Subcommittee on Fundamental Issues
Advisory Committee for Natural Resources and Energy

Suggestions Concerning Energy Mix Scenarios

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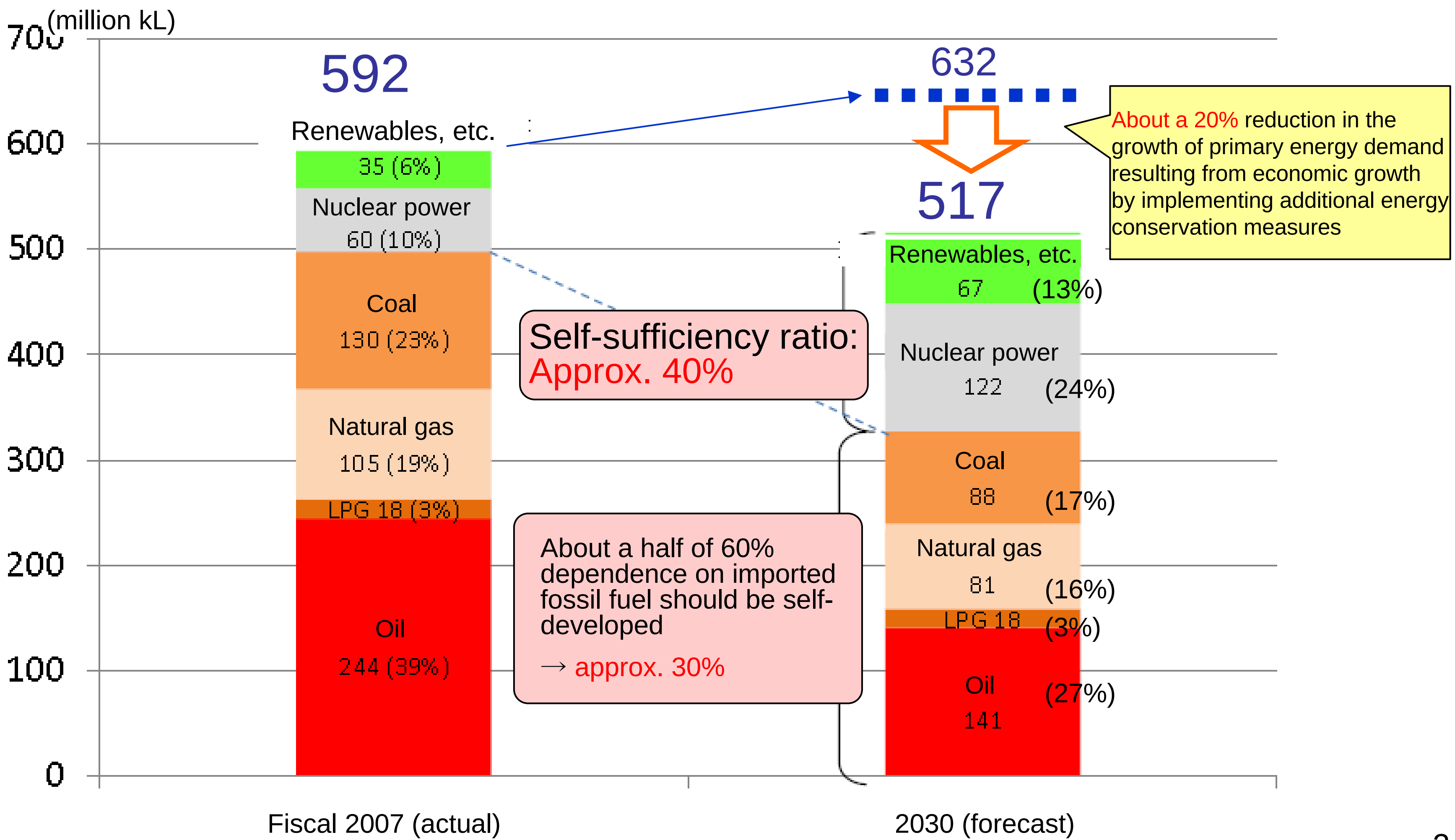
Current Basic Energy Plan: Energy mix

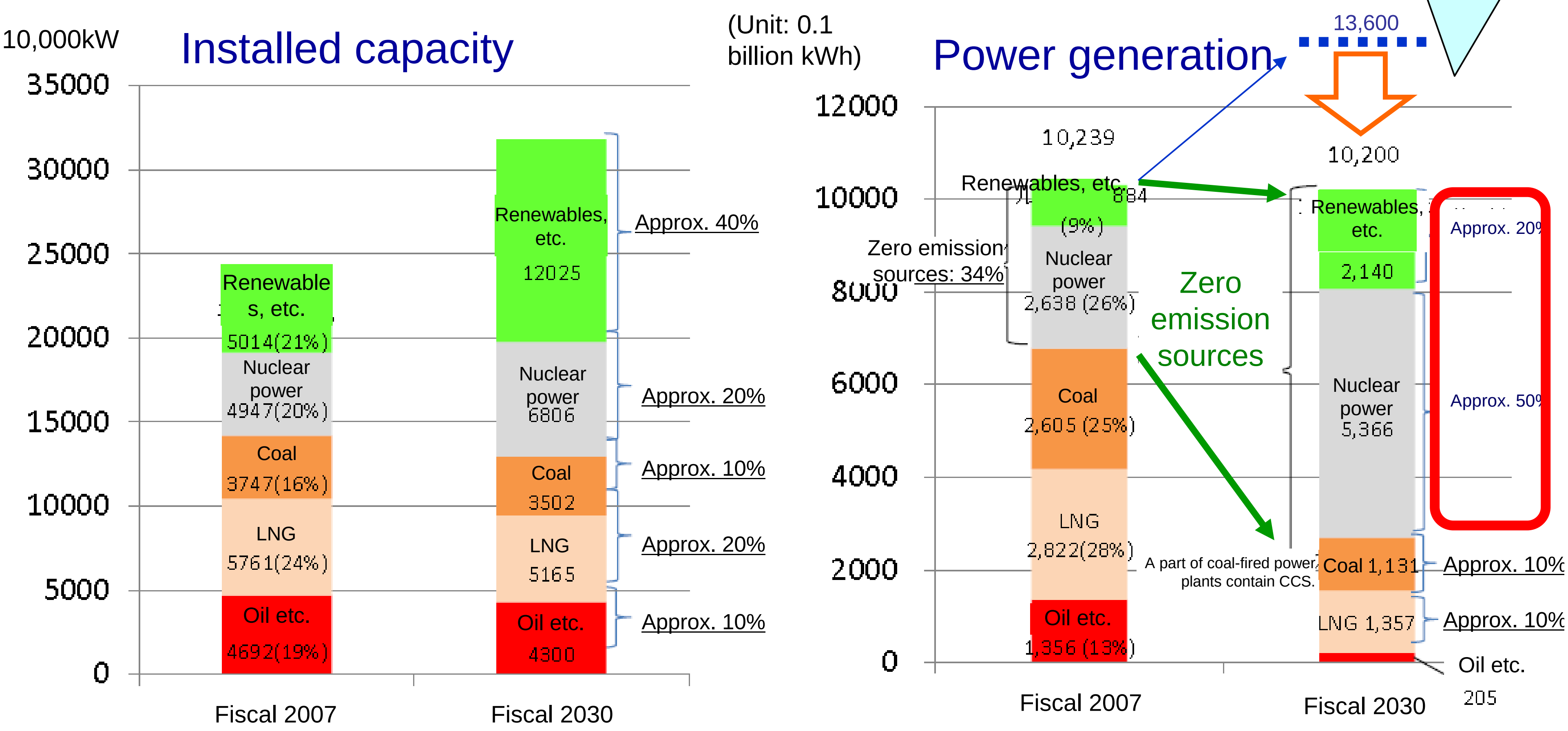
- Increasing the self-managed energy ratio (self-sufficiency ratio + self-development ratio) from 38% to ~70%
- Reducing CO2 emissions by 30% from the 1990 level



Current Basic Energy Plan: Generation mix

- Building 14 reactors at new and existing sites and improving the operating ratio from 60% to 90%
- Increasing the introduction of renewable energy by 2.4 times (by 15 times, excluding hydropower)
- Increasing the proportion of zero-emission power sources from 34% to ~70%

About a 30% reduction in the growth of electricity demand resulting from economic growth by implementing additional energy conservation measures



Proposed scenarios for the generation mix

Breakdown of power generation in 2030

	Energy conservation + cogeneration[*1]	Nuclear	Renewables	Thermal Power	Zero emission
Basic Plan	0%	Approx. 50%	Approx. 20%	30%	70%
Scenario (1)	15%	30%	25%	30%	70%
Scenario (2)	15%	25%	30%	30%	70%
Scenario (2)-2	15%	25%	25%	35%	70%[*2]
Scenario (3)	15%	15%	30%	40%	60%
Scenario (4)	15%	0%	40%	45%	55%

*1: Strictly speaking, *energy conservation* and *cogeneration* should be subtracted from the quantity of power generation (denominator) instead of being included in the calculation of the numerator (contributions from different components of the generation mix). However, the latter method is chosen here to simplify comparison with the Basic Plan.

*2: Scenario (2)-2 assumes a larger share of thermal power generation compared with Scenario 2, but a different fuel mix for thermal power generation. As a result, CO_2 emissions from power sources are the same for the two scenarios.

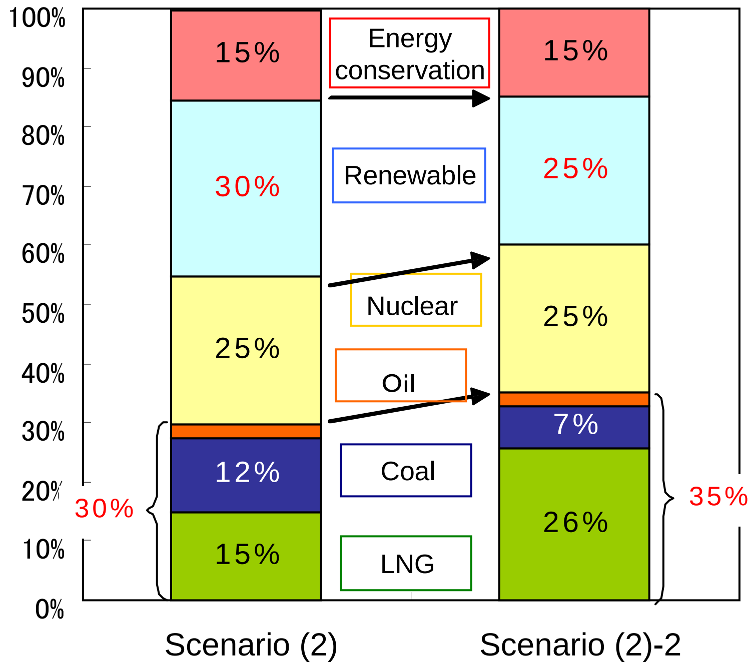
Scenario (2)-2: Expanding the share of LNG in the fuel mix for thermal generation

Considering the difficulty of expanding the use of renewable-based power according to Scenario (2), Scenario (2)-2 assumes a lower share of renewable-based power as in Scenario (1) (decrease from 30% to 25%), which is compensated by greater thermal generation (increase of share from 30% to 35%).

However, it is assumed that CO_2 emissions from power sources are the same for Scenarios (2) and (2)-2 because the latter uses more LNG as fuel to generate power.

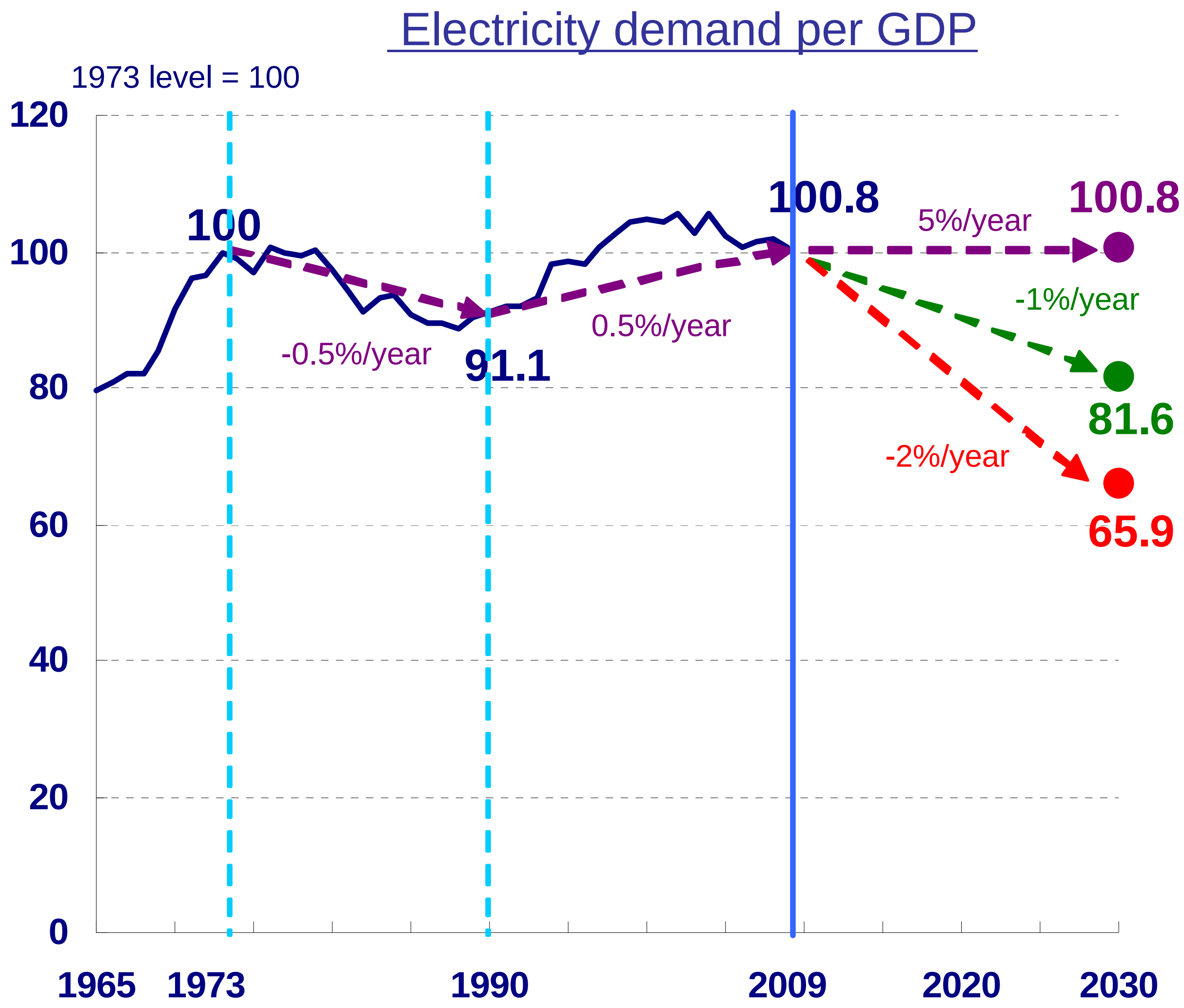
(The scenario assumes less coal-fired generation and more LNG-fired generation, while the contribution of oil-fired generation remains the same.)

Generation mix assumed in Scenario (2) and Scenario (2)-2
(CO_2 emissions are assumed to be the same for the two scenarios.)



Outlook for energy conservation (power saving)

● To decrease electricity demand, it is necessary to accelerate progress in energy conservation.



Assuming **annual economic growth of 1% up to 2030**, the electricity demand will change as follows:

+23%

0%

−19%

Energy saving of 1.5% per year will reduce electricity demand by about 10%.

Sources: IEEJ "Handbook of Energy & Economic Statistics," etc.

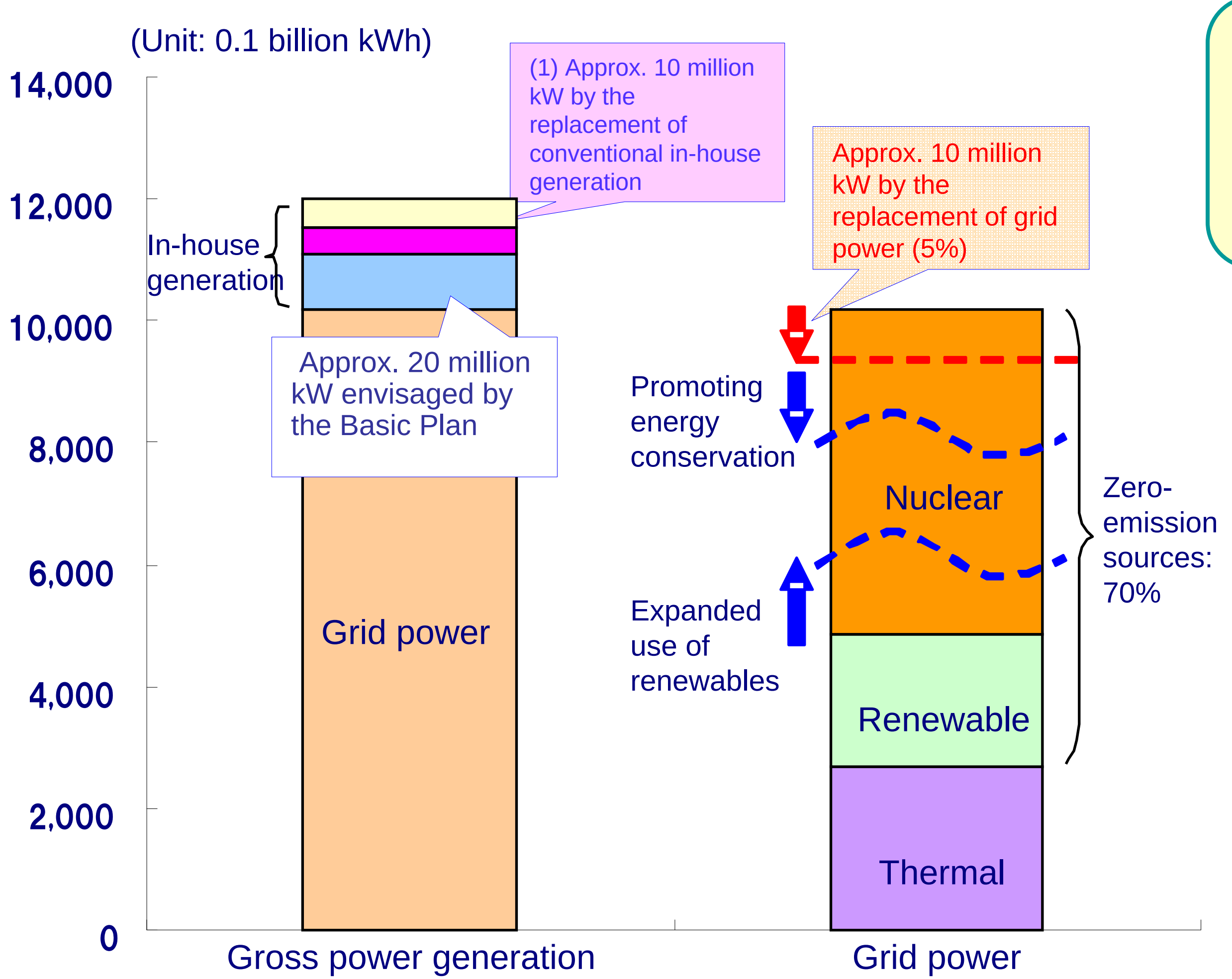
Demand side: Breakdown of energy conservation and its basis

	Final energy consumption (before and after energy conservation) and energy conservation percentage in the Basic Plan	Quantity and percentage of energy conservation added to the level assumed in the Basic Energy Plan	Quantity and percentage of electricity conservation added to the level assumed in the Basic Energy Plan	Anticipated measures and justification
Overall	420 million kL → 340 million kL (approx. -21%)	◯ Total reduction of energy demand from the Basic Plan level **-7.54 million kL (-2%)**	◯ Total reduction of electricity demand from the Basic Plan level **-96.4 billion kWh (-9%)** (Generation by utilities: -135.9 billion kWh, -14%)	* Generation by utilities includes -5% contribution from the deployment of cogeneration systems.
Residential sector	66 million kL → 45 million kL (approx. -32%)	◯ Additional energy conservation to the Basic Plan **+ 3.94 million kL (9%)** Home: -1.28 million kL (-3%) Water heating: -0.25 million kL (-0.5%) Stronger efforts for power saving: -1.42 million kL (-3%) Slow-down in electrification: +6.88 million kL (+15%)	◯ Additional electricity conservation to the Basic Plan **-56.7 billion kWh (-20%)** Home: -3.6 billion kWh (-0.7%) Stronger efforts for power saving: -15.3 billion kWh (-5%) Slow-down in electrification: -37.9 billion kWh (-13%)	- Application of stricter standards than those in 2011 to newly built houses (enforcement of European level standards): 85% (Basic Plan) → 100% - Reinforced measures for reconstruction: Two thirds of the stock should meet the 2011 standards or higher. - Percentage of households with highly efficient water heating system (in 2030): 80 to 90% (Basic Plan) → 100% - Assuming 5% power saving (based on the results of a questionnaire survey by Jyukankyo Research Institute, reported in Reference 2 for the 11th meeting of the Basic Issues Subcommittee) - Slow-down of electrification (assuming progress at half the existing rate)
Commercial sector	87 million kL → 55 million kL (approx. -37%)	◯ Additional energy conservation to the Basic Plan **-1.41 million kL (-2%)** Buildings: -1.98 million kL (-3%) Stronger efforts for power saving: -0.63 million kL (-1%) Slow-down in electrification: +1.72 million kL (+3%) Cogeneration: -.0.51 million kL (-1%)	◯ Additional electricity conservation to the Basic Plan **-29.9 billion kWh (-8%)** Buildings: -13.9 billion kWh (-4%) Stronger efforts for power saving: -6.8 billion kWh (-2%) Slow-down in electrification: -9.2 billion kWh (-3%)	- Assuming 100% enforcement of stricter standards than those in 2011 to new commercial buildings (requiring 30% improvement) by the year of: 2030 (Basic Plan) → 2020 - Reinforced measures for reconstruction: The entire stock (100%) should meet the 2011 standards or higher. - Assuming 2% power saving (based on the results of a questionnaire survey by Jyukankyo Research Institute, reported in Reference 2 for the 11th meeting of the Basic Issues Subcommittee) - Slow-down of electrification (assuming progress at half the existing rate)
Industry sector	140 million kL → 130 million kL (approx. -4%)	◯ Additional energy conservation to the Basic Plan **-7.44 million kL (-6%)** Lighting: -1.3. million kL (-1%) Cogeneration: -6.14 million kL (-5%)	◯ Additional electricity conservation to the Basic Plan **-14.0 billion kWh (-1%)** Lighting: -14.0 billion kWh (-1%)	- LED lighting: 0% (Basic Plan) → 100% - Contribution of cogeneration systems: 11 million kWh (Basic Plan) → 30 million kW (inclusive of the commercial sector)
Transport sector	90 million kL → 61 million kL (approx. -31%)	◯ Additional energy conservation to the Basic Plan **-2.62 million kL (-4%)** **Next-generation vehicles: -2.62 million kL (-4%)**	◯ Additional electricity conservation to the Basic Plan **+4.1 billion kWh (+13%)** EVs/PHEVs: +4.1 billion kWh (+13%)	- Proportion of next-generation vehicles in all vehicles sold in 2030: 70% (Basic Plan) → 100%

Deployment of cogeneration systems

(1) Improvement of overall efficiency (power generation and heat supply) as an alternative to conventional in-house power generation
(2) Extend the use of cogeneration systems to replace the demand for grid power

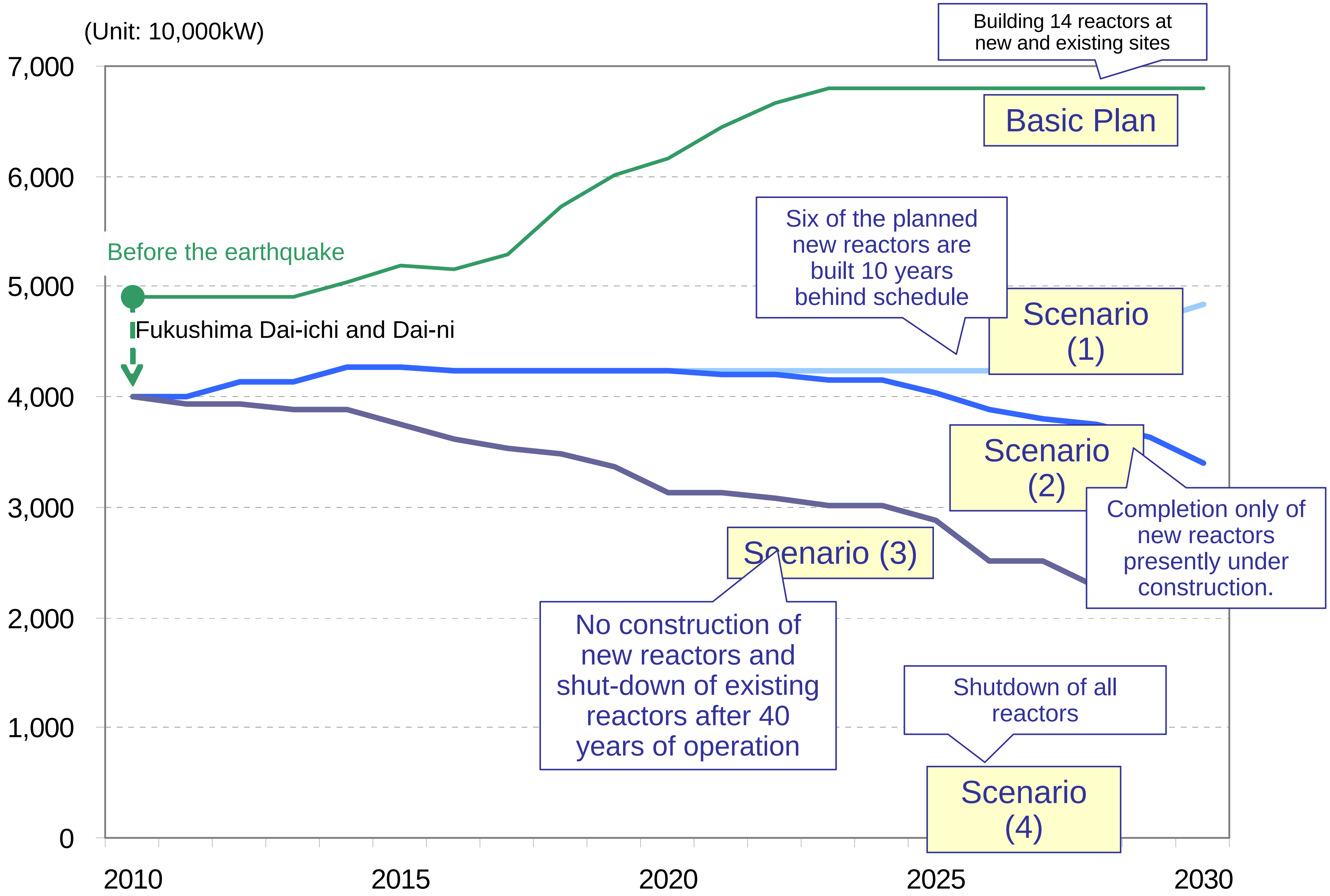
Breakdown of power generation in 2030 (equivalent to the Basic Plan)



Natural gas fired cogeneration:
Target in the Basic Plan: 11 million kW
Feasibility according to Japan Gas Association: 30 million kW

Possibility of adding 20 million kW:
(1) Replacement of conventional in-house generation:
Approx. 10 million kW
(2) Replacement of grid power
Approx. 10 million kW
(Approx. 5% of gross power generation)

Scenarios for nuclear power generation up to 2030



Scenarios for nuclear power generation (2030)

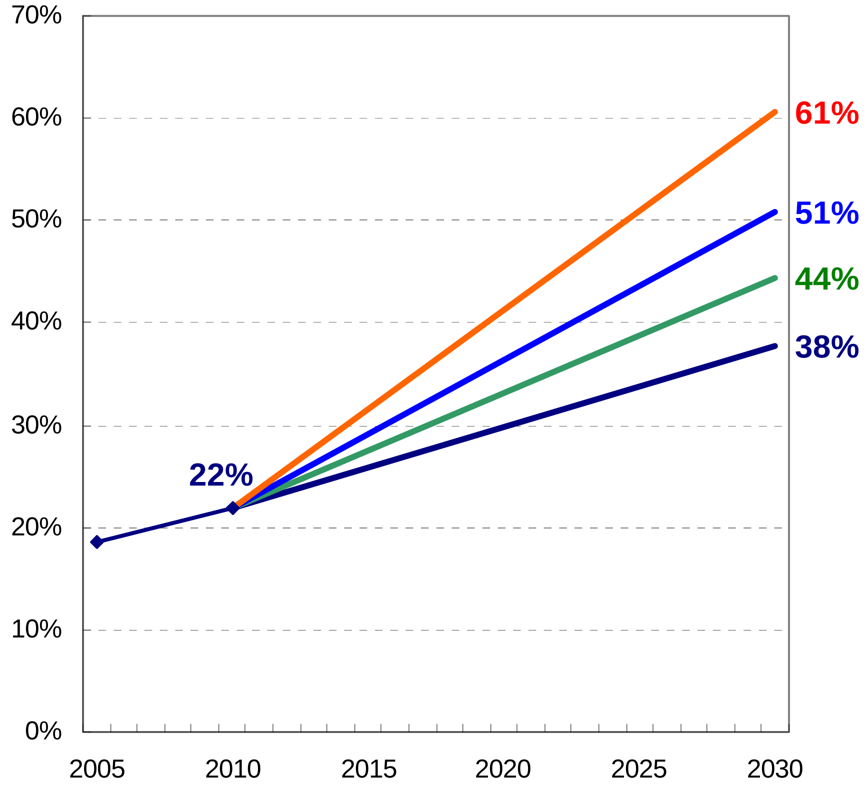
Scenario name	Basic Plan	Scenario (1)	Scenario (2) Scenario (2)-2	Scenario (3)	Scenario (4)
Scenario description	Building 14 reactors at new and existing sites	6 reactors are constructed 10 years behind the schedule	Only reactors presently under construction are completed	No reactors are newly built and existing reactors are shut down after 40 years of operation	All reactors are shut down
Installed capacity - new reactors - existing reactors	68.06 million kW 19.31 million kW (14 units) 48.76 million kW	40.10 million kW 8.80 million kW (6 units) 31.31 million kW	34.06 million kW 2.76 million kW (2 units) 31.31 million kW	21.38 million kW 0 (no new reactors) 21.38 million kW	0
Existing reactors	~	50 years	50 years	40 years	—
Operating Rate	90%	90%	80%	80%	—
Power generation	536.6 billion kWh	316.2 billion kWh	238.7 billion kWh	149.8 billion kWh	—
Contribution of nuclear power to gross power generation	53%	31%	23%	15%	0%

Note: The highest annual capacity factor recorded in the past is 84% in 1998.

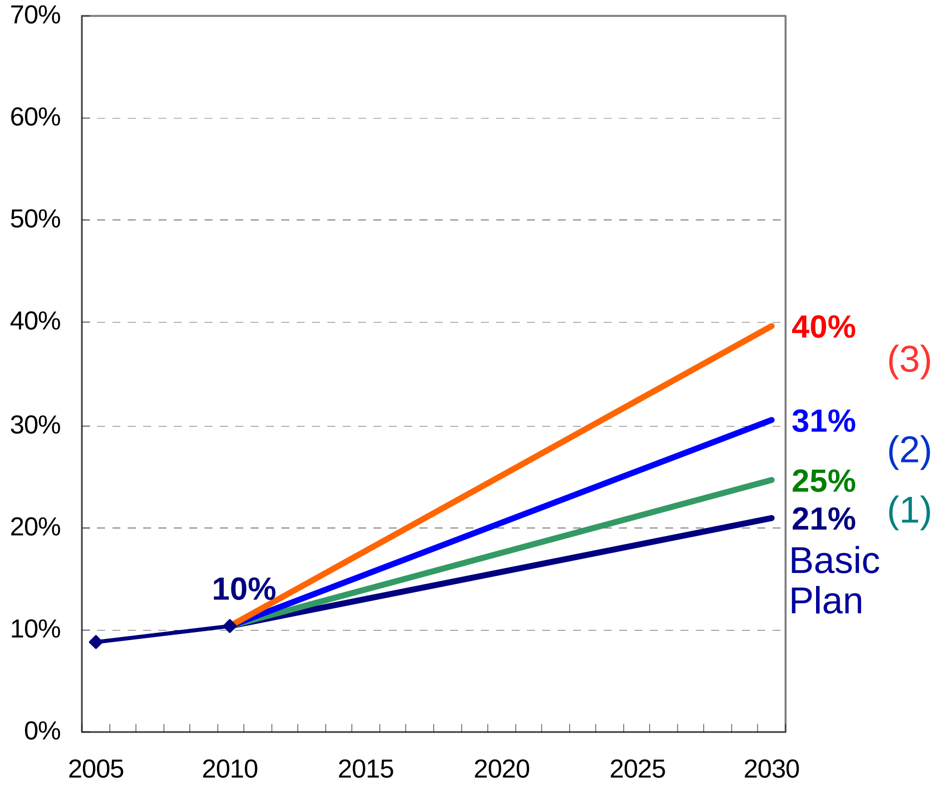
Scenarios for introducing renewable energy sources toward 2030

Even when the installed capacity of renewable power generation systems accounts for 40% to 60% of the gross installed capacity of all power sources, their contribution to the gross power generation will remain as low as 20% due to their low availability factor.

Contribution of renewable power sources to gross installed capacity (in kW)



Contribution of renewable power sources to gross power generation (in kWh)



Renewable power generation systems (1)

	Present status (2010)	Share in the generation mix in 2030 in the Basic Plan	Share in the generation mix in 2030	Basis of feasibility, assumptions, measures to be taken, notes, etc.
Photo-voltaic	0.4% (3.62 million kW)	5.6% (53 million kW)	(1) 6% 57.70 million kW (2) 8% 75.50 million kW (3): similar to (2) (4) 13% 122 million kW	(1) 2.7 million kW/year = [At 60% of newly built detached houses (0.4 million houses/year) + At 2.5%/year of existing detached houses (11 million houses) + At 10% of newly built collective housing facilities (0.5 million apartments/year) + In 0.25%/year of unused farmland (550km^2) + In 0.75%/year of factory and office areas 660km^2)] x 20 years By 2030: Installation at 43% of detached houses, at 23% of all residential facilities, in 5% of unused farmland, and in 15% of factory and office areas (2) 3.6 million kW/year = [At 80% of newly built detached houses (0.4 million houses/year) + At 3.0%/year of existing detached houses (11 million houses) + At 15% of newly built collective housing facilities (0.5 million apartments/year) + In 0.5%/year of unused farmland (550km^2) + In 1.0%/year of factory and office areas (660km^2)] x 20 years By 2030: Installation at 54% of detached houses, at 29% of all residential facilities, in 10% of unused farmland, and in 20% of factory and office areas (4) 5.9 million kW/year = [At 100% of newly built detached houses (0.4 million houses/year) + At 4.0%/year of existing detached houses (11 million houses) + At 20% of newly built collective housing facilities (0.5 million apartments/year) + In 1.0%/year of unused farmland (550km^2) + In 2.5%/year of factory and office areas (660km^2)] x 20 years By 2030: Installation at 68% of detached houses, at 37% of all residential facilities, in 20% of unused farmland, and in 50% of factory and office areas (2010: installation of 1 million kW/year, cumulative capacity of 3.62 million kW, installation at 4% of detached houses and at 2% of all housing facilities) Mega-scale photovoltaic plants (on unused farmland): three to thirteen 1MW-class photovoltaic plants built in each prefecture each year
Wind power	0.4% (2.44 million kW)	1.7% (10 million kW)	(1) 3% 14 million kW (2) 4% 20 million kW (4) 7% 36 million kW	(1) 0.6 million kW/year (0.5 million kW/year with land-based systems + 0.1 million kW/year with offshore systems) (2) 0.9 million kW/year (0.7 million kW/year with land-based systems + 0.2 million kW/year with offshore systems) (4) 1.7 million kW/year (1.2 million kW/year with land-based systems + 0.5 million kW/year with offshore systems) (2010: installation of 0.25 million kW/year, cumulative capacity of 2.44 million kW) Land-based: The annual increase in the total area occupied by wind turbine systems in the three scenarios corresponds respectively to 0.8, 1.1 and 1.9 times as large as the Yamanote loop area (63km^2). Offshore: The total area occupied by wind turbine systems in 2030 assumed by the three scenarios corresponds respectively to 0.3, 0.6 and 1.5 times as large as Lake Biwa.

- Share under present status (%) also includes parties other than general electric power companies.
- With regard to unused farmland, installation of renewable-based power generation systems is assumed only in "areas that can no longer be used as farmland" according to the results of a field survey in 2009 ("Comprehensive Survey on Uncultivated Farmland"). Areas that are deemed "not restorable as farmland" are excluded.
- With regard to detached houses, installation of renewable power generation systems is assumed only at 11 million houses where installation is feasible because of their suitability in terms of seismic design guidelines, availability of free space and roof shape. With regard to collective housing facilities, installation is assumed only at newly constructed buildings.
- For photovoltaic power generation, we assumed that output per area increases in line with the trend of generation efficiency (from the present; 16% to 25% by 2030): output per apartment in collective housing facilities to increase from 1.5kW to 2.3kW, output per 1m^2 of unused farmland to increase from 0.08kW to 0.13kW, and output per 1m^2 of factory/office area to increase from 0.1kW to 0.16kW. The output per detached house, however, is assumed to remain at 3.5kW.

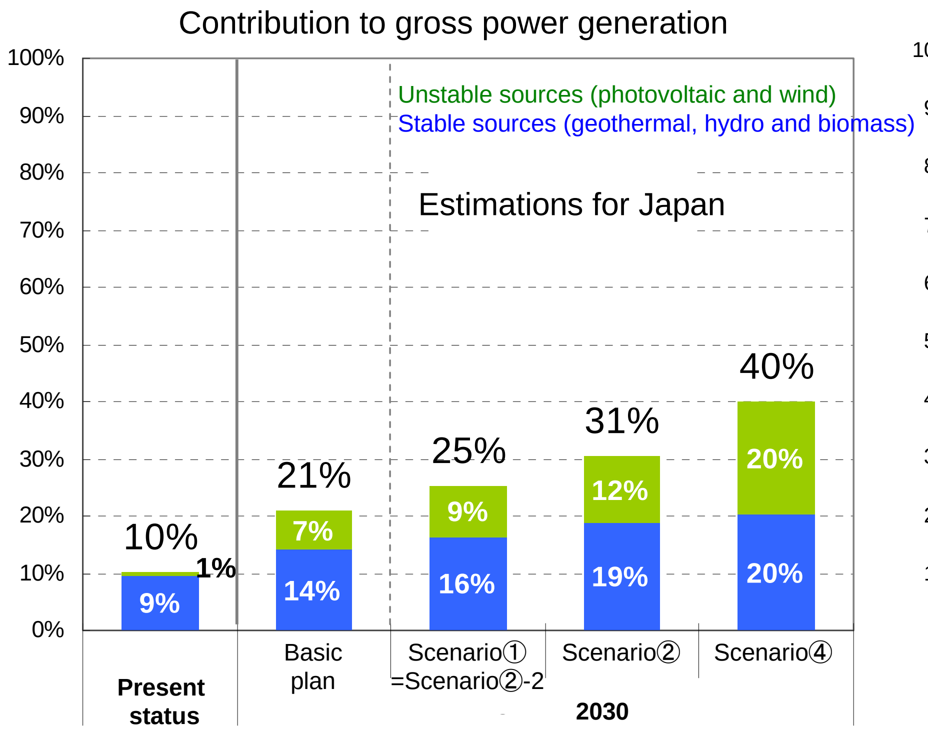
Renewable power generation systems (2)

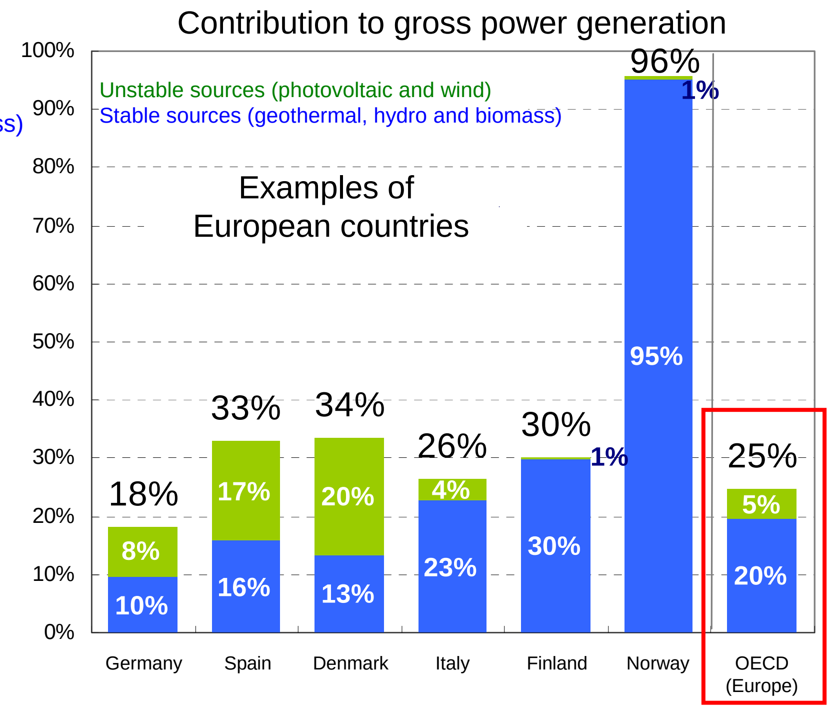
	Present status (2010)	Share in the generation mix in 2030 in the Basic Plan	Share in the generation mix in 2030	Basis of feasibility, assumptions, measures to be taken, notes, etc.
Geo-thermal	0.3% (0.53 million kW)	1.0% (1.65 million kW)	**(1) 3%** 5.1 million kW **(2) 4%** 6.7 million kW **(4) 5%** 8.3 million kW	(1) 1.7 million kW outside parks + 3.4 million kW inside parks (2) 2.1 million kW outside parks + 4.6 million kW inside parks (4) 2.6 million kW outside parks + 5.7 million kW inside parks (2010: zero additional installation, cumulative capacity of 0.53 million kW) Outside national parks: The three scenarios respectively assume 40%, 50% and 60% achievement of the potential by 2030. Inside national parks: The three scenarios respectively assume 30%, 40% and 50% achievement of the potential (identified potential in specific areas only) by 2030.
Hydro	7.7% (46 million kW)	10.5% (55.6 million kW)	**(1) 11% (7%)** 58 million kW **(2) 12% (8%)** 60.4 million kW **(4) 12% (8%)** 60.4 million kW **Figures in parentheses are for small- and medium-scale hydropower generation.**	(1) 18 million kW with small- and medium-scale hydro + 40 million kW with large-scale hydro (2) 20 million kW with small- and medium-scale hydro + 40.5 million kW with large-scale hydro (full achievement of potential hydropower) (4) 20 million kW with small- and medium-scale hydro + 40.5 million kW with large-scale hydro (full achievement of potential hydropower) (2010: cumulative capacity of 46 million kW, including 9.9 million kW from small- and medium-scale hydro) Small- and medium-scale hydro: construction of 1,000kW class hydropower stations at 8,000 to 10,000 sites by 2030
Waste and bio-mass	1.4% (2.4 million kW)	2.1%	**(1) 2%** 3.7 million kW **(2) 2%** 5.0 million kW **(4) 3%** 6.3 million kW	(1) 30% achievement of identified potential by 2030 (2) 40% achievement of identified potential by 2030 (4) 50% achievement of identified potential by 2030 (2010: installation of 40,000 kW/year, cumulative capacity of 2.4 million kW) The three scenarios respectively assume 30%, 40% and 50% achievement of identified potential in 2030, ignoring the delivery of heat from cogeneration systems.

Renewable power generation systems (3)

To deploy renewable power generation systems, it is important to seek a balance between stable and unstable sources of power.

	Present status (2010)	Contribution in 2030 assumed by the Basic Plan	Estimated contribution in 2030 (%)		
			(1), (2)-2	(2)	(4)
Unstable sources (photovoltaic and wind)	**0.8%** (6.06 million kW)	**7%**	**9%** (72 million kW)	**12%** (96 million kW)	**20%** (158 million kW)
Stable sources (geothermal, hydro and biomass)	**9.4%** (49.31 million kW)	**14%**	**16%** (67 million kW)	**19%** (72 million kW)	**20%** (75 million kW)





Challenges for the deployment of renewable power generation systems and measures to be taken

				Challenges concerning deployment	Measures to be taken to achieve the potential
Photo voltaic	Resi-dential houses	Detached houses	New	With present policy measures, it is difficult to introduce into 60-100% of newly built houses each year.	- To achieve installation at 60-80% in each year, financial support such as strong incentive schemes are necessary. - To achieve installation at 100% in each year, obligatory installation by amendment of laws such as the Building Standards Act is essential. - The utilization of a "roof rent" system must also be considered.
			Exis-ting	It is necessary to handle houses that do not meet the seismic design guidelines (houses built up to 1980).	- Support for seismic reinforcement of residential houses is required.
		Collec-tive housing	New	Problem of high cost	Financial support for owners and developers is required. Introduction of a system that allows choice by dwellers must also be considered.
			Exis-ting	Excluded from the list because of difficulties in gaining consensus between management committees and residents, providing cable connections between roof-top units and individual apartments, etc.	—
	Others	Uncultivated farmland		- Lack of sunlight, difficulty of access (remoteness), predominance of small dispersed plots, etc. - Issues regarding maintaining farmland and environmental conservation	- It is necessary to identify land that can be used for photovoltaic generation with sufficient economic merits. - Legal restrictions on rezoning of farmland and siting of factories should be relaxed.
		Factories, offices, etc.		- Concerns about building strength and available space	- Feasibility checks and consulting on necessary measures are essential. - Support for consultation and necessary measures is essential.
Wind power				- Instability of power distribution systems and uneven geological distribution - Issues regarding environmental conservation and conflicts with fishery rights - Limited availability of gradually shoaling beaches	- Introduction of power system stabilization measures and expanded capacity for power exchange are needed. - Environmental assessment, readjustment of fishery rights and prevention of bird strikes are necessary. - R&D of offshore wind power generation technology should be supported.
Geothermal				- Many sites in national parks - Risks involved in developing geothermal resources - Co-existence with hot spring resorts	- Despite the recent easing of restrictions on diagonal excavation, further efforts are needed to remove restrictions and address development risks. - It is necessary to assess the impacts on hot springs and consider the introduction of conflict management and compensation systems.
Hydro				- Long lead time for development due to readjustment of water rights	- Simplification of application procedures for development such as readjustment of water rights is necessary.
Waste and biomass				- High collection cost - Impacts on utilization for other purposes (fertilizer, compost, plowing-in, etc.) - Impacts on domestic industries due to increased import of wood chips, etc.	- Support for reducing the cost of biomass collection and transportation is required. - Utilization of biomass for other purposes must also be considered. - Domestically produced biomass (to address concerns about increased imports of biomass from overseas) should be taken into account.

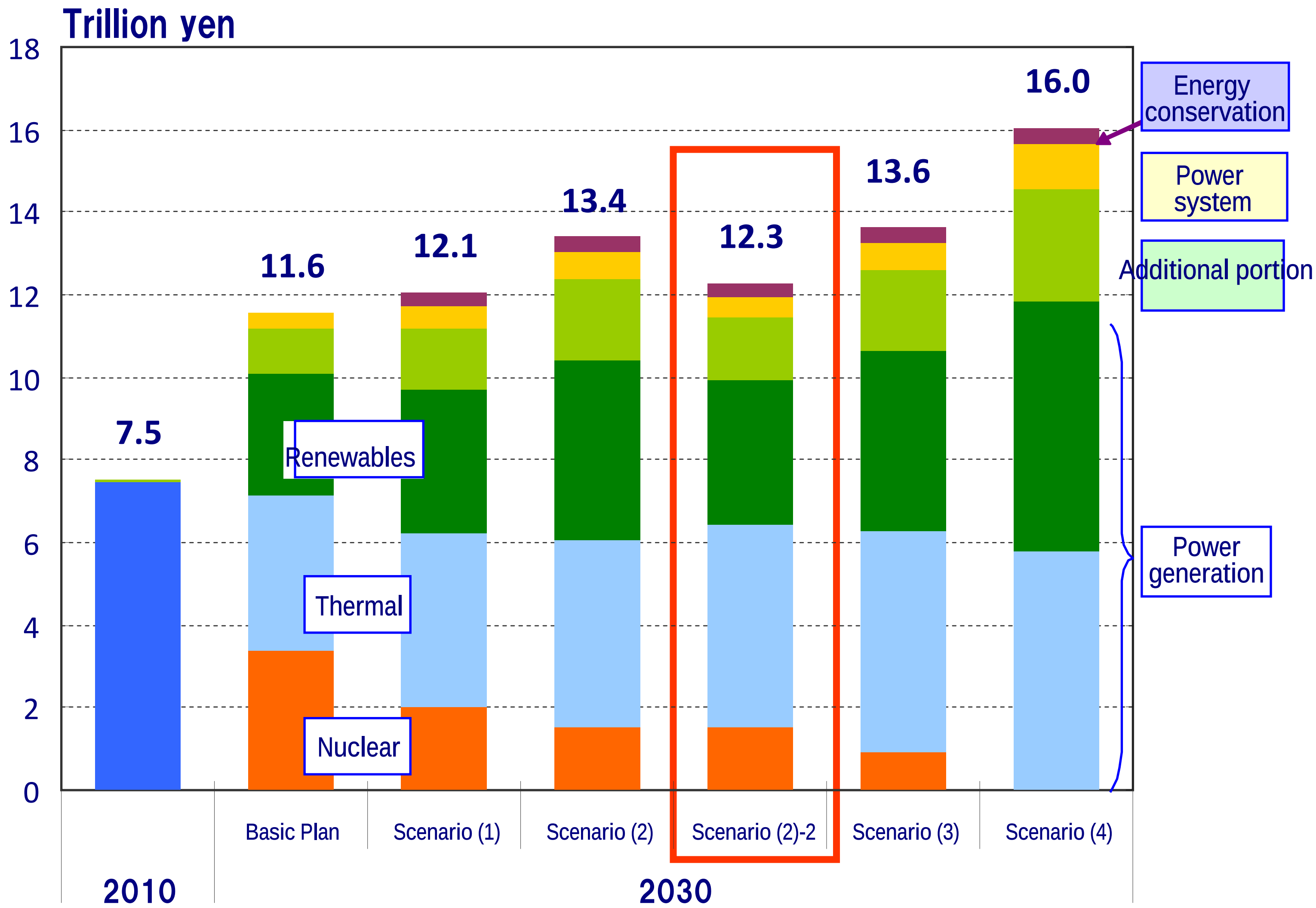
Supply side: generation mix

	Present status (2010)	Share in the generation mix in 2030 in the Basic Plan	Share in the generation mix in 2030	Basis of feasibility, assumptions, measures to be taken, notes, etc.
Renewables, etc.	10%	21%	(1) 25% (2) 31% (2)-2 25% (3) 31% (4) 40%	See Slides 12 and 13.
Nuclear power	29%	53%	(1) 31% (2) 23% (2)-2 23% (3) 15% (4) 0%	(1) Construction of six reactors (some of the reactors under planning completed 10 years behind schedule) Existing reactors go out of service after 50 years of operation. - Installed capacity: 40.1 million kW; capacity factor: 90%. (2) Construction of two reactors (completion of only those reactors which are already under construction) Existing reactors go out of service after 50 years of operation. - Installed capacity: 34.06 million kW; capacity factor: 80%. (3) No building of new reactors. Existing reactors go out of service after 40 years of operation. - Installed capacity: 21.38 million kW; capacity factor: 80%. (4) No building of new reactors. All existing reactors become unavailable by 2020. - Installed capacity: zero.
Coal	25%	11%		Total contribution of fossil-fired generation: (1) 30%, (2) 32%, (2)-2 37%, (3) 40% and (4) 46% [The breakdown of fossil-fired generation is similar among all scenarios except (2)-2.]
LNG	29%	13%		
Oil, etc.	7%	2%		
Energy conservation and cogeneration			14%	Power saving on the demand side + 19 million kW from the additional deployment of cogeneration systems (Half of the capacity is assumed to come from the replacement of conventional in-house generation.)
Total	100%	100%	100%	

Overview of the generation mix:

	Renewable	Nuclear	Fossil	Energy conservation + cogeneration
Basic Plan	Approx. 20%	Approx. 50%	30%	0%
Scenario (1)	25%	30%	30%	15%
Scenario (2)	30%	25%	30%	15%
Scenario (2)-2	25%	25%	35%	15%
Scenario (3)	30%	15%	40%	15%
Scenario (4)	40%	0%	45%	15%

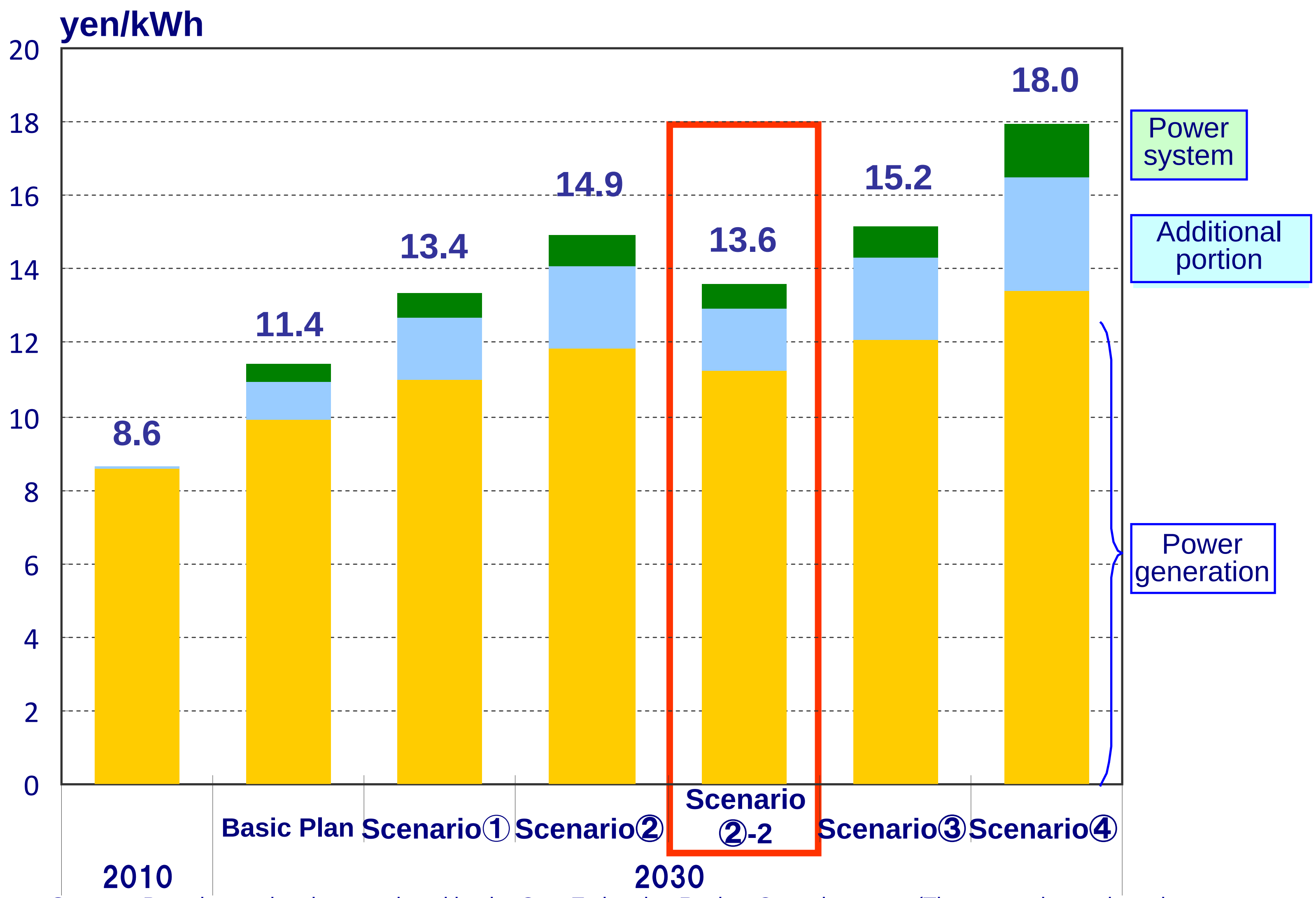
Estimated generation cost



Sources: Based on estimations by the Cost Estimation and Review Committee, etc. (The generation and purchase costs are averages between the highest and lowest of estimated costs.)

Notes: The power system stabilization cost does not include costs for measures against frequency and voltage fluctuations.
The power generation cost does not include costs related to transmission lines.
The actual cost data from 2010 are based on financial statements from general electric power companies and wholesale electric power companies.

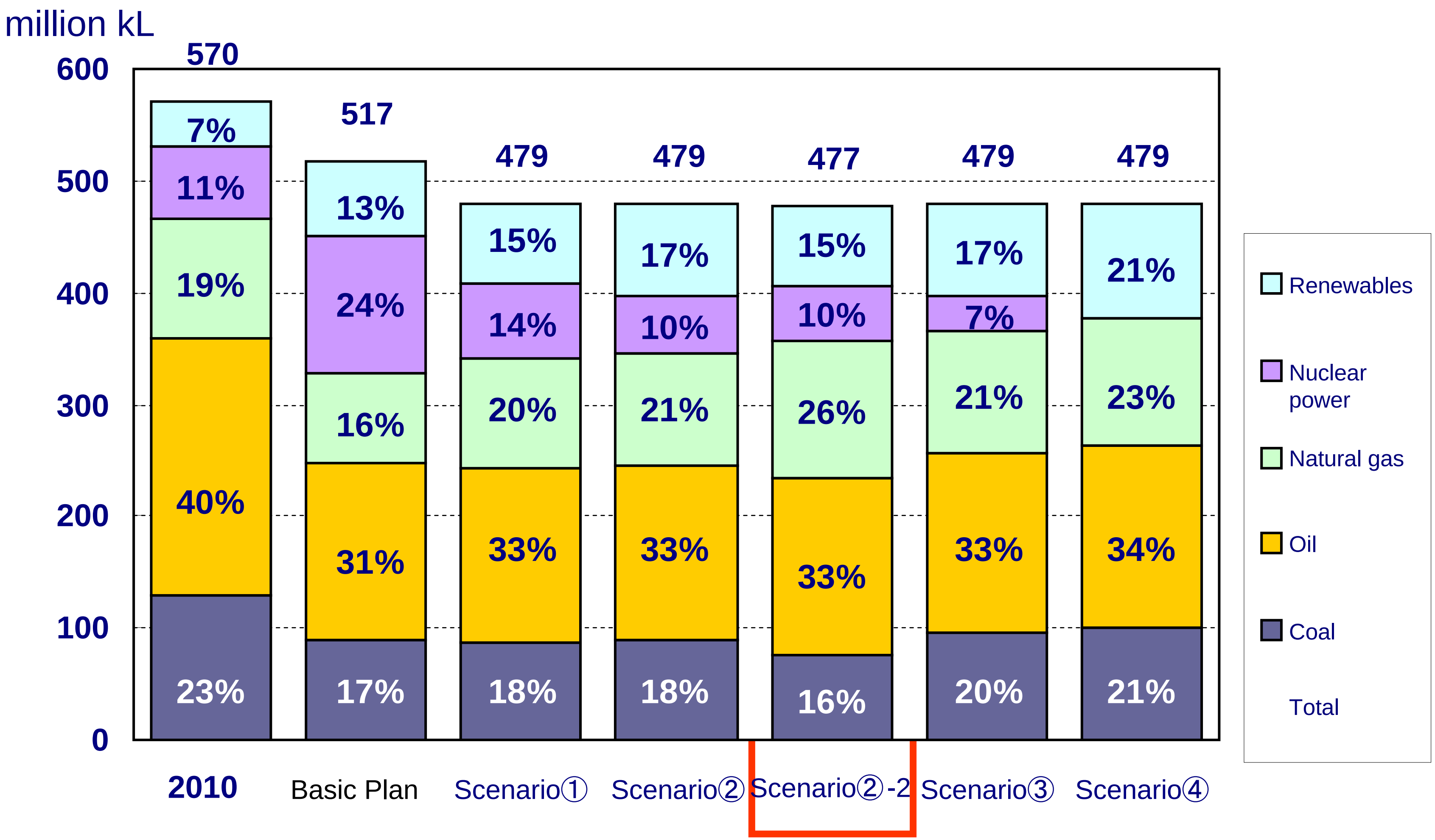
Estimations on electricity unit price (per kilowatt-hour)



Sources: Based on estimations produced by the Cost Estimation Review Committee, etc. (The generation and purchase costs used in this chart are averages between the highest and lowest of estimated costs.)

Notes: The power system stabilization cost does not include costs for the implementation of measures against frequency and voltage fluctuations.
The power generation cost does not include costs related to transmission lines.
The actual cost data from 2010 are based on financial statements from general electric power companies and wholesale electric power companies.

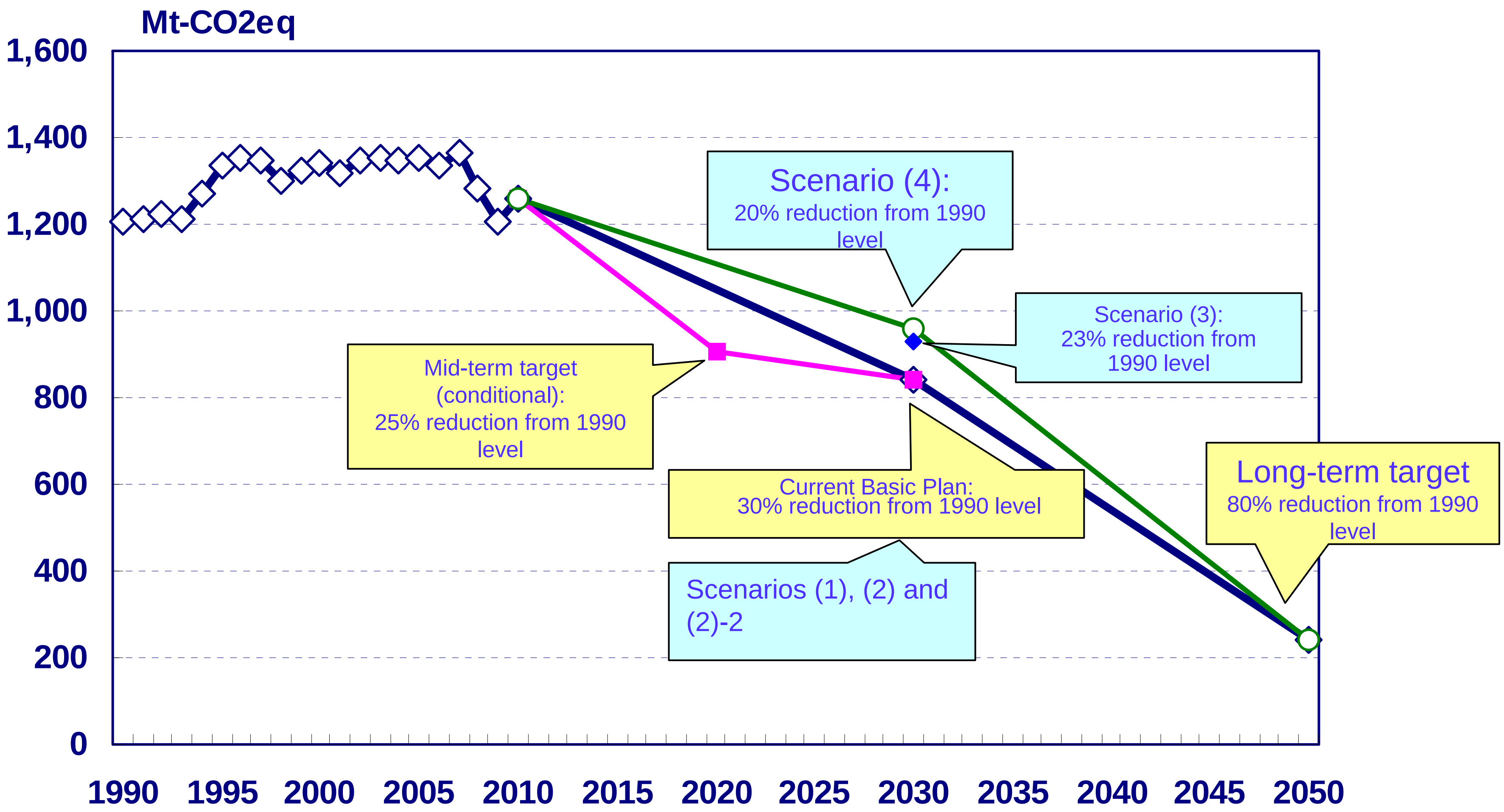
Supply side: Primary energy supply



	2010	Basic Plan	Scenario (1)	Scenario (2)	Scenario (2)-2	Scenario (3)	Scenario (4)
Self-sufficiency (including nuclear power)	19%	37%	30%	29%	26%	25%	22%
Energy-derived CO_2 (compared with 1990 level)	＋6%	-31%	-29%	-28%	-28%	-23%	-20%

Long-term trend of GHG emissions

The target of 30% reduction from the 1990 level by 2030 is consistent with the long term target of 80% reduction from the 1990 level by 2050, which reflects the agreement at G8.



Supply side: Primary energy supply

	Present status (2010)	Share in the energy mix in 2030 according to the current Basic Plan	2030 Scenario (1)	2030 Scenario (2)	2030 Scenario (2)-2	2030 Scenario (3)	2030 Scenario (4)
Renewables, etc. (million kL) Share (%)	39 6.8%	67 12.9%	71 15%	82 17%	71 15%	82 17%	102 21%
Nuclear (million kL) Share (%)	64 11.3%	122 23.6%	66 14%	50 10%	50 10%	31 7%	0 0%
Coal (million kL) Share (%)	129 22.6%	88 17.0%	86 18%	88 18%	77 16%	96 20%	101 21%
Natural gas (million kL) Share (%)	109 19.1%	81 15.7%	98 20%	100 21%	122 26%	109 23%	115 24%
Oil (million kL) Share (%)	229 40.2%	159 30.8%	157 33%	158 33%	157 33%	160 33%	161 34%
Total (million kL) Share (%)	570 100%	517 100%	479 100%	479 100%	477 100%	479 100%	479 100%
Energy-derived CO_2 (million ton) (comparison with 1990 level)	1,122 +6%	730 -31%	751 -29%	764 -28%	764 -28%	814 -23%	846 -20%

* Energy conservation ratios at final consumption, the energy mix portfolio and the ratio mix portfolio are assumed to calculate the primary energy supply portfolio using energy balance charts.
Nuclear power and renewable energy sources are converted into primary energy using the thermal power average.

General assessment of scenarios on generation mix and primary energy supply portfolio

It is important to evaluate each scenario objectively and quantitatively from perspectives such as the Three E's: economic efficiency (cost), environmental conservation (mitigation of global warming) and energy security.

	Cost	CO_2	Energy security	Feasibility
Scenario (1)	○	○	△	△△
Scenario (2)	△	○	△	△△
Scenario (2)-2	○	○	△	△
Scenario (3)	△	△	△	△△△
Scenario (4)	△△△	△	△△	△△△△

Nature of energy mix-related figures

(1) Nature of numerical figures used with reference to energy conservation, generation mix and primary energy supply portfolio

What is your view about the nature of numerical figures used with reference to energy conservation, generation mix and primary energy supply portfolio? (E.g.: targets committed to by the government, policy targets, targets to pursue, anticipated achievement, etc.)

● We take them as "policy goals" that are supported by policy measures. To achieve the announced targets, the government needs to take appropriate policy measures (deregulation, enhanced regulation, subsidies, taxation schemes, etc.) at the right timing with the minimum burden on the economy and society.

● Policy goals need to be reviewed regularly for their progress and revised periodically in line with changes in the economy, energy and environment in Japan and abroad.

(2) Other issues and figures that should be addressed by the Basic Plan (Please see Attachment 6 for policy targets, etc. that are defined in the Current Basic Plan.)

Besides the energy mix related figures referred to in (1) above, are there other issues and figures that should be addressed by the Basic Energy Plan, e.g., "to double energy sufficiency ratio from the present level"? If so, please describe them along with the nature of such figures. (E.g.: targets committed to by the government, policy targets, targets to pursue, anticipated achievement)

● Considering the need to strengthen energy security and reinforce the measures against global warming from a global viewpoint, it is essential to maintain the following targets:

- *To increase the contribution of zero emission power sources to 70% by 2030* or *to achieve 30% reduction of energy-derived CO_2 emissions from the 1990 level by 2030*
- *To increase the self-managed energy ratio (self-sufficiency ratio + self-development ratio) to 70% by 2030*

Criteria used in the evaluation of scenarios and other considerations

4. Criteria to be used in the evaluation of scenarios (Please see Attachment 7 for the list of questions from committee members about the criteria to be used.)

What do you think are the important criteria that should be used when evaluating energy mix scenarios?

● The importance of the Three E's as evaluation criteria remains unchanged because they provide basic perspectives on energy policy: economy efficiency (cost), energy security (self-sufficiency) and environmental conservation (reduction of CO_2 emissions).

● After the Great East Japan Earthquake, the evaluation should add the factors of "S" for safety and "M" for impacts on the macro economy.

● We should seek a "feasible" energy mix with respect to time, considering the lead time for the deployment of energy and environmental technologies, the anticipated pace of technological development, and the longer lead times for deploying geothermal and other technologies due to various restrictions (physical, social, policy-related and siting restrictions).

5. Other points to note

Please describe your views about other important points to be considered when evaluating energy mix scenarios.

● Attention to international affairs is important as Japan tries to strengthen its energy security:

- Geopolitical tension among energy exporting countries such as political unrest in the Middle East and the situation concerning Iran's nuclear development program
- Situation concerning energy supply from non-conventional sources (e.g. shale gas development)
- Positions and strategies of newly emerging countries, such as China and India, which compete with Japan in trying to procure energy resources
- Trend of policies introduced in other countries (e.g. nuclear power policies and renewable energy deployment policies in the West and in Asian countries)
- Trend in energy markets (e.g. evolution of oil prices, the problem of the “Asian premium” in the LNG market)
- Trend in the markets of energy and environmental technologies (e.g. export trend of renewable energy technologies from emerging countries such as China)

(Reference)

Estimation of electricity cost for each scenario

Principles concerning the estimation of electricity cost for each scenario

- Electricity costs on Slide 17 were estimated as follows.

Electricity cost = (1) Generation cost + (2) Purchasing cost (additional) + (3) Power system stabilization cost + (4) Energy conservation and cogeneration cost

(1) Generation cost

The total generation cost (construction cost + operation cost) was calculated for each generation option.

(2) Purchasing cost

This is the cost that arises from implementing a fixed-price purchasing scheme for renewable energy (excluding what is already accounted for as generation cost).

(3) Power system stabilization cost

This is the cost of implementing power system stabilization measures in order to permit the greater interconnection of unstable power sources (photovoltaic and wind turbine systems).

(4) Energy conservation and cogeneration cost

This is the total cost of the energy conservation measures listed in Slide 7.

(1) Estimation of generation cost

(1) Generation cost = Σ(operation unit cost x generated power)
+ Σ(construction unit cost x generated power at new plants)

* The operation unit cost is assumed to be the same at existing and new facilities.
* The construction unit cost of existing facilities is not considered.

○ Generation unit cost: This is based on estimations produced by the Cost Estimation and Review Committee and generation cost estimation sheets.

- Using averages between the highest and lowest generation costs estimated by the Committee.

- Divided into two parts: construction cost (depreciation) and operation cost (inclusive of maintenance/repair cost, fuel cost, etc.).

- Recalculating the unit cost of each power source, assuming the availability factor (which differ from estimations by the Cost Estimation and Review Committee for nuclear generation and thermal power generation).

○ Power generation (kWh): Different values assumed in different scenarios.

- Divided into two parts: power produced by existing facilities (built by fiscal 2010) and power produced by new facilities (built in fiscal 2011 or later).

(1) Generation cost estimations

Unit: trillion yen

	2010	Basic Plan	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Nuclear power	—	3.4～3.4	2.0～2.0	1.5～1.5	0.9～0.9	0.0～0.0
LNG	—	1.6～1.7	1.9～1.9	2.0～2.1	2.4～2.5	2.6～2.8
Coal	—	1.2～1.3	1.4～1.4	1.5～1.5	1.7～1.8	1.9～1.9
Oil	—	0.8～0.8	0.9～0.9	0.9～1.0	1.1～1.2	1.1～1.3
Large hydro	—	0.9～0.9	0.9～0.9	0.9～0.9	0.9～0.9	0.9～0.9
Photovoltaic	—	0.8～1.5	0.9～1.6	1.2～2.1	1.2～2.1	1.9～3.5
Wind power	—	0.1～0.3	0.2～0.5	0.3～0.7	0.3～0.7	0.6～1.3
Geothermal	—	0.1～0.1	0.3～0.4	0.4～0.6	0.4～0.6	0.6～0.7
Small/medium hydro	—	0.3～0.4	0.4～0.5	0.6～0.7	0.6～0.7	0.6～0.7
Biomass/waste	—	0.2～0.2	0.2～0.2	0.2～0.2	0.2～0.2	0.3～0.3
Total	7.5	9.5～10.6	9.0～10.4	9.5～11.3	9.7～11.6	10.4～13.3
Average cost (yen/kWh)	8.6	9.3～10.4	10.2～11.8	10.8～12.8	11.0～13.1	11.8～15.0

Source: Calculated using estimations and models from the Cost Estimation and Review Committee.

(2) Calculation of purchasing cost

(2) Power purchasing cost = Σ [(purchasing price – power generation unit cost) x generated power]

* Scope of power sources to be purchased: photovoltaic, wind, geothermal, small/medium-scale hydropower and biomass

* Surplus power is purchased from home-installed photovoltaic systems. For other installations, the entire quantity of generated power is purchased.

* Only the difference between the purchasing price and the sales price is accounted for to avoid duplication with the generation cost.

○ Purchasing price: Using generation cost estimation sheets issued by the Cost Estimation and Review Committee.

The purchasing price is set at a level that allows the construction/installation cost to be depreciated in 10 years, except for home-installed photovoltaic systems which need 15 years.

Note: The purchasing period is not defined. The total payment in 20 years for purchasing power, at prices that would allow depreciation in 10 years, was determined and distributed to each year in the 20-year period (from 2011 to 2030). The calculation is complete provided the purchasing period is not longer than 20 years. (If the purchasing period exceeds 20 years, the cost as of 2030 would be overestimated.)

○ Power generation: Differs among scenarios.

- The power generated by newly installed systems (after fiscal 2012) is accounted for (except for those for home-installed photovoltaic systems accounted for after 2010).

(2) Estimations of (additional) purchasing cost

Unit: trillion yen

	2010	Basic Plan	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Photovoltaic	0.06	0.1～0.9	0.1～1.0	0.2～1.3	0.2～1.3	0.2～2.0
Wind power	—	0.1～0.2	0.2～0.4	0.2～0.5	0.2～0.5	0.4～0.8
Geothermal	—	0.1～0.1	0.3～0.4	0.4～0.5	0.4～0.5	0.5～0.7
Small/medium hydro	—	0.2～0.3	0.3～0.3	0.4～0.4	0.4～0.4	0.4～0.4
Biomass	—	0.0～0.0	0.0～0.0	0.0～0.0	0.0～0.0	0.0～0.0
Total	0.06	0.6～1.6	0.9～2.1	1.2～2.8	1.2～2.8	1.5～4.0
Average cost (yen/kWh)	0.1	0.6～1.6	1.0～2.4	1.4～3.3	1.4～3.3	1.7～4.6

Reference: Assumed purchasing prices

Unit:Yen/kWh

	2010	2020	2030
Photovoltaic (home)	56.9～65.2	27.2～54.5	22.4～45.5
Photovoltaic (others)	47.4～72.9	26.3～62.6	22.9～53.8
Wind power (land-based)	15.8～27.7	14.9～27.7	14.0～27.7
Wind power (offshore)	14.9～37.0	14.9～37.0	13.7～37.0
Geothermal	19.6～25.0	19.6～25.0	19.6～25.0
Small/medium hydro	30.7～36.4	30.7～36.4	30.7～36.4
Biomass	11.2～11.4	12.1～12.2	12.8～13.0

Note: The purchasing price includes subsidies for installation. For example, the purchasing cost for (home-installed photovoltaic power systems in 2010) is deemed inclusive of the cost for subsidies (70,000 yen/kW).

Source: Calculated using estimations and models from the Cost Estimation and Review Committee

(3) Estimation of power system stabilization cost

(3) Power system stabilization cost = battery unit price x required capacity

Note: The calculation considers only a part of the total cost of power system stabilization measures.

* For photovoltaic systems: We estimated the cost of batteries required for preventing reverse power flow on power distribution lines.

* For wind turbine systems: We estimated the cost of batteries required for stabilizing outputs to power distribution lines.

○ Battery unit price: This is based on estimations produced by the Cost Estimation and Review Committee and considers falling costs in future.

- It is assumed that the installation of batteries for photovoltaic systems is evenly shared by the consumer and the utility.

Consumer (for lithium ion): 100,000 yen/kWh (2011) → 50,000 yen (2020) → 20,000 yen (2030)

Utility (for NAS): 40,000 yen/kWh (2011) → 30,000 yen (2020) → 20,000 yen (2030)

○ Required battery capacity: It is assumed that batteries are ready to store about one third of the total power that could be produced in their anticipated operating hours.

Note: To back up unstable power sources, utilities may employ thermal power and pumped-storage systems in addition to batteries.

For photovoltaic systems: battery capacity equivalent to “installed capacity x 4 hours”
For wind turbine systems: battery capacity equivalent to “installed capacity x 8 hours”

(3) Estimation of power system stabilization cost

	Basic Plan	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Battery capacity required by photovoltaic systems (Unit: 0.1 billion kWh)	2.1	2.3	3.0	3.0	4.9
Battery capacity required by wind turbines (Unit: 0.1 billion kWh)	0.6	0.9	1.2	1.2	2.2
Additional cost (trillion yen/year)	0.4	0.5	0.7	0.7	1.1
Average cost (yen/kWh)	0.5	0.7	0.9	0.9	1.4

Other measures to be considered (costs not calculated yet):
- Measures for active power control (frequency regulation) and reactive power control (voltage regulation) during normal power system operation
- Length of transmission lines for connection between newly deployed power sources and existing grids (the cost will be high if underground or undersea cables are needed)

* Note that the cost of power system related measures may change or vary significantly with changes in the demand profile and depending on the location and quantity of renewable power generation. It is important to take necessary measures while collecting and analyzing data on actual outputs from wind and photovoltaic systems when appropriate.

(4) Estimation of costs for energy conservation and cogeneration

(4) Cost of energy conservation = Σ (unit cost for initial installation x amount of installation - energy conservation benefit)

* Power conservation measures/equipment: thermal insulation of houses and buildings, enhanced awareness (with smart meters) and LED lighting

Note: Smart meters are not expected to contribute significantly to energy conservation as per Slide 7. Continuous efforts are needed to increase awareness of power conservation.

○ Cost of initial installation
- Residential house: 0.5 to 0.6 million yen per newly built house, 2 to 3 million yen per existing house (estimation by the Residential Housing Subcommittee of the Panel on Infrastructure Development)
- Building: 10,000 to 15,000 yen per m2 for new building, 20,000 to 30,000 yen per m2 for existing building (estimation by the Residential Housing Subcommittee of the Panel on Infrastructure Development)
- Smart meter: 14.000 yen (estimation by the Cost Estimation and Review Committee)
- LED lighting: 14,000 yen (fluorescent lamp replacement type)

○ Scale of installation: See Slide 7.

○ Energy conservation benefit: average service life (10 to 40 years) x power consumption saved x electricity unit price

Cogeneration cost =
Generation unit cost x generated power

○ Generation unit cost: based on estimations by the Cost Estimation and Review Committee (including value of waste heat).

○ Generated power: equivalent of 19 million kW (See Slide 7.)

Total cost in the period up to 2030

		Initial cost Trillion yen	Energy conservation benefit Trillion yen	Net cost Trillion yen
Private sector	Residential houses	3.5	-0.9	2.5
	Buildings	7.2	-3.6	3.7
	Enhanced awareness	0.7	-1.5	-0.8
Industry	LED lighting	2.6	-2.4	0.3
	Cogeneration	2.3	-0.9	1.3
Total		16.3	-9.3	7.0