

Text No.8

ENERGY SITUATION IN JAPAN

日本のエネルギー状況

May 22, 2003

Yuji Morita

The Institute of Energy Economics, Japan

森田 裕二

(財)日本エネルギー経済研究所



Energy Situation in Japan

May 22, 2003

Yuji Morita

The Institute of Energy Economics, Japan

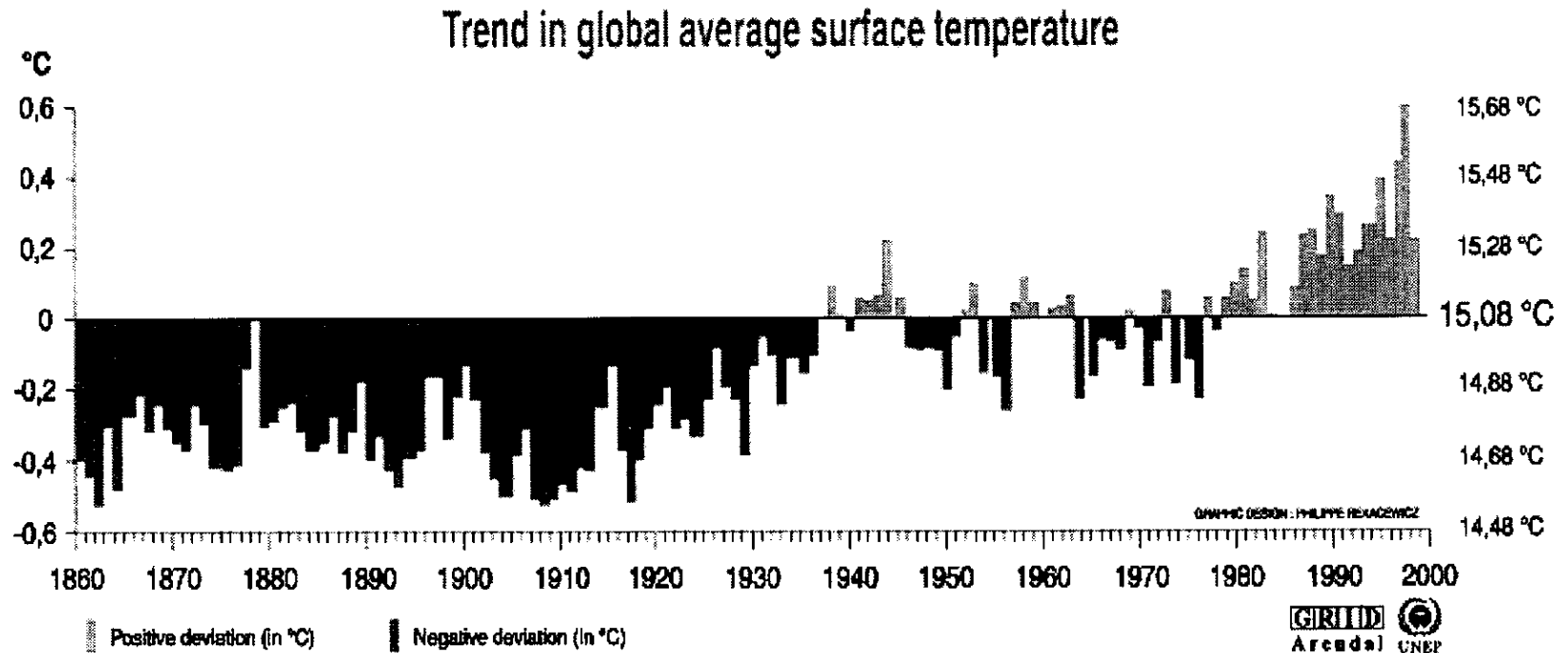
<http://eneken.ieej.or.jp>



Contents

- Preface
- Outline of Energy Demand Structure
- Energy Consumption in the Industrial Sector
- Energy Consumption in the Residential Sector
- Energy Consumption in the Commercial Sector
- Energy Consumption in the Transportation Sector
- Energy Supply and Demand by Source
- Energy Supply and Demand Forecast

Trend in Global Temperature

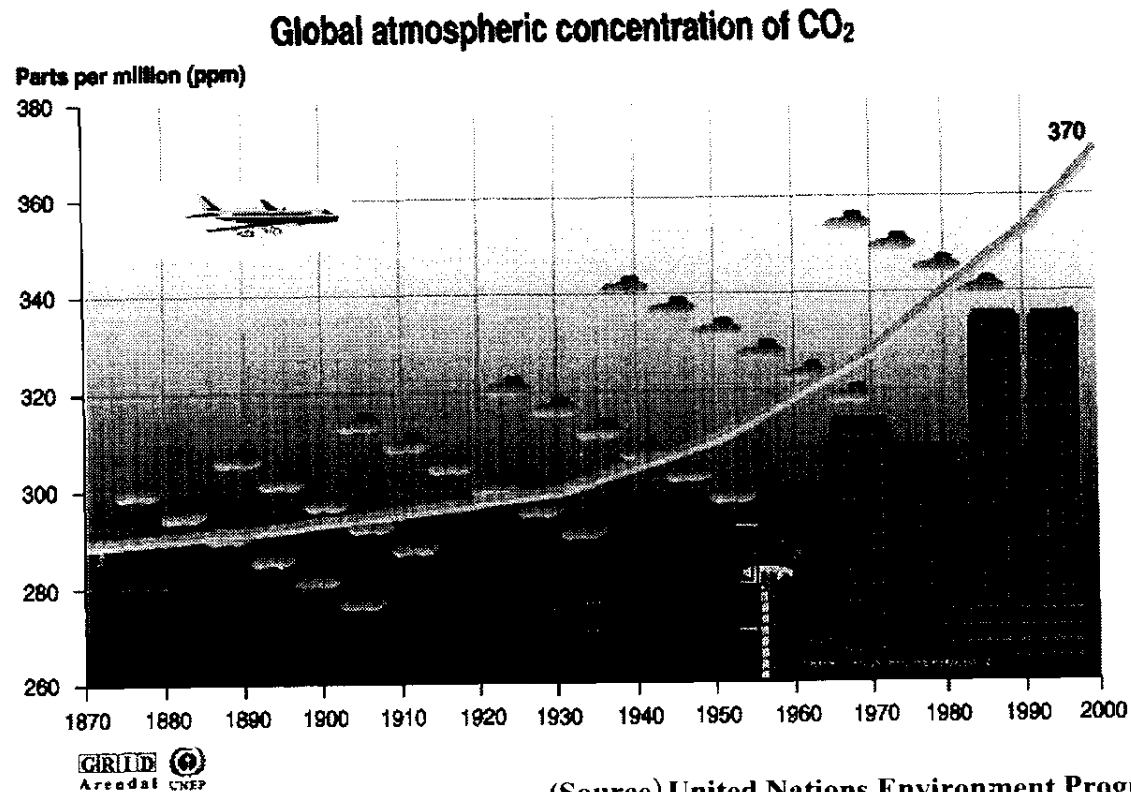


Sources: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999. (Source) United Nations Environment Program

The mean global surface temperature has increased by about 0.3 to 0.6°C since the late 19th century and by about 0.2 to 0.3°C over the last 40 years.

Global Average Temperature in 2002 : +0.58°C (against average temp. of 1971-2000) 2nd highest after 1880, Highest temperature was recorded in 1998, +0.64°C). Japan's Average Temperature in 2002 : +0.53°C (5th highest after 1898, highest was +1.04°C in 1990)

Atmospheric CO₂ Concentration

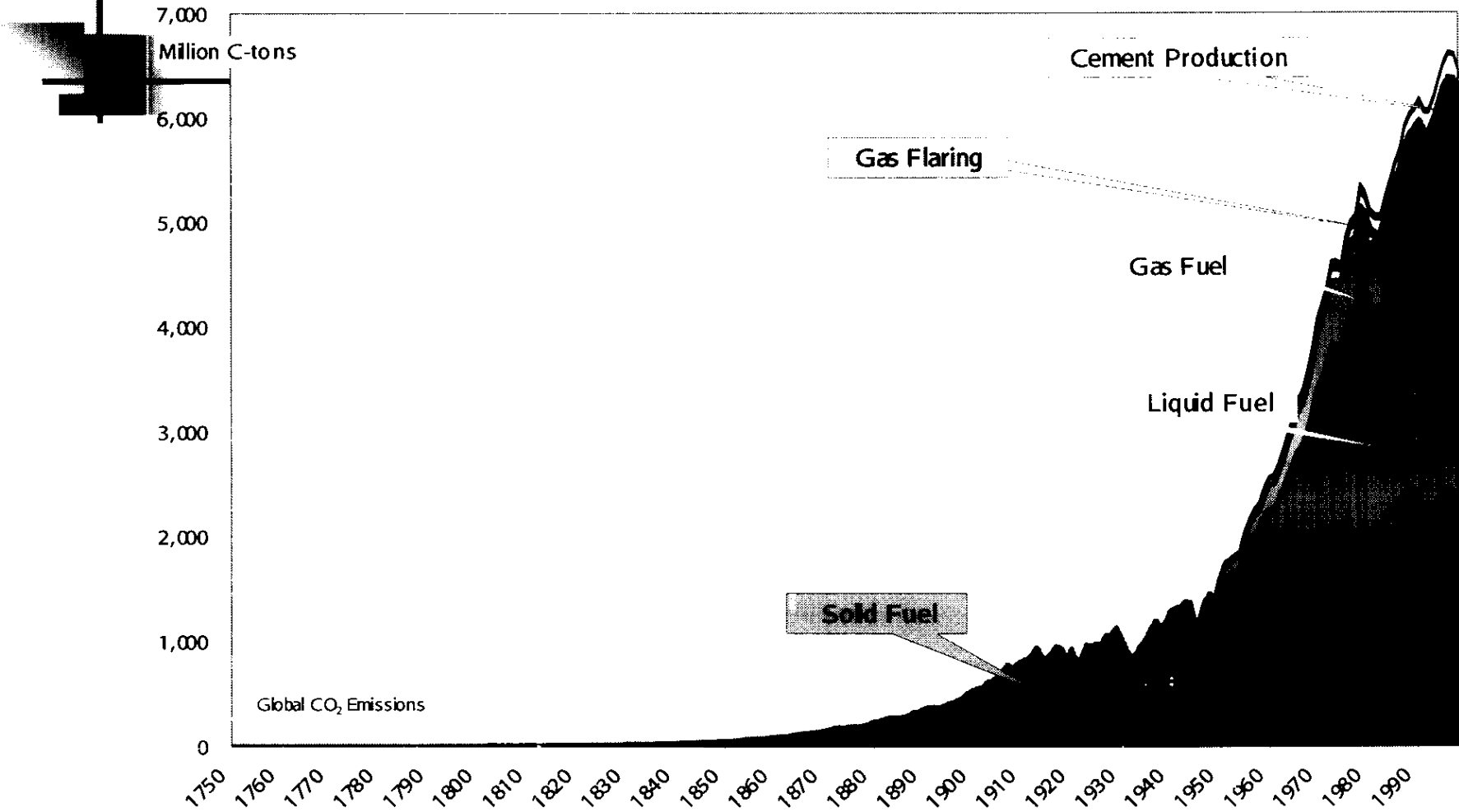


(Source) United Nations Environment Program

Sources: TP Whorf, Scripps, Mauna Loa Observatory, Hawaii; Institution of oceanography (SIO), university of California La Jolla, California, United States, 1999

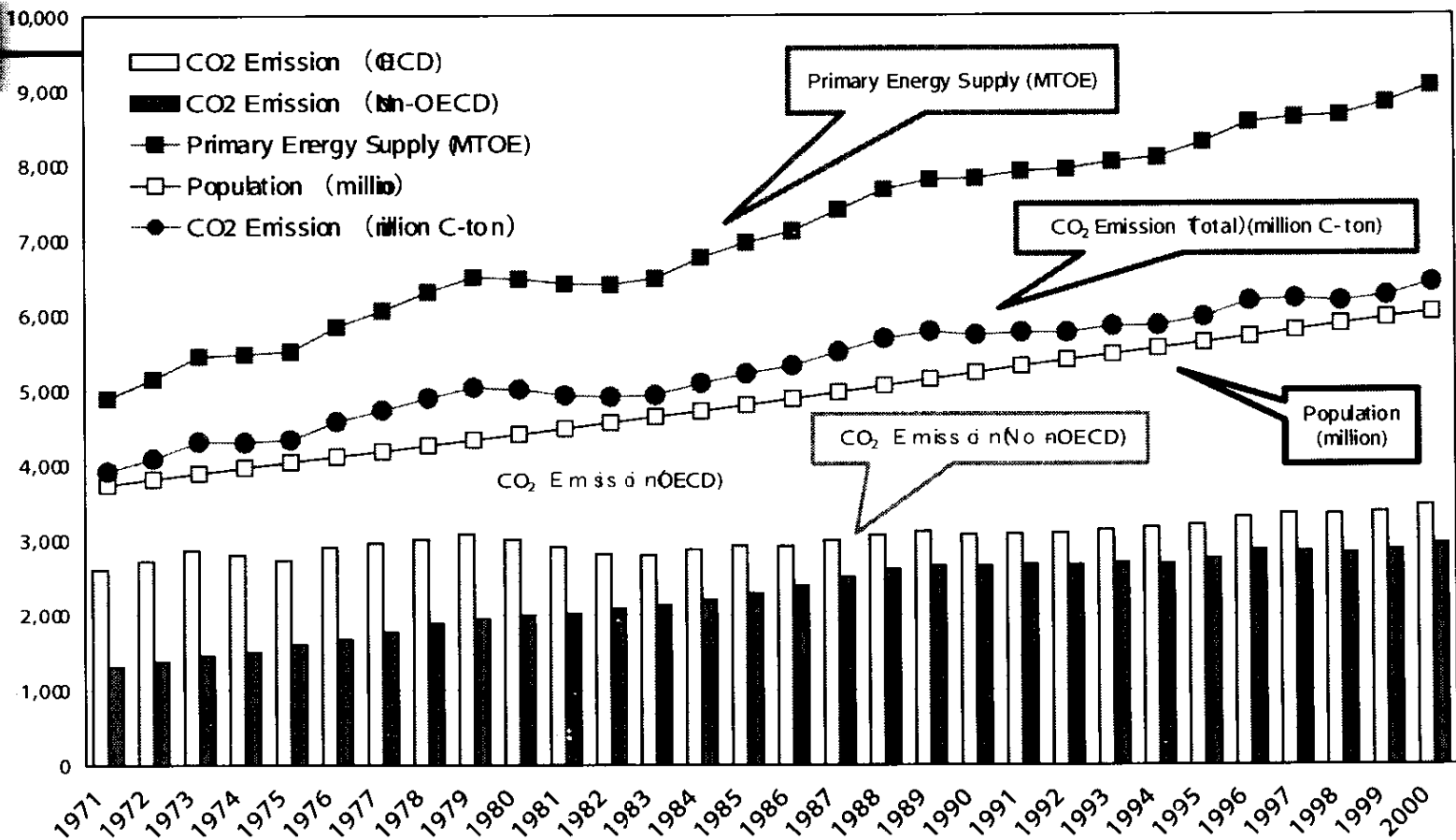
Atmospheric CO₂ has increased from a pre-industrial concentration of about 280 ppm to about 367 ppm at present. CO₂ concentration data from before 1958 are from ice core measurements taken in Antarctica and from 1958 onwards are from the Mauna Loa measurement site. The smooth curve is based on a hundred year running mean. It is evident that the rapid increase in CO₂ concentrations has been occurring since the onset of industrialization. The increase has closely followed the increase in CO₂ emissions from fossil fuels.

CO₂ Emission from Fuel Combustion

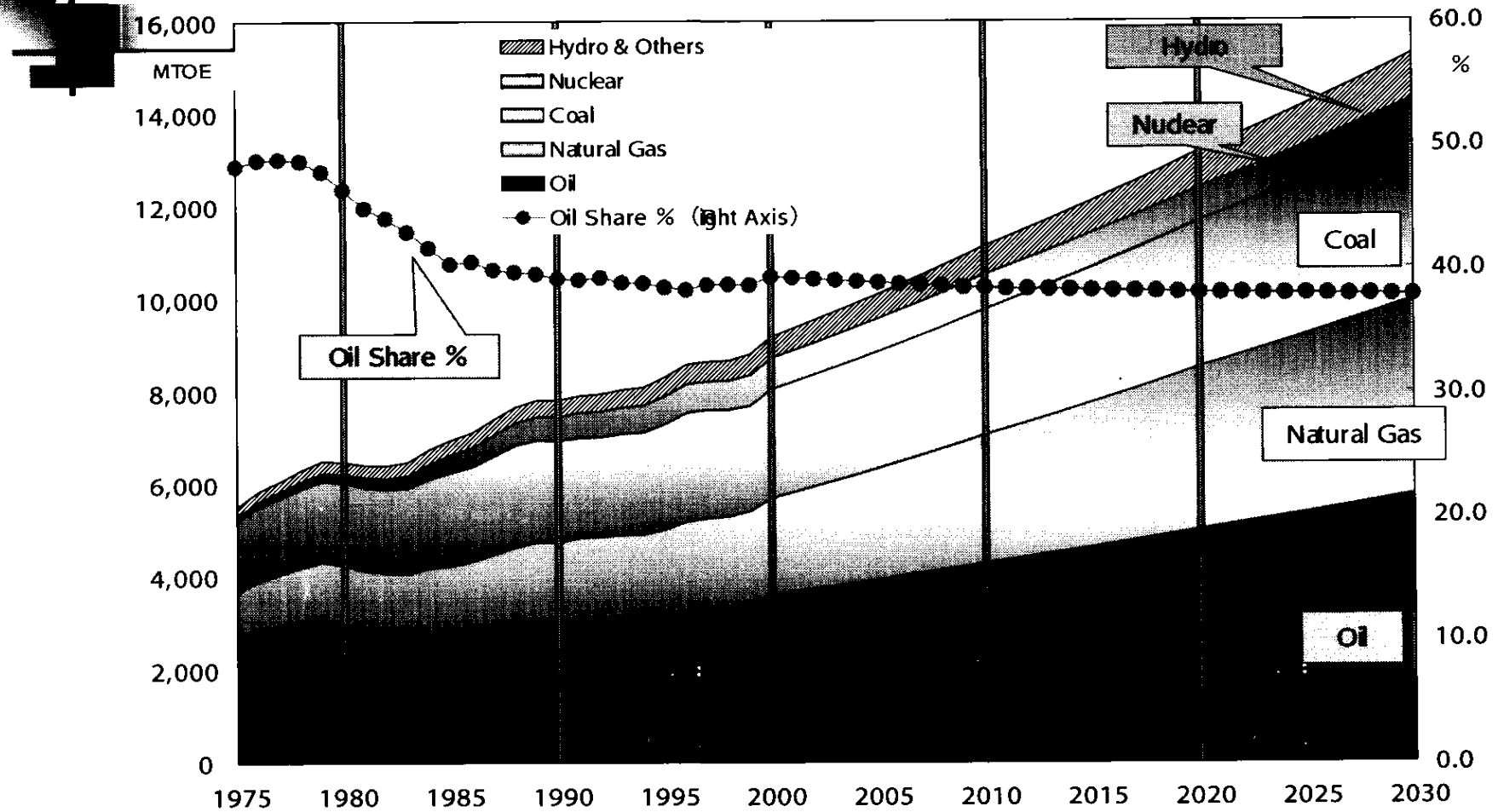


(Source) Oak Ridge National Laboratory

World Primary Energy Supply

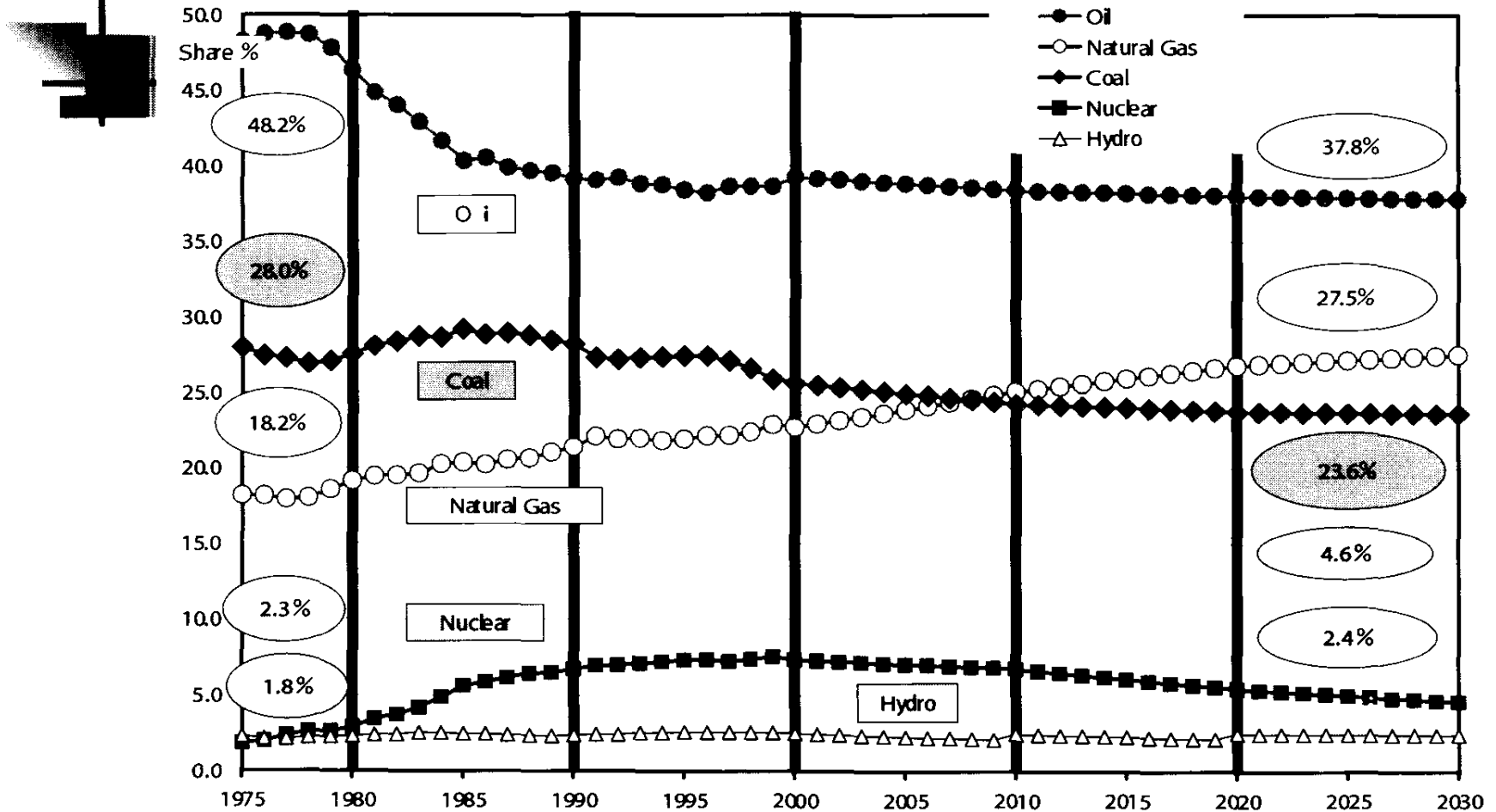


World Energy Outlook



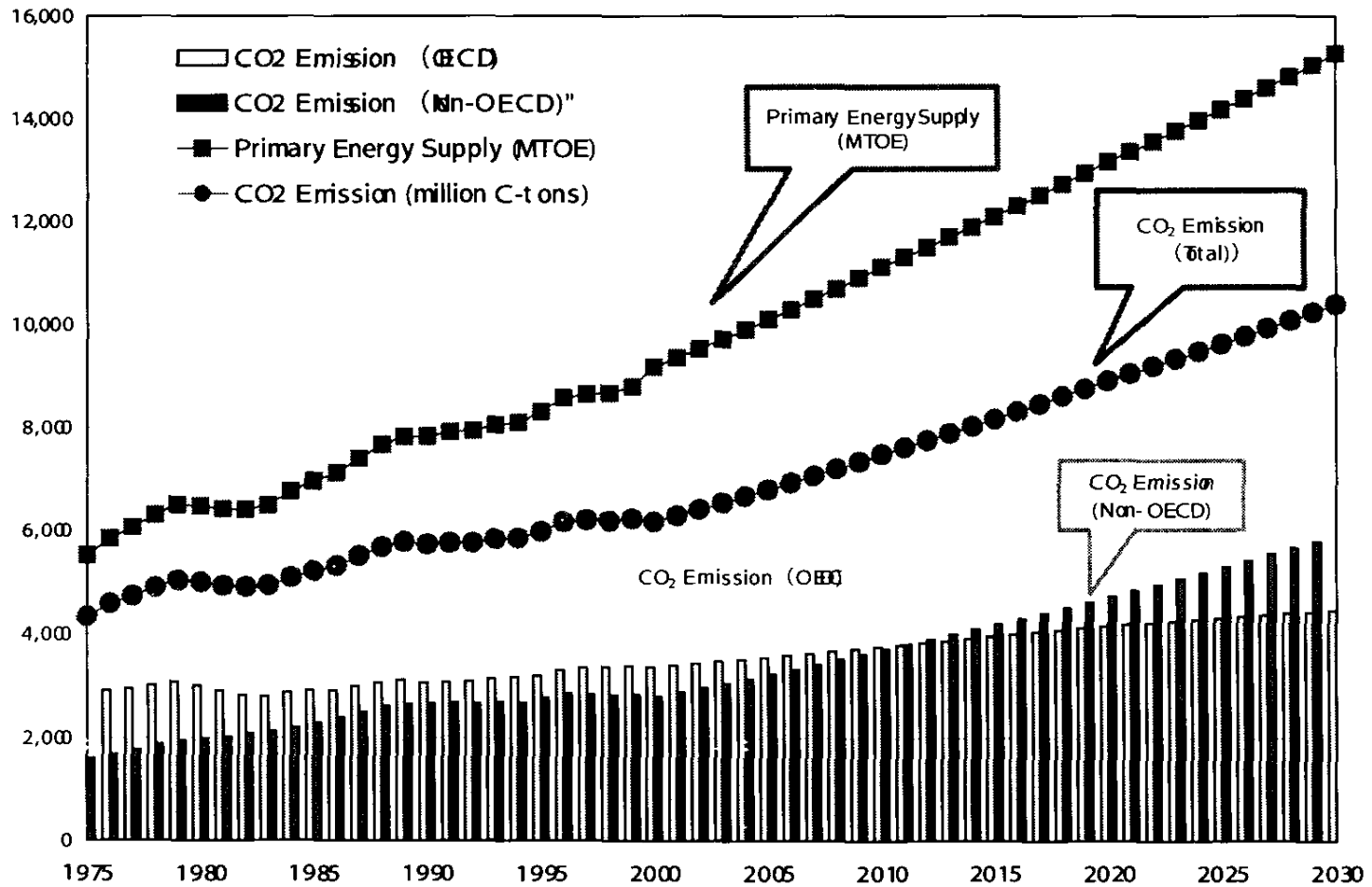
(source) IEA, World Energy Outlook 2002

Energy Share in 2030



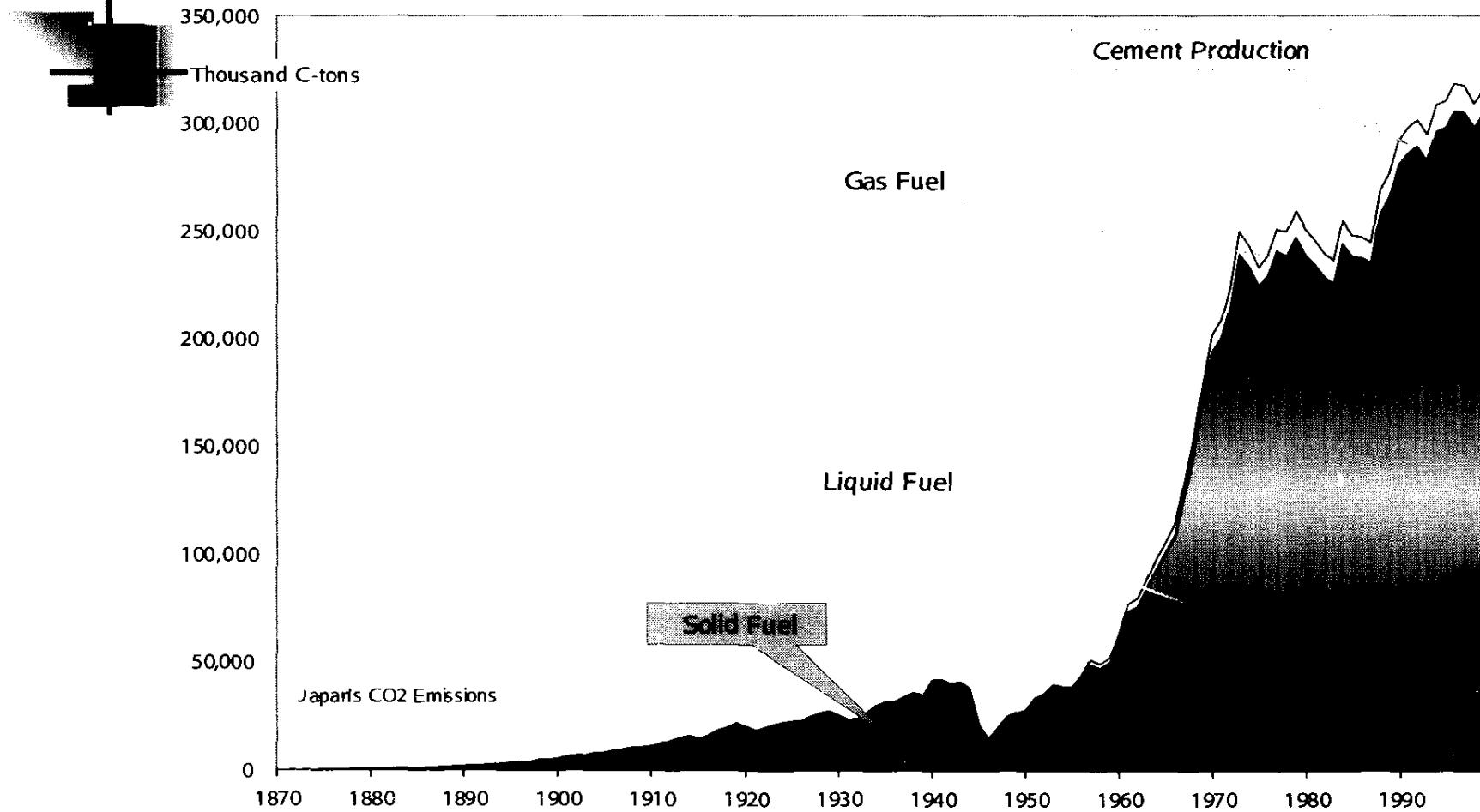
(source) IEA, World Energy Outlook 2002

CO₂ Emission Outlook



(source) IEA, World Energy Outlook 2002

Japan's CO₂ Emission



(Source) Oak Ridge National Laboratory

Excerpt from COP3 Kyoto Protocol

Target year	2008 to 2012	
Base year	1990	
Subject gas and base year	Carbon dioxide (CO ₂), methane (CH ₄), dinitrogen monoxide (N ₂ O) --- base year 1990 Hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF ₆) --- Base year may be set for 1995.	
Joint target of advanced countries and countries that have shifted to market economy	Reduction in emission of greenhouse effect gases by 5 percent at least from the base year	
Reduction rate by country	10%	Iceland
	8%	Australia
	1%	Norway
	±0%	New Zealand, Russia, Ukraine
	-5%	Croatia
	-6%	Japan, Canada, Hungary, Poland
	-7%	USA
	-8%	EU, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Liechtenstein, Luxemburg, Monaco, Holland, Portugal, Spain, Sweden, UK, Switzerland, Bulgaria, Czech, Estonia, Latvia, Lithuania, Romania, Slovakia, Slovenia

Japan's emission of carbon dioxide in 1999 was 7 percent greater than that of 1990, a situation making it difficult for Japan to achieve the reduction target agreed in COP3.



Current GHG Emissions

■ Current GHG Emissions

■ Total Emissions in 1990 (Base Year) : 1,229 Million Tons
(CO₂Equivalent)

■ Target Emissions in 2010 : 1,155 Million Tons (▲6% Reduction)

● Total Emissions in 1999 : 1,314 Million Tons (+7%)

■ Forecast

■ Emissions in 2010 (Existing Measures Incorporated) : 1,320 Million
Tons (+7%)

● Difference :▲165 Million Tons

■ **Additional Countermeasures are Necessary**

Trends in GHGs Emission

Gases by years in Japan (in Million Tons of CO2 equivalent)							
Year	CO ₂	CH ₄	N ₂ O	HFC _s	PFC _s	SF ₆	Total
1990	1,119.3	26.7	38.8	17.9	5.7	38.2	1,246.7
1991	1,138.5	26.9	38.4	18.1	6.4	43.5	1,271.8
1992	1,148.9	26.5	38.7	19.8	6.4	47.8	1,288.0
1993	1,136.4	26.4	38.5	21.3	8.9	45.4	1,276.9
1994	1,194.8	26.0	39.4	28.8	12.3	45.4	1,346.7
1995	1,208.0	25.3	39.6	31.2	16.6	52.6	1,373.2
1996	1,219.4	24.6	40.5	31.6	18.6	50.2	1,385.1
1997	1,219.4	23.7	41.0	34.9	19.7	49.7	1,388.4
1998	1,191.7	23.0	39.7	31.6	17.8	50.0	1,353.7
1999	1,232.8	22.6	34.0	38.7	17.4	34.1	1,379.5
2000	1,237.1	22.0	36.9	42.5	19.3	28.5	1,386.3

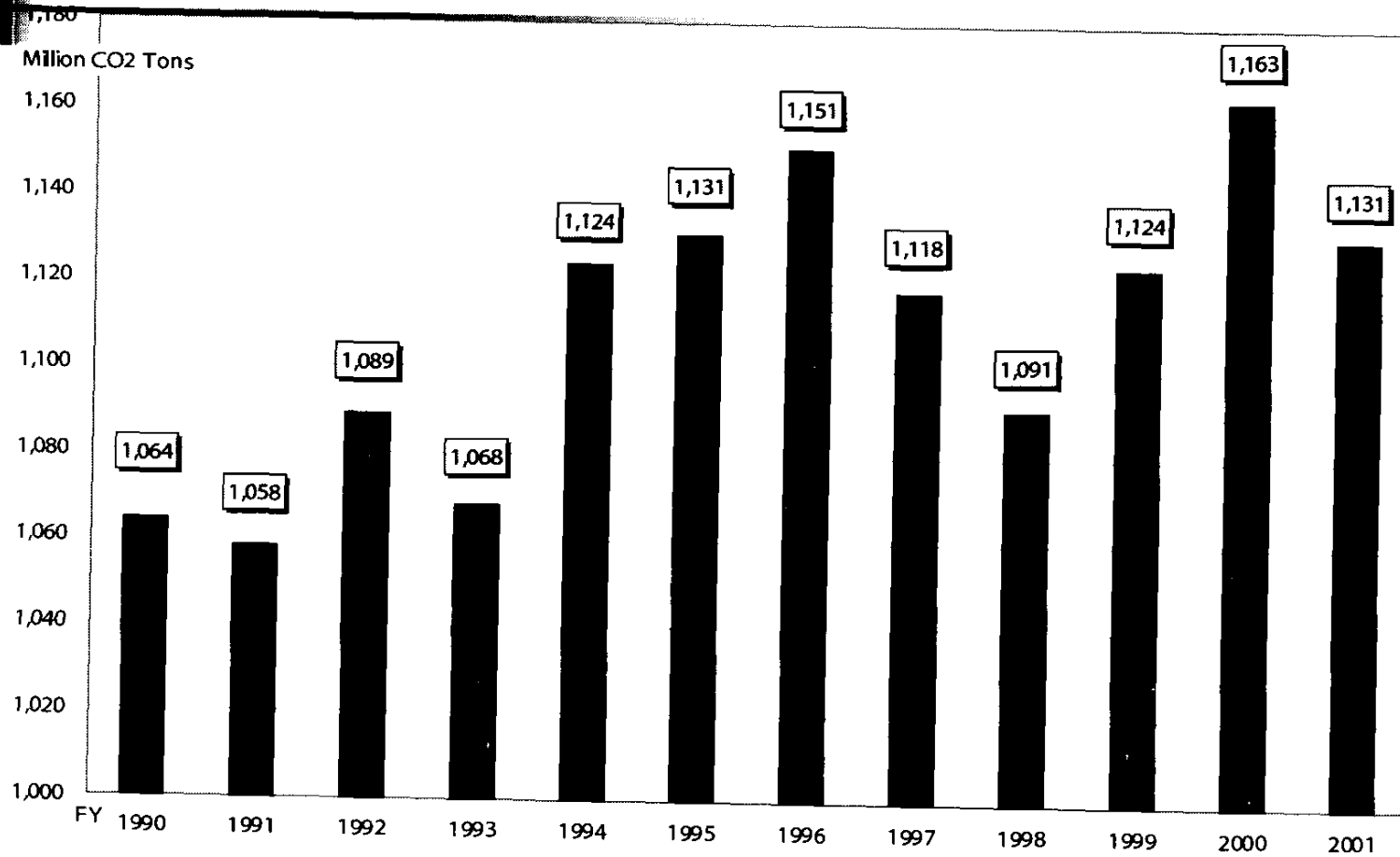
(source) UNFCCC



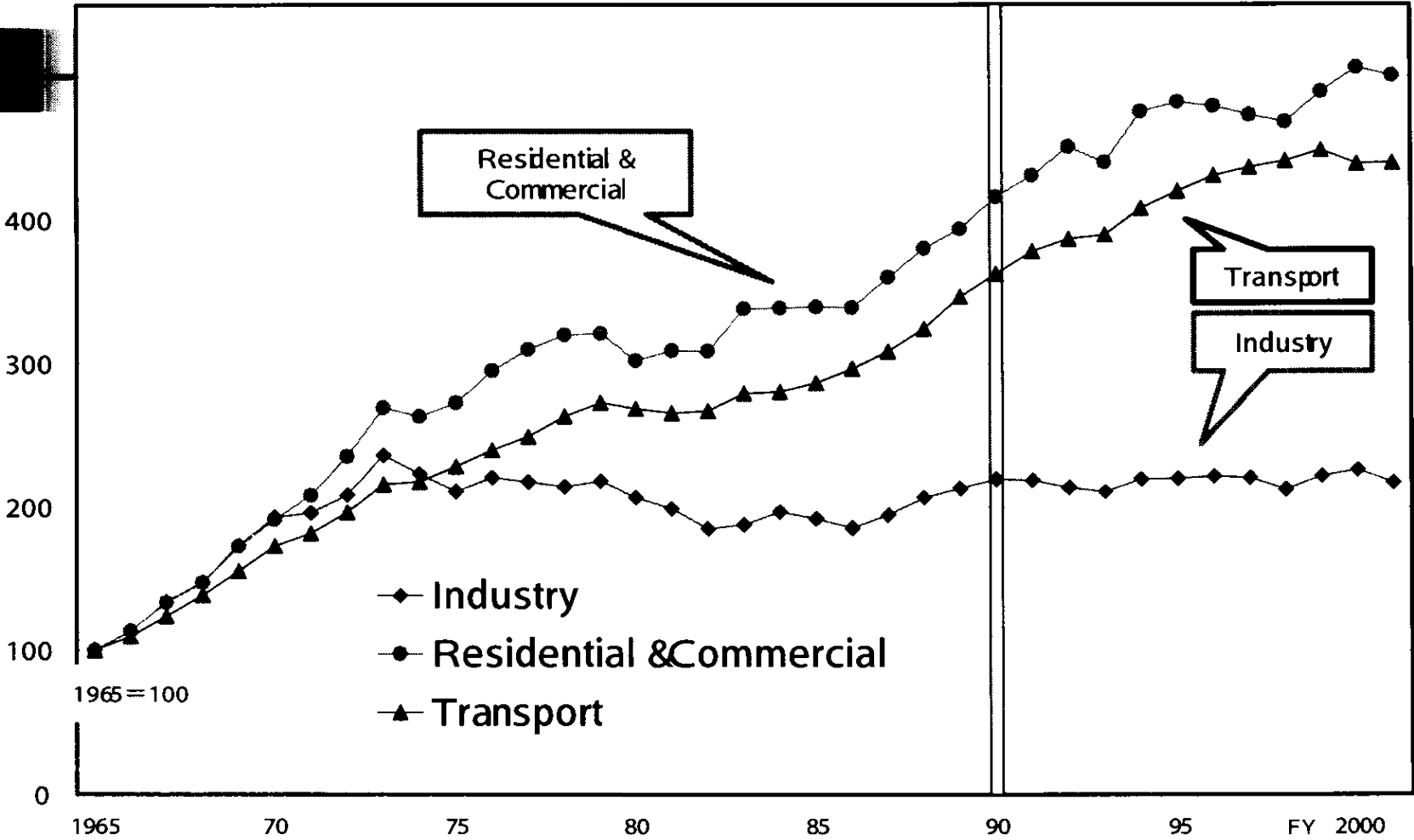
Contributions by Actions to Meet Target GHG Reduction

- Energy Related CO₂ : ~~±0~~%
- Non-energy related CO₂, CH₄ etc. :-0.5%
- Technology Development & Conservation Efforts :-2.0%
- FCCs :+2.0%
- Forest Sinks :-3.7%
- Emission Trading, etc. :-1.8%
- Total :-6.0%

Trends in Energy Related CO₂



CO₂ Emissions by Sector





Chapter 1 Outline of Energy Demand Structure

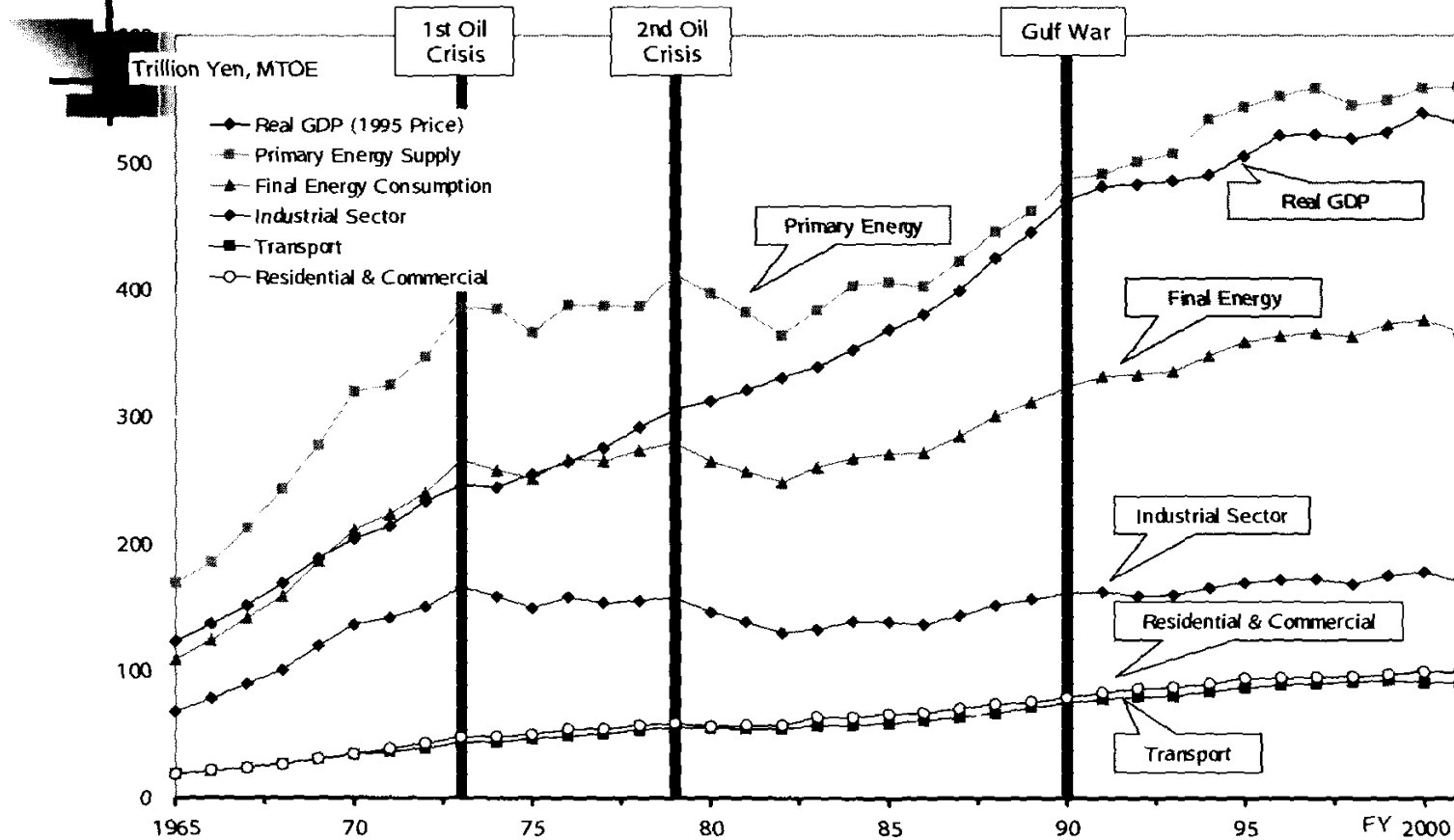
- Structure and Interpretation of Energy Balance Table
- Economic Growth and Energy Demand
- Structure of Final Energy Demand, International Comparison
- Structure of Primary Energy Supply

Energy Balance Table

(Fiscal 2001, MTOE)

Sector		Energy Source	A	B	C	D	E	F	G	H	I
			Coal	Crude & NGL	Petroleum Products	Natural Gas	Hydro	Nuclear	Electricity	Solar & Others	Total
Primary Energy Supply	1	Domestic Production	1.4	0.7		2.4	18.6	68.8		6.0	98.9
	2	Import	99.9	218.5	51.9	69.0					439.3
	3	Primary Energy Total Supply	101.3	219.2	51.9	71.4	18.6	68.8		6.0	538.2
	4	Export			-16.8						-18.0
	5	Stock Change	-0.1	1.7	2.6						4.2
	6	Primary Energy Domestic Supply	101.2	220.9	37.8	71.4	18.6	68.8		6.0	524.5
Energy Conversion & Own Use	7	Electric Utilities	-39.3	-4.3	-9.0	-50.7	-17.6	-68.7	78.0	-0.5	-117.6
	8	Oil Refining		-214.1	213.3						-0.8
	9	Others	-47.4	-0.8	-15.2	4.3	-1.1		13.0	-3.5	-17.1
	10	Own Use & Loss	-0.1		-12.1	-0.8			-4.5		-20.5
	11	Energy Conversion & Own Use	-86.8	-219.2	189.1	-46.4	-18.6	-68.8	91.0	-4.0	-135.6
Final Energy Consumption	12	Total Final Energy Consumption	16.5		217.6	25.2			82.0	3.5	367.6
	13	Industry Total	16.5		85.6	9.8			35.3	2.2	171.1
	14	Agriculture, Forestry & Fishery			10.0				0.3		10.4
	15	Mining & Construction			4.2				0.3		4.5
	16	Manufacturing Total	16.5		71.4	9.8			34.7	2.2	156.1
	17	Food			1.9	1.3			2.4		5.6
	18	Textile	0.0		1.9	0.2			0.6		2.8
	19	Paper & Pulp	1.4		2.7	0.7			3.0	2.1	9.9
	20	Chemicals	1.1		42.0	2.2			5.4		50.7
	21	Ceramics & Cement	4.7		3.6	0.4			1.8		10.9
	22	Iron & Steel	9.1		2.6	1.5			6.8		40.3
	23	Non-Ferrous Metals	0.1		1.1	0.4			1.6		3.3
	24	Metal Products & Machinery	0.1		0.9	1.9			7.0		10.0
	25	Others	0.1		14.8	1.3			5.9		22.6
	26	Residential & Commercial			36.0	15.4			44.9	1.3	98.8
	27	Residential			19.3	9.4			22.8	0.8	52.2
	28	Commercial			16.7	6.1			22.1	0.5	46.5
	29	Transport			89.1				1.9		90.9
	30	Non Energy			6.9						6.9

Trends for Relation between Energy Demand and GDP



Since the energy crises, a remarkable progress has been made in the field of energy conservation, notably in the manufacturing sector, to boost efficiency of energy consumption. Since the latter half of the 1990 in particular, energy consumption has stayed high in contrast to the low economic growth rate.

GDP Elasticity of Energy

The Income elasticity of energy (GDP elasticity) is a convenient measure to directly see the relationship between the economic growth and the energy consumption. Energy demand of a given country is determined not only by the economic scale but also affected by a number of factors, including the industrial structure, lifestyle of the people, technological standard, climatic condition. The GDP elasticity of energy intends to see the relationship between the energy consumption and the economic growth, while the latter is assumed to represent all these factors.

$$\text{GDP Elasticity of Energy} = \frac{\text{Growth rate of energy demand}}{\text{Growth rate of GDP}}$$

This is defined as the change in energy demand caused by the one-percent change in income. Macro analyses often use real GDP in place of income. In case where the rate of growth of GDP is 0.9% and the elasticity to GDP is 1.2, for example, the increase in energy demand is given by: $0.9 \times 1.2 = 1.08\%$.

GDP and Primary Energy Supply for Selected Countries

	1973-2000 Annual Growth Rate %		GDP Elasticity of Energy Consumption	Primary Energy Supply per GDP		Per- capita Primary Energy Supply	
	Real GDP (1995 Price)	Primary Energy Supply		TOE/ million US\$ (1995 Price)		TOE/ Person	
				1973	2000	1973	2000
Japan	2.9	1.8	0.62	124	92	3.00	4.13
USA	3.0	1.0	0.34	433	255	8.19	8.16
Germany	2.0	0.0	0.01	215	127	4.28	4.14
France	2.3	1.4	0.62	184	146	3.40	4.36
UK	2.1	0.2	0.10	296	180	3.93	3.90
FSU	0.3	0.3	0.76	1,972	1,930	3.40	3.14
China	8.5	4.7	0.56	2,313	892	0.30	0.74
India	5.2	5.7	1.11	538	622	0.11	0.30
Total OECD	2.7	1.3	0.47	281	192	4.17	4.73
Total Non- OECD	3.7	3.0	0.80	691	571	0.57	0.76
EU 15	2.2	0.9	0.39	214	150	3.35	3.88
ASEAN 7	5.7	6.9	1.20	287	382	0.17	0.61
Total World	2.9	1.9	0.65	345	264	1.40	1.50

The GDP elasticity of energy is getting smaller in many developed countries, while in other countries the energy elasticity exceeds unity, except for China which has a small elasticity. In China, the energy unit consumption used to be very high (in 1973 in particular), China therefore had good room for energy conservation.

Energy Conservation (Macro base)

Energy consumption per unit GDP

$$\text{Energy Intensity} = \frac{\text{Energy consumption}}{\text{GDP}} \rightarrow \text{inverse number: (energy productivity)}$$

Constant Intensity ... Elasticity = 1

Increasing Intensity... Elasticity > 1

Decreasing Intensity ... Elasticity < 1

- In order for the elasticity to be at or less than unity, the energy productivity has to be always on the increase.
- As economy of a nation matures to some extent, the increase in income is not accompanied by a large increase in energy consumption.

Macro factors for energy conservation



- Change in industrial structure, change in social structure (changes in lifestyle, traffic system)
- Change in product mix
- Change in technological intensity

International Comparison of Energy Intensity

	Energy Intensity (Primary Energy Supply per unit Real GDP, 1995 Price)				
	1973		2000		Rate of Change 2001/1973 %
	TOE/ million US\$ (1995 Price)	Japan = 100	TOE/ million US\$ (1995 Price)	Japan = 100	
Japan	123.7	100.0	92.3	100.0	-25.4
USA	433.5	350.4	255.3	276.6	-41.1
Germany	214.7	173.6	126.9	137.4	-40.9
France	184.2	148.9	146.4	158.6	-20.5
UK	295.9	239.1	180.1	195.1	-39.1
FSU	1,972.2	1,594.2	1,930.1	2,091.1	-2.1
China	2,313.0	1,869.7	892.3	966.8	-61.4
India	537.9	434.8	622.4	674.3	15.7
Total OECD	281.1	227.3	192.1	208.2	-31.7
Total Non-OECD	690.9	558.5	571.0	618.7	-17.4
EU 15	214.4	173.3	149.7	162.1	-30.2
ASEAN 7	287.0	232.0	382.4	414.3	33.3
Total World	344.5	278.5	264.4	286.5	-23.2

Final Energy Consumption by Sector

	Annual Average Growth rate %				Share				
	1965-73	1973-80	1980-90	90-2001	1965F	1973F	1980F	1990F	2001F
Final Energy Consumption	11.8	0.0	2.0	1.2	100.0	100.0	100.0	100.0	100.0
Industrial Sector (incl. Non- Energy)	11.8	-1.8	1.0	0.6	65.2	65.5	57.8	52.5	48.4
Residential & Commercial	12.5	2.4	3.4	2.1	17.2	18.1	21.4	24.4	26.9
Transportation Sector	10.8	3.4	3.1	1.8	17.6	16.4	20.8	23.0	24.7
Real GDP (1995 Price)	9.1	3.4	4.2	1.1					
IIP (Indices of Industrial Production)	12.7	2.8	4.1	-1.1					
Steel Production	14.3	-1.6	0.4	-0.8					
Number of Households	3.1	1.6	1.4	1.4					
Number of Automobiles	16.7	6.0	4.3	2.2					

During the high-growth period the final energy consumption increased almost uniformly in all sectors. After the first Energy Crisis, the industrial structure shifted to a high-value added one and energy conservation technologies made remarkable progresses. As a result, the share of the industrial sector declined while the residential & commercial sector increased the share. After 1990, the low economic growth and low IIP held down industrial consumption of energy, while the consumption by the residential & commercial sector and transportation sector increased.

International Comparison of Final Energy Demand Structure

		1971		2000	
		MTOE	Share %	MTOE	Share %
Japan	Industry	114	57.3	137	39.5
	Residential & Commercial	42	21.0	106	30.5
	Transport	37	18.5	94	27.1
	Non-Energy	7	3.5	10	2.8
	Total	199	100.0	347	100.0
USA	Industry	404	29.8	359	23.9
	Residential & Commercial	413	30.5	473	31.6
	Transport	379	28.0	610	40.7
	Non-Energy	39	2.9	56	3.7
	Total	1,354	100.0	1,499	100.0
Germany	Industry	86	38.5	76	30.9
	Residential & Commercial	92	41.0	97	39.5
	Transport	37	16.5	67	27.4
	Non-Energy	8	3.7	5	2.1
	Total	223	100.0	245	100.0
UK	Industry	57	41.0	41	25.5
	Residential & Commercial	49	35.7	64	39.3
	Transport	28	20.3	53	32.5
	Non-Energy	4	3.0	4	2.4
	Total	138	100.0	162	100.0
France	Industry	48	40.0	46	27.5
	Residential & Commercial	43	35.7	65	38.4
	Transport	23	18.8	53	31.2
	Non-Energy	7	5.6	5	2.8
	Total	121	100.0	169	100.0

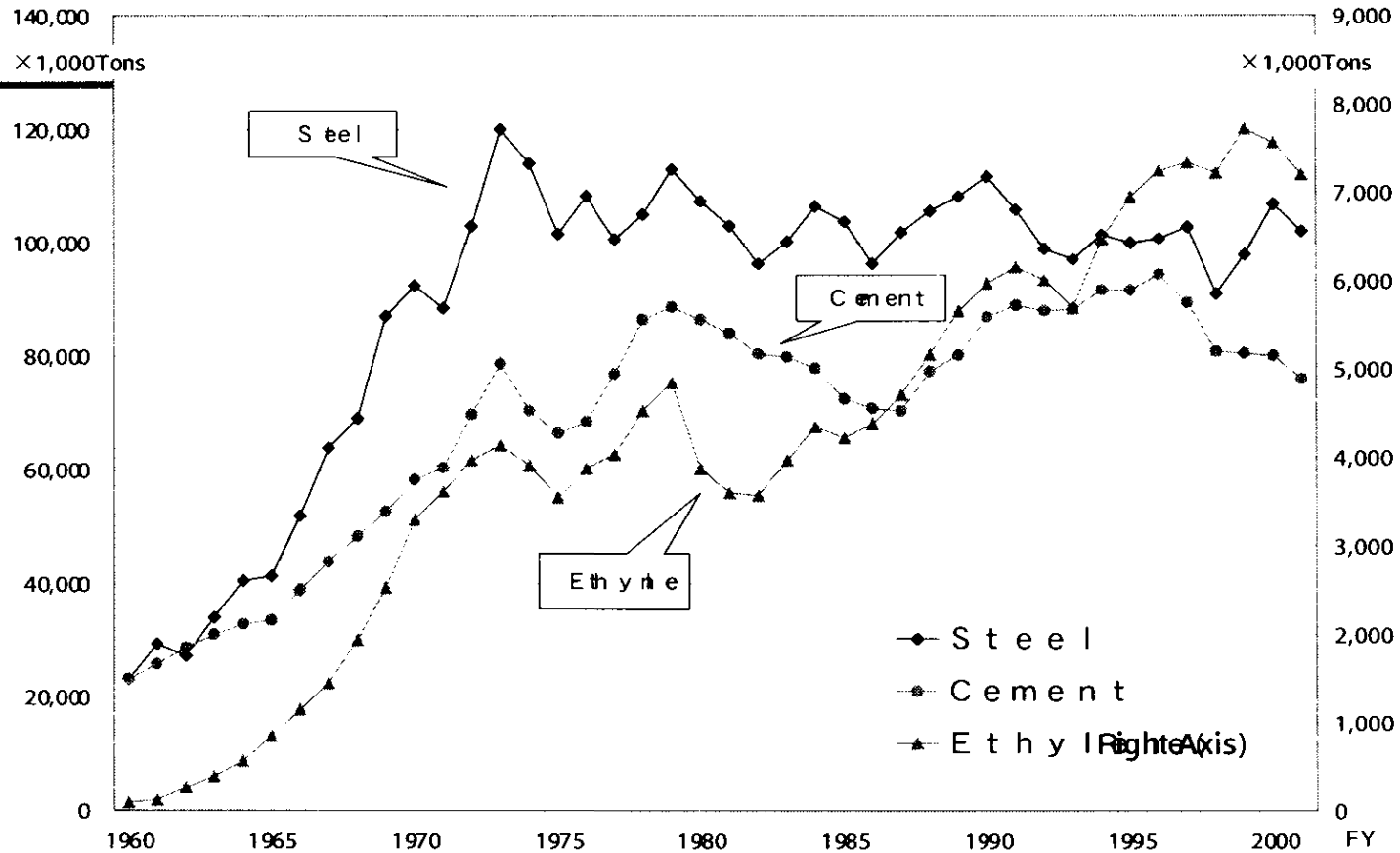
In Japan consumption used to be larger in the industrial sector and smaller in the residential & commercial sector than the United States and European countries. Recently, the share of the industrial sector is nearing that of the United States and European countries. (40 percent in Japan and less than 30 percent in the United States and European countries in 2000)

Final Energy Consumption Per-capita (2000)

		2000	
		M TO E	TOE/Person
Japan	Industry	137	1.1
	Residential & Commercial	106	0.8
	Transport	94	0.7
	Total	347	2.7
USA	Industry	359	1.3
	Residential & Commercial	473	1.7
	Transport	610	2.2
	Total	1,499	5.3
Germany	Industry	76	0.9
	Residential & Commercial	97	1.2
	Transport	67	0.8
	Total	245	3.0
UK	Industry	41	0.7
	Residential & Commercial	64	1.1
	Transport	53	0.9
	Total	162	2.7
France	Industry	46	0.8
	Residential & Commercial	65	1.1
	Transport	53	0.9
	Total	169	2.9
Non-OECD	Industry	1,003	0.2
	Residential & Commercial	794	0.2
	Transport	559	0.1
	Total	2,424	0.5

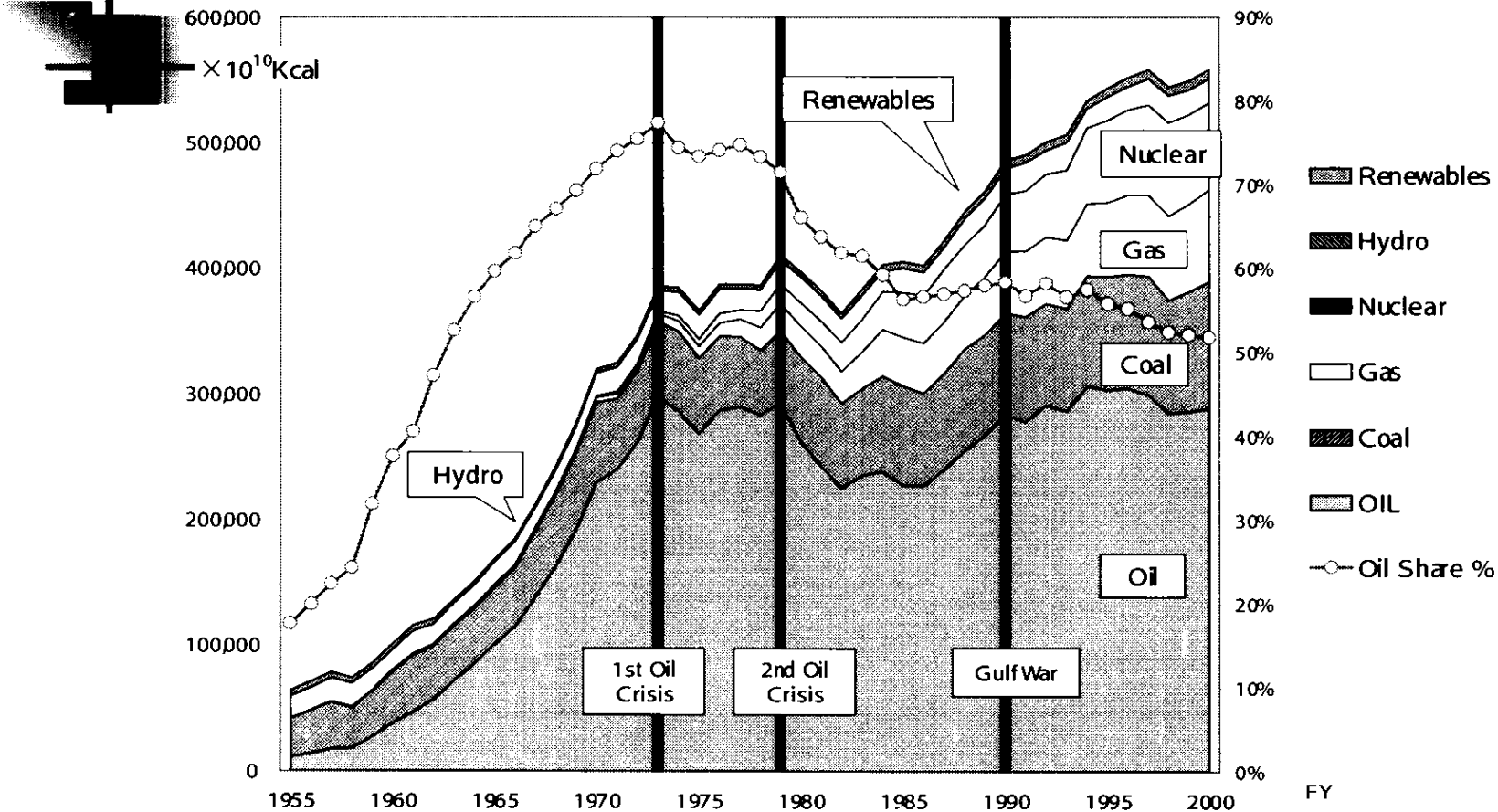
USA is outstanding in per-capita energy demand. Since USA is an automobile-centered society, the consumption in the transportation sector is larger than other countries. Among three European countries, Germany consumes a little more energy than others. This is because Germany has a greater share of the manufacturing industry and colder than other countries. The energy demand in Non-OECD countries is small in all sectors. Their energy demand is expected to increase in keeping pace with their economic development, accompanied by increasing numbers of cars and upgrading of living standards.

Japan produces a variety of Basic Materials



In Japan, the basic material industry has a larger proportion compared with the United States and the European countries. Nevertheless, energy consumption per unit GDP is one of the best in the world, thanks greatly to energy conservation.

Structure of Primary Energy Supply



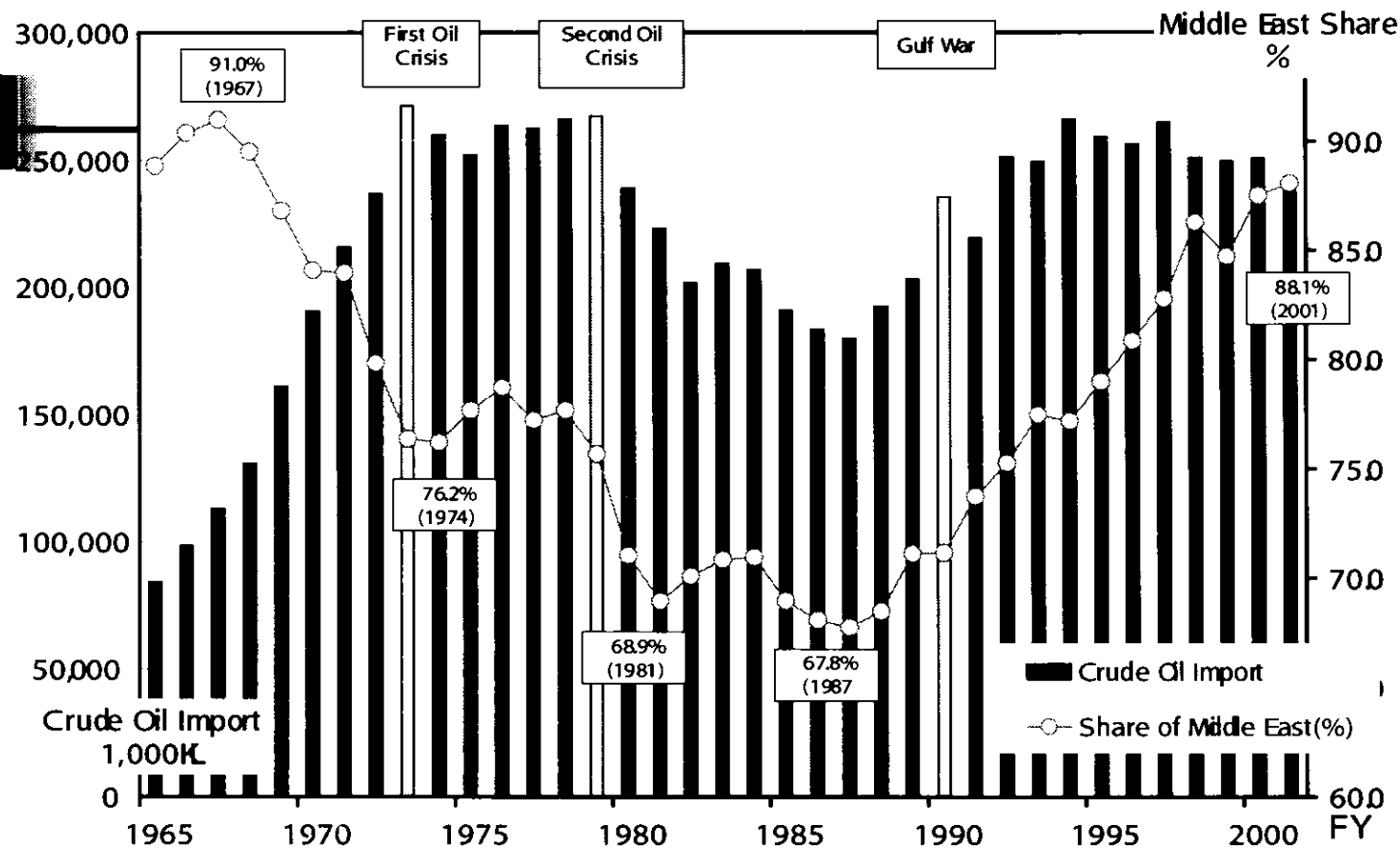
In the total primary energy supply, oil has been decreasing, coal has remained almost unchanged, and gas and nuclear energy have been increasing. Notwithstanding, oil accounts for more than half the total supply, being the most important of all the primary energy supply.



Supply security requirements

- Reduction of dependence on oil, diversification of energy sources
- Increase self-sufficiency rate of energy supply

Dependence on the Middle East for Japan's Import of Oil



The dependence on the Middle East once became lower than 70% in the 1980s. Thereafter, the dependence on the Middle East has kept increasing during the 1990s.

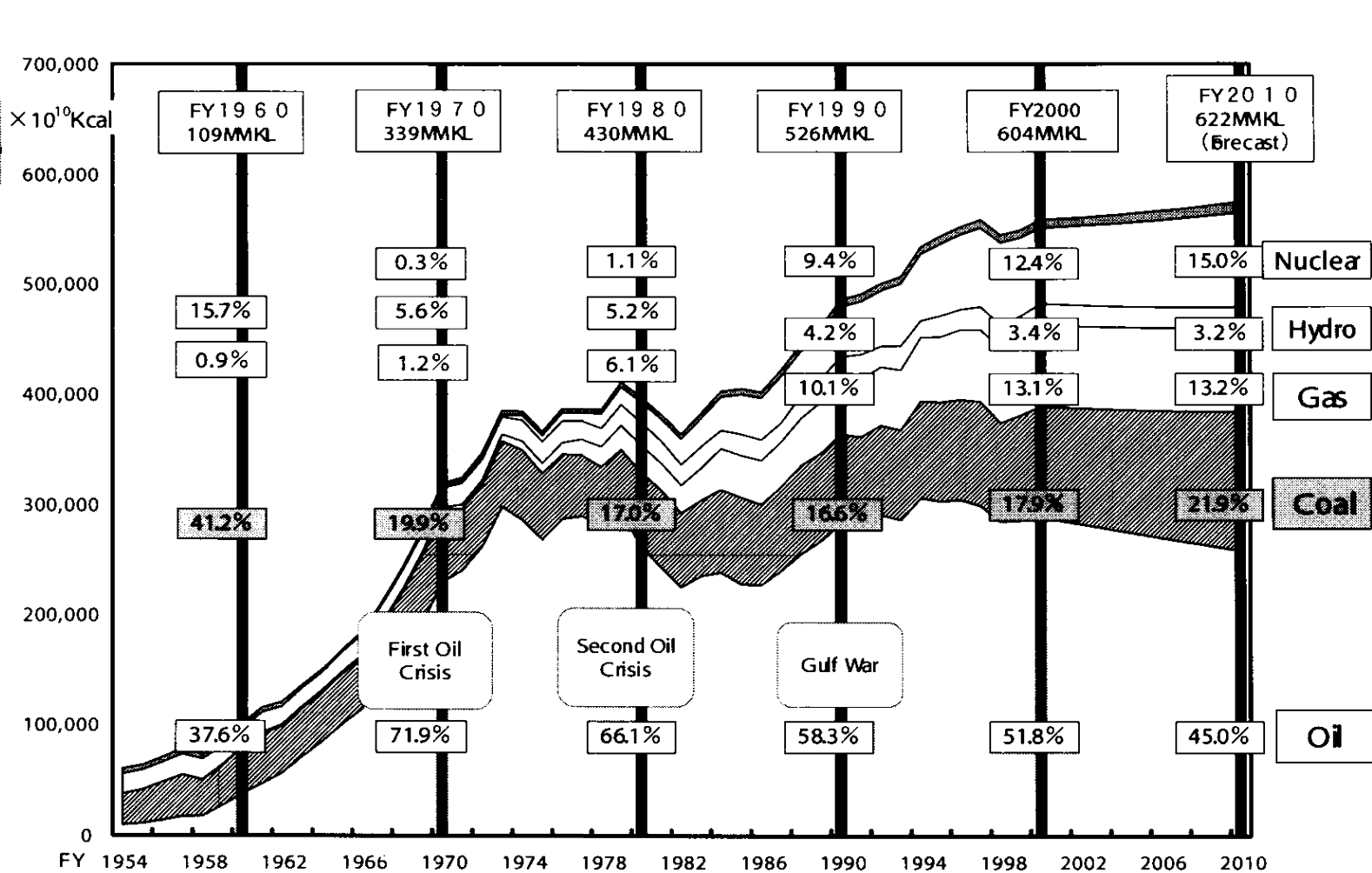
Today, the dependence on the Middle East is higher than that at the time of the first energy crisis, of 76.2%.

Requirements from environmental conservation



- Reduction of fossil fuel use
(introduction of nuclear power and new energy)
- Reduction of carbon emission in the use of fossil fuel (shift to natural gas)

Forecast of Primary Energy Supply



(source) Advisory Committee for Natural Resources and Energy (ACNRE)
 Long-term Energy Supply-Demand Outlook (July, 2001)

Total Primary Energy Supply (Unit : Million KL of Oil Equivalent)

FY	1990		1999		2010			
		Share		Share	Base Case		Target Case	
Total Primary Energy	526		593		622		about 602	
By Energy		Share		Share		Share		Share
Oil	307	58.3%	308	52.0%	280	45.0%	about 271	about 45%
Coal	87	16.6%	103	17.4%	136	21.9%	about 114	about 19%
Natural Gas	53	10.1%	75	12.7%	82	13.2%	about 83	about 14%
Nuclear	49	9.4%	77	13.0%	93	15.0%	93	about 15%
Renewable Total	29	5.6%	29	4.9%	30	4.8%	40	about 7%
Hydro	22	4.2%	21	3.6%	20	3.2%	20	about 3%
Geothermal	1	0.1%	1	0.2%	1	0.2%	1	about 0.2%
New Energy etc.	7	1.3%	7	1.1%	10	1.6%	20	about 3%

(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)

CO₂ Emission from Fuel Combustion

Unit : Million t-C)

Items	FY	1990	1999	2010	
				Base Case	Target Case
CO ₂ Emissions from Fuel Combustion (growth rate over FY1990 records)		287	313 (8.9%)	307 (6.9%)	about 287

(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)

New Energy Supply Outlook

	FY 1999		FY 2010 Outlook				2010/1999
	Actual		Existing Measures Incorporated Case		Target Case		
	Crude Oil Equivalent	Installed Capacity	Crude Oil Equivalent	Installed Capacity	Crude Oil Equivalent	Installed Capacity	
	1000 KL	MW	1000 KL	MW	1000 KL	MW	
Power Generation							
Photovoltaic Power	53	209	620	2,540	1,180	4,820	About 23 times
Windpower	35	8	320	780	1,340	3,000	About 38 times
Waste Burning Power	1,150	900	2,080	1,750	5,520	4,170	About 5 times
Biomass Power	54	80	130	160	340	330	About 6 times
Heat Use							
Solar Heating	980	-	720	-	4,390	-	About 4 times
Untapped Energy (incl. Cold Heat of Snow & Ice)	41	-	93	-	580	-	About 14times
Waste Heat Reuse	44	-	44	-	140	-	About 3 times
Biomass Heat Reuse	-	-	-	-	670	-	-
Black Liquids, Waste Wood Chips	4,570	-	4,790	-	4,940	-	About 1.1 times
Total New Energy Supply	6,930	-	8,780	-	19,100	-	About 3 times
cf. Total Primary Energy Supply	about 590 million KL		about 620 million KL		about 600 million KL		
Ratio to the Total Primary Energy	1.20%		1.40%		about 3%		

The new energy, considered to have lesser environmental impact, has drawbacks in economic feasibility and stable supply. Various preferential treatments and subsidies are provided to help increased utilization of new energy.

**(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)**

Final Energy Consumption (Unit : Million KL of Oil Equivalent)

Sector	FY	1990		1999		2010			
						Base Case		Target case	
			Share		Share		Share		Share
Industrial		183	52.5%	197	49.0%	187	45.8%	about 185	about 46%
Residential & Commercial		85	24.4%	105	26.1%	126	30.8%	about 120	about 30%
Residential		46	13.3%	55	13.8%	60	14.7%	about 58	about 14%
Commercial		39	11.2%	50	12.3%	66	16.1%	about 63	about 16%
Transport		80	23.0%	100	24.9%	96	23.4%	about 94	about 24%
Passenger Cars		39	11.0%	53	13.2%	51	12.5%	about 50	about 12%
Freight etc.		42	12.0%	47	11.7%	45	10.9%	about 45	about 11%
Total		349	100.0%	402	100.0%	409	100.0%	about 400	100.0%

(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)

Power Generation Capacity at the end of Fiscal Year (Electric Utilities)

UNIT :10MW)

FY	1990		1999		2010			
					Base Case		Target Case	
Total	17,212		22,410		26,657		25,288~27,229	
Power Sources		Share %		Share %		Share %		Share %
Thermal	10,408	60.5	13,434	59.9	15,343	57.6	14,670~ 16,220	57.0~59.6
Coal	1,223	7.1	2,488	11.1	44,101	6.5	3,155~ 4,413	12.3~16.2
LNG	3,839	22.3	5,677	25.3	6,702	25.1	6,606~ 6,696	24.6~26.1
Oil & Others	5,347	31.1	5,270	23.5	4,231	15.9	4,908~ 5,111	18.8~19.4
Nuclear	3,148	18.3	4,492	20.0	6,185	23.2	5,755~ 6,185	22.7~24.1
Hydro	3,632	21.1	4,433	19.8	5,071	19.0	4,810	17.7~19.0
General	1,931	11.2	2,002	8.9	2,070	7.8	2,069	7.6~8.2
Pumped	1,701	9.9	2,431	10.8	3,001	11.3	2,741	10.1~10.8
Geothermal	24	0.1	52	0.2	59	0.2	54	0.2

(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)

Electric Power Generation (Electric Utilities) Unit :100GWh)

FY	1990		1999		2010			
					Base Case		Target Case	
Total	7,376		9,176		10,292		about 9,970	
Power Sources		Share %		Share %		Share %		Share %
Thermal	4,466	60.5	5,063	55.2	5,074	49.3	about 4,680	about 47
Coal	719	9.7	1,529	16.7	2,351	22.8	about 1,599	about 16
LNG	1,639	22.2	2,405	26.2	2,341	22.7	about 2,549	about 26
Oil & Others	2,108	28.6	1,129	12.3	383	3.7	about 533	about 5
Nuclear	2,014	27.3	3,165	34.5	4,186	40.7	4,186	about 42
Hydro	881	11.9	893	9.7	966	9.4	952	about 10
General	788	10.7	769	8.4	803	7.8	803	about 8
Pumped	93	1.3	123	1.3	163	1.6	149	about 1
Geothermal	15	0.2	34	0.4	37	0.4	37	about 0.4
New Energy	-	-	21	0.2	29	0.3	115	about 1
CO ₂ Emission per Unit Generated (g-c/kWh)	101.9		89.9		82.6		about 73.6	

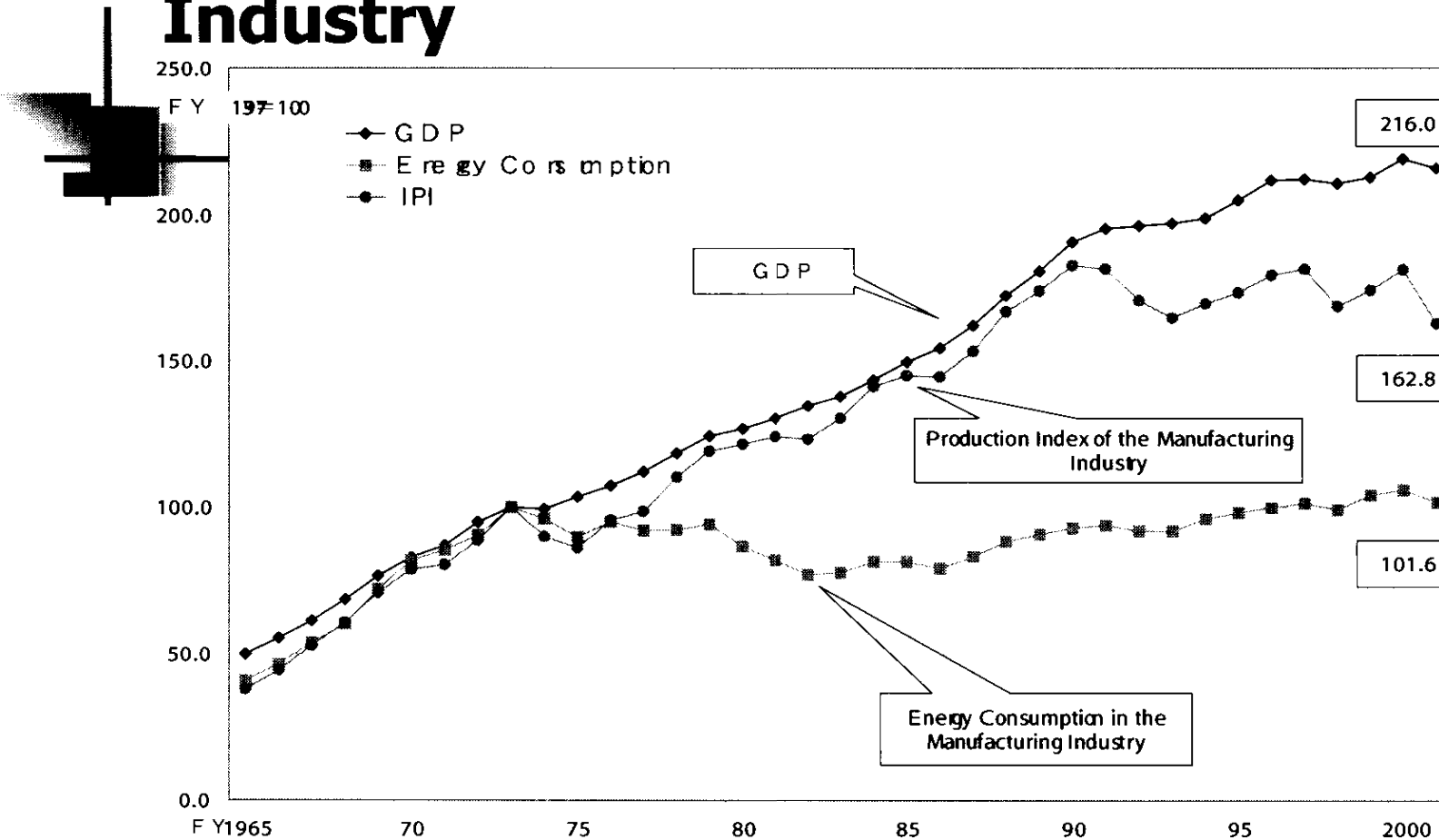
(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)

Chapter 2 Energy Consumption in the Industrial Sector



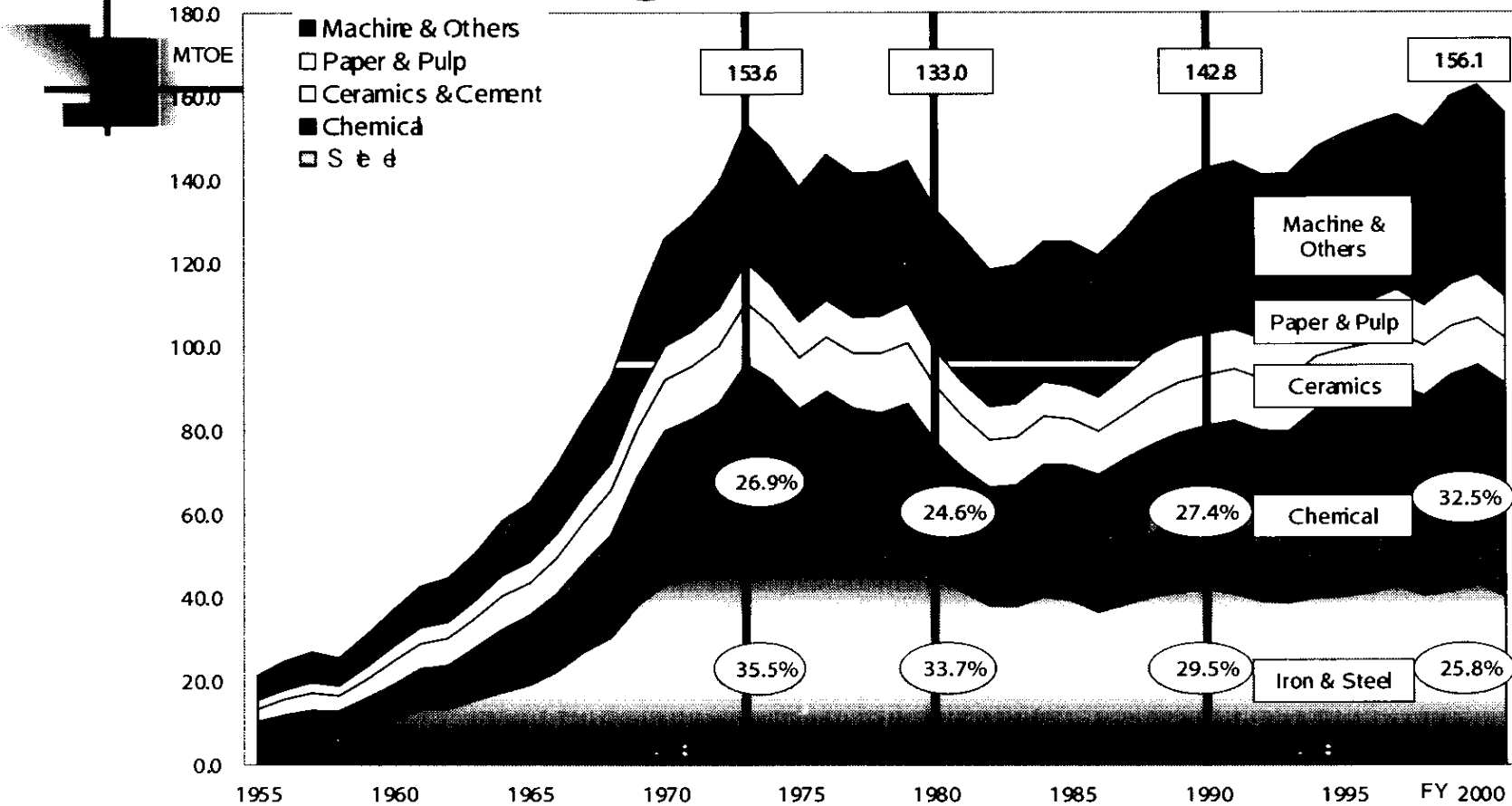
- Industrial Structural Change and Energy Consumption
- Energy Intensity

Energy Consumption in the Manufacturing Industry



Japan's economy doubled in scale over a period from 1973 to 2001; however, the energy consumption in the manufacturing industry remained unchanged. The major reasons for the decreasing rate of industrial energy consumption vis-à-vis GDP are decreasing energy intensity (promotion of energy conservation) and changing industrial structure toward a high-value added industrial structure.

Energy Consumption by type of Manufacturing



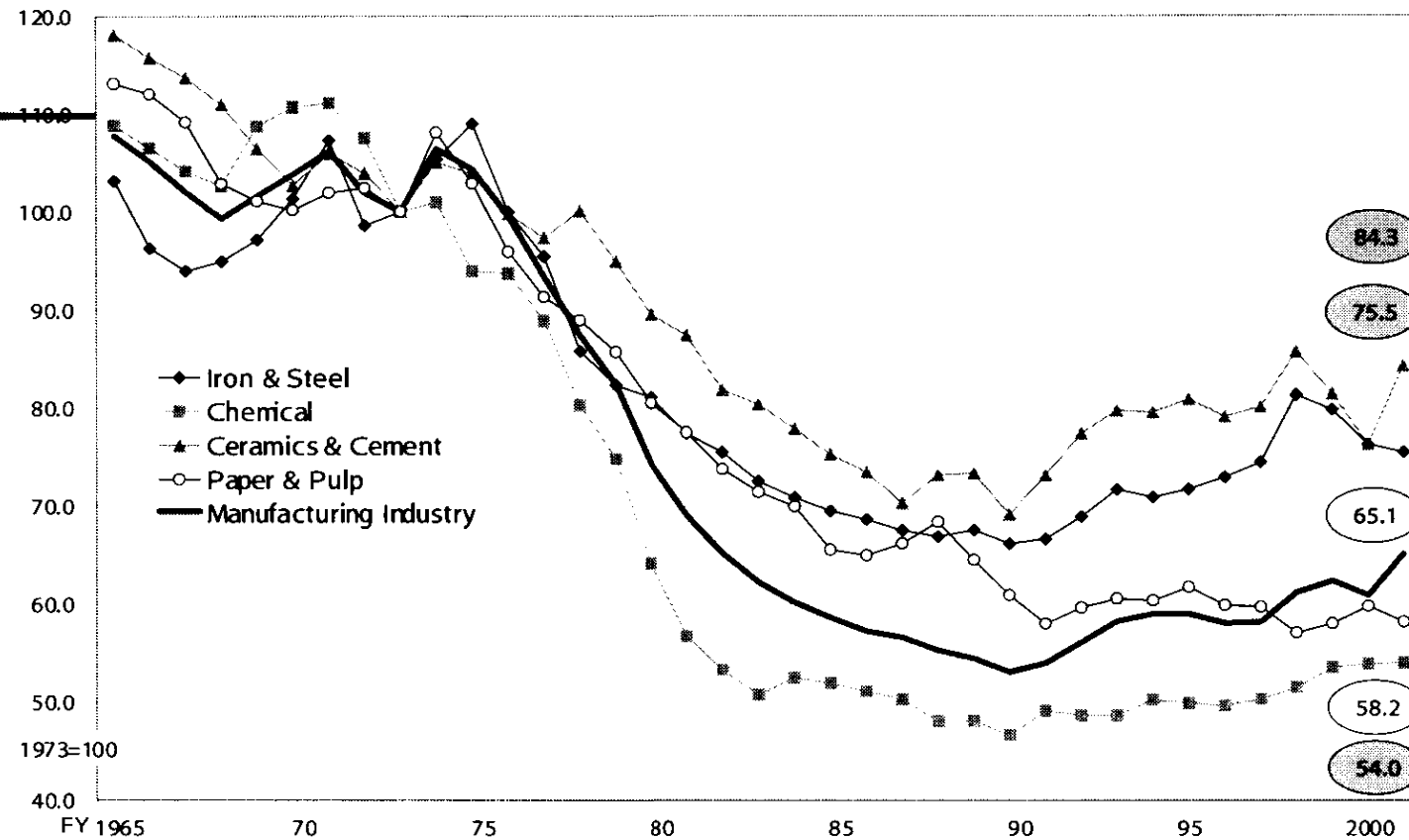
The manufacturing industry keenly promoted energy conservation since the first oil crisis of 1973. The energy consumption took an upward turn from the middle of the 1980s and, consequently, the present level is about the same as that of 1973. The iron and steel industry consumed energy most in 1973, but now the chemical industry is the largest one.

Share of Energy Intensive Industries

	1973	1980	1990	2001
Share of Energy Intensive Industries in the Manufacturing Industry	78.4	74.6	72.1	71.6
Share of Energy Intensive Industries in the Final Energy Consumption	45.4	37.5	31.9	30.4

The material industries account for about 70 to 80 percent of the total energy consumption of the manufacturing industry. Around 1973, the energy intensive industries represented about half the final energy demand. Thereafter, their shares declined and presently their shares are about 30 percent of the total.

Changes in Energy Intensity (Energy per Unit IIP, 1973=100)



The energy consumption per IIP of the total manufacturing industry declined from 100 of 1973 as base year to 53 in 1990. In recent years, this figure is increasing a little.

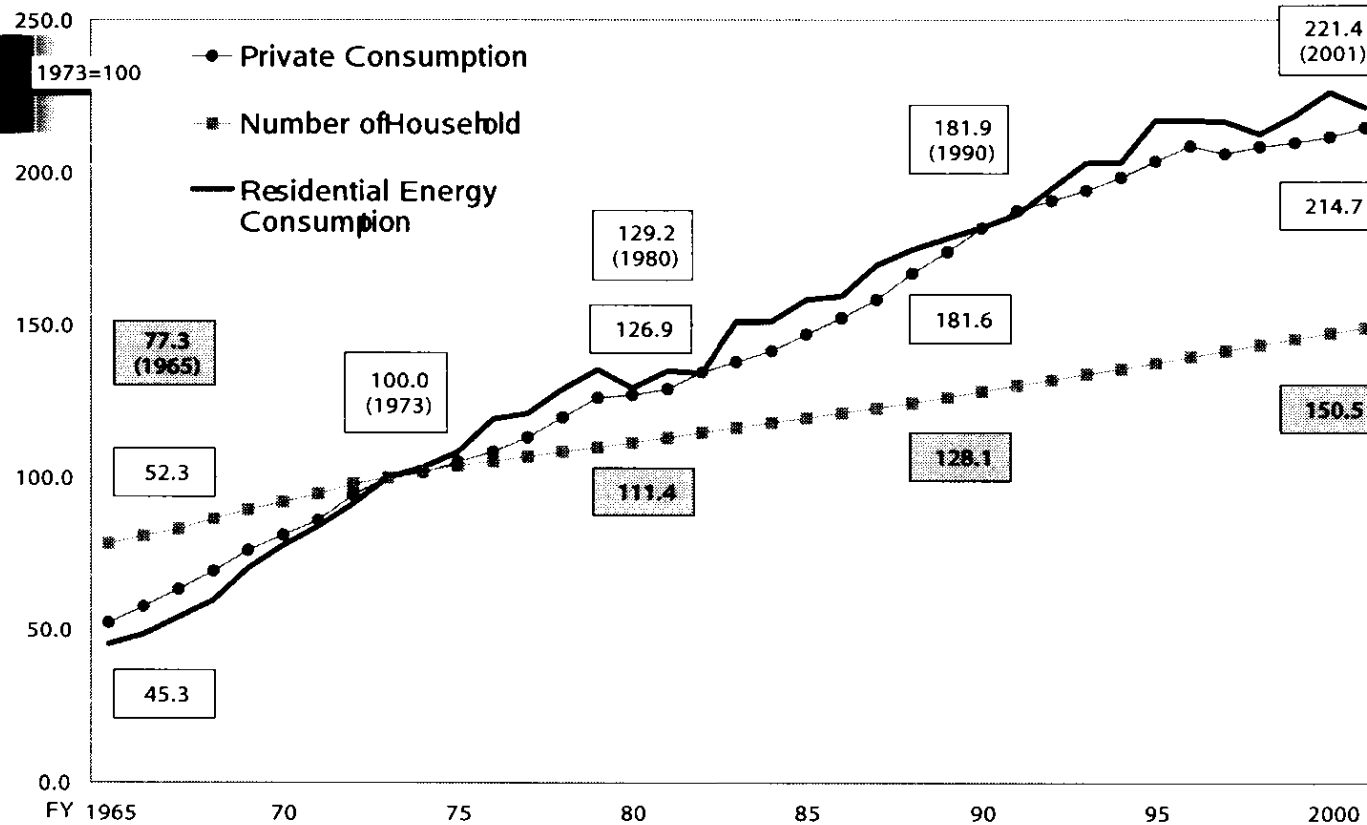
This decline was brought about not only by the energy conservation in narrower meaning (technical energy conservation) but by changes within the industries of product mixes towards making high value added products.

Chapter 3 Energy Consumption in the Residential Sector



- Number of Households and Energy Consumption by End-Use
- Lifestyle and Energy Consumption
- Penetration of Electrical Appliances and Energy Consumption (Energy Conservation)

Energy Consumption in the Residential Sector



The growth of residential energy consumption declined as a result of the two oil crises in 1973 and 1979. Notwithstanding, the residential energy consumption is now more than twice that in 1973.

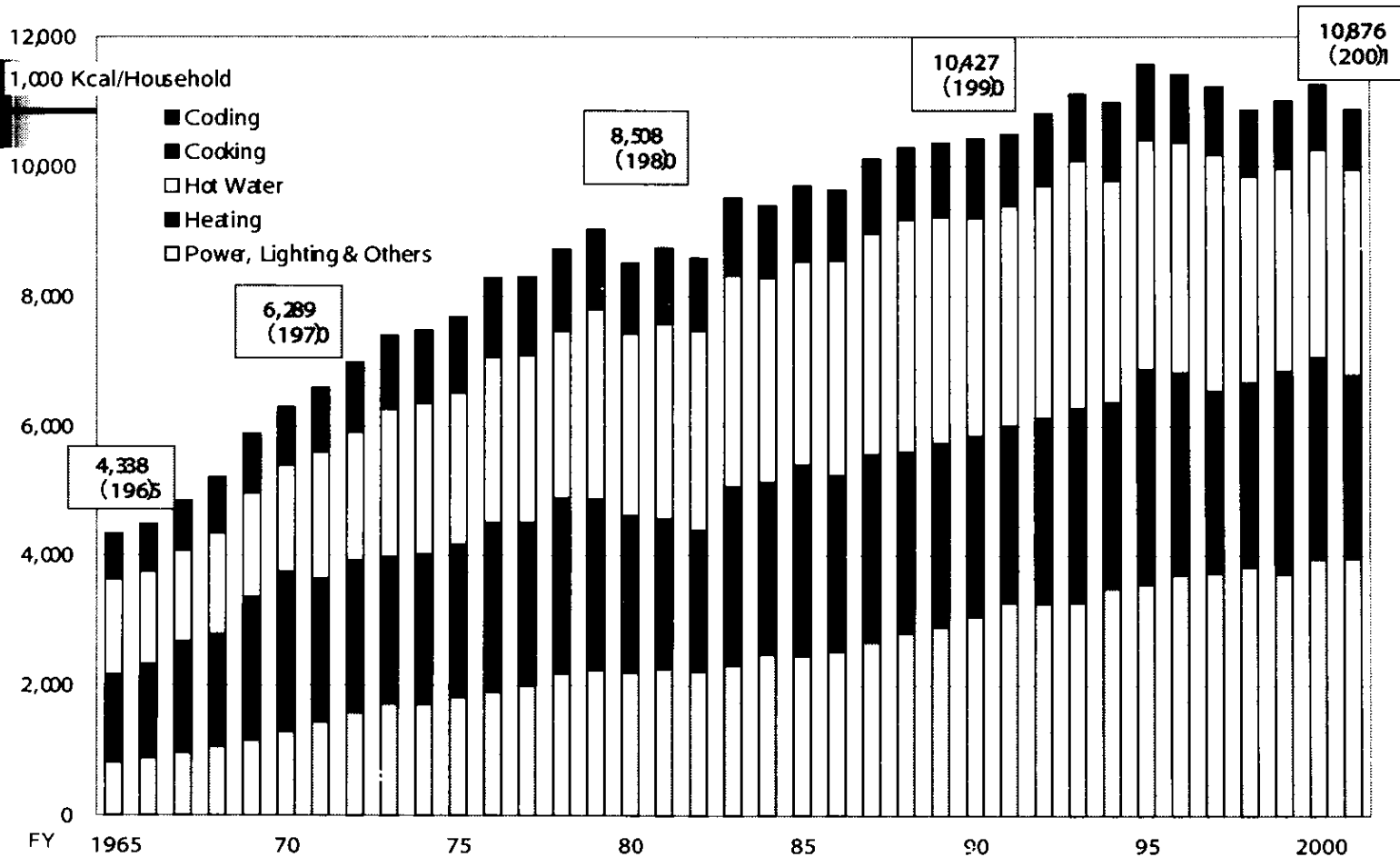
It may be noted from the figure that the sector consumption is intimately linked with personal consumption.

Income and Energy Consumption (Average annual growth rate)

	Annual Average Growth rate %			
	1965-73	1973-80	1980-90	90-2001
Energy Consumption	10.4	3.3	4.4	2.5
Private Consumption (Real, 1995=100)	8.4	3.0	4.6	2.1
Number of Households	3.1	1.6	1.4	1.4
Energy Consumption per Household	7.1	1.9	2.5	0.6
Private Consumption per Household	5.2	1.6	2.8	0.2
Income Elasticity of Energy	1.23	1.08	0.95	1.17

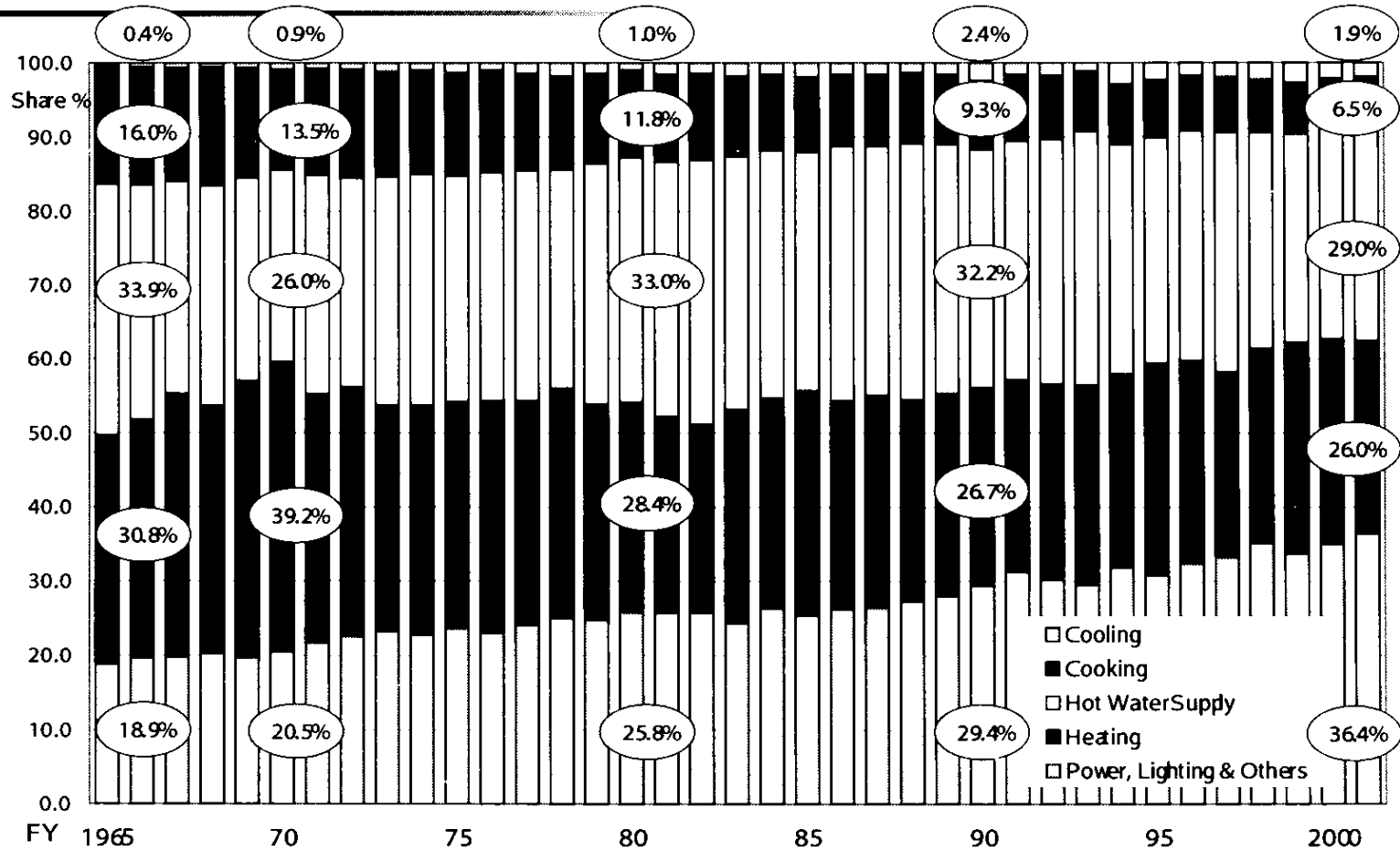
The residential energy consumption exhibits steady growth as a result of steady increases in household number and in energy intensity associated with the income rise.

Residential Energy Consumption by End-Use



The share of the power and lighting has increased with penetration of household electric appliances and with upgrading of lifestyles. Likewise, air-conditioning is becoming very common and this increases the consumption for heating and cooling. The cooking energy is decreasing as the habit of eating out becomes common and the retort food is accepted.

Residential Energy Consumption by Share of End-Use

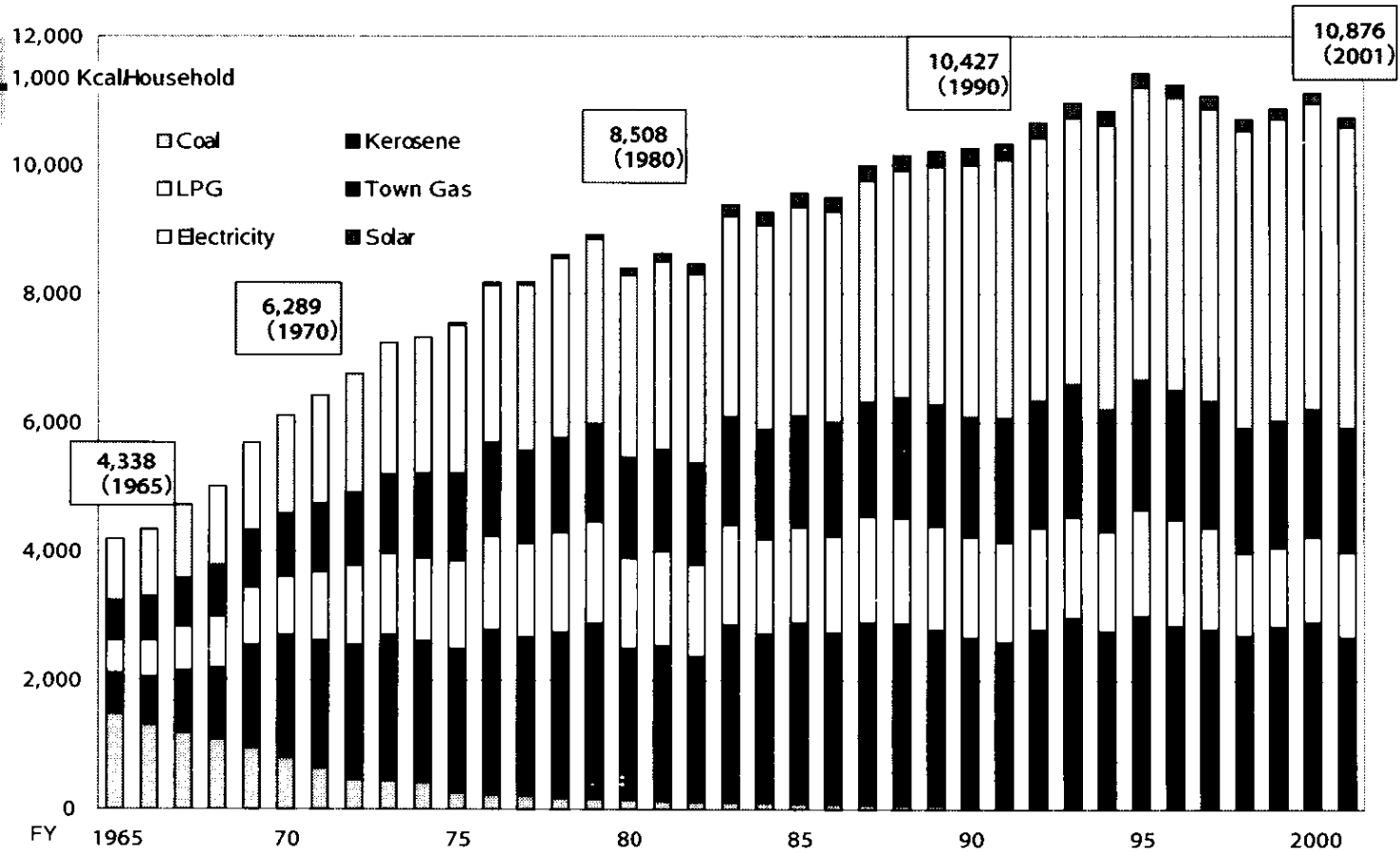


Energy Consumption in the Residential Sector by End-Use and by Source (FY2001)

	Heating	Cooling	Hot Water	Cooking	Power etc.	Total	Share %
Electricity	215	212	188	161	3,962	4,739	(43.6)
Town Gas	567	0	1,070	312	0	1,948	(17.9)
LPG	162	0	961	204	0	1,327	(12.2)
Kerosene	1,884	0	777	31	0	2,692	(24.8)
Coal etc.	5	0	13	3	0	21	(0.2)
Solar	0	0	149	0	0	149	(1.4)
Total	2,833	212	3,157	712	3,962	10,875	(100.0)
Share %	(26.0)	(2.0)	(29.0)	(6.5)	(36.4)	(100.0)	

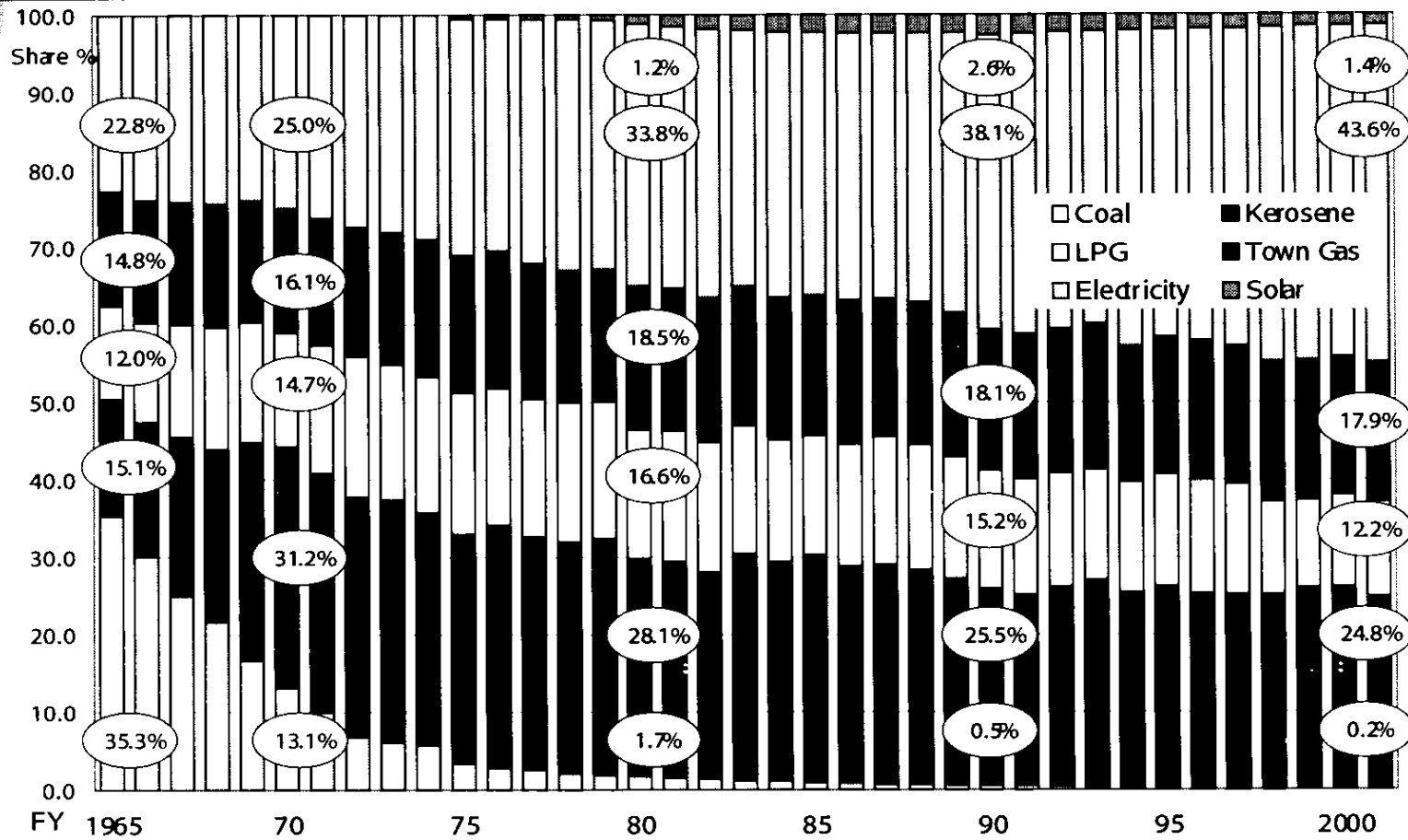
The energy source varies greatly depending upon the use. For heating, kerosene is the most important, particularly in colder areas like Hokkaido, while for cooling and power, electric power is used almost exclusively.

Residential Energy Consumption by Energy Source

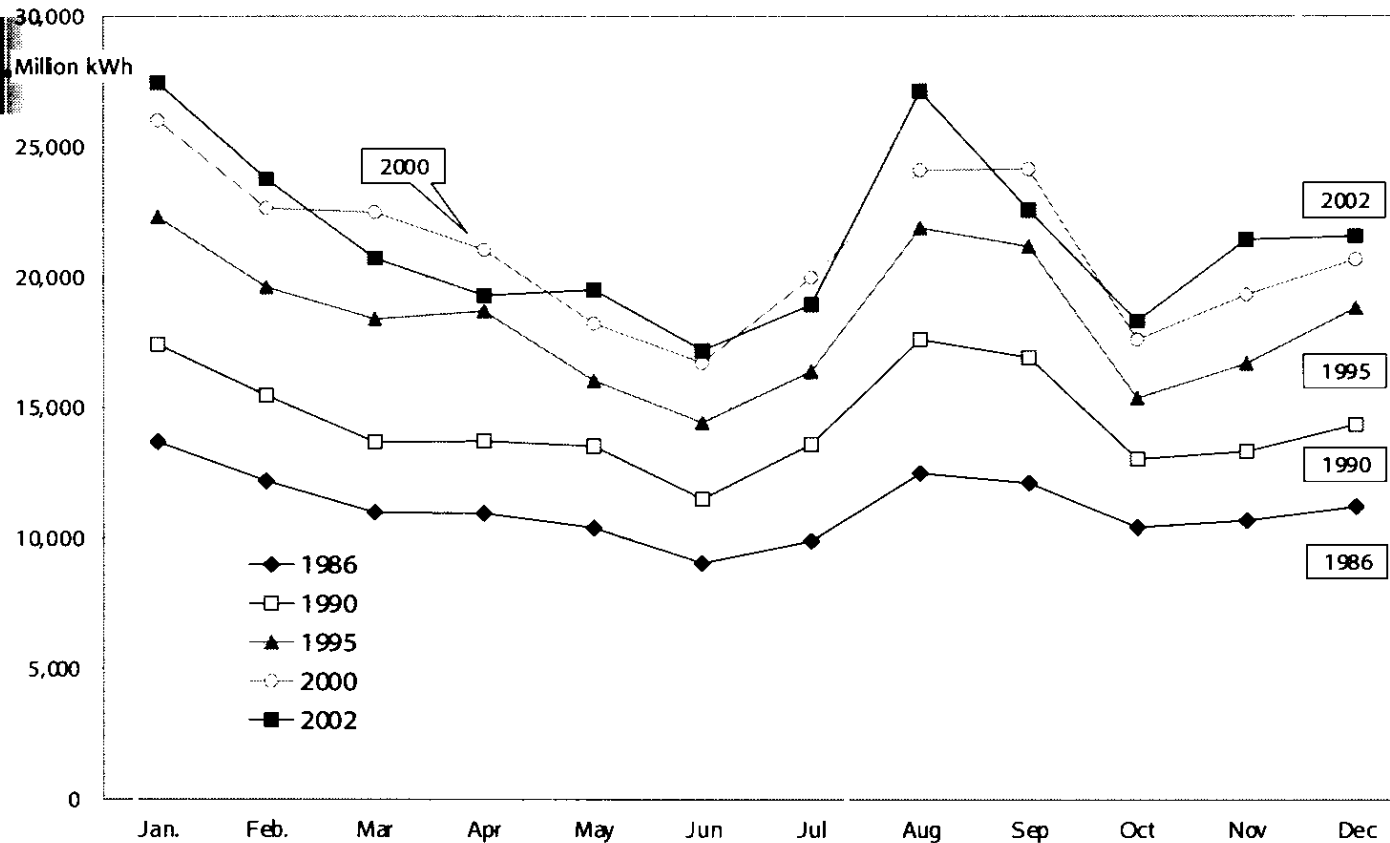


The increasing penetration of household electric appliances and increasing demand for power and lighting and heat, spreading use of heat pumps account for increasing share of electric power.

Residential Energy Consumption by Share of Energy Source



Monthly Electric Power Consumption in the Residential Sector



The residential sector increases its electric power consumption every year. (The graph is moving upward every year.)

Increasing penetration of air conditioners makes both the winter peak and summer peak more outstanding. Leveling of load is desired from the viewpoint of improving efficiency of the facilities.

Penetration of Electrical Appliances and Energy Consumption

- Improvement of efficiency of major appliances
 - Refrigerator : 1981 2.76 kWh/Year·L (236L)
 - 1991 2.28 kWh/Year·L (413L)
 - 2001 0.75 kWh/Year·L (442L)
 - TV set : 1990 227 kWh/Year
 - 1998 178 kWh/Year (22% reduction)
 - air-conditioner : 1995 363 kWh/Season
 - 2001 218 kWh/Season
(40% reduction)

Diffusion Rates of Household Electric Appliances

	Appliances	1965	1970	1975	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001
Diffusion Rate %	Oil Stove	45.8	82.0	89.5	91.3	84.0	75.3	66.1	65.7	61.2	60.4	60.4	58.9	57.7
	Air Conditioner	2.0	7.7	19.5	41.2	54.6	68.1	77.2	79.3	81.9	84.4	86.2	86.2	87.2
	Refrigerator	61.6	91.2	96.1	99.2	98.4	98.9	98.4	98.7	98.1	98.4	98.0	98.4	98.4
	Colour TV Set	1.6	42.3	93.7	98.5	98.9	99.3	99.1	99.2	99.2	98.9	99.0	99.2	99.3
Number of Holding per 100 Households	Oil Stove	—	109.2	157.1	174.9	161.0	145.6	118.2	117.7	107.4	105.8	105.0	101.0	100.6
	Air Conditioner	—	8.8	24.8	57.9	88.0	126.5	166.1	179.3	191.7	200.7	207.6	217.4	229.9
	Refrigerator	—	94.4	108.9	115.2	114.3	119.4	119.4	120.5	120.7	120.7	121.6	121.4	124.8
	Colour TV Set	—	43.5	117.2	150.9	174.7	201.3	215.1	219.8	224.6	224.0	226.2	230.6	235.0

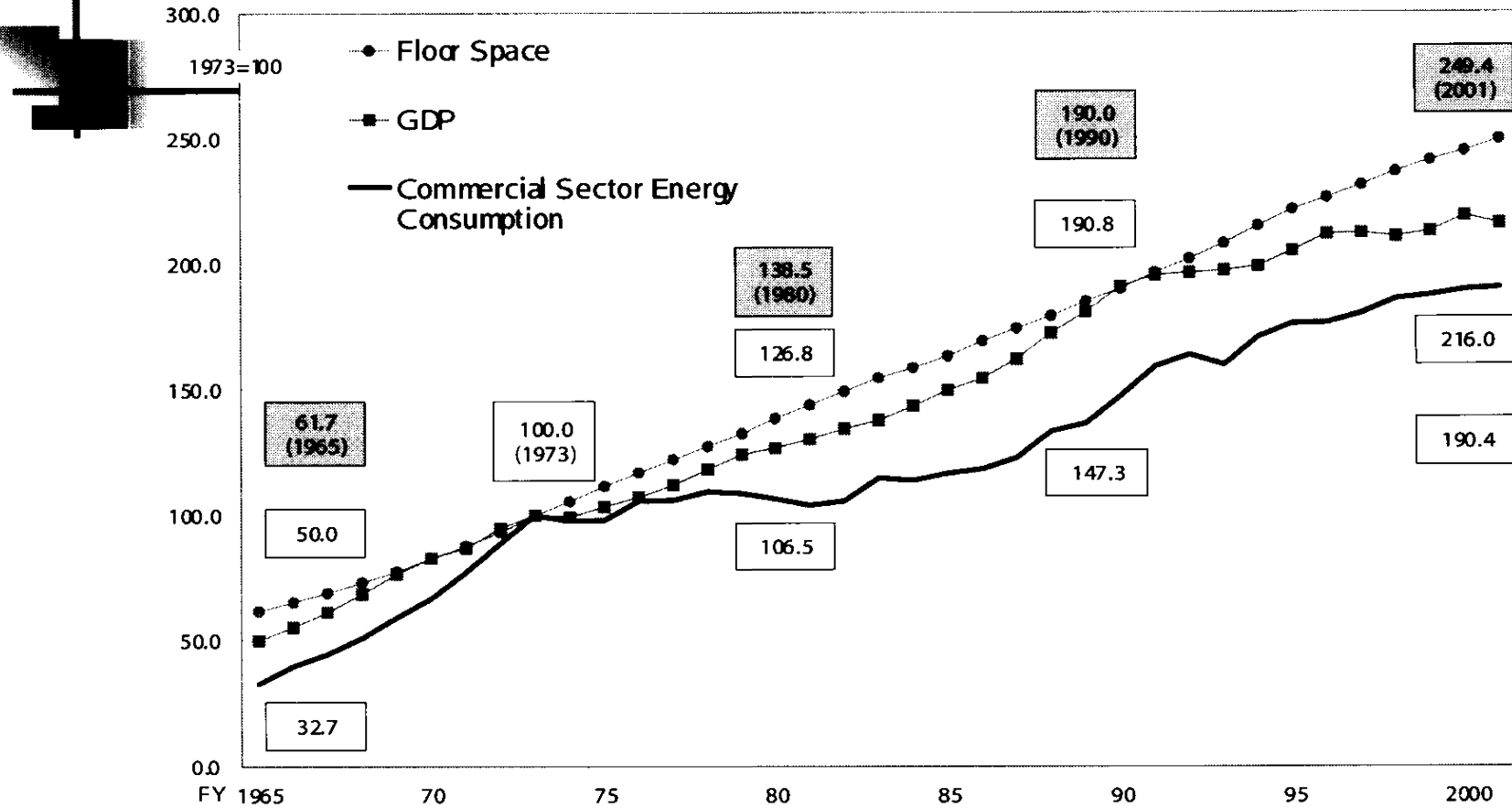
The diffusion of household electric appliances is spectacular in Japan. Many households own more than one color TV set and air-conditioner (including cooler).

Chapter 4 Energy Consumption in the Commercial Sector



- Scope of the Commercial Sector, Trends of Floor Space
- Energy Consumption by Business Type
- Energy Consumption by End-Use
- Energy Consumption by Energy Source

Energy Consumption in the Commercial Sector



The floor space used by the commercial sector has increased almost at the same rate as the GDP growth rate. While on the other hand, energy demand by the commercial sector remained almost unchanged from the first energy crisis to the bubble economy. Since the bubble economy, the energy demand has steadily increased, despite the staggering economy.

Commercial Floor Space and Energy Consumption

(Average annual growth rate)

	Annual Average Growth rate %			
	1965-73	1973-80	1980-90	90-2001
Energy Consumption	15.0	0.8	4.2	3.3
Total Floor Area	6.2	4.2	4.0	3.5
Unit Consumption per Floor Area	8.2	-3.2	0.1	-0.2
Real GDP (1995 Price)	9.1	3.4	4.2	1.1
Elasticity of Total Floor Area to GDP	0.69	1.20	0.97	3.05

The energy consumption per floor space dropped sharply after the first oil crisis.

It began to level off or to slightly increase in the latter half of the 1980s.

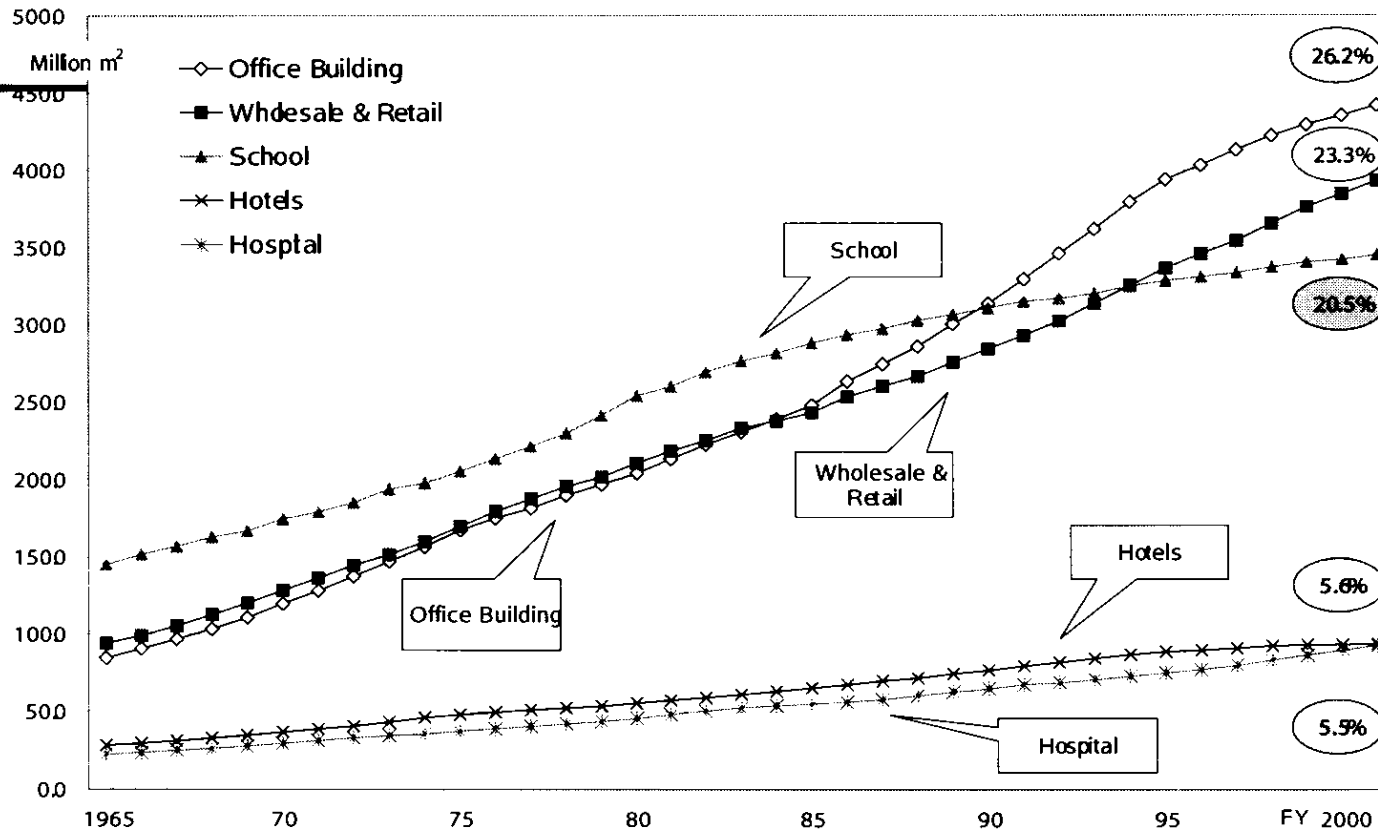
(Note)

The commercial sector indicates “commercial and service sectors” including shops, office buildings, hospitals, various schools and welfare facilities.

The administrative portion of the industrial sector such as head office buildings is included but electricity and gas utility and transportation business are excluded.

The transportation for own businesses, taxis and buses for example, is excluded.

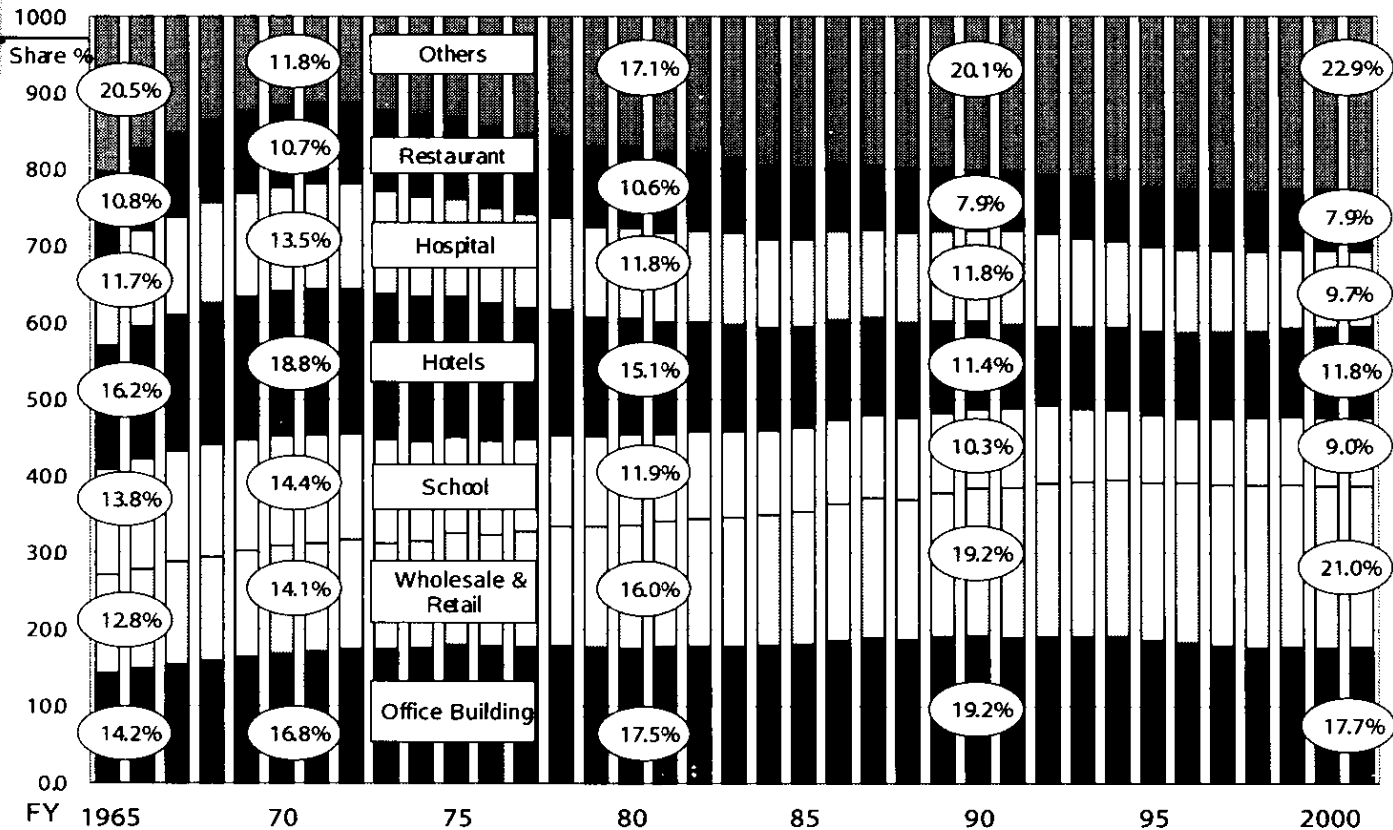
Floor Space by Business type



The office building, whole sale and retail, school accounts for about 70 percent of the total business floor space.

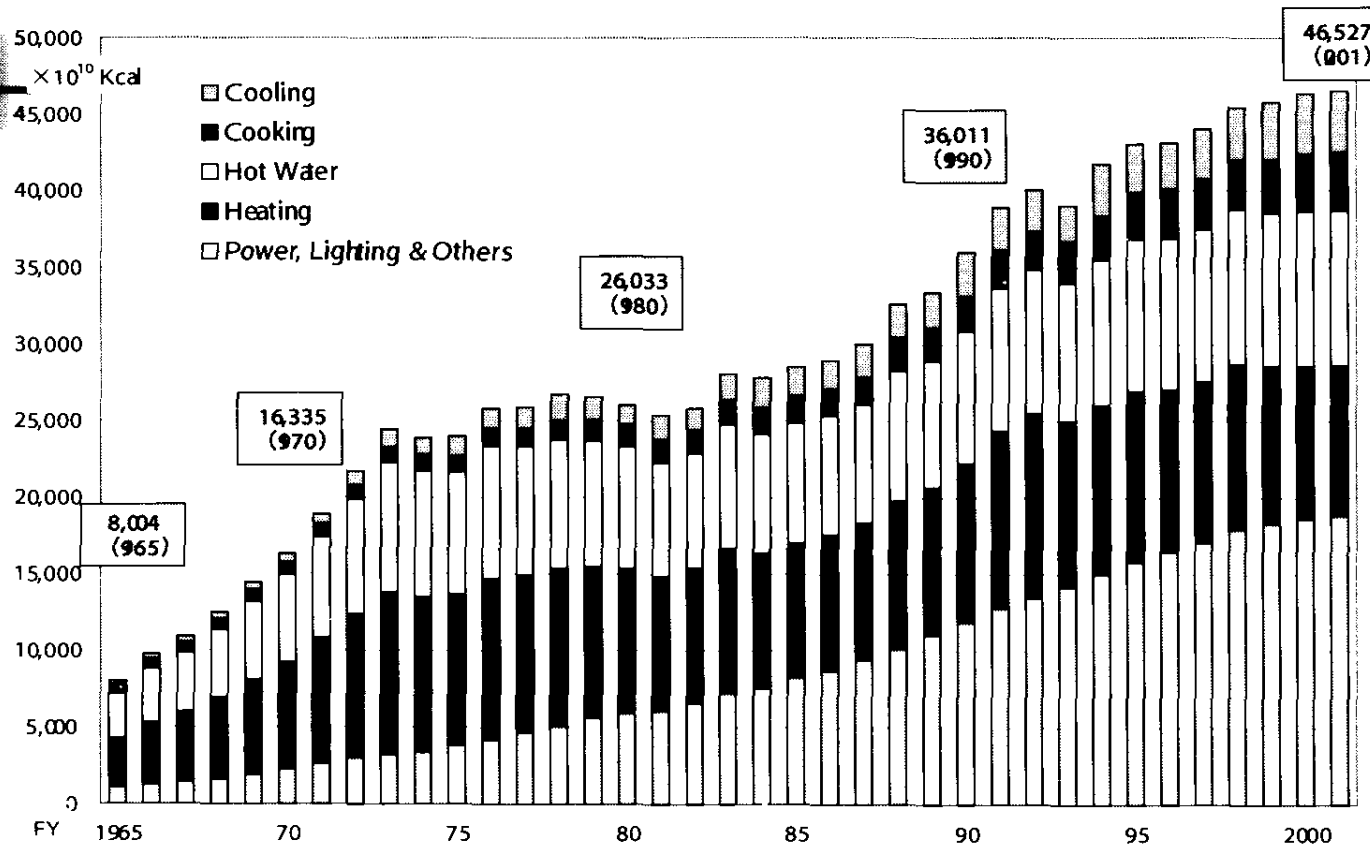
Since 1985, the rate of increase of the floor space of the office building, wholesale and retail has been increasing while that for the school has been decreasing.

Share of Energy Consumption by Business type



Formerly, the hotel and office building accounted for the greater part of the energy consumption. Recently, however, the wholesale and retail rank first at 21 percent in 2001. Also, the other service industries such as welfare facilities are increasing their shares. The school shows a declining share, 9 percent in 2001, because their floor area is not increasing fast enough.

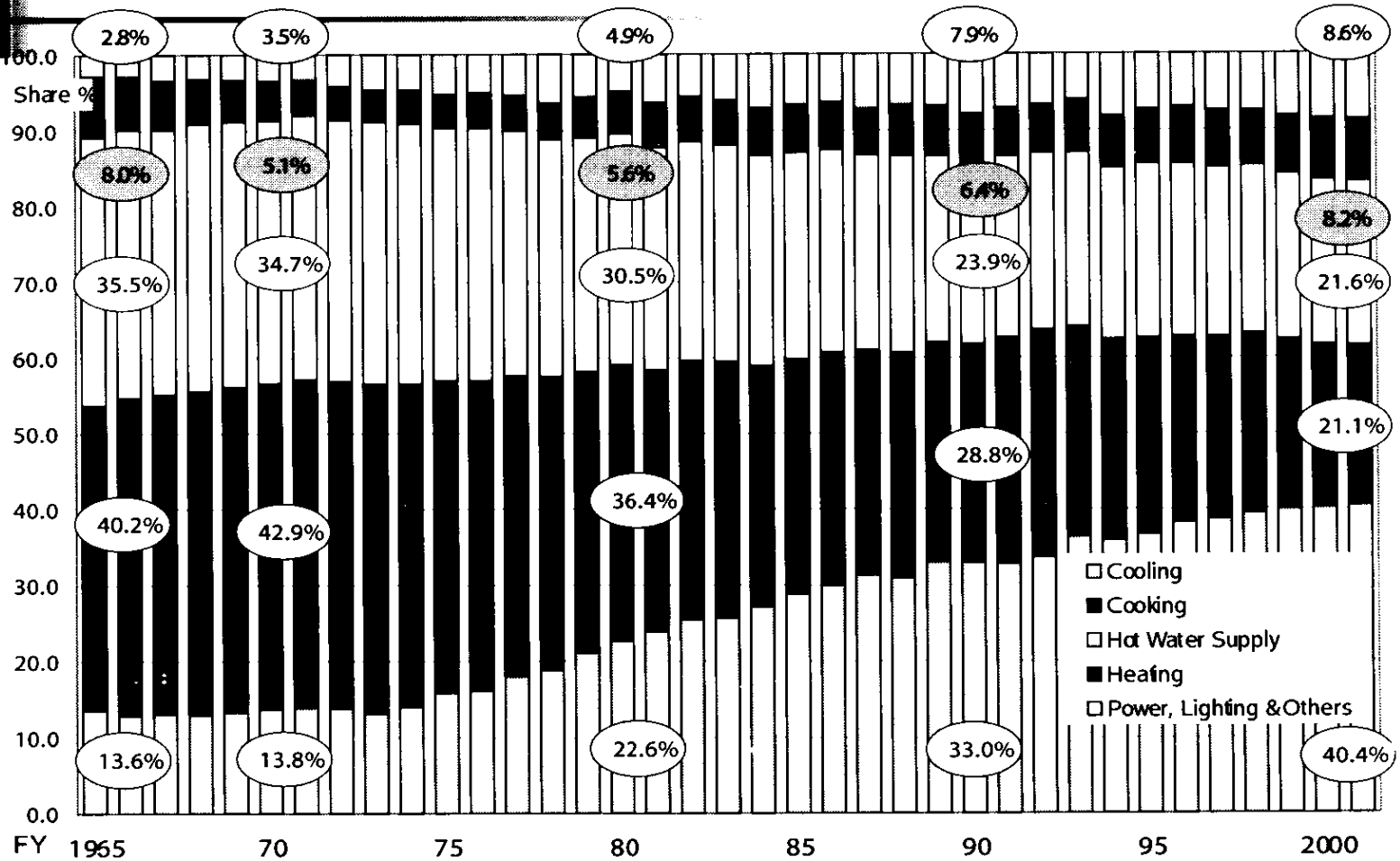
Energy Consumption by type



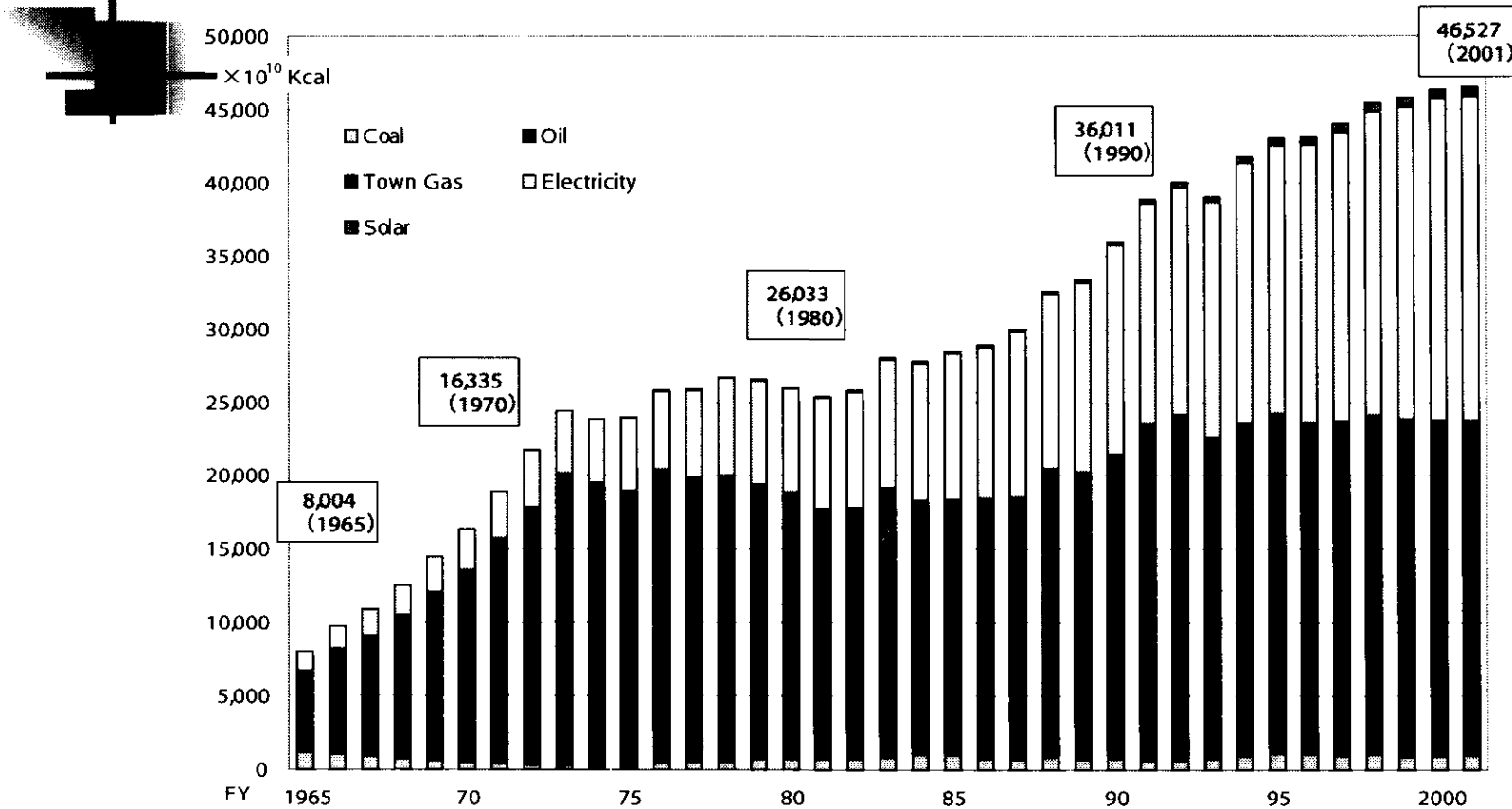
The energy intensity for power and lighting has steadily increased reflecting the computerization and increasing office floors, reaching 40 percent in fiscal 2001.

By contrast, the energy intensity for heating and hot water supply has decreasing, as a result of advancement of energy conservation (use of more efficient equipment) and improving thermal insulation of buildings.

Share of Energy Consumption by type

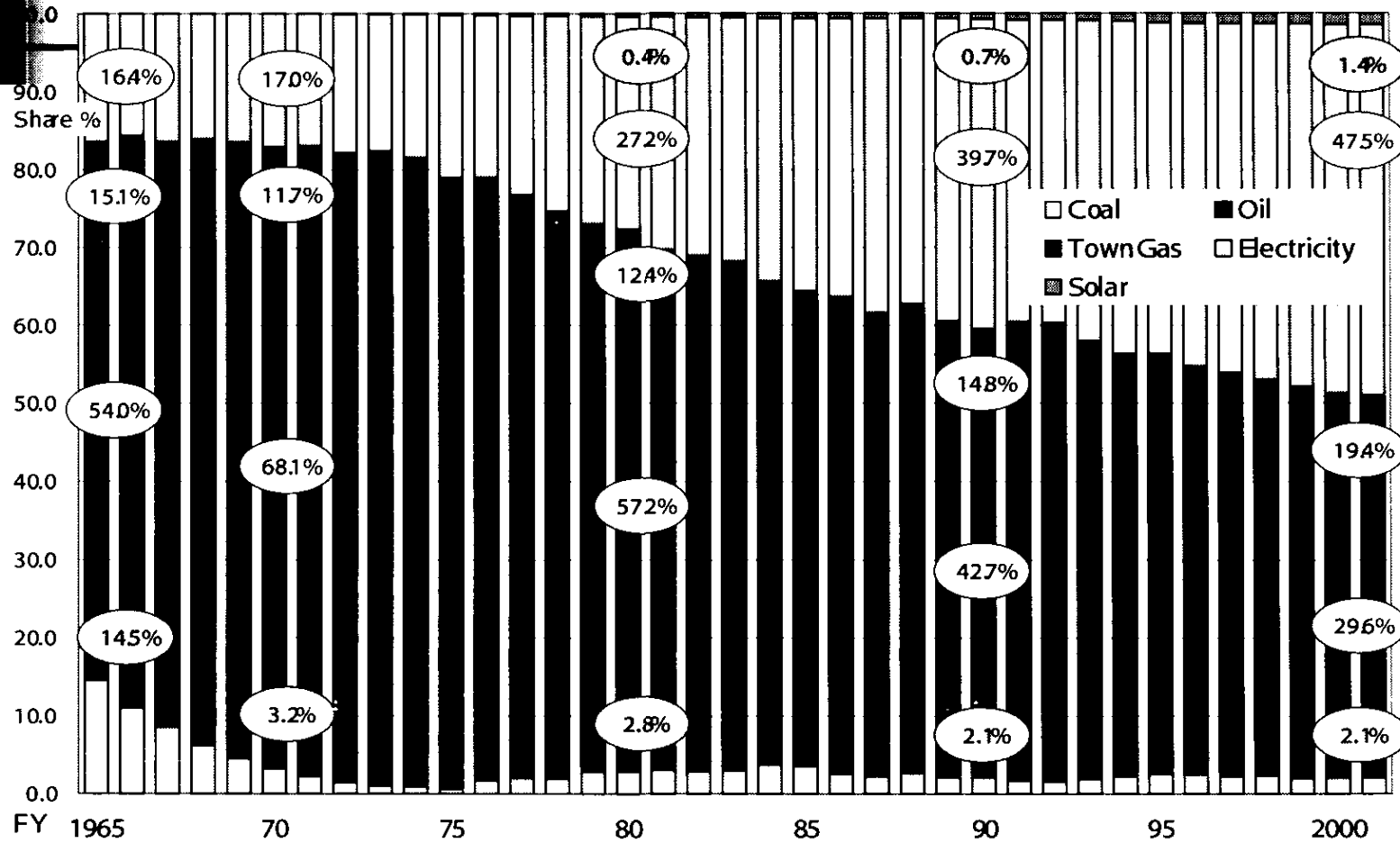


Consumption by type of Energy



The consumption of electricity and gas has been steadily increasing, reflecting the increasing demand for power and lighting. The share of electricity has increased to 47.5 %. The share of gas has increased to 19.4 %, reflecting the demand for cooling. By contrast, the share of petroleum has declined to 29.6 %, accompanying declining share of heating and hot water supply, and conversion of energy from petroleum to electricity and gas.

Share of Energy Consumption



Energy Consumption in the Commercial Sector by End-Use and by Source (FY2001)

(10³kcal/m², %)

	Heating	Cooling	Hot Water	Cooking	Power etc.	Total	Share %
Electricity	4.6	14.9	0.0	0.0	111.6	131.1	(47.5)
Town Gas	6.2	5.7	20.5	21.2	0.0	53.6	(19.4)
Oil	46.6	3.3	31.7	0.0	0.0	81.6	(29.6)
Coal etc.	0.9	0.0	3.6	1.3	0.0	5.8	(2.1)
Solar	0.0	0.0	3.9	0.0	0.0	3.9	(1.4)
Total	58.3	23.9	59.7	22.5	111.6	276.0	(100.0)
Share %	(21.1)	(8.7)	(21.6)	(8.2)	(40.4)	(100.0)	

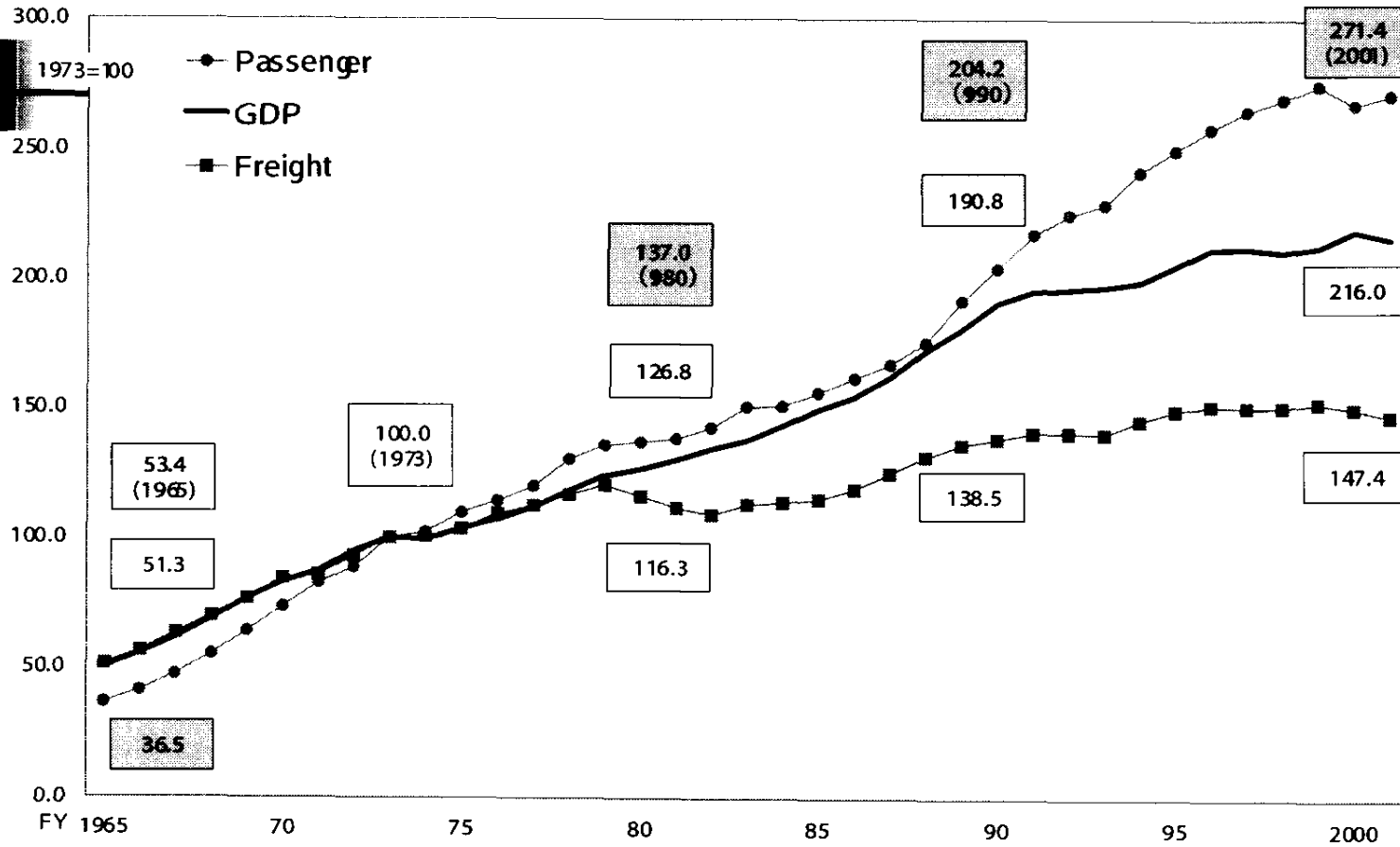
Petroleum accounts for about 80% in the heating use and for about 60% in the hot water supply use.

Electricity represents 100% in the power and lighting use, about 60% in the cooling use, and somewhat less than 10% in the heating use. Gas accounts for more than 90% in the cooking use and about 30% in the hot water supply and the cooling uses.

Chapter 5 Energy Consumption in the Transportation Sector

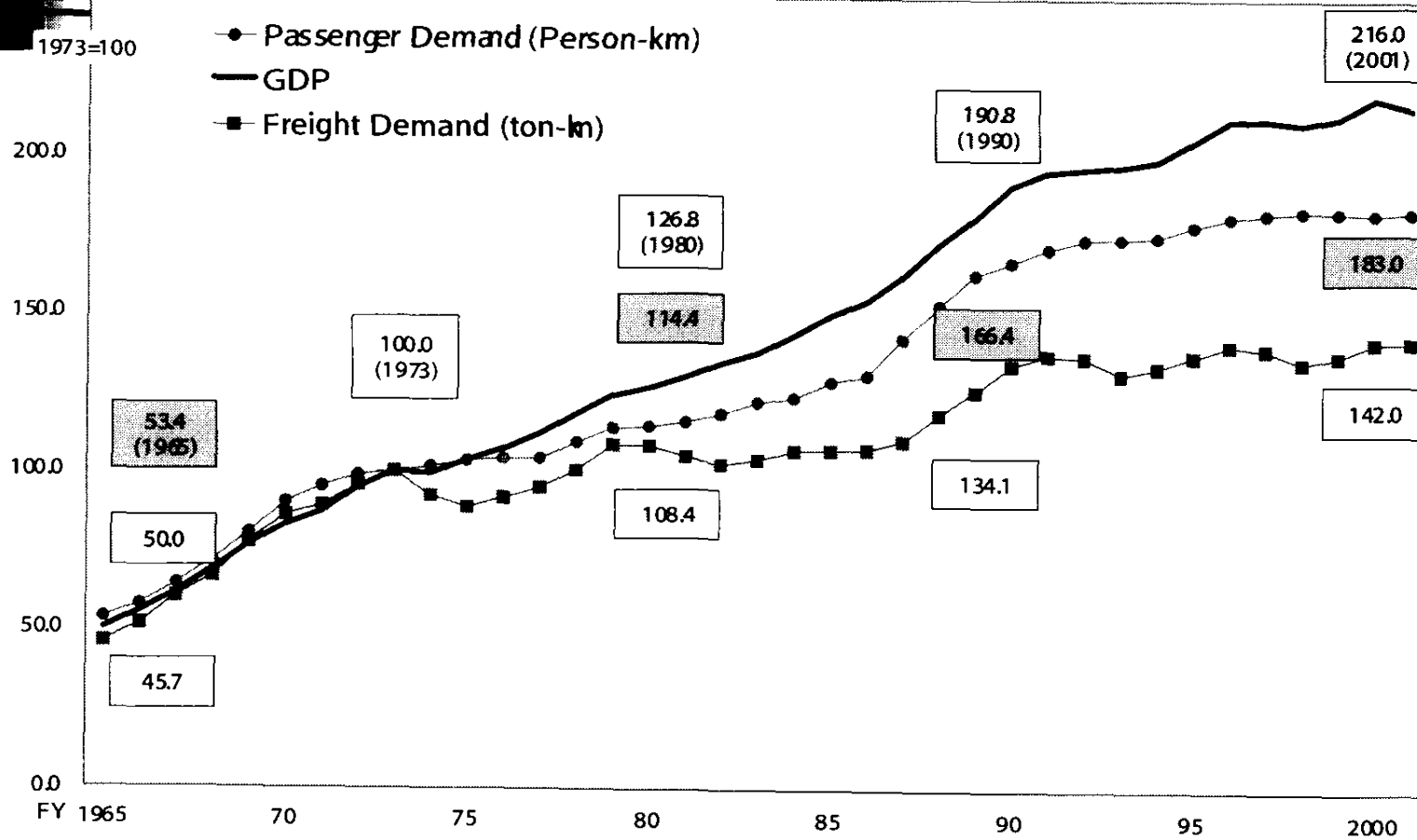
- Economic Activity and Transportation Demand, Energy Consumption
- Transportation Demand and Shares by Transportation Mode
- Energy Demand and Shares by Mode
- Energy Intensity (Energy Consumption / Transportation Demand)
- Vehicle Stock
- Energy Conservation

Energy Consumption in the Transportation Sector



The energy consumption in the passenger transportation sector has increased at a rate outpacing the GDP growth rate.

Transportation Demand in the Transportation Sector



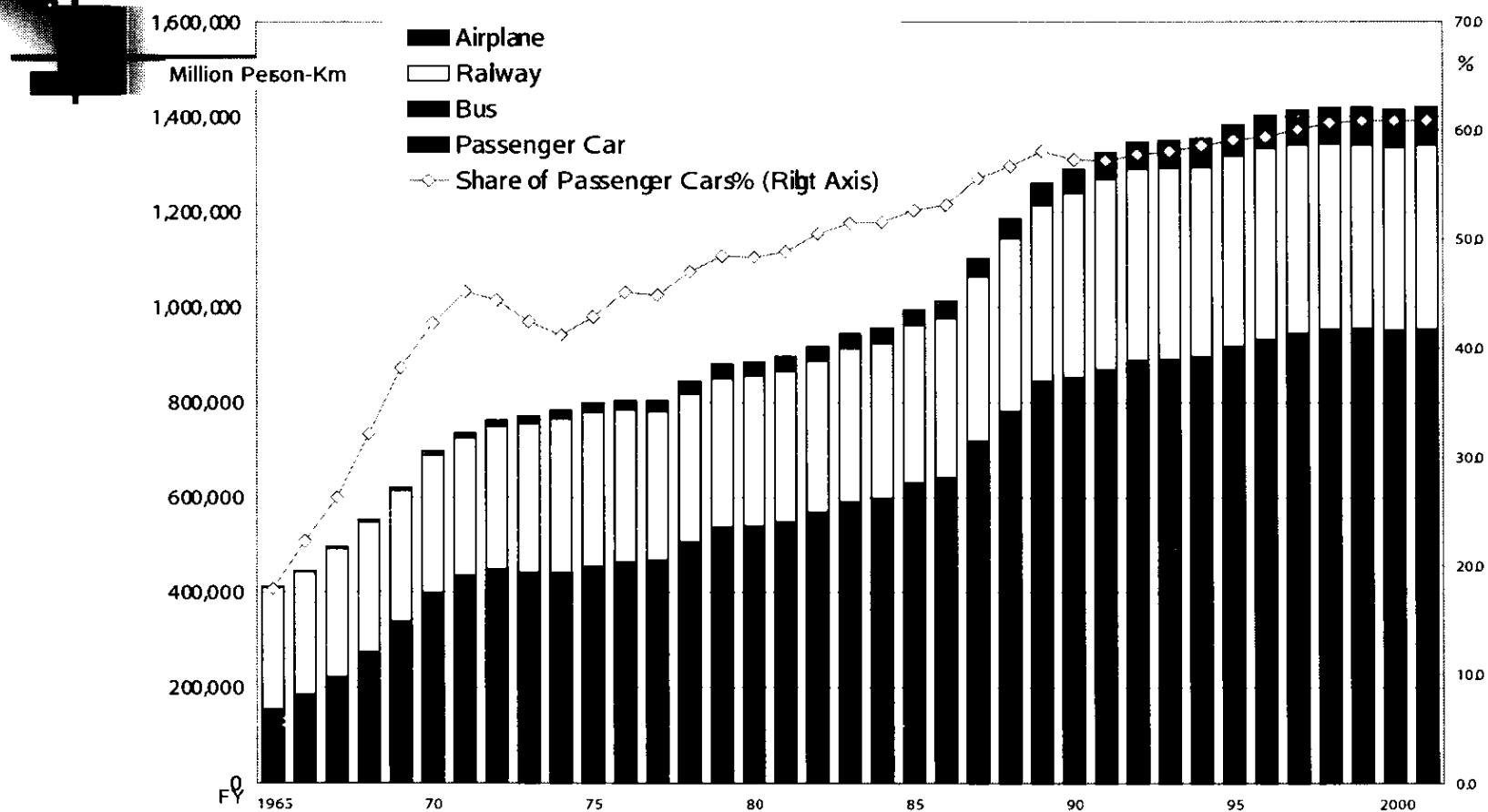
Transportation Demand and Energy Consumption (Average annual growth rate)

	Annual Average Growth rate %			
	1965-73	1973-80	1980-90	90-2001
Transportation Demand				
Passenger (Person-km)	8.2	1.7	4.8	1.2
Freight (Ton-km)	10.3	1.0	2.7	0.7
Total Energy Consumption				
Passenger	13.4	4.0	5.1	3.6
Freight	8.7	1.9	2.2	0.8
Real GDP (1995 Price)	9.1	3.4	4.2	1.1
Elasticity of Passenger Transportation Demand to GDP	0.90	0.49	1.15	1.05
Elasticity of Freight Transportation Demand to GDP	1.14	0.29	0.65	0.64

The passenger transportation has been steadily growing. The freight transportation tends to be affected by business activities and changes in industrial structure.

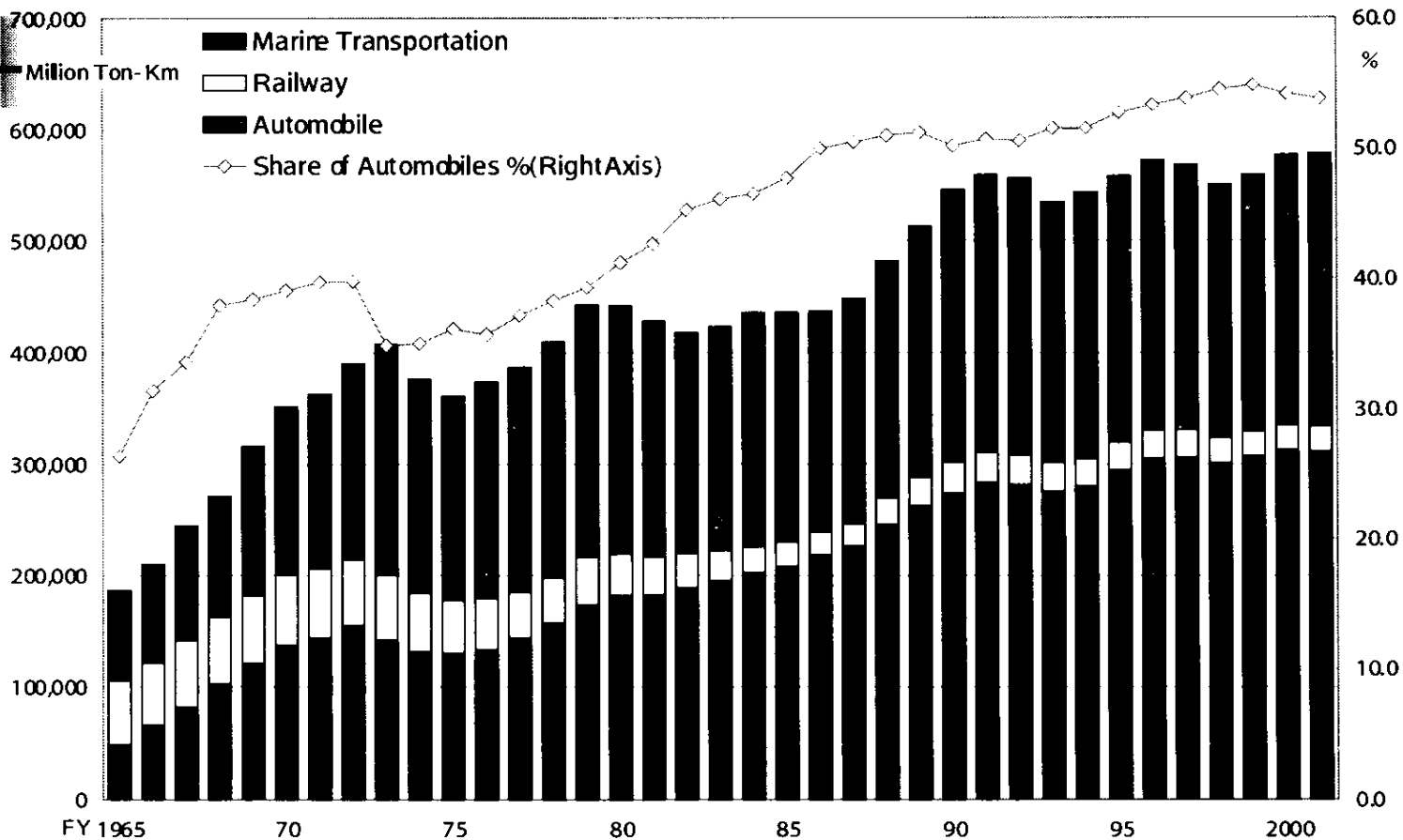
The elasticity of transportation to GDP (growth rate of transportation/GDP growth rate) varies with time. It may be noted that variation is greater in freight transportation.

Passenger Transportation Demand and Shares by Transportation Mode



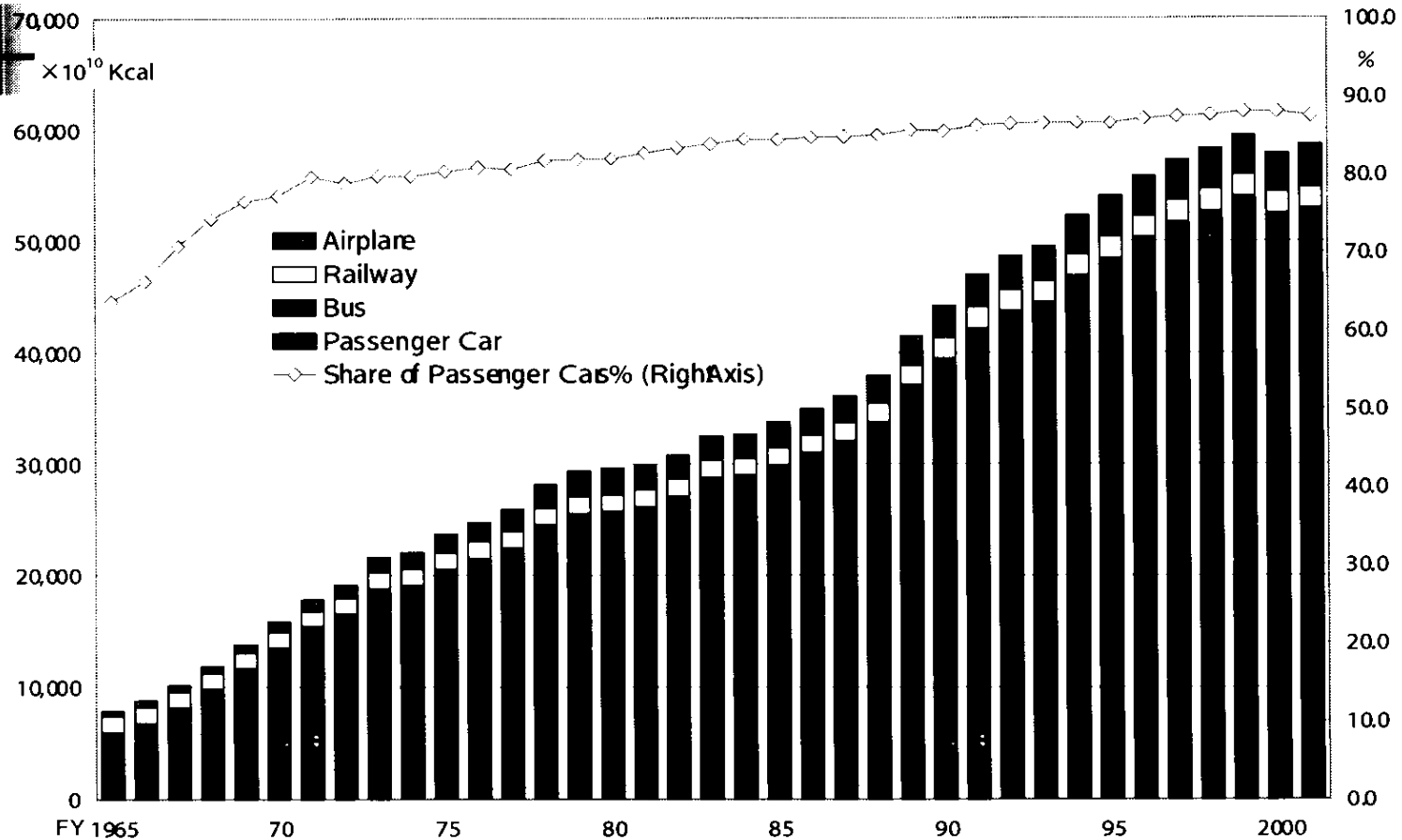
The demand for transportation by automobiles has steadily increased to over 60 percent of the total, while that for railroad has declined.

Freight Transportation Demand and Shares by Transportation Mode



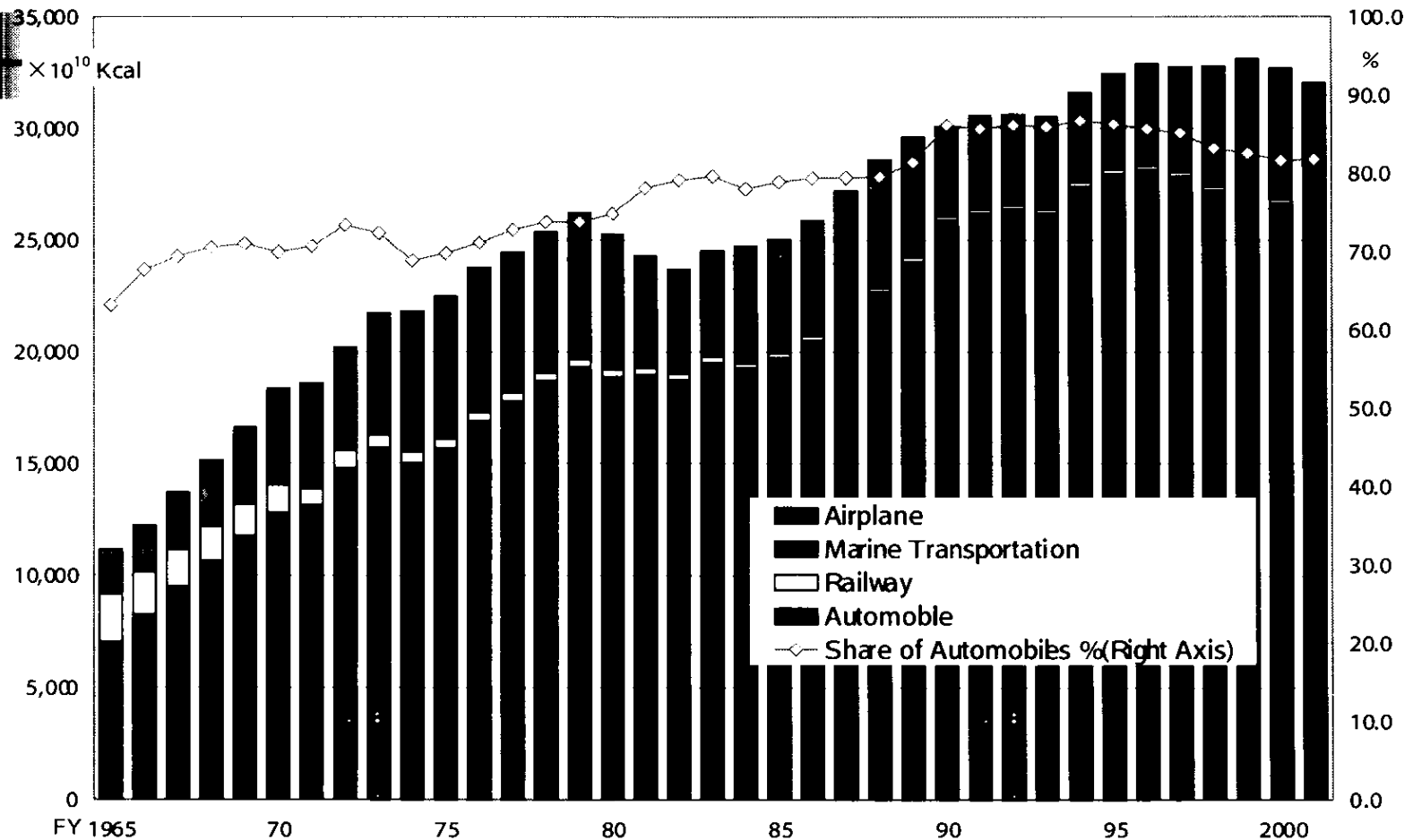
The demand for transportation by automobile and marine jointly represent more than 90% of the total demand. The share of the railroad transportation has been declining.

Energy Demand for Passenger and Shares by Transportation Mode



The energy demand for passenger cars has steadily increased to nearly 90 % recently, along with the progress of motorization.

Energy Demand for Freight and Shares by Transportation Mode



The energy demand for automobiles has leveled off since 1990. Transportation by automobile and marine transportation jointly account for most of the energy demand.

Energy Intensity (Energy Consumption per Transportation Demand)

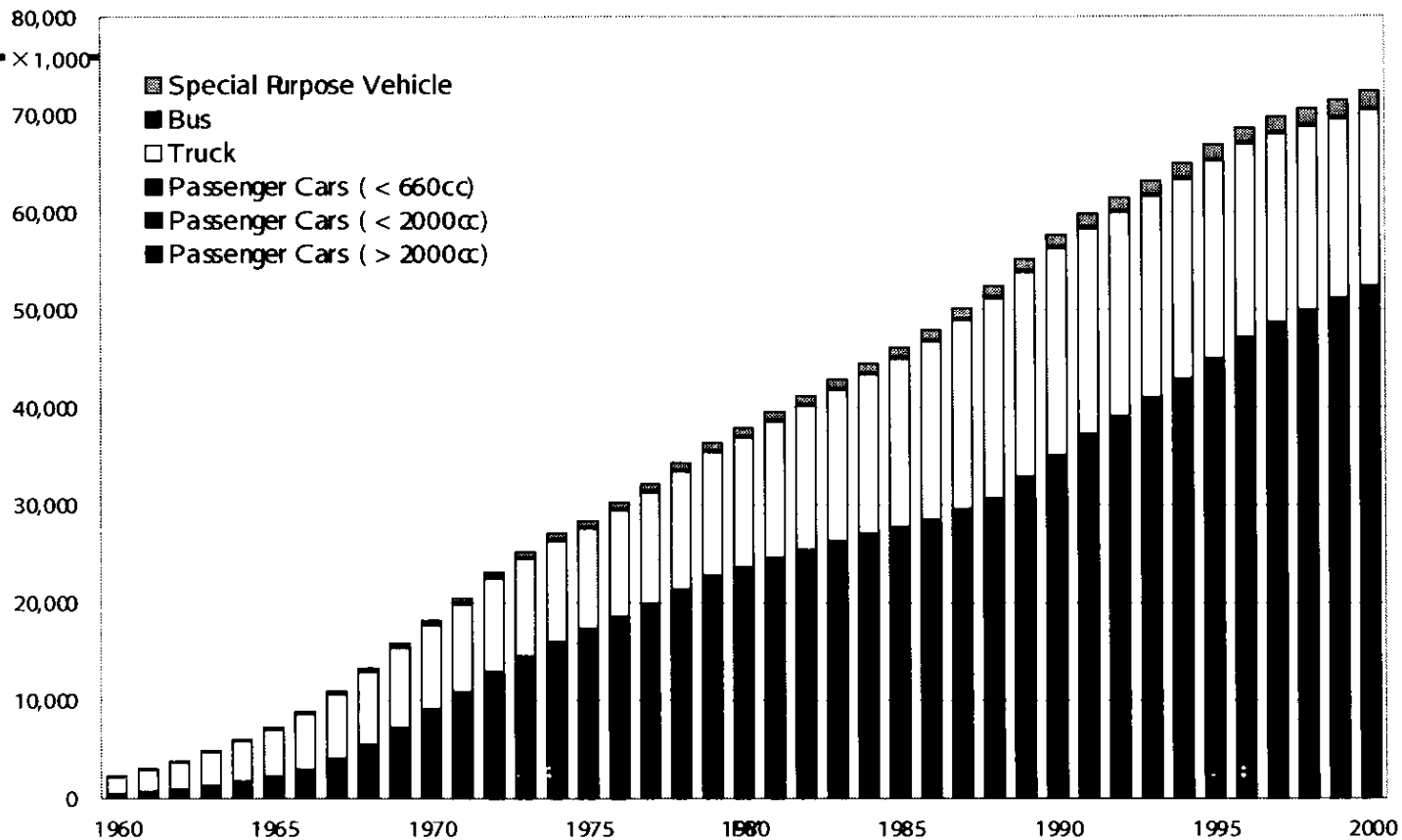
Passenger	Kca/Person · Km					
	Passenger Car	Bus	Railway	Marine	Aviation	Average
1965	681	113	57	191	1,507	190
1970	414	116	48	220	1,026	227
1980	567	122	48	214	795	334
1990	510	145	48	202	550	342
2001	593	160	50	529	474	413

The energy intensity of aircraft transportation is by far the largest, and that of railroad transportation is small.

Freight	Kca/Ton · Km				
	Automobiles	Railway	Marine	Aviation	Average
1965	1,433	375	244	9,544	598
1970	933	193	281	8,960	522
1980	1,038	86	263	7,631	572
1990	944	60	148	5,180	550
2001	840	59	213	5,252	553

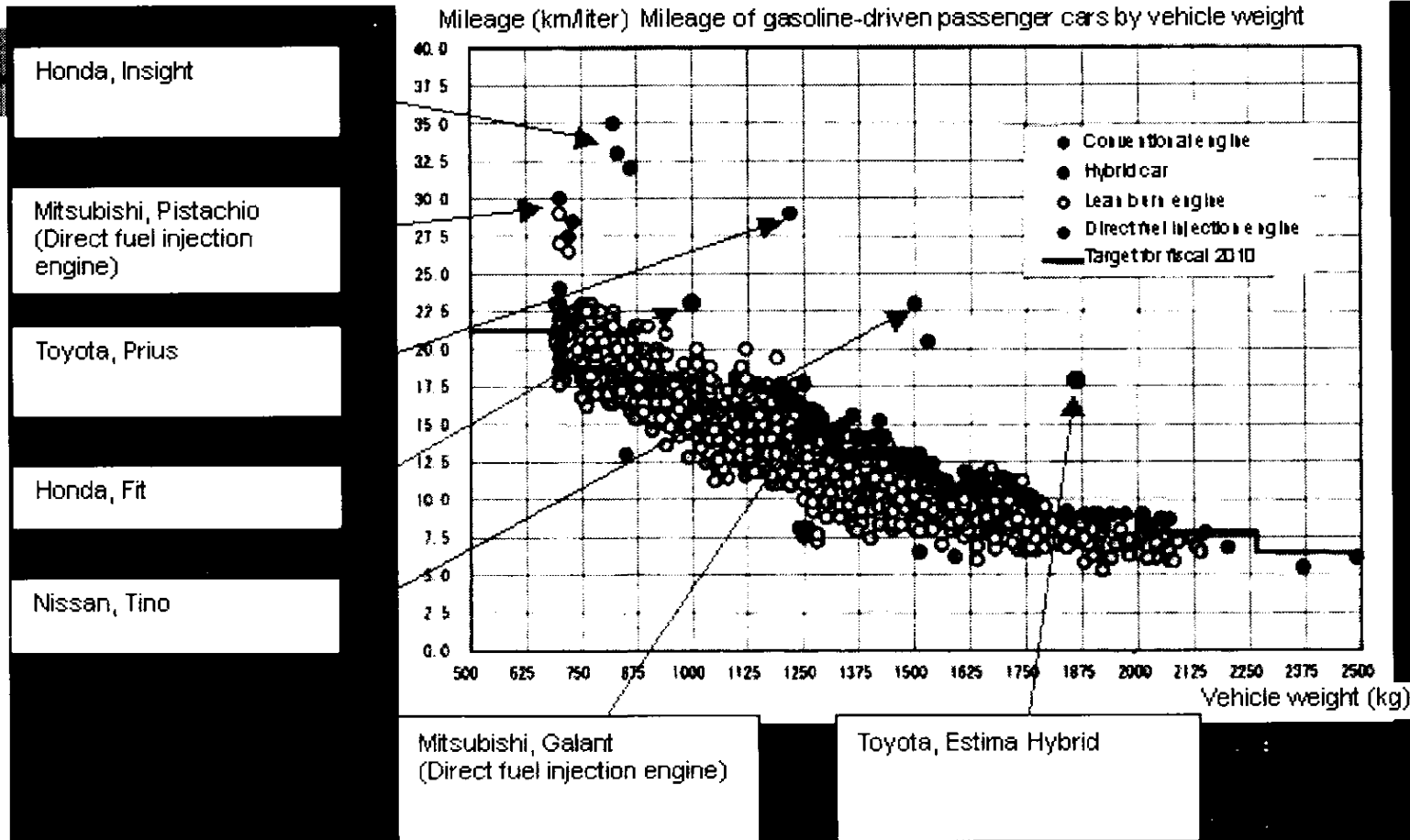
The aircraft transportation, which is the fastest, is by far the largest.

Vehicle Stock by Type and by Size



The numbers of passenger cars and automobiles driven by gasoline are increasing. The numbers of trucks and automobiles driven by diesel fuel are decreasing recently. The larger passenger cars became more popular during the 1970s. In the 1990s, the light motor vehicles increased again reflecting the sluggish economy.

Automobile Mileage by Vehicle Weight (as of the End of March 2001)

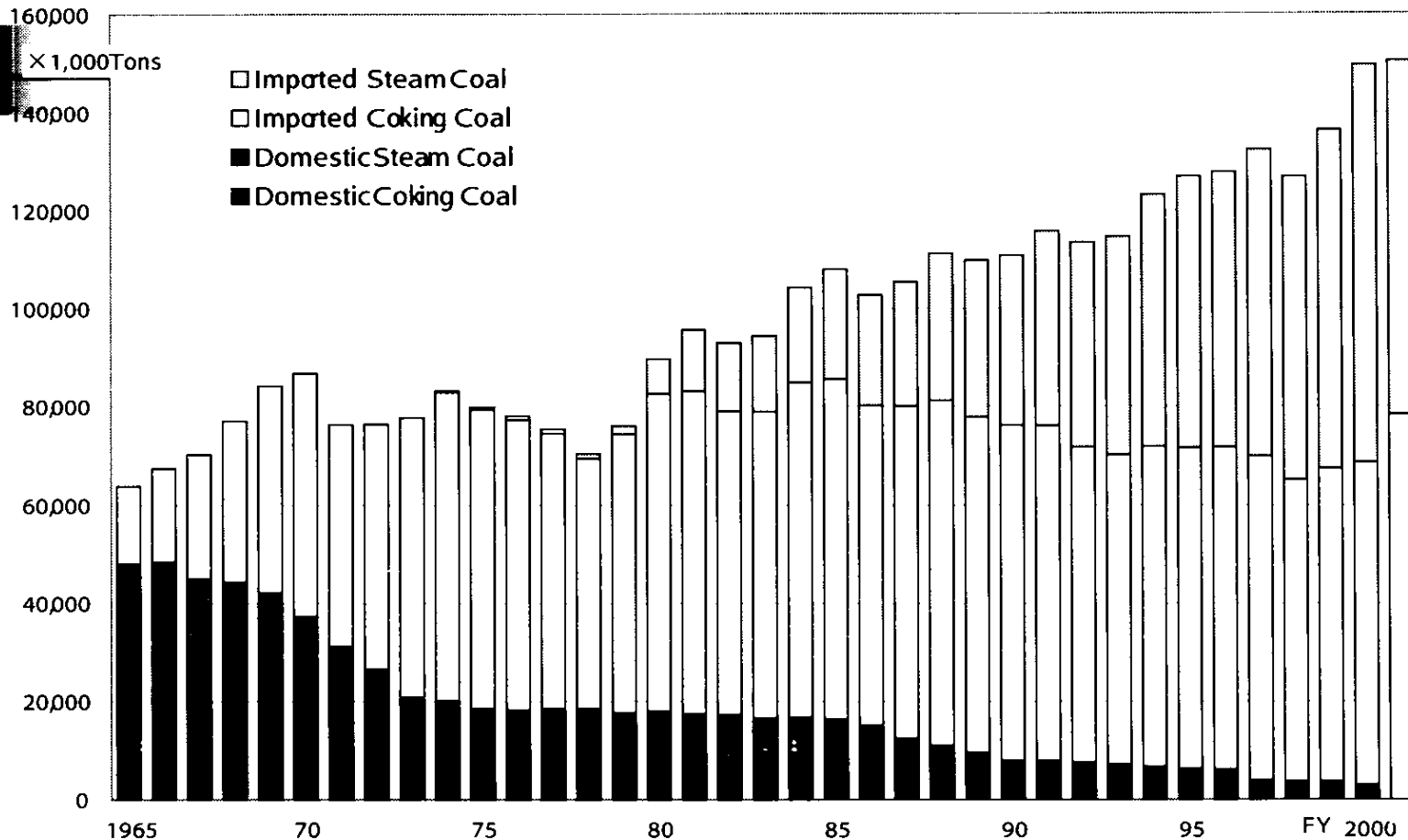


The mileage of Toyota Prius, 29 km/liter, is more than twice the average mileage, 14.1 km/liter, of the present passenger cars of the same weight class.

Chapter 6 Energy Supply and Demand by Source

- Supply and Demand of Coal
- Supply and Demand of Oil
- Supply and Demand of Town Gas
- Supply and Demand of Electric Pc

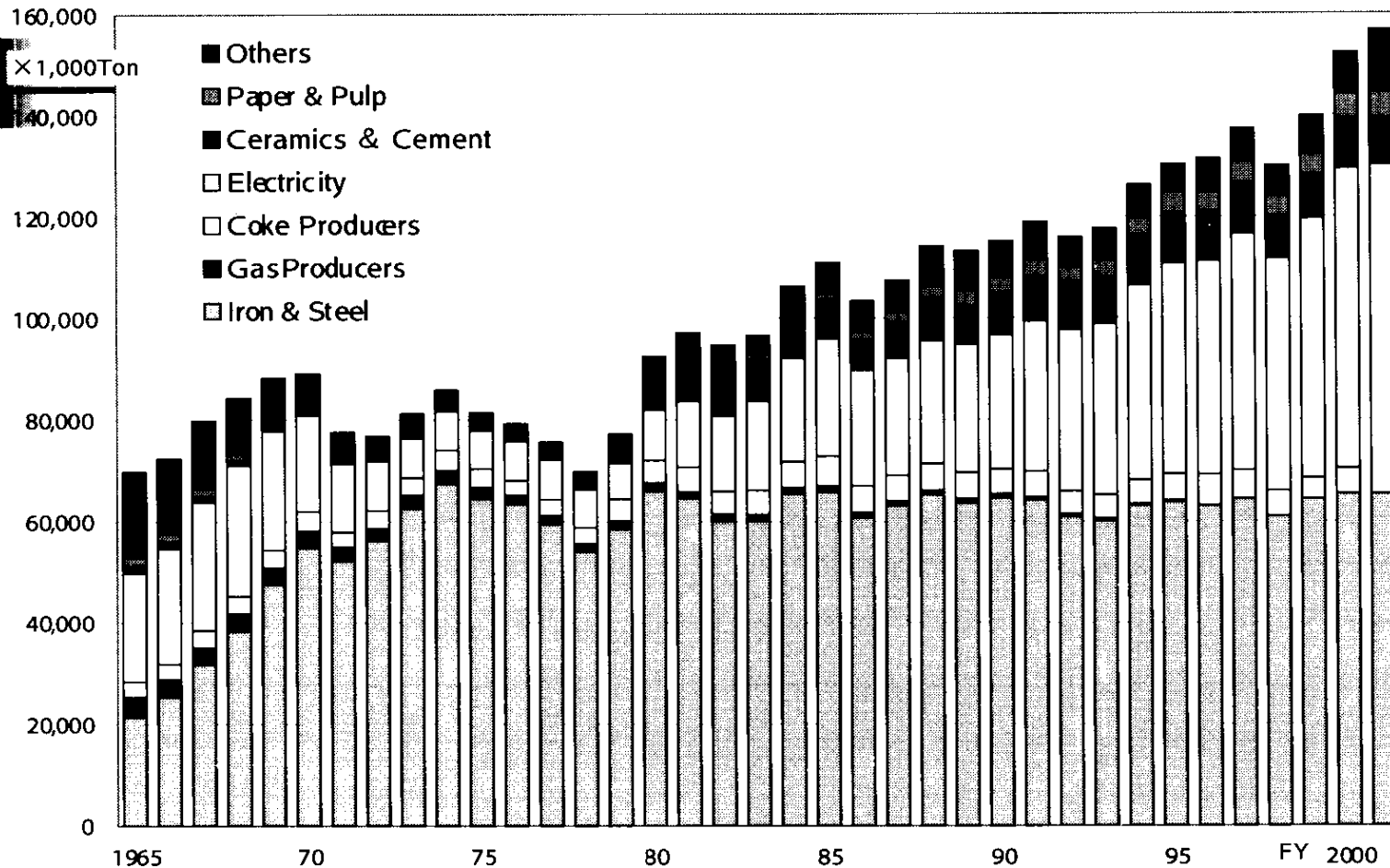
Coal Supply by Type of Coal



The supply of steam coal has been increasing. Though very little in total supply, the supply of anthracite has been increasing.

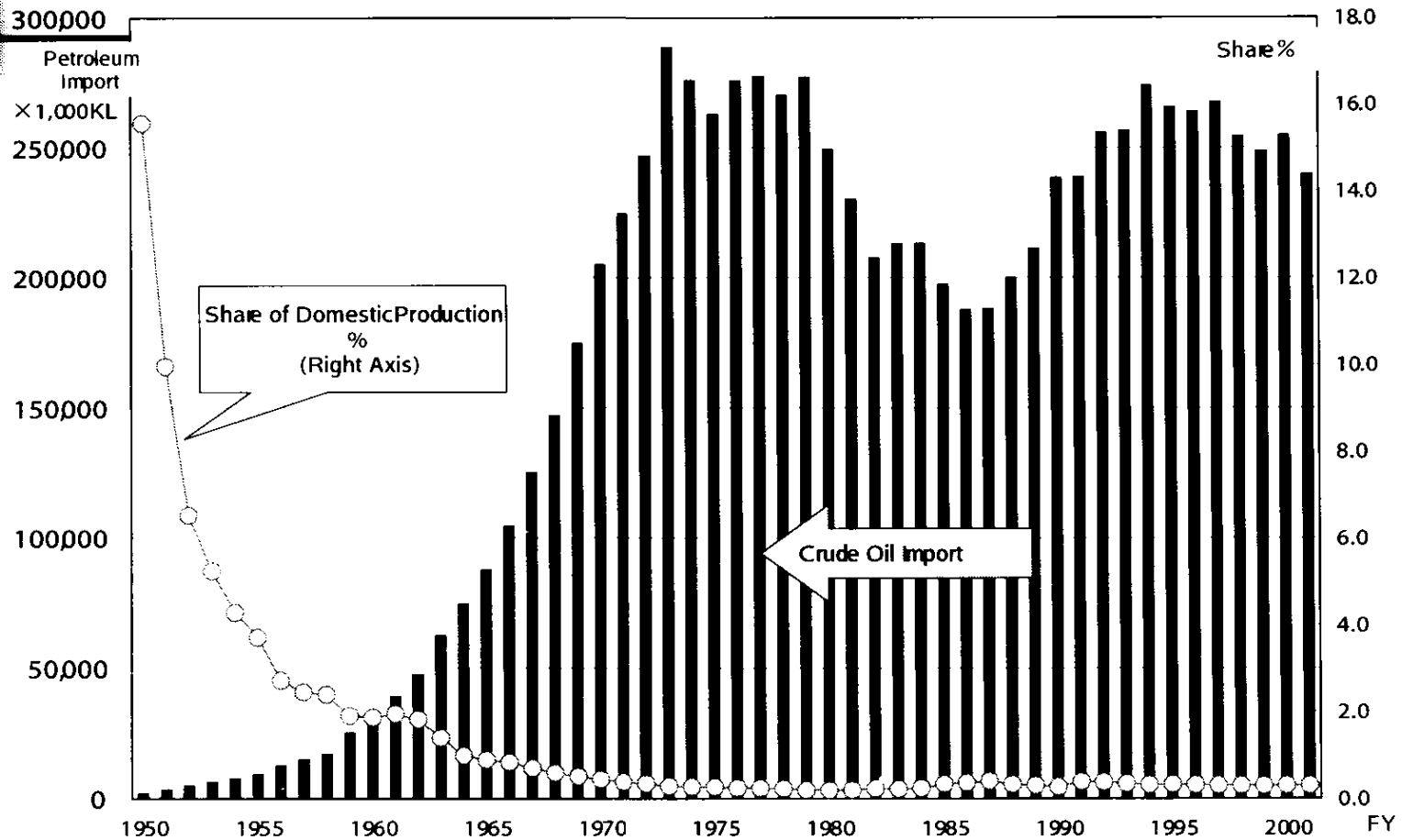
Domestic production of coal peaked in 1961 at 55,410 thousand tons. In Mar. 2002, last coal mine was closed and Japan's domestic coal mine is used only for engineers training now.

Coal Demand by Major Coal Consumer



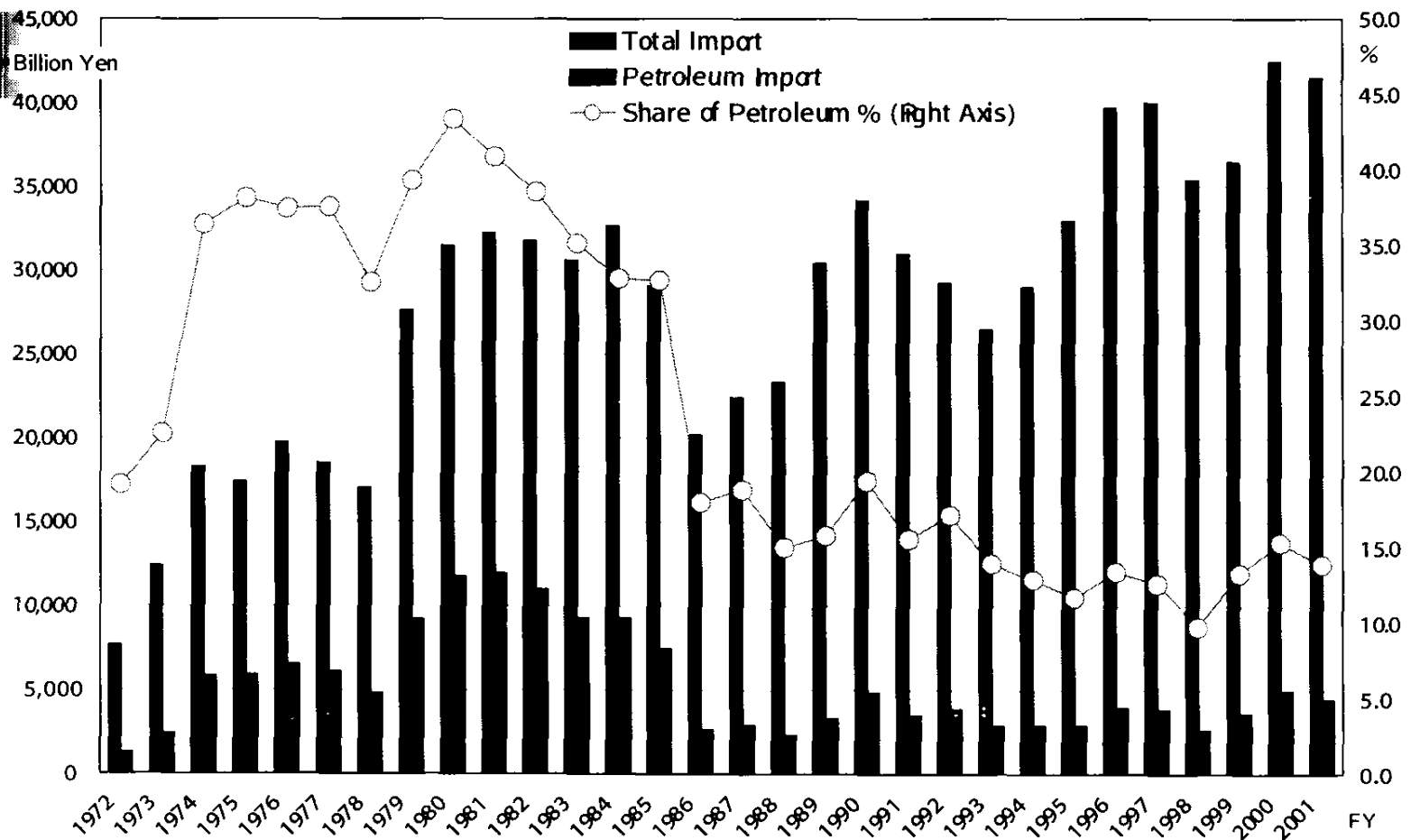
Consumption of coal in Japan has been increasing since fiscal 1978 and came close to 160 million tons in fiscal 2001. The consumption by the iron and steel industry, the largest consumer, has remained almost unchanged recently; however, there is a conspicuous increase in the demand by the electric power utility industry.

Domestic Production and Import of Crude Oil

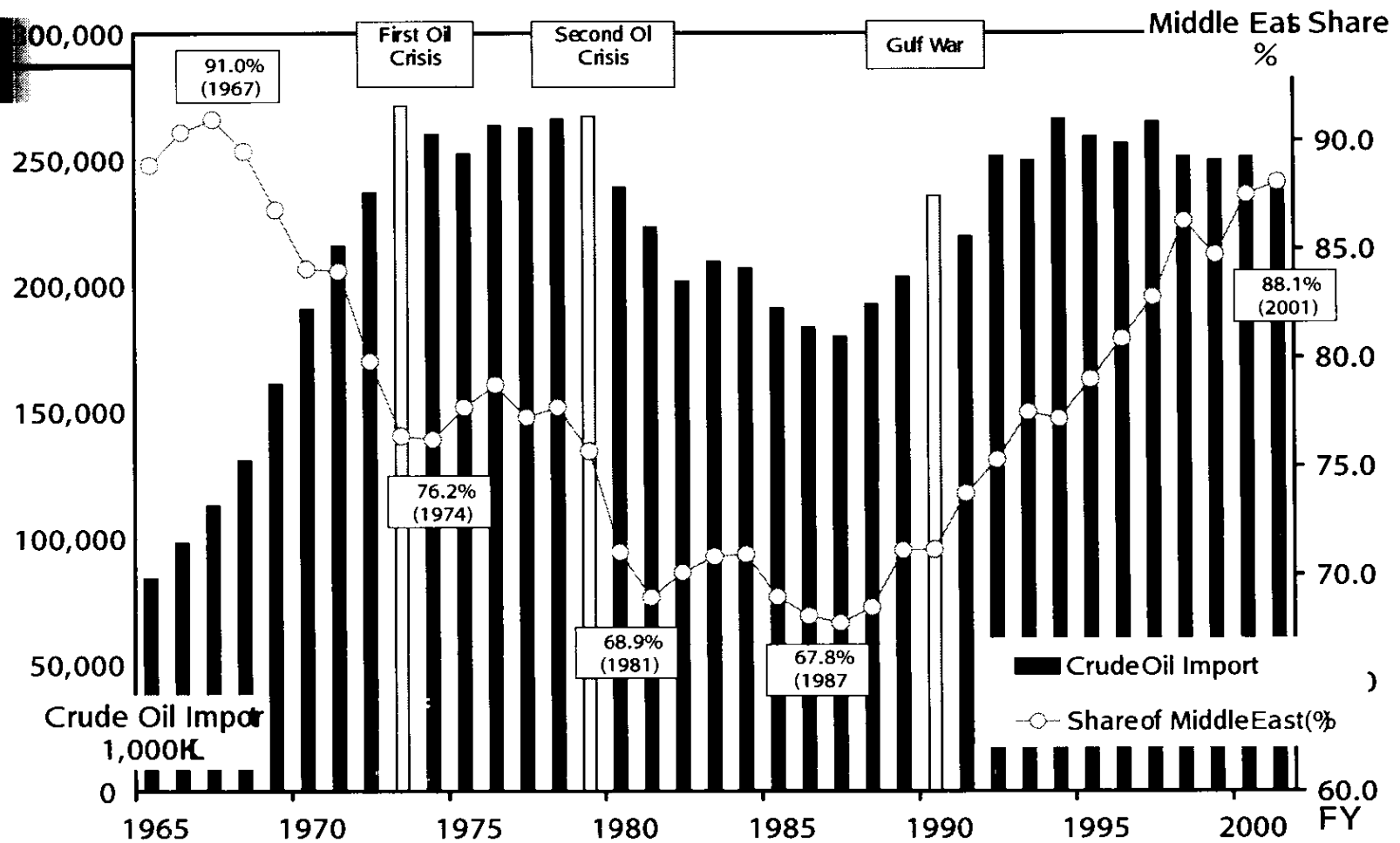


The rate of self-sufficiency of petroleum supply of Japan is 0.3 percent in fiscal 2001 (734,000 KL).

Petroleum Import Accounts

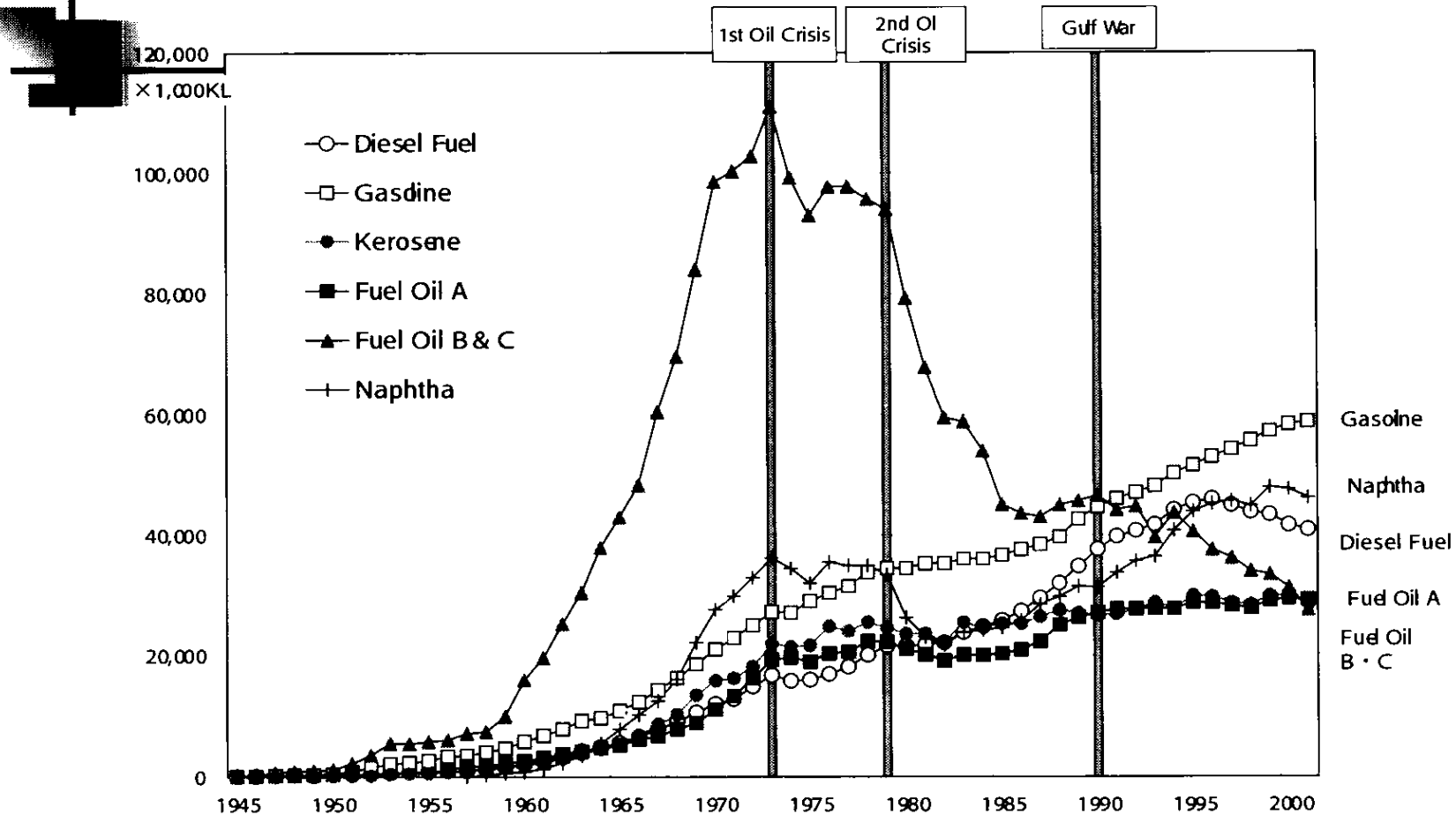


Import of Crude Oil



Japan depends on import from the Middle East to the extent of 88.1% in 2001.

Sales of Petroleum Products by Fuel



Since the latter half of the 1980s, use of alternate energy and energy conservation have been promoted. As a result, sale of heavy fuel oil (Fuel Oil B, C) has declined and that of such distillate fuels as gasoline, kerosene and diesel fuel has increased.

Demand Forecast of Petroleum Products

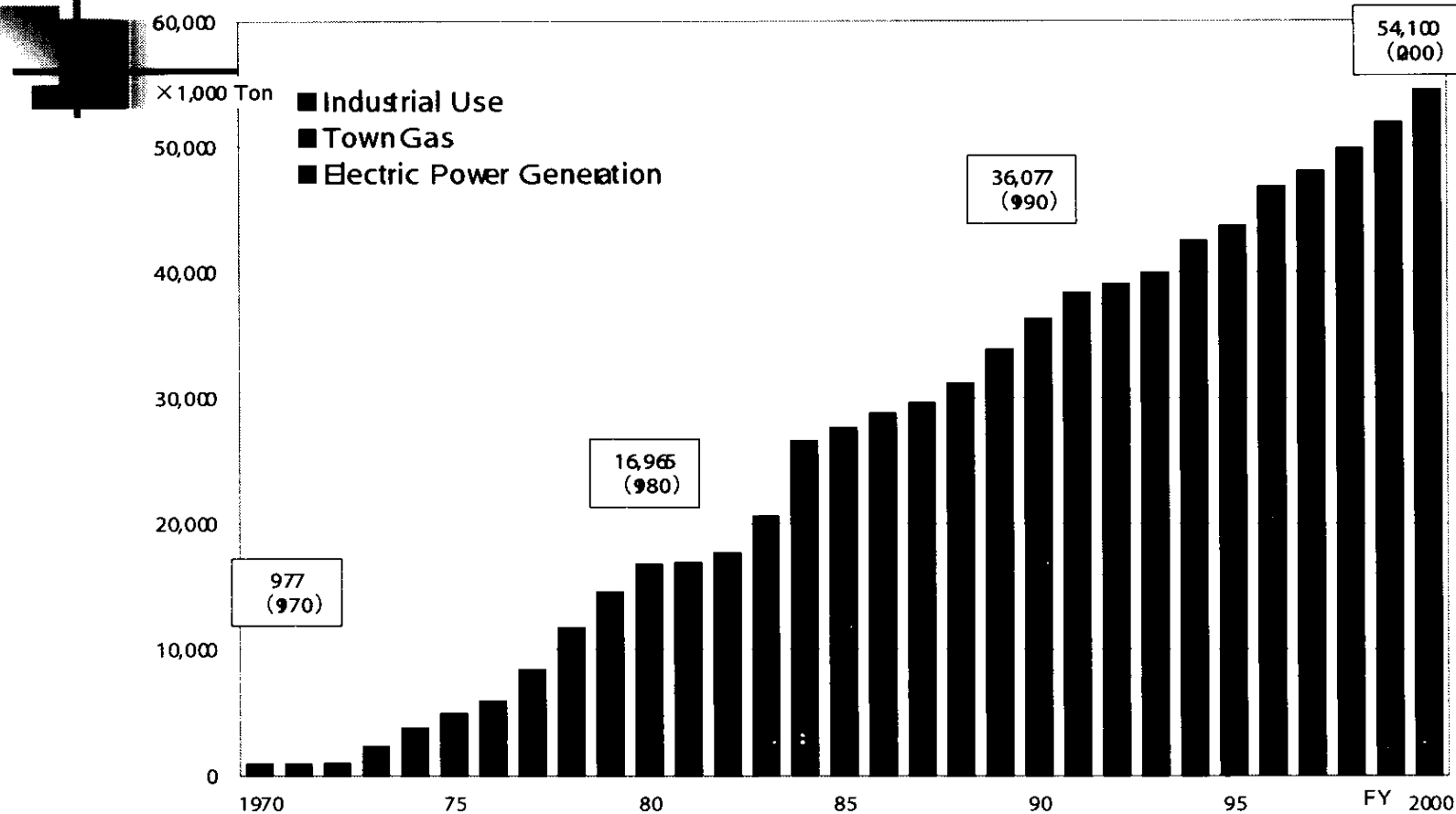
× 1,000K

Actual	1950F	1960F	1970F	1980F	1990F	1995F	1999F	2000F	2001F
Gasoline	460	5,860	21,014	34,543	44,783	51,628	57,251	58,372	58,821
Naphtha		853	27,645	26,299	31,423	43,988	48,004	47,686	46,286
Jet Fuel		192	1,174	2,967	3,739	4,849	4,639	4,608	4,995
Kerosene	89	1,912	15,835	23,565	26,701	30,017	29,949	29,917	28,499
Diesel Fuel	241	2,129	12,003	21,563	37,680	45,452	43,468	41,745	40,957
Fuel Oil	1,190	18,571	109,626	100,282	73,689	69,471	62,656	60,882	56,934
Fuel Oil A		2,600	11,096	21,082	27,066	28,796	29,151	29,510	29,295
Fuel Oil B & C	1,190	15,971	98,530	79,200	46,623	40,675	33,505	31,372	27,639
Fuel Oil Total	1,980	29,517	187,297	209,219	218,012	245,405	245,966	243,211	236,494
Lubricants	212	819	2,432	2,108	2,439	2,335	2,252	2,192	2,089

Forecast	FY2002	Forecast					Growth Rates % 2002/2007	Share %	
	Preliminary	FY2003	FY2004	FY2005	FY2006	FY2007		2002	2007
Gasoline	59,769	60,318	60,623	60,900	61,089	61,155	0.5	24.8	27.3
Naphtha	47,858	46,866	46,376	46,119	46,103	45,977	-0.8	19.9	20.5
Jet Fuel	4,915	4,950	4,962	4,983	4,991	5,010	0.4	2.0	2.2
Kerosene	30,169	29,251	28,928	28,709	28,604	28,602	-1.1	12.5	12.8
Diesel Fuel	39,441	38,314	36,822	35,486	34,364	33,457	-3.2	16.4	14.9
Fuel Oil A	29,845	29,501	29,350	29,277	29,347	29,407	-0.3	12.4	13.1
Fuel Oil B & C	28,711	24,972	22,425	21,413	20,854	20,626	-6.4	11.9	9.2
For Power Generation Use	10,487	7,340	5,059	4,221	3,748	3,571	-19.4	4.4	1.6
Others	18,224	17,632	17,366	17,192	17,106	17,055	-1.3	7.6	7.6
Fuel Oil Total	58,556	54,473	51,775	50,690	50,201	50,033	-3.1	24.3	22.3
Total Demand	240,708	234,172	229,486	226,887	225,352	224,234	-1.4	100.0	100.0

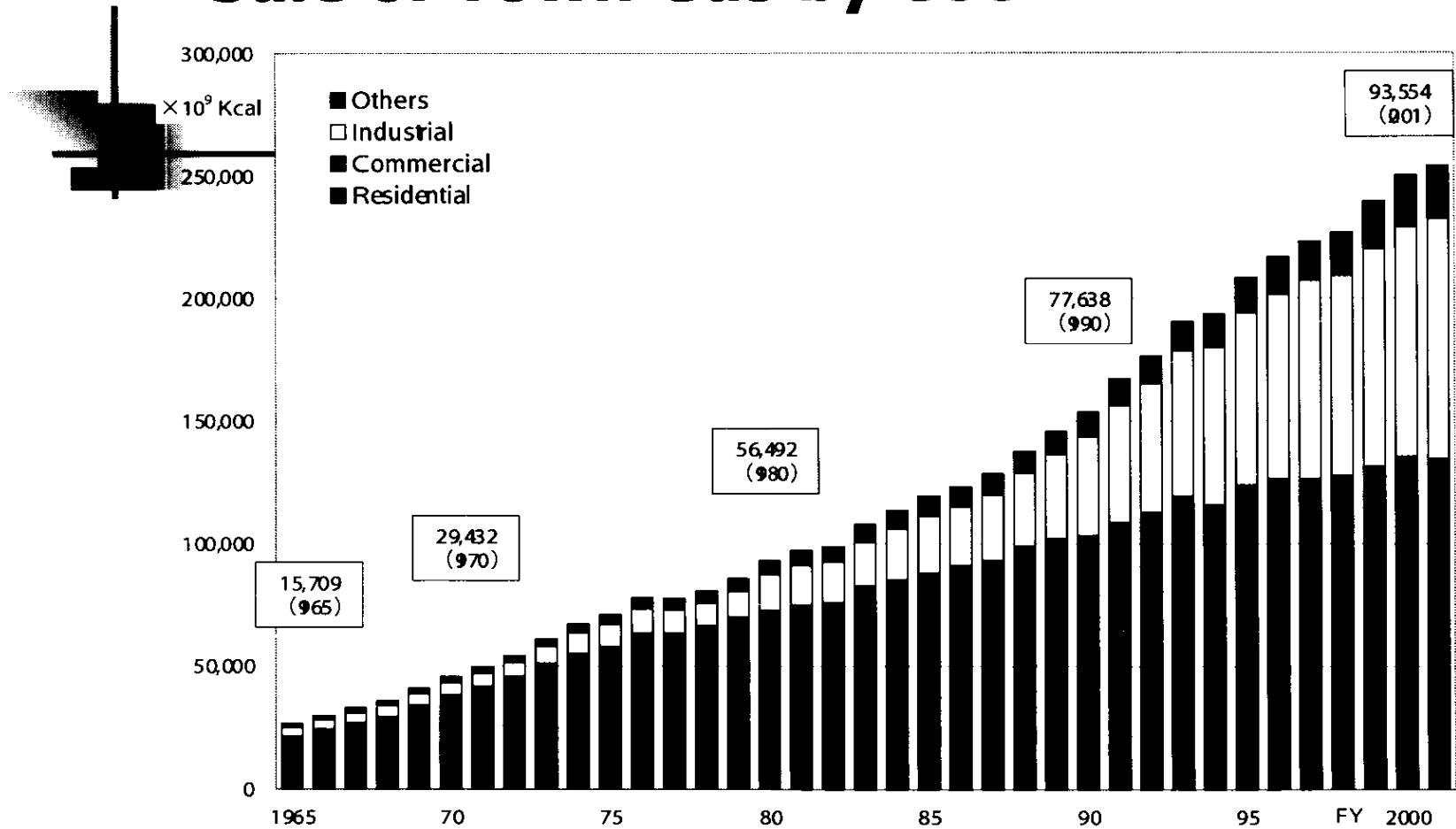
(source) METI, Mar. 2003

LNG Demand by Use



The demand for natural gas in Japan is met almost entirely by the imported LNG. In FY 2001, Japan imported 54.4million tons of LNG. About 70 percent of imported natural gas comes from Indonesia, Malaysia and Brunei, accounting respectively for 30.2, 20.8 and 11.0 percent. The imported LNG is consumed almost entirely for electric power generation, about 70 percent, and for city gas, about 30 percent.

Sale of Town Gas by Use

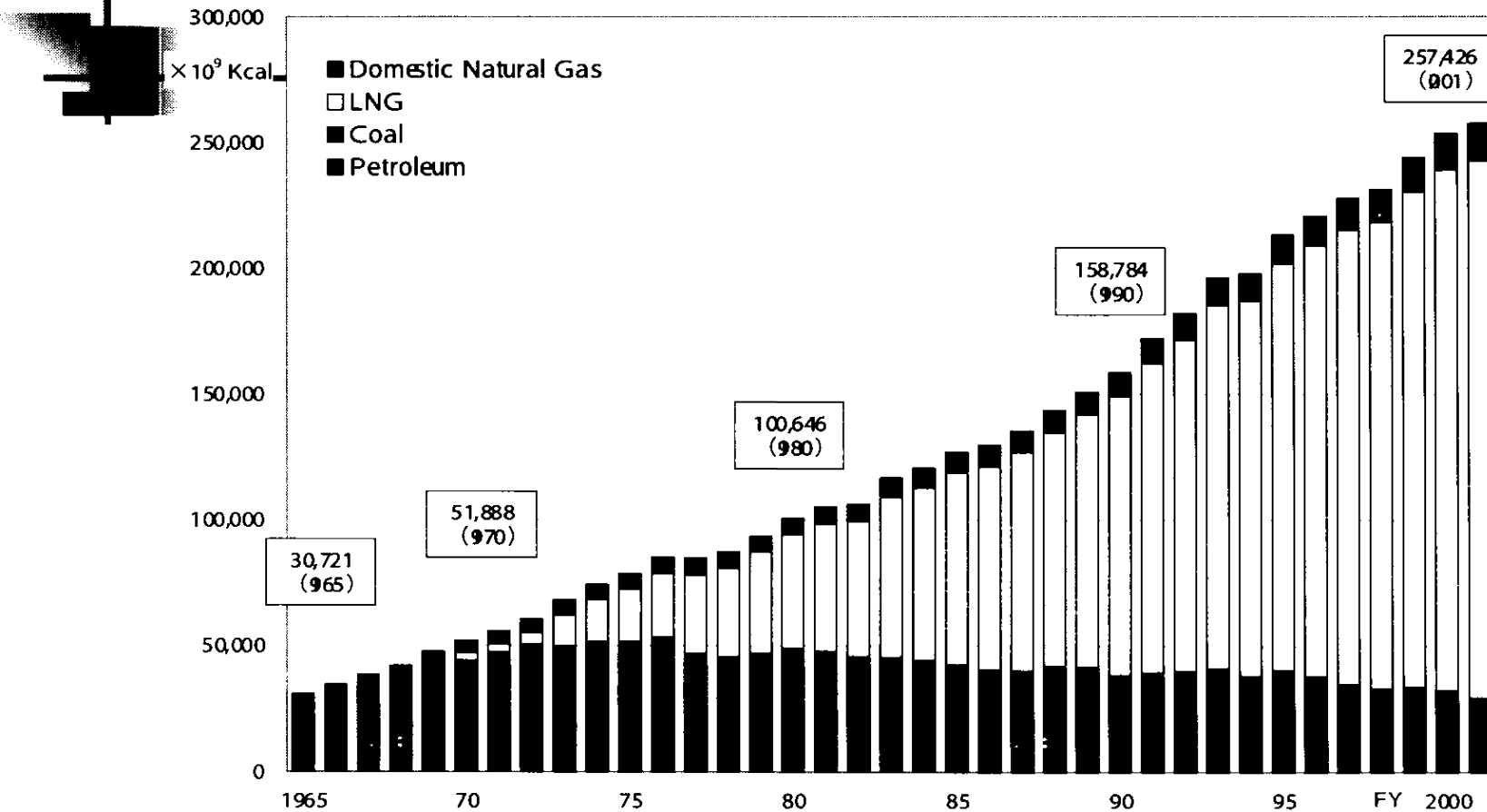


Regarding the ratios of sales by use, the industrial consumption has increased to close to 40 % while that for household use has decreased in relative terms to less than 40%. There are 237 city gas enterprises operating in Japan. Of these gas enterprises, the major four companies jointly occupy 78% of the sale and 68% of the consumer households. Regarding area, city gas supply covers only 5% of the entire area of Japan.

Share of Town Gas by Use

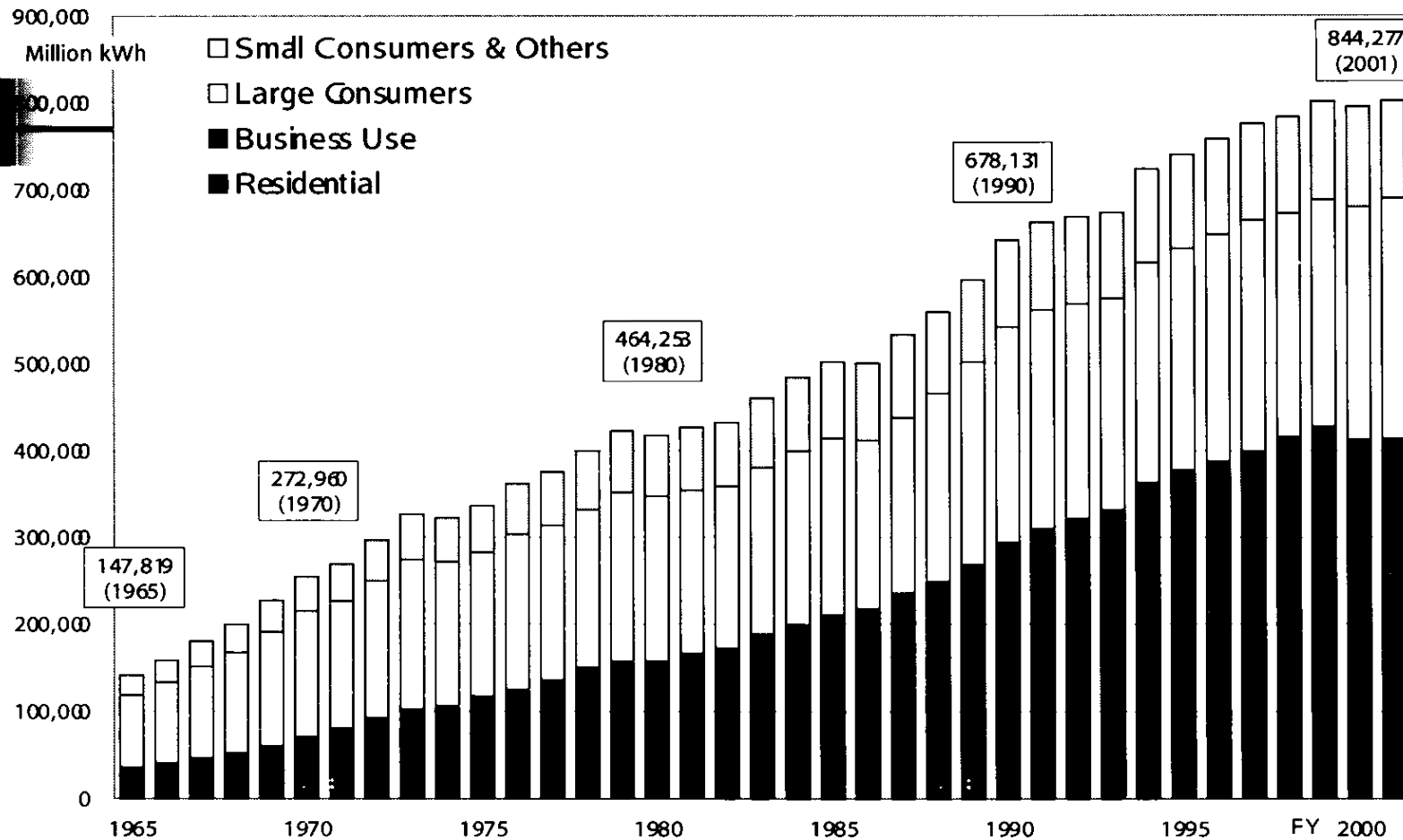


Production and Purchase of Town Gas by Sources



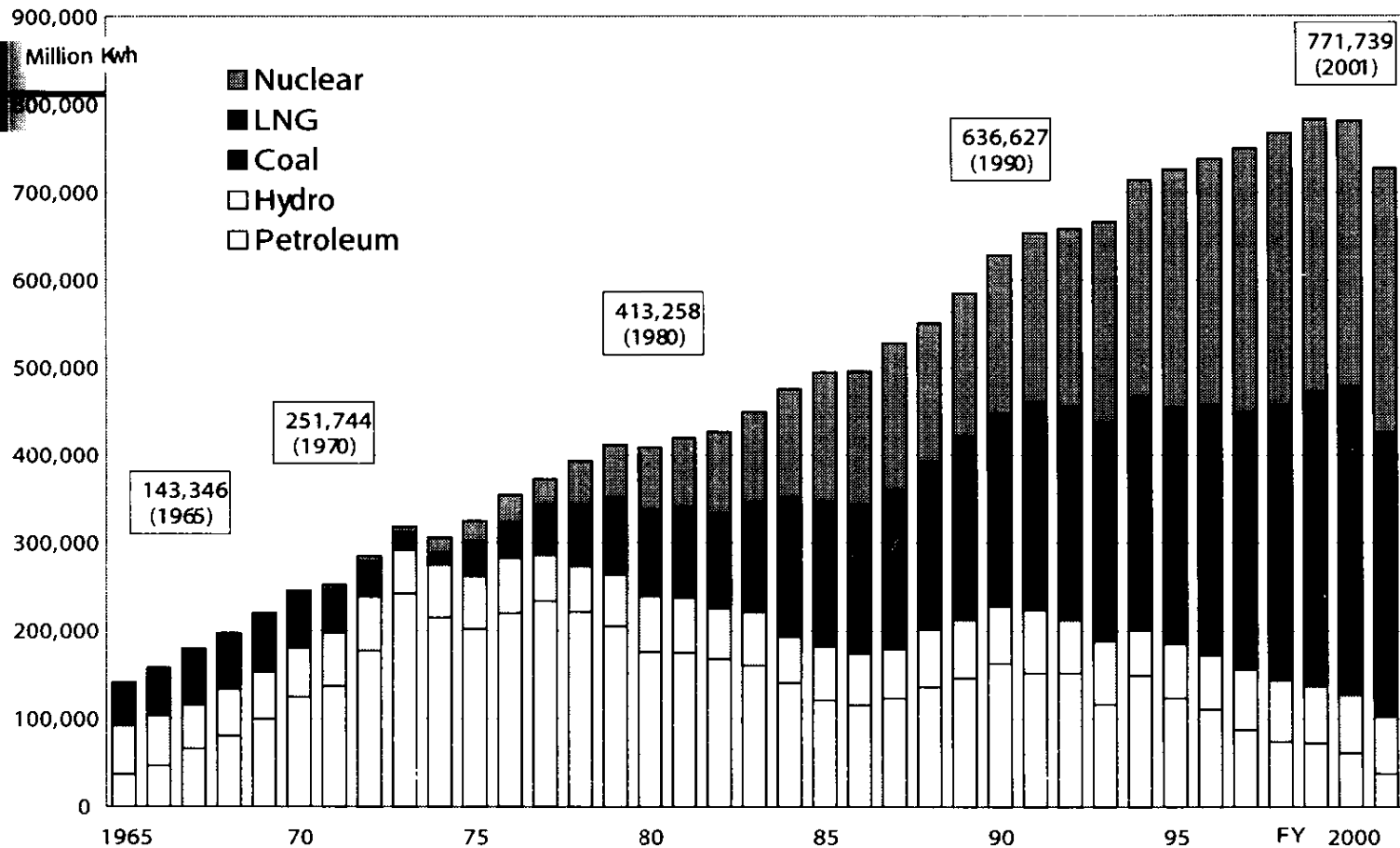
The raw material for the production of city gas has shifted at first from coal to petroleum and then from petroleum to LNG. Now, LNG accounts for 80 percent of the raw material.

Electric Power Demand by Sector (Electric Power Utility Enterprise)



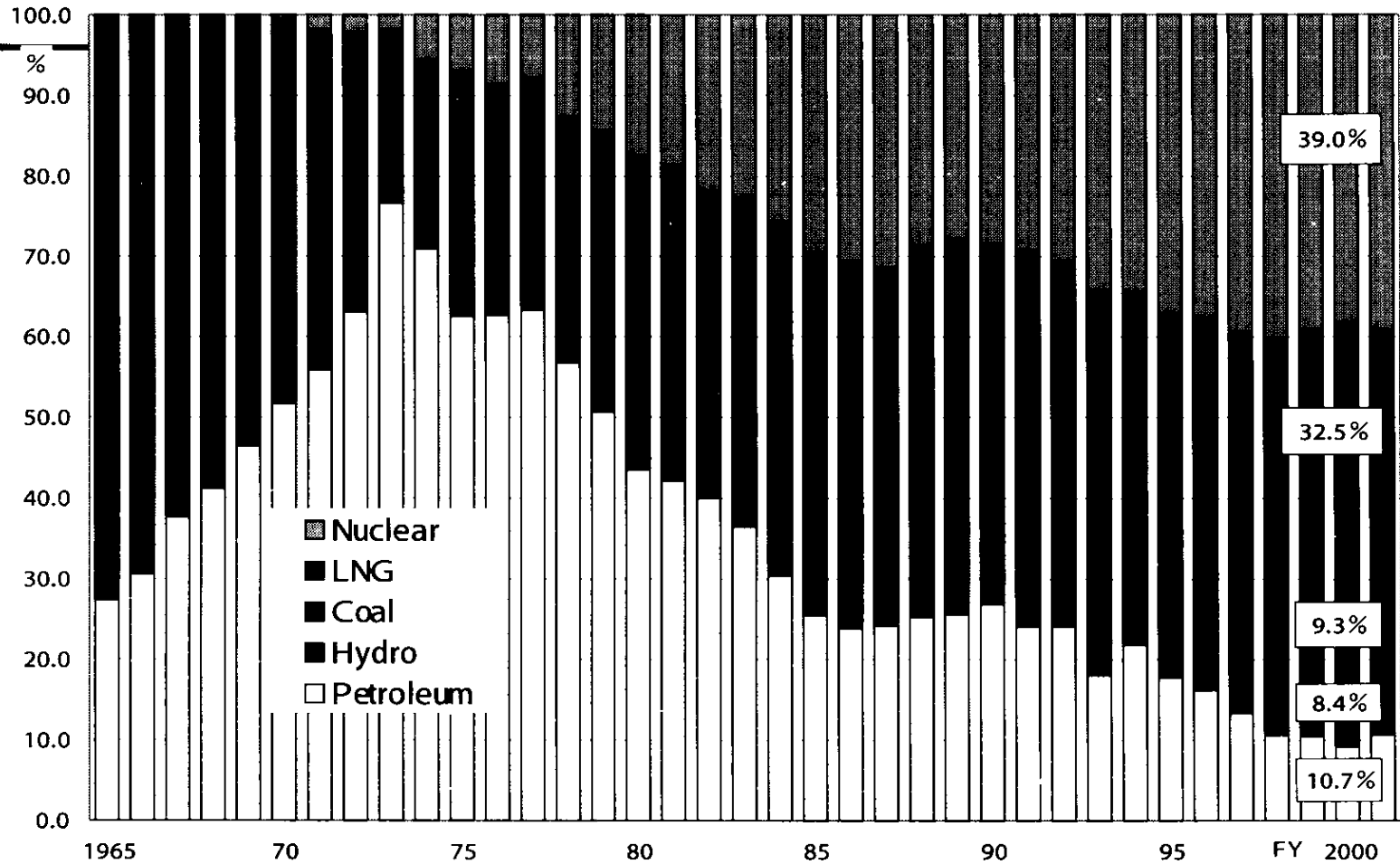
The demand for electricity has grown steadily at a rate greater than that of final total energy consumption. While energy conservation has been promoted and efficiencies of electricity-using facilities have been improved, further penetration of household electric appliances and office automation equipment have contributed to the growth of electric power demand.

Electric Power Generation by Source



The total electric power generated by the top nine electric utility companies indicates that the oil-burning power generation had increased in ratio until fiscal 1973 (74%). Since the first energy crisis, the oil-burning power generation has been steadily declining. By contrast, nuclear power generation and LNG-burning power generation have been increasing since then.

Share of Energy Source for Electric Power Generation



Chapter 7 Energy Supply and Demand Forecast



- Key factors for the future
- Long-term Energy Supply and Demand Forecast

Key factors for the future



- Economic growth, final demand structure, industrial structure (international trade structure, technical structure), IT revolution
- Social factor (aging population, privatism, social advancement of women, increase of nuclear family households, etc.)
- Saturation
- Energy conservation technology (technological advancement, economic incentive)
- Energy price
- Energy policy (promotion of energy conservation, tax system, deregulation, environmental regulation)

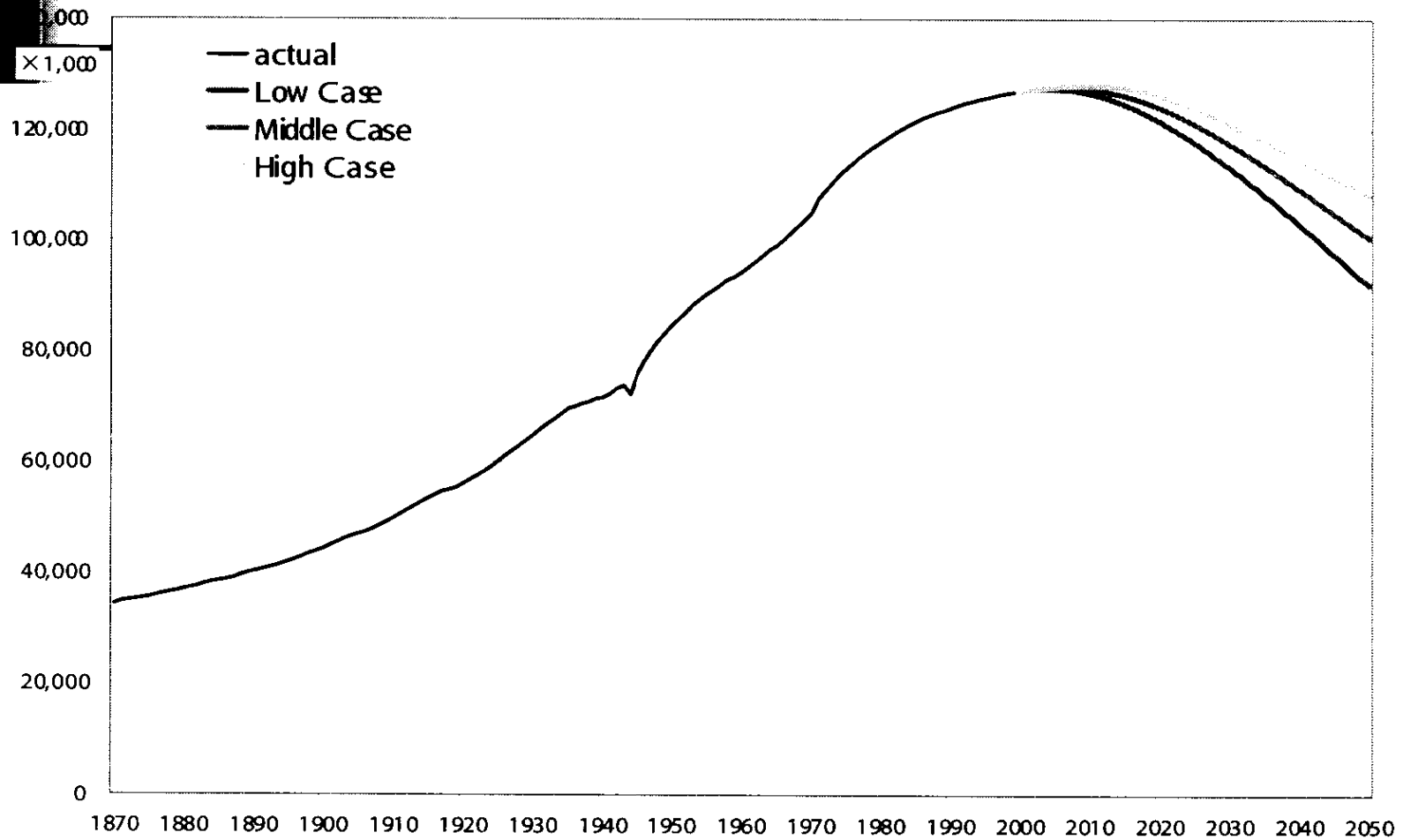
Assumption of the Base Case (Macro Frame)

Fiscal Year		1999	2005	2010	(2020)
Population	Million	126.69	127.68	127.62	124.13
Number of Household	Million	46.69	48.23	49.14	48.85
Working Population	Million	67.79	69.88	69.53	65.52
Nominal CIF Price					
Crude Oil	US\$/BBL	21	24	30	48
LNG	US\$/Ton	183	214	248	350
Steam Coal	US\$/Ton	35	42	45	72
Exchange Rate	Yen/US\$	110	110	110	110

In the Base Case, GDP growth rate was estimated at about 2% up to year 2010

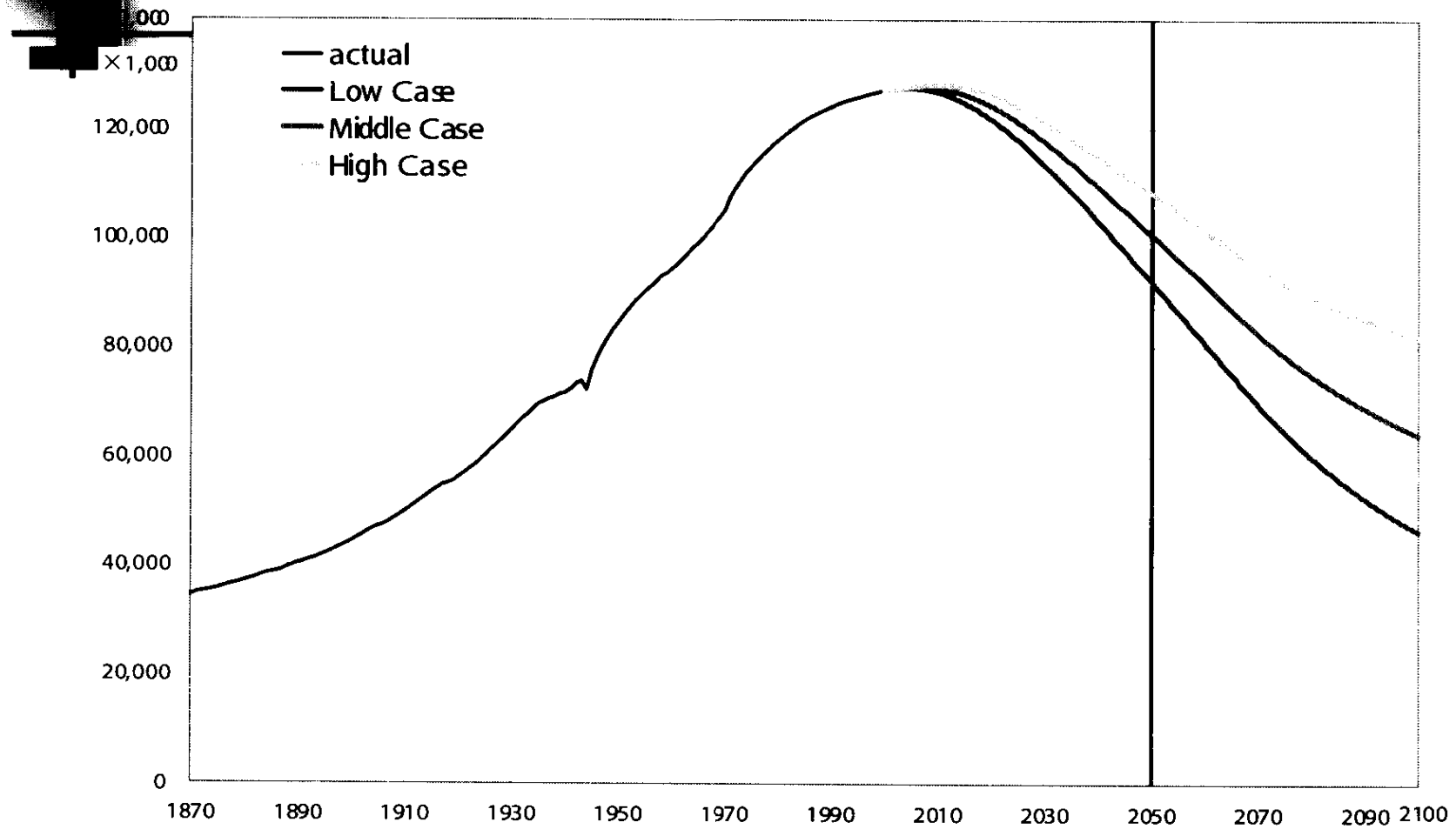
**(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)**

Population Projections for Japan



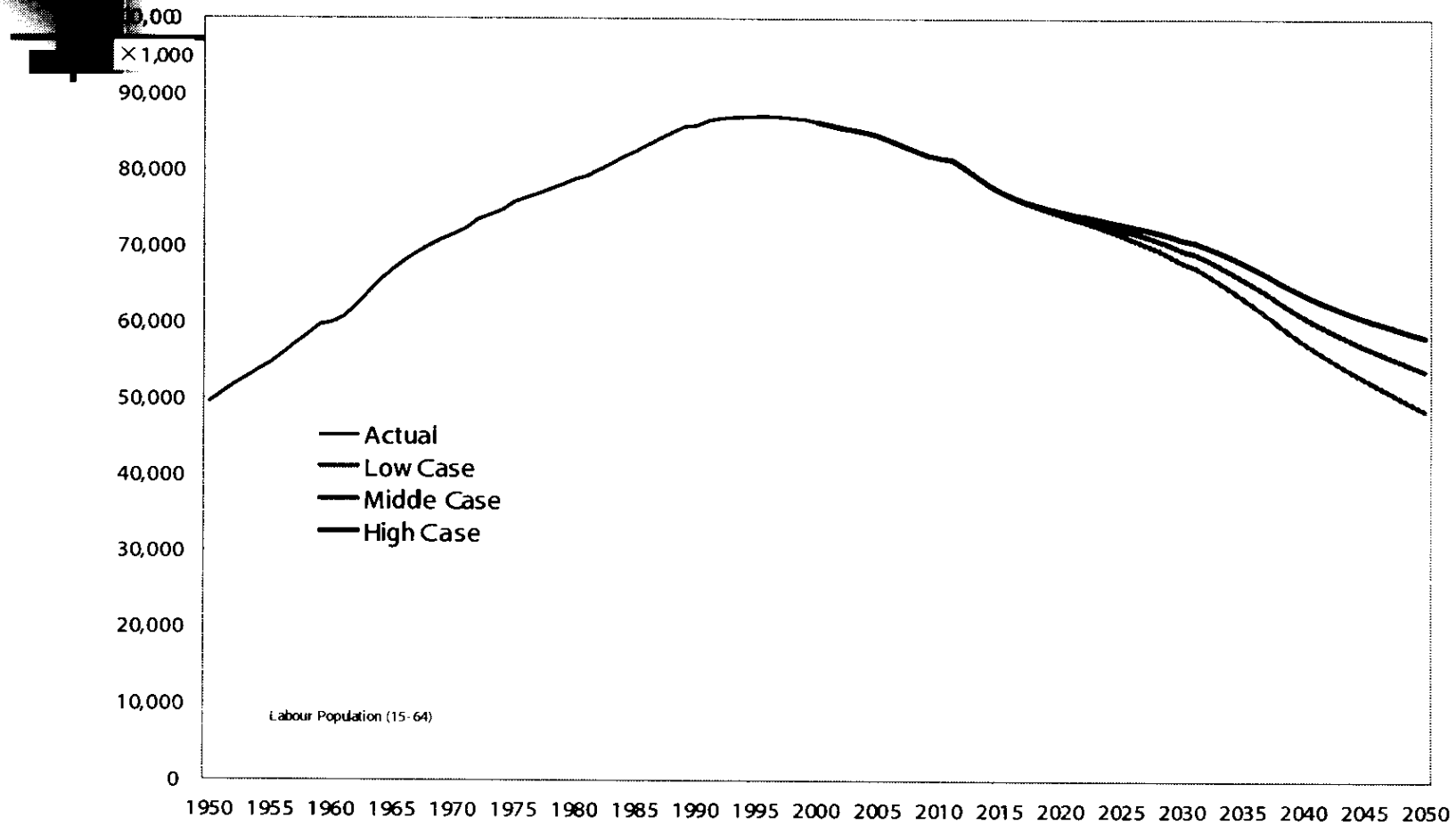
(source) National Institute of Population and Social Security Research

Long-range Population Projections



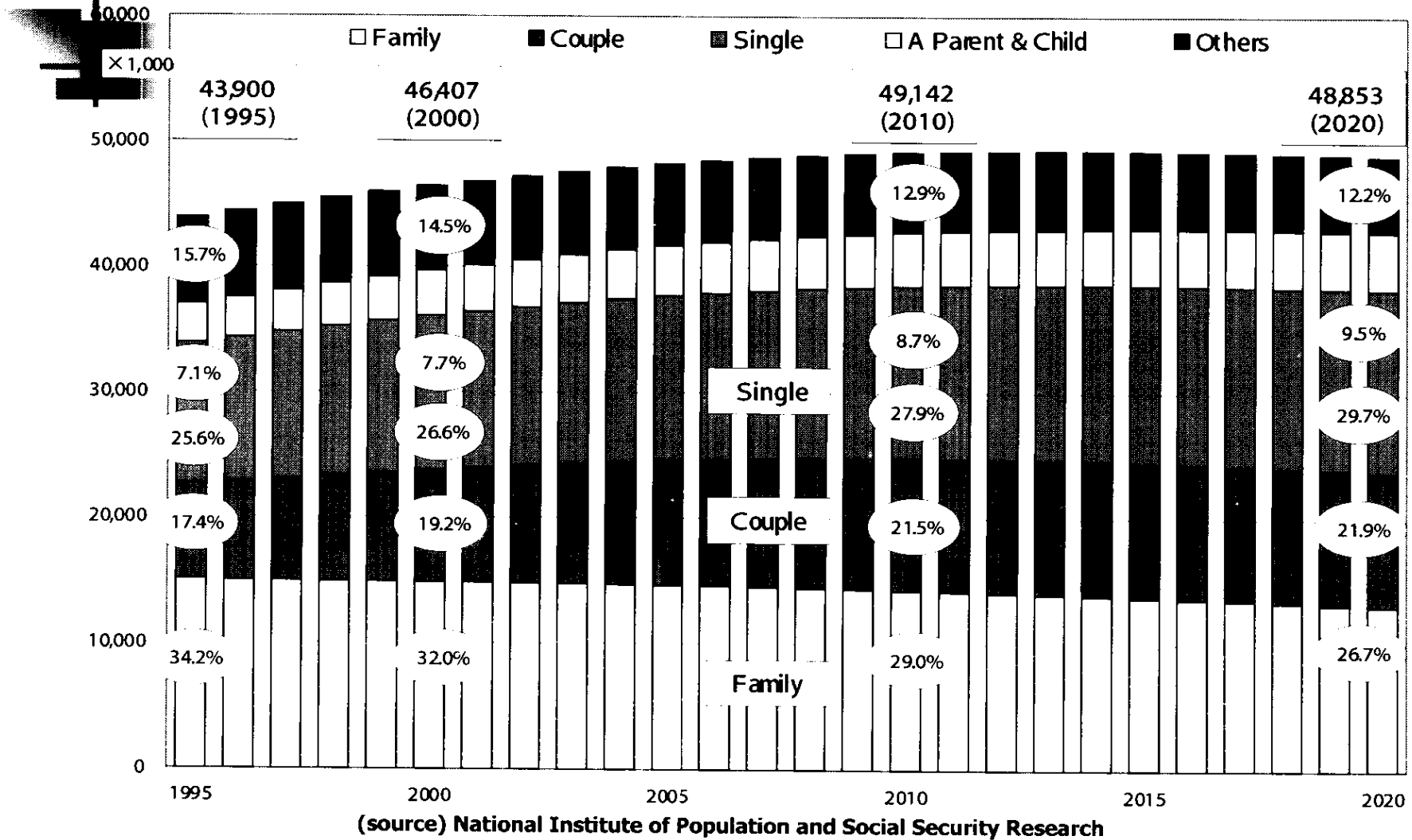
(source) National Institute of Population and Social Security Research

Labor Population Projections

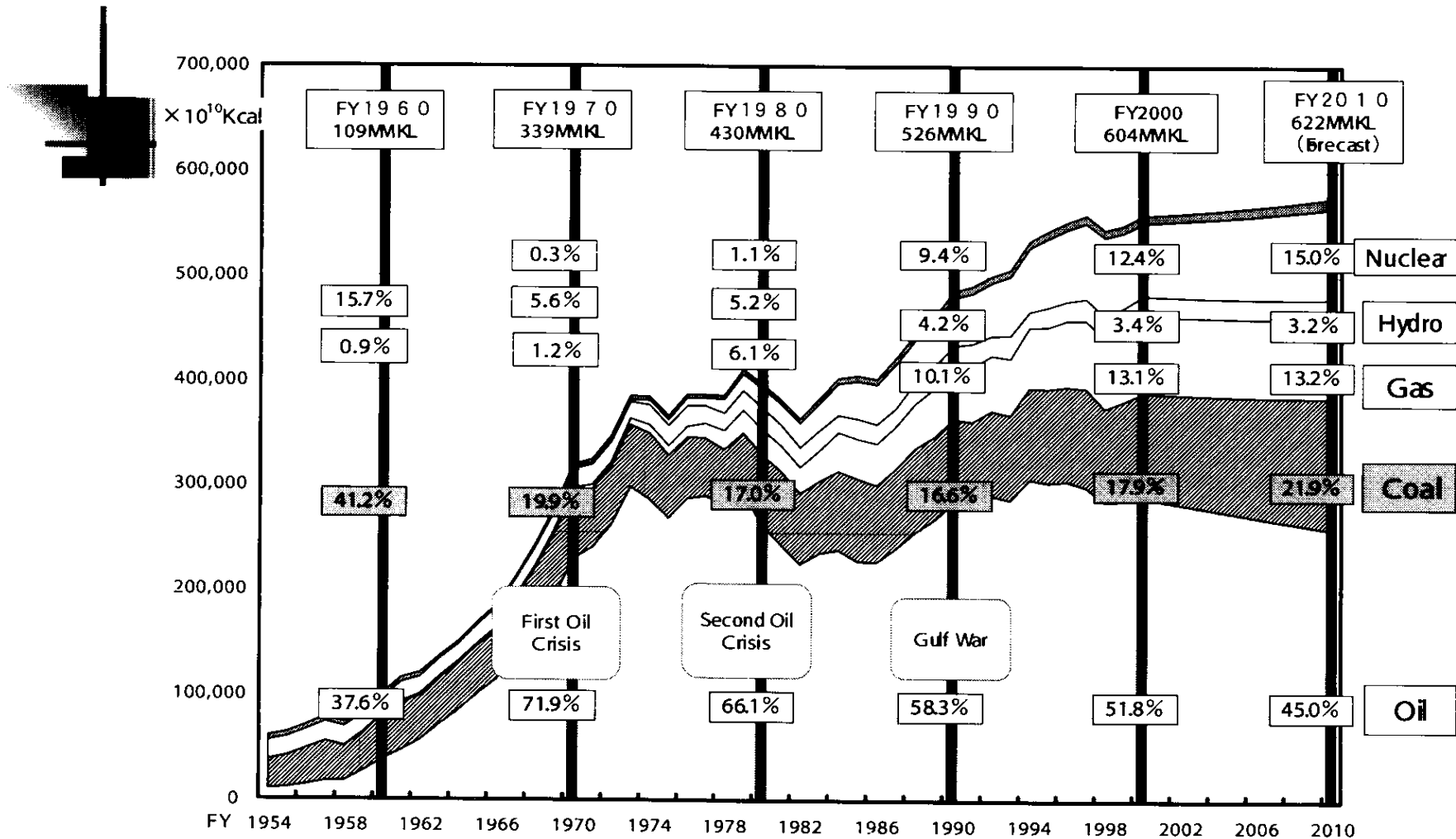


(source) National Institute of Population and Social Security Research

Household Projections for Japan



Forecast of Primary Energy Supply



(source) Advisory Committee for Natural Resources and Energy (ACNRE)
Long-term Energy Supply-Demand Outlook (July, 2001)

END

