Annex 1 Energy Saving Measures in Japan
Industry and transformation sector

Sub-sector	Energy efficiency/conservation measure	Actual	Introduction/ prevention prediction	Energy savings (thausand kL)	items	
		FY2012	FY2030	FY2030	of which, electricity	of which, fuel
Iron and steel	Improving efficiency of electricity consuming equipments		3% improving electricity consumption per produced crude steel compared to 2005	430	430	
	Increment of using waste plastics	Used waste plastics 420 tons	Used waste plastics 1,000 tons	494		
	Introducing next generation coke-making technology	1 unit	9 units	416		360
	Improving heat efficiency of power generation	Joint thermal power: 16% Own generation: 14%	Joint thermal power: 84% Own generation: 82%	403		
	Increment of energy efficient equipments	For example, Low pressure loss TRT: 82% High efficiency CDQ: 93% Recovry of low pressure steam: 95%	100%	808		
	Introducing innovative iron making process (ferro coke)	0 unit	1 unit	194		194
	Introducing of environtally frendly steel making process (COURSE50)	0 unit	1 unit	54		
	Sub-total (Iron and steel)			2,799	430	554
Chemical	Introducing energy saving technologies in petrochumical	36%	100%	71		71
	Introducing energy saving technologies other than petrochumical	Caustic soda and steam generation equimpents: 20% Other chemical: 40%	100% 100%	597	88	436
	Introducing efficient distillation process technology using film	0%	4%	124		124
	Introducing CO2 raw-materialization technology	0 unit	1 unit	5		5
	Introducing chemical products producing technologies using inedible plants as feedstock	0 unit	1 unit	29		29
	Introducing waste-water treatment system generating electricity by microbial catalysts	0%	10%	14	14	
	Introducing sealed plant factories	0%	20%	54	54	
	Sub-total (Chemical)			894	156	665

Sub-sector	Energy efficiency/conservation measure	Actual	Introduction/ prevention prediction	Energy savings (thausand kL)	items	
		FY2012	FY2030	FY2030	of which, electricity	of which, fuel
Ceramics, stone and clay products	Introducing conventional energy saving technologies, ie Waste heat power generation, Slag grinding, Air beam cooler, Improving separator, Virtical coal mill			21	8	13
	Introducing heat energy subsutitution wastes use technologies	Heat energy substitution wastes 1,600 thousand tons	Heat energy substitution wastes 1,680 thousand tons	13	-1	14
	Intyroducing innovative cement producing technologies	0%	50%	151		151
	Introducing galss melting process	0%	5.40%	50	-6	56
	Sub-total (Ceramics, stone and clay products)			235	1	234
Paper and pulp	Introducing high efficient waste paper pulp producing technologies	11%	40%	36	36	
	Introducing high-temperature and high-pressure type black liquor recovery boiler	49%	69%	59		
	Sub-total (Paper and pulp)			95	36	0
Oil refinery	Promotion of effective use of heat Introducing sophisticated control system and high efficient equipments Improving efficiency of power system Large scale process improvement and sophistication	23%	10%	770		
Cross sub-sector, other sector	Introducing high efficient air conditioning			290	155	135
	Introducing industrial heat pump (for heating and drying)	0%	9.30%	879	-199	1,078
	Introducing industrial lighting	6%	almost 100%	1,080	1,080	
	Introducing low carbon industrial furnace	24%	46%	2,906	708	2,198
	Introducing industrial motor	0%	47%	1,660	1,660	
	Introducing high efficient boiler	14%	71%	1,733		
	Introducing co-generation	50.3TWh	103.0TWh	3,022		
	Direct use of recycled plastic flake			22		22
	Introducing hybrid construction equipments	2%	32%	160		160
	Introduction of energy efficient agricultural equipments	150 thousand units	450 thousand unit	1		1
	Introducing energy efficient equipments in greenhouse horticulture	50 thousand units, 80 thousand sites	170 thousand units, 350 thousand sites	513		513
	Conversion to energy efficient fishing boats	11%	29%	61		61
	Promoting energy efficiency cooperation between different businesses			100	20	80
	Sub-total (cross sub-sector)			12,427	3,424	4,248
Plant management	Implemantation of complete energy management in industry sector	4%	23%	672	223	449
Total				17,892	4,270	6,150

Commercial sector

Sub-sector	Energy efficiency/conservation measure	Actual	Introduction/ prevention prediction	Energy savings (thausand kL)	items	
		FY2012	FY2030	FY2030	of which, electricity	of which, fuel
Building	Promotion of energy efficiency/conservation standatrd adaptation in new buildings	22%	39%	3,323	1,623	1,700
	Energy efficiency/conservation in buildings (repair)			411	168	243
Hot water supply	Introducing business purpos water heaters Laten heat recovery water heaters Business purpos heat pumps High efficient boiler	7%	44%	611	103	508
Lighting	Introducing high efficient lightings	9%	almost 100%	2,288	2,288	
Air conditioning	Introducing manegament of refrigerant (chlorofluorocarbon)	0%	83%	6	6	
Power	Improving energy efficiecny of equipments by top runner			2,784	2,784	
	Top runner (FY2012 --> 2030) - Copy machine Electricity consumption: 169kWh/unit/y --> 106kWh/unit/y Prevalence: 3420 thousand units --> 3700 thousand units - Printer Electricity consumption: 136kWh/unit/y --> 88kWh/unit/y Prevalence: 4520 thousand units --> 4890 thousand units - High efficient router Electricity consumption: 6083kWh/unit/y --> 7996Wh/unit/y Prevalence: 1830 thousand units --> 1970 thousand units - Server Electricity consumption: 2229kWh/unit/y --> 1492Wh/unit/y Prevalence: 2970 thousand units --> 3190 thousand units - Storage Electricity consumption: 274kWh/unit/y --> 131kWh/unit/y Prevalence: 11790 thousand units --> 52920 thousand units - Refrigerator-freezer Electricity consumption: 13900kWh/unit/y --> 12390kWh/unit/y Prevalence: 2330 thousand units --> 2330 thousand units - Automatic vending machine Electricity consumption: 11310kWh/unit/y --> 7700kWh/unit/y Prevalence: 2560 thousand units --> 2560 thousand units - Transformer					
Management, national campaign	Implementation of complete energy management in Commercial sector by BEMS, energy audit, etc.	6%	47%	2,353	1,294	1,059
	Efficient use of lightings	15%	almost 100%	423	423	
	Promotion and national campaign (Commercial sector)			66	66	
	Expansion of energy use to another offices			78		
Total				12,343	8,755	3,510

Residential sector

Sub-sector	Energy efficiency/conservation measure	Actual	Introduction/ prevention prediction	Energy savings (thausand kL)	items	
		FY2012	FY2030	FY2030	of which, electricity	of which, fuel
Residence	Promotion of energy efficiency/conservation standatrd adaptation in new residences	6%	30%	3,142	786	2,356
	Promotion of insulation retrofit in existing residences			425	110	315
Hot water supply	Introducing high efficient hot water heaters			2,686	-263	2,949
	CO2 refrigerant heat pump hot water heaters	4000 thousand units	14000 thousand units			
	Laten heat recovery water heaters	3400 thousand units	27000 thousand units			
	Fuel cell Solar water heaters	55 thousand units	5300 thousand units			
Lighting	Introducing high efficient lightings	9%	almost 100%	2,011	2,011	
Air conditioning Power	Improving energy efficiecny of equipments by top runner	-	-	1,335	1,048	287
	Top runner (FY2012 --> 2030) - Air conditioner (cooling) Electricity consumption: 229kWh/unit/y --> 188kWh/unit/y Prevalence: 2.71 units/family --> 2.79 units/family - Gas stove Gas consumption: 5823Mcal/unit/y --> 5565Mcal/unit/y Prevalence: 0.06 units/family --> 0.05 units/family - Oil stove Oil consumption: 720 litre/unit/y --> 716 litre/unit/y Prevalence: 0.74 units/family --> 0.54 units/family - Television (more than 32V) Electricity consumption: 79kWh/unit/y --> 63kWh/unit/y Prevalence: 0.47 units/family --> 1.29 units/family - Refrigerator (more than 300 litre) Electricity consumption: 337kWh/unit/y --> 271kWh/unit/y Prevalence: 0.82 units/family --> 0.94 units/family		Top runner (FY2012 --> 2030) - Computer Electricity consumption: 72kWh/unit/y --> 72kWh/unit/y Prevalence: 1.29 units/family --> 1.83 units/family - Magnetic disk Electricity consumption: 0.005kWh/GB --> 0.005kWh/GB Prevalence: 2.80 units/family --> 3.34 units/family - Router Electricity consumption: 31kWh/unit/y --> 26kWh/unit/y Prevalence: 0.5 units/family --> 1.0 units/family - Microwave oven Electricity consumption: 69kWh/unit/y --> 69kWh/unit/y Prevalence: 1.06 units/family --> 1.08 units/family - Rice cooker and warmer Electricity consumption: 85kWh/unit/y --> 82kWh/unit/y Prevalence: 0.69 units/family --> 0.69 units/family			
Management, national campaign	Implementation of complete energy management in resudential sector by HEMS, smart meter	0.20%	almost 100%	1,783	1,783	
	Promotion and national campaign (Residential sector)	-	-	224	107	117
	- Promotion of complete implementation of Coolbiz and Warmbiz Coolbiz (implementaion 80%), Warmbiz (implementation 81%) --> almost 100% - Implementatiopn of energy audit in residential sector Awareness of energy audit --> 3940 thousand families		- Promotion of replacement to energy efficient equipments (2012 --> 2030) Electric dehumidifier (compression type) 93.7kWh/unit/y --> 72.5kWh/unit/y Totally automatic electric washing mashine with dryer 66.0kWh/unit/y --> 36.9kWh/unit/y			
Total (Residential sector)				11,607	5,583	6024

Transport sector

Sub-sector	Energy efficiency/conservation measure	Actual	Introduction/ prevention prediction	Energy savings (thausand kL)	items	
		FY2012	FY2030	FY2030	of which, electricity	of which, fuel
Automobile	Improving fuel economy Prevalence of next generation automobiles	HEV 3%	29%	9,389	-1,001	10,390
		EV 0% PHEV 0%	16%			
		FCV 0%	1%			
		CDV 0%	4%			
Other	Other measure of transport sector	-		6,682	624	6,058
	- Promotion of trafic sream measures - Promotion of public transport system - Modal shift to freight railway - Comprehensive measure of green shipping - Reduction of land transportation distance by appropriate selection of port - Comprehensive low carbonazetion in ports - improving transport by truck - Improving energy efficiency of railway - Improvin energy efficiency of aviation - Promotion of energy efficient ship - Green truck transportation by promoting environmentally frendly automobiles - Promotin of cooperative transport - Pormotion of Intelligent Transportation System, ITS (centraized control of signals) - Improving transport safety eqipments (sophisticated signals, promoting substitution to LED lightings) - Promotion of automatic driving - Promotion fo Eco Drive - Car-sharing					
Total (Transport sector)				16,071	-377	16,448

Annex 2 Power Generation Cost Review Sheets in Japan

Cost elements of generation source and reference information (tentative translation by IEEJ)

Nuclear

Cost elements		Data from following four sample plants which started their operation within ten years and interview to relevant companies * Sample plants (Plant name, company name, capacity, operation year) Higashidori No1, Tohoku Elec., 1100MW, 2005, Hamaoka No5, Chubu Elec., 1380MW, 2005, Shiga No2, Hokuriku Elec., 1358MW, 2006, Tomari No3, Hokkaido Elec., 912MW, 2009	
Model plant capacity		1,200 MW	Average of sample plant capacities
Capacity factor		80% 70% 60%	Several conditions are set in order to compare them
Operation years		60 years 40 years	Based on life extension approval system stipulated by the Nuclear Reactor Regulation Law, 40 years and 60 years are set.
Capital cost	Construction cost	37,000 Yen/kW	Plant construction cost. Considering several units are constructed in one site, averaging correction of shared equipments, prices correction, etc are in place at model plants. Aditional safety mesures based on the Great East Japan Earthquake are excluded
	Rate of fixed asset tax	1.4%	
	Decommissioning cost	71.6 billion Yen	"Average cost per kWh based on estimated amount of nuclear generation equipment dismantle allowance" by "sample plant capacities"
Operation cost	Personal cost	2.05 billion Yen/y	Personal cost of generation plant operation. Payoff, allowance, welfare cost, retirement allowance, etc are included. Average of sample plants.
	Repair cost	2.2%/y (Percentage of construction cost)	Average of check and maintenance cost of generation equipments to keep normal operational conditions in specified operation years. Average of sample plants.
	Other cost	8.44 billion Yen/y	Waste disposal cost, supplies cost, leasehold cost, outsorcing cost, non-life insurance premium, miscellaneous wages, nuclear fuel tax, etc. Average of sample plants.
	Administartive cost	13.4%/y (Percentage of direct cost)	Nuclear generation business cost shared with total electricity business cost, of which, personal cost of headquarter, repair cost, other cost. Average of sample plants.
Fuel cost	Nuclear fule cycle cost (Front-end + back-end)	1.54 Yen/kWh (Front-end: 0.95, back-end: 0.59)	Considering current situation that all spent fuels are stored in apropriate period and reprocessed (current model), it is calculated preliminarily. Condition changes from 2011are reflected.
	Heat efficiency	34.7%	Net generation. Average of sample plants.
	Rate of own use	4.0%	Percentage of electricity own use against total generated electricty. Average of sample plants.
Price variation factor in 2020 and 2030	Technological innovation and volume efficiency	—	(Reference) In next generation light-water-reactor which is being developed by the joint project of the public and private sectors, target in 2030, rationalizations with safety improvement by seismic isolation tecnology, etc, are expected. For example, shortening of construction period by modularization technology.
Damage cost		9,108.8 billion Yen （Estimated minimum amount of countermesure for accident risks)	Expected maximum amount of damage of Fukushima Daiichi Nuclear Power Plant accident from quantitative information at present is corrected for model plant. * Damage cost is supposed to be reduced by implementation of additional safety mesures like prevention maesures of radioactive material, but these impacts are not reflected. * Calculation from "For Accelerating the Reconstruction of Fukushima From the Nuclear Disaster (Cabinet Decision on December 20, 2013)", "New Comprehensive special Business Plan (Approved change in April 2015, TEPCO)"、"TEPCO financial statement of Q3 2014", "Ministry of Finance HP", etc TEPCO: Tokyo Electric Power Company
Additional safety mesure cost		60.1 billion Yen	24 reactors of 15 nuclear power plants which new regulation statdard adaptation criterion are submitted to Nuclear Regulation Authority at present 1) latest prospect of additional safety mesure cost were provided from Electric Companies, 2) regarding four reactors of two nuclear power plants which application for permission of installement changes were approved at present, provided detail of cost were corrected to the model plant in order to improve precision, 3) reflecting these results, average of 24 reactors of 15 nuclear power plants was calculated.
Nuclear accident prevention		—	Disposition in political purpose expenses
Note		[Exchange rate] Exchange rate is assumed to be unchanged. it is used for preminary calculation of fuel cost. [Discount rate] Annual rate where future monetary value is discounted/converted to present value. If discount rate is high, present generation unit cost of generation sources which the share of fuel cost is high, is lower. For example, thermal is higher than nuclear and hydro generaly. [Direct expenses] Total of personal cost, repair cost and other cost	

Cost elements of generation source and reference information (tentative translation by IEEJ)

Hydro (Large)

Cost elements		Data from following three sample plants which started their operation within seven years and interview to relevant conpanies * Sample plants (Plant name, company name, capacity, operation year) 江卸, Hokkaido Elec. 13.8 MW, 2006, 新忠別, Hokkaido Elec. 10MW, 2006, 森吉, Tohoku elec., 11MW, 2013	
Model plant capacity		12 MW	Average of sample plant capacities
Capacity factor		45%	Based on actual perfomance, it was set.
Operation years		60 years 40 years	Based on actual perfomance, it was set. It is assumed 60 years because main equipments like water turbine will need to be replaced, if operation years exceeds 60 years.
Capital cost	Construction cost	640,000 Yen/kW	Construction cost of generation plant. Structure cost and equipments cost like generator are averaged.
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	20 million Yen/y	Personal cost of generation plant operation. Payoff, allowance, welfare cost, retirement allowance, etc are included. Average of sample plants.
	Repair cost	0.9%/y (Percentage of construction cost)	Average of check and maintenance cost of generation equipments to keep normal operational conditions in operation years. Average of sample plants.
	Other cost	0.1%/y (Percentage of	Waste disposal cost, supplies cost, leasehold cost, outsorcing cost, non-life insurance premium, miscellaneous wages, taxes, etc. Average of sample plants.
	Administrative cost	13.3%/y (Percentage of direct cost)	Hydro generation business cost shared with total electricity business cost, of which, personal cost of headquarter, repair cost, other cost. Average of sample plants.
Fuel cost	Rate of own use	0.40%	Percentage of own use electricity against total generated electricty. Average of sample plants.
Price cariation factor	Technological innovation and volume efficiency	―	Technoligical innovation and volume efficiency which affect generation cost significantly are not expected.
	Rate of fuel cost increse	―	―
	CO2 reduction cost	―	―

Cost elements of generation source and reference information (tentative translation by IEEJ)

Hydro (Medium/Small)

Cost elements		Procurement Price Calculation Committee, interview to hydro industry, etc	
Model plant capacity		200 kW	Same as Report of Power Generation Cost Verification Working Group and Procurement Price Calculation Committee
Capacity factor		60%	Procurement Price Calculation Committee
Operation years		40 years 30 years	Same as Coal-fired thermal, LNG-fired thermal and Oil-fired thermal. According to the interview to hydro indutry, there is no significant differencies between expected operation years of mini hydro and thermal power plants generally.
Capital cost	Construction cost	from 800,000 to 1,000,000 Yen/kW --> from 160 million Yen to 200 million Yen	Procurement Price Calculation Committee (Connection cost is included because it is difficlut to separate off connection cost from construction cost.)
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	7 million Yen/y	Procurement Price Calculation Committee
	Repair cost	1%/y (Percentage of construction cost)	Procurement Price Calculation Committee
	Other cost	2%/y (Percetage of	Procurement Price Calculation Committee
	Administrative cost	14%/y (Percentage of direct cost)	Procurement Price Calculation Committee
Fuel cost	First year price	—	—
	Rate of own use	—	—
	Other fuel reelevant cost	—	—
Price variation	Technological innovation and volume efficiency	—	Significant technological innovation and volume efficiency which affect generation cost are not expected.
	Rate of fuel cost increase	—	—

Cost elements of generation source and reference information (tentative translation by IEEJ)

Solar PV (Rooftop)

Cost elements		Procurement Price Calculation Committee, interview to solar indusry, etc.	
Model plant capacity		4 kW	Same as Report of Power Generation Cost Verification Working Group and Procurement Price Calculation Committee
Capacity factor		12%	Procurement Price Calculation Committee
Operation years		25 years 20 years	Manufacturers' guarantee period are from 10 to 20 years as the longest generally, although they are vary between manufactures. Generally, 20 years or 25 years is adopted in cost analysis outside Japan.
Capital cost	Construction cost	364,000 Yen/kW	Procurement Price Calculation Committee
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost.
Operation cost	Personal cost	—	—
	Repair cost	3,600 Yen/kW/y	Procurement Price Calculation Committee
	Other cost	—	—
	Administrative cost	—	—
Fuel cost	First year price	—	—
	Rate of own use	—	—
	Other fuel relevant cost	—	—
Price variation factor	Technological innovation and volume efficiency	Reduction of construction cost (thousand Yen/kW) <New policy scenario> 2020: 275 - 298 2030: 206 - 258 <Current policy scanerio> 2020: 280 - 303 2030: 220 - 274 Reduction of operation and maintenance cost (thousand Yen/kW) <New policy scenario> 2020: 2.72 - 2.95 2030: 2.04 - 2.55 <Current policy scenario> 2020: 2.77 - 3.00 2030: 2.17 - 2.71 Increase of operation years 2030: 20 - 30 years	Reduction of construction cost Module, Inverter Based on world accumulate production in New policy scenario and Current Policy Scanario of latest IEA World Energy Outlook, cost reduction is assumed progression rate 80%, learning effect. Installtion cost will not be changed. The case that module and inverter cost was convergent on global level was studied. Reduction of operation and maintenance cost Cost redudction is assumed as same as reduction rate of construction. Increase of operation yeras Based on technology development targets and the discussion of the Working Group, 2030 model plant operation years is capped 30 years. Decommissioning cost Without relation to the reduction of construction cost, the cost is same as 5% construction cost which calculated in 2014 model plant.
	Rate of fuel cost increase	—	—

Cost elements of generation source and reference information (tentative translation by IEEJ)

Solar PV (Utility scale)

Cost elements		Procurement Price Calculation Committee, interview to solar industry, etc	
Model plant capacity		2 MW	Same as Procurement Price Calculation Committee
Capacity factor		14%	Procurement Price Calculation Committee
Operation years		25 years 20 years	Manufacturers' guarantee period are from 10 to 20 years as the longest generally, although they are vary between manufactures. Generally, 20 years or 25 years are adopted in cost analysis outside Japan.
Capital cost	Construction cost	294,000 Yen/kW -->million yen 588	Procurement Price Calculation Committee (System cost included land preparation cost)
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	3,700 Yen/kW/y	The operation and maintenance cost is provided by Procurement Price Calculation Committee, but land lease equivqlent cost is exluded in this study.
	Repair cost		
	Other cost		
	Administrative cost		
Fuel cost	First year price	—	—
	Rate of own use	—	—
	Other fuel relevant cost	—	—
Price variation factor	Technological innovation and volume efficiency	Reduction of construction cost (thousand Yen/kW) <New policy scenario> 2020: 233 - 249 2030: 2185- 222 <Current policy scanerio> 2020: 236 - 253 2030: 194 - 233 Reduction of operation and maintenance cost (thousand Yen/kW) <New policy scenario> 2020: 3.24 - 3.37 2030: 2.88 - 3.16 <Current policy scenario> 2020: 3.27 - 3.39 2030: 2.95 - 3.24 Increase of operation years 2030: 20 - 30 years	Reduction of construction cost Module, Inverter Based on world accumulate production in New policy scenario and Current policy scanario of latest IEA World Energy Outlook, cost reduction is assumed progression rate 80%, learning effect. Installtion cost will not be changed. The case that module and inverter cost was convergent on global level was studied. Reduction of operation and maintenance cost Cost redudction is assumed as same as reduction rate of construction. Increase of operation yeras Based on technology development targets and the discussion of the Working Group, 2030 model plant operation years was capped 30 years. Decommissioning cost Without relation to the reduction of construction cost, the cost is same as 5% construction cost which calculated in 2014 model plant.
	Rate of fuel cost increase	—	—

Cost elements of generation source and reference information (tentative translation by IEEJ)

Wind (Onshore)

Cost elements		Procurement Price Calculation Committee, interview to wind industry, etc	
Model plant capacity		20 MW	Same as Report of Power Generation Cost Verification Working Group and Procurement Price Calculation Committee
Capacity factor		20%	Procurement Price Calculation Committee
Operation years		25 years 20 years	Almost all wind turbines in the world are designed and manufactured in compliance with the standard of International Electrotechnical Commission, IEC. IEC prescribes for design service life of wind turbine as 20 years. There are examples that wind turbines which exceed 20 yeras design service life continue to operate outside Japan.
Capital cost	Construction cost	284,000 Yen/kW --> \5.68 billion	Procurement Price Calculation Committee （Procurement Price Calculation Committee assumes construction cost as \300,000/kWh, 5.2% of which, equivalent connection cost, is excluded.)
	Plant decommisisoning cost	5% of construction costs	Data of preminary calculation of OECD/IEA“Projected Costs of Generating Electricity 2010 Edition”(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	6,000 Yen/kW/y	Procurement Price Calculation Committee
	Repair cost		
	Other cost		
	Administrative cost		
Fiel cost	First year price	—	—
	Rate of own use	—	—
	Other fuel relevant cost	—	—
Price variation factor	Technological innovation and volume efficiency	Reduction of construction cost (thousand Yen/kW) 2020: 255 - 272 - 284 2030: 205 - 252 - 284 Reduction of operation and maintenance cost (thousand Yen/kW) 2020: 5.4 - 5.7 - 6.0 2030: 4.3 - 5.3 -6.0 Improving capacity factor 2020: 20 - 23% 2030: 20 - 23%	Construction, operation and maintenance cost in 2020 and 2030 Following three cases are set based on cost elements of 2014 model plant case 1) The cost is equal to 2014 unit price. Cost reduction is not expected. case 2) The cost will be reduced according to Technology Roadmap Wind Energy 2013, IEA case 3) Cost of turbines and eledctric installations will be convergent on global price. Capacity factor after 2020 Based on technology development like improving generation efficiency of wind turbine, growing in size, and improving reliability and capacity factor, the rate is capped 23%. Decommissioning cost Without relation to the reduction of construction cost, the cost is same as 5% construction cost which calculated in 2014 model plant.
	Rate of fuel cost increase	—	—

Cost elements of generation source and reference information (tentative translation by IEEJ)

Wind (Offshore)

Cost elements		Procurement Price Calculation Committee, interview to wind industry, etc	
Model plant capacity		30 - 100 MW	Based on the study of procurement price of onshore wind farm equipments, it is assumed.
Capacity factor		30%	Procurement Price Calculation Committee
Operation years		25 years 20 years	Same as onshore wind. IEC prescribes for design service life of wind turbine as 20 years. There are examples that wind foreign companies deliver them at design service life as 25 years.
Capital cost	Construction cost	515,000 Yen/kW --> billion yen 15.45 - 51.5	Construction cost which Procurement Price Calculation Committee assumed. Connection cost equivalent is excluded. (\50,000/kWh, which is mean of \30,000 - \70,000/kWh)
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	22,500 Yen/kW/y	Procurement Price Calculation Committee
	Repair cost		
	Other cost		
	Administrative cost		
Fuel cost	First year price	—	—
	Rate of own use	—	—
	Other fuel relevant cost	—	—
Price variation factor	Technological innovation and volume efficiency	Reduction of construction cost (thousand Yen/kW) 2030: 446 - 515 Reduction of operation and maintenance cost 2030: 19.5 - 22.5	Construction, operation and maintenance costs in 2020 and 2030 Following two cases are set based on cost elements of 2014 model plant case 1) The cost is equal to 2014 unit price. Cost reduction is not expected. case 2) The cost will be reduced according to Technology Roadmap Wind Energy 2013, IEA Decommissioning cost Without relation to the reduction of construction cost, the cost is same as 5% construction cost which calculated in 2014 model plant.
	Rate of fuel cost increase	—	—

Cost elements of generation source and reference information (tentative translation by IEEJ)

Biomass

Cost elements		Procurement Price Calculation Committee, interview to biomass industry, etc	
Model plant capacity		5,700 kW	Same as Procurement Price Calculation Committee
Capacity factor		87% (the Committee) 80% 70% 60% 50%	Procurement Price Calculation Committee and actual performance. Several conditions are set in order to compare them.
Operation years		40 years 30 years 20 years	Same as Coal-fired thermal, LNG-fired thermal and Oil-fired thermal. According to the interview to biomass industry, tipical biomass generation companies expect their plant operation years from 15 to 20 years. But it is possible to set 30 years operartion.
Capital cost	Construction cost	398,000 Yen/kW --> 2.267 billion Yen	Procurement Price Calculation Committee provided construction, but 70 million Yen as connection cost is excluded in this study.
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	27,000 Yen/kW	Procurement Price Calculation Committee
	Repair cost		
	Other cost		
	Administrative cost		
Fuel cost	First year price	12,000 Yen/t	Procurement Price Calculation Committee
	Rate of fuel cost rise	—	Unused timbers from forest thinning While collection and transport cost are expected to decrease in the future by implementation of wood self-suficiency improving policy, for example, improving wood transport roads, Increase of wood demand for generation will lead to increase wood cost. Expected fuel cost will not be changed totally.
	Required fuel	60,000t	Procurement Price Calculation Committee (Required fuel in case of capacity factor 87%)
	Rate of won use	16%	Procurement Price Calculation Committee
	Fuel relevent other cost	\750/t	Procurement Price Calculation Committee
Price variation factor	Technological innovation and volume efficiency	—	Significant technological innovation and volume efficiency which affect generation cost are not expected.
	Rate of fuel cost increase	—	Unused timbers from forest thinning While collection and transport cost are expected to decrease in the future by implementation of wood self-suficiency improving policy, for example, improving wood transport roads, Increase of wood demand for generation will lead to increase wood cost. Expected fuel cost will not be changed totally.

Cost elements of generation source and reference information (tentative translation by IEEJ)

Geothermal

Cost elements		Procurement Price Calculation Committee, interview to wind industry, etc.	
Model plant capacity		30 MW	Same as Report of Power Generation Cost Verification Working Group and Procurement Price Calculation Committee
Capacity factor		83%	Procurement Price Calculation Committee
Operation years		50 years 40 years 30 years	The report of Power Generation Cost Verification Working Group was published in 2011.Expected operation years are supposed not to be changed significantly. Based on the report, actual performance at that time is assumed.
Capital cost	Construction cost	790,000 Yen/kW --> 23.7 billion Yen	Procurement Price Calculation Committee
	Plant decommisisoning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost. (Same as Procurement Price Calculation Committee)
Operation cost	Personal cost	33,000 Yen/kW/y	Procurement Price Calculation Committee
	Repair cost		
	Other cost		
	Administrative cost		
Fuel cost	First year price	—	In case that steam supplyers supply their steam to geothermal developpers as fuel, fuel cost is allocated in their financial statments. In this study, tha case that one developer supplys steam to his/her generation plant is assumed. Fuel cost is not allocated in this case becuase fuel is that extracted hot water or steam from underground.
	Rate of own use	11%	Procurement Price Calculation Committee
	Other fuel reelevant cost	—	—
Price variation factor	Technological innovation and volume efficiency	—	Technological innovation and volume efficiency which affect generation cost significantly are not expected. (Reference) More sophisticated geothermal reservoir assessment technology and scale or acid fluid provison development will be promised to improve economical efficiency.
	Rate of fuel cost increase	—	Fuel cost is not allocated because fuel is that extraced hot water or steam from underground.

Cost elements of generation source and reference information (tentative translation by IEEJ)

(Reference) Coal

Cost elements		Data from following four sample plants which started their operation within seven years and interview to relevant companies * Sample plants (Plant name, company name, capacity, operation year) New Isogo No2, J-Power, 600MW, 2009, Maiduru No2, Kansai Elec., 900MW, 2010, Hirono No6, Tokyo Elec., 600MW, 2013, Hitachinaka No2, Tokyo elec., 1000MW, 2013	
Model plant capacity		800 MW	Average of sample plant capacities
Capacity factor		80% 70% 60% 50% 10%	Considering actual performance, several conditions are set in order to comapre them.
Operation years		40 years 30 years	Considering actual performance, several conditions are set in order to comapre them.
Capital cost	Construction cost	250,000 Yen/kW	Plant construction cost. Considering several units are constructed in one site, averaging correction of shared equipments, etc, are in place at model plants. Replacements are included.
	Decommissioning cost	5% of construction cost	Data of preminary calculation of OECD/IEA"Projected Costs of Generating Electricity 2010 Edition"(2010), of which, no country provided specific decommissioning cost.
Operation cost	Personal cost	360 million Yen/y	Personal cost of generation plant operation. Payoff, allowance, welfare expenses, retirement allowance, etc are included. Average of sample plants.
	Repair cost	1.8%/y (Percentage of construction cost)	Average of check and maintenance expenses of generation equipments to keep normal operational conditions through operation years. Average of sample plants.
	Other cost	1.5%/y (Percentage of construction cost)	Waste disposal cost, supplies cost, leasehold cost, outsorcing cost, non-life insurance premium, miscellaneous wages, taxes, etc. Average of sample plants.
	Administartive cost	14.3%/y (Percentage of direct cost)	Coal-fired generation business expenses shared with total electricity business expenses, of which, personal cost of headquarter, repair cost, other cost. Average of sample plants.
Fuel cost	First year price	US$97.64/t ($0.004/MJ)	Customs value (CIF) of thermal coal in all Japan, average of 2014.
	Heat value	25.97 MJ/kg (LHV: 24.66 MJ/kg)	Standard heat value of imported termal coal. (Standard heat value used in Energy Balance and Carbon Emission Factor List)
	Heat efficiency	42%	HHV. Net generation. Average of sample plants.
	Rate of own use	6.4%	Percentage of generation plant own use electricty against total generated electricty. Average of sample plants.
	Other fuel relevant cost	2,000 Yen/t (0.077 Yen/MJ)	Petroleum and coal tax, import commission, coastal shipping freight, coal center usage fee, unloading auditors fee, etc. Average of latest actual cost of each companies
Price cariation factor	Technological innovation and volume efficiency	Improving heat efficiency 2014: 42% 2020: 42% 2030: 48%	Ultra Super Critical (USC) technology with heat efficiecny 42% is in commerial use at present. Target of heat efficiecny 48% will be achived by development Integrated coal Gasification Combined Cycle (IGCC) and advanced Ultra Super Critical (A-USC) technology by 2030.
	Fuel cost increase	IEA Current Policy Scenario IEA New Policy Scenario	First year price is $97.64/t above mentioned. From second year, price projections of Curent Policy Scenario and New Policy Scenario in IEA World Energy Outlook 2014 are adopted.
	CO2 reduction cost	IEA EU Current Policy Scenario IEA EU New Policy Scenario	Price in Current Policy Scenario The price is EU Current Policy scenario in 2020 - 2040, the price trend is extended in 2040 - 2070 (Logarithmic regression). Price in New Policy Scenario The price is EU New Policy Scenario in 2020 - 2040, the price rend is extended in 2040 - 2070 (Logarithmic regression). Price in 2014 and 2020 2014: Average ofEU-ETS in 2014. 2020: Linear interpolation.