

Japan's -25% GHG Emission Reduction Target can be Achieved Domestically

- Results of CASA 2020 Model Simulation -

Summary of Interim Report

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Citizens' Alliance for Saving the Atmosphere and the Earth (CASA)

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CASA’s Research Group on Strategic Climate Change Measures was established in April 1997 and published books including; “Proposal of CO2 emission reduction strategy (1997)”; “Climate change prevention scenario 2010 (Jikkyo Shuppan publishing, 2000)”; “Comfortable life while preventing climate change (Kamogawa publishing, 1997)”. The member comprises of about 20 researchers and experts from different discipline, such as environmental economics, environmental law, environmental policy and environmental engineering.

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*Full report is available upon request (in Japanese)

1. Accelerating Climate Change and the Needs for Mid- and Long-term Emission Reduction Targets

Climate change is accelerating more rapidly than estimated in the IPCC Fourth Assessment Report (AR4) and its catastrophic risk is rising. This is a serious concern for all human beings.

If the global average surface temperature rise is not kept below 2°C as compared to the pre-industrial level, the survival of humanity could be threatened by global environmental damages. The AR4 states that holding the global average temperature rise to 2.0–2.4°C above the pre-industrial level requires stabilizing the atmospheric greenhouse gas (GHG) concentrations at 445–490ppm (CO₂ equivalent), peaking out CO₂ emissions by 2015, and reducing the emissions 50–80% below 2000 levels by 2050. Given this, developed countries need to reduce their emissions by 25–40% below 1990 levels by 2020, and developing countries reduce their emissions by 15–30% below business as usual (BAU).

The 15th Conference of the Parties (COP15) of the UN Framework Convention on Climate Change (UNFCCC) and the 5th Meeting of the Parties of the Kyoto Protocol (COP/MOP5) held in Copenhagen in December 2009, failed to agree on a post-2012 framework with neither mid-term (2020) nor long-term (2050) emission reduction targets. To ensure the required peak out by 2015 and to avoid a gap between the first and second commitment periods of the Kyoto Protocol, we urgently need to establish a post-2012 framework including ambitious emission reduction targets.

2. Background of our CASA 2020 Model Analysis

The Democratic Party of Japan (DPJ), which came into power in September, 2009, announced the Japan's mid-term target to reduce its GHG emissions by 25% below 1990 levels by 2020. On March 12, 2010, the Cabinet approved a bill of the Basic Act on Global Warming Countermeasures. The Act includes the introduction of the following:

- Mid-term target of a 25% reduction below 1990 levels by 2020, conditional on the establishment of a “fair and effective” international framework by all major economies and agreement on their ambitious targets
- Long-term target of a 80% reduction below 1990 levels by 2050
- Carbon tax
- Domestic emissions trading scheme
- Feed-in-tariff system for whole renewable energy

However, there are several problems in the bill. First, Japan's mid-term target should be without the condition on decisions of other countries. Japan as well as other developed countries has the responsibility to act first based on the common but differentiated responsibilities. Second, the

emission trading scheme is to consider placing a cap on the absolute amount of GHG emission in principle, while including an intensity-based cap as a possible option. We have already learned from Japan's air pollution regulations that intensity-based emissions trading scheme does not ensure that total emissions will be reduced. Third, with a legislative decree, it is possible to promote energy source even if it is not exactly renewable by rights. Fourth, it promotes nuclear energy as a measure "while ensuring safety and gaining understanding and confidence of the Japanese people". One would need to evaluate fairly what advantages and disadvantages nuclear power technologies have. It should be acknowledged that a nuclear accident can cause tremendous damage and pollution compared to other power sources.

Judging from the findings of the IPCC AR4, we must tell that Japan's -25% target is not enough. However, even the 25% reduction target faces with strong oppositions by some ministries, industries and labor groups on the ground that the target would have negative impacts on Japanese economy, industries and households. These negative impacts are mostly based on arbitrary assessments or distortions by industries, but there is a tendency within the government to conform to these arguments.

Given this background, we, from a citizens' perspective, aim to analyze whether the -25% target is achievable by domestic actions, not by relying on nuclear power generation but by utilizing already available technologies and greater dissemination of renewable energies. Our analysis considers that the nuclear power plants will be decommissioned after 40 years of operation and no new nuclear plant will be operated except for the ones whose construction is currently planned. In addition, the government committee on Japan's mid-term GHG emission reduction (*Mid-term Target Committee*) considered the macroeconomic frame (e.g., real GDP growth rate, crude steel production, transport volume) as exogenous variables as requested by the industries, but the CASA 2020 Model avoids the use of such exogenous variable as much as possible so that the influence of the market economy are reflected in the simulation results. If we achieve the -25% target with domestic policies and measures, it will be our social capital for our low-carbon society for 2050. In addition, we can move forward the international climate negotiation on a post-2012 framework, which is currently in stalemate. The AR4 shows that, to avoid catastrophic damages of climate change, we need to establish a carbon-neutral society within the 21st century. CASA will further expand CASA 2020 Model to analyze the ways to achieve a low-carbon society by 2050 and a carbon-neutral society by the end of this century.

3. CO₂ emissions from fossil fuel combustion can be reduced by 25% below 1990 levels by 2020

CASA's Research Group on Strategic Climate Change Measures developed CASA 2020 Model

which combines a bottom-up technology model and a top-down macroeconomic model to consider potential reductions of fossil-fuel-based CO₂ emissions in Japan by 2020. This model estimated the amount of CO₂ emissions in the following three scenarios:

- 1) **Business as Usual (BaU) scenario:** increase of CO₂ emissions by 4% above 1990 levels by 2020
- 2) **Carbon tax scenario:** 10,000 yen/Ct or 2,727 yen/CO₂t-eq, equivalent to additional 7 yen/liter to the gasoline price.
- 3) **CASA technology scenario:** The greater use of already available technologies and the accelerated introduction of renewable energies.

The result of the estimation shows that direct CO₂ emissions in 2020 will be reduced by 1.8%, 5.2% and 25.6% from 1990 levels respectively (Table 0-1, 0-2, and Figure 0-1). CASA technology scenario considers a) energy savings from energy-efficiency measures and b) an energy shift (from nuclear and fossil fuels to renewable energies) as the main measure. The energy-efficiency measures results in an emissions reduction by 27.1% below 1990 levels through the reduction in the final energy demand in the industry, transport and buildings sectors, and the energy shift reduced 22.8% in the energy supply sector.

Our BaU scenario, which reduces emissions by 1.8% below 1990 levels by 2020, is based on assumptions that are nearly identical to what is assumed for the option 1 scenario of the Government's *Mid-term Target Committee* (the original draft of April 2009). As opposed to the 4% increase of emissions from 1990 levels in the Government's option 1 scenario, our BaU estimation resulted in almost 6% more reductions. The difference can mainly be explained by the fact that, as opposed to the *Mid-term Target Committee*, our model considered the Lehman Shock in 2008 and the economic stagnation thereafter.

Table 0-1 Estimated fossil-fuel-based CO₂ emissions in 2020 (direct emissions)

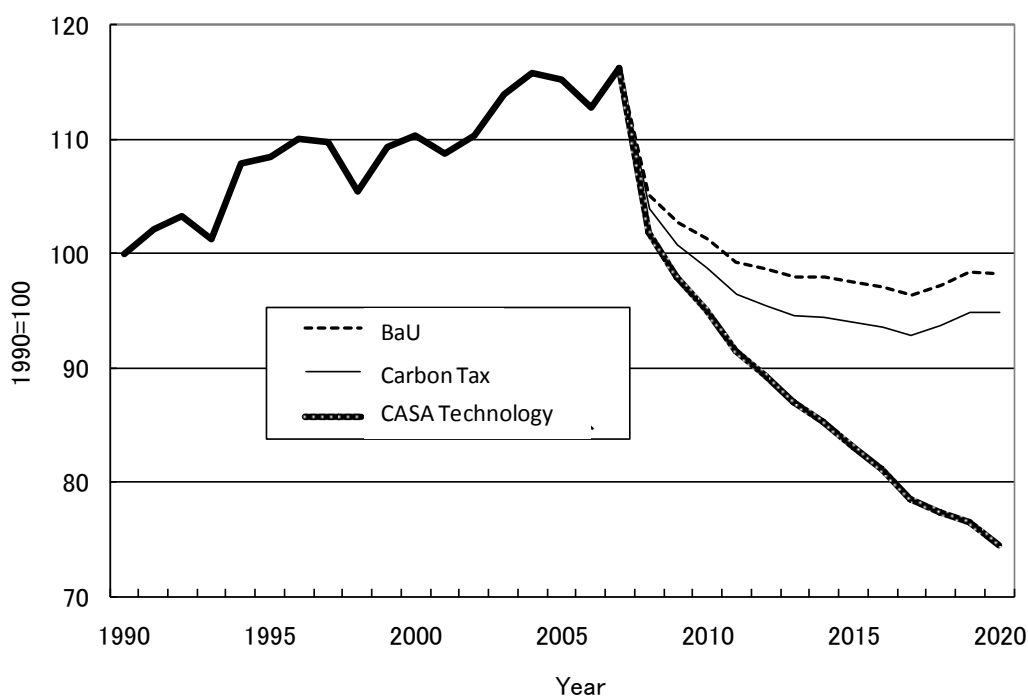
Sector	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Technology
Energy supply (electricity)	367	412	462	430	416	283
Industry	341	325	316	244	223	226
Transportation (freight)	211	259	250	89	89	71
Transportation (passenger)				163	162	111
Commercial buildings	84	101	107	39	38	31
Residential buildings	57	69	68	75	75	65
Energy-related CO ₂ emissions	1,059	1,167	1,203	1,040	1,004	788
(compared to 1990 level)	—	10.2%	13.6%	-1.8%	-5.2%	-25.6%

Note: The numbers do not match with the official government data (1990, 2000 and 2005) as CO₂ emissions from captive power generation is accounted in the energy supply sector but not in the industry sector. Point-of-emissions are defined at the point in the energy chain where emissions are released.

Table 0-2 Estimated fossil-fuel-based CO₂ emissions in 2020 (allocated to the end-use sector)

Sector	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Technology
Energy supply (electricity)	68	71	78	52	50	34
Industry	482	467	456	400	371	328
Transportation (freight)	217	265	257	89	90	71
Transportation (passenger)				171	170	116
Commercial buildings	164	206	238	129	126	89
Residential buildings	127	158	174	200	198	149
Energy-related CO ₂ emissions	1,059	1,167	1,203	1,040	1,004	788
(compared to 1990 level)	—	10.2%	13.6%	-1.8%	-5.2%	-25.6%

Figure 0-1 Comparison of estimated CO₂ emissions in 2020 in different scenarios (direct emissions)



The change in energy demand of each sector shows that there is still a huge room for energy saving. CASA technology measures scenario reduces the energy demand by 11.7% below 1990 levels (24% below 2005 levels) in 2020 (Table 0-3) and the primary energy supply by 8.8% below 1990 levels (Table 0-4). The change in composition of electricity production shows that it reduces nuclear power plants sequentially and largely increases new energy¹ (Table 0-5). As for the share of the electricity generation from renewable energies, photovoltaic is largest, followed by wind, biomass and small-scale hydro power (Table 0-6).

The effect of CO₂ emission reductions in the carbon tax scenario can be calculated as the gap between the estimated CO₂ emissions in the carbon tax and BaU scenarios (i.e., 5.2% reduction minus 1.8% reduction), which equals to a 3.4% reduction below 1990 levels in 2020. Therefore, if one simply adds the reduction from the carbon tax and the CASA technology measures, a 29% reduction below 1990 levels can be achieved domestically in 2020. It should be noted that CASA technology measures scenario considers technologies that are already commercially available and assume a reasonable level of technology penetration in 2020. Therefore, further emission reductions could be expected if additional emerging technologies and/or a higher level of technology penetration would be assumed.

Table 0-3 Final energy demand by sector

(10 bn kcal)

	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Technology
Industry	160,798	177,740	170,536	143,862	137,102	133,365
Transport/freight	29,464	32,639	31,746	31,073	31,252	24,859
Transport/passenger	44,922	58,100	58,965	58,318	58,003	40,207
Commercial buildings	36,467	46,973	47,326	34,211	33,596	29,484
Residential buildings	42,380	52,688	56,220	54,649	54,430	49,356
Total	314,031	368,140	364,793	322,112	314,382	277,270
(compared to 1990 level)	—	17.2%	16.2%	2.6%	0.1%	-11.7%

¹ The government uses the term “new energy” which includes waste power generation and excludes geothermal generation. CASA does not consider waste power generation as renewable energy, but geothermal generation (conventional ones).

Table 0-4 Primary energy supply by energy source

(10 bn kcal)

	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Technology
Coal	80,459	98,606	115,040	86,104	76,608	56,348
Oil	263,808	267,187	256,130	228,577	231,219	194,783
Natural gas	49,283	73,401	78,803	83,851	80,927	60,846
Hydro	20,521	19,253	17,031	13,850	13,850	19,803
Nuclear	45,509	69,241	64,139	57,182	57,182	57,182
Geothermal/New Energy	6,689	7,334	7,317	10,736	10,736	36,329
Total	466,269	535,022	538,460	480,300	470,522	425,291
(compared to 1990 level)	—	14.7%	15.5%	3.0%	0.9%	-8.8%

Table 0-5 Amount of electricity generation by energy source

(1mio kWh)

	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Technology
Coal power	126,315	252,435	342,786	209,711	183,275	72,335
Oil power	257,959	150,641	154,205	161,402	180,245	159,800
Gas power	173,149	266,101	264,850	300,572	287,756	216,261
Hydro power	95,835	96,817	86,350	71,571	71,571	102,332
Nuclear	202,272	322,050	304,755	275,336	275,336	275,336
Geothermal/New Energy	1,742	3,456	4,980	22,995	22,995	142,027
Total	857,272	1,091,500	1,157,926	1,041,587	1,021,178	968,091
(Compared to 1990 level)	—	27.3%	35.1%	21.5%	19.1%	12.9%

Table 0-6 Amount of electricity generation by renewable energy source

(1 mio kWh)

	2000	2005	2020		
			BaU	Carbon Tax	CASA Technology
Solar	2	1	5,814	5,814	79,208
Wind	108	1,754	8,945	8,945	32,149
Biomass	0	0	2,708	2,708	10,985
Small hydro	0	0	2,013	2,013	10,793
Geothermal	3,319	3,226	3,515	3,515	8,892
Total	3,429	4,981	22,995	22,995	142,027

Note 1: Biomass does not include waste power generation, captive power generation based on black liquor in the paper & pulp sector, or waste energy recovery for electricity generation.

Note 2: The amount of electricity generation by biomass and small hydro in 2000 and 2005 is shown as zero. This is because the government's database (Energy Balance Table), our data source, does not provide a thorough coverage of these energy sources. This applies to solar as well. The figure for solar is also considered to be significantly smaller than the actual amount.

4. Climate change measures and economic growth are compatible

The impact of mitigation measures on the manufacturing industries is summarized in Table 0-7. Negative economic impacts are found in the cement industry in which the amount of cement production will decrease due to the change in the industrial structure. On the other hand, the production of crude steel and ethylene will slightly increase. Also, the growth of the service industry will result in the increase in the office floor areas, and the growing transport demand will increase the volume of both freight and passenger transport.

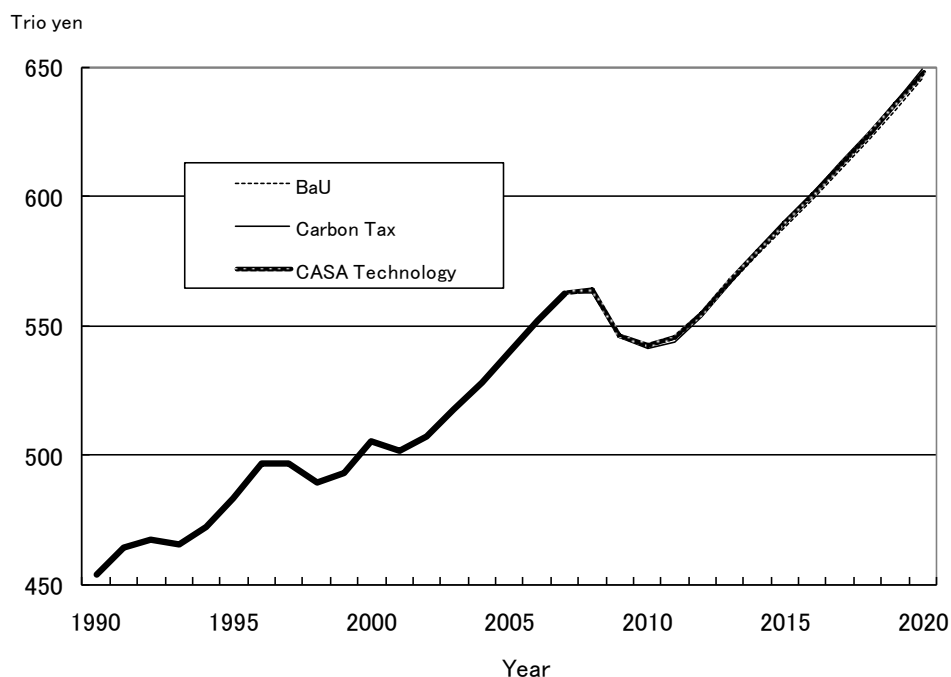
Under all the scenarios we analyzed, no significant differences are observed on the real GDP, disposable income, unemployment rate and oil price. Thus, it can be concluded that the mitigation measures considered in our analysis do not result in deterioration of the economy. The real GDP drastically declined after Lehmann Shock around 2010, but it will increase more than 10 billion yen by 2020 compared to 2005 (Figure 0-2). This shows that the mitigation measures are compatible with the economic growth.

The same can be said for disposable income and unemployment rate, but CASA 2020 Model does not include the effect of job creation from the growth of the environment industry and ripple effects of the tax revenue under the carbon tax scenario. These remain the future task for the CASA 2020 Model. If one could include such effects, the real GDP and disposal income would increase and the unemployment rate would decrease.

Table 0-7 Impact of mitigation measures on the economy

			1990	2000	2005	2020		
						BaU	Carbon Tax	CASA Technology
Industry	Crude steel	1,000 ton	111'710	106'901	112'718	110'483	99'761	111'128
	Ethylene	1,000 ton	5'966	7'566	7'549	8'271	8'255	8'270
	Cement	1,000 ton	86'893	80'068	70'127	58'728	57'201	58'711
	Paper/ paper board	1,000 ton	28'538	31'742	31'070	32'398	32'237	32'386
	Industrial Production Index	2005=100	100.5	99.4	100.7	97.5	96.7	97.6
Residential buildings	Nr. of households	10'000	4'180	4'802	5'110	5'434	5'434	5'434
Commercial buildings	Floor area	mio m ²	1'285	1'656	1'759	1'924	1'925	1'924
Transport	Freight	100 mio ton-kg	5'468	5'780	5'704	6'265	6'277	6'286
	Passanger	100 mio person-kg	11'313	12'969	13'042	15'316	15'307	15'331
Macroeconomy	Real GDP	trio yen	453.6	505.6	540.0	646.0	649.2	648.5
	Disposable income	trio yen	265.0	299.0	291.8	281.5	312.8	282.1
	Unemployment Rate	%	2.1	4.7	4.3	5.4	5.5	5.4
	Oil price	\$/barrel	23	28	56	150	163	150

Figure 0-2 Transition of the real GDP



5. Explanation of CASA 2020 Model

CASA 2020 Model consists of *3E Model* – Macroeconomic Model (Economy), Energy Balance Model (Energy) and the amount of CO₂ emissions (Environment) – as well as *Bottom-up Model* which adds up mitigation potential of each technology measure (Figure 0-3). The main character and advantage of this model is that it enables the analysis of economic impacts of the implementation of detailed mitigation measures.

In Bottom-up Model, we assumed diffusion rates of the mitigation measures in order to estimate Energy Efficiency Index (EEI) in the industry, transport (freight and passenger) and buildings (commercial and residential) sectors. The number of mitigation measures we considered sums up to 112: Industry (29), transport (24) and buildings sector (59). In the energy supply sector, Energy Supply Model was developed to estimate the effect of CO₂ emission reduction according to the scenario that nuclear power plants will be phased out and renewable energies be diffused drastically.

CASA 2020 Model utilized the characteristic of the econometric model in the model simulation. That is, we endogenized the influence of market economy while avoiding utmost the use of exogenous variables. The model design enables policy simulations. By providing feedback of the impact of the carbon tax to the macro economy, it can assess the effect of the carbon tax on the CO₂

emissions and the macro economy. Still, this is an interim report and research questions remains on - but not limited to - the estimation of positive effects of the implementation of the mitigation measures, such as job creation in the environment industry.

Figure 0-3 Structure of CASA 2020 Model

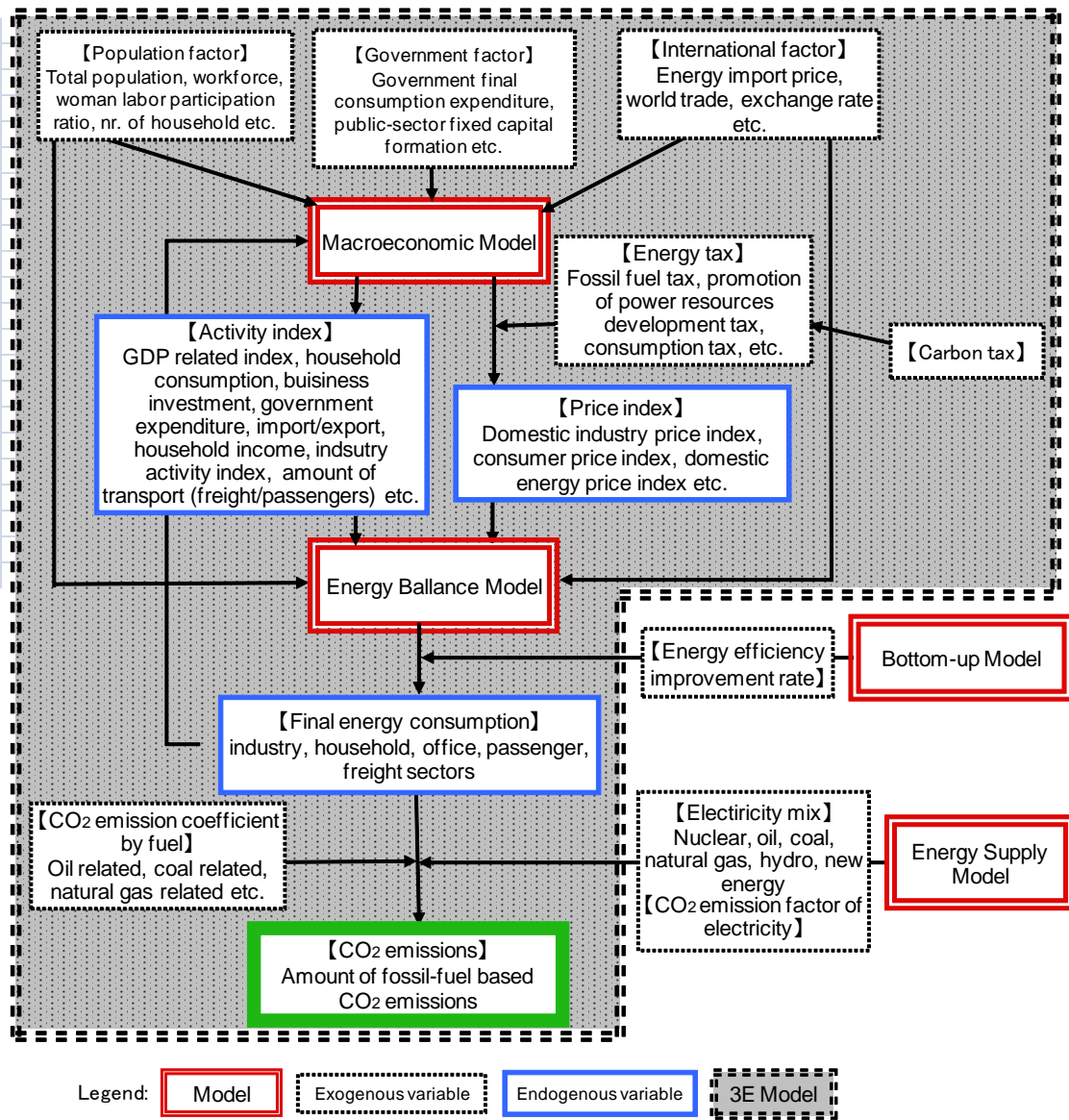


Table 0-8 Technology and measures considered in Bottom-up Model

Sector		Technology/measures
Industry	Steel	CDQ, second generation coke oven, TRT dry system, LDG waste heat recovery, DC electric arc furnace, recycling of scrap steel, plastic recycling in blast furnace, etc.
	Cement	Clinker cooler efficiency improvement, waste heat recovery for electricity generation, portland blast furnace cement, etc.
	Pulp & paper	High-efficient manufacturing of waste-paper pulp, high-efficiency contact pressure draining device, etc.
	Chemical	Naphtha catalytic cracking, waste energy recovery in ethylene gas turbine, etc.
	Cross-sectoral	High-efficiency boiler
Residential buildings	Cooling/heating	Efficient air conditioners, double glass system, efficient insulation/passive homes, shading in summer, etc.
	Hot water supply	Solar water heater, water-saving showerhead, hot water supply with heat pump system, etc.
	Lighting	Efficient refrigerators, lighting with sensors, standby energy reduction device etc.
	Whole building	HEMS
Commercial buildings	Cooling/heating	Co-generation, fuel cell, double glazed glass, efficient air conditioner, etc.
	Hot water supply	Water-saving showerhead, waste-heat recovery, etc.
	Lighting	Efficient vending machines, efficient copy machines, motion sensor lighting, day light use, etc.
	Whole building	BEMS, power/heat control system, etc.
Transport passenger	Private automobile	Fuel efficiency improvement, diffusion of clean energy vehicle, idling stop device
	Private light automobile	Fuel efficiency improvement
	Taxi	Fuel efficiency improvement, idling stop device
	Bus	Fuel efficiency improvement
	Railway	Installation of energy-efficient equipment
	Air	Installation of energy-efficient equipment
Transport freight	Truck	Fuel efficiency improvement, idling stop device, speed control device
	Air	Installation of energy-efficient equipment