Table 6-23 Thailand Natural Gas Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	KTOE/MMscf	0.0243	0.0243	0.0243	0.0243				
	Constants	Gcal/MMscf	246.0	246.0	246.0	246.0				
		1000bbl/MMscf	71.0	74.0	76.0	96.0				
Agriculture	growth rate	%		1.7	1.7	1.7				
Fishing	elastic value			1.0	1.0	1.0				
Forestry	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Mining	growth rate	%		7.5	7.5	5.3				
Quarrying	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	MMscf								
Beverages	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	MMscf								
Wearing	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	MMscf								
Wood Products	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	MMscf								
Printing	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.8	0.8	0.8				
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	MMscf	32500	39060	44153	63634	6.3	6.3	5.4	5.8
Coal	Weight	KTOE	790	949	1073	1546	6.3	6.3	5.4	5.8
Plastics	Calory	1000 Gcal	7895	9609	10862	15654	6.3	6.3	5.4	5.8
	Value	mill baht	2308	2850	3356	6109	7.3	7.7	6.9	6.5
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	MMscf	3500	4558	5435	7426	9.2	9.2	4.6	6.5
Mineral	Weight	KTOE	85	111	132	180	9.2	9.2	4.6	6.5
	Calory	1000 Gcal	861	1121	1337	1827	9.2	9.2	4.6	6.5
	Value	mill baht	249	337	413	713	10.3	10.7	8.3	9.2
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	MMscf								
Machinery	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate									
	elastic value									
	C.S. rate									
Total	Volume	MMscf	36000	43617	49558	71060	6.6	6.6	5.3	5.8
	Weight	KTOE	875	1060	1205	1727	6.6	6.6	5.3	5.8
	Calory	1000 Gcal	8856	10730	12199	17481	6.6	6.6	5.3	5.8
	Value	mill baht	2558	3223	3769	6822	8.1	8.1	8.8	8.5
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			1.0	1.0	1.0				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf	142700	174853	200219	288856	7.0	7.0	5.4	6.1
	Weight	KTOE	3468	4249	4865	7019	7.0	7.0	5.4	6.1
	Calory	1000 Gcal	35104	43014	49254	71061	7.0	7.0	5.4	6.1
	Value	mill baht	10132	12939	15217	27731	8.5	8.4	9.0	8.8
Construction	growth rate	%		7.5	7.5	7.3				
	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			1.2	1.2	1.2				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Banks	growth rate	%		5.9	5.9	5.3				
Insurance	elastic value			1.0	1.0	1.0				
Real estate	C.S. rate	%		100.0	100.0	100.0				
Service	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Total	Volume	MMscf	178700	218470	249807	359926	6.9	6.9	5.4	6.0
	Weight	KTOE	4342	5308	6070	8746	6.9	6.9	5.4	6.0
	Calory	1000 Gcal	43960	53744	61452	88542	6.9	6.9	5.4	6.0
	Value	mill baht	12688	16167	18985	34553	8.4	8.4	8.9	8.7
Forecast	Volume	MMscf	179000		253000	358000				
	Weight	KTOE	4350		6391	8659				

Comment :
growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-24 Thailand Renewable Energy Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	KTOE/1000t	0.4000	0.4000	0.4000	0.4000				
	Constants	1000kcal/t	4000.0	4000.0	4000.0	4000.0				
		baht/t	4000.0	4000.0	4000.0	4000.0				
Agriculture	growth rate	%		1.7	1.7	1.7				
Fishing	plastic value									
Forestry	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Mining	growth rate	%		7.5	7.5	9.3				
Quarrying	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	Value	mill baht								
Manufacturing	growth rate	%		5.6	5.6	6.4				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	1000 t								
Beverages	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		10.2	10.2	7.2				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	1000 t								
Wearing	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		9.4	9.4	6.8				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	1000 t								
Wood Products	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	1000 t								
Printing	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		7.8	7.9	6.7				
	plastic value									
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	1000 t								
Coal	Weight	KTOE								
Plastics	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		11.5	11.5	5.7				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	1000 t								
Mineral	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		8.6	8.6	6.9				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%		8.3	8.3	7.1				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	1000 t								
Machinery	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Manufacturing	growth rate	%		6.9	6.9	6.0				
	plastic value									
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t	5790	5790	5790	5790				
	Weight	KTOE	2316	2316	2316	2316				
	Calory	1000 Gcal	23160	23160	23160	23160				
	value	mill baht	23160	23160	23160	23160				
Manufacturing	growth rate									
	plastic value									
	C.S. rate									
Total	Volume	1000 t	5790	5790	5790	5790				
	Weight	KTOE	2316	2316	2316	2316				
	Calory	1000 Gcal	23160	23160	23160	23160				
	value	mill baht	23160	23160	23160	23160				
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	plastic value									
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Construction	growth rate	%		7.5	7.5	7.3				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	plastic value									
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	1000 t	21800	21800	21800	21800				
	Weight	KTOE	8720	8720	8720	8720				
	Calory	1000 Gcal	87200	87200	87200	87200				
	value	mill baht	87200	87200	87200	87200				
Transportation	growth rate	%			5.4	5.2				
Communication	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Banks	growth rate	%		5.9	5.9	5.3				
Insurance	plastic value									
Real estate	C.S. rate	%		100.0	100.0	100.0				
Service	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Others	growth rate	%		5.0	5.0	5.0				
	plastic value									
	C.S. rate	%		100.0	100.0	100.0				
	Volume	1000 t								
	Weight	KTOE								
	Calory	1000 Gcal								
	value	mill baht								
Total	Volume	1000 t	27590	27590	27590	27590				
	Weight	KTOE	11036	11036	11036	11036				
	Calory	1000 Gcal	110360	110360	110360	110360				
	value	mill baht	110360	110360	110360	110360				
Forecast	Volume	1000 t	27700		27500	27500				
	Weight	KTOE	11080		11000	11000				

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and Industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-25 The Difference between the Energy Demand Prospect by the Thai Government and the Ones by Simulation Model (1992)

Energy sources	Unit	Thai government's prospect	The simulation's prospect	The difference	
				Absolute value difference	%
Coal	1000t	495	493	- 2	- 0.4
lignite	1000t	12115	12176	61	0.5
LPG	1000kl	1713	1706	- 7	- 0.4
Gasoline	1000kl	3423	3445	22	0.6
Diesel	1000kl	8493	8454	- 39	- 0.5
Kerosene	1000kl	152	151	- 1	- 0.7
Fuel Oil	1000kl	3314	3254	- 60	- 1.8
Natural Gas	MMscf	263000	249807	- 13193	- 5.0
Renewable	1000t	27500	27590	90	0.3

Minus signs mean that the simulation's prospect values are smaller than government's prospect values.

Table 6-26 The Difference between the Energy Demand Prospect by the Thai Government and the Ones by Simulation Model (1999)

Energy sources	Unit	Thai government's prospect	The simulation's prospect	The difference	
				Absolute value difference	%
Coal	1000t	4224	4261	37	0.9
lignite	1000t	21828	21341	- 487	- 2.2
LPG	1000kl	2520	2536	16	0.6
Gasoline	1000kl	4740	4731	- 9	- 0.2
Diesel	1000kl	12519	12469	- 50	- 0.4
Kerosene	1000kl	184	182	- 2	- 1.1
Fuel Oil	1000kl	3894	3910	16	0.4
Natural Gas	MMscf	358000	359926	1926	0.5
Renewable	1000t	27500	27590	90	0.3

Minus signs mean that the simulation's prospect values are smaller than the Thai government's prospect values.

According to these results, the differences of 1992 except for natural gas and fuel oil are less than 1% and this can be considered to be within the allowable range. In 1999, the differences except for natural gas and lignite are less than 1% and similarly, this can be considered to be within the allowable range.

The energy consumption value before the energy saving countermeasure can be calculated by the simulation model, the results are shown in Table 6-27. The Used energy prices in the simulation model are quoted from "Total picture status of Energy in Thailand in the Future." (See Table 6-4)

Table 6-27 Prospect of Energy Consumption Value before Energy Saving

(Unit: Mill baht)

Energy sources	1987	1992	1999	99/87 (%)
Coal	299	560	5199	26.9
lignite	1825	3166	5762	10.1
LPG	6669	9213	17500	8.4
Gasoline	22202	29263	51398	7.2
Diesel	35226	54995	107484	9.7
Kerosene	789	1058	1697	6.6
Fuel Oil	6944	9729	15483	6.9
Natural Gas	12688	18985	34553	8.7
Renewable	110360	110360	110360	0.0

6.3 The Energy Demand Prospect in Samut Prakarn before Energy Saving

(1) Calculation condition

The energy demand prospect in Samut Prakarn before energy saving is calculated in the following algorithm.

① For manufacturing, the energy consumption for 1988 of Samut Prakarn is summed from the questionnaires in Samut Prakarn (See table 6-28) and the energy consumption for 1988 of overall Samut Prakarn is estimated through the 1988 summation energy consumption.

② For agriculture, fishery and forestry in Samut Prakarn, the energy consumption is small and there are no reliable sources for estimating them, therefore these sectors are omitted at the time of the simulation model calculations.

③ For commercial and traffic sectors, the gross domestic product ratio of Samut Prakarn toward the overall Thailand is obtained and the energy consumption of commercial and traffic sectors in Samut Prakarn is estimated from the energy consumption of overall Thailand by using the previous ratio.

④ Concerning the industry future growth rate in Samut Prakarn and the energy elastic values to industry's growth rate, the same industry future growth rate and energy elastic values are adopted as those of overall Thailand.

(2) Result of calculation

Tables 6-29 through 6-37 show the calculation results for energy consumption of Samut Prakarn. The summaries of the calculation results are shown in Tables 6-38 through 6-41.

Table 6-28 Samut Prakarn's Energy Consumption by Business Categories

Industry	Heavy oil	Light oil	Kereo-sene	Other liquid	Coal	Renew-able	LNG	LPG
	kl	kl	kl	kl	t	t	MMscf	t
Food Industry	52293	18	613		900	21766		56
Textile Industry	54777	25			1405	3199		608
Wood Industry	134					15448		
Pule and Paper	23991				4730			
Chemical Industry	23613	761				31		267
Cereamic Industry	50100	1400						2350
Iron Industry	22127	51		35				
non ferrous metal	2178							70
Metal & Machine	7381	2823	152	71				7955
Electricity	324000						98182	
Other Industry	438							
Total	560972	5078	765	106	7035	40446	98182	11306
ｻﾑｯﾄﾌﾟﾗｶｰﾝの使用量	738727	5862	789	106	11616	49601	98182	14196
	1.75	1.15	1.03	1.00	1.65	1.23	1.00	1.26
Food Industry	91408	21	632	0	1486	26695	0	70
Textile Industry	95860	29	0	0	2320	3923	0	763
Wood Industry	235	0	0	0	0	18945	0	0
Pule and Paper	41984	0	0	0	7810	0	0	0
Chemical Industry	41323	878	0	0	0	38	0	335
Cereamic Industry	87675	1616	0	0	0	0	0	2951
Iron Industry	38722	59	0	35	0	0	0	0
non ferrous metal	3812	0	0	0	0	0	0	88
Metal & Machine	12917	3259	157	71	0	0	0	9988
Electricity	324000	0	0	0	0	0	98182	0
Other Industry	767	0	0	0	0	0	0	0
Total	738701	5862	789	106	11616	49601	98182	14196

The upper block is energy consumption in aggregate of questionnaires.
The lower block is energy consumption which estimate all area of the district.

Table 6-29 Samut Prakarn Coal Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/t	0.6000	0.6000	0.6000	0.6000				
	Constants	1000kcal/t	6300.0	6300.0	6300.0	6300.0				
		baht/t	950.0	1050.0	1130.0	1220.0				
Manufacturing	growth rate	%		5.6	5.8	4.4				
	elastic value			0.8	0.8	0.6				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	t	1486	1695	1850	2357	4.5	4.5	3.5	3.9
Beverages	Weight	TOE	892	1017	1110	1414	4.5	4.5	3.5	3.9
	Calory	Gcal	9362	10677	11655	14849	4.5	4.5	3.5	3.9
	value	1000 baht	1412	1780	2091	2876	8.0	8.4	4.7	6.1
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.6				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	t	2320	2936	3434	5082	8.2	8.2	5.8	6.8
Wearing	Weight	TOE	1392	1761	2061	3049	8.2	8.2	5.8	6.8
	Calory	Gcal	14616	18494	21635	32019	8.2	8.2	5.8	6.8
	value	1000 baht	2204	3082	3881	6201	11.8	12.2	8.9	9.0
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.8	0.6				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	t								
Wood Products	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	t	7810	9155	10178	14132	5.4	5.4	4.8	5.3
Printing	Weight	TOE	4686	5493	6107	8479	5.4	5.4	4.8	5.3
	Calory	Gcal	49203	57678	64124	89032	5.4	5.4	4.8	5.3
	value	1000 baht	7420	9613	11502	17241	9.0	9.4	6.0	7.5
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.8	0.9	1.1				
	C.S. rate	%		100.0	100.0	100.0				
Chemical	Volume	t								
Petroleum	Weight	TOE								
Coal	Calory	Gcal								
Plastics	value	1000 baht								
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.8	0.9	1.1				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	t								
Mineral	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	t								
Machinery	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value									
	C.S. rate	%								
Total	Volume	t	11816	13786	15463	21572	5.5	5.9	4.9	5.3
	Weight	TOE	6970	8271	9278	12943	5.9	5.9	4.9	5.3
	Calory	Gcal	73181	86849	97414	135901	5.9	5.9	4.9	5.3
	value	1000 baht	11035	14475	17472	26317	9.5	9.9	6.0	7.5
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			1.5	2.0	1.6				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	t	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	TOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	value	1000 baht	0	0	0	0	0.0	0.0	0.0	0.0
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			1.1	1.1	1.1				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	t	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	TOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	value	1000 baht	0	0	0	0	0.0	0.0	0.0	0.0
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	t	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	TOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	value	1000 baht	0	0	0	0	0.0	0.0	0.0	0.0
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	t	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	TOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	value	1000 baht	0	0	0	0	0.0	0.0	0.0	0.0
Total	Volume	t	11816	13786	15463	21572	5.5	5.9	4.9	5.3
	Weight	TOE	6970	8271	9278	12943	5.9	5.9	4.9	5.3
	Calory	Gcal	73181	86849	97414	135901	5.9	5.9	4.9	5.3
	value	1000 baht	11035	14475	17472	26317	9.5	9.9	6.0	7.5
Forecast	Volume	t								
	Weight	TOE								

Comment : growth rate = 1000 baht
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
TOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-30 Samut Prakarn Lignite Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/t	0.3600	0.2750	0.2750	0.2750				
	Constants	1000kcal/t	3500.0	3500.0	3500.0	3500.0				
		baht/t	250.0	250.0	260.0	270.0				
Manufacturing	growth rate	%		5.6	5.0	4.4				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	t								
Beverages	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	t								
Wearing	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	t								
Wood Products	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	t								
Printing	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		7.8	7.8	6.7				
	elastic value			0.8	0.8	0.8				
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	t								
Coal	Weight	TOE								
Plastics	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	t								
Mineral	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		8.5	8.4	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		8.5	8.5	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	t								
Machinery	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate									
	elastic value									
	C.S. rate									
Total	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			1.5	2.0	1.6				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			1.1	1.1	1.1				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Total	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Forecast	Volume	t								
	Weight	TOE								

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
kTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-31 Samut Prakarn LPG Consumption (base case)

Industry	Items	U n i t	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/kl	0.6301	0.6301	0.6301	0.6301				
	Constants	1000kcal/kl	6360.0	6360.0	6360.0	6360.0				
		baht/kl	5200.0	5300.0	5400.0	6900.0				
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	kl	70	78	85	105	3.9	3.9	3.1	3.4
Beverages	Weight	TOE	44	49	53	66	3.9	3.9	3.1	3.4
	Calory	Gcal	445	500	540	667	3.9	3.9	3.1	3.4
	value	1000 baht	364	415	453	724	6.8	4.9	6.8	5.9
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	kl	763	936	1077	1520	7.1	7.1	5.0	5.9
Wearing	Weight	TOE	481	591	679	958	7.1	7.1	5.0	5.9
	Calory	Gcal	4853	5968	6851	9665	7.1	7.1	5.0	5.9
	value	1000 baht	3966	4973	5817	10486	7.8	8.1	8.8	8.4
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	kl								
Wood Products	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		-5.8	6.8	6.0				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	kl								
Printing	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.7	0.7	0.7				
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	kl	325	354	438	604	5.5	5.5	4.7	5.0
Coal	Weight	TOE	211	248	275	381	5.5	5.5	4.7	5.0
Plastics	Calory	Gcal	2131	2506	2785	3845	5.5	5.5	4.7	5.0
	value	1000 baht	1742	2087	2368	4170	6.2	6.5	6.4	7.5
Manufacturing	growth rate	%		11.5	11.5	8.7				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	kl	2951	3723	4346	5715	8.1	8.1	4.0	5.7
Mineral	Weight	TOE	1859	2346	2738	3601	8.1	8.1	4.0	5.7
	Calory	Gcal	18768	23676	27641	36349	8.1	8.0	4.0	5.7
	value	1000 baht	15345	19730	23469	35435	8.7	9.1	7.7	8.2
Manufacturing	growth rate	%		8.6	8.6	6.5				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.7	0.7	0.7				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	kl	9988	11832	13247	18502	5.8	5.8	5.0	5.9
Machinery	Weight	TOE	6293	7455	8347	11721	5.8	5.8	5.0	5.9
	Calory	Gcal	63524	75252	84250	118311	5.8	5.8	5.0	5.9
	value	1000 baht	51938	62710	71533	126356	6.5	6.8	8.7	7.8
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.7	0.7	0.7				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								

Industry	Items	U n i t	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value									
	C.S. rate	%								
Total	Volume	kl	14107	16965	19153	26547	6.3	6.4	4.7	5.4
	Weight	TOE	8889	10690	12069	16727	6.3	6.4	4.7	5.4
	Calory	Gcal	89721	107899	121810	168836	6.3	6.4	4.7	5.4
	value	1000 baht	73356	89516	103644	183171	7.0	7.4	8.5	7.9
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			0.6	0.6	0.6				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			1.2	1.2	1.2				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	kl	11165	13208	14774	22390	5.8	5.8	6.1	6.0
	Weight	TOE	7035	8322	9308	14108	5.8	5.8	6.1	6.0
	Calory	Gcal	71009	84000	93956	142358	5.8	5.8	6.1	6.0
	value	1000 baht	58056	70000	79774	154188	6.4	6.8	9.9	8.5
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	3401	4044	4558	6899	5.9	5.9	5.7	5.8
	Weight	TOE	2143	2548	2871	4221	5.9	5.9	5.7	5.8
	Calory	Gcal	21629	25717	28863	42603	5.9	5.9	5.7	5.8
	value	1000 baht	17684	21431	24500	46221	6.6	6.9	8.5	8.3
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			0.9	0.9	0.9				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	13	15	17	23	4.5	4.5	4.5	4.5
	Weight	TOE	8	10	11	14	4.5	4.5	4.5	4.5
	Calory	Gcal	85	97	100	145	4.5	4.5	4.5	4.5
	value	1000 baht	70	81	90	157	5.2	5.5	8.2	7.0
Total	Volume	kl	28686	34232	38521	55658	6.1	6.1	5.4	5.7
	Weight	TOE	18075	21569	24272	35070	6.1	6.1	5.4	5.7
	Calory	Gcal	182445	217714	244995	353982	6.1	6.1	5.4	5.7
	value	1000 baht	149168	181428	206014	384037	6.7	7.1	9.2	8.2
Forecast	Volume	kl								
	Weight	TOE								

Comment : growth rate = industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-32 Samut Prakarn Gasoline Consumption (base case)

Industry	Items	U n i t	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/kl	0.7451	0.7451	0.7451	0.7451				
	Constants	1000kcal/kl	7520.0	7520.0	7520.0	7520.0				
		baht/kl	8550.0	5300.0	8495.0	10865.0				
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	kl	281	321	350	446	4.6	8.5	3.5	5.9
Beverages	Weight	TOE	209	239	261	332	4.6	8.5	3.5	5.9
	Calory	Gcal	2113	2410	2631	3352	4.6	8.5	3.5	5.9
	value	1000 baht	2403	1699	2972	4843	-10.9	32.3	7.2	6.0
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	kl	49	62	73	108	8.2	8.2	5.8	6.8
Wearing	Weight	TOE	37	46	54	81	8.2	8.2	5.8	6.8
	Calory	Gcal	371	469	549	813	8.2	8.2	5.8	6.8
	value	1000 baht	422	331	620	1174	-11.8	36.9	9.5	6.9
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	kl	32	40	46	67	7.5	7.5	5.4	6.3
Food Products	Weight	TOE	24	30	34	50	7.5	7.5	5.4	6.3
	Calory	Gcal	242	301	348	504	7.5	7.5	5.4	6.3
	value	1000 baht	275	213	393	727	-8.3	36.1	9.2	8.4
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	kl	96	112	126	173	5.4	5.4	4.8	5.1
Printing	Weight	TOE	71	84	93	128	5.4	5.4	4.8	5.1
	Calory	Gcal	719	843	937	1301	5.4	5.4	4.8	5.1
	value	1000 baht	818	534	1059	1680	-10.1	33.5	8.5	7.2
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Chemical	Volume	kl	189	227	256	369	6.3	6.3	5.4	5.8
Petroleum	Weight	TOE	141	169	191	275	6.3	6.3	5.4	5.8
Coal	Calory	Gcal	1419	1705	1927	2778	6.3	6.3	5.4	5.8
Plastics	value	1000 baht	1613	1202	2177	4013	-9.3	34.6	9.1	7.9
Manufacturing	growth rate	%		11.5	11.5	9.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	kl	311	405	483	659	9.2	9.2	6.6	6.5
Mineral	Weight	TOE	232	302	360	491	9.2	9.2	6.6	6.5
	Calory	Gcal	2337	3043	3629	4959	9.2	9.2	6.6	6.5
	value	1000 baht	2657	2145	4100	7164	-6.9	38.3	8.3	8.6
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	kl	46	57	65	94	6.9	6.9	5.5	6.1
	Weight	TOE	35	42	48	70	6.9	6.9	5.5	6.1
	Calory	Gcal	348	425	486	706	6.9	6.9	5.5	6.1
	value	1000 baht	396	300	549	1022	-8.9	35.3	8.3	8.2
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	kl	132	161	183	269	6.6	6.6	5.7	6.1
Machinery	Weight	TOE	99	120	136	200	6.6	6.6	5.7	6.1
	Calory	Gcal	995	1207	1373	2021	6.6	6.6	5.7	6.1
	value	1000 baht	1132	851	1551	2920	-9.1	35.0	9.5	8.2
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	87	103	114	159	5.5	5.5	4.8	5.1
	Weight	TOE	65	77	85	118	5.5	5.5	4.8	5.1
	Calory	Gcal	658	773	861	1195	5.5	5.5	4.8	5.1
	value	1000 baht	748	545	972	1726	-10.0	33.6	8.5	7.2

Industry	Items	U n i t	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value	-								
	C.S. rate	%								
Total	Volume	kl	1224	1486	1694	2344	6.7	6.8	4.7	5.6
	Weight	TOE	912	1107	1262	1747	6.7	6.8	4.7	5.6
	Calory	Gcal	9203	11177	12741	17629	6.7	6.8	4.7	5.6
	value	1000 baht	10463	7877	14392	25471	-9.0	35.2	8.5	7.7
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			0.7	0.7	0.7				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			1.2	1.2	1.2				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Transportation	growth rate	%		5.4	5.6	5.2				
Communication	elastic value			1.1	1.1	0.9				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	29168	34681	38925	53611	5.9	5.9	4.7	5.2
	Weight	TOE	21733	25841	29002	39945	5.9	5.9	4.7	5.2
	Calory	Gcal	219144	260799	292702	403154	5.9	5.9	4.7	5.2
	value	1000 baht	249387	183807	330652	582483	-9.7	34.1	8.4	7.3
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	701	812	895	1260	5.0	5.0	5.0	5.0
	Weight	TOE	522	605	667	939	5.0	5.0	5.0	5.0
	Calory	Gcal	5275	6107	6732	9472	5.0	5.0	5.0	5.0
	value	1000 baht	5998	4304	7605	13687	-10.5	32.9	8.8	7.1
Total	Volume	kl	31093	36979	41515	57215	6.0	6.0	4.7	5.2
	Weight	TOE	23168	27553	30931	42631	6.0	6.0	4.7	5.2
	Calory	Gcal	233821	278062	312175	430257	6.0	6.0	4.7	5.2
	value	1000 baht	265848	195989	352649	621641	-9.7	34.7	8.4	7.3
Forecast	Volume	kl								
	Weight	TOE								

Comment : growth rate = 1000 baht
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent

Table 6-33 Samut Prakarn Diesel Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/kl	0.8620	0.8620	0.8620	0.8620				
	Constants	1000kcal/kl	8700.0	8700.0	8700.0	8700.0				
		baht/kl	5480.0	5992.5	6505.0	8620.0				
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	kl	21	24	26	33	4.5	4.5	3.5	3.9
Beverages	Weight	TOE	18	21	23	29	4.5	4.5	3.5	3.9
	Calory	Gcal	183	208	227	290	4.5	4.5	3.5	3.9
	value	1000 baht	119	144	170	287	7.6	8.9	7.8	7.9
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	kl	29	37	43	64	8.2	8.2	5.8	6.8
Wearing	Weight	TOE	25	32	37	55	8.2	8.2	5.8	6.8
	Calory	Gcal	252	319	373	553	8.2	8.2	5.8	6.8
	value	1000 baht	159	220	279	548	11.4	12.7	10.1	10.9
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	kl								
Wood Products	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	kl								
Printing	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.8	0.8	0.8				
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	kl	878	1055	1193	1715	6.3	6.3	5.4	5.8
Coal	Weight	TOE	757	910	1028	1478	6.3	6.3	5.4	5.8
Plastics	Calory	Gcal	7638	9180	10377	14916	6.3	6.3	5.4	5.8
	value	1000 baht	4811	6323	7759	14819	9.5	10.8	9.7	5.8
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	kl	1616	2104	2509	3429	9.2	9.2	4.6	5.5
Mineral	Weight	TOE	1393	1814	2163	2955	9.2	9.2	4.6	5.5
	Calory	Gcal	14059	18307	21831	29828	9.2	9.2	4.6	5.5
	value	1000 baht	8656	12610	16323	29554	12.5	13.8	8.9	10.6
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	kl	59	72	82	120	6.9	6.9	5.5	6.1
	Weight	TOE	51	62	71	103	6.9	6.9	5.5	6.1
	Calory	Gcal	513	627	716	1043	6.9	6.9	5.5	6.1
	value	1000 baht	323	432	535	1033	10.1	11.4	8.9	10.2
Manufacturing	growth rate	%		8.5	8.3	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	kl	3259	3982	4495	6617	6.6	6.6	5.7	6.1
Machinery	Weight	TOE	2809	3407	3874	5704	6.6	6.6	5.7	6.1
	Calory	Gcal	28353	34385	39102	57564	6.6	6.6	5.7	6.1
	value	1000 baht	17859	23684	29237	57035	9.9	11.1	10.0	10.2
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value									
	C.S. rate	%								
Total	Volume	kl	5862	7244	8348	11981	7.3	7.3	5.3	6.1
	Weight	TOE	5053	6245	7196	10328	7.3	7.3	5.3	6.1
	Calory	Gcal	50599	63027	72628	104234	7.3	7.3	5.3	6.1
	value	1000 baht	32124	43412	54304	103276	10.6	11.8	9.6	10.2
Electricity	growth rate	%			7.3	5.6				
Gas	elastic value				0.7	0.7				
Water	C.S. rate	%			100.0	100.0				
	Volume	kl	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	TOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	value	1000 baht	0	0	0	0	0.0	0.0	0.0	0.0
Trades	growth rate	%			4.8	5.1				
Restaurans	elastic value				1.2	1.2				
Hotels	C.S. rate	%			100.0	100.0				
Residential	Volume	kl	16	20	22	33	5.8	5.8	6.1	6.0
	Weight	TOE	14	17	19	29	5.8	5.8	6.1	6.0
	Calory	Gcal	144	170	190	288	5.8	5.8	6.1	6.0
	value	1000 baht	90	117	142	285	9.0	10.2	10.5	10.0
Transportation	growth rate	%			5.4	5.4	5.2			
Communication	elastic value				1.15	1.20				
	C.S. rate	%			100.0	100.0				
	Volume	kl	60799	72643	82171	125527	6.2	6.2	6.2	6.2
	Weight	TOE	52408	62791	70832	108204	6.2	6.2	6.2	6.2
	Calory	Gcal	528947	633736	714890	1092083	6.2	6.2	6.2	6.2
	value	1000 baht	333176	436513	534524	1087041	9.4	10.7	10.6	10.3
Others	growth rate	%			5.0	5.0	5.0			
	elastic value				1.0	1.0	1.0			
	C.S. rate	%			100.0	100.0	100.0			
	Volume	kl	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	TOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	value	1000 baht	0	0	0	0	0.0	0.0	0.0	0.0
Total	Volume	kl	66677	80107	90541	137541	6.3	6.3	6.2	6.2
	Weight	TOE	57476	69052	78046	118560	6.3	6.3	6.2	6.2
	Calory	Gcal	580090	696935	787708	1196605	6.3	6.3	6.2	6.2
	value	1000 baht	365590	480042	588970	1165602	9.5	10.8	10.5	10.3
Forecast	Volume	kl								
	Weight	TOE								

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and Industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-34 Samut Prakarn Kerosene Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/kl	0.8174	0.8174	0.8174	0.8174				
	Constants	1000kcal/kl	8250.0	8250.0	8250.0	8250.0				
		baht/kl	6120.0	6565.0	7010.0	9300.0				
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	kl	632	687	726	845	2.8	2.8	2.2	2.4
Beverages	Weight	TOE	517	561	593	691	2.8	2.8	2.2	2.4
	Calory	Gcal	5214	5664	5985	6971	2.8	2.8	2.2	2.4
	value	1000 baht	3868	4507	5086	7858	5.2	6.2	6.4	6.1
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	kl								
Wearing	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		9.4	9.4	5.8				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	kl								
Wood Products	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	kl								
Printing	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		7.8	7.9	6.7				
	elastic value			0.5	0.5	0.5				
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	kl								
Coal	Weight	TOE								
Plastics	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	kl								
Mineral	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	kl	157	177	192	246	4.2	4.4	3.6	3.9
Machinery	Weight	TOE	128	145	157	201	4.2	4.2	3.6	3.8
	Calory	Gcal	1295	1463	1587	2026	4.2	4.1	3.6	3.8
	value	1000 baht	961	1166	1349	2284	6.6	7.6	7.8	7.5
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.5	0.5	0.5				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value									
	C.S. rate	%								
Total	Volume	kl	789	864	918	1091	3.1	3.1	2.5	2.7
	Weight	TOE	645	706	750	891	3.1	3.1	2.5	2.7
	Calory	Gcal	6509	7128	7573	8997	3.1	3.1	2.5	2.7
	value	1000 baht	4829	5672	6435	10147	5.5	6.5	6.7	6.4
Electricity	growth rate	%		7.1	7.3	5.6				
Gas	elastic value			0.5	0.5	0.5				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			0.5	0.5	0.5				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	kl	1013	1088	1141	1361	2.4	2.4	2.6	2.5
	Weight	TOE	828	889	933	1112	2.4	2.4	2.6	2.5
	Calory	Gcal	8359	8978	9412	11226	2.4	2.4	2.6	2.5
	value	1000 baht	6201	7142	7997	12655	4.8	5.8	6.8	6.1
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	17	18	19	23	2.7	2.7	2.6	2.6
	Weight	TOE	14	15	16	19	2.7	2.7	2.6	2.6
	Calory	Gcal	138	149	157	188	2.7	2.7	2.6	2.6
	value	1000 baht	102	119	134	212	5.1	6.1	6.8	6.3
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			0.5	0.5	0.5				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	kl	15	16	17	20	2.5	2.5	2.5	2.5
	Weight	TOE	12	13	14	17	2.5	2.5	2.5	2.5
	Calory	Gcal	124	134	141	167	2.5	2.5	2.5	2.5
	value	1000 baht	92	106	119	188	4.9	5.9	6.7	6.1
Total	Volume	kl	1834	1986	2095	2494	2.7	2.7	2.5	2.6
	Weight	TOE	1499	1624	1712	2039	2.7	2.7	2.5	2.6
	Calory	Gcal	15130	16356	17253	20578	2.7	2.7	2.5	2.6
	value	1000 baht	11224	13039	14685	23197	5.1	6.1	6.8	6.2
Forecast	Volume	kl								
	Weight	TOE								

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-35 Samut Prakarn Fuel Oil Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/kl	0.9412	0.9412	0.9412	0.9412				
	Constants	1000kcal/kl	9500.0	9500.0	9500.0	9500.0				
		baht/kl	2960.0	2975.0	2990.0	3960.0				
Manufacturing	growth rate	%		5.5	5.6	4.4				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	80.0				
Food Beverages	Volume	kl	91408	104252	102422	104388	4.5	-0.9	0.3	1.1
	Weight	TOE	86033	98122	96399	98250	4.5	-0.9	0.3	1.1
	Calory	Gcal	865376	990332	971007	991690	4.5	-0.9	0.3	1.1
	value	1000 baht	270568	310149	306241	413378	4.7	-0.6	4.4	5.6
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	80.0				
Textiles Wearing	Volume	kl	95860	121293	127707	151201	8.2	2.6	2.4	3.9
	Weight	TOE	90229	114161	120197	142310	8.2	2.6	2.4	3.9
	Calory	Gcal	910670	1152288	1213215	1436405	8.2	2.6	2.4	3.9
	value	1000 baht	263746	360648	381843	536754	8.3	2.9	6.6	6.4
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.7	0.6				
	C.S. rate	%		100.0	100.0	100.0				
Wood Wood Products	Volume	kl	235	292	332	439	7.5	6.6	4.1	5.3
	Weight	TOE	221	275	312	413	7.5	6.6	4.1	5.3
	Calory	Gcal	2253	2775	3152	4170	7.5	6.6	4.1	5.3
	value	1000 baht	695	859	992	1738	7.1	6.8	8.3	7.9
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	80.0				
Paper Printing	Volume	kl	41984	49215	49244	54698	5.4	0.0	1.5	2.2
	Weight	TOE	39515	46321	46348	51482	5.4	0.0	1.5	2.2
	Calory	Gcal	398648	467345	467618	519632	5.4	0.0	1.5	2.2
	value	1000 baht	124273	146415	147240	216604	5.6	0.3	5.7	4.7
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.8	0.8	0.8				
Chemical	C.S. rate	%		100.0	90.0	80.0				
Petroleum Coal Plastics	Volume	kl	41329	49653	50525	58255	6.3	0.9	2.1	2.9
	Weight	TOE	38893	46742	47554	54829	6.3	0.9	2.1	2.9
	Calory	Gcal	392569	471803	479991	553416	6.3	0.9	2.1	2.9
	value	1000 baht	122316	147749	151071	230688	6.5	1.1	6.2	5.4
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	80.0				
Nonmetallic Mineral	Volume	kl	81675	114168	122527	133931	9.2	3.6	1.3	3.6
	Weight	TOE	82520	107455	115322	126056	9.2	3.6	1.3	3.6
	Calory	Gcal	832913	1084594	1164006	1272543	9.2	3.6	1.3	3.6
	value	1000 baht	259516	339649	368155	530366	9.4	3.9	5.4	6.1
Manufacturing	growth rate	%		8.5	8.6	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	80.0				
Basic Metal	Volume	kl	38722	47271	48605	56639	5.9	1.4	2.2	3.2
	Weight	TOE	36445	44497	45747	53309	5.9	1.4	2.2	3.2
	Calory	Gcal	367859	449129	461749	538071	5.9	1.4	2.2	3.2
	value	1000 baht	114617	140648	145329	224251	7.1	1.7	6.4	5.8
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	80.0				
Fabricated Metal Machinery	Volume	kl	16729	20288	20764	24454	6.6	1.2	2.4	3.2
	Weight	TOE	15745	19093	19542	23016	6.6	1.2	2.4	3.2
	Calory	Gcal	158926	192732	197259	232315	6.6	1.2	2.4	3.2
	value	1000 baht	49518	60356	62085	96838	6.8	1.4	6.6	5.7
Manufacturing	growth rate	%		8.9	8.9	8.0				
	elastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	90.0	80.0				
	Volume	kl								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value									
	C.S. rate	%								
Total	Volume	kl	415936	500448	522126	584005	7.0	1.5	1.6	2.9
	Weight	TOE	389597	476669	491425	549665	7.0	1.5	1.6	2.9
	Calory	Gcal	3932392	4811258	4960195	5548046	7.0	1.5	1.6	2.9
	value	1000 baht	1225251	1506683	1561155	2312658	7.1	1.8	5.8	5.4
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			1.5	1.5	1.1				
Water	C.S. rate	%		100.0	100.0	80.0				
	Volume	kl	324000	442514	544730	662215	10.9	10.9	2.8	6.1
	Weight	TOE	304949	416494	512700	623275	10.9	11.0	2.8	6.1
	Calory	Gcal	3078000	4203882	5174938	6291025	10.9	10.9	2.8	6.1
	value	1000 baht	959040	1316479	1626784	2622365	11.1	11.2	7.0	8.7
Trades	growth rate	%			4.8	5.1				
Restaurans	elastic value				1.2	1.2				
Hotels	C.S. rate	%			100.0	100.0				
Residential	Volume	kl	240	284	318	482	5.8	5.8	6.1	6.0
	Weight	TOE	226	268	299	454	5.8	5.8	6.1	6.0
	Calory	Gcal	2283	2701	3021	4578	5.8	5.8	6.1	6.0
	value	1000 baht	711	846	951	1909	5.9	6.0	10.5	8.6
Transportation	growth rate	%			5.4	5.7				
Communication	elastic value				1.1	1.1				
	C.S. rate	%			100.0	100.0				
	Volume	kl	3821	4555	5112	7545	5.9	5.9	5.7	5.8
	Weight	TOE	3605	4287	4811	7101	5.9	5.9	5.7	5.8
	Calory	Gcal	36291	43268	48561	71679	5.9	5.9	5.7	5.8
	value	1000 baht	11339	13550	15284	29679	6.1	6.2	10.0	8.6
Others	growth rate	%			5.0	5.0				
	elastic value				1.0	1.0				
	C.S. rate	%			100.0	100.0				
	Volume	kl	855	990	1091	1535	5.0	5.0	5.0	5.0
	Weight	TOE	805	932	1027	1445	5.0	5.0	5.0	5.0
	Calory	Gcal	8122	9402	10366	14586	5.0	5.0	5.0	5.0
	value	1000 baht	2531	2944	3263	6080	5.2	5.3	9.3	7.6
Total	Volume	kl	742862	954791	1073377	1255780	8.7	6.0	2.3	4.5
	Weight	TOE	699182	898649	1010262	1181940	8.7	6.0	2.3	4.5
	Calory	Gcal	7052188	9070512	10197081	11929914	8.7	6.0	2.3	4.5
	value	1000 baht	2198871	2840502	3209397	4972890	8.9	6.3	6.5	7.0
Forecast	Volume	kl								
	Weight	TOE								

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-36 Samut Prakarn Natural Gas Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/MMscf	24.3000	24.3000	24.3000	24.3000				
	Constants	Gcal/MMscf	246.0	246.0	246.0	246.0				
		1000bt/MMscf	71.0	74.0	75.0	98.0				
Manufacturing	growth rate	%		5.6	5.6	4.4				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	MMscf								
Beverages	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		10.2	10.2	7.2				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	MMscf								
Wearing	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		9.4	9.4	6.6				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	MMscf								
Wood Products	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		6.8	6.8	6.0				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	MMscf								
Printing	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		7.9	7.8	6.7				
	plastic value			0.8	0.8	0.8				
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	MMscf								
Coal	Weight	TOE								
Plastics	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		11.5	11.5	9.7				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	MMscf								
Mineral	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.6	8.6	6.9				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	MMscf								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		8.3	8.3	7.1				
	plastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	MMscf								
Machinery	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Manufacturing	growth rate	%		6.9	6.9	6.0				
	plastic value			0.8	0.8	0.8				
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	plastic value									
	C.S. rate	%								
Total	Volume	MMscf								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	plastic value			1.0	1.0	1.0				
Water	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf	98182	120304	137757	198749	7.0	7.0	5.4	6.1
	Weight	TOE	2385823	2923391	3347491	4829002	7.0	7.0	5.4	6.1
	Calory	Gcal	24152772	29594821	33888178	48892268	7.0	7.0	5.4	6.1
	value	1000 baht	6970922	8502507	10469518	19019909	8.5	8.4	9.0	8.8
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	plastic value			1.2	1.2	1.2				
Hotels	C.S. rate	%		100.0	100.0	100.0				
Residential	Volume	MMscf								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	plastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Others	growth rate	%		5.0	5.0	5.0				
	plastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	100.0				
	Volume	MMscf								
	Weight	TOE								
	Calory	Gcal								
	value	1000 baht								
Total	Volume	MMscf	98182	120304	137757	198749	7.0	7.0	5.4	6.1
	Weight	TOE	2385823	2923391	3347491	4829002	7.0	7.0	5.4	6.1
	Calory	Gcal	24152772	29594821	33888178	48892268	7.0	7.0	5.4	6.1
	value	1000 baht	6970922	8502507	10469518	19019909	8.5	8.4	9.0	8.8
Forecast	Volume	MMscf								
	Weight	TOE								

Comment : growth rate = Industrial product's growth rate
plastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-37 Samut Prakarn Renewable Energy Consumption (base case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	TOE/t	0.4000	0.4000	0.4000	0.4000				
	Constants	1000kcal/t	4000.0	4000.0	4000.0	4000.0				
		baht/t	4000.0	4000.0	4000.0	4000.0				
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Food	Volume	t	26695	26695	26695	26695				
Beverages	Weight	TOE	10678	10678	10678	10678				
	Calory	Gcal	106780	106780	106780	106780				
	Value	1000 baht	106780	106780	106780	106780				
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Textiles	Volume	t	3923	3923	3923	3923				
Wearing	Weight	TOE	1569	1569	1569	1569				
	Calory	Gcal	15692	15692	15692	15692				
	Value	1000 baht	15692	15692	15692	15692				
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Wood	Volume	t	18945	18945	18945	18945				
Wood Products	Weight	TOE	7578	7578	7578	7578				
	Calory	Gcal	75780	75780	75780	75780				
	Value	1000 baht	75780	75780	75780	75780				
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Paper	Volume	t								
Printing	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value									
Chemical	C.S. rate	%		100.0	100.0	100.0				
Petroleum	Volume	t	38	38	38	38				
Coal	Weight	TOE	15	15	15	15				
Plastics	Calory	Gcal	152	152	152	152				
	Value	1000 baht	152	152	152	152				
Manufacturing	growth rate	%		11.5	11.5	8.7				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Nonmetallic	Volume	t								
Mineral	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Basic Metal	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value									
	C.S. rate	%		100.0	100.0	100.0				
Fabricated Metal	Volume	t								
Machinery	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value									
Unclassified	C.S. rate	%		100.0	100.0	100.0				
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%								
	elastic value									
	C.S. rate	%								
Total	Volume	t	49601	49601	49601	49601				
	Weight	TOE	19840	19840	19840	19840				
	Calory	Gcal	198404	198404	198404	198404				
	Value	1000 baht	198404	198404	198404	198404				
Electricity	growth rate	%			7.2	7.2	5.6			
Gas	elastic value									
Water	C.S. rate	%			100.0	100.0	100.0			
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Trades	growth rate	%			4.8	4.8	5.1			
Restaurans	elastic value									
Hotels	C.S. rate	%			100.0	100.0	100.0			
Residential	Volume	t	283400	283400	283400	283400				
	Weight	TOE	113360	113360	113360	113360				
	Calory	Gcal	1133600	1133600	1133600	1133600				
	Value	1000 baht	1133600	1133600	1133600	1133600				
Transportation	growth rate	%			5.4	5.4	5.2			
Comunication	elastic value									
	C.S. rate	%			100.0	100.0	100.0			
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Others	growth rate	%			5.0	5.0	5.0			
	elastic value									
	C.S. rate	%			100.0	100.0	100.0			
	Volume	t								
	Weight	TOE								
	Calory	Gcal								
	Value	1000 baht								
Total	Volume	t	333001	333001	333001	333001				
	Weight	TOE	133200	133200	133200	133200				
	Calory	Gcal	1332004	1332004	1332004	1332004				
	Value	1000 baht	1332004	1332004	1332004	1332004				
Forecast	Volume	t								
	Weight	TOE								

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-38 Prospect of Energy Demand in Samut Prakarn (1987)

Energy sources	Unit	Overall Thailand (Actual)	Samut Prakarn (Estimation)	Ratio %
Coal	1000t	315.0	11.6	3.7
lignite	1000t	7020.0	0.0	0
LPG	1000kl	1282.0	28.7	2.2
Gasoline	1000kl	2597.0	31.1	1.2
Diesel	1000kl	6428.0	66.7	1.0
Kerosene	1000kl	129.0	1.8	1.4
Fuel Oil	1000kl	2346.0	742.9	31.7
Natural Gas	MMscf	178700.0	98182.0	54.9
Renewable	1000t	27950.0	333.0	1.2

Table 6-39 Prospect of Energy Demand in Samut Prakarn (1992)

Energy sources	Unit	Overall Thailand (forecast)	Samut Prakarn (forest)	Ratio %
Coal	1000t	495.0	15.5	3.1
lignite	1000t	12176.0	0.0	0.0
LPG	1000kl	1706.0	38.5	2.3
Gasoline	1000kl	3445.0	41.5	1.2
Diesel	1000kl	8454.0	90.5	1.1
Kerosene	1000kl	151.0	2.1	1.4
Fuel Oil	1000kl	3254.0	1073.4	33.0
Natural Gas	MMscf	249807.0	137757.0	55.1
Renewable	1000t	27590.0	333.0	1.2

Table 6-40 Prospect of Energy Demand in Samut Prakarn (1999)

Energy sources	Unit	Overall Thailand (forecast)	Samut Prakarn (forest)	Ratio %
Coal	1000t	4261.0	21.6	0.5
lignite	1000t	21341.0	0.0	0.0
LPG	1000kl	2536.0	55.7	2.2
Gasoline	1000kl	4731.0	57.2	1.2
Diesel	1000kl	12469.0	137.5	1.1
Kerosene	1000kl	182.0	2.5	1.4
Fuel Oil	1000kl	3910.0	1255.8	32.1
Natural Gas	MMscf	359926.0	198749.0	55.2
Renewable	1000t	27590.0	333.0	1.2

Table 6-41 Prospect of Energy Consumption Value in Samut Prakarn (unit: Mill baht)

Energy sources	1987	1992	1999	99/87 (%)
Coal	11	17	26	7.5
lignite	0	0	0	0.0
LPG	149	208	384	8.2
Gasoline	266	353	622	7.3
Diesel	365	589	1186	10.3
Kerosene	11	15	23	6.2
Fuel Oil	2199	3209	4973	7.0
Natural Gas	6970	10470	19080	8.8
Renewable	1332	1332	1332	0.0

6.4 Energy Saving Investment in Samut Prakarn and its Effect

In accordance with the investigation, concerning the energy consumption of the plants in Samut Prakarn mentioned in the preceding section, energy consumption before and after energy saving countermeasure and energy saving investment are estimated.

(1) Energy saving volume

Table 6-42 shows the energy (fuel oil) consumption volume and value when energy saving countermeasures are taken for the 49 stacks at which K=13 must be achieved. On the basis of the Japanese experience, energy saving rate is set for each industry as shown in Table 6-42. (Refer to section 3.4, Chapter 3). As for the calculation for energy saving, assuming that energy saving is performed yearly at the energy saving rate of each industry shown in Table 6-42 to energy consumption of 1992, the energy saving volume of each year is subtracted from the energy consumption of 1992. The energy consumption of each industry which will increase from 1992 to 1999 before energy saving countermeasure are added to the 1992 energy consumption after energy saving countermeasures, using the algorithm described in the preceding section. Thus energy consumption after energy saving countermeasures can be obtained in accordance with the expression (6-3).

Energy consumption after energy saving measure in 1999

= (energy consumption before energy saving measure in 1999 − energy consumption in 1992)

+ (energy consumption of 1992) × (1−0.0281) × 7 ..... (6-3)

Table 6-43 shows the saved energy volume of the plants after implementing the energy saving countermeasures in Samut Prakarn by industries. According to table 6-43, the 1992 energy consumption is estimated at 83,324 kl. On the other hand, the energy consumption (fuel oil) of all manufacturing sectors in Samut Prakarn in 1992 is approximately 522,000 kl as shown in Table 6-42, therefore 16% of the energy consumption in Samut Prakarn is regarded as the objective for energy saving. The aggregate saved energy volume from 1993 to 1999 is 65,500 kl, and it is 11% of the fuel oil consumption of all Samut Prakarn's manufacturing sectors in 1999.

Table 6-42 Saved Energy and its Cost When Energy Saving Counterinvasures are Implemented in Samut Prakarn.

SEQ	Business Categories	Kind of Fuels	1992's Consump. kl	1999's Consump. kl	Energy Saving %	1999's Basic Val. after E.S. kl	1999's Consump. after E.S. kl	Investment for E. Saving 10000Baht
42.0	Textiles & Wearing	FUEL OIL	129	172	2.61	105	148	253
13.0	Textiles & Wearing	FUEL OIL	2158	2878	2.61	1764	2484	4149
20.0	Textiles & Wearing	FUEL OIL	1287	1716	2.61	1052	1482	2475
15.0	Textiles & Wearing	FUEL OIL	2518	3358	2.61	2058	2898	4844
4.0	Textiles & Wearing	FUEL OIL	2588	3451	2.61	2116	2980	4981
14.0	Textiles & Wearing	FUEL OIL	1073	1431	2.61	877	1235	2064
29.0	Textiles & Wearing	FUEL OIL	1287	1717	2.00	1107	1537	1895
33.0	Textiles & Wearing	FUEL OIL	715	954	2.61	584	823	1379
21.0	Textiles & Wearing	FUEL OIL	526	702	2.61	430	605	1011
28.0	Textiles & Wearing	FUEL OIL	2589	3453	2.00	2227	3091	3812
	TOTAL		14120	18833	2.44	11706	16419	25420
18.0	Paper & Printing	FUEL OIL	4872	7798	2.89	3886	5913	10383
46.0	Paper & Printing	FUEL OIL	5722	7632	2.89	4564	6474	12194
19.0	Paper & Printing	FUEL OIL	4872	7798	2.89	3886	5913	10383
47.0	Paper & Printing	FUEL OIL	4872	3899	2.89	3886	2913	10383
45.0	Paper & Printing	FUEL OIL	5722	7634	2.89	4564	6474	12194
10.0	Paper & Printing	COAL	5638	7521	2.89	4497	6380	3870
	TOTAL		31639	42280	2.89	25385	35857	59407
5.0	Fabricated Metal	FUEL OIL	102	136	2.00	88	122	147
49.0	Metal & Machinery	FUEL OIL	286	1382	1.75	251	347	369
6.0	Metal & Machinery	FUEL OIL	156	208	1.75	137	189	200
43.0	Metal & Machinery	FUEL OIL	257	343	1.75	226	312	326
7.0	Metal & Machinery	DIESEL	83	111	1.75	73	101	105
	TOTAL		782	1044	1.75	686	948	1000
26.0	Basic Metal	FUEL OIL	5067	6759	1.75	4446	6138	6530
25.0	Foods & Beverages	FUEL OIL	417	557	2.00	359	499	611
11.0	Foods & Beverages	FUEL OIL	641	855	2.00	551	765	948
24.0	Foods & Beverages	FUEL OIL	1030	1374	2.00	886	1230	1516
12.0	Foods & Beverages	FUEL OIL	104	140	2.00	89	125	158
2.0	Foods & Beverages	FUEL OIL	444	592	2.00	382	530	653
17.0	Foods & Beverages	FUEL OIL	1430	1908	2.00	1230	1708	2106
23.0	Foods & Beverages	FUEL OIL	417	557	2.00	359	499	611
41.0	Foods & Beverages	FUEL OIL	1030	1374	2.00	886	1230	1516
8.0	Foods & Beverages	FUEL OIL	340	453	2.00	292	405	505
40.0	Foods & Beverages	FUEL OIL	1030	1374	2.00	886	1230	1516
27.0	Foods & Beverages	FUEL OIL	268	358	2.00	230	320	400
1.0	Foods & Beverages	FUEL OIL	5720	7632	2.00	4919	6831	8435
3.0	Foods & Beverages	FUEL OIL	298	398	2.00	256	356	442
36.0	Foods & Beverages	FUEL OIL	0	16619	0.00	0	16619	0
	TOTAL		13169	34191	2.00	11325	32347	19417
37.0	Chemical & Petroleum	FUEL OIL	1126	1503	3.88	820	1197	3222
44.0	Chemical & Petroleum	FUEL OIL	172	229	3.88	125	182	495
38.0	Chemical & Petroleum	FUEL OIL	1126	1503	3.88	820	1197	3222
31.0	Chemical & Petroleum	FUEL OIL	2815	3755	3.88	2050	2990	8055
26.0	Chemical & Petroleum	FUEL OIL	944	1259	3.88	688	1003	2696
34.0	Chemical & Petroleum	FUEL OIL	1545	2030	3.88	1125	610	4423
30.0	Chemical & Petroleum	FUEL OIL	756	1008	3.88	551	803	2159
32.0	Chemical & Petroleum	FUEL OIL	479	639	3.88	349	509	1369
48.0	Chemical & Petroleum	FUEL OIL	242	323	3.88	176	257	684
9.0	Chemical & Petroleum	FUEL OIL	2	2	10.00	2	3	0
	TOTAL	FUEL OIL	9207	11252	3.88	6707	8752	26325
39.0	Nonmetallic & Minera	FUEL OIL	3338	4452	3.88	2431	3545	9551
35.0	Nonmetallic & Minera	FUEL OIL	4172	5565	3.88	3039	4432	11930
22.0	Nonmetallic & Minera	DIESEL	1669	2226	3.88	1216	1773	477
	TOTAL		9179	12243	3.88	6686	9750	21958
The above factories Total		OIL&DIES	83324	126738	2.81	66930	110344	160213
Samut Prakarn Manuf. Total		FUEL OIL	522126	584005			574023	
The above factoles' shares		%	16.0	21.7				
99/92 Growth Rate		%		1.6			1.4	
Thailand's Manufact. Total		FUEL OIL	1781000	1987000				
The Energy saved Factories		FUEL OIL	284223	431209				546495

Table 6-43 Saved Energy Volume of the Plants in Samut Prakarn (mostly fuel oil)

Industry	Number of stacks	1992 kl	1999 before the countermeasure kl	1999 after the countermeasure kl	Energy saving rate of 1992-1999 %
Foods & Beverages	14	13169	34191	32347	14.0
Paper & Printing	6	31698	42280	35867	20.2
Chemical & Petroleum	10	9207	11252	8752	27.2
Textiles & Wearing	10	14120	18833	16419	17.1
Metal & Machinery	4	782	1044	948	12.3
Fabricated Metal	1	102	136	122	14.0
Basic Metal	1	5067	6759	6138	12.3
Nonmetal & Mineral	3	9179	12243	9750	27.2
Total	49	83324	126738	110343	19.7

(2) Investment for energy saving

The energy saving investments which become equivalent to the energy value reduced by energy saving (capital turnover term: three years) are appropriated (See Table 6-42). The energy saving investments of each industry in Samut Prakarn are compiled as shown in Table 6-44.

Table 6-44 The Energy Saving Investments in Samut Prakarn

Industry	Energy saving investment (1,000 baht)
Foods & Beverages	19417
Paper & Printing	59407
Chemical & Petroleum	26325
Textiles & Wearing	25420
Metal & Machinery	1000
Fabricated Metal	147
Basic Metal	6539
Nonmetal & Mineral	21958
Total	160213

(3) Effect of energy saving

The effect of energy saving in Samut Prakarn reaches 1.6 fold of energy saving investments, to 260 million baht as shown in Table 6-45. In this calculation, saved energy value from 1993 to 1999 are evaluated with the 1999 fuel oil price, 3960 baht/kl.

Table 6-45 Energy Saving Effect In Samut Prakarn (from 1993 to 1999)

Year	Saved energy volume	Price (1,00 baht)
1993	2341 kl	9270
1994	4683	18545
1995	7023	27811
1996	9364	37081
1997	11705	46352
1998	14046	55622
1999	16387	64893
Total	65549 kl	259, 574, 000 baht

The saved energy values are evaluated with the 1999 fuel oil price, 3,960 baht/kl.

6.5 Energy Saving Investment and Effect in Thailand

In this section, the effect of energy saving is calculated under the assumption of implementing the same energy saving countermeasure in overall Thailand as in Samut Prakarn.

(1) Precondition

1) Energy saving period

The energy saving period is determined to be from 1993 to 1999 on the basis of 1992. This is similarly one of Samut Prakarn.

2) Energy saving rate

The energy saving rate of each industry in overall Thailand are set as shown in Table 6-46. (Refer to section 3.4, Chapter 3).

Table 6-46 Energy Saving Rate to be Achieved by Industrial Categories in Thailand

Industry	Energy saving rate
Agriculture & Fishing	2.0 / Year
Mining & Qarrying	2.0
Foods & Beverages	2.0
Textiles & Wearing	2.4
Wood & Wood Products	2.0
Paper & Printing	3.0
Chemical & Petroleum	4.0
Nonmetallic & Mineral	2.0
Basic Metal	2.0
Fabricated & Machinery	2.0
Electricity & Gas	3.0
Construction	2.0
Trades & Hotels & Resid.	2.0
Transport & Communcation	2.0
Banks & Service	2.0

Thailand's energy saving investments are estimated with the ratio between the fuel oil consumption of the manufacturing sector in Samut Prakarn and that of the manufacturing sector in overall Thailand.

(2) Saved energy volume

Table 6-47 shows the result of calculation of fuel oil consumption after implementing energy saving countermeasures in overall Thailand. If the fuel oil demand before energy saving countermeasures in Thailand (See Table 6-18) is compared with the fuel oil demand after energy saving countermeasures in 1999, the results shown in Table 6-48 are obtained.

Table 6-47 Fuel Oil Consumption in Thailand (Save Energy Case)

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
	Physical	KTOE/1000kl	0.9412	0.9412	0.9412	0.9412				
	Constants	1000xcal/kl	9500.0	9500.0	9500.0	9500.0				
		baht/kl	2950.0	2975.0	2990.0	3960.0				
Agriculture	growth rate	%		1.7	1.7	1.7				
Fishing	elastic value			1.0	1.0	1.0				
Forestry	C.S. rate	%		100.0	100.0	86.0				
	Volume	1000 kl	1	1	1	1	1.7	1.7	-0.5	0.4
	Weight	KTOE	1	1	1	1	1.7	1.7	-0.5	0.4
	Calory	1000 Gcal	10	10	10	10	1.7	1.7	-0.5	0.4
	Value	mill baht	3	3	3	4	1.9	2.0	3.6	2.9
Mining	growth rate	%		7.5	7.5	5.3				
Quarrying	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	86.0				
	Volume	1000 kl	14	17	19	21	7.5	7.5	1.1	3.7
	Weight	KTOE	13	16	18	20	7.5	7.5	1.1	3.7
	Calory	1000 Gcal	129	160	185	196	7.5	7.5	1.1	3.7
	Value	mill baht	40	50	58	83	7.7	7.8	5.2	6.3
Manufacturing	growth rate	%		5.6	5.6	4.4				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	68.8				
Food	Volume	1000 kl	255	291	286	250	4.5	-0.9	-1.9	-0.2
Beverages	Weight	KTOE	240	274	269	236	4.5	-0.9	-1.9	-0.2
	Calory	1000 Gcal	2422	2762	2714	2378	4.5	-0.9	-1.9	-0.2
	Value	mill baht	755	865	854	991	4.7	-0.6	2.2	2.3
Manufacturing	growth rate	%		10.2	10.2	7.2				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	68.8				
Textiles	Volume	1000 kl	302	382	402	396	8.2	2.6	-0.2	2.3
Wearing	Weight	KTOE	284	359	378	373	8.2	2.6	-0.2	2.3
	Calory	1000 Gcal	2867	3628	3820	3763	8.2	2.6	-0.2	2.3
	Value	mill baht	893	1136	1202	1568	8.3	2.9	3.9	4.8
Manufacturing	growth rate	%		9.4	9.4	6.8				
	elastic value			0.8	0.7	0.6				
	C.S. rate	%		100.0	100.0	86.0				
Wood	Volume	1000 kl	19	24	27	30	7.5	6.6	1.9	4.0
Wood Products	Weight	KTOE	18	22	25	29	7.5	6.6	1.9	4.0
	Calory	1000 Gcal	180	223	254	288	7.5	6.6	1.9	4.0
	Value	mill baht	56	70	80	120	7.7	8.8	6.0	6.8
Manufacturing	growth rate	%		6.8	6.8	6.0				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	63.2				
Paper	Volume	1000 kl	104	122	123	108	5.4	0.0	-1.8	0.2
Printing	Weight	KTOE	98	115	115	101	5.4	0.0	-1.8	0.2
	Calory	1000 Gcal	992	1163	1164	1021	5.4	0.0	-1.8	0.2
	Value	mill baht	309	364	386	426	5.6	8.3	2.2	2.7
Manufacturing	growth rate	%		7.9	7.9	6.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	57.6				
Chemical	Volume	1000 kl	66	79	81	67	6.3	0.9	-2.6	0.1
Petroleum	Weight	KTOE	62	75	76	63	6.3	0.9	-2.6	0.1
Coal	Calory	1000 Gcal	827	754	767	637	6.3	0.9	-2.6	0.1
Plastics	Value	mill baht	195	234	241	265	6.5	1.1	1.4	2.6
Manufacturing	growth rate	%		11.5	11.5	5.7				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	68.8				
Nonmetallic	Volume	1000 kl	426	554	595	559	9.2	3.6	-0.9	2.3
Mineral	Weight	KTOE	401	522	560	526	9.2	3.6	-0.9	2.3
	Calory	1000 Gcal	4044	5266	5652	5313	9.2	3.6	-0.9	2.3
	Value	mill baht	1240	1645	1779	2215	9.4	3.9	5.2	4.8
Manufacturing	growth rate	%		8.6	8.6	6.9				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	68.8				
Basic Metal	Volume	1000 kl	89	109	112	112	6.9	1.4	0.0	1.9
	Weight	KTOE	84	102	105	105	6.9	1.4	0.0	1.9
	Calory	1000 Gcal	845	1032	1061	1063	6.9	1.4	0.0	1.9
	Value	mill baht	265	323	334	443	7.1	1.7	4.1	4.4

Industry	Items	Unit	1987	1990	1992	1999	90/87	92/90	99/92	99/87
Manufacturing	growth rate	%		8.3	8.3	7.1				
	elastic value			0.8	0.8	0.8				
	C.S. rate	%		100.0	90.0	68.8				
Fabricated Metal	Volume	1000 kl	7	9	9	9	6.6	1.2	0.2	1.9
Machinery	Weight	KTOE	7	8	8	8	6.6	1.2	0.2	1.9
	Calory	1000 Gcal	68	82	84	85	6.6	1.2	0.2	1.9
	Value	mill baht	21	26	26	35	6.8	1.4	4.3	4.4
Manufacturing	growth rate	%		6.9	6.9	6.0				
	elastic value			0.6	0.5	0.6				
Unclassified	C.S. rate	%		100.0	90.0	68.8				
	Volume	1000 kl	126	148	148	141	5.5	0.1	-0.7	1.0
	Weight	KTOE	118	139	139	133	5.5	0.1	-0.7	1.0
	Calory	1000 Gcal	1193	1402	1405	1342	5.5	0.1	-0.7	1.0
	Value	mill baht	372	439	442	559	5.7	0.4	3.4	3.5
Manufacturing	growth rate									
	elastic value									
	C.S. rate									
Total	Volume	1000 kl	1393	1717	1781	1673	7.2	1.8	-0.9	1.5
	Weight	KTOE	1312	1616	1676	1574	7.2	1.8	-0.9	1.5
	Calory	1000 Gcal	13238	16312	16919	15890	7.2	1.8	-0.9	1.5
	Value	mill baht	4125	5108	5325	6624	7.4	2.1	3.2	4.0
Electricity	growth rate	%		7.3	7.3	5.6				
Gas	elastic value			1.5	1.5	1.1				
Water	C.S. rate	%		100.0	100.0	63.2				
	Volume	1000 kl	575	785	967	928	10.9	11.0	-0.6	4.1
	Weight	KTOE	541	739	910	874	10.9	11.0	-0.6	4.1
	Calory	1000 Gcal	5462	7460	9183	8820	10.9	11.0	-0.6	4.1
	Value	mill baht	1702	2336	2890	3676	11.1	11.2	3.5	5.6
Construction	growth rate	%		7.5	7.5	7.3				
	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	86.0				
	Volume	1000 kl	15	19	22	32	8.3	8.2	5.7	6.8
	Weight	KTOE	14	17	20	30	8.3	8.2	5.7	6.8
	Calory	1000 Gcal	139	176	207	305	8.3	8.2	5.7	6.8
	Value	mill baht	43	55	65	127	8.4	8.5	10.1	9.4
Trades	growth rate	%		4.8	4.8	5.1				
Restaurans	elastic value			1.2	1.2	1.2				
Hotels	C.S. rate	%		100.0	100.0	86.0				
Residential	Volume	1000 kl	18	22	24	32	5.8	5.8	3.9	4.6
	Weight	KTOE	17	21	23	30	5.8	5.8	3.9	4.6
	Calory	1000 Gcal	176	208	232	303	5.8	5.8	3.9	4.6
	Value	mill baht	55	65	73	126	5.9	6.0	8.1	7.2
Transportation	growth rate	%		5.4	5.4	5.2				
Communication	elastic value			1.1	1.1	1.1				
	C.S. rate	%		100.0	100.0	86.0				
	Volume	1000 kl	319	380	426	541	5.9	5.9	3.5	4.5
	Weight	KTOE	300	357	401	509	5.9	5.9	3.5	4.5
	Calory	1000 Gcal	3031	3606	4047	5137	5.9	5.9	3.5	4.5
	Value	mill baht	945	1129	1274	2141	6.1	6.2	7.7	7.1
Banks	growth rate	%		5.9	5.9	5.3				
Insurance	elastic value			1.0	1.0	1.0				
Real estate	C.S. rate	%		100.0	100.0	86.0				
Service	Volume	1000 kl	0	0	0	0	0.0	0.0	0.0	0.0
	Weight	KTOE	0	0	0	0	0.0	0.0	0.0	0.0
	Calory	1000 Gcal	0	0	0	0	0.0	0.0	0.0	0.0
	Value	mill baht	0	0	0	0	0.0	0.0	0.0	0.0
Others	growth rate	%		5.0	5.0	5.0				
	elastic value			1.0	1.0	1.0				
	C.S. rate	%		100.0	100.0	86.0				
	Volume	1000 kl	11	12	14	17	5.0	5.0	2.8	3.7
	Weight	KTOE	10	12	13	16	5.0	5.0	2.8	3.7
	Calory	1000 Gcal	102	118	130	157	5.0	5.0	2.8	3.7
	Value	mill baht	32	37	41	65	5.2	5.3	7.0	6.2
Total	Volume	1000 kl	2346	2953	3254	3244	8.0	5.0	0.0	2.7
	Weight	KTOE	2208	2779	3063	3054	8.0	5.0	0.0	2.7
	Calory	1000 Gcal	22287	28049	30913	30821	8.0	5.0	0.0	2.7
	Value	mill baht	6944	8784	9729	12848	8.1	5.2	4.1	5.3
Forecast	Volume	1000 kl	2346		3314	3894				
	Weight	KTOE	2208		3119	3665				

Comment : growth rate = Industrial product's growth rate
elastic value = Rate between energy consumption growth rate and industrial growth rate
C.S. rate = Energy Conversion rate or Energy saving rate
KTOE = 1000 Ton of Oil Equivalent
Gcal = 1,000,000 kcal

Table 6-48 Comparison of Fuel Oil Consumption between before and after Energy Saving Countermeasures in Thailand (1999) Unit: 1,000 kl

Industry	Before energy saving countermeasures	After energy saving countermeasures	Difference
Agriculture & Fishing	1	1	- 0
Mining & Qarrying	24	21	- 3
Foods & Beverages	291	250	- 41
Textiles & Wearing	476	396	- 80
Wood & Wood Products	35	30	- 5
Paper & Printing	136	108	- 28
Chemical & Petroleum	93	67	- 26
Nonmetallic & Mineral	650	559	- 91
Basic Metal	130	112	- 18
Fabricated & Machinery	10	9	- 1
Other Manfacturing	164	141	- 23
Electricity & Gas	1175	928	-247
Construction	37	32	- 5
Trades & Hotels & Resid.	37	32	- 5
Transport & Communcation	629	541	- 88
Service & Others	19	17	- 2
Manufacturing Total	1987	1673	-314
Whole Industries Total	3910	3244	-666

Minus signs mean the reduction of energy demand after energy saving countermeasures.

Energy saving rate of manufacturing sector: in Thailand

Approximately 16% in 1999

Energy saving rate of all industries in Thailand

Approximately 17% in 1999

(3) Investment for Energy Saving

As mentioned in 6.4, the affected fuel oil from energy saving countermeasures in Samut Prakarn is set to 16% of the total fuel oil consumption in Samut Prakarn, and when energy saving countermeasures are carried out to the 16% fuel oil, the investment for energy saving in Samut Prakarn reaches 160 million baht. Thus Thailand's saved fuel oil is determined at 16% of the total fuel oil consumption in Thailand, and the investment for the energy saving is calculated. Table 6-49 shows this result and Table 6-50 shows the investment for energy saving of all industries in Thailand.

Table 6-49 Energy Saving Investment for Manufacturing Sector in Thailand

	Samut Prakarn's manufacturing sector	Thailand's entire manufacturing sector
Fuel oil consumption	522126 kl	1781000 kl
Energy saving investments	160 mill Baht	546 mill Baht

Table 6-50 Energy Saving Investments for all Industries in Thailand

	Manufacturing sector in Thailand	All industries in Thailand
Fuel oil consumption	1781000 kl	3254000 kl
Energy saving investments	546 mill Baht	998 mill Baht

(4) Effect of energy saving

The fuel oil consumption in overall Thailand before energy and after energy saving countermeasures in 1999 are evaluated with the 1999 fuel oil price, 3,960 baht/kl. The effect of the energy saving countermeasures is calculated with the difference between the both. The results are shown in Table 6-51.

Table 6-51 Energy Saving Effect in All of Thailand (1999) Unit: mill Baht

Industry	[illegible]	[illegible]	Difference
Agriculture & Fishing	4	4	- 0
Mining & Qarrying	97	83	- 14
Foods & Beverages	1153	991	-162
Textiles & Wearing	1885	1568	-317
Wood & Wood Products	140	120	- 20
Paper & Printing	539	426	-113
Chemical & Petroleum	369	265	-104
Nonmetaltic & Mineral	2575	2215	-360
Basic Metal	515	443	- 72
Fabricated & Machinery	41	35	- 6
Other Manfacturing	650	559	- 91
Electricity & Gas	4654	3676	-978
Construction	148	127	- 21
Trades & Hotels & Resid.	147	126	- 21
Transport & Commoncation	2490	2141	-349
Service & Others	76	65	- 11
Manufacturing Total	7867	6624	-1243
Whole Industries Total	15483	12848	-2635

Minus signs mean the reduction of energy consumption value after energy saving Energy saving effect of Thailand manufacturing sector: Approximately 1.2 billion baht in 1999

Energy saving effect of all industries in Thailand: approximately 2.6 billion baht in 1999

7 Influence of Environment Countermeasures on Thai Economy

7.1 Influence on Demand

First, the following premises are established for researches of the influence of the investment in making stack higher and energy saving on Thai economy.

① The investment in making stack higher and energy saving is regarded as a shift from the investment funds for overall equipment and investment without increase in new investment funds.

② Although a price hike is afraid because of the increase in production cost due to environment expenses (environment measure investment and environment preservation expenses), the country's domestic consumption and export is regarded as steady on the assumption that such environment expenses will not affect the economy.

③ The energy surplus created by making stack higher and energy saving in Thailand is considered to be allowcated for export.

④ Under the above assumption, environment measure investment is included in overall investment but the expenses for environment preservation is separated from consumption.

Let Y be income; C consumption; V environment preservation expenses; I investment; E export; M import; st saving propensity, then income (Y) will be given by expression (7-1).

$$Y = C+V+I+E-M \quad \cdots\cdots (7\text{-}1)$$

The relationship between consumption and income is given by expression (7-2).

$$C+V = (1-st)\cdot Y \quad \cdots\cdots (7\text{-}2)$$

Then, as demonstrated by expression (7-3), income (Y) is given by investment and the remainder of import subtracted from export.

i.e.

$$Y = (1-st)\cdot Y+I+E-M \quad \cdots\cdots (7\text{-}3)$$

Namely,

$$Y = (I+E-M)/st \quad \cdots\cdots (7\text{-}4)$$

I (investment) does not change because investment does not change whether the country's investment will be conducted for expanding reproduction equipment or for making stack higher and energy saving.

When some of the environment investment are allocated to import, the environment investment leads to "an increase in import (enlargement of M) while the energy surplus due to making stack higher and energy saving leads to "an increase in export (enlargement of E). Therefore, GDP is affected only by an increase of import (ΔM) and increase of export (ΔE). Where ΔGDP is the

change of GDP in that case, then ΔGDP is given by the following expression (7-5).

$$\Delta GDP = (\Delta E - \Delta M)/st \quad \cdots\cdots (7\text{-}5)$$

7.2 Influence on Production

As for the influence of investment on production, "growth rate of aggregate supply ability" decreases because the funds for expansive reproduction is shifted to environment measure investment. This is expressed with economic elements as follows:

$$pr = \Delta Y/I \quad \cdots\cdots (7\text{-}6)$$
$$rr = V/Y \quad \cdots\cdots (7\text{-}7)$$

Where,

pr: Capital productivity

rr: Environment preservation expense rate

ct: Propensity to consume

But, $I = st \cdot Y$, $st = 1 - ct - rr$

Growth rate of aggregate supply ability $= \Delta Y/Y$

$= (\Delta Y/I) \cdot (I/Y)$

$= pr \cdot st$

$= pr \cdot (1 - ct - rr)$ ..... (7-8)

i.e., Growth rate of aggregate supply ability = capital productivity·(1 −propensity to consume − environment preservation expense rate)

Accordingly, as "environment preservation expense rate" increases, "growth rate of aggregate supply ability" decreases.

As explained above, environment measure investment leads to the increase of environment preservation expense and ultimately slows down the growth rate of domestic aggregate supply ability. Therefore, in an economy with a high operation rate, insufficient supply ability leads to import growth or to price hikes due to commodity shortages which, in turn, curbs the country's gross demand, ultimately giving a negative impact on the increase of GDP.

Considering environment measures from a viewpoint of energy saving and conversion, they affect economy in terms of the amount of import of equipment for environment measure and that of energy. In addition, since the increase of environment investment leads to the slow down of productivity growth and the rise in environment preservation expenses such as the operation cost of environment measure equipment, economy is slowed down in terms of domestic supply.

Environment investment, however, does not always have negative factors to economy. In addition to the export of energy surplus, the elimination of traffic jams prevents such bad conditions triggered by them as exhaust gas pollution, transportation expense increase, human body exhaustion and pollution diseases, which brings with the social benefit. As seen in Japan, the development of the business related to environmental pollution measures and equipment is a good example of

the direct contribution of environmental measures to economy. But it is difficult to calculate such contribution and to analyse the influence on GDP.

7.3 Influence of Making Stack Higher on Thai GDP

As explained in paragraph 2.3, the expenses for 49 stacks in Samut Prakarn industrial district are 115,000,000 bahts, excluding expense for construction of stack foundations. The prospect concerning the influence of making stack higher on GDP is described here under based on the following 7 premises:

① The expenses for making stack higher in Samut Prakarn are assumed to be 230 million bahts which is a double of the estimated 115 million bahts, including cost of foundation construction and demolition cost of old stacks.

② The manufacturing industry in Samut Prakarn occupies 12% of overall manufacturing production of Thailand in 1985. Therefore, the overall expenses for all stacks in Thailand are assumed to be calculated in the same ratio. Accordingly, the amount of the overall expenses is 1.92 billion bahts as follows:

230 million bahts/0.12 = 1.92 billion bahts

③ The amount of investment for making stack higher is assumed that some of plant and equipment investment should be allocated. In other words, the overall plant and equipment investment in Thailand is assumed to be unchanged, but the production ability is curbed in the proportion to high stack construction expense.

④ All the materials, engineering and capitals for making stack higher are assumed to be supplied from Thailand with no change in import and export.

⑤ The GDP output for an fixed asset in Thailand (called capital productivity) is assumed to be 90 percent. The yearly change of capital productivity in Japan is shown in Table 7-1.

Table 7-1 Change of Capital Productivity in Japan (%)

	1975	1980	1985	1988
Manufacturing Industry	88	88	78	101
All Industries	71	65	57	67

⑥ Although the investment of making stacks higher is expected to be performed for a considerable period of time, all the investment is assumed to be completed in a starting year. This clarifies the condition of the maximum influence of making stacks higher on GDP. These three years, 1993, 1995 and 1997, are determined as the starting year of the investment.

⑦ The prospect of GDP in Thailand was established based on The NEPO's data, considering the country's recent economic prospect.

Table 7-2 Prospect of Thailand GDP by NEPO

Period	Growth Rate
1986－1990	6.0%
1991－1996	5.6%
1997－2001	4.8%

Source; Total Picture Status of Energy in Thailand in the Future January 1988

(1) GDP prospect before environment countermeasures.

For the purpose of calculating the influence of the making stacks higher on the Thai economy. the prospect of GDP before making stack higher has been calculated for 1992 and 1999 on the basis of the NEPO data and the estimation for 1989, and 1990. Table 7-3 shows the result.

Table 7-3 Prospect of GDP Before Making Stack Higher (Unit: one billion bahts)

Case	1988	1992	1999	92／88	99／92
GDP	1466	2021	2893	8.36	5.26

The Calculation is based on 1988's nominal GDP, and on real GDP growth rate for 1989 and later years. Therefore, the GDP for 1992 and 1999 is the real GDP on 1988 constant prices.

(2) Influence of making stacks higher on GDP

Judging from the previous premises, making stacks higher do not change Thailand's import and export, so they also do not give any change to Thailand's gross demand (gross demand = GDP + import). On the other hand, in the economic situation where the country has a very active production with constant full operations, the decrease of the investment for the advancement of ability means reduction of production ability, resulting in the increase of import because the gross demand cannot be fulfilled from the country's domestic production. In this case, GDP will decrease because of GDP = gross demand − import.

Granted that making stacks higher constructed under such condition, the decrease of GDP will be calculated as in Table 7-4. Let Case A be the construction of making stacks higher in 1993; Case B in 1995; Case C in 1997. The summary of the result shown in Table 7-4 is presented in Table 7-5.

Table 7-4 Influence of Investment for Making Stacks on GDP

GDP trend reduced by Satck building (Case A : Implementing in 1993)

	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	99/92
GDP forecasted by NEPO	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2513	2634	2761	2893	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
Stack Building Cost in S.P.	bil Baht						0.115							
Civil Work for S.B. in S.P.	bil Baht						0.115							
Total S.B. Cost in S.P.	bil Baht						0.230							
Production Value Rate	%						12.0							
Samut P. vs Thailand														
Stack Building Cost in T.L.	bil Baht						1.917							
GDP / Fixed Assets in T.L.	%						90.0	90.0	90.0	90.0	90.0	90.0	90.0	
GDP reduced by S.B.	bil Baht						1.73	1.73	1.73	1.73	1.73	1.73	1.73	
Accumu. GDP reduced	bil Baht						1.73	3.45	5.18	6.90	8.63	10.35	12.08	
GDP effected by S.B.	bil Baht	1466	1648	1813	1914	2021	2132	2252	2378	2507	2626	2750	2881	5.19
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.5	5.6	5.6	5.4	4.7	4.7	4.8	
(Difference)	bil Baht		0.00	0.00	0.00	0.00	-1.72	-1.72	-1.72	-6.90	-8.63	-10.35	-12.07	

GDP trend reduced by Satck building (Case B : Implementing in 1995)

	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	99/92
GDP forecasted by NEPO	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2513	2634	2761	2893	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
Stack Building Cost in S.P.	bil Baht								0.115					
Civil Work for S.B. in S.P.	bil Baht								0.115					
Total S.B. Cost in S.P.	bil Baht								0.230					
Production Value Rate	%								12.0					
Samut P. vs Thailand														
Stack Building Cost in T.L.	bil Baht								1.917					
GDP / Fixed Assets in T.L.	%								90.0	90.0	90.0	90.0	90.0	
GDP reduced by S.B.	bil Baht								1.73	1.73	1.73	1.73	1.73	
Accumu. GDP reduced	bil Baht								1.73	3.45	5.18	6.90	8.63	
GDP effected by S.B.	bil Baht	1466	1648	1813	1914	2021	2134	2254	2378	2510	2629	2754	2884	5.21
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.5	5.5	4.7	4.7	4.7	
(Difference)	bil Baht		0.00	0.00	0.00	0.00	0.00	0.00	-1.72	-3.45	-5.18	-6.90	-8.63	

GDP trend reduced by Satck building (Case C : Implementing in 1997)

	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	99/92
GDP forecasted by NEPO	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2513	2634	2761	2893	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
Stack Building Cost in S.P.	bil Baht										0.115			
Civil Work for S.B. in S.P.	bil Baht										0.115			
Total S.B. Cost in S.P.	bil Baht										0.230			
Production Value Rate	%										12.0			
Samut P. vs Thailand														
Stack Building Cost in T.L.	bil Baht										1.917			
GDP / Fixed Assets in T.L.	%										90.0	90.0	90.0	
GDP reduced by S.B.	bil Baht										1.73	1.73	1.73	
Accumu. GDP reduced	bil Baht										1.73	3.45	5.18	
GDP effected by S.B.	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2513	2632	2757	2888	5.21
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.7	4.7	4.7	
(Difference)	bil Baht		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.72	-3.45	-5.18	

GDP forecast by NEPO : 1988's GDP is actual. 1989 and 1990's GDP are estimation value 1991-1999's GDP are forecasted by NEPO. And then, 1988's GDP is nominal, 1989-1999's GDP are 1988 constant prices.

Production Value Rate : *These values are ratio between Samut Prakarn's Manufacturing* Production value and Thailand's manufacturing production value.

GDP/Fixed Assets in T.L. : The percentage value is a ratio between Thailand's GDP and Thailand's Fix Assets. In the Japanese case, the percentage is about 25% until 1970's.

It is considering that the invested production equipments are available during 5~10 years. If 1.917 bil bahts would invest for making stocks higher instead of production equipments. It is considered that production equivalent to the investment amount is reduced during 5~10 years.

Therefore investments for making stock higher influence GDP with the following relations.

1.917 bil bahts × 0.9=1.73 bil Baths (productibility is 90%)

Value added of 1.73 bil baths is reduced every year. If GDP influenced by the investment is calculated by using the GDP outlook of NEPO, it is as follows;

unit Bil Baths

year	1993	1994	1995	1996	1997	1998	1999
A. GDP by NEPO	2134	2254	2380	2513	2634	2761	2893
B. *Biulding* cost	*1.92*						
C. Producti-vibility	90%						
D. Redused Value add	1.73	1.73	1.73	1.73	1.73	1.73	1.73
E. Cumulative D.	1.73	3.45	5.18	6.90	8.63	10.35	12.08
F. Reduced *GDP*	2133	2252	2378	2507	2626	2750	2881

Investment for making stock higher does not only influence the GDP in the invested year, but also GDP during the prodution equipment available.

Table 7-5 Influence of Investment for Making Stacks Higher on GDP (Unit: billion bahts)

Case	1988	1992	1999.	92/88	99/92
Basis	1466	2021	2893	8.36	5.26
Case A	1466	2021	2881	8.36	5.19
Case B	1466	2021	2884	8.36	5.21
Case C	1466	2021	2888	8.36	5.23

Case A: when making stacks higher is in 1993
Case B: when making stacks higher is in 1995
Case C: when making stacks higher is in 1997

From those results, it is understood that there is no change in GDP growth rate in each case between 1988 and 1992 because of the construction of high stacks after 1993, but the GDP growth rate of each case decreases after 1993. The decrease of GDP growth rate in each case from 1992 to 1999 and the decrease of GDP in 1999 are as follows.

1) Decrease of the GDP growth rate from 1992 to 1999

   GDP growth rate in CASE A decrease by the annual rate of 0.07 percent against the basis case.

   GDP growth rate in CASE B decrease by the annual rate of 0.05 percent against the basis case.

   GDP growth rate in CASE C decrease by the annual rate of 0.03 percent against the basis case.

2) Decrease of GDP in 1999

   1999's GDP decreases in Case A by 12.07 billion bahts (0.42%) against the base CASE.
   1999's GDP decreases in Case B by 8.63 billion bahts (0.30%) against the base case.
   GDP decreases in Case A by 5.18 billion bahts (0.18%) against the base case.

   As those results of the calculation, it can be concluded that making stacks higher has little affect on Thailand economy though over estimation construction expenses, full economy operation and high capital productivity are assumed.

7.4 Influence of Energy Saving on Thailand Economy

As explained in paragraph 6.5, the effort of energy saving overall Thailand is 2.6 billion bahts in 1999 and the investment for energy saving is estimated about one billion bahts in 1999. With the

following premises in addition to that, influence on GDP caused by the Thailand energy saving is as the following.

① The investment for energy saving is assumed to be used for energy saving shifted from investment of production equipment. In other words, the country's all equipment investment does not change, and production ability growth is curbed in proportion to the size of energy saving.

② All the materials, know-how and capitals for energy saving are assumed to be supplied from inside Thailand. And the surplus energy occuring arising from the investment for energy saving is assumed to be able to export at the current price.

③ The GDP output for each fixed asset in Thailand (called capital productivity) is assumed to be 90 percent. It is the same as the capital productivity in the case of high stack construction.

④ The investment for energy saving is assumed to be performed constantly between 1993 and 1999.

⑤ The change of GDP in Thailand before energy saving
As in the case of high stack construction, Thailand's GDP prospect by NEPO is assumed to be the basis prospect before energy saving.

(1) GDP prospect before energy saving

For the purpose of calculating the influence of energy saving on the Thai economy, the prospect of GDP before energy saving has been calculated for 1992 and 1999 on the basis of the NEPO data. Table 7-3 shows the result.

(2) Influence of energy saving on GDP

The influence of the energy saving investment or the export of surplus energy on GDP is shown in Table 7-6. And the summary of the result is shown in Table 7-7. Judging from those results, if energy saving is implemented in Thai manufacturing sectors, the influence of energy saving on GDP is one billion bahts in 1999, and if implemented in all the industries in Thailand, the influence will reach two billion bahts on GDP in the same year. It is because that the effective trade of energy surplus (here assumed to be export) is greater than a negative effect of energy saving investment.

Therefore, it is concluded from the above calculation that the investment for energy saving has little influence on the GDP's growth rate and the energy saving rather gives a positive influence to GDP under considering the effective trade of energy surplus (export here).

Table 7-6 Influence of the Investment for Energy Saving on GDP

GDP Sensitivity Analysis with Save Energy in Manufacturing Industry

	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	99/92
GDP forecasted by NEPO	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2513	2634	2761	2893	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
Investment for Save Energy in Manufacturing	bil Baht						0.078	0.078	0.078	0.078	0.078	0.078	0.078	
GDP/Fixed Assets in Manufactur	%						90.0	90.0	90.0	90.0	90.0	90.0	90.0	
GDP reduced by Investment	bil Baht						0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Accumu. GDP reduced	bil Baht						0.07	0.14	0.21	0.28	0.35	0.42	0.49	
Export QTY of surplus Fuel Oil	1000 kl						40.0	80.0	120.0	160.0	200.0	240.0	280.0	
Fuel Oil Prices	baht/kl					2990.0	3110.0	3230.0	3360.0	3500.0	3640.0	3790.0	3960.0	
Export Value of surplus Fuel	*bil Baht*						*0.124*	*0.258*	*0.403*	*0.560*	*0.728*	*0.910*	*1.109*	
GDP reflected by Save Energy	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2514	2635	2761	2894	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
(Difference)	bil Baht						0.05	0.12	0.19	0.28	0.38	0.49	0.62	

GDP Sensitivity Analysis with Save Energy in Thai Industries

	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	99/92
GDP forecasted by NEPO	bil Baht	1466	1648	1813	1914	2021	2134	2254	2380	2513	2634	2761	2893	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
Investment for Save Energy in Thai Whole Industries	bil Baht						0.143	0.143	0.143	0.143	0.143	0.143	0.143	
GDP/Fixed Assets in Thai Whole Industries	%						90.0	90.0	90.0	90.0	90.0	90.0	90.0	
GDP reduced by Investment	bil Baht						0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Accumu. GDP reduced	bil Baht						0.13	0.26	0.39	0.51	0.64	0.77	0.90	
Export QTY of surplus Fuel Oil	1000 kl						79.0	237.0	316.0	395.0	474.0	553.0	632.0	
Fuel Oil Prices	baht/kl					2990.0	3110.0	3230.0	3360.0	3500.0	3640.0	3790.0	3960.0	
Export Value of surplus Fuel	bil Baht						0.246	0.766	1.062	1.383	1.725	2.096	2.503	
GDP reflected by Save Energy	bil Baht	1466	1648	1813	1914	2021	2135	2254	2381	2514	2635	2762	2895	5.26
(Growth Rate)	%		12.4	10.0	5.6	5.6	5.6	5.6	5.6	5.6	4.8	4.8	4.8	
(Difference)	bil Baht		0.00	0.00	0.00	0.00	0.12	0.51	0.68	0.87	1.08	1.32	1.60	

GDP forecast by NEPO : 1988's GDP is actual, 1989 and 1990's GDP are estimation value 1992-1999's GDP are forecasted by NEPO. And then, 1988's GDP is nominal, 1989-1999's GDP are 1988 constant prices.

GDP/Fixed Assets in T.L. : The percentage value is a ratio between Thailand's GDP and *Thailand's Fix Assets*. In the Japanese case, the percentage is about 25% until 1970's.

Table 7-7 Influence of Investment for Energy Saving on GDP (Unit: billion bahts)

Year		1988	1992	1999	99/92
Basis GDP		1466	2021	2893	5.26%
Energy Saving in Manufacturing Industry		1466	2021	2894	5.26%
	difference	0	0	+1	
Energy Saving in All Industries		1466	2021	2895	5.27%
	difference	0	0	+1	

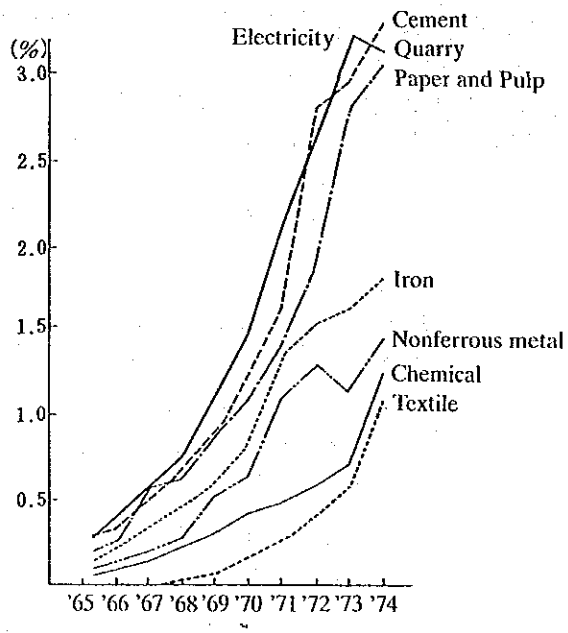
8. Pollution Prevention Cost in Japan

8.1 Pollution Prevention Cost

(1) Components of Pollution Prevention Cost

Pollution prevention costs include operation cost such as labor cost and energy cost accompanied by investment for environmental protection, capital cost such as depreciation cost and loan interest for equipments, research and development cost for technology and fuel conversion cost. But to grasp these costs is not easy because concept of "pollution prevention" and its cost are defined differently from company to company.

The ratio of pollution prevention cost against sales cost including operation cost and capital cost by industry are shown in White Paper on Environment in Japan 1987 as shown in Fig. 8-1. As seen in Fig. 8-1, the ratio of pollution prevention cost against sales cost of some industries varies within a range of 1% and 3%. And they show rapid increases from 1965 on.



Pollution prevention costs:
These are cumulative figures of depreciation cost and operation cost estimated for new investments for pollution prevention every year.
Sales costs:
These are accounted for enterprises with annual sales amount more than 100 million yen.

Fig. 8-1 The Share of Pollution Prevention Cost in Sales Cost

(2) Pollution prevention investment

The share of pollution prevention investment to Japan's GNP as shown in Table 8-1,—rapidly increased from 1974 on when the issue became the public concern and thus investment hit the even most high level of 1.8% of Japan's GNP in 1975,—maintained comparatively high at from 1.6% to 1.8% during 1976 through 1981. But after 1982, investments accomplished one round coverage in Japanese industries, declined to around 1.3% of GNP.

Japan's pollution prevention expenditure radically went up since 1974. The expenditure were addressed to strenghtening of monitoring and control system, subsidies for environmental protection works, promotion of survey and research for environment protection, compensation for victims of environment pollution, promotion for natural conservation, purchase of pollution prevention equipments and maintenance cost for them, treatment plants of sewage water and effluent water and wastes and private company's pollution prevention investments. The total of the expenditures amounted to 600 billion yen in 1970, but it became four times larger to 2.6 trillion in 1975, and then reached 4 trillion in 1980. The expenditure remained at 4 trillion yen level from 1980 until today.

The pollution prevention budget of Japanese national government reached 1.8% of the national general accounting budget in 1975. The figure increased up to 2% of the general accounting budget in 1976, then it became 2.7% in 1980. The increasing pollution prevention budget, however, stopped after 1981 and the shares of the pollution prevention budget in 1986 and 1987 remained at 2.0%. The share of the pollution prevention budget in local governments became around 4% in 1971, then continued increasing after the year and reached 6.5% in 1978. After 1979, the pollution prevention budget had increased at the same increasing rate of local government's budgets, and the share of pollution prevention budget in local governments is kept at 5~6% level.

The amount of aggregate investment for pollution preventions in private sector maintained is the highest in three consecutive years of 1974, 1975 and 1976. They are 12%, 15% and 13% respectively. After the year, the figure declined, and became the same level of Japanese national government, that is, 2.2% in 1987. As for the investment for pollution prevention borne by industries in 1975, the figure in descending order is chemical industry (220 billion yen), iron industry (200 billion yen), electricity industry (170 billion yen) and oil refinery industry (130 billion yen). The amounted combined occupied 78% of Japanese private firm's total investment in 1975. Though most of Japanese industries reduced investment amount for pollution prevention in 1985, electricity industry alone occupied 70% of the private firm's investment, 244.3 billion yen.

Table 8-1 (1) Changes of Environment Protection Investment

Subjects	Expenditure elements/Industries	Unit	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
State Government	State Government budget for environment protection	100 million yen	666	1114	1693	2737	3397	3751	4856	6267	8678	11253	11664
	Share to State General Account	%	0.8	1.2	1.4	1.8	1.8	1.8	2.0	2.2	2.5	2.9	2.7
Local Government	Expenditure for Environment Protection	100 million yen	83	112	198	237	253	258	260	292	337	386	397
	Expenditure for Construction Work	100 million yen	3451	5426	7593	8524	10710	12772	13308	16747	20488	22748	24811
	Expenditure for Relief of Victims	100 million yen	121	196	296	453	658	805	1042	1184	1395	1533	1672
	Total of Local Government's Expenditure for Environment protection	100 million yen	3655	5734	7887	9214	11621	13835	14610	18224	22220	24667	26880
	Share to Local Government's General Account	%	3.5	4.6	5.2	5.0	4.8	6.4	5.8	5.5	6.5	5.9	5.9
	Total of State government and Local government	100 million yen	4321	6848	9580	11951	15018	17586	19466	24491	30898	35920	38544
	Share to State and local government's general account	%	2.3	3.1	3.5	3.6	3.5	4.1	3.9	3.9	4.5	4.4	4.3
Private Firm's Pollution Prevention Investments	Textile	100 million yen	30	53	79	96	191	226	91	41	23	12	17
	Paper and Pulp	100 million yen	68	148	196	327	443	429	370	164	126	117	76
	Chemical	100 million yen	246	281	345	670	1874	2203	1226	574	251	151	126
	Oil refinery	100 million yen	222	395	531	594	957	1261	1097	502	321	124	223
	Cement and glass	100 million yen	44	78	92	206	286	219	143	100	165	144	82
	Iron	100 million yen	404	721	727	841	1354	1961	2204	1238	1112	802	402
	Nonferrous metal	100 million yen	139	112	136	104	225	223	121	148	72	45	33
	Machinery	100 million yen	115	175	231	397	486	371	340	328	226	176	191
	Electricity	100 million yen	297	488	609	723	1414	1721	2266	1545	1377	1093	1728
	Mine and coal	100 million yen	54	171	155	228	377	435	384	282	96	80	68
	Gas	100 million yen	88	15	27	32	57	82	38	34	29	24	16
	Other manufacturing	100 million yen	9	14	41	67	79	46	30	32	21	17	21
	Total of private firm's investment for pollution prevention	100 million yen	1716	2651	3169	4285	7743	9177	8310	4988	3819	2785	2983
	Share to Private firm's equipment and investment	%	3.6	6.0	7.4	7.9	12.1	15.3	13.3	7.4	5.2	3.5	3.0
Pollution Prevention Expenditure	Total expenditure for environment protection in Japan	100 million yen	6037	9499	12749	16236	22761	26763	27776	29479	34717	38705	41527
	Share to Japanese nominal GNP	%	0.83	1.18	1.38	1.44	1.70	1.81	1.68	1.60	1.71	1.77	1.76
Compared Trends	Japan's general account budget	Trillion yen	8.1	9.5	11.9	14.8	19.1	21.2	24.2	29.1	34.4	38.7	43.4
	Total of Local government's general accounts	Trillion yen	10.3	12.4	15.3	18.3	24.0	21.5	25.3	33.3	34.3	42.1	45.7
	Total of State and local government's general accounts	Trillion yen	18.4	21.9	27.2	33.1	43.1	42.7	49.5	62.4	68.7	80.8	89.1
	Total of Private firm's equipment and investment	Trillion yen	4.8	4.4	4.3	5.4	6.4	6.0	6.2	6.7	7.4	8.0	9.8
	Japan's nominal GNP	Trillion yen	73.1	80.5	92.3	112.4	133.9	147.9	165.7	184.4	202.7	218.9	235.8

Comments: The contents of Japanese government's environment protection budget are settlement of environment standard, strengthening of surveillance and control, subsidy for environment protection work, promotion of survey and research for environment protection, countermeasures for victims and promotion for natural preservation.
The contents of local government's environment protection budget are purchase of machineries and equipments, maintenance of machineries and equipments.
The expenditure of local government's construction works include prevailing of water and drain, settling of waste proceeding equipments and so on.
The private firm's investment amount for pollution prevention are adopted the paid up cash value.
The private firm's equipment and investment amount are adopted the assumption value in proportion to construction.

Table 8-1 (2) Changes of Environment Protection Investment

Subjects	Expenditure elements/Industries	Unit	1981	1982	1983	1984	1985	1986	1987	75/70	80/75	85/80	87/85	87/70
State Government	State Government budget for environment protection	100 million yen	12055	11923	11769	11469	11172	10944	10879	41.3	25.5	−0.9	−1.3	17.9
	Share to State General Account	%	2.6	2.5	2.3	2.2	2.1	2.0	2.0					
Local Government	Expenditure for Environment Protection	100 million yen	409	223	266	288	300	300	287	25.5	9.0	−5.4	−2.2	7.6
	Expenditure for Construction Work	100 million yen	26194	25505	24727	23760	24521	26683	31074	29.9	14.2	−0.2	12.6	13.8
	Expenditure for Relief of Victims	100 million yen	1770	1756	1751	1683	1792	1750	1750	46.1	15.7	1.4	−1.2	17.0
	Total of Local Government's Expenditure for Environment protection	100 million yen	28373	27484	26744	25731	26613	28733	33111	30.5	14.2	−0.2	11.5	13.8
	Share to Local Government's General Account	%	5.8	5.4	5.1	4.8	4.7	4.9	6.1					
	Total of State government and Local government	100 million yen	40428	39407	38513	37200	37785	39677	43990	32.4	17.0	−0.4	7.9	14.6
	Share to State and local government's general account	%	4.2	4.0	3.7	3.5	3.5	3.5	4.1					
Private Firm's Pollution Prevention Investments	Textile	100 million yen	19	17	23	28	29	35	10	49.8	−40.4	11.3	−41.3	−6.3
	Paper and Pulp	100 million yen	80	41	27	67	177	115	102	44.5	−29.3	18.4	−24.1	2.4
	Chemical	100 million yen	130	155	81	193	146	146	68	55.0	−43.6	3.0	−31.8	−7.3
	Oil refinery	100 million yen	211	121	108	139	104	82	80	41.5	−29.3	−14.1	−12.3	−5.8
	Cement and glass	100 million yen	66	69	40	44	35	19	17	37.8	−17.8	−15.7	−30.3	−5.4
	Iron	100 million yen	468	639	492	328	257	202	156	37.2	−27.2	−8.6	−22.1	−5.4
	Nonferrous metal	100 million yen	24	15	10	18	22	13	11	9.9	−31.8	−7.8	−29.3	−13.9
	Machinery	100 million yen	232	224	194	178	226	211	212	26.4	−12.4	3.4	−3.1	3.7
	Electricity	100 million yen	2426	2748	3556	2430	2443	1848	1999	42.1	0.1	7.2	−9.5	11.9
	Mine and coal	100 million yen	91	165	62	31	37	27	25	51.8	−31.0	−11.5	−17.8	−4.4
	Gas	100 million yen	19	20	15	16	18	21	14	−1.4	−27.9	2.4	−11.8	−10.2
	Other manufacturing	100 million yen	13	10	6	8	10	11	5	38.6	−14.5	−13.8	−29.3	−3.4
	Total of private firm's investment for pollution prevention	100 million yen	3779	4224	4614	3480	3504	2730	2699	39.8	−20.1	3.5	−12.2	2.7
	Share to Private firm's equipment and investment	%	3.5	3.9	4.2	2.8	2.7	2.2	2.2					
Pollution Prevention Expenditure	Total expenditure for environment protection in Japan	100 million yen	44207	43631	43127	40680	41289	42407	46689	34.7	9.2	−0.1	6.3	12.8
	Share to Japanese nominal GNP	%	1.76	1.65	1.52	1.34	1.29	1.27	1.33					
Compared Trends	Japan's general account budget	Trillion yen	46.9	47.2	50.6	51.4	53.0	53.6	54.1	21.2	15.4	4.1	1.0	11.8
	Total of Local government's general accounts	Trillion yen	49.1	51.1	52.3	53.8	56.2	58.7	54.3	15.9	16.3	4.2	−1.7	10.3
	Total of State and local government's general accounts	Trillion yen	96.0	98.3	102.9	105.2	109.2	112.3	108.4	18.3	15.8	4.2	−0.4	11.0
	Total of Private firm's equipment and investment	Trillion yen	10.7	10.9	11.1	12.3	12.7	12.5	12.3	4.8	10.3	5.4	−1.8	5.8
	Japan's nominal GNP	Trillion yen	251.3	263.9	284.1	303.0	321.2	334.7	350.8	15.1	9.8	6.4	4.5	9.7

8.2 Financing of Pollution Prevention Investment

Private companies bear pollution prevention cost in line with polluter pays principle in Japan. But Japanese national government as well as local governments share the part of the cost in form of public investment for environment protection. Enterprises can get subsidies by application. The typical examples are special financing arrangement prepared for and there are a number of financing institutions in Japan to which borrowers have access with better terms than to city banks.

(1) Japan Environment Corporation

Japan Environment Corporation is one promoting construction and financing of industrial pollution prevention countermeasures for reducing pollution from private firm's factories. In Oct. 1987, the corporation's function were enhanced to promote anti-pollution countermeasures for city life.

The corporation's construction and transfer project include ① supporting of jointly invested facilities and buildings for pollution prevention, ② construction of public welfare facilities (green zone, parks), ③ development of green buffer zone for anti-pollution, ④ construction of national parks, ⑤ development of sites for industrial relocation. The corporation executes the above works, on subcontract base. Once the jobs completed, the corporation transfer the assets to private firms or organizations which request the works. The net price of assets is construction cost plus capital costs calculated in terms of long-term and low interest payment conditions. The corporation's loan project finances ① anti-pollution equipment of industries, ② prevention works for city solid contamination, and ③ construction of joint treatment facilities for wastes. Japan Environment Corporation's activities are as shown in Table 8-2.

Table 8-2 Activities of Japan Environment Corporation

100 million yen

	1970	1975	1980	1985
Construction transfer project	60	1535	450	370
Loan project	81	1370	230	280

(2) System of Financial and Other Assistance for Small Business Modernization

This financing arrangement was made to lend investment money through local governments to facilitate renovation of small and medium scale firm's equipments pursuant to the Law on Financial and Other Assistance for Small Business Modernization.

In the arrangement, there is a loan system for anti-pollution equipments. The loan arranged with the Law are as shown in Table 8-3.

Table 8-3 The Loan Arranged for Small Business

100 million yen

1970	1975	1985
4	291	456

(3) Official finance institutions

Small Business Finance Corporation's loan have been carried out from Sep. 1965 for anti-pollution equipments of small and medium scale firms as special loan system. The loan are applied to waste water disposal facilities, smoke and soot removal facilities and industrial water pipe line for industries. Further, from 1970, the loan application range was expanded to noise prevention facilities, and individual factory's relocation. The People's Finance Corporation also established the special loan system for anti-pollution equipments in 1970. The People's Finance Corporation's loan are applied to waste water disposal facilities, smoke and soot removal facilities, noise prevention facilities and industrial water pipe line. Japan Small Business Corporation also has established the assistant system related to anti-pollution equipment, which aims to promote construction of joint waste water disposal facilities. Japan Development Bank's special loan is applied to desulphurization equipment for fuel oil, transfer-equipment to industrial water service and waste oil disposal facilities. Further, the bank is furnishing the fund to exhaust gas desulphurizer, reconstruction of big cities, modernization of distribution system, factory dispersion from over crowding and pollution regulation district and area wide air-conditioning. Table 8-4 shows the loan financed by the official finance institutions.

Table 8-4 Loan Financed by the Official Finance Institutions

100 million yen

Finance Institutions	1970	1975	1985
Small Business Finance Corporation	7	420	1486
The People's Finance Corporation	—	180	190
Japan Development Bank	90	2213	810
Others	—	150	40
Total	97	2963	2526

8.3 Tax Reduction System for Promoting Pollution Prevention

The tax reduction systems for private sector is existing in Japan to promote the establishment of pollution prevention countermeasures. The short-term depreciation of anti-pollution equipments (to be permitted to depreciate half value of anti-pollution equipment assets in the acquisition year and the next year) and reduction for some tax in a case of purchasing automobiles which passed environment standard regulation are the representative ones of the systems.

The following are the actual examples mentioned in the White Paper on Environment published from 1970 to 1988.

① The special depreciation and reduction of fixed property tax which used to be applied to desulphurization equipments assets only are expanded for the pressure distillation equipments of indirect desulphurization. (1970)

② The customs tax reduction system of fuel oil was established to promote desulphurization of fuel oil by refineries. (1971)

③ Though the permission to be able to depreciate half value of anti-pollution equipment assets in the first year was given to private firms, the valid term of the permission was extended. (1975)

④ For automobiles which passed the 1976 automobile exhaust gas regulations, the sales tax and acquisition tax were reduced. (1976)

⑤ The reduction of the automobile acquisition tax for electromobiles was extended for two years. (1981)

⑥ The special deduction of the income tax in saling the lands to the Japan Environment Corporation for consolidating factories was executed for land salers. (1988)

PART VIII DESIRABLE SURVEILLANCE SYSTEM FOR ENVIRONMENT QUALITY AND EMISSION SOURCES IN FUTURE

This chapter describes the desirable legal and administrative frameworks to be adopted in the future so that the Air Quality Management Planning in the Samut Prakarn industrial district which will be formed based on the recommendation of this study will be smoothly executed by the Government of Thailand.

1. Legal and Administration Framework of Air Pollution Control in Thailand

We collected the following related acts and had interviews with the officials of the related Government Agencies and other institutes concerned, to grasp the present condition of the air pollution control in Thailand.

(1) Collected acts

① Improvement and conservation of National Environmental Quality Act (ICNEQA) 1975
② Factory Act (FAC) 1969
③ Industrial Estate Authority of Thailand Act (IEATA) 1979
④ *Public Health Act (PHA) 1941*
⑤ The City Planning Act 1979
⑥ The Poisonous Articles Act (PAA)
⑦ Cleanliness and Orderliness of Country Act (COCA) 1960
⑧ Local Health Administration Act 1952
⑨ *Bangkok Metropolitan Administration Act 1975*
⑩ Provincial Administration Act 1955
⑪ Municipal Act 1953
⑫ Announcement of Revolutionary Party No. 326, 1956

(2) Related ministries and agencies visited

① Environmental Quality Standard Division, Office of the National Environment Board
② Air Pollution Control Section, Division of Industrial Environment, the Ministry of Industry
③ Provincial Industrial Office, Samut Prakarn Province
④ Industrial Estate Authority of Thailand
⑤ The Ministry of Commerce
⑥ The Institute of Environmental Research, Chulalongkorn University
⑦ Thailand Development Research Institute

The materials for the acts collected and the information obtained at the interviews mentioned above were brought back to Japan and were examined in comparison with the Japanese legal system. Section 1.1 shows the present condition of the legal and administrative frameworks and Section 1.2 shows the findings on it.

1.1 Present Condition of Air Pollution Control in Thailand

1.1.1 Legal Framework

The 12 Acts mentioned above were examined in two roughly divided groups composed of the legal control related to environmental protection, especially industrial pollution control, and the enforcement system for the legal control.

To put it concretely, ICNEQA, FAC, IEATA, PHA, PAA and COCA corresponded to the former and the City Planning Act, Bangkok Metropolitan Administration Act, Provincial Administration Act and Municipal Act the latter.

Of ICNEQA, FAC, IEATA, PHA, PAA and COCA, ICNEQA is strongly characteristic of the basic law for environmental protection and industrial pollution control in Thailand. Compared with this, FAC is the only law possible to enforce the control of industrial pollution and IEATA is considered to be the law responsible to control the industrial pollution related to industrial estates. Compared to these three acts, however, PHA, PAA and COCA are hardly related to environmental administration, as long as we examine it from the standpoint of air pollution control. It can be pointed out that all of these five acts except ICNEQA have only a very weak concept of air pollution control. The provisions or wording related to the control of wastewater effluence are found but the provisions related to the emission of smoke are not found at all in all these five acts. We presume such facts are due to the facts that (i) waste water pollution is evidently visual in contrast to air pollution, and (ii) the pollution of Chao Phlaya river and underground water directly affects the drinking water of people, agriculture, and fisheries, while it takes air pollution, a relatively long time to affect people's health (such as asthma), etc. This may also have been influenced by the fact that the degree of seriousness of the air pollution has been low because of the condition of the economic development up to the present in Thailand. Anyway, we think that the objective consciousness for air pollution control is weak in the system for environmental protection in Thailand.

Examining the acts collected to grasp the legal basis which backs the system enforcing the environmental protection, we judged that there were no noteworthy prescriptions in the acts other than ICNEQA, FAC and IEATA. Though ICNEQA prescribed the establishment of the National Environment Board (NEB) and the Office of the National Environment Board (ONEB) as its administrative organization, the allotment of the enforcement responsibility among the central administrative agencies is not clear. The environmental administration is very diversified and requires extensive viewpoints—including industrial policies, land utilization, and city planning. ICNEQA stipulates the establishment of the NEB consisting of a Deputy Prime Minister as chairman, the Permanent Secretaries of the concerned agencies and experts appointed to secure the unification of the government's environmental policies. The question, however, is who enforces it. ONEB, as mentioned later, is not necessarily judged to have a practical right. Of course, as it is considered desirable for administrative efficiency to utilize the professional knowledge of the related ministries in enforcing the diversified environmental administration, the enforcement based

on the legal authority of related ministries and agencies will be selected. However, the provisions related to the cooperation with NEB or ONEB can't be found in PHA, etc. other than that the viewpoint of the industrial pollution prevention is found in FAC and IEATA.

In addition to the problems among the central administrative agencies mentioned above, the provisions which prescribe the relation between NEB or ONEB and local Government are scarcely found. The provision on cooperation with the central administrative agencies related to the environmental administration cannot be found at all in the Provincial Administration Act.

From the result of the overall analysis of the 12 acts collected mentioned above, we consider the acts which are important in studying the air pollution control in Thailand are the three acts of ICNEQA, FAC and IEATA. The details of the legal framework, mainly of these three acts, are described as follows:

(1) Improvement and Conservation of the National Environmental Quality Act

ICNEQA is the basic law to enforce the environmental administration of Thailand. The excellent features as the basic law are summarized below:

① It prescribes to establish the National Environment Board consisted of the Deputy Prime Minister as chairman, the Secretary General of ONEB, the Permanent Secretaries of the eight (8) Agencies and ten (10) experts and to have NEB form a plan of overall environmental policies so that the unity of environmental administration can be executed.

② It prescribes the establishment of the Office of the National Environment Board as the administrative organization of NEB.

③ It introduces the concept of preventive environment control administration and gives NEB and ONEB a prior examination authority for projects which threaten the environmental quality.

The main prescriptions of ICNEQA of which features are outlined above are as follows:

1) In Section 5 the authority and obligations of NEB are prescribed as follows:

① To plan a policy of environmental conservation and represent it to the cabinet,

② To represent an opinion to the cabinet on projects of government agencies, government enterprises and private enterprises which threaten environmental quality,

③ To represent the standards for evaluation of the effects on environment quality,

④ To propose the environmental quality standard (emission standards) to the Government Agencies concerned,

⑤ To submit opinons to the Prime Minister on environment-related regulations of the Government Agencies concerned and to coordinate the work between governmental agencies, government enterprises and the private sector, and

⑥ To provide advice and suggestions to the cabinet and the Prime Minister as requested.

From these obligations of NEB we can read that the environmental administration in Thailand is integrated and unified into NEB. In addition, according to Section 6, NEB has the authority to demand to the Agencies and institution concerned the materials related to the project which threatens to badly affect the environmental quality and consequently to propose amendments (im-

proved) of projects to the cabinet.

2) In Section 12 the following obligations of ONEB are presribed, leading to clarify its roles as an administrative organization of NEB:
   ① Performing work entrusted by NEB,
   ② Investigation and study of the environmental condition, etc. related to the preparation of the environmental standard,
   ③ Proposal of the environmental improvement to NEB,
   ④ Grasp of the condition of observing environmental controls and its report to NEB,
   ⑤ Study, enlightenment, and propagation related to the environment.

3) In Section 17 (1) and Section 18 the prior examination—Environment Impact Assessment (EIA)—on the project which threatens to badly affect the environmental quality is prescribed. Section 17 (1) prescribes that the Prime Minister should announce the scope (type of industry and scale) of projects to be objects of EIA in the official gazette according to the advice of NEB and Section 18 prescribes that EIA should be implemented by ONEB. The scope of the EIA objects prescribed in the official gazette of the Ministry of Science, Technology and Energy dated Sept. 27, 1981 according to Section 17 (1) is as shown in Table 1-1.

Table 1-1 Type and Sizes of Projects or Activities Requiring Environmental Impact Assessment (EIA) Reports

Items	Types of Projects or Activities		Sizes
1	Dam or Reservoir		storage volume greater than 100,000,000 cubic meters or storage surface area greater than 15 square kilometers
2	Irrigation		irrigated area greater than 80,000 rais (12,800 hectares)
3	Commercial Airport		all sizes
4	Hotel or Resort Facilities in an environmentally sensitive area such as areas adjacent to rivers coastal areas, lakes or beaches or in the vicinity of national parks		greater than 80 rooms
5	Mass Transit System and Expressway as defined by the Announcement of the Revolutionary Party No. 290, 24 November B.E. 2515		all sizes
6	Mining as defined by the Mineral Act No. 1 B.E. 2510, No. 2 B.E. 2516 and No. 3 B.E. 2522		all sizes
7	Industrial Estate as defined by the Industrial Estate Authority of Thailand Act, B.E. 2522		all sizes
8	Commercial Port and Harbour		with capacity for vessels of greater than 500 ton-gross
9	Thermal Power Plant		Capacity greater than 10 MW
10	Industries	(1) Petrochemical Industry	greater than 100 tons/day of raw materials required in production processes of oil refinery and/or natural gas separation
		(2) Oil Refinery	all sizes
		(3) Natural Gas Separation of Processing	all sizes
		(4) Chlor-Alkaline Industry requiring NaCl as raw material for production of Na_2CO_3, NaOH, HCl, Cl_2, NaOCl and Bleaching Powder	production capacity of each or combined product greater than 100 tons/day
		(5) Irons and/or Steel Industry	requiring from are and/or scrap iron as raw materials for production greater than 100 tons/day or using furnaces with combined capacity greater 5 tons/batch
		(6) Cement Industry	all sizes
		(7) Smelting Industry other than Iron and Steel	production capacity greater than 50 tons/day
		(8) Pulp Industry	production capacity greater than 50 tons/day

Source: Notification of the Ministry of Science, Technology and Energy, B.E. 2524 issued under Improvement and Conservation of National Environmental Quality Act, B.E. 2518 as amended in B.E. 2521, published in the Royal Government Gazette (Special issue), Vol. 98, part 158, dated September 27, B.E. 2524 (1981)

4) Section 5 (6) says, "NEB has the power to recommend the Standards of Environmental Quality to the governmental agencies having the statutory to prescribe them." and Section 17 (2) says, "The Prime Minister shall, with the advice of NEB, have the power to issue Notification in the Government Gazette the Environmental Quality Standards which, by law, are not within the scope of power and duties of any governmental agency. The words of environmental quality standards, which are used in both articles, mean the emission standards in Section 5 (6) because they are forced by the act managed by each ministry or agency while they mean the overall environmental quality standards in Section 17 (2) because they are established by the Prime Minister from an overall national standpoint.

Up to the present the environmental quality standards related to the ambient air quality according to Section 17 (2) have not been established. The National Ambient Air Quality Standards shown in Table 1-2, however, were announced as the notification of ONEB in 1981, and the standard values have been used practically by governmental agencies as an environmental quality standard.

For the emission standards according to Section 5 (6), the black smoke degree standard—requiring 40% or less on the Ringelmann Scale—was established according to FAC while the standards for other substances have not yet been established up to the present. The guideline for 31 substances, however, has been indicated by the Ministry of Industry and the contents are as shown in Table 1-3.

Table 1-2 National Ambient Air Quality Standards (Guideline) in Thailand

Pollutants	1 hr average value mg/m^3	8 hr average value mg/m^3	24 hr average value mg/m^3	1 yr average value mg/m^3	Methods of Measurement
Carbon Monoxide (CO)	50	20	–	–	Non-Dispersive Infrared Delection
Nitrogen Dioxide (NO_2)	0.32	–	–	–	Gase Phase Chemiluminescence
Sulfur dioxide (SO_2)	–	–	0.30	0.10*	Pararosaniline
Total Suspended Particulate (TSP)	–	–	0.33	0.10*	Gravimetric
Photochemical Oxidant (O_3)	0.20	–	–	–	Chemiluminescence
Lead (Pb)	–	–	0.01	–	Wet Ashing

Note: * = Geometric mean value.

Sources: (1) Standard: Notification of Office of the National Environment Board, No. 2, dated November 6, B.E. 2524, (1981) published in the Royal Government Gazette, Vol. 98, Part 197, dated December 1, B.E. 2524 (1981) P. 4322–4323.
(2) Methods of Measurement: Notification of the Ministry of Science, Technology and Energy, issued under Improvement and Conservation of National Environmental Quality Act B.E. 2518, B.E. 2521, published in the Royal Government Gazette, Vol 98, Part 197, dated December 1, B.E. 2524 (1981) P. 4299–4306.

Table 1-3 Proposed Industrial Emission Standards (Guideline) by the Ministry of Industry in Thailand

No.	Pollutants	Emission sources	Standard values
1	Particulate matters	—Furnace and boiler Fuel oil burning Coal burning —Iron industry —Cement plant and calcium carbide plant —Rock, grits and quarrying plant (production amount 50,000 ton/Y or more) —Other emission sources	 0.3 g/Nm^3 0.5 g/Nm^3 400 mg/Nm^3 400 mg/Nm^3 400 mg/Nm^3 500 mg/Nm^3
2	Smoke	—Furnace and boiler	Ringelmann measurement value shall not exceed 45%.
3	Aluminium	—Furnace and iron manufacturing facilities	(Dust) 300 mg/Nm^3 (Al) 50 mg/Nm^3
4	Alcohol	All emission sources	0.05 lb/min.
5	Aldehyde	All emission sources	0.05 lb/min.
6	Ammonia	Gas plant	25 ppm
7	Antimoney	All emission sources	25 mg/Nm^3
8	Aromatic compound	All emission sources	0.05 lb/min
9	Asbestos	All emission sources	27 mg/Nm^3
10	Arsenic	All emission sources	20 mg/Nm^3
11	Beryllium	All emission sources	10 mg/Nm^3
12	Carbonyl	Ash	25 ppm
13	Chlorine	All emission sources	20 mg/Nm^3
14	Ethylene	For both manufacturing and use	0.03 lb/min
15	Ester	All emission sources	0.05 lb/min
16	Fluorine	All emission sources	0.3 lb/ton PO25
17	Hydrogen chloride	All emission sources	200 mg/Nm^3
18	Hydrogen fluoride	All emission sources	10 mg/Nm^3
19	Hydrogen sulfide	All emission sources	100 ppm
20	Cadmium	All emission sources	1.0 mg/Nm^3
21	Copper	All emission sources	Particulate 300 mg/Nm^3 (Cu) 20 mg/Nm^3
22	Lead	All emission sources	Particulate 100 mg/Nm^3 (Pb) 30 mg/Nm^3
23	Mercury	All emission sources	0.1 mg/Nm^3
24	Carbon monoxide	All emission sources	1000 mg/Nm^3
25	Sulfur dioxide	Manufacturing of sulfuric acid and others —Bangkok and its outskirts —Other areas	500 ppm 400 ppm 700 ppm
26	Nitrogen oxides	Burning Manufacturing of HNO_3 and others	1000 mg/Nm^3 2000 mg/Nm^3
27	Nitric acid	All emission sources	70 mg/Nm^3
28	Organic substances	All emission sources	0.01 lb/min
29	Phosphoric acid	All emission sources	3 mg/Nm^3
30	Sulfur trioxide	All emission sources Componds of H_2SO_4	35 mg/Nm^3 As a value of H_2SO_4
31	Sulfuric acid	All emission sources	35 mg/Nm^3

5) Section 20 prescribes that the Prime Minister has the authority to take emergency measures for the emergent change of the environmental pollution. It is also prescribed that this authority can be transferred to the Changwat Governor for an emergency in the Changwat area.

(2) The Factory Act

FAC has the character of the industrial pollution control act while ICNEQA is characteristic of a basic law for the environmental conservation. Since FAC, however, widely aims to secure the

safety level of the labor environment health and hygiene in a factory, the pollution control is only one item on the equal level with them. FAC is, therefore, not the law system to be called a complete industrial pollution control act.

It is because FAC has the following system that it can secure the industrial pollution control:

1) License system for establishment and operation of factories.
   ① A person who wants to establish a factory has to apply to the Ministry of Industry for its establishment. The approval standard is prescribed in the ordinance of the Ministry of Industry.—Approval of establishment (Article No. 8)
   ② A person who has obtained the approval of the factory establishment has to apply to the Ministry of Industry for its operation.—Approval of operation (Article No. 12)
   ③ A factory manager has to apply to the Ministry of Industry for the renewal of the operation license every three years.—Approval of renewal (Article No. 16 and Article No. 17)
   ④ The prescriptions related to ① and ② mentioned above are correspondingly applied to the expansion and removal of a factory and modification of machinery.—(Article No. 21 and Article No. 26)

   According to item ① to ④ mentioned above, the Ministry of Industry can check the safety level, labor environmental, health and hygiene and environmental pollution control measures of the factory before its establishment and operation and, thus the advance reporting system of the Ministry of Industry has been developed together with the prescription of the order of improvement.

2) Control measures to factories
   ① In the case where a factory threatens to cause harm to regional residents, the Ministry of Industry has the authority to suspend temporarily the operation of the factory.—(Article No. 35)
   ② An official of the Ministry of Industry is given authority to enter a factory to make inspection as required.—(Article No. 36)
   ③ The matters which a factory should observe are prescribed in 15 items, the details of which are further prescribed as the ordinance of the Ministry of Industry.—(Article No. 39)

   Though the matters which a factory should observe in item ③ above are considered to be the basis of the contents of control (license of factory establishment and operation) in FAC, the matters related to the industrial pollution among the 15 items are only "waste disposal, waste water treatment and installment of ventilator" in Article 39 (6) and the others are related to safety, labor environment, health and hygiene. In other words, they lack items based on the viewpoint of air pollution control. Further, the main part of the details prescribed in the Ministerial Ordinance related to Article 39 (6) is restricted to disposal of hazardous materials, waste water treatment and ventilation within a factory and lacks items related to air pollution control.

   As mentioned above, the control items related to the air pollution cannot be found in this

FAC. However, "the emission standards based on the smoke blackness degree (Ringelmann scale)" as shown below have been prescribed as the only air pollution control standards since 1971 by the Notifiction of the Ministry of Industry according to Article 39 (16).

Industrial Emission Standards

In order to avoid industrial nuisance problems, the intensity of smoke at the mout of the stack shall not exceed 40 percent of total blackness by the Ringlemann scale except for th short periods of time during starting of operation, soot blowing, or other malfunctions of th soot control system.

Penalty : According to Factory Act No.2, B.E. 2518 (1975) which rules that violator are subjecte up to one month imprisonment or fined not more than 10,000 baht or both.

Source: Notification of the Ministry of Industry No.4, B.E. 2514 (1971) issued under the Factory Act B.E. 2512 (1969) dated August 11, B.E. 2514 (1971), published in the Royal Government Gazette, Vol. 86 (Special issue) dated August 14, B.E. 2514 (1971)

3) Abolition of license and penalty

As a pledge prescription for intending to enforce item 1) and 2) above, the prescription of the temporary suspension or abolition of an operation approval and penalty provisions are established in Article 40 through Article 50.

(3) Industrial Estate Authority of Thailand Act (IEATA)

This act prescribes the establishment of the industrial estate authority (IEA) as a government enterprise, IEA's obligation of developing the industrial estate, standards of selling the industrial estate in lots, standards of administration on the grounds of the industrial estate, organization of this authority, etc. Such prescriptions clarify that ① IEATA is an act managed by the Ministry of Industry and ② the Ministry of Industry manages and supervises this authority. This act contains no prescriptions for the management of the factories in the industrial estate developed by IEA from the viewpoint of air pollution control but says that it manages the factories in the industrial estate according to the national laws and codes related to the public health and the environmental quality. The move into the industrial estate is made under the approval according to the standards prescribed by the Board of Directors of IEA.

(4) Public Health Act (PHA)

PHA is a law aiming at maintaining the public hygiene mainly related to garbage collection and food contamination. Therefore, control from the viewpoint of the industrial pollution cannot be found in almost all the provisions but in Article 19 the emission of smoke or uncombusted substances is prescribed as nuisance which does harm to a person from the viewpoint of public hygiene and is put into the object of control together with other nuisances (various filth, vibration, noise, odor, etc.). It is prescribed that the control of these nuisances is managed under the supervision of local administrators.

(5) Laws related to motor vehicle exhaust gas regulation

For the law system related to motor vehicle exhaust gas, the emission standards based on

ICNEQA article 5 (6) are proposed to the related agencies by ONEB and, according to this, the Police Department, Ministry of State and the Land Transport Department, the Ministry of Transport and Communication determine the emission standards based on the laws of which each agency takes charge of. The Police Department bases its emission standard upon the Revolutionary Party No. 16 and the Land Transport Department, upon Land Transport Act. Table 1-4 shows the details of these emission standards.

Table 1-4 Motor Vehicle Emission Standards

Organization	Parameters	Emission Standards		Measuring Methods (summary)
		Measuring Systems	Maximum Permissible Limit (%)	
(1) ONEB (Office of the National Environment Board)	Black Smoke	Bosch or	50	1) At rapid acceleration under no-load condition to maximum rotating speed. Use maximum value of the two measurements.
		Hartridge Bosch	52 40	2) On test bench, running with full-load at 60% of the maximum rotating speed. Use average value of the two measurements.
	CO	Non-Dispersive Infrared Detection	6	1) Idling 2) Average value of the two measurements
(2) The Police Department	Black Smoke	Smoke meter	40	At proper rotating speed
(3) Department of Land Transport	Black Smoke	Bosch or	50	The same as ONEB in 1)
		Hartridge Bosch	52 40	The same as ONEB in 2)
	CO	Non-Dispersive Infrared Detection	6	The same as ONEB.

As shown in Table 1-4, the emission standards of the Police Department and the Land Transport Department correspond to the emission standards proposed by ONEB completely. The substances objective for regulation are black smoke and carbon monoxide (CO) but not nitrogen oxide (NO), lead compound (Pb) and hydrocarbon (HC). As for the regulation methods, the Land Transport Department controls motor vehicles registered under the Land Transport Act through vehicle inspection conducted per year and the Police Department checks all types of vehicles on roads according to the Road Traffic Act (regarding only black smoke as objective for control).

(6) Other acts

The prescriptions directly related to the environmental control were hardly found in the City Planning Act 1979, the Poisonous Articles Act, Cleanliness and Orderliness of Country Act, Local Health Administration Act, Bangkok Metropolitan Administration Act, Provincial Administration Act, Municipal Act, and Announcement of Revolutionary Party No. 326. The City Planning Act is

on the standpoint of improving the dwelling environment in developing and promoting the city planning and not on the standpoint of diminishing and preventing the industrial pollution. The Poisonous Articles Act also prescribes the control of the manufacturing, storage, import and export, and discharge of poisonous substances but does not prescribe the control of their discharge into the smoke and waste water from manufacturing processes.

Further, in the Provincial Administration Act and Municipal Act the prescription related to the public hygiene (securing of drinking water, garbage disposal, etc.) as the obligation of the local administrative agency exists but the definite prescription related to pollution control including that for air pollution does not exist.

1.1.2 Present State of Administrative Organization

There are eight governmental agencies constructing NEB, as prescribed by ICNEQA, including the Ministry of National Defense, Ministry of Agriculture, Ministry of Transport and Communication, Ministry of Interior, Ministry of Science, Technology and Energy, Ministry of Public Health, Ministry of Industry and the National Economic Social Development Board. From this it is evident that the environmental administration in Thailand is conducted by many separate agencies. Confining the administration to the air pollution control, however, we can consider that the administrative control for factories as main emission sources is operated mainly by the Ministry of Science, Technology and Energy having ONEB as a subordinate organization and the Ministry of Industry with participation of the Ministry of the Interior and the Ministry of Transport and Communication in the function of the motor vehicles exhaust gas control judging from the study mentioned in Section 1.1.1.

The alloted task of the environmental administration in the central government administrative agencies is as shown in Fig. 1-1.

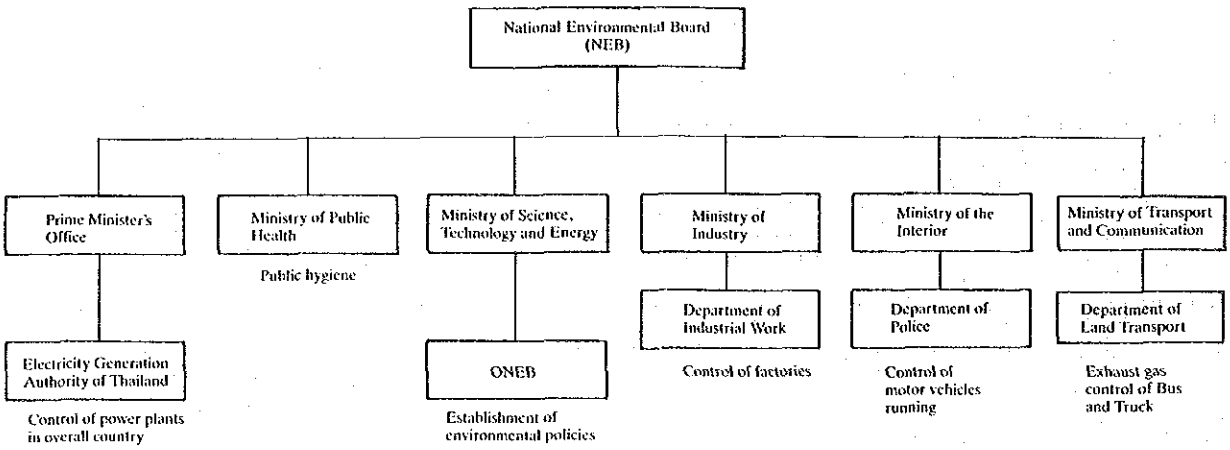


Fig. 1-1 Organization Chart of Environmental Administration in Thailand

The local administrative agencies are sectioned into Province (Changwat) and city (town, village) agencies. Samut Prakarn Province which is the objective area of this investigation is divided into five counties (Amphoes) of Phra Pradaeng, Prasamut Jedi, Samut Prakarn, Bang Plee, Bang Bo, and each Amphoe is further divided into forty-five wards. Samut Prakarn City which exists at Pak Nam Tambon in Samut Prakarn Amphoe and Phra Pradaeng City which exists at Talad Tambon in Phra Pradaeng Amphoe have a municipal government and the remaining 43 Tambons are wards directly administered by Samut Prakarn Province.

Accordingly, the local administrative agencies in Samut Prakarn Province are the Provincial Agency and two Municipal Agencies but we cannot understand that these local administrative agencies perform the administration of the air pollution prevention as shown by the Provincial Administration Act, etc. in 1.1.1. However, the administrative organization of Samut Prakarn Province shown in Fig. 1-2 indicates the existence of the Changwat Industrial Office. It has been confirmed by the explanation at the interview with the Ministry of Industry and the Industrial Office of Samut Prakarn Province that this Industrial Office is involved in the provincial industrial pollution control as the window of the application for the license of the establishment and operation of factories according to FAC.

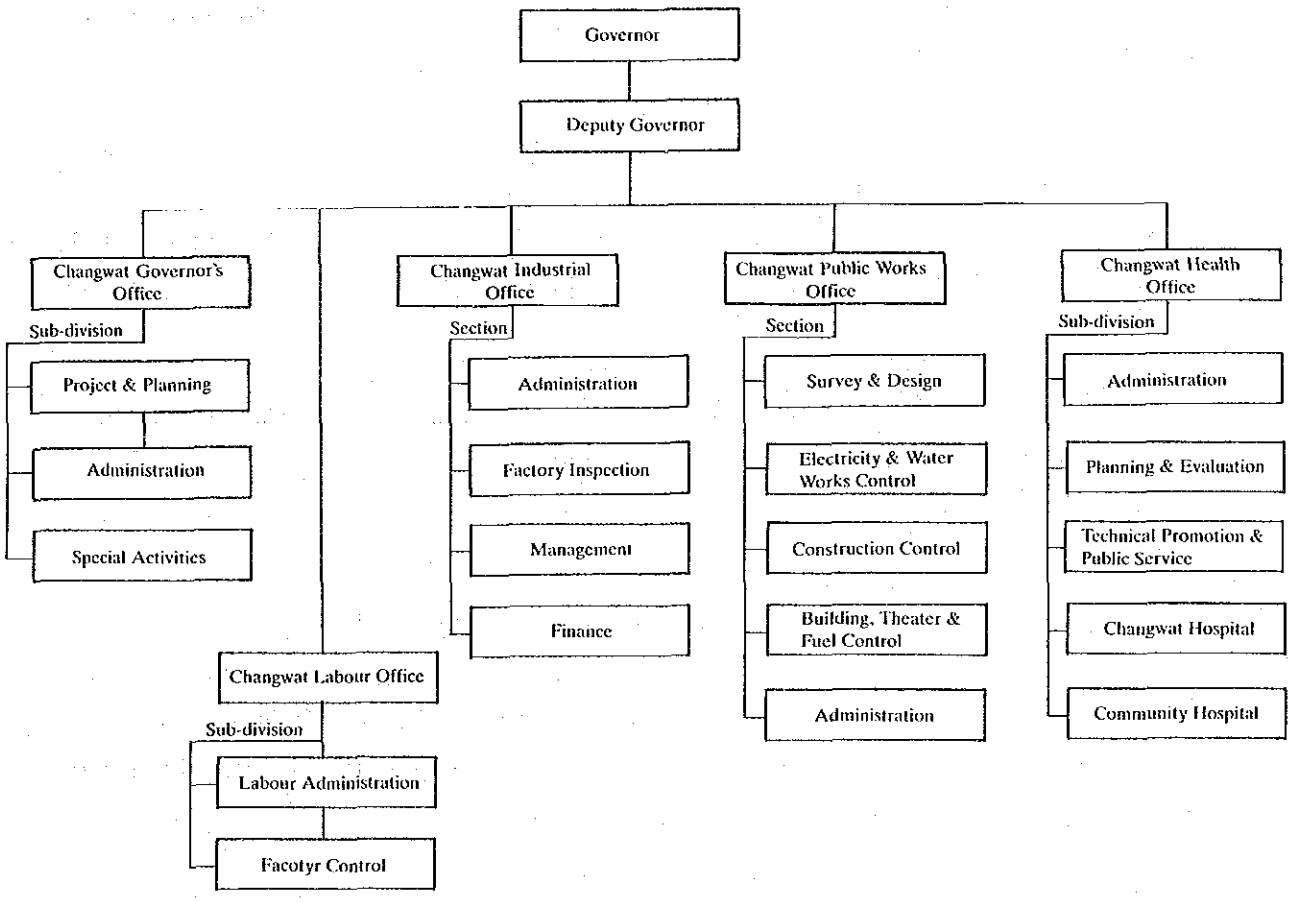


Fig. 1-2 Organization Chart of Samut Prakarn Province

From the matters mentioned above, it can be judged that the administrative organization in Thailand related to the emission control for stationary sources is limited to ONEB, the Ministry of Industry and the Industrial Office of Samut Prakarn Province and the outline is as follows:

(1) ONEB

ONEB, which is NEB's enforcement administrative organization, is regarded as one department of the Ministry of Science, Technology and Energy in the administrative organization and is composed of the administrative office and four divisions, each of which consists of five to seven sections as shown in Fig. 1-3. As basic role of ONEB is as shown in 1.1.1 (1) 2), the details of the role of each division are as follows:

1) Information and Environmental Quality Promotion Division
   ① Public relations related to the whole ONEB
   ② Implementation of education, enlightenment and training on environment
   ③ Cooperation with foreign governments and institutes, and various international organizations
2) Environmental Policy and Planning Division
   ① Determination of long and short term environment improvement plans and determination of various policy drafts and of their implementation methods
   ② Surveillance of activities of government agencies, government enterprises and private sector, related to environmental quality
3) Environmental Impact Evaluation Division
   ① Examination and evaluation of Environmental Impact Assessment (EIA) on development projects
   ② Investigation and study for determining plans for overall environmental preservation of specially designated areas (Chao Phraya river basin, etc.)
4) Environmental Quality Standard Division
   ① Monitoring of environmental quality and collection of data
   ② Study of environmental standards and other environmental-quality-related standards, and representation of opinion on them
   ③ Investigation and examination on pollution problems

(2) Ministry of Industry—Department of Industrial Work

The Ministry of Industry is a very large government agency, having four departments such as the Department of Industrial Work (DIW), Department of Mining Resources, and three government enterprises including the Industrial Estate Authority. The DIW among these manages the factory control according to FAC and is divided into several divisions, in which the Industrial Environment Division exists as shown in Fig. 1-4.

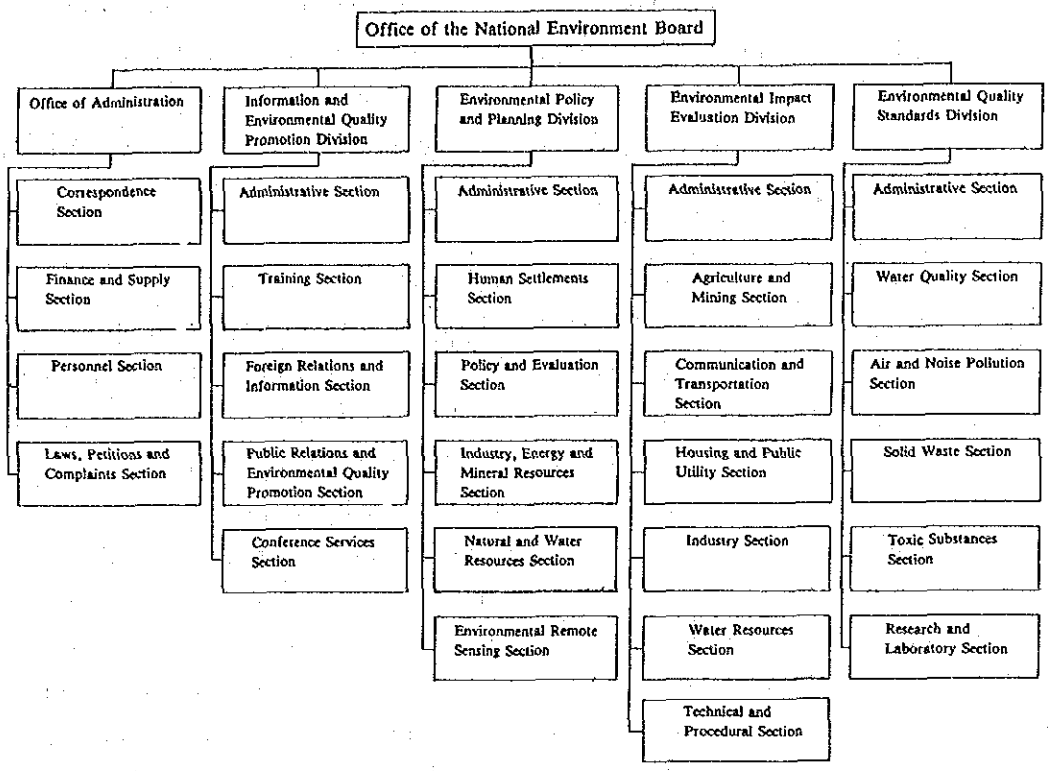


Fig. 1-3 Organization Chart of ONEB

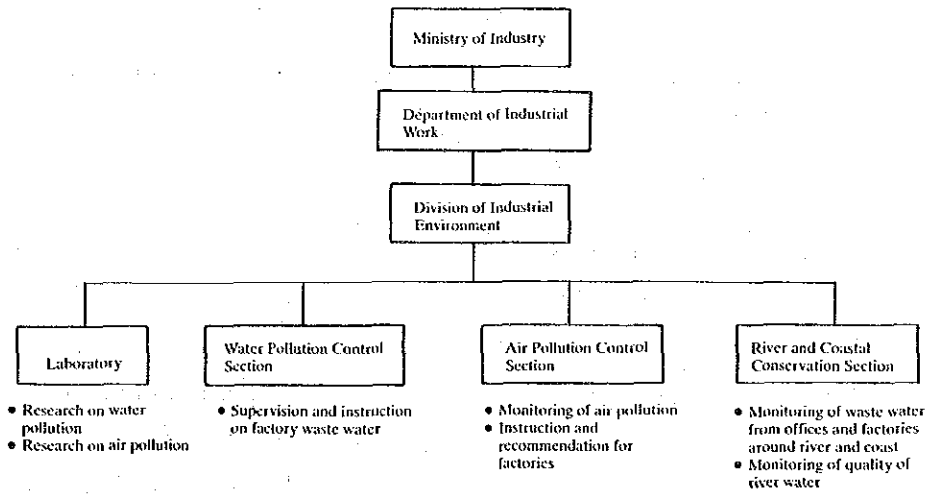


Fig. 1-4 Organization Chart of the Ministry of Industry Related to Environmental Policy

The examination of the application for the approval or renewal of the establishment, increase and operation of a factory according to FAC is controlled by the Factory Control Division but the judgement on the effect upon the environmental quality is asked of the Industrial Environment Division. This Division is also responsible for implementing pollution control such as a factory inspection conducted as required based on the complaint of regional residents related to industrial pollution.

The Air Pollution Control Section, which consists of 3 supervisors and 13~15 inspectors, conducts factory inspections on nearly 600 cases per year. The inspection standards on which the control of this Section is grounded are the environmental standards as ONEB's guideline and the emission standards of the Notification of the Ministry of Industry. The data obtained by the measurement for inspection are analyzed at the Laboratory of this Division.

(3) Changwat Industrial Office—Industrial officials of Ministry of Industry

Industrial officials are dispatched to 72 Changwats except Capital Bangkok from the Ministry of Industry and this local official controls the Changwat Industrial Office at each Changwat. The Industrial official is a person in the Section Chief class of the ministry proper in the administrative official rank, and his staff, comprised of as many as about 10 persons, the number of whom differs with the scale, etc. of each Changwat, organize the office. Though this Changwat Industrial Office is formally under the command of the Changwat Governor as one department of the Changwat administrative organization, the duties of this office are ① the execution of the responsibilities as representative of the Ministry of Industry and ② the execution of a part of the various duties of four departments in the Ministry of Industry, and this office substantially performs the function as a local agency of the Ministry of Industry. The examination of the application for approval of establishment and the operation of a factory is the main duty of this office. The duties on license related to establishment and the operation of a factory are items exclusively controlled by the Department of Industrial Work of the Ministry of Industry proper. The authority to perform the duties, however, is given to the industrial office within the scope mentioned below:

① Examination of the application for approval of the establishment and operation of the factories belonging to 33 non-pollution type industries.

② Examination of the application for renewal of the operation of the existing factories in all types of industries (99 classifications)

The result of the examination of the industrial official on the application should be reported to the Department of Industrial Work and the Changwat Governor.

On the other hand, motor vehicle exhaust gas restrictions are conducted by both Land Transport Department and Police Department. The cooperation between both departments and ONEB are performed through NEB which the permanent secretaries of the ministry (Ministry of State, and Ministry of Transport and Communication) to which each department belongs joins as its member and the detailed adjustment is performed by the Technical Subcommittee on Automotive Air Pollution Control instituted in the ONEB. Meanwhile there is no stipulation in the Land Transport Act and the Road Traffic Act for establishing and enforcing each emission standards according to the recommendation of ONEB. The cooperation between the three parties, therefore, is not backed up legally, which permits the existence of the three different emission standards at the same time as shown in Table 1-4.

1.2 Constraints of Air Pollution Control in Thailand

As mentioned in 1.1, in Thailand the basic policy of the environmental preservation is determined by NEB based on ICNEQA and implemented by ONEB. In this respect, the unification of the environmental administration has been established and the implementation of the consistent policy has been possible, like that in other countries. In the stage of the executing air pollution control, however, the main administrative organ related to the control for stationary sources is the Ministry of Industry which makes FAC the basic law while the Department of Land Transport and the Department of Police are responsible for the motor vehicle exhaust gas control. In addition, FAC itself is not the law aiming at the prevention of industrial pollution but is the control law related to establishment of a factory.

From the observation of the present state of the legal system and the administrative organization in the measures for air pollution in Thailand, the following constraints can be pointed out:

(1) The acts to enforce the air pollution control or the existent codes have not been adjusted. ICNEQA prescribes the establishment of NEB, policy planning by NEB, establishment of the environmental standards by the Prime Minister, recommendation of the establishment of the emission standards to the government agencies concerned, prior examination of development projects by ONEB, etc. so that ONEB can determine and implement the framework of the environment preservation administration. It, however, does not have the provisions as to enforcement of control: ① how, ② by whom, and ③ based on which standards an industrial emission source should be controlled.

In FAC it is prescribed that the examination of the application for approval of establishment and the operation of a factory should be made based on the smoke blackness degree and ONEB environmental standards (guideline) as one factor of the examination condition, but its effectiveness seems slight because the air pollution control is not the main part of this Act.

The Land Transport Act has the constraint that the regulation on car exhaust gas restriction is not specified in the relation with ICNEQA.

(2) Because the execution acts for the air pollution control have not been adjusted, the following points are not clear:

1) Control objective substances as the scope of control
   The following are shown in the environmental standards as a guideline according to ONEB notification but this does not have the legal ground:
   CO, NO_2, SO_2, TSP, Photochemical oxidant, Pb
2) Emission facilities as the scope of control
   To make the objects of the administrative control clear, it is necessary to define emission facilities based on the kind, emission volume and concentration.
3) Control objective persons—control objective emission sources

The emission sources which emit the substances of 1) from their facilities in 2) are not defined. Consequently, the persons to be controlled became many and unspecific, and the data collection on emission sources has not been achieved, thus the effective administration has not been implemented. It is necessary to make clear the scope of the control objective persons also in the meaning to expect the emission sources to take an autonomous attitude toward the environmental quality preservation.

4) Control measures

It is an absolutely necessary condition as measures for controlling an industrial emission source to set up the obligation to the establishment of emission disposal facilities and the emission standards (concentration or volume) for every control objective substance and emission facilities. In addition, it is also necessary to designate a control objective area if consideration is made from the viewpoint of more effective administration.

5) Data collection system for emission sources

For implementing the air environmental control, it is necessary for the administration side to collect the detailed data of each emission source. They are, if shown concretely, as follows:

① Name and address of factory

② Kind and structure of emission facility (details of capacity such as burning capacity and heating area)

③ Way of use of emission facilities (details of operating condition, kind and volume of fuel used, etc.)

④ Smoke treatment method, etc.

These are required to be sufficiently useful for the judgement of the planning and execution of policies on the administrative side.

(3) *The control of the environmental quality can be performed in the linkage in which the administrative* purpose (environmental standards as an objective or index) is set up, in which measures such as emission control are used to attain the purpose and in which these control measures are constantly checked if they are effectively carried out. In other words, the permanent monitoring of the environmental quality enables the mutual check between the administrative purpose and the administrative measures. However, there are no prescriptions in ICNEQA for the obligation to permanently monitor the environmental quality on the administrative side.

(4) ICNEQA prescribes that the prime minister has the power to establish the environmental quality standards and the measuring methods in Section 17 and says in Section 25 that "whoever violates it shall be liable to imprisonment for a term of not exceeding one month or to a fine of not more than 1,000 baht or both". In other words, the environmental quality standards in this provision are judged not to be the concept of the objective or index for carrying out the administrative measures but to be the concept of the control standards. It is considered that application of a penalty is practically difficult because it is usually difficult to specify the violator for the environmental stand-

ards and that Section 17 (2) lacks appropriateness from the viewpoint of a legal theory because the setting up of the control standards are prescribed in Section 5 (6). Basically, it is a problem that the prescription of the environmental quality standards which are to be the core of the environmental quality control has not been adjusted.

(5) As discussed in the Part VI, the contribution rate of motor vehicle exhaust gas reached 80% to 90% of NO_2 concentration at the point where the environmental standard of NO_2 is exceeded in Samut Prakarn industrial district. Thus, to reduce the concentration of NO_x, the restriction of motor vehicle exhaust gas is important, however, the current motor vehicle exhaust gas restriction in Thailand has the following constraint to be improved:

① The substances objective for restriction are only black smoke and CO, but NO_x is not regarded as the objective.

② The vehicle types under the control by Land Transport Department are limited to buses and trucks, but the ordinary passenger vehicles are excluded.

(6) The repletion of the staff on the administrative side to implement the environmental control is not enough. ONEB is a system with a sufficient organization and staff to perform the promotion of the environmental administration in Thailand. Moreover, in the DIW of the Ministry of Industry, the Industrial Environmental Division and the Air Pollution Control Section are also established.

However, it cannot be expected for these staff of the central government agencies to execute the environmental control administration including the collection of the emission source data and the smooth promotion of the control measures covering 72 Changwats in the whole country of Thailand. Further, even in Samut Prakarn Province which is the greatest industrial province in Thailand, since there is no specialized environment division or department although the Provincial Industrial Office exists, it is impossible to execute the environmental administration in close contact with a region. In addition, the technical staff carrying out the permanent monitoring of the environmental quality is very deficient.

2. Legal and Administrative Improvement for the Air Quality Management Planning

2.1 Legal Framework on Air Pollution Control in Japan

Japan has a relatively long history of environmental pollution and the first phenomenon appeared in the 1880s. Industrial pollution in the general sense, however, was not experienced until quite a long time had passed, and people did not get interested in environmental pollution until social interest in it rose and pollution control measures were taken by administrative organ in the 1960s. In 1967, the Basic Law for Environment Pollution Control was established to set up the principle for conducting pollution control. On the basis of the Basic Law, the laws concerned with control of air pollution, water pollution, noise, and vibration were enacted.

This section describes the Basic Law, the Air Pollution Control Law and the Law for the Establishment of Organization for Pollution Control in Specified Factories. We expect that this will contribute to the promotion of legal framework on the Air Quality Management Planning for the Samut Prakarn Industrial District in Thailand.

2.1.1 The Basic Law for Environment Pollution Control

(1) Objectives of the Basic Law for Environment Pollution Control

The objectives of the Basic Law is to protect people's health and preserve their living environment. Another objective is to establish the basic and synthetic measures for pollution prevention and therefore clarify the responsibility of enterprises, and nationl and local governments.

Although this law was specified to attain harmony between the preservation of the environment and the sound development of economy when this law was enacted, this specification was considered as taking preference over the economy and thus people doubted the attitude of the government toward handling pollution control measures. Thus, in 1970, the government eliminated this specification and instead, recognized the protection of people in a positive measure and preservation of the living environment regardless of the influence of economic development as the purpose of pollution prevention.

(2) Definition of environmental pollution

To clarify the objectives of pollution control measures which the government copes with, the following seven types are defined as environmental pollution that adversely affects people's health and living environment.

① Air pollution
② Water pollution
③ Soil pollution
④ Noise
⑤ Vibration
⑥ Subsidence of ground
⑦ Odor

For this reason, radio wave obstruction and health hazards caused by food contamination are handled outside of the objective for this law.

(3) Responsibility of enterprises

Because of the recognition that the results of corporate activities are the main factor of environmental pollution occurrence, the responsibility of enterprises is stipulated ahead of those of the national and local governments. The content of the responsibility of enterprises is summarized into the following three points:

① Taking measures required for pollution prevention such as the treatment of smoke and soot, waste water, and refuse.

This sector includes the observance of the standards based on the Air Pollution Control Law, Water Pollution Control Law and other laws, and installation of a smoke and soot removal facility and waste water treatment facility. In addition, the responsibility of assignment of a person in charge of pollution prevention is included due to the Law for the Establishment of the Organization for Pollution Control in Specified Factories.

② Cooperating with the pollution control measure conducted by the national and local governments

An example included in this sector is that entreprises should bear the expense of public pollution preventive construction (construction of a green belt, dredging of rivers, construction of sewerage, etc.) on the basis of the concept of the "Pollution Pays Principle" (PPP). The details are specified by the Law concerning Enterprises Bearing the Cost of Public Pollution Control Works. In addition, the responsibility to cooperate for a variety of pollution control measures to be executed by the national and local governments is included.

③ Efforts to prevent pollution by the use of material for production and processing of products

This sector includes an effort to produce no product whose waste is impossible to dispose of, concretely for example, fulfillment of unleaded gasoline project for oil refiners to prevent lead pollution from automobile exhaust gas.

(4) Responsibility of the national government

This law stipulates that the national government should establish and fulfill the basic and synthetic measures to prevent environmental pollution. In this law, the following nine articles are specified:

① setting and securing the environmental quality standards

② Establishing restrictions concerned with discharge such as the Air Pollution Control Law

③ Fulfillment of the restrictions related to land use and arrangement of a facility producing pollution

④ Promotion of the arrangement of pollution preventive facility such as the arrangement of sewerage

⑤ Arrangement of the surveillance and measurement systems

⑥ Investigations of pollution
⑦ Promotion of the R&D of pollution preventive technology
⑧ Spread of the knowledge about pollution prevention
⑨ Consideration of pollution prevention in local development measure and protection of natural environment (preservation of green area, etc.)

(5) Responsibility of the local government

As compared with the responsibility of the national government to establish and fulfill the basic and synthetic measures for environmental pollution prevention, the local government is specified to have a responsibility to take its measure in parallel to that of the national government, and establish and fulfill measures corresponding to the natural and social conditions of a given area.

(6) Responsibility of people

The responsibility of people to pollution occurrence and the countermeasure is small as compared with those of enterprises, and the national and local governments. People are, however, members of a country and local community, and stand on the position to advance pollution prevention together with enterprises, and national and local governments. Further, people must take responsibility for the generation of automobile exhaust gas, flue gas from household heating systems and effluent of waste water. From this recognition, this law specifies that people should cooperate in the pollution control measures conducted by the national and local governments as the responsibility of people for pollution control activity.

(7) Environmental Quality Standards

The article 9 of this law specifies that the national government should determine the environmental quality standards concerning air pollution, water pollution, noise and soil pollution and make efforts to secure them. The environmental quality standards related to air pollution are specified as shown in Table 2-1.

In the case that many factories are gathered, even if the emission volume is controlled in an individual factory, the accumulation of individual emission pollutes the environment remarkably in composite effects. To avoid such phenomenon, the environmental quality standards are specified as criteria desired to maintain human health and preserve the living environment. Thus, the environmental quality standards specified in this law are not based on the concept such as allowable limit and ideal value, but objective criteria for reducing pollution by taking a variety of measures such as setting emission standards and factory location restrictions.

As mentioned above, the environmental quality standards are specified from two standpoints of maintenance of human health and preservation of the living environment. The air environmental quality standards are determined for the first reason for maintaining human health and the preservation of the living environment is secured within the standard value.

Considering the explication of a new substance adversely affecting the human body in future and the development of technology, this law specifies that the government should always make an

Table 2-1 Environmental Quality Standards in Japan

Substance	Sulfur dioxide	Carbon monoxide	Nitrogen dioxide	Suspended particulate matter	Photochemical oxidant
Environmental condition	The daily average of hourly values shall be below 0.04 ppm and the hourly value shall be below 0.1 ppm.	The daily average of hourly values shall be below 10 ppm and the average of hourly values in eight (8) consecutive hours shall be below 20 ppm.	The daily average of hourly values shall be within or lower than the range between 0.04 ppm to 0.06 ppm.	The daily average of hourly values shall be below 0.10 mg/m^3 and the hourly value shall be below 0.20 mg/m^3.	The hourly value shall be below 0.06 ppm.
Measurement method	Conductometric method	Method using non-dispersion infrared-ray analyzer	For a place where it is judged that its air pollution by nitrogen dioxide can be grasped, light absorption luminous intensity method using Salzman reagent is employed.	Weight concentration measuring methods based on filtration collection, or light scattering method, or piezoelectric microbalance method or β-ray attenuation method yielding values having a linear relation with the values of the above method.	Absorptiometry using neutral potassium iodide solution, or coulometry.

Remarks:
1 Suspended particulate matter: Airborne particles of 10 microns or less in diameter.
2 Photochemical oxidant: Oxidizing substances such as ozone and peroxyacetyl nitrate (PAN) produced by photochemical reactions (only those capable of isolating iodine from neutral potassium iodide, excluding nitrogen dioxide).

appropriate judgment from scientific viewpoints and revise the environmental quality standard value as required.

(8) Establishment of pollution prevention plan

From the same viewpoint mentioned above, this law also stipulates that the Government should establish an environmental pollution control program to prevent positively pollution problems in the region where industrial development is promoted since environmental pollution prevention in such region cannot be attained only by imposing an emission control on an individual factory. Although an environmental pollution control program should be established and fulfilled by local government corresponding to the actual situation of that region to prevent pollution, cooperation between national and local governments is indispensable because of the close relationship with national measures such as the national land utilization program, industrial location policy and energy policy. For this reason, an environmental pollution control program is established in the following manner.

① The prime minister produces the basic policy of the pollution prevention plan.

② The prime minister requests the Conference on Environmental Pollution Control to examine the plan and hear the opinion of governors of a related prefecture. After that, he shows the basic policy to the governor of a related prefecture and instructs him to establish the pollution prevention plan.

③ Upon receiving the plan, the governor produces a pollution prevention plan on the basis of the basic policy and submits it to the prime minister for approval.

④ The prime minister approves that pollution prevention plan through an examination of the Conference on Environmental Pollution Control and submit its approval to the governor.

Up to 1989, the tasks for establishment of the environmental pollution control programs were conducted by the goverment seven times, and 41 programs in total have been established.

(9) Conference on Environmental Pollution Control and Council for Control of Environmental Pollution

1) The Conference on Environmental Pollution Control

Because a problem concerning pollution is very complicated, the administrative organ corresponding to it ranges over some government agencies in multiple aspects. For example, it relates to administration of hygiene and welfare from the viewpoint of human health, administration of trade and industry from the viewpoint of industrial cultivation and administration of construction from the standpoint of urban development and environment. To correspond to this condition, in 1971, the environmental pollution related bureaus of individual agencies were unified to establish the Environment Agency. Although the administration of environmental pollution control was unified, there were still a great number of matters related to the administration of each agency and the necessity of communication and adjustment between agencies existed. In addition, to set up an Environmental Pollution Control Program to promote a synthetic pollution control policy, an organization to promote that synthetic administration was required. From this background, the concept of an administrative committee having strong authority to unify pollution control administration was generated. However, because pollution phenomenon was complicated and ranged over many fields, the administrative organ could not help but become specialized in multiple aspects. For these reasons, as an organization to secure the consistency of governmental pollution control while making the best use of the administrative efficiencies in the special fields of each agency, the Government finally decided to establish the Conference on Environmental Pollution Control headed by the prime minister as chairman and consisting of the ministers of the concerned agencies. That is, while the Conference examines and determines synthetic measures, each determined measure is executed under the authority of the concerned agency. The synthesis and matching of individual administrations are secured sufficiently through examination at the Conference because the ministers of the concerned agencies act as members of the Conference. Although the Conference looks like an inner cabinet, it has no authority substituting the government and is subsidiary organization belonging to the Prime Minister's Office while managed by the Environment Agency.

2) Council for Control of Environmental Pollution

① The Central Council for Control of Environmental Pollution

A pollution problem is related often to multiple fields and scientifically unknown to the public. Thus specialized knowledge, research and judgments on a wide viewpoint are necessary to establish a countermeasure. For the solution of a problem and taking an appropriate countermeasure, it is necessary to listen to the opinions of scholars and experts. The Central Council for Control of Environmental Pollution was established in the Environment Agency as an advisory organ for the prime minister, the minister of the Environment Agency and the ministers concerned. Currently, the Central Council comprises synthetic, planning, control palnning, air, water divisions, etc., totaling nine divisions and about 80 persons, mainly scholars, are appointed as members of the Council.

② Local Council for Control of Environmental Pollution of each prefecture

This Law also stipulates that each prefecture has to set its own council, corresponding to the Central Council. Since a pollution problem is strongly affected by natural, social and economic conditions in an area, it is necessary to reflect the opinions of local people and government in formulating a concrete countermeasure. That is the reason why establishment of the Local Council was obligated to each prefecture as advisory organ for its governor, investigating and examining the basic matters of pollution control on its peculiar standpoint. As of 1989, all the prefectures have this council.

③ Municipal Council for Control of Environmental Pollution

Although the purpose of the municipal council is the same as that of each prefecture, the establishment of this council depends on each city while each prefecture is under an obligation to establish its local council. The main role of the Municipal Council is to examine the correlation between construction of a new plant and pollution, and advise a city of its findings. As of 1989, about 100 cities have their councils.

(10) Settlement of environmental disputes and relief for victims of pollution

To establish the administrative system for settlement of environmental disputes and relief for victims of pollution after damage has occurred from pollution, this law specifies that the government should take required measures. Although it is possible to apply ordinary laws to handle disputes and relief to a pollution problem, often these laws cannot cope with this issue because there are a great number of unspecified victims and assaulters in most cases, and the relationship between the cause and effect is difficult to clarify and victims often stand on a socially weak point. From this recognition, this law specifies some provisions to solve rapidly a dispute related to pollution and provide relief.

According to this spsecification, the Law concerning the Environmental Pollution Dispute was enacted in 1970 and the Environmental Dispute Coordination Commission was also established. In 1973, the Law concerning Special Measures for the Relief of victims of the Pollution-related Patients was established to assist victims whose health has been damaged by pollution.

2.1.2 Air Pollution Control Law

In December 1968, the Air Pollution Control Law was enforced to replace the old "Smoke and Soot Regulation Law". This law was established on the principle of the Basic Law established in 1967, that is, the government should protect human health and preserve the living environment synthetically and positively through restriction of exhaust and setting of environmental quality standards. Upon establishment, the following points were discussed concerning whether they should be included in the Air Pollution Control Law according to the tenor of the Basic Law.

① To introduce the concept of pollution control for an overall area by setting environmental quality standards in contrast with the old law intended to control only individual emission sources.

② In addition to the stipulations of the "prior report system of smoke and soot emitting facilities" in the old law, to introduce into the new law the concept of a permission system for the installation of a smoke and soot emitting facility (restriction of factory establishment).

③ To stipulate the maximum permissible limits of motor vehicle exhaust in the new law.

④ To enable the new law to control air pollution from a preventive prospect.

⑤ To introduce into the new law the stipulations concerning emergency measures in case the air pollution reaches the extent which may cause damage to human health or the living environment.

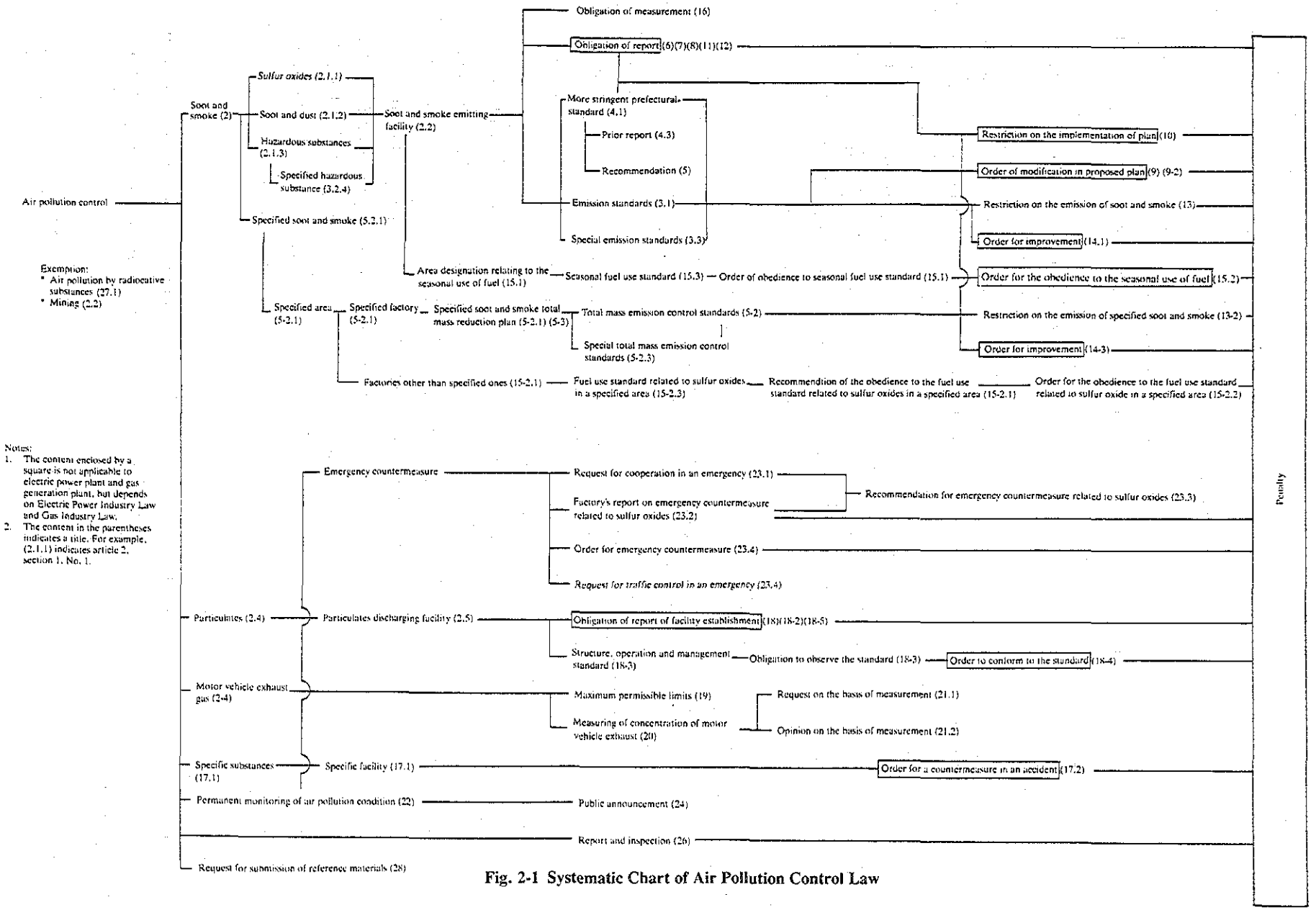
Of the matters mentioned above, a discussion was concentrated on item ②, that is, restriction of the installation of a facility, in particular. The point was that although the necessity of a factory location restriction could be recognized from the spirit of the Basic Law, if restricted from only the viewpoint of air pollution control, it provided an excessive restriction because (i) not only air pollution but also water pollution has to be considered for restriction of factory location, (ii) the viewpoint of preventing overcrowding of a city is required as well as pollution control measures, and (iii) synthetic countermeasures such as dispersion of factories and construction of industrial parks are required. Through these discussions, the restriction of a factory location fell under control of the Plant Location Rationalization Law whose purpose was to prevent concentration of plants without order. Only the prior report system of a facility was specified in the Air Pollution Control Law.

(1) System of the Air Pollution Control Law

This law consists of the following chapters:

Chapter I:	General Provisions (purpose, definition)
Chapter II:	Regulation of Soot and Smoke Emission
Chapter II-2:	Regulation of Particles
Chapter III:	Maximum Permissible Limits of Motor Vehicle Exhaust
Chapter IV:	Monitoring of the Air Pollution Level
Chapter IV-2:	Compensation for Damages
Chapter V:	Miscellaneous Provisions
Chapter VI:	Penalty Provisions

Fig. 2-1 outlines the system of this law.



Notes:
1. The content enclosed by a square is not applicable to electric power plant and gas generation plant, but depends on Electric Power Industry Law and Gas Industry Law.
2. The content in the parentheses indicates a title. For example, (2.1.1) indicates article 2, section 1, No. 1.

Fig. 2-1 Systematic Chart of Air Pollution Control Law

(2) Substances under control

The following substances are defined as the substances under control of the Air Pollution Control Law.

1) Soot and smoke

① Sulfur oxide generated as a result of combustion of fuel and the like.

② "Soot and dust" generated as a result of combustion of fuel and the like or of the use of electricity as a heat source.

(i) The components of soot and dust include unburnt carbon (soot) and a variety of organic and inorganic metals.

(ii) "Generation by use of electricity" means the phenomenon that soot and dust are generated through high temperature heating reaction in the process of combustion, by using electricity.

③ Of the substances generated as a result of combustion, synthesis, resolution and other treatments (excluding mechanical treatment), the ones which may cause damage to human health and the living environment are referred to as hazardous substances.

(i) As of 1989, the substances specified as hazardous substances are:

Cadmium and its compound

Chlorine and hydrogen chloride

Fluorine, hydrogen fluoride and silicon fluoride

Lead and its compound

Nitrogen oxide

(ii) The reason why mechanical processing is excluded is that the substance generated by mechanical processing such as crush and selection is restricted as particulates.

2) Particulates

Particulates mean any substance generated or scattered by mechanical treatment such as crush and selection or heaping of material. Although "soot and dust" are sometimes generated in the form of particles, in most cases they are generated in the form of gas or mist and their sizes are relatively small. As compared with "soot and dust", as particulates are generated by mechanical treatment such as crush and cut, heaping in a stock yard, transportation with a conveyer and selection, the size of a particulate is larger than "soot and dust", thereby affecting human health less. As for discharge style, there is no special discharge port equipped on most plants. For these reasons, particulates are restricted separately from "soot and dust."

3) Motor vehicle exhaust gas

Of the substances generated by driving automobiles, the following substances are specified as the ones under control and the maximum permissible limits are determined except for particle substances.

Carbon monoxide

Hydrocarbon

Lead compound

Nitrogen oxide

Particle substance

4) Specific substances

Of the substances generated by chemical treatment such as synthesis and resolution of material, some are designated as specific substances and the countermeasure for the accidental case that such special substance is discharged in large quantity is specified. As long as a specific substance is discharged from burning, it is restricted as soot and smoke. A large amount of a specific substances, however, is discharged when an accident occurs. Thus only the obligation to take a countermeasure against an emergency is specified but no restriction is taken with an emission standard. As of 1989, 28 substances such as ammonia, hydrocarbon and hydrogen cyanide have been specified.

(3) Soot and smoke emitting facility and particulate discharging facility

1) Soot and smoke emitting facility

For soot and smoke emitting facilities, the facility types objective for control are specified with the application, raw fuel type and scale limits. This not only clarifies the range of objectives for control, but also is based on the reason that it is impossible to control all soot and smoke emitting facilities and a sufficient effect can be expected by restricting facilities larger than specified from the viewpoint of air pollution prevention.

As of 1989, the number of facilities specified as a soot and smoke emitting facility amounts to 26 including a boiler.

2) Particulate discharging facility

On the same concept as a soot and smoke emitting facility, with the application and scale limits, a coke oven, stock yard, belt conveyer and bucket conveyer, crusher and grinder, and sieve are specified totaling five types as a particulate discharging facility.

(4) Restriction standard

A variety of restriction standards are specified for the substances under control mentioned in (2) above. The restriction standards are the general emission standard, special emission standard, total mass emission control standard, fuel use standard, structure/operation/management standard, maximum permissible limit, security standard and more stringent prefectural standard. These standards are considered in relation to the environmental quality standards upon their establishment. For example, the emission standard must be set so as to maintain and satisfy the environmental quality standards.

1) Emission standard

① General emission standard

The concept for setting the emission standard so as to maintain and satisfy the environmental quality standards is divided into the following two types:

First, if pollution combines due to excessive concentration of plants, the reduction of total emission volume in an area is considered to control

pollution concentration below the environmental quality standards.

Second, if facilities discharging pollutants are limited and the possibility of combined pollutions is negligible, a specified dilution rate between the emission concentration and environmental concentration is considered.

In the Air Pollution Control Law, the emission standard of soot and smoke is specified on the basis of the first concept because emission sources of sulfur oxides and soot and dust are concentrated locally in most cases. The emission standard of hazardous substances, however, is based on the second concept because the emission sources are peculiar and the facilities are seldom gathered at one place.

As the method to control air pollution, either the concentration control method or the emission volume control method should be taken. The control methods adopted in the Air Pollution Control Law are as follows:

(i) Sulfur oxides: Ground concentration control method depending on the effective stack height determined for the specified area (K-value control)
This method aims to disperse sulfur oxide by making the stack taller so that the ground concentration satisfies the environmental quality standard value. This cannot be called a genuine emission volume control method, but it is necessary to reduce the emission volume unless a making-stack-taller is attained. This can be, therefore, classified in the emission volume control method. For the details of the K-value control method, see PART VI "Improvement of Discharge Source and Consideration of the Effects."

(ii) Soot and dust: Concentration control method depending on the facility type and scale
Because the emission concentration of soot and dust is determined by the performance of a dust collector, the concentration control method is adopted. Even if the emission concentration is the same, however, as contribution rates of bigger emission sources to environmental concentration is larger than that of smaller sources, a strict emission control standard is applied to larger facilities. Thus the concept of emission volume control is employed while concentration control is apparently applied.

(iii) Hazardous substance: Concentration control method depending on substance type and facility type
The concentration control method is employed from the same reason as soot and dust. The reason why a factor of facility scales is disregarded in this is that the selection range of hazardous substance removing equipment is limited and it is necessary for facilities discharging such substance to suppress its concentration below a specified level regardless of the scale of facility. Meanwhile, of hazardous