

# No Need to Rely on Nuclear to Achieve Japan's

## -25% GHG Reduction Target Domestically

~ Results of CASA 2020 Model (Ver.3) Simulation ~

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Citizens Alliance for Saving the Atmosphere and the Earth

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### Summary

1. The catastrophe at the Fukushima nuclear power station made it clear that there are sometimes any technical ways to keep radioactive substances safely and perfectly within reactors. Japan's "nuclear safety myth" is shattered and there is a vital need for a change in energy policy that does not rely on nuclear powers.
2. CASA urgently considered with its "CASA 2020 Model" whether energy demand in 2020 can be met without relying on nuclear powers as well as possibilities to reduce CO<sub>2</sub> by 25% below 1990 levels and its economic impact.
3. The assumption was that **reactors in Fukushima and Hamaoka** as well as those more than **30 years of operation** are **decommissioned immediately** and all reactors will be gradually decommissioned after 30 years of operation and **abolish all by 2030**.
4. The simulation results show quantitatively that even **if Japan does not rely on nuclear powers, it can still reduce 25.2% of CO<sub>2</sub> by 2020** when shifting our energy source to LNG and renewables and introducing energy saving technologies and **this has limited macroeconomic impact**.
5. Climate change is progressing. Our results show that there is no reason to withdraw Japan's international commitment of reducing 25% of greenhouse gasses by 2020.
6. Introduction of feed in tariff is a must for the rapid diffusion of renewables. This should be considered as a prior investment for economic ripple effect and a way to lay out new economic development model.
7. The Japanese government needs to face the risk of nuclear accident fully and should start public discussion on nuclear powers considering pros and cons based on objective data and facts.

## **1. Introduction**

The earthquake that struck Northeastern Japan on March 11, did not only cause unprecedented loss and damage with more than 23,000 people killed or missing, but also triggered historical nuclear power disaster. Due to station black out in four of the six reactors at Fukushima Daiichi nuclear power station, cooling function was lost that caused core meltdown in three reactors. Due to the hydrogen exposition of three reactors, radioactive substances were released in the air and ocean and spread over a broad area. One needs to expect to deal with the problem at least for several decades and to pay huge cost to make the community come back to life.

The nuclear catastrophe made it clear that there are no technical ways to block in immense radioactive substances “safely and perfectly” in nuclear reactors and once an accidental increase of nuclear chain reaction occurs, it is extremely difficult to control the situation. Even after three months, there is no prospect to curb radioactive leakages.

Until now, Japanese government basic standpoint on nuclear power has been that; “it is the main electricity source for Japan as it ensures stable energy supply and is economically efficient, quasi-domestically produced energy”, and “without nuclear power, stable energy supply and counter the problem of global warming is near-impossible” (*Plan to strengthening nuclear power plants*; June 2009; Ministry of Economy, Trade and Industry-METI). In the “Basic Energy Plan”, drawn up in June 2010, it planned to install 9 new nuclear reactors (capacity utilization rate of about 85%) by 2020 and more than 14 (utilization rate of about 90%) by 2030.

The nuclear catastrophe, however, shattered Japan's “nuclear safety myth” and “low price myth” that were spread by METI and electric power companies. On 6<sup>th</sup> May, 3<sup>rd</sup> - 5<sup>th</sup> reactors in Hamaoka were stopped following a request from the government and the Japanese Prime Minister Kan announced that the Basic Energy Plan needs to be reviewed from scratch.

Even in such a situation, there are still voices from industries that they could not meet energy needs without nuclear powers and that Japan should promote nuclear powers with extra security measures. In addition, there is also a movement to drop its 25% mid-term greenhouse gas (GHG) reduction target.

Yet, it is hard to say that there has ever been a public discussion to promote nuclear powers in Japan. **Calm public discussion is needed whether it is possible to meet energy supply without nuclear powers and if they are needed to achieve the 25% reduction target.** CASA's proposal is to provide a material for the discussion from citizens' perspective.

## **2. Past CASA's simulation results of emission reduction potential**

CASA has developed its own bottom-up model that aggregated the effect of technology and energy efficiency measures and announced the estimation results of CO<sub>2</sub> emission reduction

potential in Japan for 2010, in October 1997<sup>1</sup>.

(1) “CASA 2020 Model” (Ver.1, May 2010)

Combining its existing bottom-up model, CASA newly developed “CASA 2020 Model”, a Macroeconomic & Energy Balance Model, which enabled to analyse more detailed technology scenario and its economic impact.

Ver.1 assumed that nuclear power plants will be decommissioned after 40 years of operation and calculated CO<sub>2</sub> emissions for 2020; for the JPY10,000/C-t carbon tax case; and for the CASA technology case that introduces existing technologies and renewable energies. As a result, carbon tax case reduced emissions by 5.2% below 1990 levels and CASA technology case by 25.6%. In terms of macroeconomic impact, it showed little difference on the real GDP, disposable income and unemployment rate from the BaU scenario<sup>2</sup>.

(2) “CASA2020Model” (Ver.2, March 2011)

Based on the comments received after publishing Ver.1, the assumptions for renewable energy dissemination scenario and nuclear powers were reviewed and data was updated. In Ver.1, new construction of nuclear powers were assumed as 5 (utilization rate of 75%), but in Ver.2, it was changed to 2 reactors in Shimane and Ooma (utilization rate of 73%). The result was 4.5% reduction below 1990 levels with carbon tax case and 26.3% reduction with CASA technology case. Macroeconomic impact was estimated as JPY100 trillion increase in GDP compared to 2005 by 2020 and economic ripple effect by climate change measures investment was JPY21.5 trillion per year (JPY215 trillion by 2020) and this ripple effect increased the opportunity for 1.15 million employments<sup>3</sup>.

### **3. Assumptions of CASA 2020 Model (Ver.3) estimation**

The Assumption of CASA 2020 Model (Ver.3) estimation is as follows:

- (1) For nuclear powers, 10 reactors in Fukushima and 3 reactors in Hamaoka as well as those reactors more than 30 years of operation will be decommissioned immediately and all reactors will be gradually decommissioned after 30 years of operation and abolish all by 2030. No new reactors will be built, except for those that are now built. In this assumption, 27 reactors will be decommissioned immediately and 11 reactors by 2020 and all 54 reactors by 2030 (Table 1). Only those in Shimane and Ooma is considered to be newly built (both reactors will be decommissioned in 2030). From the past performance, utilization rate is considered as 73% as in the “Ver.2” (1998-2007average). As a result,

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<sup>1</sup> Please see Y. Mizutani Ed. (2000).*2010 Scenario to prevent global warming*, Jikkyo Shuppan. In Japanese

<sup>2</sup> “Japan’s -25% GHG Reduction Target Can be Achieved Domestically-Simulation results of CASA 2020 Model; Ver.1 Interim report” can be downloaded (Summary in English):  
<http://www.bnet.ne.jp/casa/teigen/paper/CASAModel2020Ver1%20clear%20version.pdf>

<sup>3</sup> CASA2020Model(Ver.2) can be downloaded (Japanese):  
<http://www.bnet.ne.jp/casa/2020model/2020casamodelv2.pdf>

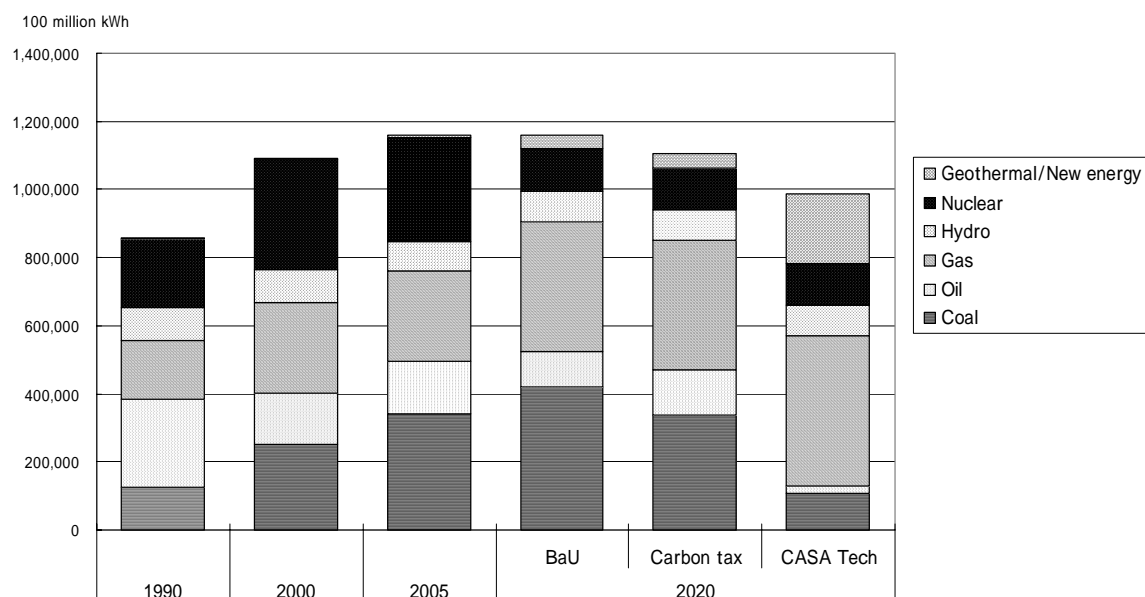
share of nuclear powers in total electricity generation that was 26.3% in 2005, was reduced to 12.5% by 2020.

- (2) As for the energy supply, gas and renewables will be increased and coal will be reduced. Electricity generation from coal fired powers had increased 2.7 times compared to 1990 levels in 2005, but as for the CASA technology case, it decreases by 15% below 1990 levels by 2020 and by 69% below 2005 levels. Electricity generation from gas fired powers is considered to increase 2.6 times compared to 1990 levels by 2020 and 1.7 times compared to 2005. In this case, 45% of all electricity generation will be from gas (Figure 1). Although one needs to increase the utilization rate of gas fired power for a great amount, this is economically reasonable as the building cost is four times smaller than the coal fired ones for the same capacity.
- (3) For renewables, it is assumed that electricity generation will increase 117 times compared to 1990 levels by 2020 and 41 times compared to 2005. In 2020, 20.5% of the total electricity generation will be from renewable energies (Figure 1). This is viable both from technical point of view and resource availability.
- (4) Technologies that are assumed to be used in industry, transport and building sectors are listed in Table 2. Since there is too little technical data available for the industry sector, one could only consider those technologies that are certainly available and introduced. Therefore, the energy saving effect in this sector is estimated very conservatively.

**Table 1 Assumptions of capacity utilization rate, operation year and decommission of nuclear power plants**

Name of company	Power plant	Capacity usage (10,000 kw)	Operation year	End operation	Name of company	Power plant	Capacity usage (10,000 kw)	Operation year	End operation
Japan Atomic Power	Toukai	17	1966	1998	Tokyo Electric Power	Fukushima Daini3	110	1985	2011
Chubu Electric Power	Hamaoka1	54	1976	2009	Tokyo Electric Power	Kashiwazakikariwa1	110	1985	2015
Chubu Electric Power	Hamaoka2	84	1978	2009	Chubu Electric Power	Hamaoka3	110	1987	2011
Kansai Electric Power	Mihama1	34	1970	2011	Tokyo Electric Power	Fukushima Daini4	110	1987	2011
Japan Atomic Power	Tsuruga1	36	1970	2011	Japan Atomic Power	Tsuruga2	116	1987	2017
Tokyo Electric Power	Fukushima Daiichi1	46	1971	2011	chugoku Electric Power	Shimane2	82	1989	2019
Kansai Electric Power	Mihama2	50	1972	2011	Hokkaido Electric Power	Tomari1	58	1989	2019
Kansai Electric Power	Takahama1	83	1974	2011	Tokyo Electric Power	Kashiwazakikariwa2	110	1990	2020
Kyushu Electric Power	Sendai1	89	1974	2011	Tokyo Electric Power	Kashiwazakikariwa5	110	1990	2020
Chugoku Electric Power	Shimane1	46	1974	2011	Kansai Electric Power	Ooi3	118	1991	2021
Tokyo Electric Power	Fukushima Daiichi2	78	1974	2011	Hokkaido Electric Power	Tomari2	58	1991	2021
Kansai Electric Power	Takahama2	83	1975	2011	Kansai Electric Power	Ooi4	118	1993	2023
Kyushu Electric Power	Genkai1	56	1975	2011	Chubu Electric Power	Hamaoka4	114	1993	2011
Kansai Electric Power	Mihama3	83	1976	2011	Tokyo Electric Power	Kashiwazakikariwa3	110	1993	2023
Tokyo Electric Power	Fukushima Daiichi3	78	1976	2011	Hokuriku Electric Power	Shika1	54	1993	2023
Shikoku Electric Power	Ikata1	57	1977	2011	Kyushu Electric Power	Genkai3	118	1994	2024
Tokyo Electric Power	Fukushima Daiichi4	78	1978	2011	Shikoku Electric Power	Ikata3	89	1994	2024
Tokyo Electric Power	Fukushima Daiichi5	78	1978	2011	Tokyo Electric Power	Kashiwazakikariwa4	110	1994	2024
Japan Atomic Power	Toukai Daini	110	1978	2011	Tohoku Electric Power	Onagawa2	83	1995	2025
Kansai Electric Power	Ooi1	118	1979	2011	Tokyo Electric Power	Kashiwazakikariwa6	136	1996	2026
Kansai Electric Power	Ooi2	118	1979	2011	Kyushu Electric Power	Genkai4	118	1997	2027
Tokyo Electric Power	Fukushima Daiichi6	110	1979	2011	Tokyo Electric Power	Kashiwazakikariwa7	136	1997	2027
Kyushu Electric Power	Genkai2	56	1981	2011	Tohoku Electric Power	Onagawa3	83	2002	2030
Shikoku Electric Power	Ikata2	57	1982	2012	Chubu Electric Power	Hamaoka5	127	2005	2011
Tokyo Electric Power	Fukushima Daini1	110	1982	2011	Tohoku Electric Power	Higashidoori1	110	2005	2030
Tokyo Electric Power	Fukushima Daini2	110	1984	2011	Hokuriku Electric Power	Shika2	121	2005	2030
Tohoku Electric Power	Onagawa1	52	1984	2014	Hokkaido Electric Power	Tomari3	91	2009	2030
Kansai Electric Power	Takahama3	87	1985	2015	Chugoku Electric Power	Shimane3	137	2011	2030
Kansai Electric Power	Takahama4	87	1985	2015	J-POWER/Electric Power Development	Ooma	138	2014	2030
Kyushu Electric Power	Sendai 2	89	1985	2015					

**Figure 1 Electricity generation by source**



**Table 2 Technologies and measures used in the bottom-up model**

Sector		Technology/measures
Industry	Steel	CDQ, second generation coke oven, TRT dry system, LDG waste heat recovery, DC electric arc furnace, plastic recycling in blast furnace, etc.
	Cement	Vertical coal mill, Air beam cooler system, Pre-grinding roller mill, waste
	Pulp & paper	Waste material reuse technologies, High-efficient manufacturing of waste-
	Chemical	Waste energy recovery in ethylene gas turbine, etc.
	Cross-sectoral	High-efficiency boiler, industrial heat pump system etc.
Residential buildings	Cooling/heating	Efficient air conditioners, efficient insulation, 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
	Whole building	HEMS
Commercial buildings	Cooling/heating	Renovation and insulation, efficient air conditioner, etc.
	Hot water supply	Solar water heater, latent-heat recovery, etc.
	Electricity	Efficient PC, efficient copy machines, efficient refrigerator etc.
	Whole building	BEMS, power/heat control system, etc.
Transport passenger	Private automobile	Fuel efficiency improvement, diffusion of hybrid cars, idling stop device
	Private light	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

## **4. Simulation results of CASA 2020 Model( Ver.3 ) - 25% reduction**

### **can be achieved by 2020**

This model estimated the amount of CO<sub>2</sub> emissions from fossil fuels in the following three scenarios:

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

**The simulation results show that direct CO<sub>2</sub> emissions in 2020 will be increased by 16.2%, 7.9% and reduced by 25.2% from 1990 levels respectively (Figure 2 &3).**

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 29.0% below 1990 levels (33.7% below 2005 levels) through the reduction in the final energy demand in the industry, transport and buildings sectors. In CASA technology scenario, the final energy consumption will be reduced by 15.0% below 1990 levels (26.8% below 2005 levels) and shows great energy saving potential in each sector (Figure 4).

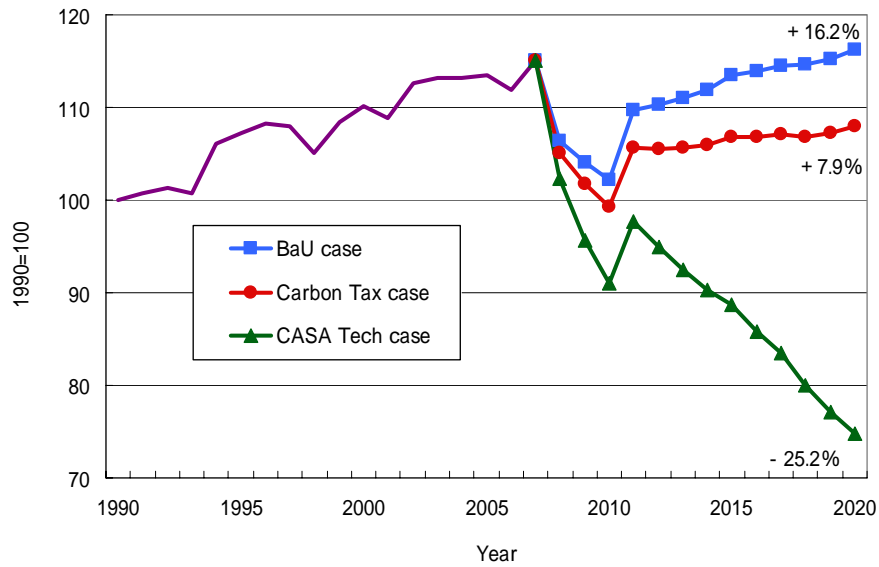
The efficiency improvement of power plants and energy shift reduced the CO<sub>2</sub> emissions by 17.9% below 1990 levels (34.8% below 2005 levels) in the energy supply sector. Electricity generation from nuclear powers will decrease by 60% below 2005 levels by 2020, but promotion of energy saving and renewable energy and gas-fired power will cover the shortfall. In 2020, the total electricity generation from renewable energy will be 203.2 billion kWh. Wind power has the biggest share of 33%, followed by solar powers 29.8%, biomass and waste 25% (Figure 5). This simulation is quite reasonable considering the renewable resource availability estimation that was published by a governmental organization<sup>4</sup>.

It should be noted that CASA technology scenario can estimate quantitatively and it considers realistic technologies that are already commercially available. Therefore, further emission reductions could be expected if additional emerging technologies and/or a higher level of technology penetration would be assumed.

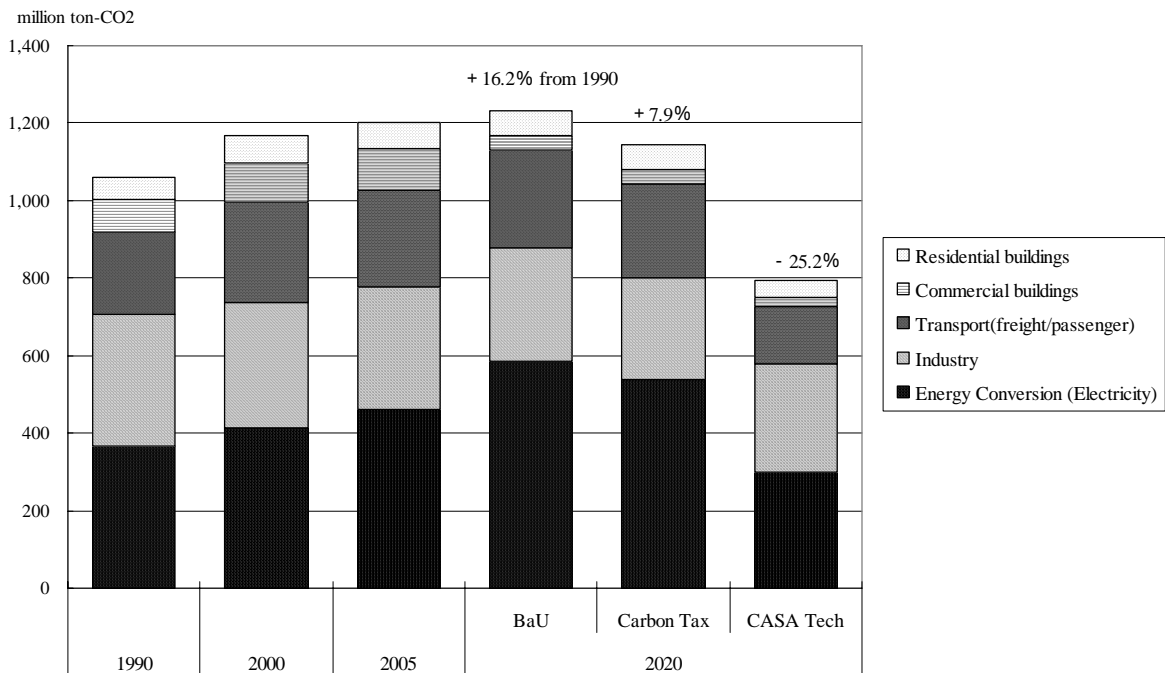
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<sup>4</sup> NEDO estimates potential physical installation of solar energy for buildings as 223.8 billion kWh. The “2010 Survey report on potential renewable energy installation” by the ministry of environment reported that the potential installation of solar energy for non-building is 134.5 billion kWh, wind energy is 206.9 billion kWh, biomass and waste as 155.8 billion kWh and geothermal as 131.5 billion kWh.

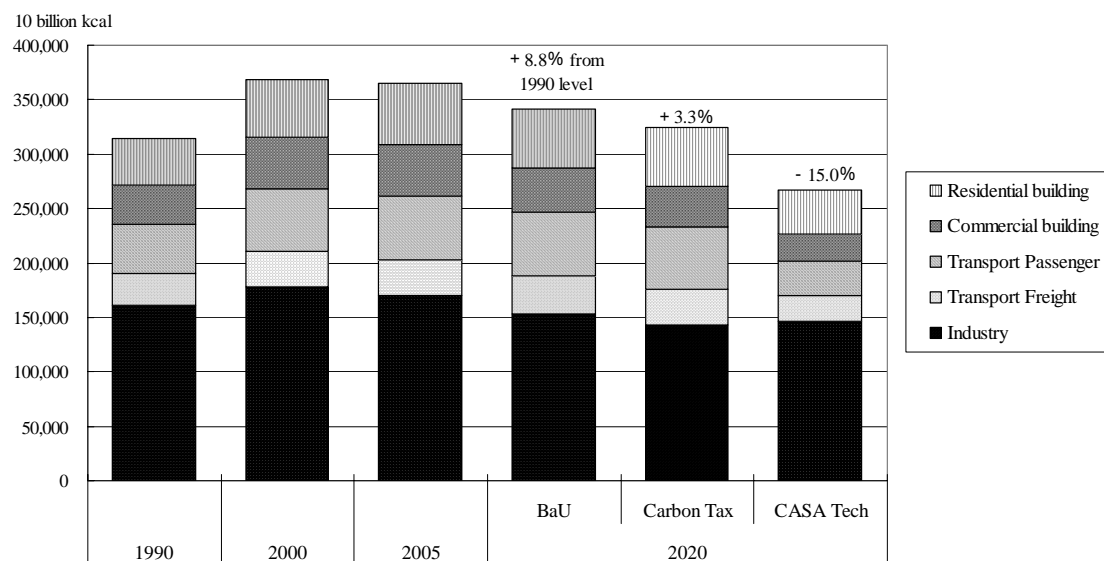
**Figure 2 CO<sub>2</sub> emission pathways to 2020**



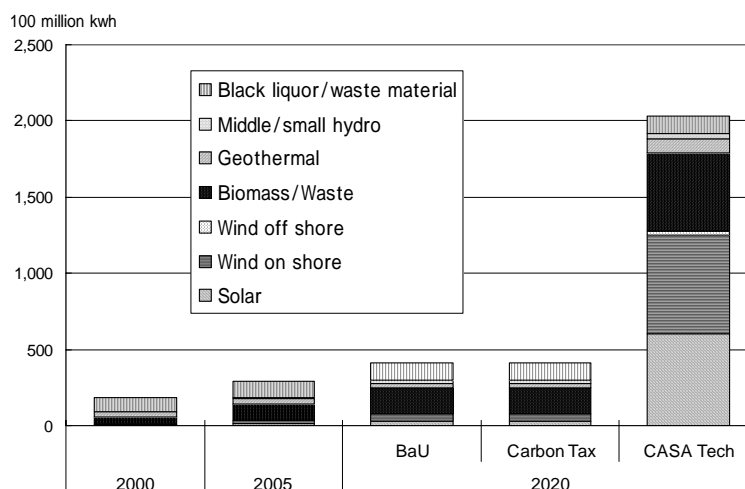
**Figure 3 CASA 2020 Model simulation results of CO<sub>2</sub> emissions (direct emissions)**



**Figure 4 Final energy consumption by sector**



**Figure 5 Electricity generation by renewable energy source (Geothermal • New energy<sup>5</sup>)**



## **5. Climate change measures and economic growth are compatible**

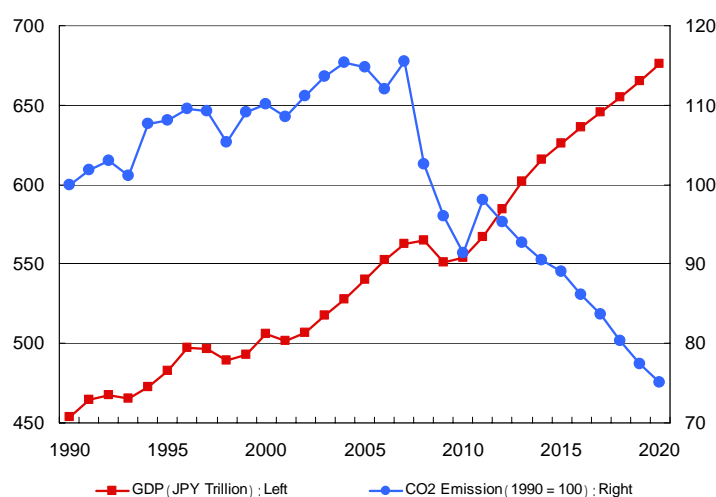
The simulation results of CASA 2020 Model (Ver.3) show little differences on the real GDP, disposable income and unemployment rate. Thus, it can be concluded that the mitigation measures considered in our analysis do not result in deterioration of the economy. **The real GDP drastically declined after Lehmann Shock around 2010, but it will increase more than JPY 100 trillion by 2020 compared to 2005 (Figure 6). This shows the compatibility of economic growth and climate change mitigation measures.**

<sup>5</sup> 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.

**Table 3 Socio economic impact of climate change measures**

			1990	2000	2005	2020		
						BaU	Carbon tax	CASA Tech
Industry	Crude steel	1,000 ton	111,710	106,901	112,718	123,994	106,602	123,215
	Ethylene	1,000 ton	5,966	7,566	7,549	8,262	8,246	8,259
	Cement	1,000 ton	86,893	80,068	70,127	60,475	58,494	59,953
	Paper/ paper board	1,000 ton	28,538	31,742	31,070	33,701	33,188	33,256
	Industrial Production Index	2005 = 100	100.5	99.4	100.7	99.7	98.3	99.3
Residential buildings	Nr. of households	10,000	4,180	4,802	5,110	5,044	5,044	5,044
Commercial buildings	Floor area	million m <sup>2</sup>	1,285	1,656	1,759	1,931	1,930	1,931
Transport	Freight	100 million ton-km	5,468	5,780	5,704	6,510	6,403	6,518
	Passanger	100 million person-km	11,313	12,969	13,042	15,542	15,334	15,537
Macroeconomy	Real GDP	trillion yen	453.6	505.6	540.0	675.2	664.4	676.1
	Disposable income	trillion yen	265.0	299.0	291.8	332.6	333.6	333.9
	Unemployment Rate	%	2.1	4.7	4.3	4.9	5.0	4.9

**Figure 6 Real GDP and CO<sub>2</sub> emissions (CASA technology case)**



## **6. To abandon 25% reduction target is not acceptable**

If the global average surface temperature rise is not kept below 2°C as compared to the pre-industrial levels (about 1850), the survival of humanity could be threatened by global environmental damages. The IPCC Fourth Assessment Report (AR4) states that holding the global average temperature rise to 2.0–2.4°C above the pre-industrial level requires peaking out CO<sub>2</sub> emissions by 2015, and reducing the emissions 50–85% 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 Cancun Agreements that were reached at the 16<sup>th</sup> Conference of the Parties (COP16) to the UN Framework Convention on Climate Change (UNFCCC) and the 6<sup>th</sup> Meeting of the

Parties (CMP6) to the Kyoto Protocol on 11<sup>th</sup> December 2010, confirmed the long-term goal of holding the increase in average global temperature below 2 degrees above pre-industrial levels. Moreover, it urges developed countries including Japan to increase their mid-term reduction pledges in the range of 25-40% below 1990 levels in aggregate and to adopt an agreement to avoid a gap between the 1<sup>st</sup> and 2<sup>nd</sup> commitment period of the Kyoto Protocol.

Former Prime Minister Hatoyama had announced the Japan's mid-term GHG reduction target as 25% below 1990 levels by 2020 at the UN General Assembly in September, 2009. **To achieve this mid-term target and the long-term target of an 80% reduction by 2050, the Cabinet approved a bill called the Basic Act on Global Warming Countermeasures in March 2010. The Act includes the introduction of carbon tax, domestic emissions trading scheme and feed in tariff system for the whole renewable energy.** However, it is still discussed in the Diet and there is no prospect as to when the bill can be passed into law.

Moreover, recent media reported that there is a movement within the government and industry to abandon its 25% mid-term GHG reduction target on the grounds of the catastrophe. However, climate change increasingly poses a severe problem and 25% reduction by 2020 is a minimum target. Achievement of this target is a responsibility of the current generation to the next one. The catastrophe of Fukushima nuclear power plants released immense amount of radioactive substances and is polluting over a broad area, here and abroad. It is a twofold betrayal to future generation if Japan were to withdraw its international commitment that relates to the human survival.

## **7. Public discussion is needed to review energy policy!**

The problems of the nuclear powers are not only of earthquake and safety, but there are many other issues, such as radioactive waste disposal, economic efficiency, vulnerability to security threats etc. In addition, careful consideration is needed whether CO<sub>2</sub> emissions from nuclear powers are less than those from renewable energies, given the catastrophe and management of radioactive waste for a significant period of time.

Worldwide, the movement of denuclearization is accelerating. In June 2011, it is reported that 95% of Italian voters opposed to resume nuclear power generation. Germany and Switzerland also decided to phase out nuclear power plants. In developing countries, those which were considering building one are now reconsidering it.

In Japan, there has been no public discussion on nuclear power plant construction. METI and Electricity Company relevant people, who are advocators, have decided to promote nuclear powers in a council (Advisory Committee on Energy and Natural Resources) behind the closed doors. **The Japanese government needs to face the risk of nuclear accident fully and should start public discussion on nuclear power policy considering pros and cons, and based on objective data and facts.** Reconsidering energy policy is our responsibility for the next generation.

Supplementary information ( Data for figures )

**Figure 1 Electricity generation by source**

(million kWh)

	1990	2000	2005	2020		
				BaU	Carbon tax	CASA Tech
Coal	126,315	252,435	342,786	421,652	338,910	107,886
Oil	257,959	150,641	154,205	103,980	131,209	19,993
Gas	173,149	266,101	264,850	379,672	379,672	442,311
Hydro	95,835	96,817	86,350	90,115	90,115	90,115
Nuclear	202,272	322,050	304,755	123,329	123,329	123,329
Geothermal/New energy	1,742	3,456	4,980	41,388	41,388	203,178
Electricity supply	857,272	1,091,500	1,157,926	1,160,136	1,104,623	986,812
(compared to 1990 levels)	-	27.3%	35.1%	35.3%	28.9%	15.1%
Share Geothermal/New energy	0.2%	0.3%	0.4%	3.6%	3.7%	20.6%

**Figure 3 CASA 2020 Model simulation results of CO<sub>2</sub> emissions (direct emissions)**

(million ton-CO<sub>2</sub>)

Sector	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Tech
Energy Conversion (Electricity)	367	412	462	586	540	301
Industry	341	325	316	292	261	279
Transport (freight)	211	259	250	97	93	67
Transport (passenger)				155	152	81
Commercial buildings	84	101	107	39	37	22
Residential buildings	57	69	68	62	61	43
Energy-related CO <sub>2</sub> emissions	1,059	1,167	1,203	1,231	1,143	793
(compared to 1990 level)	-	10.2%	13.6%	16.2%	7.9%	-25.2%

**Figure 4 Final energy consumption by sector**

(10 billion kcal)

	1990	2000	2005	2020		
				BaU	Carbon Tax	CASA Tech
Industry	160,798	177,740	170,536	153,456	142,540	145,974
Transport Freight	29,464	32,639	31,746	34,592	32,961	24,025
Transport Passenger	44,922	58,100	58,965	58,417	57,201	31,420
Commercial building	36,467	46,973	47,326	40,677	38,272	24,569
Residential building	42,380	52,688	56,220	54,440	53,287	40,941
Total	314,031	368,140	364,793	341,583	324,261	266,930
(compared to 1990)	-	17.2%	16.2%	8.8%	3.3%	-15.0%

**Figure 5 Electricity generation by renewable energy source (Geothermal • New energy)**

(100 million kWh)

	2000	2005	2020		
			BaU	Carbon Tax	CASA Tech
Solar	4	15	31	31	605
Wind on shore	3	19			646
Wind off shore	0	0	44	44	26
Biomass/Waste	53	111	173	173	510
Geothermal	31	32	32	32	96
Middle/small hydro	0	7	17	17	32
Black liquor/waste material	92	104	117	117	117
Total	183	288	414	414	2,032