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The prediction of CO2 emissions up to 2020 in Japanese economic activities

JIDEA team Japan[1]

1. The method of estimation of CO2 emission and it's forecast

1-1. Necessity of dynamic model based on I-O table

The dynamic econometric model based on I-O table is the most suitable method for forecasting the amount of CO2 emission caused by economic activities. We can point out the three reasons.

The first; the CO2 emission is closely linked with Industrial production. To forecast the industrial production sector by sector, the I-O based dynamic model is indispensable.

The second; the amount of CO2 emission depends on the consumption of each energy source. Accordingly, it is necessary to know the industries' amount of energy consumption by energy source. For this purpose, I-O based model linked to the material I-O table can deliver necessary data detailed enough for our study.

The third; it is necessary that the evolution of industrial structure corresponding to economic growth should be properly included in the model.

Our estimation of CO2 emission is performed with two simulations. With the first simulation, we want to clarify how much amount of CO2 would be emitted by each industrial sector or household, what is the relation of primary and secondary sector of energy consumption. In this simulation, we assume the sector of electric power generation consist of only two sectors; "Commercial electric power" and "Electric power self generated ".

The second simulation focuses on "Commercial electric power (columns)" which is consisted of three sectors; "nuclear energy", "thermal energy" and "water and other energy". In this simulation, we want to clarify, if thermal power generation substituted by nuclear power generation, how much it affects the CO2 emission.

As the method to calculate CO2 emission, we applied almost same calculation process for these two simulations, but they differ only at the final step where the intermediate coefficient of "Commercial electric power" sector is altered because of the substitution of thermal power with nuclear power. It should be noted that the total demand for electricity is always same before and after the substitution of thermal power generation with nuclear power.

1-2. Outline of the procedure of CO2 emission estimation

The outline of procedure to estimate the CO2 emission is shown in Fig.1-1. By JIDEA model, we can obtain how much energy will be necessary for each industry over the coming 15 years; the necessity of energy consumption is expressed in monetary term. To estimate the CO2 emission, it is necessary to know the quantity of energy consumed

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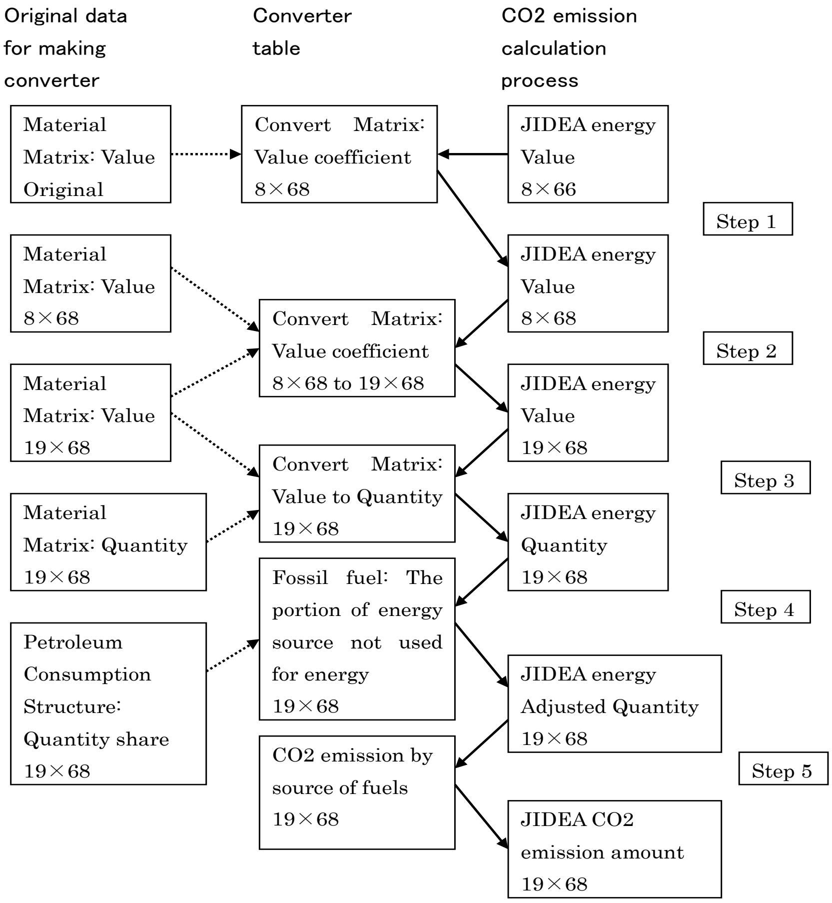
by energy source measured in material unit. For this purpose, we can use "the material matrix" which Japanese government statistical office publishes every 5 years[2]. The material matrix works as the bridge table between the monetary terms and physical terms. In the material matrix table, each row expresses quantity of goods as well as value. Each row has its own unit depending on its material nature. The columns are classified by industries same as normal I-O table. As the unit of quantity is different in each row, the column total is meaningless. A part of the material matrix is shown in Table 1-1. From this table, we can get each industry's material coefficient dividing quantity by value.

Fig. 1. The outline of mechanism to estimate CO2 emission



<u>The 1st step</u>: the two columns of JIDEA model such as "Electricity" and "City gas" should be divided into more detailed classification. If we want to calculate the precise CO2 emission, the sector of "Commercial Electric generation" should be divided into "Electric power generation" and "Electricity self generated " because these two sectors have different input structure. City Gas sector should be also divided into "City gas supply" and "Hot water supply". This dividing ratio can be obtained from the original I-O table which has more detailed classifications.

[2] Source: Ministry of International Affairs and Communications, Statistical Bureau, Director-General for Policy Planning & statistical Research and Training Institute

Table 1-1. Example of Material Matrix of Input-Output table in 2000

row-code	row-item	column-code	column-item	Unit-code	Unit	Quantity	Value
711011	coal	71101	Coal, Crude oil, Natural gas	060	t	3324	16
711011	coal	114101	Tobacco	060	t	4766	31
711011	coal	151101	Spinning	060	t	322	2
711011	coal	151401	Dying	060	t	1718	13
711011	coal	151901	Cord, Net	060	t	86	1
711011	coal	151909	Other textile products	060	t	322	2
711011	coal	152209	Other clothes	060	t	172	2
711011	coal	181101	Pulp	060	t	64921	307
711011	coal	181201	Paper	060	t	1104785	5354
711011	coal	181202	Corrugated paper	060	t	92542	433
711011	coal	182909	Sanitary paper	060	t	17250	136
711011	coal	201101	Chemical fertilizer	060	t	202527	879
711011	coal	202901	Inorganic pigment	060	t	10616	92
711011	coal	202903	Salt	060	t	174691	1502
711011	coal	202909	Other inorganic chemicals	060	t	5222	45
711011	coal	203101	Basic petro-chemicals	060	t	65738	440
711011	coal	203102	Petroleum based aromatic	060	t	34795	305
711011	coal	203201	Aliphatic intermediate	060	t	1422479	6560
711011	coal	203202	Cyclic intermediate	060	t	293928	1464
711011	coal	203301	Synthetic rubber	060	t	290650	1372
:	:	:	:	:	:	:	:

(Source: 2000 Material Input-Output Table)

The 2nd step: JIDEA model has only 8 sectors related to energy source. For more precise estimation of CO2 emission, the 8 sectors should be divided into 19 sectors[3] as shown in Table 1-2. As can be seen in Table 1-6, the CO2 emission amount per energy source is quite different by energy. Fortunately the Material I-O matrix has distinguished energy sources into 19 sectors. Accordingly, 8 sectors of JIDEA model can be extended into 19. The JIDEA code corresponding to Material I-O code is indicated in Table 1-2.

CO2 is emitted not only from hydrocarbon fuels but also from some kind of chemical reaction. The most important reaction is calcium carbonate reaction in which calcium carbonate changes into calcium dioxide and CO_2.

$$CaCO_3 \rightarrow CaO + CO_2$$

This reaction takes place in furnace when the lime stone ($CaCO_3$) is heated more than 900 Centigrade. CaO acts as reducing agent in the furnace. Accordingly we assumed that when limestone is used as intermediate inputs in "Iron & Steel", "Cement" and "Glass industry", limestone becomes a source of CO2 emission.

[3] Lime stone is the source of CO2 emission in spite of its non energy character.

Table 1-2. The Corresponding Table for Material I-O code and JIDEA code

Item	Material matrix			JIDEA model	
	Orignal-c	Energy-c	unit	JIDEA Model item	Model-c
Lime stone	621011	1	t	Non-metalic or	3
Coal	711011	2	t	Coal	4
Crude oil	721011	3	kl	Petro & gas exploration	5
Natural gas	721012	4	1000m3		5
Gasoline	2111011	5	kl	Petroleum products	21
Jet fuel	2111012	6	kl		21
Kerosene	2111013	7	kl		21
Light oil	2111014	8	kl		21
Heavy oil A	2111015	9	kl		21
Heavy oil B and C	2111016	10	kl		21
Naphtha	2111017	11	kl		21
LPG	2111018	12	t		21
Other petro products	2111019	13	–		21
Cokes	2121011	14	t	Coal products	22
Other coal products	2121019	15	–		22
Power station	5111001	21	miilion kw	Electric power	54
Housemade electricity	5111041	22	million kw		54
City gas	5121011	23	1000m3	City gas & hot water	55
Self Generated Electricity	5122011	24	G joule		55

(Source: 2000 Material Input-Output Table and JIDEA model)

The 3rd step: values of energy in 19 sectors extended from 8 sectors of JIDEA model are converted into 19 sectors of quantities by the Value to Quantity Coefficient Matrix. A part of Coefficient Matrix converting Value to Quantity is shown in Table 1-3. Table 1-3 contains also 4 sectors related to "Iron & Steel" which are used to calculate the amount of "Lime stone" required to produce the steel products.

Table 1-3. Example of Coefficient Matrix converting Value to Quantity

Item or Industry			Agriculture, Fishery, Forestry	Metal mining	Non-Metal mining	Coal	Crude oil, Naturl gas	Food	Beverage	Textile	Clothing	Wooden products	..
	Energy-c	unit	1	2	3	4	5	6	7	8	9	10	..
Lime stone	1	t	0	0	1248.551	0	0	0	0	0	0	0	..
coal	2	t	0	0	0	207.75	0	153.7419	0	136	86	0	..
crude oil	3	kl	0	0	0	0	0	0	0	0	0	0	..
natural gas	4	1000m3	0	0	0	0	31.75	0	0	0	0	0	..
gasoline	5	kl	11.27547	11.28571	11.27669	11.33333	11.3	11.28125	11.28205	11.27273	11.27586	11.27612	..
jet fuel	6	kl	0	0	0	0	0	0	0	0	0	0	..
kerosene	7	kl	37.352762	37.75	37.34752	38	37.5	37.35265	37.35015	37.35407	37.35484	37.34992	..
light oil	8	kl	14.841505	15.04545	14.84402	15	15.15	14.82975	14.89207	14.80465	14.65079	14.84359	..
heavy oil A	9	kl	40.69087	40.72093	40.72367	40.72857	40.72414	40.72144	40.72119	40.72103	40.72207	40.72289	..
heavy oil B and C	10	kl	47.859075	47.44	47.57276	47	47	47.67009	47.99472	47.57678	47.50251	47.50471	..
naphtha	11	kl	0	0	0	0	0	0	0	0	0	0	..
LPG	12	t	27.769826	26.5	27.72385	0	26.5	27.79219	27.7603	27.7299	27.71918	28.0431	..
cokes	14	t	72	0	72.02927	0	0	0	0	0	0	72	..
pig iron	16	t	0	0	0	0	0	0	0	0	0	0	..
feroarroy	17	t	0	0	0	0	0	0	0	0	0	0	..
converter steel	18	t	0	0	0	0	0	0	0	0	0	0	..
steel	19	t	0	0	0	0	0	0	0	0	0	0	..
power station	21	miilion kw	0.0696836	0.069466	0.069636	0.069488	0.069551	0.055218	0.054107	0.069658	0.069663	0.069641	..
electricity	22	million kw	0	0.103314	0.103165	0.102863	0.103365	0.103111	0.103209	0.103134	0.110714	0.102896	..
city gas	23	1000m3	6.8666667	0	6.862069	7	6.714286	24.52235	24.87651	20.34417	20.34275	25.80378	..
heat supplyer	24	G joule	0	0	0	0	151.1	151.1186	151.1193	151.1178	151.1176	151.1188	..

(Source: calculated by JIDEA team Japan)

The 4th step: the fossil fuels are not always used as energy but as a material required to produce other materials. The portion of fossil fuels not used for energy differs by sector. How much portion of fossil fuels used as energy is published in The

Statistics on Consumption Structure of Petroleum and Other Energy Materials[4]. The part of this statistics is shown in Table 1-4.

From this statistics, we can derive the table; The ratio of fossil fuels not used as energy. The part of this table is shown in Table 1-5.

Table 1-4. The Statistics on Consumption Structure of Petroleum and Other Energy Materials

Industrial classifi-cation	Item	Fuel code	Fuel item	Unit	Input	Consumption						Output	Stock
						Total	Material for other products	Boiler	Direct heating	Co-generation	Other		End of the year
:	:	:	:	:	:	:	:	:	:	:	:	:	:
0	Total	2010	Crude Oil	kl	1957592	1863869	1840883	22986	–	–	–	61396	54986
2000	Chemical Industry	2010	Crude Oil	kl	1949066	1855317	1840883	14434	–	–	–	61396	54973
2030	Organic Chemical	2010	Crude Oil	kl	1949066	1855317	1840883	14434	–	–	–	61396	54973
2031	Basic Petro-Chemical	2010	Crude Oil	kl	219795	219795	219795	–	–	–	–	–	–
2032	Aliphatic Chemic. Intmed.	2010	Crude Oil	kl	657219	629314	629314	–	–	–	–	–	40785
2036	Cyclo-intmed Chem.	2010	Crude Oil	kl	26110	26045	26045	–	–	–	–	–	1738
2039	Other Inorg. Chem.	2010	Crude Oil	kl	1045942	980163	965729	14434	–	–	–	61396	12450
2500	Ceramic & Stone	2010	Crude Oil	kl	8526	8552	–	8552	–	–	–	–	13
2590	Other Ceramic & Stone	2010	Crude Oil	kl	8526	8552	–	8552	–	–	–	–	13
2596	Calcium Sulfate	2010	Crude Oil	kl	8526	8552	–	8552	–	–	–	–	13
0	Total	2110	Gasoline	kl	145137	146587	–	–	–	–	146587	341	3821
1200	Food Mnfg.	2110	Gasoline	kl	4084	4068	–	–	–	–	4068	–	60
1210	Animal Husband	2110	Gasoline	kl	341	340	–	–	–	–	340	–	1
1211	Meat Prod.	2110	Gasoline	kl	185	184	–	–	–	–	184	–	1
1212	Milk Prod.	2110	Gasoline	kl	76	76	–	–	–	–	76	–	–
1219	Other Animal Husband.	2110	Gasoline	kl	80	80	–	–	–	–	80	–	–
1220	Fishery Prod.	2110	Gasoline	kl	1552	1543	–	–	–	–	1543	–	35
:	:	:	:	:	:	:	:	:	:	:	:	:	:

(Source: METI, The Statistics on Consumption Structure of Petroleum and Other Energy Materials)

Table 1-5. The ratio of fossil fuels not used as energy

	…	12	13	14	15	16	17	18	19	20	21	…
	…	Pulp & paper	Printing & publishing	inorganic chemicals	Petro chemicals	Organic chemicals	Synthetic Resine	Synthetic fiber	Final chemicals	Pharmathutics	Petro products	…
Lime stones	…	1	1	1	1	1	1	1	1	1	1	…
Heavy oil A	…	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	…
Heavy oil B and C	…	0.0000		0.023381	0.021813		0.0000		0.000199	0.0000	0.153863	…
	…											…
Gasoline	…	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	…
Gas as biproducts of cokes	…								0.9415		0.0000	…
Naphtha	…				0.9986	1.0000	1.0000	0.0000	0.9459		0.8896	…
LPG	…	0.0000	0.0000	0.1155	0.7375	0.8150	0.7414		0.6659	0.0000	0.6893	…
LNG	…	0.0000		0.0000	0.0000	0.4589	0.0000			0.0000		…
Converted oil	…				1.0000		1.0000				1.0000	…
Light oil	…	0.0000	0.0000	0.0000	0.0000	0.0090	0.2198	0.0000	0.1100	0.0000	0.0227	…
Crude oil	…				1	0.99222					1.0000	…
Furnace gas	…				0.0000							…
Coal	…	0.0000		0.0111	0.0000	0.0258	0.0155	0.0000	0.8878		0.5829	…
Cokes from coal	…			0.3312	0.0000	0.3977			0.8051		1.0000	…
Cokes from petroleum	…	0.0000		0.8626	0.0000	0.0959	0.0595	0.0000	0.0375		0.0309	…
Hydro-carbon gas from petr	…	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0159	…
Hydro-carbon oil	…			0.9686	0.0000	0.0000	0.0000	0.0000	0.4187	0.0000	0.0050	…
Natural gas	…			0.4537	0.0000	0.3572	0.6078				0.0000	…
Converter gas	…			0.2217	0.0000							…
Electricfurnace gas	…				0.0000				0.0000			…
City gas	…	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	…
Keroscene	…	0.0000	0.0000	0.0000	0.0000	0.9178	0.0000	0.0000	0.0138	0.0000	0.9282	…

* Lime stone value is always "1" except Steel industry, Cement and Glass industry.

(Source: calculated by JIDEA team Japan)

The 5th step: we apply the ratio of carbon contained in each hydrocarbon fuels to calculate CO2 emission amount by industry. The calorific ratio and CO2 emission ratio by fuels are shown in Table 1-6.

4 The statistics is published by METI but the publication of this series has been stopped since 2001.

Table 1-6. The calorific ratio and CO2 emission ratio by fuels

Fuel	Quantity	Calorific value	CO2 Emission per Calory (kg)	CO2 Emission per Quantity (t)
	Unit	MJ/Unit	kg-	t-CO2/Unit
Coal for cokes	t	31814	81.61	2.596
Coal	t	25426	94.75	2.409
Crude oil	kl	38721	67.64	2.619
Natural gas	1000m3	41023	50.81	2.084
LNG*	t	54418	49.57	2.698
Gasoline	kl	35162	66.03	2.322
Kerosene	kl	36418	67.62	2.463
Jet fuel	kl	37255	66.82	2.489
Light oil	kl	38511	68.01	2.619
Heavy oil A	kl	38930	69.6	2.710
Heavy oil B/C	kl	41023	72.68	2.982
Naphtha	kl	33488	67.95	2.276
LPG	t	50232	59.73	3.000
Reformed oil	kl	33488	70.45	2.359
Hydro-carbon oil	t	41023	77.09	3.162
Hydro-carbon gas	1000m3	39348	59.41	2.338
Petro cokes	t	35581	93.18	3.315
Cokes	t	30139	107.66	3.245
Cokes furnace gas	1000m3	20093	42.36	0.851
Blast furnace gas	1000m3	3349	99.32	0.333
Revolver furnace gas	1000m3	8372	141.44	1.184
Electric furnace gas	1000m3	8372	183.25	1.534
Coal pit gas	1000m3	36000	50.26	1.809
Coal tar	t	32065	89.15	2.859
Commercial Electric powe	million Kwh	7431018		512.258
Self generated electricity	million Kwh	6249819		431.333
City gas	1000m3	27788		1.455
Heat supply	giga joule	505		0.037

(Source: Center for Global Environmental Research; Embodied Energy and Emission Intensity Data for Japan Using Input-Output Tables – Inventory Data for LCA－)

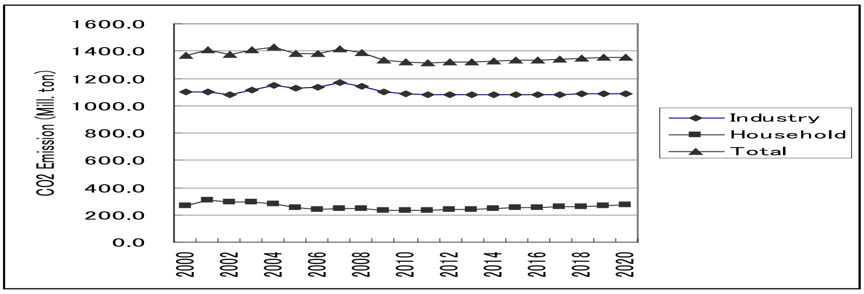
2. Results of Prediction of CO2 Emissions by Japanese Economic Activities

2-1. Overview of the prediction of CO2 emission

The result of estimation and prediction of Japanese CO2 emission up to 2020 are summarized in Fig.2-1. CO2 emission leaped up in 2004 and 2007, and from 2008 to 2010, affected by the sub-prime loan shock, Japanese economic activities stagnated and CO2 emission shrunk accordingly. After that, CO2 emission will increase slightly. The main player of this increase will be the household sector, while the CO2 emission by industrial activities is keeping almost constant level (see also Table 2-1).

It goes without saying that the CO2 emission is correlated to the industrial output, and inversely related to the industrial energy efficiency. To present these relations more clearly, the indices of CO2 emission per GDP and CO2 emission per capita were calculated and put in the right hand side of Table 2-1.

Fig. 2-1. CO2 Emission by household and Industries (unit: million ton)



(Source: prepared by JIDEA team Japan)

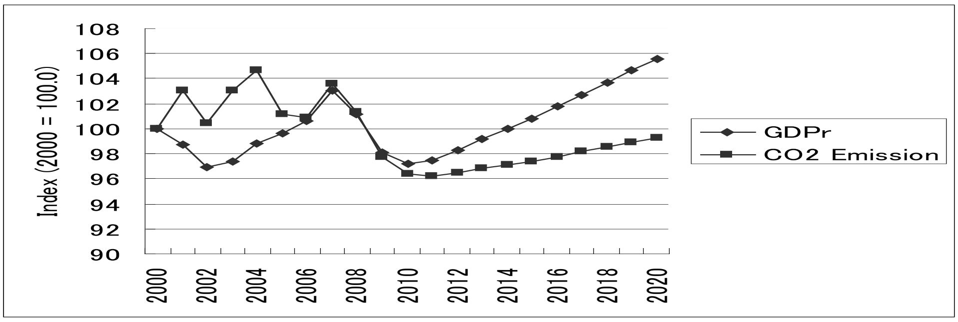
Table 2-1. Japanese CO2 Emission by Economic Activities

Year	CO2 Emission by Industry	CO2 Emission by Househ	CO2 Emission Total	Relative Share by Household	GDP in Real Terms	CO2 Emission	CO2/GDP	CO2/ Population
	Quantity (100 Mill. Ton)			(%)	Index (2000 = 100)			
2000	1098.0	268.5	1366.5	19.6	100.0	100.0	100.0	100.0
2005	1126.6	256.3	1382.9	18.5	99.6	101.2	101.6	100.5
2010	1085.1	232.4	1317.5	17.6	97.2	96.4	99.2	96.4
2015	1081.2	249.9	1331.0	18.8	100.8	97.4	96.6	98.9
2020	1085.4	271.1	1356.5	20.0	105.6	99.3	94.0	103.3

(Source: prepared by JIDEA team Japan)

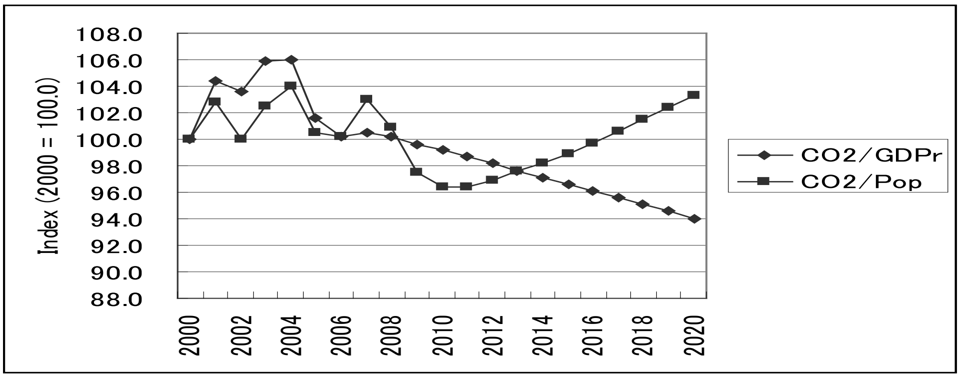
Comparing with the figure in 2000, total CO2 emission will slightly decrease to 99.3% in 2020, while real GDP will increase to 105.6 in 2020 (Table2-1 or Fig.2-2). Consequently CO2 emission per GDP in real term will decrease to 94% in 2020. This means that the energy efficiency of Japan measured by CO2 emission per GDP in real term will decline rapidly in this period (Table2-1 or Fig.2-3). On the other hand, the CO2 emission per capita will increase by 3.3% point and especially after 2010. As the result, share of the household relative to the total amount of CO2 emission will decrease from 19.6% to 17.6% in 2010, then increase to 20.0% in 2020. In spite of population decline, the up-grading in living standard or endless pursuit of comfort of living will be a cause to augment energy consumption, especially electricity by household.

Fig.2-2. Indices of GDP and CO2 Emission (2000 = 100)



(Source: prepared by JIDEA team Japan)

Fig.2-3. Indices of CO2 Emission per Real GDP and per Capita (2000 = 100)

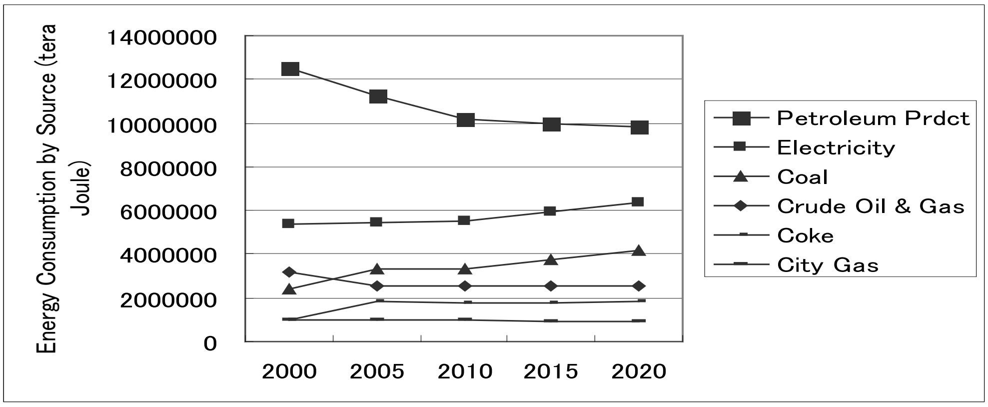


(Source: prepared by JIDEA team Japan)

2-2. Prediction of energy consumption by source

Needless to say, CO2 emission is closely linked with the fossil fuel consumption. Fig.2-4 shows consumption of energy by source in terms of *tera* joule including secondary energies of electricity and city gas. The electricity, 30% of which comes from nuclear energy in Japan,[5] will increase rapidly. In contrast to the decline of crude oil and gas consumption after 2005, coal consumption will increase gradually. One caution should be noted that the prices of coal, crude oil and natural gas are fixed at the level of 2006 in this prediction[6].

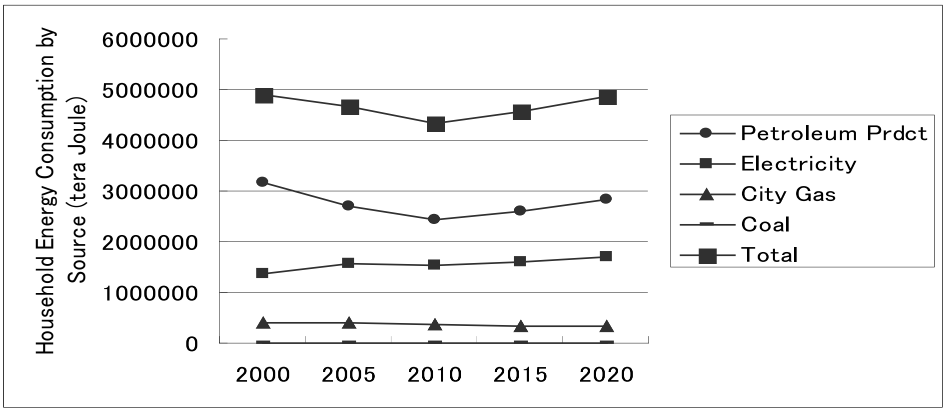
Fig.2-4. Consumption of Energy by Source (unit: *tera* joule)



(Source: prepared by JIDEA team Japan)

The household energy consumption by source is presented in Fig.2-5. The consumption of petroleum products, decreasing in 2005 and 2010 because of the economic recession, will increase up to 2020, while the consumption of electricity, though slightly decreasing in 2010, will also continue to increase.

Fig.2-5. Household Energy Consumption by Source (unit: *tera* joule)



(Source: prepared by JIDEA team Japan)

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[5] Detailed discussion will be given in section 3.

[6] Foreign exchange rate was also fixed to 2006 level.

2-3. Prediction of CO2 emission by industry

There are two sources of CO2 emission by industry, namely, one is secondary energy producing sectors such as electric power (commercial and self generating), city gas and heat supply, and the other is a group of industries excluding secondary energy producing sectors, or non-secondary energy producing sectors. Total amount of CO2 emission by industry is the sum of the CO2 emissions of these two sectors. Table 2-2 describes the estimation and prediction of CO2 emission by secondary and non-secondary energy producing sectors in the form of index.

Table 2-2. Secondary Energy Producing Sectors: CO2 Emission Index and Relative Share

Year	Secondary Energy Producing Sectors				Non-Secondary Energy Prducing Sectors	Total	Secondary Energy Producing Sctors	Non-Secondary Energy Producing Sctors
	Electric Power (Commercial	Electric Power (Self Generating)	City Gas	Heat Supply				
	Index (2000 = 100.0)						Share (%)	
2000	100.0	100.0	100.0	100.0	100.0	100.0	29.4	70.6
2005	107.5	94.6	101.5	77.1	99.5	101.2	30.5	69.5
2010	108.9	97.5	100.5	105.2	92.2	96.4	32.5	67.5
2015	118.3	103.3	94.5	100.4	90.7	97.4	34.2	65.8
2020	128.8	109.7	89.0	96.4	90.0	99.3	36.0	64.0

(Source: prepared by JIDEA team Japan)

The share of CO2 emission by the secondary energy producing sectors relative to total amount of CO2 emission, shown in the right hand side of Table 2-2, was 29.4% in 2000 and is predicted to be 36% in 2020. Especially the electric power (commercial) sector is clearly expanding as the index of electric power (commercial) will be 128.8 in 2020. What is much more interesting is the detailed picture of CO2 emission by industries excluding secondary energy producing sectors. In this study the industrial activities are composed of 66 sectors.

In calculating the amount of CO2 emitted by industries, there is a problem how to deal with the emission of CO2 by the sector of electric power. Each industrial sector uses electric energy, but electric energy is a secondary energy produced from fossil fuels or from other primary energies. An industry which uses electric energy only, emits no CO2, while generating electricity itself inevitably emits considerable amount of CO2. Who should be responsible for emission of CO2, the producer or the consumer of electric energy, or both? In this analysis the amount of CO2 emission by electric power industry, which is one of the secondary energy producing sectors, was imputed to the amount of CO2 emitted by non-secondary energy producing sectors, the end-user of electricity generated. The beneficiary-pays principle will be most appropriate.

Table 2-3 presents the amount of CO2 emission predicted up to 2020 by top 20 sectors selected by the descending order of the amount of CO2 emission in 2020. The share of these 20 sectors relative to total CO2 emission was calculated and put in the last row of the table. It was 80.6% in 2000, and climbing up to the level of 83% in 2005, its share will be 82.3% in 2020.

As Table 2-3 shows, big three sectors measured by the level of CO2 emission are sectors of "Iron & Steel" (1st), "Transportation" (2nd) and "Trade" (3rd). In 2000, 34.1% of total amount of CO2 emission was ascribed to these three sectors, and this figure will slightly climb up to 35.2% in 2020[7]. "Iron & Steel" sector will increase CO2 emission up to 2020, though its 2010 level will be lower than the 2005 level. Both "Transportation" sector and "Trade" sector will achieve to reduce its CO2 emission to 94% and 74% of 2000 level in 2020 respectively.

Table 2-3. CO2 Emission by Non-Secondary Energy Producing Industries
(Upper 20 sectors) (unit: million ton)

Sector No.	Sector's Name	2000	2005	2010	2015	2020
29	Iron & Steel	134.8	169.8	169.3	174.2	179.9
61	Transportation	123.4	119.7	125.6	120.5	116.6
59	Trade	115.9	101.3	88.2	86.6	85.7
64	Education & Research	62.1	68.1	64.9	67.9	72.0
50	Miscll. Manufacturing	6.4	84.2	71.9	69.5	67.4
65	Personal Services	59.1	56.0	57.0	55.6	54.6
21	Petro Products	55.3	45.0	38.1	37.3	37.0
63	Government Services	34.5	35.8	33.2	32.0	31.1
25	Glass	37.8	22.9	28.4	28.2	28.2
12	Pulp&Paper	31.7	32.7	29.5	28.6	27.9
16	Organic Chem	24.3	22.3	23.1	24.6	26.6
51	Construction	33.4	27.1	25.2	25.3	24.3
66	Advertizing	22.8	21.6	20.7	21.7	22.8
6	Food Products	24.1	25.3	21.4	20.6	19.9
58	Water & Sewage	17.4	17.8	16.5	18.1	19.9
26	Cement	32.3	22.3	21.4	20.6	19.4
14	Inorganic Chem	16.6	14.9	15.3	15.5	16.0
47	Other Vehicles	11.6	12.2	14.0	14.8	15.6
60	Finance&Real Estate	16.5	16.5	15.6	15.5	15.6
1	Agri., Forestry&Fishery	25.4	19.3	18.1	15.5	13.2
	Sub Total	885.4	934.9	897.4	892.5	893.6
	Grand Total	1098.0	1126.6	1085.1	1081.2	1085.4
Share of Upper 20 Sectors (%)		80.6	83.0	82.7	82.5	82.3

(Source: prepared by JIDEA team Japan)

In the sectors ranked in 11th to 20th level in this CO2 emission table, "Food products" sector (14th), "Cement" (16th) and "Agriculture, forestry and fishery" sector (20th) are reducing the CO2 emission, while "Organic chemicals" (11th) and "Inorganic chemicals" (17th), though reaching to the lower level in 2005, are constantly increasing CO2 emission up to 2020. Other sectors will be more or less increasing the level of CO2 emission by 2020 owning to the gradual recovery of the Japanese economy after 2010, though some of them are temporally lowering the level of CO2 emission in 2010.

Table 2-4 presents the annual average rate of CO2 emission from 2010 to 2020 by industry excluding secondary energy producing sectors. The left hand side of the table indicates upper 20 sectors ranked by the order of the annual average rate of CO2 emission, while in the right hand side, lower 20 sectors are listed.

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[7] From Table 2-3, the relative share of these big three sectors can be easily calculated.

Table 2-4. Annual Average Rate of CO2 Emission by Industry from 2010 to 2020

Upper 20 sectors (unit: %)

Sector No.	Sector's Name	2020/ 2010
42	Semiconductor & IC	1.98
56	Water & Sewage	1.88
43	Electronic Parts	1.60
23	Plastic products	1.50
48	Other Transportation	1.48
16	Organic Chemicals	1.39
20	Medicines	1.20
46	Motor Vehicle	1.15
60	Communication & Broadcasting	1.07
47	Other Vehicles	1.06
62	Education & Research	1.04
30	Non-Ferrous Metal	1.00
32	Metal Construction	0.98
64	Office Supply & N.E.C.	0.96
44	Heavy Electric	0.90
17	Plastic products	0.76
36	General Mach. Others	0.72
29	Iron & Steel	0.61
45	Other Light	0.60
41	Applied Electronic Devices	0.57

Lower 20 sectors (unit: %)

Sector No.	Sector's Name	2020/ 2010
9	Clothing	-6.31
2	Metal Ore	-6.11
15	Petro Chemical	-5.36
4	Coal	-4.57
1	Agriculture, Forestry & Fishery	-3.08
39	Computer	-2.97
3	Non-Metal Ore	-2.46
13	Printing & Publishing	-1.95
10	Wood Products	-1.77
27	Pottery	-1.51
11	Furniture	-1.43
52	Civil Engineering (Pub)	-1.42
38	Electric Mach. Household	-1.23
5	Crude Oil & Ntrl Gas	-1.21
26	Cement	-0.99
49	Precision Machinery	-0.92
28	Other Ceramics	-0.88
7	Beverages and Tabacco	-0.88
33	Metal Products	-0.76
59	Transportation	-0.74

(Source: prepared by JIDEA team Japan)

Comparing these two groups with each other, some of the industries ranked in the upper 20 sectors seem to be industries much more competitive in the international market than the industries in the lower 20 sectors which can be categorized as the declining industries.

2-4. Typology of industry; emitting less CO2 or more in 2020

As already mentioned in the first page of this paper, the CO2 emission is deeply correlated to the industrial output and inversely related to the industrial energy efficiency (or the inverse of energy per output).

Relations among the annual rate of increase in CO2 emission, the growth rate of industrial output and the rate of increase in energy per output can be tactically described using a kind of 3D graph. Fig. 2-6 is a coordinate graph showing positive and negative numbers. Out of 66 sectors, industries ranked in the upper 30 sectors of CO2 emission excluding secondary energy producing sectors are represented in this graph.

The vertical axis in Fig. 2-6 indicates the growth rate of real output by industry (*b*) from 2010 to 2020 and by the horizontal axis the rate of increase in energy per output (*c*) (or the inverse of energy efficiency) in the same period is indicated. The more increased the energy per output is, the more deteriorated is the energy efficiency.

On the diagonal line of 45 degrees uprising towards the left hand side in the graph, the following relation is always maintained. Adding up the growth rate of output (*b*) and the rate of increase in energy per output (*c*) comes to zero, which means the rate of increase in CO2 emission (*a*) is zero[8]. Therefore, industries placed over the diagonal line

[8] CO2 emission = CO2 emission ratio * real output*energy per output

in Fig. 2-6 such as “Glass”, “Business services”, “Non-ferrous metal”, “Iron & Steel”, “Plastic products” and “Inorganic chemicals”, *etc* are categorized in the industries with increasing CO2 emission, while industries placed under the diagonal line in the graph are denoted as the industry with less CO2 emitting. They are “Construction”, “Trade”, “Transportation”, “Food products”, “Cement”, and more.

Industries in the first quadrant of Fig. 2-6 are industries both with increasing growth rates of output and with increasing rate of energy per output, which will be main actors escalating CO2 emission, though only two sectors of “Plastic products” and “Iron & Steel” are classified in this group.

Industries in the second quadrant of the graph are those with increasing output but decreasing energy per output, contributing to lower the level of CO2 emission, though depending on the position placed on which side of the diagonal line of 45 degree. 22 sectors selected and placed in this quadrant are “Business services”, “Construction”, “Trade”, “Finance & Real estate”, “Transportation”, “Government services”, “Personal services”, “Organic chemicals”, “Glass”, “Non-ferrous metal”, “Food products”, “Inorganic chemicals”, “Pulp & Paper”, “Processed non-ferrous metal”, “Civil engineering (public)”, “Final chemicals”, “Communication”, “Information services”, “Coal products” and “Other vehicles”, “Other public services” and “Water & Sewages”.

Five industries in the third quadrant of the graph are industries with both declining output and decreasing energy per output, which include “Agriculture, Forestry & Fishery”, “Other ceramics”, and “Metal others”, “Cement” and “Miscellaneous manufacturing”. Especially reduction in the agricultural energy per output is remarkable. This is mainly because of the lasting downward tendency in agricultural output. Historical picture will give some help. Reduction in agricultural production in Japan was about 2% from 1990-92 to 2002-04,[9] while the direct on-farm energy consumption was decreased by 5% from 1990-92 to 2002-04, though Japan’s share in total OECD on-farm energy consumption was 10% in 2000-04, next to the U.S.A. of which share was 23%[10].

Only one sector located in the fourth quadrant of the graph is “Petroleum products” with decreasing output but increasing energy per output. According to the projection of domestic demand for petroleum products up to 2014 by METI (Ministry of Economy, Trade and Industry), demands for fuel oil such as gasoline, naphtha, kerosene, light oil and heavy oil are supposed to decline from 201.0 (million kl) in 2008 to 160.8 (million kl) in 2014, though the reason is not shown in the report.[11]

Assuming rates of increase in CO2 emission, real output and energy per output as a, b and c, the following formula will be introduced, since CO2 emission ratio is constant. $a = b + c$. On the diagonal line of 45 degrees in Fig. 2-6, b and c has the same value with opposite sign. Therefore a, rate of increase in CO2 emission should be zero.

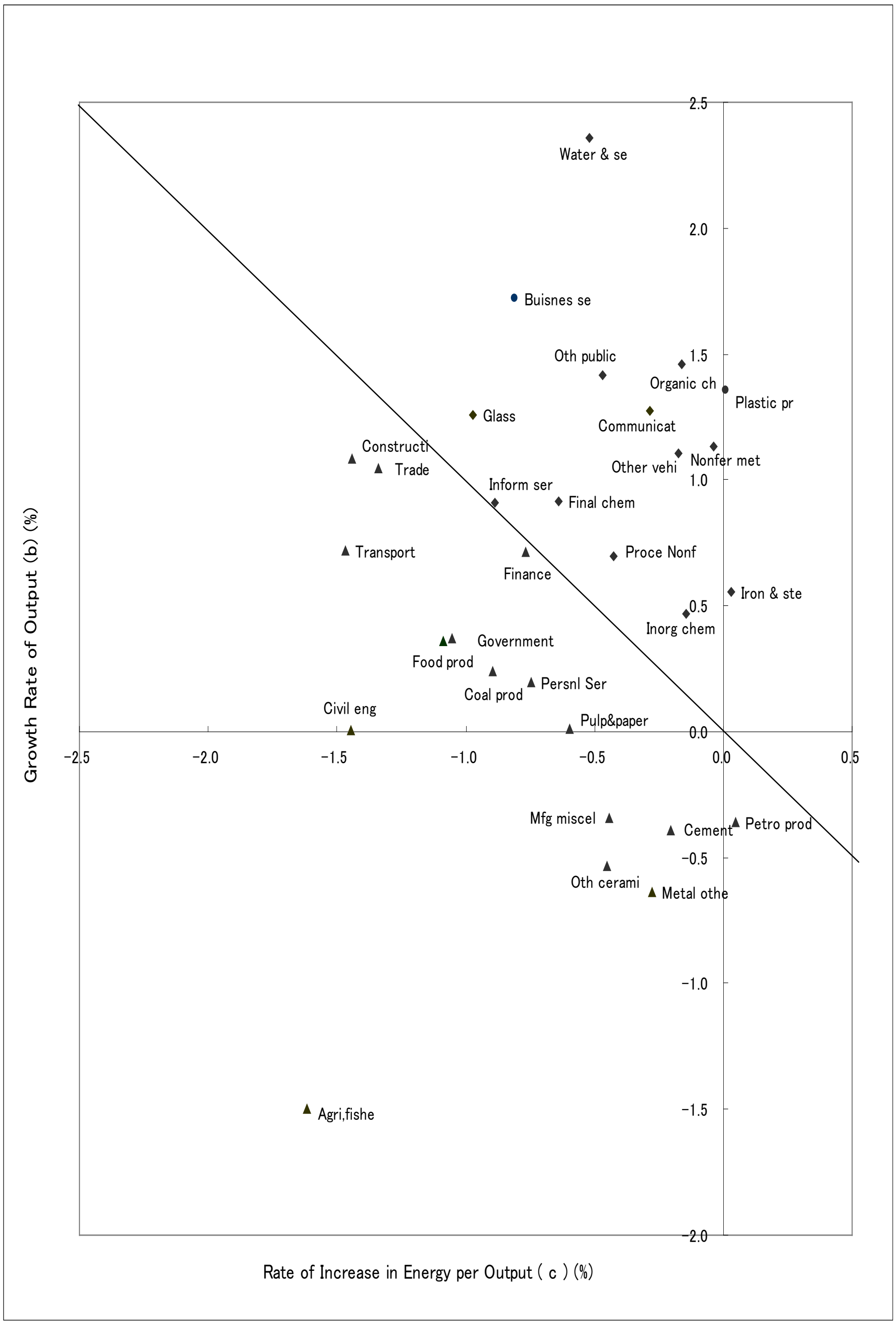
[9] Calculated from the data available in the agricultural production statistics table by MOAFF (Ministry of Agriculture, forestry and Fishery)

[10] See Figure 1.4.2., p.79 in OECD (2008), *Environmental Performance of Agriculture in OECD Countries Since1990,* 575p. OECD Publication, Paris.

[11] http://www.meti.go.jp/committee/materials2/downloadfiles/g100409a06j.pdf(2010/07/31)

Fig. 2-6. Relations between the Growth Rate of Real Output and the Rate of Increase in Energy per Output

(unit: %)



(Source: prepared by JIDEA team Japan)

2-5. Remaining problems revealed from the comparison

CO2 emission in Japan is also estimated by two other institutions. One is by National Institute for Environmental Studies, Japan (NIES) and the other is by Keio Economic Observatory of Keio University (KEO). Though simple comparison of these three results including JIDEA's is not fruitful since the methods and databases used are certainly different from each other, if the estimates in the year 2000 are compared, JIDEA's estimate is the highest, the second is KEO's and NIES's is the lowest (see Table 2-5). In other words, since NIES's is regarded as the official figure of CO2 emission of Japan, both JIDEA's and KEO's are overestimated.

Table 2-5. CO2 Emission Estimated by 3 Institutes

Year	NIES*1) (2010)	KEO*2) (2001) (2008)	JIDEA*3) (2009)	RealGDP*3) (2000 price)	NIES (2010)	KEO (2008)	JIDEA (2009)	RealGDP (2000 price)
		Million ton		Trillion. yen		Index (2000=100)		
1990	1143	1208	1313	456.5	91.1	91	96.1	88.0
1995	1226	1313	1381	489.2	97.8	98.6	101.0	94.3
2000	1254	1331	1366	518.9	100.0	100.0	100.0	100.0
2005	1286		1383	516.9	102.6		101.2	99.6
2006	1267		1378	522.3	101.0		100.9	100.7
2007	1301		1416	534.7	103.7		103.6	103.1
2008	1214		1385	524.9	96.8		101.3	101.2
2009			1336	509.0			97.7	98.1
2010			1317	504.3			96.4	97.2
2015			1331	523.1			97.4	100.8
2020			1357	548.0			99.3	105.6

(Sources: *1) From Table 1, p.2 in National Institute for Environmental Studies, Japan (2010), *National Greenhouse Gas Inventory Report of Japan,* April.
http://www-gio.neis.go.jp/aboutghg/nir/2010/NIR_JPN_2010_v3.0E.pdf (2010/08/14)

*2) Keiichiro Asakura Hitoshi Hayami, *et al* (2001), *The Input-Output Table for Environmental Analysis,* Keio University Press.
Satoshi Nakano, Hitoshi Hayami, Nasao Nakamura and Masayuki Suzuki (2008), *The Input-Output Table for Environmental Analysis and its Application,* Keio University Press.

*3) Data prepared by JIDEA team Japan.)

Reasons of overestimating CO2 emission by JIDEA team seem to be the following;

1) The conversion coefficient of value to quantity
The data of I-O table are expressed in value term. To estimate CO2 emission, as already mentioned in section 1, it needs to convert the value to quantity in the material table.
JIDEA's conversion table is based on the material I-O table of the year 2000 and fixed up to 2020. This is mainly because the material matrix is published every 5 years and the base year of JIDEA model is also the year 2000. Since the relation between material and quantity in the material I-O table changes year by year, it may cause relatively large distortion in JIDEA's estimation of CO2 emission.
2) The aggregation of industrial sectors
JIDEA model is composed of 66 industrial sectors and has 8 sectors related to energy, while the I-O base table has 19 energy related sectors. Therefore these 8 sectors in JIDEA model should be divided into19 sectors consistent with the I-O base table of 2000. These dividing ratios in 2000 were kept constant and applied to the data from 1990 to 2020. This may be one of the causes of some distortions in the prediction.
3) Import and export definition
The import and the export in the final demand components are not included as the

sources of CO_2 emission. I-O table used in JIDEA model is the competing import type, namely, imported goods and domestically produced goods are of no difference as input goods. Thus the imported materials are mixed in the intermediate input and household consumption.

Another problem unsolved is how to calculate CO_2 emission caused by energies supplied to foreign ships or airplanes and to the Japanese ones in the foreign country. According to the definition of domestic input in the I-O table, to which JIDEA's database is following, the former is counted in the export and the latter is categorized as the import.

4) Iron and steel industry

"Iron & Steel" industry, one of the main sectors emitting enormous amount of CO_2, has very complicated mechanism in its energy consumption and CO_2 emission. The process to make iron from iron ore, coke and limestone, and steel from iron are very complicated and different according to the method of production. To calculate CO_2 emission more precisely, emission of CO_2 gas should be measured in every stage of the process. JIDEA model has a simplified process in estimating CO_2 emission from the amount of input materials of coke and limestone, while the other institutions employ more sophisticated calculation process. This difference may be crucial to obtain better estimation of CO_2 emission.

3. Simulation for reduction of CO2 emission using nuclear power

We forecast Japanese economy and its CO_2 emission up to 2020, which is shown in the previous section. In this section, we will make two simulations how much we can reduce its emission in 2020 by substituting thermal power generation with nuclear power.

The first case is assuming to have the current expansion plan of nuclear power generation realized by 2020. We call this as the practical case.

The second case is how we can accomplish the mid-long term target of 25% reduction of her CO_2 emission in 2020 against 1990, which was advocated by former Prime Minister Yukio Hatoyama. We name it the extreme case.

For the methodology, please refer to the technical note at the end of this session.

3-1. The Practical case

The assumptions[12] for simulation are shown below and Table 3-1.

1. The nuclear power generation capacity will be increased by 11.35 million kw[13] from 49.47 million kw in FY2007 to 60.82 million kw in FY2010.
2. The average utilization rate is 88.0 %[14], which is higher than that of

[12] Though assumption figures are expressed in fiscal year (FY), our model data are in calendar year (CY). We neglect the differences as they are not so much.

[13] This is the total capacities of planned nuclear power generators which are to go into operation by the end of FY2009.

[14] This rate is supposed to be derived by assuming that the stoppage of the plant by regular inspection should be some 38 days, which is the average of USA.

60.9% in FY2007. (see Fig. 3-1)

3. The total amount of power generation by nuclear energy will be 468.8 billion kwh in FY2010. This is a 77.7% increase against the level in FY2007.

These presumptions are based on National Institute for Environmental Studies of Japan's assumptions for the mid-long term projection of Japanese national greenhouse gas emissions[15].

Table 3-1. The trends of Japanese nuclear power generation factors and their projection in 2020

(unit : No.,million KW, billion kwh, %)

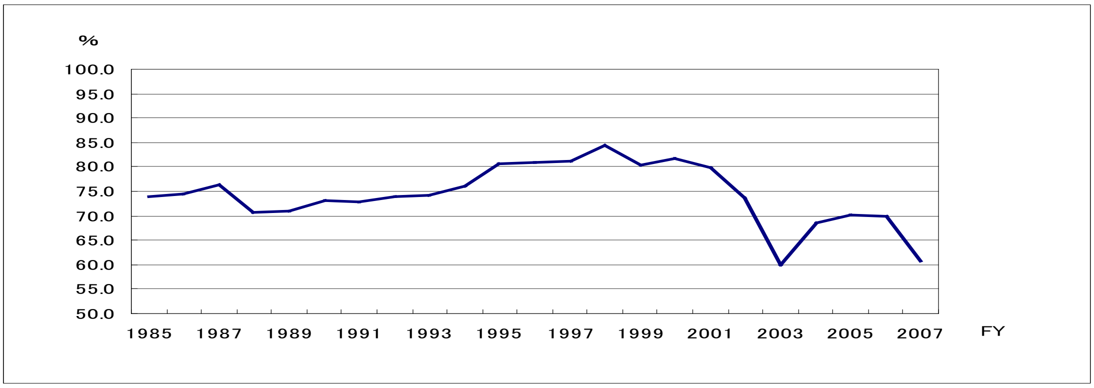
FY	No. of generators (CY)	Total capacities of generators	Annual outputs of electric power generated by nuclear power	Utilization rate	Share of nuclear generation
1985	32	24.52	159.0	74.0	27.2
1986	32	25.68	167.3	74.4	28.7
1987	35	27.88	186.6	76.4	30.0
1988	35	28.70	177.6	70.6	27.4
1989	37	29.28	181.9	70.9	26.6
1990	39	31.48	201.4	73.0	27.3
1991	41	33.24	212.3	72.9	27.8
1992	41	34.42	223.1	74.0	28.8
1993	45	38.38	249.1	74.1	31.8
1994	48	40.37	269.0	76.1	32.2
1995	49	41.19	291.1	80.7	34.0
1996	50	42.55	302.1	81.0	34.6
1997	52	44.92	319.1	81.1	35.6
1998	52	44.92	332.2	84.4	36.8
1999	51	44.92	316.5	80.4	34.5
2000	51	44.92	321.9	81.8	34.3
2001	51	45.74	319.8	79.8	34.6
2002	52	45.74	294.9	73.6	31.2
2003	52	45.74	240.0	59.9	25.7
2004	52	47.12	282.4	68.4	29.1
2005	54	49.58	304.8	70.2	30.8
2006	55	49.47	303.4	70.0	30.5
2007	55	49.47	263.8	60.9	25.6
2020	**63**	**60.82**	**468.8**	**88.0**	

Note: Utilization rate = Annual outputs of electric power generated by nuclear power divided by(Total capacities of generators*24h*365days)

(Source: METI; Energy Whitepaper of 2009
http://www.enecho.meti.go.jp/topics/hakusho/2007energyhtml/excel/213-4-2.xls
INFOBASE of nuclear power p.11for the No. of Generators.
http://www.fepc.or.jp/library/data/infobase/pdf/info_d.pdf)

[15] http://www-iam.nies.go.jp/aim/prov/middle_report.htm (as of August 11, 2010)

Fig. 3-1. Utilization rate



(Source: calculated by JIDEA team Japan)

The results of CO2 reduction by substituting thermal power generation to nuclear power generation is shown in Table 3-2.

In the practical case, which assumes the current construction plan for nuclear power plant materialized by 2020 with a high utilization rate, we can expect only 8.0%[16] reduction of CO2 emission against the baseline figure in 2020.

Table 3-2. The results of CO2 reduction

(unit: million ton, %)

CY	CO2 emmission	Estimated figures	Reduction rate
2000	1254	1,366	
2020	Baseline	1,357	
	Practical case	1,248	−8.0

Note: 1. Practical case: Substituting thermal power generation to atomic one by scheduled plan as of 2020.

2. Reduction rate is calculated against the baseline figure of 1357.

(Source: JIDEA Team Japan's estimate)

3-2. The Extreme case

In this subsection, we calculated how much of thermal power generation should be replaced by the nuclear power to materialize the mid-long term targets of 25% reduction of CO2 in 2020 against 1990.

As our model uses the CY data against the observation data of FY, there is a discrepancy observed in the CO2 emission volume even in the base year. In order to eliminate the residual[17], we created adjusted data by reducing the error of the observation and estimated data in 2000. We will use this adjusted data for this simulation as we have to compare with the historical figure in 1990.

[16] We admit that this reduction rate may be overestimated as we assumed increasing trends of nuclear power generation in this model.

[17] This may be derived by 1) the difference of CY and FY, 2) the coarseness of Material matrix, and 3) the correspondence with value and Material matrix is fixed in 2000, and so forth.

The estimated figures are calculated by fixing ratio of fossil fuels not used as energy and the convert matrix of value to quantity at 2000 level. Therefore the figures shown here are theoretical one.

The result is shown in Table 3-3.
Our simulation shows that almost all of its thermal power generation should be substituted with the nuclear power even we assume the 88% utilization rate to accomplish the 25% cuts of CO_2 in 2020.
This means that we should make use of 2.25 times of nuclear power generators whose capacity is 11,010.17 million kw, against the end of 2009 in number.

Table 3–3. The trends of CO2 emmission in Japan

(unit: million ton)

CY	CO2 Emission[1]	Estimation[2]	Adjusted[3]
1990	1143	1,313	1,200
1991	1153	1,330	1,217
1992	1161	1,350	1,237
1993	1154	1,204	1,092
1994	1213	1,448	1,336
1995	1226	1,381	1,268
1996	1239	1,899	1,787
1997	1235	2,246	2,133
1998	1199	1,546	1,434
1999	1234	1,532	1,420
2000	1254	1,366	1,254
2001	1238	1,409	1,296
2002	1276	1,372	1,260
2003	1282	1,409	1,296
2004	1281	1,430	1,318
2005	1286	1,383	1,270
2006	1267	1,378	1,266
2007	1301	1,416	1,303
2008	1214	1,385	1,272
2009		1,336	1,223
2010		1,317	1,205
2011		1,315	1,202
2012		1,319	1,206
2013		1,323	1,210
2014		1,327	1,214
2015		1,331	1,219
2016		1,336	1,224
2017		1,342	1,229
2018		1,347	1,235
2019		1,352	1,239
2020	Baseline	1,357	1,244
	Extreme	967	855
Ratio against 1990		−28.7	−25.2

Note; 1. CO2 emission (FY) announced by the Ministry of Environment
2. Estimation by Model (CY 2000= base)
3. Adjusted; applying the constant term adjustment in 2000.
(Source: Japan Center for Climate Change Actions' Web site (http://www.jccca.org/) and estimation by JIDEA team Japan.)

Technical note:

Substituting nuclear power for thermal power

For the electric power sector, JIDEA model only distinguishes one sector, but in the detailed I-O table, it consists of 4 sectors; “Nuclear power”, “Thermal power”, “Water and other powers” and “Electric power self generated”. Accordingly, to make simulation to substitute “Thermal power” with “Nuclear power”, we need to calculate these 4 sectors’ intermediate inputs separately and after the calculation we unify these 4 sectors inputs into one coefficient, namely, “electric power total coefficient”.

In the frame work of I-O table, the flow of calculation expressed in equation is as follows: assuming “Electric power total” as E, “Electricity produced by Nuclear power” N, “Thermal power” T, “Water and other power” O and “Electric power self generated” H, the intermediate input of each power generation by input materials is notated as E_i, N_i, T_i, O_i and H_i, then,

$$E_i = N_i + T_i + O_i + H_i$$

$$\sum_{i=1}^{n} E_i = \sum_{i=1}^{n} N_i + \sum_{i=1}^{n} T_i + \sum_{i=1}^{n} O_i + \sum_{i=1}^{n} H_i$$

$$E = N + T + O + H$$

Dividing E_i, A_i, F_i and O_i by their total and making them coefficient as e_i, n_i, t_i and o_i, then,

$$e_i = E_i / \sum_{i=1}^{n} E_i \qquad n_i = N_i / \sum_{i=1}^{n} N_i \qquad t_i = T_i / \sum_{i=1}^{n} T_i \qquad o_i = O_i / \sum_{i=1}^{n} O_i$$

$$h_i = H_i / \sum_{i=1}^{n} H_i$$

Then we can calculate,

$$N_i = n_i N, \ T_i = t_i T, \ O_i = o_i O, \ H_i = h_i H, \ E_i = e_i E$$

$$e_i = (N_i + T_i + O_i + H_i) / E$$

Now, we assume that the production of electricity by “Nuclear power” is increased with the rate α and the same amount of electricity substitutes that of “Thermal power”. The total electricity has not changed but the weight of above mentioned 4 sectors are changed. Accordingly “Unified Electric power coefficient” should be changed. If changed amount of electricity by “Nuclear power” is named as N', by “Thermal power” as T', then,

$$N' = (1+\alpha)N \,, \quad T' = T - \alpha N \,,$$

After substitution of "Thermal power" by "Nuclear power", if the coefficient of total unified electric power named as e_i', the following identity is obtained.

$$e_i' = (n_i N' + t_i T' + o_i O + h_i H)/E$$

Table 3-4. The changes of input coefficients according to the cases

Sector No.	Item	Baseline	Practical case	Extreme case
4	Coal mining	0.020577	0.017392	0.001936
5	Petro & gas exploration	0.039468	0.033363	0.003729
9	Clothing	0.000115	0.000120	0.000144
10	Timber	0.000019	0.000018	0.000013
11	Furniture	0.000587	0.000558	0.000417
13	Printing & publishinging	0.002639	0.002567	0.002219
14	Inorganic basic chemicals	0.000183	0.000159	0.000042
19	Final chemicals	0.000548	0.000474	0.000117
21	Petroleum refinery products	0.017781	0.015865	0.006564
22	Coal products	0.003314	0.003058	0.001813
28	Other ceramic, stone & clay produc	0.000035	0.000031	0.000013
30	Non-ferrous metals refinery produc	0.000018	0.000022	0.000040
31	Processed non-ferrous metal produ	0.000703	0.000794	0.001239
33	Other metal products	0.000482	0.000482	0.000481
40	Communication equipment	0.000006	0.000006	0.000005
43	Electronic Parts	0.000008	0.000008	0.000007
45	Electric illuminator, batteries & ot	0.000011	0.000010	0.000009
50	Miscellaneous manufacturing prod	0.012546	0.011702	0.007608
51	Construction	0.038653	0.039077	0.041135
54	Electric power	0.029740	0.030070	0.031671
55	Gas & hot water supply	0.000081	0.000079	0.000069
56	Water supply & treatment	0.006520	0.006661	0.007346
57	Trade	0.014931	0.013611	0.007203
58	Financial & insurance services	0.033912	0.033116	0.029252
59	Transportation services	0.017994	0.015795	0.005122
60	Communication & Broadcasting	0.003515	0.003407	0.002880
62	Education, research & Medical ser	0.024198	0.024869	0.028126
63	Information service	0.016678	0.016187	0.013800
64	Business Service	0.092103	0.090674	0.083738
65	Personal Service	0.000464	0.000468	0.000489
66	Office Supply & N.E.C.	0.004249	0.004417	0.005230
	Intcoltot	0.382077	0.365059	0.365059

Note: When the value of input coefficient is 0, the sector is not listed in the table.
(Source: Calculated by JIDEA team Japan)