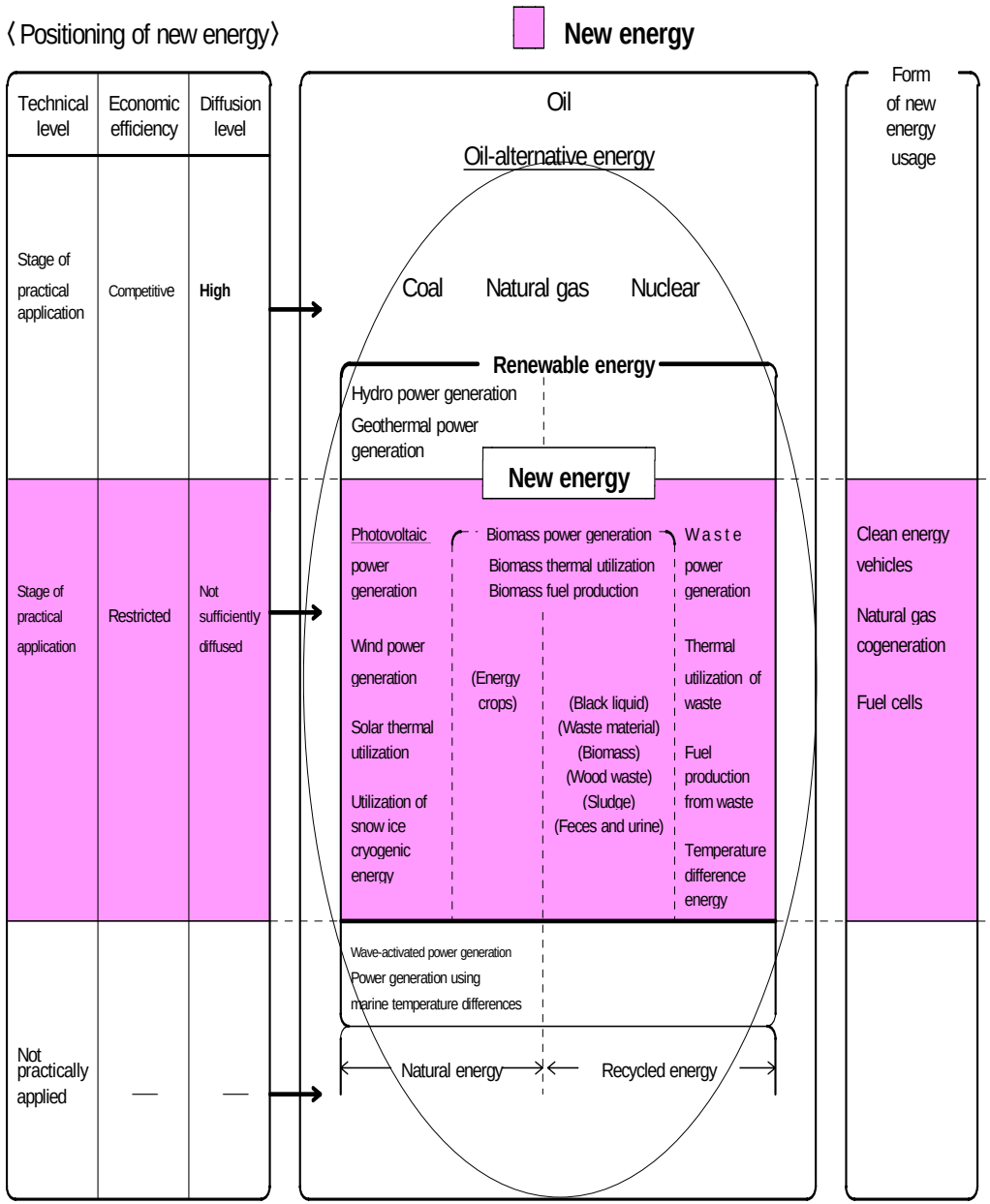
Specifically, new energy resources include the following:

- **New energy on the supply side**
  (Power generation field)
  - Photovoltaic power generation
  - Wind power generation
  - Waste power generation
  - Biomass power generation

  (Thermal field)
  - Solar thermal utilization
  - Thermal utilization of waste
  - Biomass thermal utilization
  - Utilization of snow ice cryogenic energy
  - Temperature difference energy

  (Power generation / heat)
  - Fuel production from waste
  - Biomass fuel production
- **New energy on the demand side**
  - Electric vehicles (including hybrid), natural gas vehicles, methanol vehicles
  - Natural gas cogeneration
  - Fuel cells

〈Positioning of new energy〉



(Remarks) Black liquid means waste liquid generated from the pulp production process.

Significance of Introducing New Energy

New energy has various significances, such as contributing to the construction of a sustainable economic society, and the creation of new industries and employment, etc., and contributing to securing stable energy supply and addressing global environmental problems, as domestic energy resources with low restriction, and as oil-alternative energy that contributes to lowering oil dependency, and that places a low burden on environment, such as low emission of carbon dioxide.

◯Oil-alternative energy that contributes to securing stable energy supply
- Domestically produced energy facilitating stable energy supply, on which less resource constraint is imposed.
- Oil-alternative energy that reduces oil dependency

◯Clean energy with less environment impact
- Clean energy with less environment impact compared with fossil energy (new energy on the supply side)
- If energy efficiency is high, consumption of fossil energy can be reduced (new energy on the demand side)

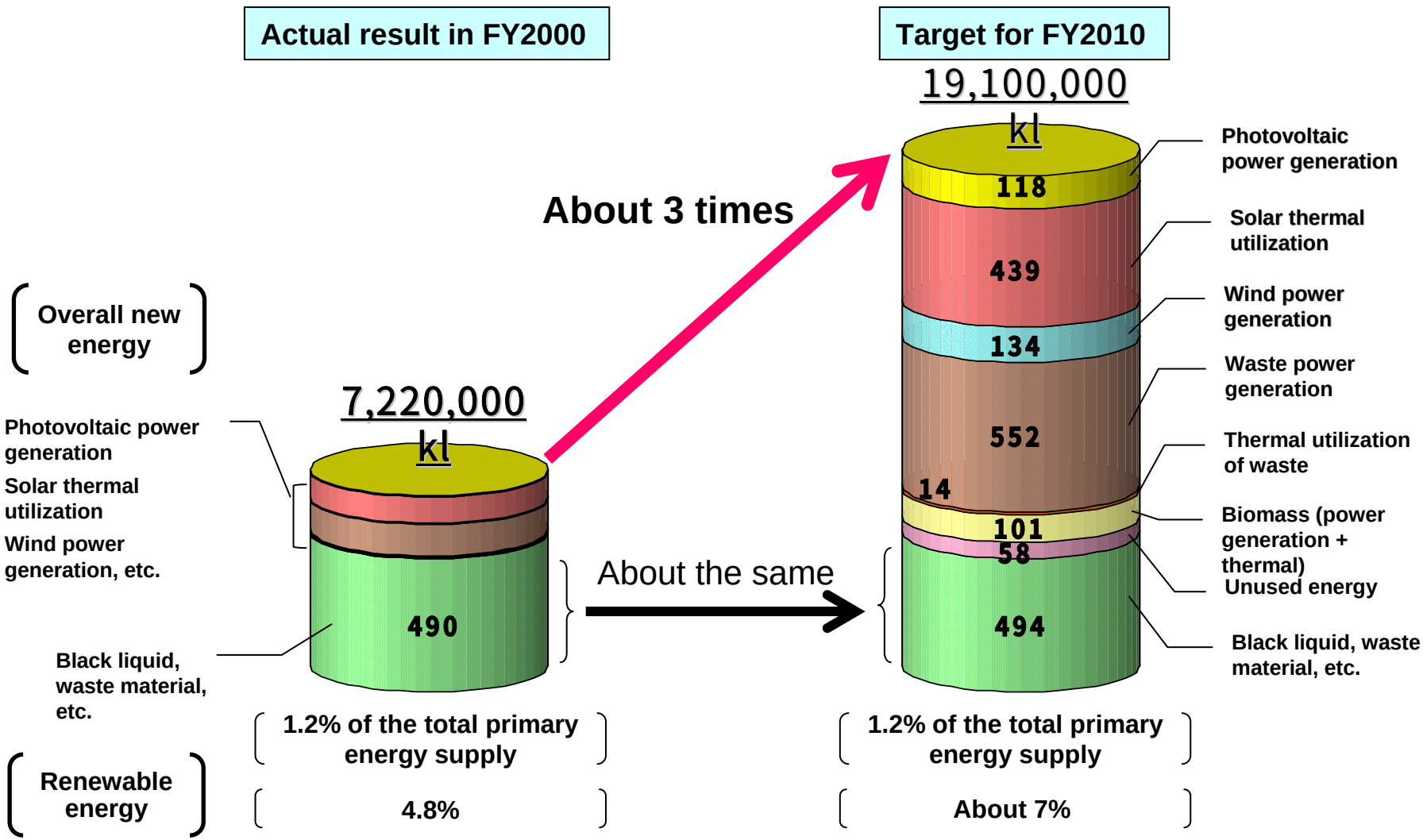
◯Contribute to the creation of new industry and employment
- High potential for creating new markets and employment in the process of developing new technology and products
- Contribute to strengthening the competitiveness of Japanese companies

◯Benefits of a distributed energy system
- Can be used as a stand-alone energy system independent from commercial power distribution, in the event of an emergency, such as a disaster.
- Can be installed near where energy is needed, resulting in reduced energy loss during electric power transmission.

◯Potential for leveling the power consumption (reducing peak consumption)
- It is possible to level power consumption by operating the photovoltaic power generation system, etc., during the daytime in the summer.

Actual Result of Introducing New Energy, and Targets of Introduction for FY 2010

- ○The new energy introduction target for fiscal 2010, based on the maximum efforts by governments and the people, was set at 19.1 million kl, in terms of crude oil.
- ○This target was positioned in the Global Warming Measures Promotion Outline (decided by the Global Warming Measures Promotion Headquarters, on March 19, 2002).



Actual Result of Introducing New Energy, and New Introduction Targets (No. 1)

As a result of study based on the maximum efforts of governments and the people, the “new energy introduction target,” on the supply side, was newly set at 19.1 million kl, in terms of crude oil (the rate in the total primary energy supply is about 3%).

New energy on the supply side

		FY2000	FY2010 target		2010 / 2000	Measures to achieve the new energy introduction target for FY2010
			Present measures maintenance case	Target case		
Power generation field	Photovoltaic power generation	81,000 kl (330,000 kW)	620,000 kl (2,540,000 kW)	1,180,000 kl (4,820,000 kW)	About 15 times	Promotion of cost reduction through mass production effect by technological development and introduction support, to achieve early market independence.
	Wind power generation	59,000 kl (144,000 kW)	320,000 kl (780,000 kW)	1,340,000 kl (3,000,000 kW)	About 23 times	Study on stabilization and systematic measures, in addition to subsidy measures for advanced facilities and model projects, to promote further introduction.
	Waste power generation	81,000 kl (1,030,000 kW)	2,080,000 kl (1,750,000 kW)	5,520,000 kl (4,170,000 kW)	About 5 times	Promotion of technological development, and continuation of support toward model projects.
	Biomass power generation	47,000 kl (69,000 kW)	130,000 kl (160,000 kW)	340,000 kl (330,000 kW)	About 7 times	Clear positioning as new energy; careful judgment of economic efficiency and effectiveness, by conducting technological development and experimental testing; providing of subsidy, etc., toward model projects, as it is highly expected as a new energy.
Thermal utilization field	Solar thermal utilization	890,000 kl	720,000 kl	4,390,000 kl	About 5 times	Promotion of cost reduction through support for introducing advanced or high-level systems
	Thermal utilization of waste	45,000 kl	44,000 kl	140,000 kl	About 3 times	Continuation of support toward model projects that are conducted by local public bodies and private businesses.
	Biomass thermal utilization	—	—	670,000 kl	—	Clear positioning as new energy; careful judgment of economic efficiency and effectiveness, by conducting technological development and experimental testing, and providing of subsidy, etc., toward model projects, as it is highly expected as a new energy.
	Unused energy (including snow ice cryogenic energy)	45,000 kl	93,000 kl	580,000 kl	About 13 times	Promotion of technological development, and continuation of support toward enterprises that use unused energy. Implementation of research on snow ice cryogenic energy.
	Black liquid, waste material, etc. (*)	4,900,000 kl	4,790,000 kl	4,940,000 kl	About the same	Further effective use of black liquid and waste material in the paper manufacturing and pulp industry.
Total (rate in total primary energy supply)		7,220,000 kl (1.2%)	8,780,000 kl (1.4%)	19,100,000 kl (about 3%)	About 3 times	
Total primary energy supply		About 600 million kl	About 620 million kl	About 600 million kl		

* Organized as one of biomass, and partially includes those used for power generation.

Actual Result of Introducing New Energy, and New Introduction Targets (No. 2)

Renewable energies

	FY2000	FY2010 target		2010 / 2000
		Present measures maintenance case	Target case	
Total of new energy supply	7,000,000 kl	9,000,000 kl	19,000,000 kl	About 2.7 times
Hydro (conventional)	21,000,000 kl	20,000,000 kl	20,000,000 kl	About the same
Geothermal	1,000,000 kl	1,000,000 kl	1,000,000 kl	About the same
Total of renewable energies (rate in the total primary energy supply)	29,000,000 kl (4.9%)	30,000,000 kl (4.8%)	40,000,000 kl (About 7%)	About 1.4 times
Total primary energy supply	604	622	602	

Demand-side new energy sources

	FY2000	FY2010 target		2010 / 2000	Measures to achieve the new energy introduction target for 2010
		Present measures maintenance case	Target case		
Clean energy vehicles *1	82,000 vehicles	890,000 vehicles	3,480,000 vehicles	About 42 times	Promotion of technological development, and cost reduction through mass production effect to be achieved by subsidy. Maintaining support for providing of fuel supply equipment.
Natural gas cogeneration *2	1,700,000 kl	3,440,000 kl	4,640,000 kl	About 3 times	Promotion of technological development for cost reduction and higher efficiency, and providing of subsidy for leading-edge equipment and model projects
Fuel cells	12,000 kl	40,000 kl	2,200,000 kl	About 183 times	For the phosphoric acid type, continuation of subsidy for model projects. For the proton exchange type, acceleration of technological development, implementation of experimental testing, and establishment of standards, etc., for safety.

*1 Including demand-side new energy sources, such as electric vehicles, fuel cell vehicles, hybrid vehicles, natural gas vehicles, methanol vehicles, and diesel-alternative LP gas vehicles.

*2 Including those powered by fuel cells.

International Comparison of Results of New Energy Introduction

International comparison of photovoltaic and wind power generation

Installed capacity (unit: 10,000 kW)					
Photovoltaic (as of the end of FY2001)			Wind (as of the end of December 2001)		
① **Japan**	45.22	46.0%	① Germany	875.3	49.4%
② Germany	19.47	19.8%	② US	424.5	24.0%
③ US	16.78	17.1%	③ Spain	333.5	18.8%
④ Australia	3.36	3.4%	④ Denmark	241.7	13.7%
⑤ Netherlands	2.05	2.1%	⑤ India	150.7	8.5%
⑥ Italy	2.00	2.0%	⑥ Italy	69.7	3.9%
⑦ Switzerland	1.76	1.8%	⑦ UK	48.5	2.7%
⑧ Mexico	1.50	1.5%	⑧ Netherlands	48.3	2.7%
⑨ France	1.39	1.4%	⑨ China	39.9	2.3%
⑩ Spain	0.91	0.9%	⑩ **Japan**	31.2	1.8%
⑪ Canada	0.88	0.9%	⑪ Sweden	28.0	1.6%
⑫ Austria	0.66	0.7%	⑫ Greece	27.2	1.5%
⑬ Norway	0.62	0.6%	⑬ Canada	20.7	1.2%
⑭ Korea	0.48	0.5%	⑭ Portugal	12.7	0.7%
⑮ Sweden	0.30	0.3%	⑮ Ireland	12.5	0.7%
⑯ Finland	0.28	0.3%	⑯ Egypt	12.5	0.7%
Global total	98.22	100%		1,770.6	100%

[Note] The value on wind power for Japan is based on the survey by NEDO (as of the end of March 2002).

[Source]
- NEDO research based on IEA statistics for the result of photovoltaic power generation as of the end of FY2001.
- "Wind Power Monthly April 2001" for the result of wind power generation as of the end of December 2001.

Rates of renewable energies in the total energy supply volume in various countries

Renewable energy sources: solar, wind, waste, hydraulic [excluding pumped storage type], geothermal, etc.)

	Primary energy supply		Based on generated power volume	
	Record of 1999	Target for 2010	Record of 1999	Target for 2010
Japan	4.9% (4.8%)	About 7%	10.3%	About 11%
US	5.4%	6.9%	9.6%	9.2%
Canada	16.8%	–	61.1%	–
EU	5.5%	12.0%	14.8%	22.1%
UK	1.2%	–	3.8%	10.0%
France	7.0%	–	14.6%	21.0%
Germany	1.9%	–	6.2%	12.5%
Italy	5.1%	–	20.1%	25.0%
Denmark	9.3%	–	12.4%	29.0%
Sweden	29.7%	–	48.6%	60.0%
Austria	23.9%	–	71.5%	78.1%

	Record of 1997	Prospect for 2010
Entire world	5%	5%
OECD nations	6%	6%
Developing nations	4%	4%

[Note] The values for Japan are on the fiscal-year basis. The number in ( ) shows the record of FY 2000.

[Source]
- Report by the Advisory Committee on Energy and Natural Resources (July 2001) for the FY1999 record and the 2010 target for Japan.
- "Comprehensive Energy Statistics (FY2001 edition) by the Agency of Natural Resources and Energy, for the FY2000 record.
- "Energy Balance of OECD Countries 1998-1999" (2001 edition) for overseas records for 1999.
- The above report for the U.S.A. 2010 target on total primary energy supply.
- EU command (September 2001) for the EU 2010 target.
- IEA "World Energy Outlook 2000" for the 1979 record and the 2010 prospect for the entire world, etc.

Problems in New Energy Introduction and Efforts to Overcome the Problems (Output Stability)

Problems concerning output stability

Natural energy, such as photovoltaic power generation and wind power generation, is unstable in output because of dependency on sunshine, wind conditions, etc.

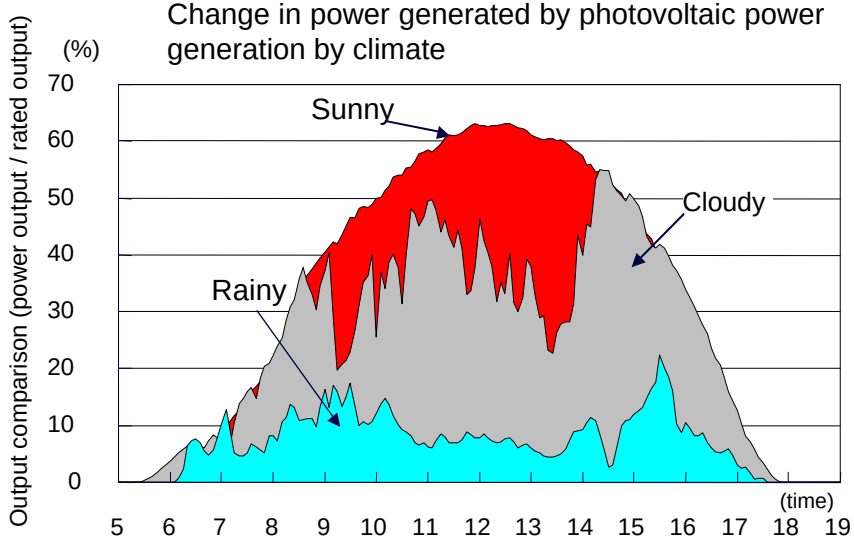
At present, therefore, these renewable energies are considered to be supplementary power sources, since power sources are expected to assure stable power, and, to ensure stable power supply, it is necessary to combine renewable energy with an adjustable power source or storage battery.

It is pointed out that general customers can also be affected through deterioration of electricity quality according to increased incorporation of new energy into electric systems, such as large-scale introduction of wind power generation, whose output is unstable.

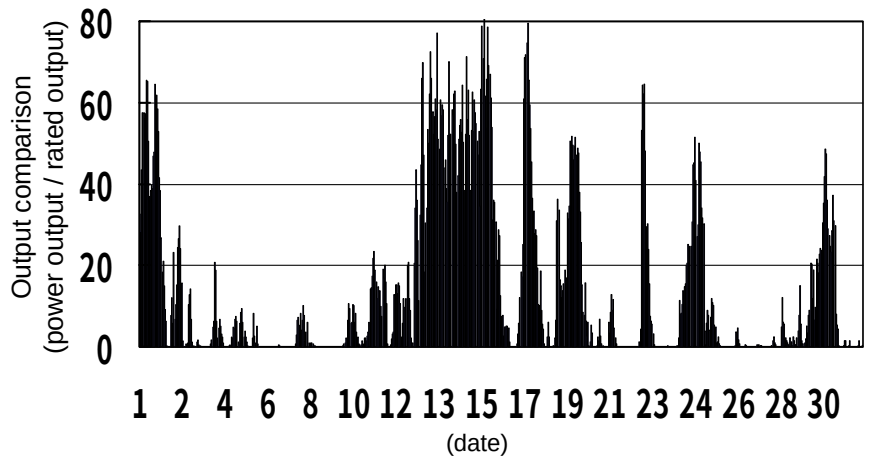
Efforts to overcome the problems

To conduct experimental study, etc., on the effects of voltage variation and frequency variation on the electric systems, regarding photovoltaic power generation and wind power generation combined with storage batteries.

Change in power generated by photovoltaic power generation by climate



Change in power output in August 1999 at Tappi Wind Park



Problems in New Energy Introduction and Efforts to Overcome the Problems (Use Efficiency)

Use efficiency of representative new energies

	Power generation efficiency	Facility usage rate
Photovoltaic power generation *1	10~15%	12%
Wind power generation *2	20~40%	15~30%
General waste power generation *3	10~30%	Average 61%
Natural gas *4	For the public: 35% For industry: 35~36%	For the public: 3,000 hours/year For industry: 6,000 hours/year
Fuel cells (phosphoric acid type)	35%	6000 hours/year

*1 The equipment use rate of photovoltaic power generation depends on the duration of sunshine, etc.

*2 The equipment capacity of wind power generation depends on wind conditions, but it is generally considered to be about 20%.

*3 The equipment use rate of general waste power generation is the actual result of FY1999. Power generation efficiency was calculated considering caloric power of general waste as 2,100 kcal/kg.

*4 Power generation efficiency, and equipment use rates, of natural gas cogeneration and fuel cells, are representative values. Also, as to general energy efficiency, which is efficiency of power generation and utilization of waste heat, over 70% was achieved.

(Reference: General power efficiency and equipment use rates of existing power sources)

	Power generation efficiency	Equipment use rate
Coal-fired power	40%	About 70%
Oil-fired power	37%	About 20%
LNG-fired power	41%	About 50%
Nuclear	34.5%	About 80%

Average of 10 general electric enterprises in fiscal 1998

Some new energies have low energy conversion efficiency, such as power generation efficiency, and low equipment use rates, and they have problems in use efficiency.

Technological development to improve energy conversion efficiency, such as generation efficiency, and the equipment use rate, is needed.

Improvement of the use rate will also lead to the following:

(1) An increased number of sites that have potential to introduce new energy and increased introduction capacity

(2) Improved economic efficiency.

Problems in Introducing and Expanding New Energy (Economic Efficiency)

Problems concerning economic efficiency

Technological development and implementation of introduction-promoting measures have been reducing equipment cost and power generation cost of new energy, but the present cost levels are still higher than those of the existing power sources.

The present power generation cost of residential photovoltaic power generation is as high as a few times the household electric charge.

The wind power generation cost has decreased (about 9 to 14 yen /kWh) through reduction of equipment cost achieved by adoption of large-scale equipment in recent years, but the cost of small- and medium-scale equipment is still high.

Efforts to overcome the problems

Technological development to improve energy conversion efficiency, etc., and implementation of introduction support projects, such as equipment cost subsidy schemes, aimed at establishing market independence by creating initial demand (for example, aiming to lower the cost of residential photovoltaic power generation to the level of the household electric power charge).

● Power generation cost of new energy

(unit: about yen/kWh)

Type	Photovoltaic power generation		Wind power generation		Waste power generation		Biomass power generation	Small- and medium-scale hydro power generation
	Residential	Non-residential	Large scale	Small and medium scale	Large scale	Small and medium scale		
Power generation cost	46~66	73	9~14	18~24	9~11	11~12	7~21	14

[Source] Report (July 2001) by the New Energy Subcommittee of the Advisory Committee on Energy and Natural Resources, and others

● Power generation cost by power source

(unit: yen/kWh)

Type	Nuclear power generation	LNG-fired power	Coal-fired power	Oil-fired power
Power generation cost	5.9	6.4	6.5	10.2

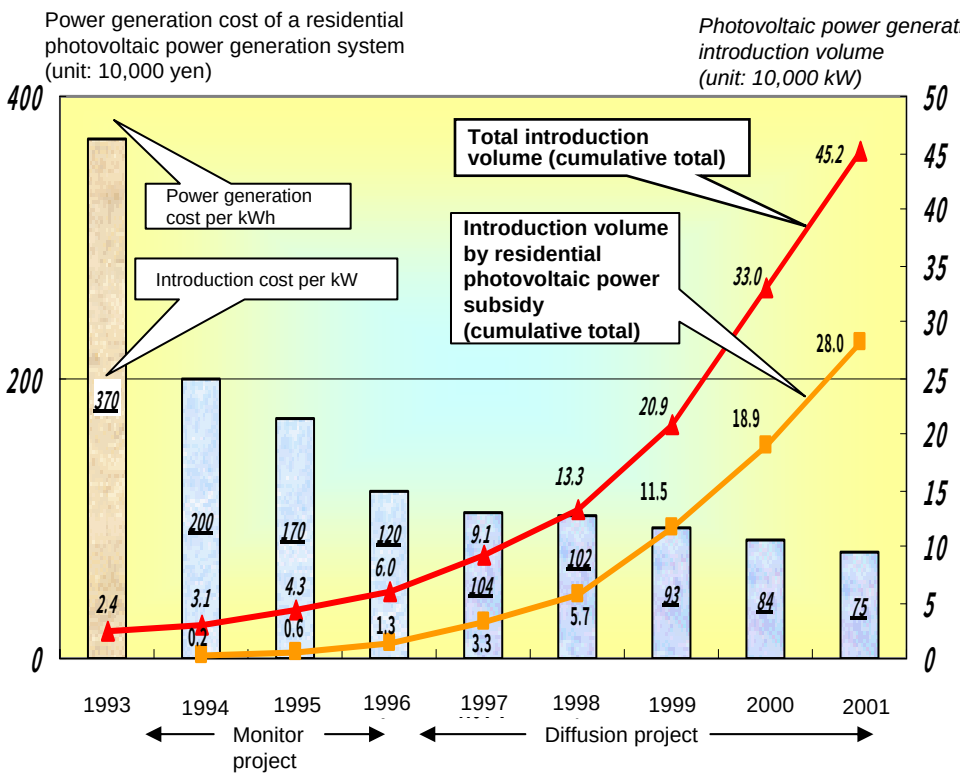
[Source] Data of the 70th Nuclear Power Subcommittee (December 1999) of the Advisory Committee for Energy

Image of Efforts to Improve Economic Efficiency of New Energy

Change in economic efficiency of residential photovoltaic power generation

Reduced the average system price to about 0.77 million yen /kW, which is about one-fifth of that of eight years ago (FY1993), through technological development achieved over the past 20 years, surplus electricity schemes by electric companies (from 1992), installation subsidy by the Government (from 1994), etc.

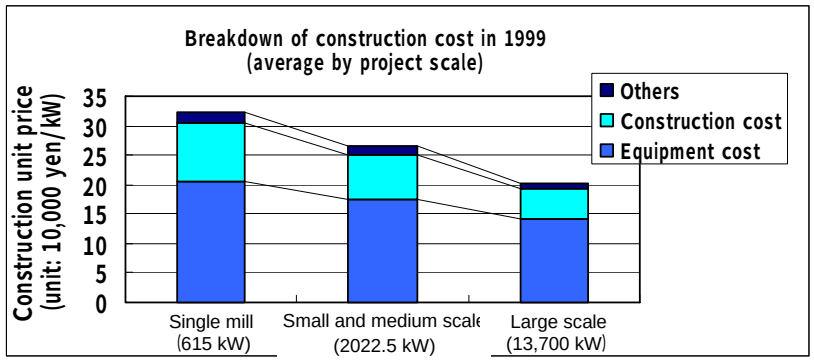
Change in introduction volume, price, and power generation cost of a residential photovoltaic power generation system

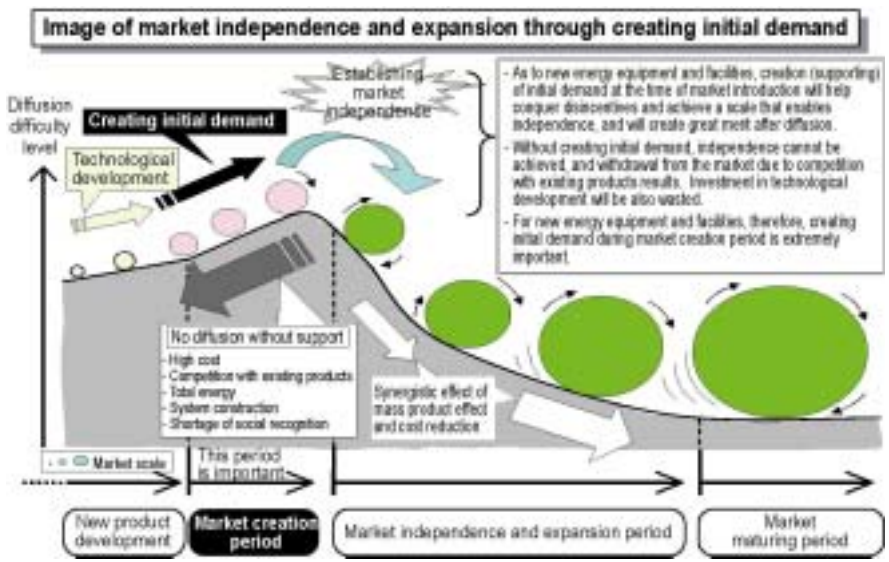


Source: Trial calculation by the Ministry of Economy, Trade and Industry, based on discussion with the maker, etc.

Relation between equipment scale and economic efficiency of wind power generation

As to wind power generation, generally, the larger the scale, the lower the installation cost. In recent years, equipment size and project scale have been increasing.





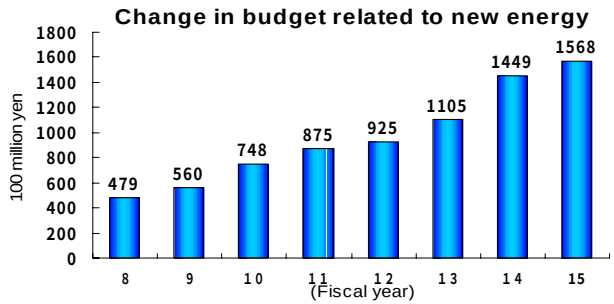
Policy Strengthening toward Expansion of New Energy Introduction

Legal aspect

January 2002	Added two new energy sources: “biomass” and “snow ice,” to the new energy sources stipulated in the Law on Promoting Use of New Energy (in fiscal 2002, the Government began supporting projects to introduce these energies).
May 2002	Establishment of the “Special Measures Law on Promoting Use of New Energy, etc., by Electric Enterprises” This Law made it obligatory, starting in April 2003, for electric enterprises to increase the power generation rate by new energy sources, such as photovoltaic power, wind power, and biomass.)

Budget aspect

Fiscal 2003 budget plan related to new energy: 156.8 billion yen
(an increase by 11.9 billion yen compared with the previous fiscal year; almost tripled in the past six years)



Collaboration among ministries

- **The entire Government positioned new energy introduction targets in the Global Warming Measures Promotion Outline decided in March 2002.**
- **Especially in the biomass field, systematic collaboration among ministries is important.**

Ministry of Economy, Trade and Industry	Ministry of Agriculture, Forestry and Fisheries	Ministry of Land, Infrastructure and Transportation	Ministry of the Environment
New energy measures	Biomass measures related to agriculture, forestry, and fisheries	Measures related to construction waste material and sewage sludge	Waste measures

Support for technological development and experimental testing, and appropriate collaboration in support for individual projects

Political or Policy Support for Development and Introduction of New Energy

● Change in budget

Fiscal year	1996	1997	1998	1999	2000	2001	2002	2003
Monetary amount (hundred million yen)	479	560	748	875	625	1,105	1,449	1,568
Balance (hundred million yen)	46	81	188	127	50	180	344	119
Growth rate	10.6	16.9	33.6	17.0	5.7	19.5	31.1	8.2

● Budget system

Phase		Content	Project	FY2003 FY2002 for ( )
Technological development		Implementation of technological development regarding important development issues, to promote cost reduction and performance improvement of new energy technology	•Photovoltaic power generation-related (7.4 billion yen) •Wind power generation-related (2.3 billion yen) •Fuel cells-related (23.4 billion yen) •Biomass-related (2.8 billion)	About 43.4 billion yen (about 38.8 billion yen)
Experimental testing		Implementation of experimental testing for experimenting and confirming the effectiveness in actual use, through such as extraction, elucidation, and management of problems that would hinder practical application of developed technology and its market introduction, based on the results of technological development.	•Field test on new technology for photovoltaic power generation, etc. (3.5 billion yen) •Experimental study on integrated linkage-type photovoltaic power generation systems (2.4 billion yen) •Experimental testing on unused energy, such as biomass (2.8 billion yen) •Experimental study on proton exchange-type fuel cells (3.9 billion yen)	About 18.8 billion yen (about 10 billion yen)
Promoting introduction	Establish-ment of market independ-ence	Creating initial demand for early establishment of market independence through mass production, as to new energy that is in the stage of practical application.	•Support to introduce residential photovoltaic power generation systems (10.5 billion yen) •Support to introduce advanced solar thermal utilization systems for residential use (2.8 billion yen) •Support to introduce clean energy vehicles (15.4 billion yen)	About 94.6 billion yen (about 96.1 billion yen)
	Advanced projects	Support to introduce advanced new energy by enterprises, municipalities, etc., and promote diffusion of similar projects	•New energy enterprise support measures (38.8 billion yen) •Regional new energy introduction promotion measures (12.7 billion yen) •Projects, such as establishment of regional new energy visions (1.3 billion yen)	
	Grass-roots level	Support for new energy introduction promotion projects by NGOs, etc., to accelerate grassroots-level new energy introduction.	•New energy non-profit activity promotion project (1.1 billion yen)	

Support System to Expand New Energy Use

General introduction flow

Establishment of regional new energy plans
- Grasping and analysis of regional characteristics
- Establishment of individual project plans, etc.

Study on project introduction and project implementation
- Introduction planning
- Study on financial source
- Project method
- Experimental testing, etc.

Judgment on project implementation

Coordination with related agencies, establishment of implementation plan, designing, **Installation construction**

Start of service of new energy

Main support systems

Support

Projects, such as establishment of regional new energy visions (for local public bodies)
Provision of subsidy for part of project costs toward local public bodies, to establish plans for discovering various energies latent in local regions, and giving fresh encouragement to improve regional vitality toward the 21st century. (Subsidy: set amount)

FY2002 budget: 1,230 million yen → FY2003 budget: 1,320 million yen

Support

Experimental testing on unused energies, such as biomass
(For enterprises and local public bodies)
Provision of subsidy for part of project costs toward enterprises, etc., that conduct experimental testing projects and project feasibility research, to effectively use unused resources that are latent in regions, such as biomass, as energy.

FY2002 budget: 1,100 million yen → FY2003 budget: 2,820 million yen

○Experimental testing project, subsidy: less than half (up to 50 million yen / case and year)
○Project feasibility research, subsidy: set amount (up to 10 million yen / case and year)

Support

Regional new energy introduction promotion project
(for local public bodies)
Provision of subsidy for part of project costs toward local public bodies, etc., that conduct model projects or advanced efforts, such as large-scale and intensive introduction of new energy. (subsidy: less than half)

FY2002 budget: 12.7 billion yen → FY2003 budget: 12.71 billion yen

New energy enterprise support project (for enterprises)
Provision of subsidy for part of project costs toward advanced enterprises that introduce new energy according to plans approved based on the New Energy Law. (subsidy: less than 1/3)

FY2002 budget: 23.62 billion yen → FY2003 budget: 38.82 billion yen

Independent Efforts by Electric Companies to Introduce New Energy

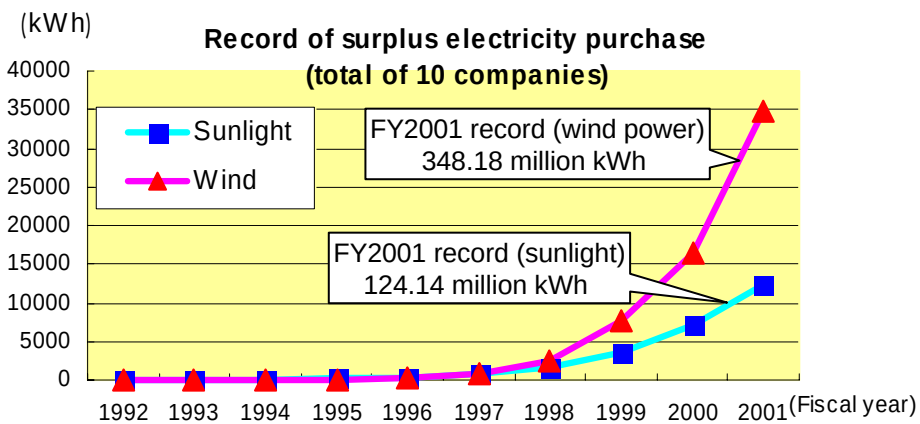
Surplus electricity purchase scheme

○Surplus electricity purchase scheme (from April 1992)

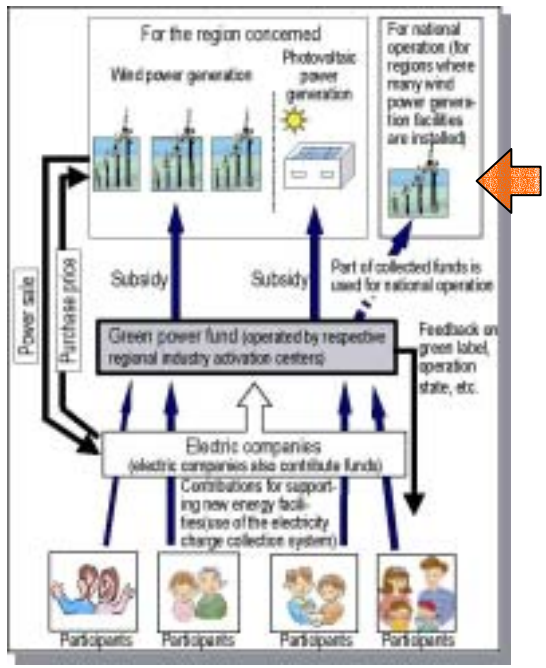
- Power generated from new energies, such as sunlight and wind, is purchased based on a surplus electricity purchase scheme independently set up by each electric company.
- As to photovoltaic power and wind power, the purchase price is the same as the market electricity charge.
- For an offer for electricity sales, the entire volume is purchased, in principle.
- However, as to large-scale wind power generation, a bidding system is partially introduced (from autumn 2000).

[Electricity purchase schemes for enterprises (long-term contract scheme)]

- Because wind power generation has been operating as actual business considerably, each electric company purchases it for a long term and stably, and wind power purchase schemes for businesses are separately set.
- Purchase unit price is 11.2 to 11.7 yen / kWh.
- Contract period is 15 years or 17 years.

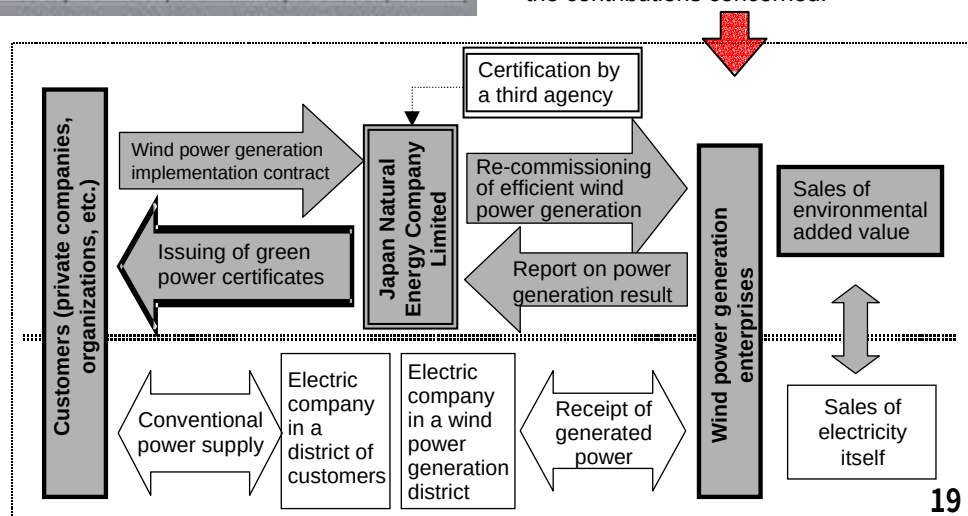


Green power system



[Green power system]
Ten electric companies throughout Japan collect contributions, for 500 yen per share from consumers in the electricity supply district, and, using the contributions and the companies' own contributions, as funds, the operator of the power fund system in each region issues subsidies for photovoltaic power generation and large-scale wind power generation for public benefit in the district concerned.

[Green power certificate system]
Entrusted companies established by electric companies collect capital contributions for wind power generation, from private companies, and, using them as funds, they commission power generation to wind power generation enterprises. Green power certificates are issued, to prove support based on the contributions concerned.



Outline on the Special Measures Law on Use of New Energy, etc., by Electric Enterprises

Law obligating electric enterprises to use electricity from new energy, etc. (enacted in 2002)

- ○Setting of a target for use of electricity from new energy, etc., by all electric enterprises
  - • Electricity from new energy, etc., means electricity obtained by converting wind power, photovoltaic power, geothermal power, small- and medium-scale hydro power, biomass and others.
  - • Target for use is 12.2 billion kWh for FY2010. (There is no breakdown target by new energy source.)
- ○For the standard use volume of electricity from new energy, etc., to be achieved by each electric enterprise, the entire use target is allocated according to the ratio of electric energy sold by each.
  - • An electric enterprise can freely choose which new energy sources to use to achieve the standard use volume.
- ○A legal pledge is required regarding achieving the standard use volume.
- ○Being a new energy power generation facility is authorized by the Government.
- ○Actual obligation is planned to start in April 2003.

(As of January 2003)

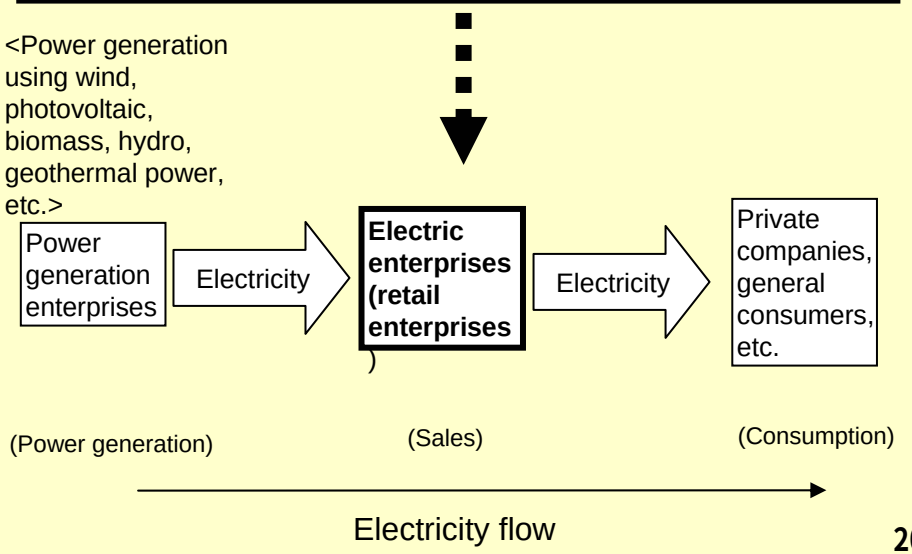
Electric enterprises (retail enterprises) applicable to obligation: a total of 25 companies

[General electric enterprises] a total of 10 companies

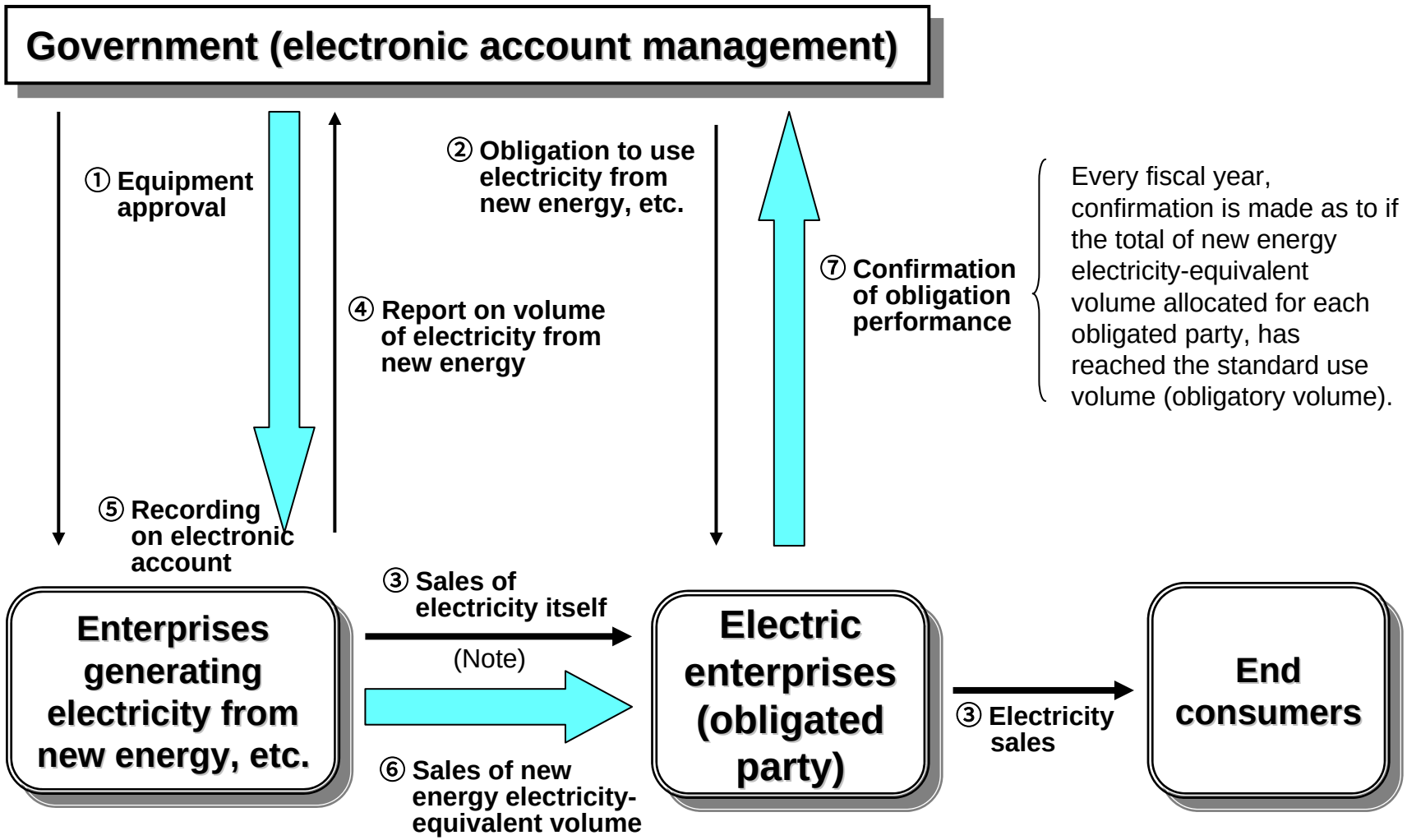
Hokkaido Electric Power Co., Ltd.	Tohoku Electric Power Co., Ltd.
Tokyo Electric Power Co., Ltd.	Chubu Electric Company, Incorporated
Hokuriku Electric Power Co.	Kansai Electric Power Co., Inc.
Chugoku Electric Power Co., Inc.	Shikoku Electric Power Co., Inc.
Kyushu Electric Power Co., Inc.	Okinawa Electric Power Co., Inc.

[Specific-scale electric enterprises, specific electric enterprises] a total of 15 companies

Diamond Power
E-LEX
Suwa Energy Service
Amagasaki Utility Service And others



Scheme of the Special Measures Law on Use of New Energy, etc., by Electric Enterprises



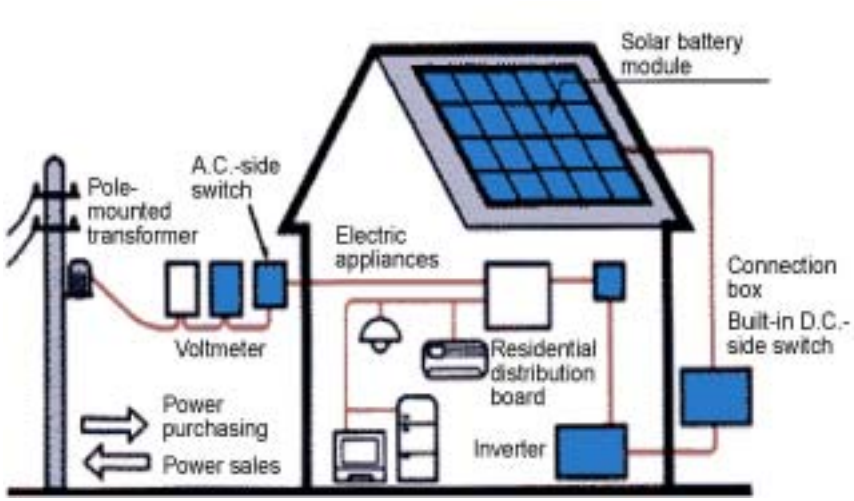
(Note) ③ electricity sales and ⑥ sales of the new energy electricity-equivalent volume can be separated and conducted to different enterprises.

References

(New Energy-Related)

What is Photovoltaic Power Generation?

The method of generating power by using the phenomenon of electricity being generated when light is directed onto silicone semiconductor, etc., and directly converting solar energy into electricity by a solar battery (microchip).



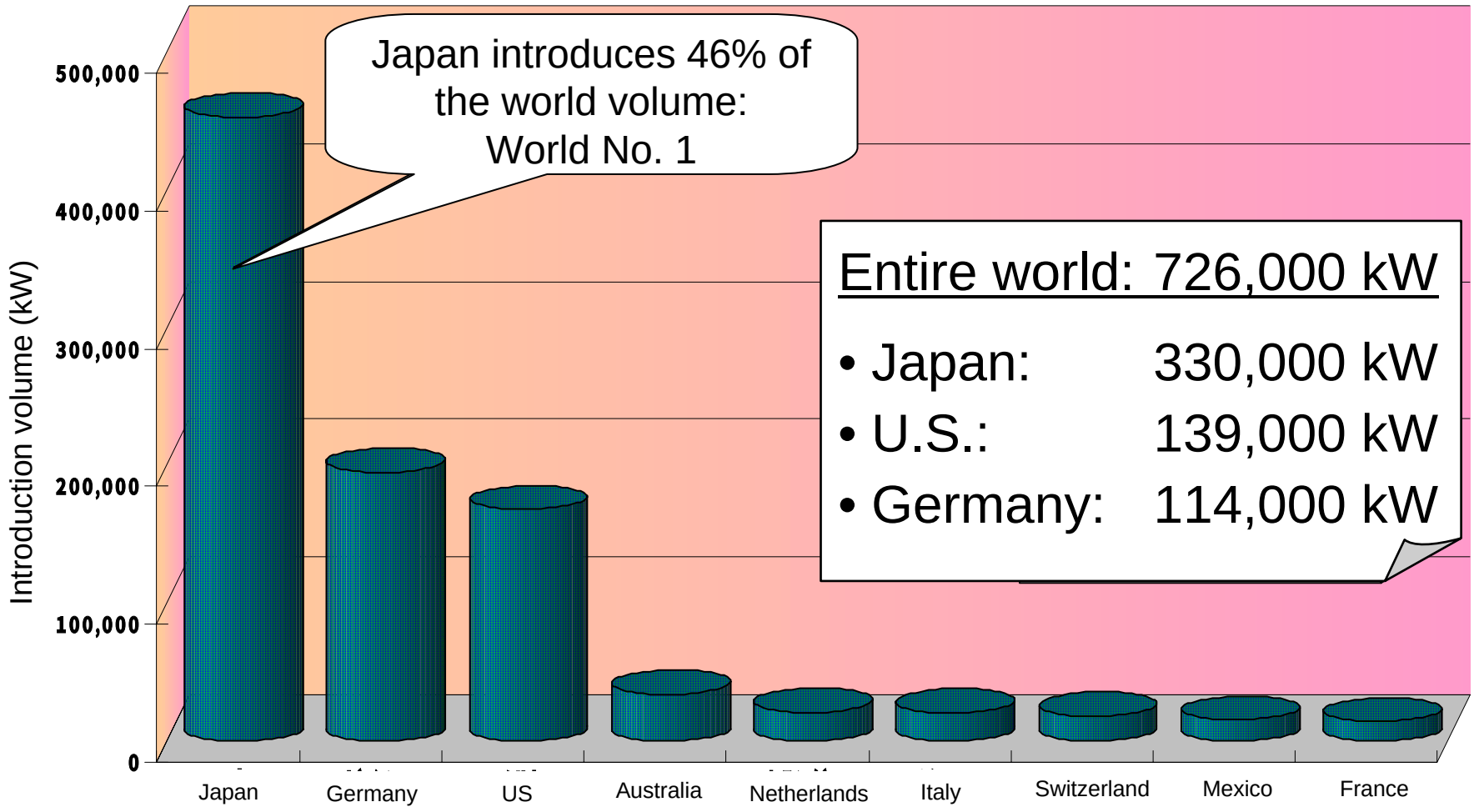
* Inverter: Converts generated D.C. power to A.C. power
* Metering device: Calculates power purchased from and power sold to an electric company.

For 3.5 kW equipment

- Necessary
- Electricity generated: about 3,680 kWh/year
  Trial calculation formula:
  3,680 kWh/year = 3.5kW x (24h x 365D) x use rate 12%
- Electricity consumed by a general household: about 3,600 kWh per year
- Durability: 10 to over 20 years
  * Legal durability: 15 years
- Cost: About 3 million yen including construction fee (FY2000)

(Remarks)
- The size of electricity equipment (kW) corresponds to the size of the diameter of a water pipe.
- The electricity generated (kWh) corresponds to the volume of water from a water pipe.

Recent Photovoltaic Power Generation Introduction Volume (International Comparison)



Source: Trends in Photovoltaic Applications / IEA (as of 2001) (provisional value)

Scenario on Introduction and Expansion of Photovoltaic Power Generation

2002 2005 2010 2020 2030

Stage of experimental testing and introduction

Diffusion stage

Research and development / technological development

- Development of diffusion promotion-type technology
- Development of advanced solar battery technology
- Development of revolutionary next-generation technology
- Research and development, and investigation, on common basic technology
- Integrated linkage-type experimental testing

Establishment of essential technology

(Medium- and long-term technological development)

Establishment of essential technology

(Research and development on common basic technology to meet new needs)

Implementation of technological development for further cost reduction and efficiency improvement

Measures toward introduction and diffusion

Support for experimental testing and introduction

- Photovoltaic power generation field test project
- Project to establish a foundation for introducing residential photovoltaic power generation
- Project to aid promotion of regional new energy introduction

2010 introduction target: photovoltaic power generation 4.82 million kW

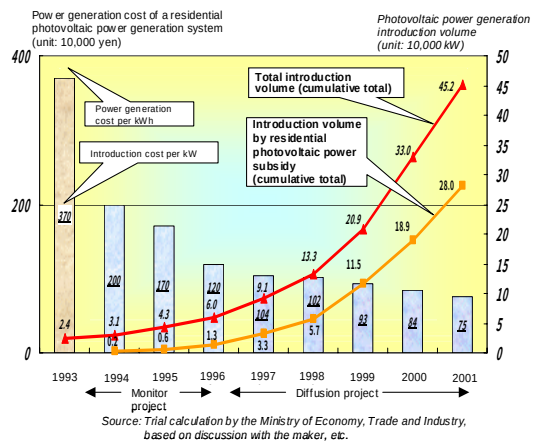
Establishment of infrastructure in the software aspect (systems)

- Review of related systems and regulations (construction of certification systems, etc.)
- Special Measures Law on Use of New Energy, etc., by Electric Enterprises (from 2003)

International cooperation

- International joint experimental development on photovoltaic power generation systems, etc.

Change in introduction volume, price, and power generation cost of a residential photovoltaic power generation system



Source: Trial calculation by the Ministry of Economy, Trade and Industry, based on discussion with the maker, etc.

Private companies' efforts

Economic target

Module cost (technological level)	140 yen/W →	100 yen /W →	75 yen /W →	50 yen /W →	30 yen /W
Residential system sales price		370,000 yen/kW	300,000 yen/kW	200,000 yen/kW	120,000 yen/kW
Power generation cost (introduction level)		30 yen/kW	25 yen/kW	10〜15 yen/kW	5〜10 yen/kW

Electric companies

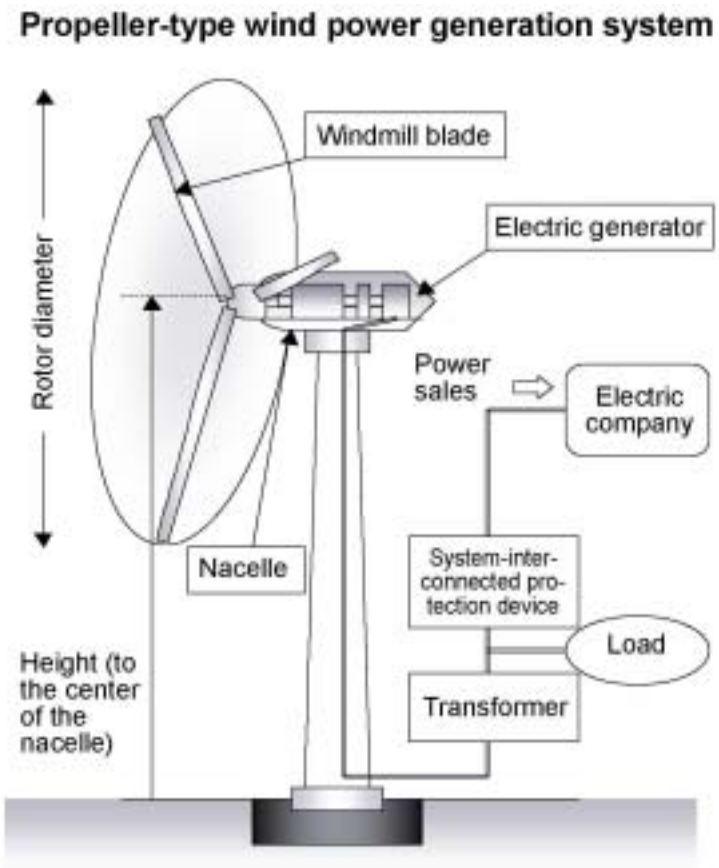
- Market expansion through surplus electricity purchase scheme
- Support by a green power system

Makers, etc.

- Maintenance of international superiority by using results of technological development and improving productivity

What is Wind Power Generation?

The method of generating power by rotating windmills,
and conveying the rotational movement to power generators.



In the case of 1,000 kW equipment

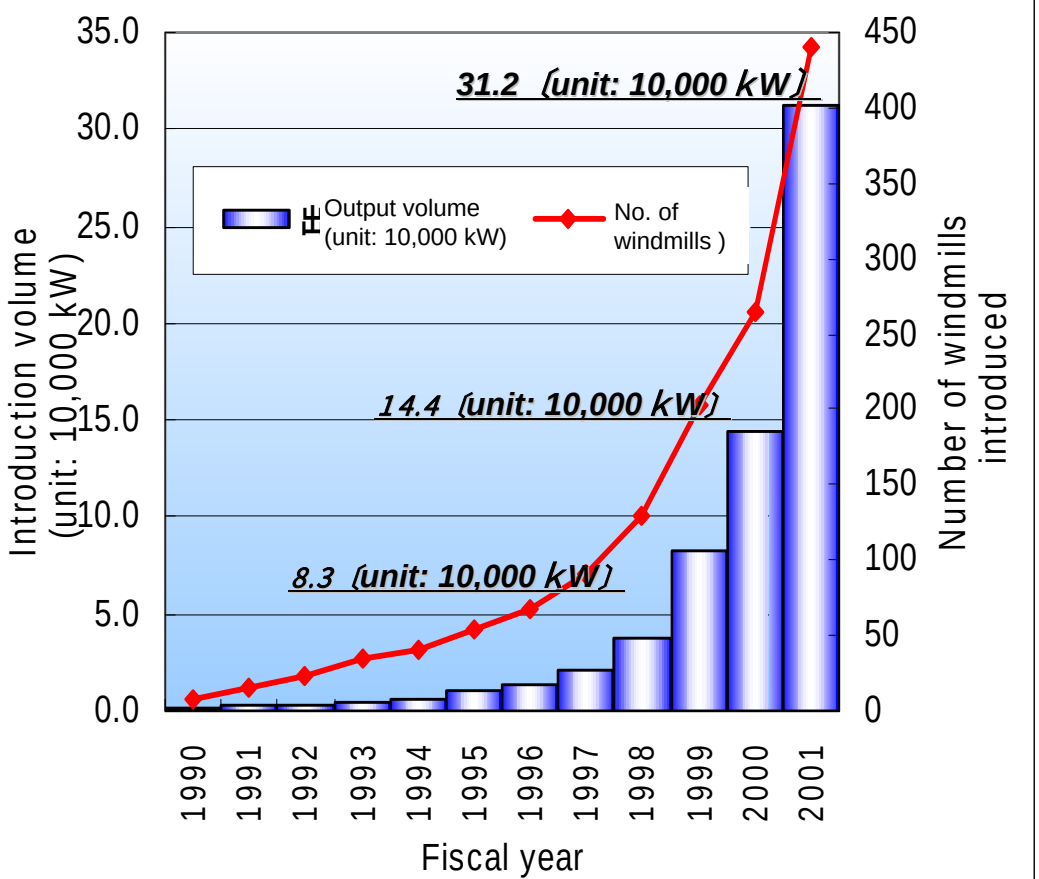
(Rotor diameter: D=56 m, height (to the center of nacelle): 60 m)

- Necessary site area: about 50,000 m^2
- Electricity generated:
  about 1.75 million kWh/year
  Trial calculation formula:
  175 kWh/year = 1,000 kW x (24h x 365D) x use rate 20%
  (For about 468 general households)
- Durability: 17 years (legal durability)
- Cost: About 200 to 300 million yen,
  including construction fee (FY2000)

Change in Wind Power Generation Introduction Volume in Japan

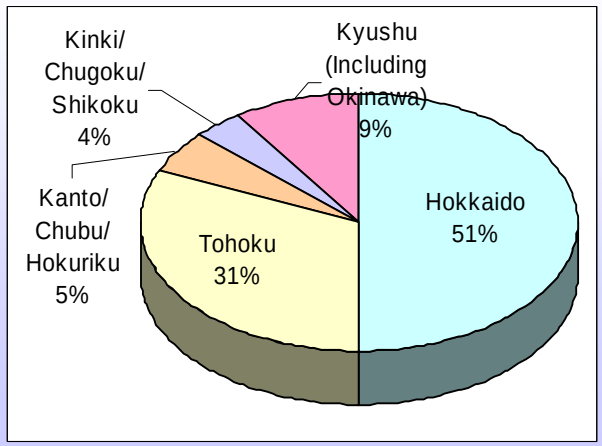
End of FY2001
31.2 (unit: 10,000 kW)

Actual introduction record



Source: NEDO research data

Introduction state by region (end of FY2001)

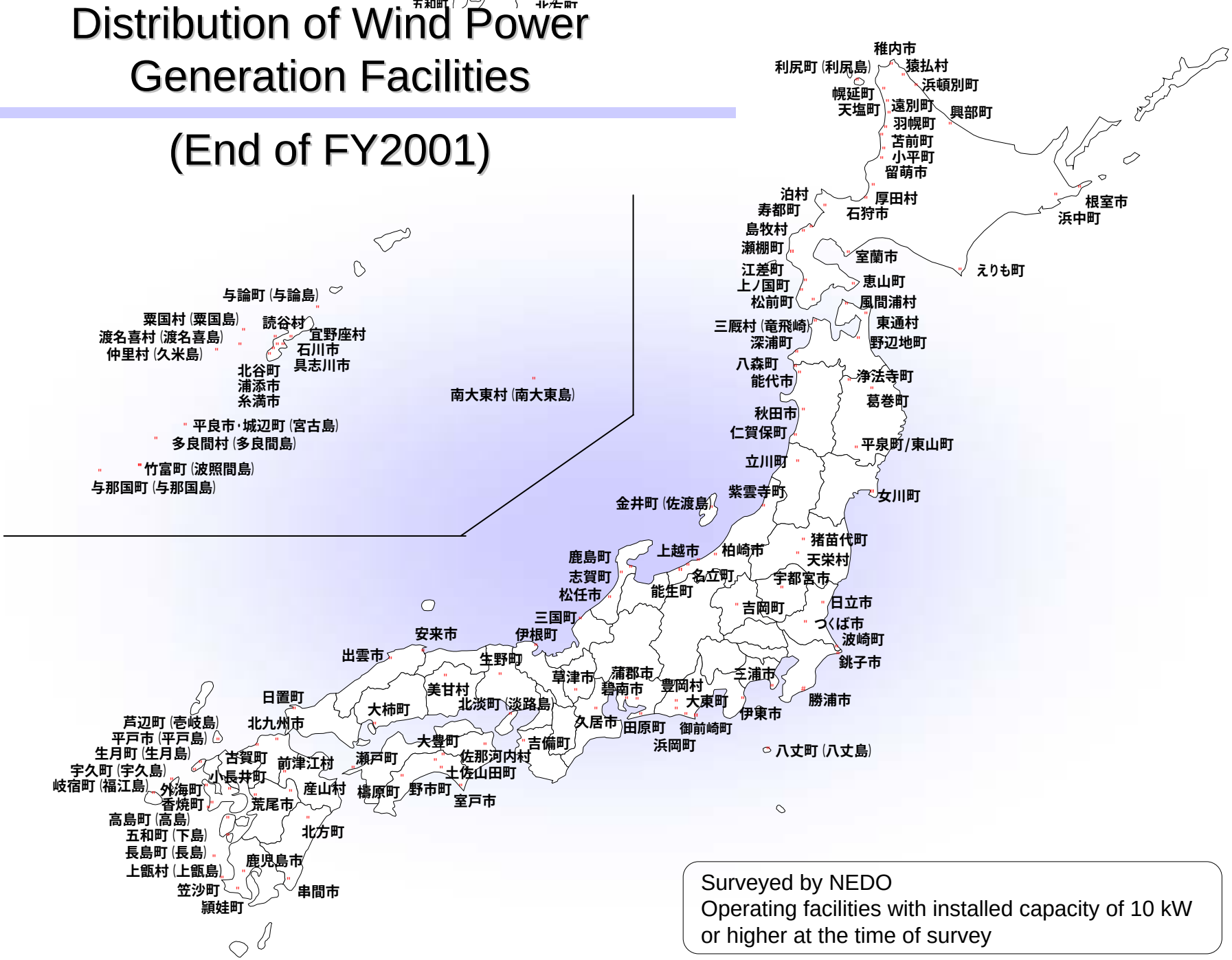


Prefectures with high introduction volumes (end of FY2001)

Hokkaido	157,000 kW
Akita Pref.	46,000 kW
Aomori Pref.	39,000 kW
Okinawa Pref.	12,000 kW
Nagasaki Pref.	10,000 kW
Yamagata Pref.	5,000 kW
Kagoshima Pref.	5,000 kW
Kyoto Pref.	5,000 kW
Niigata Pref.	4,000 kW
Fukushima Pref.	4,000 kW

Distribution of Wind Power Generation Facilities

(End of FY2001)



Surveyed by NEDO
Operating facilities with installed capacity of 10 kW or higher at the time of survey