添付資料

第 10 章　技術移転

添付資料 10-1　電力需要予測および一次エネルギー予測マニュアル

MANUAL

for

ENERGY AND POWER DEMAND FORECASTING

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CONTENTS

Chapter 1 Model Structure

1.1 Concept of the Power Demand Forecast

(1)Viewpoint of the Forecasting

The power demand of Vietnam displays a characteristic of favorable economic growth since the year 2000, difference of demand types by region, and a rapid increase of day time demand. The JICA Team will analyze the past changes of power demand trends and the actual facts, and grasp its constitutional factors for forecasting the future power demand of this country.

These changes of power demand can be considered to reflect the changes of social economic structure following the economic development of Vietnam, as power demand means the results of economic and social activities. In this connection, the JICA team will study the development stages of Vietnam and analyze the actual situation of the power demand structure as the results of the social economic activities. The power demand forecasting models to be developed are as stated below.

① The models linked to the social economic development plan

"Economic Development Forecast Serving Study on Energy Development for The Period up to 2050" in the previous session is considered as the preconditions for the models. The models forecast the power demand in line with "High Case", "Base Case" and "Low Case" in the development plan.

② Power demand forecast by region and its characteristics

Vietnam lies long from north to south, and has regionally different power demand characteristics. The Team will grasp these characteristics, and implement power demand forecast by dividing Vietnam into the northern part, the central part and the southern part.

③ Power demand forecast incorporating energy price effects

The crude oil price hike brings about the price hikes of natural gas and petroleum products. General speaking, saving of energy is done when the prices of fuel oil products and gas rise. The saving effects following these energy price hikes will be reflected in the power demand forecast.

④ The power demand forecasted by the total energy consumption in sectors

This power demand forecast study is also responsible for relating electric power to the primary energy. Therefore, the model does not only forecast power demand, but also forecasts the demand volume of the whole energy by sector, and calculates the power demand by sector from the proportion of the power occupying in the total energy. At the time of calculation, the

electricity shares by sector of the neighboring countries are adopted for reference.

⑤ Daily load curve

Daily load curve and peak demand are important information for making power development plan, The JICA team will take the data of neighboring countries as reference, and establish a forecast model by using the present daily load curves of Vietnam, Asian countries (Malaysia, Thailand, the Philippines and Indonesia) and Japan on the assumption that the Vietnamese daily load curve will follow those of these countries.

⑥ Matching the primary energy supply and energy consumption in power stations

Compatibility of energy supply with the primary energy consumption in power stations is sought in this Study. Accordingly, this is a model which can forecast the consumption trends and import and export trends of the primary energies in order to facilitate analyses to be done after the power demand forecasts. Introduction of oil refinery plants is closely related with the supply of fuel oil and diesel to be used for thermal power generation. This model can also analyze the trends of these matters from the power demand forecasts.

(2) Output from the power demand forecasting model

① Energy and power demand forecast by economic scenario (High, Base, Low cases) and by region (North, Central, South). The time span is from 2005 to 2025.

② Power demand forecast by sector (Agriculture, forestry and fishery sector, Transportation sector , Commercial & transportation sector, Residential use)

③ Daily load curve, load factor and peak demand are forecasted by region

④ Import and export of the energies are forecasted by energy

1.2 The Structure of Power Demand Forecasting Model

(1) Annual Power Consumption Forecast

The functions of the model are follows;

① To simulate the relations among economy, energy and power demand

② To analyze the policy agendas including energy price impact, increasing electrification ratio and fuel conversion of power stations

③ To evaluate energy conservation

④ To analyze the differences of north, central and south regions.

⑤ To make the energy balance between power demand and primary energy

In the model, the economic indicators that are expressed by the Government and the related organizations are used as external variables, and the other indicators that are not expressed are calculated as internal variables in the model. In the power demand forecasting block of the model, the power demand is forecasted as one of the energy demand in the sectors. After that, power generation and fuel consumption for power supply and power capacities are estimated.

Energy data and economic data are selected from the sources that the Institute of Energy can collect. And the data such as real GDP and relative energy prices required in the model are calculated in the model. By doing so, the data formatted by the primary data are stored.

Generally speaking, econometric models are built up as the aggregate of regression and definition equations. And the statistic and economic logical tests are examined. For building the model, the following tests are executed;

① The evaluation of power demand forecasting equations

- Determination coefficient(more than 0.85)
- T-value test of regression coefficient (More than 2.0)
- Durbin Watson ratio （1＜DW<3）
- Sign test of the regression coefficient

② The evaluation of macro economic forecast

- Real GDP growth rate
- GDP per person（US$ base）
- Labor productivity growth rate
- Unemployment rate

③ The evaluation of the energy demand forecast

- Energy demand growth rate
- Energy consumption per GDP（GDP elasticity）
- Energy consumption per person
- Electrification ratio

For building the above model, econometric method is applied according to the above outline, the model can be classified to two blocks, macro economic block and power demand block. The classification clarifies the relation between economic trends and power demand trends.

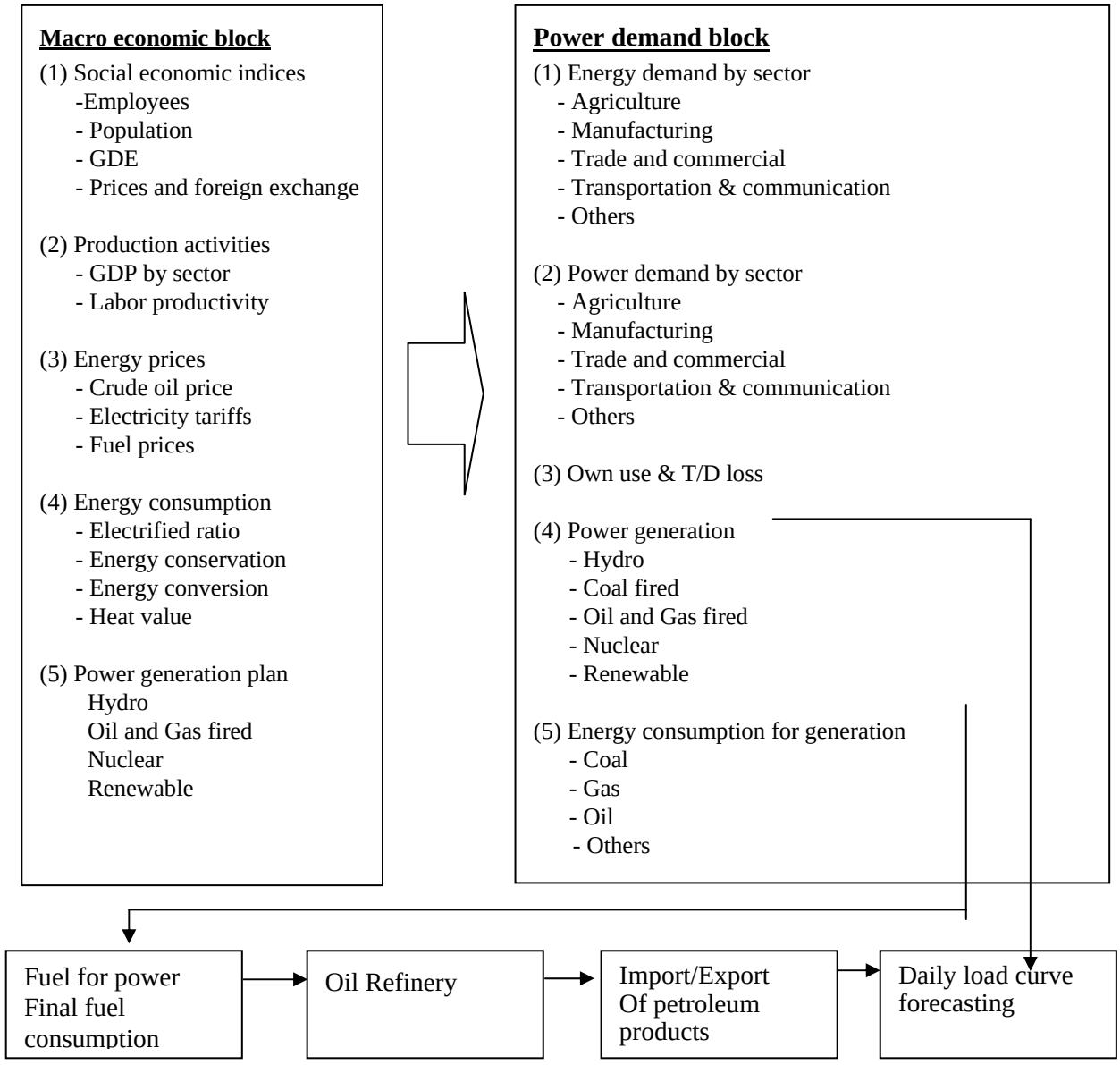

Figure 1-2-1 Outline of the Power Demand Forecasting Model

1.3 The structure of Daily Load Curve Forecasting

The daily load curve in Vietnam is going the middle way from the night time peak demand to the daytime peak demand. The neighbor countries such as Thailand and Japan have already moved to the developed country type which has peak demand in the daytime in summer season instead of developing country type which has peak demand in the evening. In Vietnam, the daily load curve is shifting from the daytime type to the nighttime type, and the power consumption characteristic is expected to change into a developed country type with economic development.

The procedures of the daily load curve forecasting built by JICA team are as follows;

① Collection of the daily load curve data to be forecasted
- The power dispatched data classified by North, Center and South regions
- The hourly data from 1996 to 2004

② Explanation variable data
- Population by region
- GDP by region
- Temperature by region
- Humidity by region
- Electrification ratio by region

③ Classification of daily load curve data as a unit in forecasting
- 3 days peak data in a month
- Weekday data (From Monday to Saturday)
- Holiday data (Sunday and national holidays)

④ Making forecasting equations by regression analysis

Annual daily load curve forecasted by regression analysis

Daily load curve forecasted for weekdays and holidays

Daily load curve forecasted for peak demand days,

Table 1-3-1 Number of the Data Required for Forecasting Daily Load Curve

region	Explanation variable	Dependent variable	Forecast result of daily load curve
North Central South	GDP by region Temp By region Humidity by region Electrification	3 day peak demand type Weekday demand type Holiday demand type	DLC of the whole country DLC of three regions DLC of types

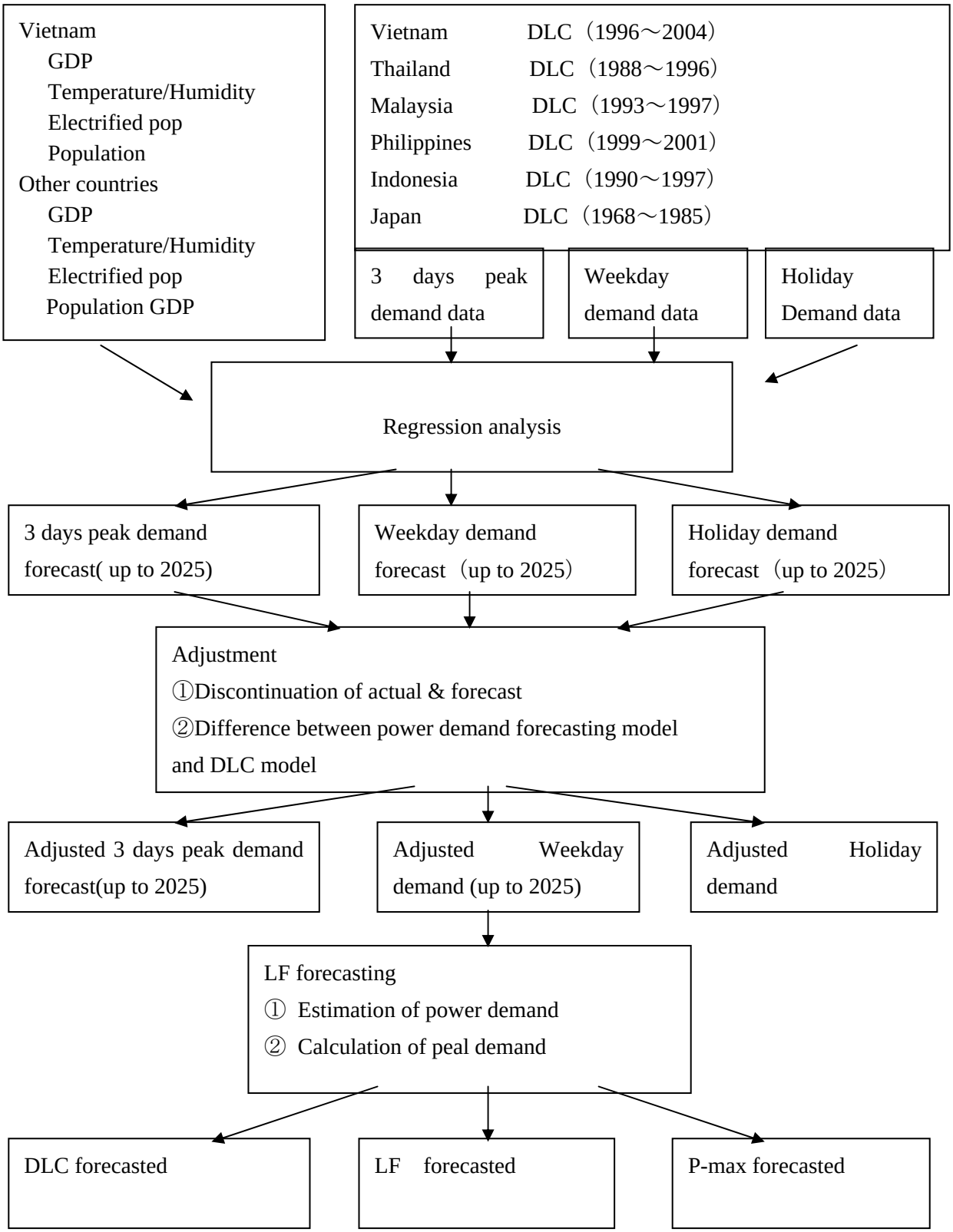

Figure 1-3-1 Outline of Daily Load Curve Forecasting Model

Chapter 2. Functions and operation of power demand forecasting model

2.1 The functions of the sheets

Power demand forecasting model consists of 8 work sheets including SimpleE sheets. The functions and its roles are as the following table.

Table 2-1-1 The functions of the sheets

	Functions and roles
Power sheet	Input the future power development plan Calculate generation share of thermal power plants Show generation by generator Calculate operation load by generator
Data Sheet	Input actual values on Economy, Power, Energy, Prices and Efficiency Input political and exogenous variables Calculate total and evaluation values Describe variable names and comments.
Model sheet	Build structure equations (Definition and Regression) Evaluate regression equations Define the data used in the model
Simulation sheet	Show the data used in the model Show the forecasting values
Growth sheet	Calculate growth rates Calculate elasticity
Adjust sheet	Set estimation values Recalculate forecasting values based on the estimation values
ExImport sheet	Set oil refinery plants Calculate petroleum product production Calculate the balance of export and import of petroleum products
Summary sheet	Summarize power demand Compare the power demand forecasting among other organizations

2.2 Power sheet

(1) Power generation (Base Load) table

The future installed hydro, nuclear importation and renewable energy power stations are described in “Power generation (Base Load) table” in Power sheet. The time schedules and the capacities of the power stations are input in the table.

Table 2-2-1 **Power generation (Base Load) table in Power sheet**

Power generation (Base Load)

				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4	Building	Hydro power	MW	400	599	239	72		370	393	470	260	435
5		Nuclear power	MW										
6													
7	Capacity	Hydro power	MW	3,300	3,899	4,137	4,209	4,209	4,579	4,972	5,442	5,702	6,137
8		Nuclear power	MW										
9		Foreign trade	MW										
10			MW										
11	Generation	Hydro power	GWh	14,551	18,210	18,198	18,986	18,435	20,056	21,777	23,836	24,975	26,880
12		Nuclear power	GWh										
13		Foreign trade	GWh										
14		Renewable	GWh					0	201	436	715	999	1,344
15													

a. Building

In the area, the planned capacities of hydro and nuclear power stations are input in the years (2000 to 2025).

b. Capacity

In the area, the accumulative capacities of hydro and nuclear are calculated.

When power is imported, the imported capacities are described in the foreign trade area.

c. Generation

The power generation of hydro, nuclear and importation are calculated by using the capacity data. The power generation from renewable energies is set in the Renewable area.

The power generation data in the future send to “Data sheet” as the future data of the exogenous variables.

(2) Power generation (Thermal) table

The future installed thermal power stations are described in “Power generation (Thermal) table” in Power sheet. The time schedules and the capacities of the thermal power stations are input in the table.

Table 2-2-2 Power generation (Thermal) table in Power sheet

Power generation (Thermal)											
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Building	Thermal(Coal)	MW		600.0	100.0	100.0	110.0	110.0	300.0	30.0	1,230.0	1,010.0
	Thermal(FO)	MW					300.0					
	Gasturbine(FO)	MW										
	Gasturbine(GAS)	MW	720.0	740.0	431.0	480.0	480.0	660.0	360.0	360.0	360.0	360.0
	Gas steam(GAS)	MW			56.0	566.0						
	Diesel generator	MW										
	Power from Fossil	MW										
Capacity	Thermal(Coal)	MW	450	1,050	1,150	1,250	1,360	1,470	1,770	1,800	3,030	4,040
	Thermal(FO)	MW	300	300	300	300	600	600	600	600	600	600
	Gasturbine(FO)	MW	300	300	300	300	300	300	300	300	300	300
	Gasturbine(GAS)	MW	720	1,460	1,891	2,371	2,851	3,511	3,871	4,231	4,591	4,951
	Gas steam(GAS)	MW	50	50	106	672	672	672	672	672	672	672
	Diesel generator	MW	30	30	30	30	30	30	30	30	30	30
	Power from Fossil	MW	1,850	3,190	3,777	4,923	5,813	6,583	7,243	7,633	9,223	10,593
Load	Power from Thermal(Coal)	%	66.5	31.7	33.9	52.0	65.0	65.0	65.0	65.0	65.0	65.0
	Power from Thermal(FO)	%	49.6	50.2	43.3	46.0	46.0	46.0	46.0	46.0	46.0	46.0
	Power from Gasturbine(FO)	%	57.4	54.0	45.2	62.0	62.0	62.0	62.0	62.0	62.0	62.0
	Power from Gasturbine(GAS)	%	64.3	31.4	34.5	33.4	65.0	65.0	65.0	65.0	65.0	65.0
	Power from Gas steam	%	68.5	92.5	279.8	60.8	65.0	65.0	65.0	65.0	65.0	65.0
	Power from Diesel	%	90.4	36.3	33.6	17.8						
	Power from Fossil	%	61.9	36.4	42.7	44.3						
Geneartion	Power from Thermal(Coal)	GWh	2,621	2,919	3,419	5,698	7,749	8,376	10,085	10,256	17,264	23,019
	Power from Thermal(FO)	GWh	1,303	1,319	1,137	1,210	2,420	2,420	2,420	2,420	2,420	2,420
	Power from Gasturbine(FO)	GWh	1,509	1,418	1,187	1,630	1,630	1,630	1,630	1,630	1,630	1,630
	Power from Gasturbine(GAS)	GWh	4,056	4,017	5,715	6,945	16,234	19,992	22,041	24,091	26,141	28,191
	Power from Gas steam	GWh	300	405	2,598	3,578	3,826	3,826	3,826	3,826	3,826	3,826
	Power from Diesel	GWh	238	95	88	47	47	47	47	47	47	47
	Power from Fossil	GWh	10,026	10,174	14,144	19,108	31,905	36,290	40,049	42,270	51,328	59,133
Shares	Power from Thermal(Coal)	S%	26.1	28.7	24.2	29.8	24.3	23.1	25.2	24.3	33.6	38.9
	Power from Thermal(FO)	S%	13.0	13.0	8.0	6.3	7.6	6.7	6.0	5.7	4.7	4.1
	Power from Gasturbine(FO)	S%	15.1	13.9	8.4	8.5	5.1	4.5	4.1	3.9	3.2	2.8
	Power from Gasturbine(GAS)	S%	40.5	39.5	40.4	36.3	50.9	55.1	55.0	57.0	50.9	47.7
	Power from Gas steam	S%	3.0	4.0	18.4	18.7	12.0	10.5	9.6	9.1	7.5	6.5
	Power from Diesel	S%	2.4	0.9	0.6	0.2	0.1	0.1	0.1	0.1	0.1	0.1
	Power from Fossil	S%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a. Building

In the area, the capacities of coal fired thermal, fuel oil fired thermal, fuel oil fired turbine, gas fired turbine, gas steam and diesel generator are set in the years when installed.

b. Capacity

In the area, the accumulative capacities of the thermal power stations are calculated in the area.

c. Load

In the area, the loads of the thermal power stations except diesel engines are input in the area. Regarding diesel engines, the generation of the engines are input in Generation area directly.

d. Generation

In the Generation line, the power generation of the thermal generators except diesel engines are calculated by using the above capacities. The generation of diesel engines is input in the area directly.

e. Shares

In the Share area, the generation shares of the thermal generators are calculated.

The generation shares are sent to Data sheet as future values of exogenous variables.

(3) Forecasted power supply table

The forecasted power generation by power generator are arranged in the forecasted power supply table. The data are sent from Simulation sheet.

Table 2-2-3 Forecasted power supply table in Power sheet

Power supply forecasted

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Generation	Power from Hydro	GWh	14,550.7	18,209.6	18,197.7	18,986.1	18,435.4	20,056.0	21,777.4	23,836.0	24,974.8	26,880.1
	Power from Fossil	GWh	10,375.3	10,271.3	15,485.8	20,374.0	27,170.2	31,943.6	39,765.6	45,604.4	53,381.9	61,328.0
	Power foreign trade balance	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power from Renewable energy	GWh	0.0	0.0	0.0	0.0	0.0	200.6	435.5	715.1	999.0	1,344.0
	Power from Nuclear	GWh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total of power generation	GWh	24,926.0	28,480.9	33,683.5	39,360.1	45,605.6	52,200.2	61,978.5	70,155.4	79,355.7	89,552.1
Shares	Power from Hydro	%	58.4	63.9	54.0	48.2	40.4	38.4	35.1	34.0	31.5	30.0
	Power from Fossil	%	41.6	36.1	46.0	51.8	59.6	61.2	64.2	65.0	67.3	68.5
	Power foreign trade balance	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power from New energy	%	0.0	0.0	0.0	0.0	0.0	0.4	0.7	1.0	1.3	1.5
	Power from Nuclear	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total of power generation	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Load	Power from Hydro	%	50.3	53.3	50.2	51.5	50.0	50.0	50.0	50.0	50.0	50.0
	Power from Nuclear	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a. Generation

The forecasted power generation of Hydro、Fossil、Foreign trade、Renewable energy and Nuclear power stations are arranged in the generation area.

b. Shares

The generation shares by power generator are calculated in the Share area.

c. Load

The operation load of hydro and nuclear stations are calculated in the Load area.

(4) Thermal power supply forecasted table

The forecasted power generation by thermal power generator are arranged in the forecasted thermal power supply table. The data are sent from Simulation sheet.

Table 2-2-4 Thermal power supply forecasted table in Power sheet

76	Thermal power supply forecasted												
77				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
78	Generation	Power from Thermal(Coal)	GWh	2,620.9	2,919.5	3,418.6	4,829.3	6,598.8	7,372.4	10,013.4	11,064.8	17,954.7	23,873.2
79		Power from Thermal(FO)	GWh	1,302.7	1,318.8	1,137.3	1,209.9	2,060.7	2,130.0	2,402.7	2,610.8	2,516.7	2,509.7
80		Power from Gasturbine(FO)	GWh	1,509.0	1,418.0	1,187.0	1,630.0	1,388.1	1,434.8	1,618.5	1,758.6	1,695.2	1,690.5
81		Power from Gasturbine(GAS)	GWh	4,056.0	4,017.2	5,714.9	6,945.5	13,824.3	17,597.2	21,885.3	25,991.6	27,187.1	29,237.6
82		Power from Gas steam	GWh	300.0	405.0	2,598.0	3,578.0	3,258.5	3,368.1	3,799.3	4,128.2	3,979.5	3,968.4
83		Power from Diesel	GWh	237.5	95.5	88.2	46.8	39.8	41.2	46.4	50.5	48.6	48.5
84		Power from Fossil	GWh	10,026.1	10,174.0	14,144.1	18,239.6	27,170.2	31,943.6	39,765.6	45,604.4	53,381.9	61,328.0
85													
86	Shares	Power from Thermal(Coal)	S%	26.1	28.7	24.2	26.5	24.3	23.1	25.2	24.3	33.6	38.9
87		Power from Thermal(FO)	S%	13.0	13.0	8.0	6.6	7.6	6.7	6.0	5.7	4.7	4.1
88		Power from Gasturbine(FO)	S%	15.1	13.9	8.4	8.9	5.1	4.5	4.1	3.9	3.2	2.8
89		Power from Gasturbine(GAS)	S%	40.5	39.5	40.4	38.1	50.9	55.1	55.0	57.0	50.9	47.7
90		Power from Gas steam	S%	3.0	4.0	18.4	19.6	12.0	10.5	9.6	9.1	7.5	6.5
91		Power from Diesel	S%	2.4	0.9	0.6	0.3	0.1	0.1	0.1	0.1	0.1	0.1
92		Power from Fossil	S%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
93													
94	Load	Power from Thermal(Coal)	%	66.5	31.7	33.9	44.1	55.4	57.3	64.6	70.2	67.6	67.5
95		Power from Thermal(FO)	%	49.6	50.2	43.3	46.0	39.2	40.5	45.7	49.7	47.9	47.7
96		Power from Gasturbine(FO)	%	57.4	54.0	45.2	62.0	52.8	54.6	61.6	66.9	64.5	64.3
97		Power from Gasturbine(GAS)	%	64.3	31.4	34.5	33.4	55.4	57.2	64.5	70.1	67.6	67.4
98		Power from Gas steam	%	68.5	92.5	279.8	60.8	55.4	57.2	64.5	70.1	67.6	67.4
99		Power from Diesel	%	90.4	36.3	33.6	17.8	15.2	15.7	17.7	19.2	18.5	18.5
100		Power from Fossil	%	61.9	36.4	42.7	42.3	53.4	55.4	62.7	68.2	66.1	66.1
101													

a. Generation

The forecasted power generation of coal fired thermal、fuel oil fired thermal、fuel oil gas-turbine、gas fired gas-turbine、gas steam and diesel engine are arranged in the generation area. The data are sent from Simulation sheet.

b. Shares

The generation shares by power generator are calculated in the Share area.

c. Load

The operation load of the thermal power stations are calculated in the Load area.

2.3 Data sheet

Data sheet is created by SimpleE. The actual values for all kinds of variables and future values in exogenous variables are set in the sheet. There are two kinds of actual data in the Data sheet, one is an input data, another is calculation data.

In the model, the actual data are basically created from 1990 to 2003 and the future values are forecasted from 2004 to 2025. The variables in the model have actual data that the values are input or calculated. And the future values for some variables are given as political or economical assumptions. The variables are called “Exogenous variables”. Other words, the future values of the other variables are calculated in the model, the variables are called “Endogenous variables”.

If the forecasting cells are blank in the model, the variables are endogenous. Other words, the variables that the future data are given are exogenous variables.

For making endogenous variable changes to exogenous variable, we set the future values in the forecasting terms of the variable. The future values given are used preferentially in the model, even though expressions are defined for the variable in Model sheet.

The variables are arranged in line with the model structure orders. Then calculation of the model is basically performed from the upper variables to below variables. But it is possible that the upper variables are calculated by using the results of the below variables. And if the model contains the simultaneous equations, the SimpleE can solve the simultaneous equations.

The model has the following function blocks as model structures.

Table 2-3-1 Function blocks in Data sheet

NO.	Function blocks	Line numbers
1	Social forecasting	5～30
2	Economic forecasting	30～120
3	Coefficient& Energy prices	121～163
4	Power demand forecasting in Africulture.Forestry.Fishry sector	164～376
5	Power demand forecasting in Industry sector	
6	Power demand forecasting in Transportation sector	
7	Power demand forecasting in Commercial & Services sector	
8	Power demand forecasting in Residential	
9	Power demand forecasting in Other sector	
10	Power supply forecasting	377～422
11	Energy balance	423～462
12	Power demand in North region	
13	Power demand in Center region	
14	Power demand in South region	463～637

(1) Social data forecasting

In the social forecasting block, the social values required for energy and power demand

forecasting are calculated. For setting the social indicators and the growth rates from the social economic development plan as the preconditions of the model, the future values are calculated by using the above data.

Table 2-3-2 Social data forecasting block in Data sheet

	High case			TREND	1	2	13	14	15	16	35	36
F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
5	Economic data	Exchange rate	Dn/US$	ECEXC	5,588.0	9,628.0	15,400.0	15,700.0	15,785.0	16,077.0	21,188.0	21,188.0
6												
7	Population	Country number	Million pers	POPNUM	66.0	67.2	79.7	80.8				
8		Growth rate	G%	POPNGR		1.9	1.3	1.3	1.4	1.40	0.75	0.75
9		Urban number	Million pers	POPUBN	12.9	13.2	20.0	20.8				
10		Urban population share	S%	POPUGR	19.5	19.7	25.1	25.8	26.1	26.3	31.8	32.1
11												
12	Household	County Number	Million HH	HHNUM	13.3	13.6	17.5	17.8				
13		Growth rate	G%	HHNGR		2.3	1.2	1.7	1.5	1.5	1.5	1.5
14		Urban number	Million HH	HHUBN	2.6	2.7	4.4	4.6				
15		Urban HH rate	S%	HHUGR	19.5	19.7	25.1	25.8				
16												
17	Labor number	Agriculture	Million pers	LABAGR	21.2	21.6	23.3	23.1				
18		Manufacturing & Mining	Million pers	LABMAN	2.6	2.7	4.5	4.9				
19		Services & Others	Million pers	LABOTH	5.6	5.8	12.7	13.2				
20		Unemployed	Million pers	LABUNE	1.0	1.1	0.7	0.7				
21		Total	Million pers	LABTOT	30.4	31.2	41.2	41.9				
22												
23		Labor force share to Pop	%	LABSHP	46.0	46.4	51.7	51.9				
24												
25	Labor shares	Agriculture & Forestry	S%	LASAGR	68.7	69.2	56.6	55.1				
26		Manufacturing & Mining	S%	LASMAN	8.6	8.7	10.9	11.7				
27		Services & Others	S%	LASOTH	18.4	18.6	30.8	31.5				
28		Unemployed	S%	LASUNE	3.3	3.5	1.7	1.7	1.7	1.7	1.7	1.7
29		Total	S%	LASTOT	100.0	100.0	100.0	100.0				
30												

a. Exchange rate

The actual exchange rates are set in the area. The variable is exogenous and the future values from social economic development plan are set in the future area.

b. Population

The actual data on the number of the population in whole country are set.

The annual growth rates on the population are calculated.

The actual data on the number of the urban population are set.

The shares of the urban population to the total population are calculated.

The annual growth rates of the total population are exogenous. The future annual growth rates are set from the social economic development plan.

The shares of the urban population to the total population are exogenous.

The future shares of the urban population are set with the assumption after referring the latest value.

c. Household

The actual data on the number of the households in the whole country are set.

The annual growth rates on the households are calculated.

The number of the household in urban area is calculated with the shares of the urban population to the total. The shares are input.

The annual growth rates on the household in urban area are calculated.

The annual growth rates on the household in urban area are exogenous.

The annual growth rates on the household in urban area are set, but it is desirable that the growth rates of the urban households are greater than the growth rates of the total population.

d. Labor number

The number of the labor by sector(Agriculture、Manufacturing & Mining、Services & Others、Unemployed) are input.

The labor share to the total population is calculated.

e. Labor shares

The shares of the labor by sector(Agriculture、Manufacturing & Mining、Services & Others、Unemployed) are calculated.

The future labor shares are set with the same values as the latest value.

(2) Economic forecasting

In the economic forecasting block, the forecasting values required for forecasting energy and power demand are calculated. For setting the economic indicators and the growth rates from the social economic development plan as the preconditions of the model, the future values are calculated by using the above data.

Table 2-3-2 Economic forecasting block in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
33	GDP	nGDP at current price	Billion Dn	GDNOM	41,855.0	76,707.0	535,762.0	605,586.0				
34		Growth rate	G%	GDNGR		82.8	10.6	13.0				
35												
36		uGDP on US $ base	Million US$	GDDOL	7,508.1	7,967.1	34,789.7	38,572.4				
37		Growth rate	G%	GDDGR		6.1	9.1	10.9				
38												
39		uGDP per capita on US$ base	US$ per capi	GDPDOL	113.7	118.5	436.4	477.4				
40		Growth rate	G%	GDPDGR		4.2	7.7	9.4				
41												
42		rGDP at 1994 price	Billion Dn	RGDP	131,968.0	139,634.0	313,247.0	335,989.0				
43		Growth rate	G%	RGDPGR		5.8	6.4	7.3	8.0	8.0	8.0	8.0
44												
45		GDP deflator 1994 price	1994=100	GDFLT	31.8	54.9	171.0	180.2				
46		Growth rate	G%	GDFGR		72.8	4.0	5.4	6.0	6.0	6.0	6.0
47												
48		rGross Domestic Savings	Billion Dn	GDSAV	3,834.3	14,104.1	89,820.8	94,798.7				
49		Share to GDP	%	GDSHA	2.9	10.1	28.7	28.2	28.2	28.2	28.2	28.2
50		Elasticity to Private Con		GDEVPC			2.3	1.4	1.9	1.9	1.9	1.9
51												
52		rLabor productivity in Manufac	1000 Dn /per	LAPMAN	4,488.7	4,639.0	7,734.5	8,155.1				
53		Growth rate	G%	LAPMGR			2.8	3.3				
54												
55												
56	nGDE at the cu	Final consumption	Billion Dn	NGEFC	40,736.0	68,959.0	382,137.0	434,721.0				
57		Gross fixed capital formation	Billion Dn	NGEGF	6,025.0	11,506.0	177,883.0	212,480.0				
58		Exports of goods and services	Billion Dn	NGEEX	15,120.0	23,714.0	304,262.0	365,394.0				
59		Import of goods and services	Billion Dn	NGEIM	18,886.0	27,639.0	331,946.0	411,119.0				
60		Statistical discrepancy	Billion Dn	NGESD	-930.0	167.0	3,326.0	4,110.0				
61		Total	Billion Dn	NGETOT	41,855.0	76,707.0	535,762.0	605,586.0				
62												
63	rGDE at 1994 p	Final consumption	Billion Dn	RGEFC	128,133.7	125,528.8	223,426.2	241,190.3				
64		Gross fixed capital formation	Billion Dn	RGEGF	18,951.4	20,945.0	104,002.3	117,887.4				
65		Exports of goods and services	Billion Dn	RGEEX	47,558.4	43,167.9	177,884.6	202,726.6				
66		Import of goods and services	Billion Dn	RGEIM	59,751.3	50,312.8	194,080.7	228,095.5				
67		Statistical discrepancy	Billion Dn	RGESD	-2,825.3	304.0	1,944.6	2,280.3				
68		Total	Billion Dn	RGETOT	131,968.0	139,634.0	313,247.0	335,989.0				
69												
70	Shares of rGDE	Final consumption	%	RREFC	97.1	89.9	71.3	71.8				
71		Gross fixed capital formation	%	RREGF	14.4	15.0	33.2	35.1				
72		Exports of goods and services	%	RREEX	36.0	30.9	56.8	60.3				
73		Import of goods and services	%	RREIM	45.3	36.0	62.0	67.8				
74		Statistical discrepancy	%	RRESD	-2.2	0.2	0.6	0.7				
75		Total	%	RRETOT	100.0	100.0	100.0	100.0				
76												
77	nGDP at the cu	Agriculture & Forestry	Billion Dn	NGPAGR	16,252.0	31,058.0	123,383.0	132,193.0				
78		Manufacturing & Mining	Billion Dn	NGPMAN	9,513.0	18,252.0	206,197.0	241,933.0				
79		Commercial & Trade	Billion Dn	NGPTRA	5,460.0	9,742.0	75,617.0	83,397.0				
80		Transport and communications	Billion Dn	NGPTRN	1,449.0	2,860.0	21,095.0	22,589.0				
81		Service & Others	Billion Dn	NGPSER	9,281.0	14,795.0	109,470.0	125,474.0				
82		Total	Billion Dn	NGPTOT	41,955.0	76,707.0	535,762.0	605,586.0				
83												
84	rGDP at 1994 p	Agriculture & Forestry	Billion Dn	RGPAGR	51,120.1	56,536.6	72,130.0	73,342.8				
85		Manufacturing & Mining	Billion Dn	RGPMAN	29,922.8	33,225.1	120,558.4	134,228.4				
86		Commercial & Trade	Billion Dn	RGPTRA	17,174.2	17,733.9	44,211.4	46,270.0				
87		Transport and communications	Billion Dn	RGPTRN	4,557.8	5,206.2	12,333.7	12,532.7				
88		Service & Others	Billion Dn	RGPSER	29,193.1	26,932.2	64,004.4	69,615.0				
89		Total	Billion Dn	RGPTOT	131,968.0	139,634.0	313,247.0	335,989.0				
90												
91	Shares of rGDP	Agriculture & Forestry	S%	SHPAGR	38.7	40.5	23.0	21.8				
92		Manufacturing & Mining	S%	SHPMAN	22.7	23.8	38.5	40.0				
93		Commercial & Trade	S%	SHPTRA	13.0	12.7	14.1	13.8				
94		Transport and communications	S%	SHPTRN	3.5	3.7	3.9	3.7				
95		Service & Others	S%	SHPSER	22.1	19.3	20.4	20.7				
96		Total	S%	SHPTOT	100.0	100.0	100.0	100.0				
97												
98	Sector growth	Agriculture & Forestry		RRPAGR			3.9	3.1	3.4	3.4	2.5	2.5
99		Manufacturing & Mining		RRPMAN			10.2	11.1	10.5	10.5	10.0	10.0
100		Commercial & Trade		RRPTRA			4.2	4.1	7.7	7.7	8.0	8.0
101		Transport and communications		RRPTRN			6.1	5.8	7.7	7.7	8.0	8.0
102		Service & Others		RRPSER			4.1	4.9	7.7	7.7	8.0	8.0
103		Total		RRPTOT			6.3	6.8	8.0	8.0	8.0	8.0
104												
105	Elasticity	Agriculture & Forestry		ELAAGR			0.8	0.5				
106		Manufacturing & Mining		ELAMAN			1.6	1.7				
107		Commercial & Trade		ELATRA			0.7	0.8				
108		Transport and communications		ELATRN			1.0	0.9				
109		Service & Others		ELASER			0.7	0.8				
110		Total		ELATOT			1.0	1.0				
111												
112												
113	rGDP by Elasti	Agriculture & Forestry		WRKAGR			70,982.6	74,590.1				
114		Manufacturing & Mining		WRKMAN			124,417.6	135,314.6				
115		Commercial & Trade		WRKTRA			43,139.2	46,233.6				
116		Transport and communications		WRKTRN			12,630.5	13,100.8				
117		Service & Others		WRKSER			62,802.6	67,497.2				
118		Total		WRKTOT			313,972.5	336,736.3				
119												

a. nGDP at current price

The data of nominal GDP are set from nominal GDP by sector.

The annual growth rates are calculated.

b. uGDP on US $ base

The data of $ based GDP are calculated by using nominal GDP and exchange rate.

c**. uGDP per capita on US$ base**

The data of $ based GDP per capita are calculated by using $ based GDP and total population.

d. rGDP at 1994 price

The data of real GDP are calculated by using nominal GDP and GDP deflator. The constant price of the deflator is 1994.

The annual growth rates of the rGDP are exogenous.

The future growth rates of the rGDP are given from the real GDP growth rates in the scenarios of The Social Economic Development Plan.

e. GDP deflator 1994 price

The data of GDP deflators are set. The constant price of the deflator is 1994.

The growth rate of the GDP deflator is exogenous.

The future growth rates of GDP deflator are given from the GDP deflator growth rates in the scenarios of The Social Economic Development Plan.

f. rGross Domestic Savings

The data of the real gross domestic savings are calculated by using the real GDP and the ratios to the gross domestic savings.

The ratios to the gross domestic savings are input.

The future growth rates of the savings are exogenous.

The future growth rates of the savings are given with the same values as one of the latest year.

g. rLabor productivity in Manufacturing at 1994 price

The data of the real labor productivity in manufacturing are calculated by using the real GDP and the number of labor.

The annual growth rates of the labor productivity are calculated.

h. nGDE at the current price

The components of nGDE at the current price are Final consumption, Gross fixed capital formation, Exports, Import and Statistical discrepancy. The all above data are input.

i. rGDE at 1994 price

The components of rGDE at 1994 price are calculated by the components of nGDE and GDP deflator.

j. Shares of rGDP

The component shares of rGDP are calculated with “The component of rGDE / rGDE *100”.

k. nGDP at the current price

The nGDP by sector (Agriculture & Forestry, Manufacturing & Mining, Commercial & Trade, Transport and Communications and Service & Others) are input.

l. rGDP at 1994 price

The rGDP by sector, (Agriculture & Forestry, Manufacturing & Mining, Commercial & Trade, Transport and Communications and Service & Others) are calculated with “nGDP by sector / GDP deflator”.

m. Shares of rGDP

The sector shares of rGDP are calculated with “The sector of rGDP / rGDP *100”.

n. Sector growth rate in 5 years

The annual growth rates of the sectors are calculated.
The annual growth rates of the sectors are exogenous.
The future growth rates of the sector are given from the social economic development plan.

o. Elasticity

The sector elasticity to rGDP are calculated with “The annual growth rate of the sector / the annual growth rate of rGDP”.

P. rGDP by Elasticity

The sector rGDP are calculated with “the rGDP growth rate * sector elasticity * the previous sector rGDP“

(3) Coefficient and Energy prices

In the block, energy conversion factors, power efficiencies, energy prices and power tariffs that are needed for energy forecasting are input and forecasted.

Table 2-3-3 Coefficient and Energy prices forecasting block in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
122	Coversion factor to KTOE	Standard Oil(10000Kcal/kg)	10,000	COFASCO	1.0	1.0	1.000	1.000	1.000	1.000	1.000	1.000
123		Coal(5600Kcal/kg)	5,600	COFACOA	0.6	0.6	0.560	0.560	0.560	0.560	0.560	0.560
124		Gasoline(10500Kcal/kg)	10,500	COFAGAS	1.1	1.1	1.050	1.050	1.050	1.050	1.050	1.050
125		Kerosene (10320Kcal/kg)	10,320	COFAKER	1.0	1.0	1.032	1.032	1.032	1.032	1.032	1.032
126		Diesel (10150Kcal/kg)	10,150	COFADIE	1.0	1.0	1.015	1.015	1.015	1.015	1.015	1.015
127		Petroluem Products	11,500	COFAPET	1.1	1.1	1.050	1.050	1.050	1.050	1.050	1.050
128		Fuel oil (9910Kcal/Kg)	9,910	COFAFUE	1.0	1.0	0.991	0.991	0.991	0.991	0.991	0.991
129		Natural gas (9000Kcal/m3)	9,000	COFANAG	0.9	0.9	0.900	0.900	0.900	0.900	0.900	0.900
130		Renewable energy (3302Kcal/Kg)	3,302	COFAREW	0.3	0.3	0.330	0.330	0.330	0.330	0.330	0.330
131		Electricity (860Kcal/KWh)	860	COFAELE	0.1	0.1	0.086	0.086	0.086	0.086	0.086	0.086
132												
133	Power efficiency	Power from Thermal(Coal)	35%	COPOCOA	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
134		Power from Thermal(FO)	35%	COPOFOT	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
135		Power from Gasturbine(FO)	48%	COPOFOB	5.5	5.5	5.5	5.5	5.8	5.8	5.8	5.8
136		Power from Gasturbine(GAS)	48%	COPOGAB	5.0	5.0	5.0	5.0	5.2	5.2	5.2	5.2
137		Power from Gas steam	40%	COPODAS	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
138		Power from Diesel	36%	COPODIE	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
139												
140	Energy price	WTI crude oil price	US$/bbl	EPRCWTI	24.5	21.5	28.1	31.2	40.0	50.0	40.0	40.0
141		Crude oil Price in Vietnam	1000Dn/bbl	EPRCRD	137.0	207.0	401.7	480.2				
142		NG price in Vietnam	$/MMBTU	EPRNG	0.0	0.0	4.0	4.0				
143		Gasoline price in Vietnam	Dong/kg	EPRGAS	840.0	3,220.0	6,933.3	6,933.3				
144		Kerosene price in vietnam	Dong/kg	EPRKER		2,353.1	5,051.1	5,051.1				
145		Diesel price in Vietnam	Dong/kg	EPRDIE	630.0	2,200.0	4,408.0	4,408.0				
146		Fuel oil price in Vietnam	Dong/kg	EPRFO	732.4	1,106.7	2,147.7	2,815.3				
147		Electricity for Agriculture us	Dn/KWh	EPRELA	450.4	473.5	604.3	700.0				
148		Electricity for Residential us	Dn/KWh	EPRELR	386.8	401.8	668.9	800.7				
149		Electricity for Industry use	Dn/KWh	EPRELI	857.0	877.2	762.0	858.6				
150		Electricity for Commercial use	Dn/KWh	EPRELC	922.0	963.4	1,342.9	1,400.0				
151												
152	G.R of Eneergy prices	WTI crude oil price	%	GRPRWTI		-12.3	0.7	19.4				
153		Crude oil Price in Vietnam	%	GRPRCRD		51.1	2.1	21.8				
154		NG price in Vietnam	%	GRPRNG		0.0	2.0	2.0				
155		Gasoline price in Vietnam	%	GRPRGAS		283.3	4.0	0.0				
156		Kerosene price in vietnam	%	GRPRKER		0.0	4.0	0.0				
157		Diesel price in Vietnam	%	GRPRDIE		249.2	7.6	0.0				
158		Fuel oil price in Vietnam	%	GRPRFO		51.1	2.1	21.8				
159		Electricity for Agriculture us	%	GRPRAGR		5.1	6.0	15.8				
160		Electricity for Residential us	%	GRPRELR		3.9	10.2	34.5				
161		Electricity for Industry use	%	GRPRELI		3.1	7.0	-13.8				
162		Electricity for Commercial use	%	GRPRELC		4.5	3.3	4.3				
163												

a. Conversion factor to KTOE

Physical energy units such as kg, m3 and kWh are converted to KTOE. The factors are used during the starting year(1990) and final year(2025) The calories of the energies in the conversion factor table are set as follows;

Table 2-3-4 Conversion factor block in Data sheet

Energies	Calorie	KTOE
Standard Oil	10,000Kcal/kg	1000t=1KTOE
Coal	5,600Kcal/kg	1000t=0.56KTOE
Gasoline	1,0500Kcal/kg	1000t=1.05KTOE
Kerosene	10,320Kcal/kg	1000t=1.032KTOE
Diesel	10,150Kcal/kg	1000t=1.015KTOE
Fuel oil	9,910Kcal/Kg	1000t=0.991KTOE
Natural gas	9,000Kcal/m3	Million m3=0.9KTOE
Renewable energy	3,300cal/Kg	1000t=0.3300
Electricity	860Kcal/KWh	1GWh=0.086KTOE

The future conversion factor is exogenous.

b. Power efficiency

Thermal power efficiencies are given by thermal power generation types such as coal fired power generator, fuel oil fired power generator, fuel oil gas turbine, gas turbine, gas steam and diesel. The efficiencies are used at calculating the energies used in the generators.

Table 2-3-5 Power efficiency block in Data sheet

Thermal power generator	Efficiency	Expressions
Power from Thermal(Coal)	35%	2.28(GWh/1000t)=5600*0.35/860
Power from Thermal(FO)	35%	4.03(GWh/1000t)=9910*0.35/860
Power from Gas-turbine(FO)	48%	5.53(GWh/1000t)=9910*0.48/860
Power from Gas-turbine(GAS)	48%	5.02(GWh/1000t)=9000*0.48/860
Power from Gas steam	40%	4.19(GWh/Mil m3)=9000*0.40/860
Power from Diesel	36%	4.25(GWh/1000t)=10,150*0.36/860

The future power efficiencies are exogenous.

c. Energy price

The actual petroleum prices and electricity tariffs are input in the table. As WTI(West Texas Index) is often used for forecasting oil prices in the world, it is prepared for forecasting Vietnam crude oil price forecasting.

In Vietnam, petroleum products are mainly imported from Asian oil market. The purchasing costs depend on international market prices. It is considered that the future petroleum prices depend on international crude oil prices.

The electricity tariffs by category are input in the table. The future electricity tariffs are decided not only petroleum prices, but also energy policy. In the model, it is assumed that the future electricity tariffs by category depend on the production costs, then the power tariffs are effected by the imported fuel oil prices of Vietnam. It can be considered that the fuel oil prices in Vietnam are decided in market mechanisms.

d. Growth rate of Energy prices

The annual growth rates of the energy prices are calculated for energy demand forecasting, especially the annual growth rate s of the energy prices affect to energy conservation indices.

(4) Power demand forecasting in Agriculture &Forestry &Fishery sector

In the block, the energy and power demand are forecasted by sector. The sector consists of Agriculture, Forestry and Fishery. As dependent variable, energy conservation factor is set in energy demand forecasting equations of the sector. The factor is affected by technical improvement and energy price such as petroleum products, natural gas, renewable energies and electricity are used in the sector. In the energy demand forecasting model, the sectoral total energies are forecasted at first, next, electricity demand is forecasted by using the power ratio to sectoral total energy demand.

The fossil energies including petroleum products and natural gas are forecasted by the deference of subtracting the electricity demand from the sectoral total energy demand.

Table 2-3-6 Power demand forecasting block in Data sheet
(Agriculture &Forestry &Fishery sector)

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
164	Agriculture.Forestry.& Fish	Energy conservation rate	S%	PAENCOR	100.0	100.0	100.0	100.0				
165		Technical Improvement	%	PAENTEC	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0
166		Elasticity to Energy price		PAENEVP		-0.14	2.82	-0.07	0.00	0.00	-0.01	-0.01
167		Energy intensity to GDP	TOE/Bil Don	PAENEFF	1.7	1.6	1.4	1.4				
168		Energy demand before E.save	KTOE	PAENDEM	225.3	221.6	452.4	478.1				
169		Energy demand after E.save	KTOE	PAENDEA	225.3	221.6	452.4	478.1				
170		Electricity ratio	S%	PAENELR	7.2	7.5	9.1	9.2	10.0	11.0	13.0	13.0
171		Power demand (kTOE)	KTOE	PAENELT	16.3	16.6	41.4	44.1	47.4	56.6		
172		Power demand (GWh)	GWh	PAENELE	189.8	193.4	480.9	512.8	551.0	657.7		
173												
174		Coal demand	KTOE	PADMCOA	64.0	68.0	25.0	24.0				
175		LPG demand	KTOE	PADMLPG	0.0	0.0	0.0	0.0				
176		Gasoline demand	KTOE	PADMGAS	45.0	40.0	82.0	84.0				
177		Jetfuel demand	KTOE	PADMJET	0.0	0.0	0.0	0.0				
178		Kerosene demand	KTOE	PADMKER	0.0	0.0	0.0	0.0				
179		Diesel demand	KTOE	PADMDIE	97.0	93.0	289.0	309.0				
180		Fuel oil demand	KTOE	PADMFUL	3.0	3.0	15.0	17.0				
181		Natural gas demand	KTOE	PADMNG	0.0	0.0	0.0	0.0				
182		Renewable energy demand	KTOE	PADMREW	0.0	0.0	0.0	0.0				
183		Total	KTOE	PADMTOT	209.0	205.0	411.0	434.0				
184												
185	0.0	Coal demand	S%	PASMCOA	30.6	33.7	6.1	5.5	6.1	6.1	6.1	6.1
186	0.0	LPG demand	S%	PASMLPG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
187	0.0	Gasoline demand	S%	PASMGAS	21.5	19.5	20.0	19.4	20.0	20.0	20.0	20.0
188	0.0	Jetfuel demand	S%	PASMJET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
189	0.0	Kerosene demand	S%	PASMKER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
190	0.0	Diesel demand	S%	PASMDIE	46.4	45.4	70.3	71.2	70.3	70.3	70.3	70.3
191	0.0	Fuel oil demand	S%	PASMFUL	1.4	1.5	3.6	3.9	3.6	3.6	3.6	3.6
192	0.0	Natural gas demand	S%	PASMNG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
193	0.0	Renewable energy demand	S%	PASMREW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
194	0.0	Total	S%	PASMTOT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
195												

a. Energy conservation rate

Energy conservation in the actual terms is 100%. It means that energy conservation in the past years, especially in 2002 and 2003 are starting position. The future energy conservation is compared to the starting position. The energy conservation rate is affected by changes of energy prices and technical improvement.

b. Technical Improvement

Energy consumption is conserved by all kinds of technical improvement. In 30 years after the first oil crisis, Japan had energy conservation improvement with 2% per year. Most of the reasons

are improvement of the production line and installation of new equipment. Both of them are included in technical improvement in the model. Such kinds of technical improvement are a major factor for energy conservation.

c. Elasticity to Energy price

Another factor as energy conservation is energy price hikes. When energy prices and electricity tariffs increases, all kinds of energies in the sector are usually saved.

According to Japanese experiences, energy demand elasticity to energy price is the ranges from –0.1 to –1.0. In the model, For Agriculture sector, the assumption of energy demand elasticity to energy price is –0.01, it is very small

d. Energy intensity to GDP

Energy intensity in Agriculture sector to GDP is calculated by using energy demand in Agriculture sector and GDP in the whole country. It is used for the evaluation of the future energy demand in Agriculture sector.

e. Energy demand before Energy saving

Energy demand in Agriculture sector is forecasted in the area. First, the energy demand before making energy conservation is calculated in the area.

f. Energy demand after energy saving

Energy demand after making energy conservation in Agriculture sector is forecasted in the area. It is calculated by the energy demand forecasting value before energy conservation and energy conservation rate.

g. Electricity ratio

Electricity ratio is an electricity share of the energy demand in Agriculture sector. The ratio is exogenous. The values are exogenously estimated after referring other countries' electricity ratio.

Table2-3-7 International Electricity ratio of Agriculture sector

Agriculture sector %

	1995	1996	1997	1998	1999	2000
Japan	2.7	2.8	2.9	3.0	3.2	2.1
Taiwan	1.7	1.8	2.1	2.3	2.3	2.1
Australia	1.5	1.5	1.5	1.5	1.5	1.5
Indonesia	0.0	0.0	0.0	0.0	0.0	0.0
Korea	0.9	1.0	0.9	1.0	1.1	1.2
China	12.8	13.2	13.5	12.8	13.7	13.7
Vietnam	6.0	6.4	6.7	7.1	8.5	9.2
Thailand	0.6	0.6	0.5	0.7	0.5	0.5
Pilippines	19.8	16.7	18.1	13.8	20.1	10.1

Source: APERC Energy Data Base

h. Power demand（ｋTOE）

Power demand is forecasted with “Energy demand forecasting value * Power ratio”.
The power demand unit forecasted is kTOE, not GWh.

i. Power demand（GWh）

Power demand with GWh is calculated by “Energy demand forecasting value with kTOE * 0.086”.

j. Fossil energy demand

As fossil energies used in Agriculture sector, Coal, LPG, Gasoline, Jet-fuel, Kerosene, Diesel demand, Fuel oil, Natural gas and Renewable energy are calculated with total energy demand and fossil energy ratio in Agriculture sector.

k. Fossil energy demand ratio

Fossil energy demand ratios are exogenous. The future values of fossil energy demand ratio are decided by the energy supply policies of Vietnam.

(5) Power demand forecasting in Industry sector

As dependent variable of Industry sector, energy conservation factor is set in energy demand forecasting structure of the sector. The factor is affected by technical improvement and energy price such as petroleum products, natural gas, renewable energies and electricity are used in the sector. In the energy demand forecasting model, the sectoral total energies are forecasted at first, next, electricity demand is forecasted by using the power ratio to sectoral total energy demand.
The fossil energies including petroleum products and natural gas are forecasted by the deference of subtracting the electricity demand from the sectoral total energy demand.

Table2-3-8 Power demand forecasting in Industry sector in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
196	Industry	Energy conservation rate	S%	MANNCOR	100.0	100.0	100.0	100.0				
197		Technical Improvement	%	MANNTEC	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0
198		Elasticity to Energy price		MANNEVP		-0.01	0.75	-0.08	0.00	0.00	-0.30	-0.30
199		Energy intensity to GDP	TOE/Bil Don	MANNEFF	34.2	34.0	29.6	29.0				
200		Energy demand before E.save	KTOE	MANNDEM	4,510.3	4,745.9	9,259.3	9,749.6				
201		Energy demand after E.save	KTOE	MANNDEA	4,510.3	4,745.9	9,259.3	9,749.6				
202		Electricity ratio	S%	MANNELR	5.5	5.6	11.8	13.5	14.8	15.7	34.0	34.0
203		Power demand (kTOE)	KTOE	MANNELT	247.3	264.9	1,088.3	1,316.6	1,538.9	1,798.1		
204		Power demand (GWh)	GWh	MANNELE	2,875.6	3,080.2	12,654.3	15,309.7	17,894.0	20,908.6		
205												
206		Coal demand	KTOE	MANMCOA	1,020.0	1,142.0	2,944.0	3,113.0				
207		LPG demand	KTOE	MANMLPG	0.0	0.0	57.0	87.0				
208		Gasoline demand	KTOE	MANMGAS	0.0	0.0	0.0	0.0				
209		Jetfuel demand	KTOE	MANMJET	0.0	0.0	0.0	0.0				
210		Kerosene demand	KTOE	MANMKER	4.0	4.0	11.0	10.0				
211		Diesel demand	KTOE	MANMDIE	233.0	223.0	695.0	896.0				
212		Fuel oil demand	KTOE	MANMFUL	211.0	243.0	1,168.0	1,172.0				
213		Natural gas demand	KTOE	MANMNG	0.0	9.0	19.0	18.0				
214		Renewable energy demand	KTOE	MANMREW	2,795.0	2,860.0	3,277.0	3,137.0				
215		Total	KTOE	MANMTOT	4,283.0	4,481.0	8,171.0	8,433.0				
216												
217	0.0	Coal demand	S%	MASMCOA	23.9	25.5	36.0	36.9	38.0	39.0	39.0	39.0
218	0.0	LPG demand	S%	MASMLPG	0.0	0.0	0.7	1.0	1.1	1.1	2.9	3.0
219	0.0	Gasoline demand	S%	MASMGAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
220	0.0	Jetfuel demand	S%	MASMJET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
221	0.0	Kerosene demand	S%	MASMKER	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
222	0.0	Diesel demand	S%	MASMDIE	5.5	5.0	8.5	10.6	10.0	8.8	8.8	8.8
223	0.0	Fuel oil demand	S%	MASMFUL	4.9	5.4	14.3	13.9	15.3	17.5	38.8	37.8
224	0.0	Natural gas demand	S%	MASMNG	0.0	0.2	0.2	0.2	0.2	0.2	0.8	0.8
225	0.0	Renewable energy demand	S%	MASMREW	65.6	63.8	40.1	37.2	35.3	33.2	11.7	10.8
226	0.0	Total	S%	MASMTOT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
227												

a. Energy conservation rate in Industry sector

Energy conservation rate in the actual terms is 100%. It means that energy conservation in the past years, especially in 2002 and 2003 are starting position. The future energy conservations are compared to the starting position. The energy conservation rate is affected by changes of energy prices and technical improvement.

Ex Energy conservation rate in 2004 2025

2004	2005	2010	2015	2020	2025
100	98	93	88	83	78

Energy consumption decreases with 22% in 2025 when compared to 2004.

b. Technical Improvement

Energy consumption is conserved by all kinds of technical improvement. In 30 years after the first oil crisis, Japan had energy conservation improvement with 2% per year. Most of the reasons are improvement of the production line and installation of new equipment. Both of them are included in technical improvement in the model. Such kinds of technical improvement are a major factor for energy conservation.

c. Elasticity to Energy price

Another factor as energy conservation is energy price hikes. When energy prices and electricity tariffs increases, all kinds of energies in the sector are saved.

According to Japanese experiences, energy demand elasticity to energy price is the ranges from –0.1 to –1.0. In the model, For Industry sector, the assumption of energy demand elasticity to energy price is –0.3.

d. Energy intensity to GDP

Energy intensity in Industry sector to GDP is calculated by using energy demand in Industry sector and GDP in the whole country. It is used for the evaluation of the future energy demand in Industry sector.

e. Energy demand before Energy saving

Energy demand in Industry sector is forecasted in the area. First, the energy demand before making energy conservation is calculated in the area.

f. Energy demand after energy saving

Energy demand after making energy conservation in Industry sector is forecasted in the area. It is calculated by the energy demand forecasting value before energy conservation and energy conservation rate.

g. Electricity ratio

Electricity ratio is an electricity share of the energy demand in Industry sector. The ratio is exogenous. The values are exogenously estimated after referring other countries' electricity ratio.

Table 2-3-9 International Electricity ratio of Industry sector

Industry %

	1995	1996	1997	1998	1999	2000
Japan	26.5	26.8	27.1	27.4	26.7	26.6
Taiwan	22.1	22.2	22.9	23.3	24.4	26.2
Australia	20.3	19.9	20.0	21.4	21.9	22.0
Indonesia	12.4	11.9	14.3	13.8	13.9	12.9
Korea	19.0	19.6	19.4	19.2	19.4	20.0
China	5.1	5.3	5.5	5.8	6.0	6.1
Vietnam	12.8	14.1	13.4	14.0	15.1	17.0
Thailand	22.7	20.6	22.5	22.4	23.9	25.4
Malaysia	18.0	19.8	21.4	21.4	23.1	22.2
Pilippines	19.7	19.7	20.2	26.9	20.4	31.7

h. Power demand（kTOE）

Power demand is forecasted with "Energy demand forecasting value * Power ratio". The power demand unit is kTOE, not GWh.

i. Power demand（GWh）

Power demand with GWh is calculated by “Energy demand forecasting value with kTOE * 0.086”.

j. Fossil energy demand

As fossil energies used in Industry sector, Coal, LPG, Gasoline, Kerosene, Diesel, Fuel oil, Natural gas and Renewable energy are calculated with total energy demand and fossil energy ratio in Industry sector.

k. Fossil energy demand ratio

Fossil energy demand ratios are exogenous. The future values of fossil energy demand ratio are decided by the energy supply policies of Vietnam.

(6) Power demand forecasting in Transportation sector

As dependent variable of Transportation sector, energy conservation factor is set in energy demand forecasting equations of the sector. The factor is affected by technical improvement and energy price such as petroleum products, natural gas, renewable energies and electricity are used in the sector.

Table 2-3-10 Power demand forecasting in Transportation sector in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
228	Transportation	Energy conservation rate	S%	TRENCOR	100.0	100.0	100.0	100.0				
229		Technical Improvement	%	TRENTEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
230		Elasticity to Energy price		TRENEVP		-0.21	7.14	0.22	0.00	0.00	-0.10	-0.10
231		Energy intensity to GDP	TOE/Bil Don	TRENEFF	10.7	9.5	15.8	16.6				
232		Energy demand before E.save	KTOE	TRENDEM	1,408.0	1,330.0	4,943.0	5,561.0				
233		Energy demand after E.save	KTOE	TRENDEA	1,408.0	1,330.0	4,943.0	5,561.0				
234		Electricity ratio	S%	TRENELR	0.36	0.38	0.53	0.49	0.55	0.62	1.93	2.00
235		Power demand (kTOE)	KTOE	TRENELT	5.0	5.0	26.0	27.0	28.0	29.0		
236		Power demand (GWh)	GWh	TREENELE	58.1	58.1	302.3	314.0	325.8	337.2		
237												
238		Coal demand	KTOE	TREMCOA	14.0	23.0	0.0	0.0				
239		LPG demand	KTOE	TREMLPG	0.0	0.0	0.0	0.0				
240		Gasoline demand	KTOE	TREMGAS	601.0	532.0	2,063.0	2,148.0				
241		Jetfuel demand	KTOE	TREMJET	100.0	111.0	284.0	263.0				
242		Kerosene demand	KTOE	TREMKER	0.0	0.0	0.0	0.0				
243		Diesel demand	KTOE	TREMDIE	659.0	625.0	2,378.0	2,880.0				
244		Fuel oil demand	KTOE	TREMFUL	34.0	39.0	218.0	270.0				
245		Natural gas demand	KTOE	TREMNG	0.0	0.0	0.0	0.0				
246		Renewable energy demand	KTOE	TREMREW	0.0	0.0	0.0	0.0				
247		Total	KTOE	TREMTOT	1,408.0	1,330.0	4,943.0	5,561.0				
248												
249	0.0	Coal demand	S%	TRSMCOA	1.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0
250	0.0	LPG demand	S%	TRSMLPG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
251	0.0	Gasoline demand	S%	TRSMGAS	42.7	40.0	41.7	38.6	41.7	41.7	43.7	43.9
252	0.0	Jetfuel demand	S%	TRSMJET	7.1	8.3	5.7	4.7	5.7	5.7	4.3	4.2
253	0.0	Kerosene demand	S%	TRSMKER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
254	0.0	Diesel demand	S%	TRSMDIE	46.8	47.0	48.1	51.8	48.1	48.1	48.7	48.7
255	0.0	Fuel oil demand	S%	TRSMFUL	2.4	2.9	4.4	4.9	4.4	4.4	3.3	3.3
256	0.0	Natural gas demand	S%	TRSMNG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
257	0.0	Rcncwablc cncrgy demand	S%	TRSMREW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
258	0.0	Total	S%	TRSMTOT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
259												

In the energy demand forecasting model, the sectoral total energies are forecasted at first, next, electricity demand is forecasted by using the power ratio to sectoral total energy demand.
The fossil energies including petroleum products and natural gas are forecasted by the deference of subtracting the electricity demand from the sectoral total energy demand.

a. Energy conservation rate in Transportation sector

Energy conservation rate in the actual terms is 100%. It means that energy conservation in the past years, especially in 2002 and 2003 are starting position. The future energy conservations are compared to the starting position. The energy conservation rate is affected by changes of energy prices and technical improvement.

Ex Energy conservation rate in 2004 2025

2004	2005	2010	2015	2020	2025
100	98	93	88	83	78

Energy consumption decreases with 22% in 2025 when compared to 2004.

b. Technical Improvement

Energy consumption is conserved by all kinds of technical improvement. In 30 years after the first oil crisis, Japan had energy conservation improvement with 2% per year. Most of the reasons are improvement of the production line and installation of new equipment. Both of them are included in technical improvement. Such kinds of technical improvement are a major factor for energy conservation.

c. Elasticity to Energy price

Another factor as energy conservation is energy price hikes. When energy prices and electricity tariffs increases, all kinds of energies in the sector are saved.
According to Japanese experiences, energy demand elasticity to energy price is the ranges from –0.1 to –1.0. In the model, For Transportation sector, the assumption of energy demand elasticity to energy price is –0.1.

d. Energy intensity to GDP

Energy intensity in Transportation sector to GDP is calculated by using energy demand in Transportation sector and GDP in the whole country. It is used for the evaluation of the future energy demand in Transportation sector.

e. Energy demand before Energy saving

Energy demand in Transportation sector is forecasted in the area. First, the energy demand before making energy conservation is calculated in the area.

f. Energy demand after energy saving

Energy demand after making energy conservation in Transportation sector is forecasted in the area. It is calculated by the energy demand forecasting value before energy conservation and energy conservation rate.

g. Electricity ratio

Electricity ratio is an electricity share of the energy demand in Transportation sector. The ratio is exogenous. The values are very small. In the future, subway is planned in Ho-Chi-Min city. The electricity for transportation sector will be supplied to the subway.

h. Power demand（k TOE）

Power demand is forecasted with "Energy demand forecasting value * Power ratio". The power demand unit is kTOE, not GWh.

i. Power demand（GWh）

Power demand with GWh is calculated by "Energy demand forecasting value with kTOE * 0.086".

j. Fossil energy demand

As fossil energies used in Transportation sector, Gasoline, Jet-fuel, Diesel, Fuel oil are calculated with total energy demand and fossil energy ratio in Transportation sector.

k. Fossil energy demand ratio

Fossil energy demand ratios are exogenous. The future values of fossil energy demand ratio are decided by the energy supply policies of Vietnam.

(7) Power demand forecasting in Commercial & Services sector

As dependent variable of Commercial & Services sector, energy conservation factor is set in energy demand forecasting equations of the sector. The energy conservation factor is affected by technical improvement and energy price such as petroleum products, natural gas, renewable energies and electricity are used in the sector. In the energy demand forecasting model, the sectoral total energies are forecasted at first, next, electricity demand is forecasted by using the power ratio to sectoral total energy demand.

The fossil energies including petroleum products and natural gas are forecasted by the deference of subtracting the electricity demand from the sectoral total energy demand.

Table 2-3-11 Power demand forecasting in Commercial sector in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
260	Commercials & Service	Energy conservation rate	S%	COMNCOR	100.0	100.0	100.0	100.0				
261		Technical Improvement	%	COMNTEC	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0
262		Elasticity to Crude oil price		COMNEVP		-0.01	-1.79	-0.22	0.00	0.00	-0.20	-0.20
263		Energy intensity to GDP	TOE/Bil Don	COMNEFF	2.2	2.2	4.0	3.8				
264		Energy demand before E.save	KTOE	COMNDEM	295.1	310.4	1,240.2	1,267.0				
265		Energy demand after E.save	KTOE	COMNDEA	295.1	310.4	1,240.2	1,267.0				
266		Electricity ratio	S%	COMNELR	3.8	3.7	9.9	10.5	11.6	12.3	33.2	35.0
267		Power demand (kTOE)	KTOE	COMNELT	11.1	11.4	122.2	133.4	153.2	173.9		
268		Power demand (GWh)	GWh	COMNELE	128.9	132.9	1,421.1	1,550.8	1,781.0	2,022.0		
269												
270		Coal demand	KTOE	COMMCOA	10.0	30.0	201.0	205.1				
271		LPG demand	KTOE	COMMLPG	0.0	0.0	121.0	122.7				
272		Gasoline demand	KTOE	COMMGAS	0.0	0.0	0.0	0.0				
273		Jetfuel demand	KTOE	COMMJET	0.0	0.0	0.0	0.0				
274		Kerosene demand	KTOE	COMMKER	147.0	151.0	247.0	250.5				
275		Diesel demand	KTOE	COMMDIE	87.0	82.0	325.0	329.6				
276		Fuel oil demand	KTOE	COMMFUL	31.0	36.0	134.0	135.9				
277		Natural gas demand	KTOE	COMMNG	0.0	0.0	0.0	0.0				
278		Renewable energy demand	KTOE	COMMREW	0.0	0.0	0.0	0.0				
279		Total	KTOE	COMMTOT	284.0	299.0	1,118.0	1,133.7				
280												
281	0.0	Coal demand	S%	COSMCOA	6.7	10.0	26.0	26.0	26.0	26.0	26.0	26.0
282	0.0	LPG demand	S%	COSMLPG	0.0	0.0	10.8	10.8	10.8	10.8	10.8	10.8
283	0.0	Gasoline demand	S%	COSMGAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
284	0.0	Jetfuel demand	S%	COSMJET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
285	0.0	Kerosene demand	S%	COSMKER	51.8	50.5	22.1	22.1	22.1	22.1	22.1	22.1
286	0.0	Diesel demand	S%	COSMDIE	30.6	27.4	29.1	29.1	29.1	29.1	29.1	29.1
287	0.0	Fuel oil demand	S%	COSMFUL	10.9	12.0	12.0	12.0	12.0	12.0	12.0	12.0
288	0.0	Natural gas demand	S%	COSMNG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
289	0.0	Renewable energy demand	S%	COSMREW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
290	0.0	Total	S%	COSMTOT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
291												

a. Energy conservation rate in Commercial & Services sector

Energy conservation rate in the actual terms is 100%. It means that energy conservation in the past years, especially in 2002 and 2003 are starting position. The future energy conservations are compared to the starting position. The energy conservation rate is affected by changes of energy prices and technical improvement.

b. Technical Improvement

Energy consumption is conserved by all kinds of technical improvement. In 30 years after the first oil crisis, Japan had energy conservation improvement with 2% per year. Most of the reasons are improvement of the production line and installation of new equipment. Both of them are included in technical improvement. Such kinds of technical improvement are a major factor for energy conservation.

c. Elasticity to Energy price

Another factor as energy conservation is energy price hikes. When energy prices and electricity tariffs increases, all kinds of energies in the sector are saved.

According to Japanese experiences, energy demand elasticity to energy price is the ranges from –0.1 to –1.0. In the model, For Commercial & Services sector, the assumption of energy demand elasticity to energy price is –0.2.

d. Energy intensity to GDP

Energy intensity in Commercial & Services sector to GDP is calculated by using energy demand in Commercial & Services sector and GDP in the whole country. It is used for the evaluation of the future energy demand in Commercial & Services sector.

e. Energy demand before Energy saving

Energy demand in Commercial & Services sector is forecasted in the area. First, the energy demand before making energy conservation is calculated in the area.

f. Energy demand after energy saving

Energy demand after making energy conservation in Commercial & Services sector is forecasted in the area. It is calculated by the energy demand forecasting value before energy conservation and energy conservation rate.

g. Electricity ratio

Electricity ratio is an electricity share of the energy demand in Commercial & Services sector. The ratio is exogenous. The values are exogenously estimated after referring other countries' electricity ratio.

Table2-3-12 International Electricity ratio of Commercial & Residential sector

Commercial &Residential %

	1995	1996	1997	1998	1999	2000
Japan	43.9	43.9	45.4	47.1	47.8	44.8
Taiwan	64.5	63.6	65.9	66.2	65.8	67.2
Australia	52.3	53.0	53.7	54.4	55.3	55.5
Indonesia	3.8	4.3	4.8	5.3	5.4	5.8
Korea	18.0	19.3	21.0	25.7	24.0	27.6
China	6.3	7.0	8.0	9.5	10.0	10.0
Vietnam	30.5	29.9	33.5	35.9	35.7	35.6
Thailand	70.5	70.3	72.6	75.0	72.2	71.2
Malaysia	55.2	49.7	65.0	68.2	61.0	63.4
Pilippines	39.0	40.6	47.2	45.2	43.7	40.0

h. Power demand（ｋTOE）

Power demand is forecasted with "Energy demand forecasting value * Power ratio". The power demand unit is kTOE, not GWh.

i. Power demand（GWh）

Power demand with GWh is calculated by “Energy demand forecasting value with kTOE * 0.086”.

j. Fossil energy demand

As fossil energies used in Commercial & Services sector, Coal, LPG, Gasoline, Kerosene, Diesel, Fuel oil, Natural gas and Renewable energy are calculated with total energy demand and fossil energy ratio in Commercial & Services sector.

k. Fossil energy demand ratio

Fossil energy demand ratios are exogenous. The future values of fossil energy demand ratio are decided by the energy supply policies of Vietnam.

(8) Power demand forecasting in Residential sector

As dependent variable of Residential sector, energy conservation factor is set in energy demand forecasting structure of the sector. The factor is affected by technical improvement and energy price such as petroleum products, natural gas, renewable energies and electricity are used in the sector.

Table2-3-13 Power demand forecasting in Residential sector in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
292	Residentials	Energy conservation rate	S%	RESNCOR	100.0	100.0	100.0	100.0				
293		Technical Improvement	%	RESNTEC	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0
294		Elasticity to Energy price		RESNEVP		-0.04	-2.14	-0.04	0.00	0.00	-0.10	-0.10
295		Energy intensity to GDP	TOE/Bil Don	RESNEFF	76.9	75.3	43.1	42.7				
296		Energy demand before E.save	KTOE	RESNDEM	10,146.9	10,516.3	13,502.7	14,352.1				
297		Energy demand after E.save	KTOE	RESNDEA	10,146.9	10,516.3	13,502.7	14,352.1				
298		Electricity ratio	S%	RESNELR		2.4	8.7	9.5	10.4	11.3	29.1	30.0
299		Power demand (kTOE)	KTOE	RESNELT	238.9	254.3	1,177.7	1,381.1	1,518.4	1,734.9		
300		Power demand (GWh)	GWh	RESENELE	2,778.0	2,957.5	13,693.7	15,828.8	17,656.0	20,173.5		
301												
302		Coal demand	KTOE	REDMCOA	207.0	336.0	756.0	892.0	892.0			
303		LPG demand	KTOE	REDMLPG	0.0	0.0	263.0	367.0	367.0			
304		Gasoline demand	KTOE	REDMGAS	0.0	0.0	0.0	0.0	0.0			
305		Jetfuel demand	KTOE	REDMJET	0.0	0.0	0.0	0.0	0.0			
306		Kerosene demand	KTOE	REDMKER	61.0	63.0	151.0	151.0	151.0			
307		Diesel demand	KTOE	REDMDIE	11.0	10.0	22.0	20.0	20.0			
308		Fuel oil demand	KTOE	REDMFUL	3.0	3.0	11.0	4.0	4.0			
309		Natural gas demand	KTOE	REDMNG	0.0	0.0	0.0	0.0	0.0			
310		Renewable energy demand	KTOE	REDMREW	8,626.0	9,850.0	11,122.0	11,557.0	11,557.0			
311		Total	KTOE	REDMTOT	8,808.0	10,262.0	12,325.0	12,991.0	12,991.0			
312												
313	0.0	Coal demand	S%	RESMCOA	2.1	3.3	6.1	6.9	7.4	8.1	13.3	14.2
314	0.0	LPG demand	S%	RESMLPG	0.0	0.0	2.1	2.8	3.8	5.0	13.2	12.5
315	0.0	Gasoline demand	S%	RESMGAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
316	0.0	Jetfuel demand	S%	RESMJET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
317	0.0	Kerosene demand	S%	RESMKER	0.6	0.6	1.2	1.2	1.2	1.2	1.2	1.2
318	0.0	Diesel demand	S%	RESMDIE	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
319	0.0	Fuel oil demand	S%	RESMFUL	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1
320	0.0	Natural gas demand	S%	RESMNG	0.0	0.0	0.0	0.0	0.0	0.0	28.0	30.0
321	0.0	Renewable energy demand	S%	RESMREW	97.2	96.0	90.2	89.0	87.2	85.4	44.0	41.8
322	0.0	Total	S%	RESMTOT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
323												

In the energy demand forecasting model, the sectoral total energies are forecasted at first, next, electricity demand is forecasted by using the power ratio to sectoral total energy demand.
The fossil energies including petroleum products and natural gas are forecasted by the deference of subtracting the electricity demand from the sectoral total energy demand.

a. Energy conservation rate in Residential sector

Energy conservation rate in the actual terms is 100%. It means that energy conservation in the past years, especially in 2002 and 2003 are starting position. The future energy conservations are compared to the starting position. The energy conservation rate is affected by changes of energy prices and technical improvement.

b. Technical Improvement

Energy consumption is conserved by all kinds of technical improvement. In 30 years after the first oil crisis, Japan had energy conservation improvement with 2% per year. Most of the reasons are improvement of the production line and installation of new equipment. Both of them are included in technical improvement. Such kinds of technical improvement are a major factor for energy conservation.

c. Elasticity to Energy price

Another factor as energy conservation is energy price hikes. When energy prices and electricity tariffs increases, all kinds of energies in the sector are saved.
According to Japanese experiences, energy demand elasticity to energy price is the ranges from –0.1 to –1.0. In the model, For Residential sector, the assumption of energy demand elasticity to energy price is –0.1.

d. Energy intensity to GDP

Energy intensity in Residential sector to GDP is calculated by using energy demand in Residential sector and GDP in the whole country. It is used for the evaluation of the future energy demand in Residential sector.

e. Energy demand before Energy saving

Energy demand in Residential sector is forecasted in the area. First, the energy demand before making energy conservation is calculated in the area.

f. Energy demand after energy saving

Energy demand after making energy conservation in Residential sector is forecasted in the aea It is calculated by the energy demand forecasting value before energy conservation and energy

conservation rate.

g. Electricity ratio

Electricity ratio is an electricity share of the energy demand in Residential sector. The ratio is exogenous. The values are exogenously estimated after referring other countries' electricity ratio.

Table2-3-14 International Electricity ratio of Commercial & Residential sector

Commercial &Residential %

	1995	1996	1997	1998	1999	2000
Japan	43.9	43.9	45.4	47.1	47.8	44.8
Taiwan	64.5	63.6	65.9	66.2	65.8	67.2
Australia	52.3	53.0	53.7	54.4	55.3	55.5
Indonesia	3.8	4.3	4.8	5.3	5.4	5.8
Korea	18.0	19.3	21.0	25.7	24.0	27.6
China	6.3	7.0	8.0	9.5	10.0	10.0
Vietnam	30.5	29.9	33.5	35.9	35.7	35.6
Thailand	70.5	70.3	72.6	75.0	72.2	71.2
Malaysia	55.2	49.7	65.0	68.2	61.0	63.4
Pilippines	39.0	40.6	47.2	45.2	43.7	40.0

h. Power demand（k TOE）

Power demand is forecasted with "Energy demand forecasting value * Power ratio". The power demand unit is kTOE, not GWh.

i. Power demand（GWh）

Power demand with GWh is calculated by "Energy demand forecasting value with kTOE * 0.086".

j. Fossil energy demand

As fossil energies used in Residential sector, Coal, LPG, Gasoline, Kerosene, Diesel, Natural gas and Renewable energy are calculated with total energy demand and fossil energy ratio in Residential sector.

k. Fossil energy demand ratio

Fossil energy demand ratios are exogenous. The future values of fossil energy demand ratio are decided by the energy supply policies of Vietnam.

(9) Power demand forecasting in Other sector

As dependent variable of Other sector, energy conservation factor is set in energy demand forecasting structure of the sector. The factor is affected by technical improvement and energy

price such as petroleum products, natural gas, renewable energies and electricity are used in the sector. In the energy demand forecasting model, the sectoral total energy demand equals to electricity demand, it means that only electricity demand appears in the sector. the power demand in the sector is forecasted.

Table2-3-15 Power demand forecasting in Other sector in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
324	Others	Energy conservation rate	S%	NONNCOR	100.0	100.0	100.0	100.0				
325		Technical Improvement	%	NONNTEC	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0
326		Elasticity to Energy price		NONNEVP		-0.03	25.41	0.82	0.00	0.00	-0.10	-0.10
327		Energy intensity to GDP	TOE/Bil Don	NONNEFF	0.101	0.100	0.304	0.345				
328		Energy demand before E.save	KTOE	NONNDEM	13.3	13.9	95.1	115.8				
329		Energy demand after E.save	KTOE	NONNDEA	13.3	13.9	95.1	115.8	134.5	153.8		
330		Electricity ratio	S%	NONNELR	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
331		Power demand (kTOE)	KTOE	NONNELT	13.3	13.9	95.1	115.8	119.5	136.2		
332		Power demand (GWh)	GWh	NONNELE	154.9	161.7	1,106.3	1,346.5	1,389.4	1,583.3		
333												
334		Coal demand	KTOE	NONMCOA	0.0	0.0	0.0	0.0				
335		LPG demand	KTOE	NONMLPG	0.0	0.0	0.0	0.0				
336		Gasoline demand	KTOE	NONMGAS	0.0	0.0	0.0	0.0				
337		Jetfuel demand	KTOE	NONMJET	0.0	0.0	0.0	0.0				
338		Kerosene demand	KTOE	NONMKER	0.0	0.0	0.0	0.0				
339		Diesel demand	KTOE	NONMDIE	0.0	0.0	0.0	0.0				
340		Fuel oil demand	KTOE	NONMFUL	0.0	0.0	0.0	0.0				
341		Natural gas demand	KTOE	NONMNG	0.0	0.0	0.0	0.0				
342		Renewable energy demand	KTOE	NONMREW	0.0	0.0	0.0	0.0				
343		Total	KTOE	NONMTOT	0.0	0.0	0.0	0.0				
344												
345	0.0	Coal demand	S%	NOSMCOA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
346	0.0	LPG demand	S%	NOSMLPG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
347	0.0	Gasoline demand	S%	NOSMGAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
348	0.0	Jetfuel demand	S%	NOSMJET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
349	0.0	Kerosene demand	S%	NOSMKER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
350	0.0	Diesel demand	S%	NOSMDIE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
351	0.0	Fuel oil demand	S%	NOSMFUL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
352	0.0	Natural gas demand	S%	NOSMNG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
353	0.0	Renewable energy demand	S%	NOSMREW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
354	0.0	Total	S%	NOSMTOT	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0
355												

a. Energy conservation rate in Residential sector

Energy conservation rate in the actual terms is 100%. It means that energy conservation in the past years, especially in 2002 and 2003 are starting position. The future energy conservations are compared to the starting position. The energy conservation rate is affected by changes of energy prices and technical improvement.

b. Technical Improvement

Energy consumption is conserved by all kinds of technical improvement. In 30 years after the first oil crisis, Japan had energy conservation improvement with 2% per year. Most of the reasons are improvement of the production line and installation of new equipment. Both of them are included in technical improvement. Such kinds of technical improvement are a major factor for energy conservation.

c. Elasticity to Energy price

Another factor as energy conservation is energy price hikes. When energy prices and electricity tariffs increases, all kinds of energies in the sector are saved. According to Japanese experiences, energy demand elasticity to energy price is the ranges from –0.1 to –1.0. In the model, For Other sector, the assumption of energy demand elasticity to energy price is –0.1.

d. Energy intensity to GDP

Energy intensity in Other sector to GDP is calculated by using energy demand in Other sector and GDP in the whole country. It is used for the evaluation of the future energy demand in Other sector.

e. Energy demand before Energy saving

Energy demand in Other sector is forecasted in the area. First, the energy demand before making energy conservation is calculated in the area.

f. Energy demand after energy saving

Energy demand after making energy conservation in Other sector is forecasted in the area. It is calculated by the energy demand forecasting value before energy conservation and energy conservation rate.

g. Electricity ratio

Electricity ratio is an electricity share of the energy demand in Other sector. The ratio is 100%. It is exogenous.

h. Power demand（k TOE）

Power demand is forecasted with “Energy demand forecasting value * Power ratio”. The power demand unit is kTOE, not GWh.

i. Power demand（GWh）

Power demand with GWh is calculated by “Energy demand forecasting value with kTOE * 0.086”.

(10) Power supply forecasting

By the above procedures, power demand and energy demand by sector are forecasted. In the block, it is calculated how to supply the power meeting to the power demand. At first, the total power demand and energy demand in the whole country is calculated. Next, power supply is calculated, Hydro power, Nuclear power, Renewable energy power and Purchasing power from

abroad are exogenous variable. The values of the exogenous variables are already calculated in Power sheet. In the power supply block, thermal power supplies are mainly calculated. After that, fossil energies consumed in the thermal stations are calculated.

Table 2-3-16 Power supply forecasting block in Data sheet

H	I	J	TIMF	1990	1991	2002	2003	2004	2005	2024	2025
Power demand in final use	Agriculture.Forestry.Fishery	GWh	PWDMPA	189.8	193.4	480.9	512.8	551.0	657.7	1,027.9	1,032.8
	manufacturing	GWh	PWDMMN	2,875.6	3,080.2	12,654.3	15,309.7	17,894.0	20,908.6	175,920.9	188,275.6
	Transportation	GWh	PWDMTR	58.1	58.1	302.3	314.0	325.6	337.2	6,521.6	6,928.4
	Commercials.Banking..Services	GWh	PWDMCM	128.9	132.9	1,421.1	1,550.8	1,781.0	2,022.0	25,002.9	27,960.0
	Residentials	Gwh	PWDMRE	2,778.0	2,957.5	13,693.7	15,828.8	17,856.0	20,173.5	121,380.5	131,758.2
	Other	GWh	PWDMNO	154.9	161.7	1,108.3	1,348.5	1,389.4	1,583.3	6,724.5	7,184.1
	Total	GWh	PWDMTOT	6,185.3	6,583.8	29,658.6	34,860.6	39,597.0	45,682.3	336,578.3	363,137.1
Energy Demand	Coal demand	KTOE	DEDCOA	1,324.0	1,800.0	4,016.0	4,685.0	5,798.0			
	LPG demand	KTOE	DEDLPG	0.0	0.0	441.0	576.7				
	Gasoline demand	KTOE	DEDGAS	646.0	572.0	2,145.0	2,232.0				
	Jetfuel demand	KTOE	DEDJET	100.0	111.0	284.0	263.0				
	Kerosene demand	KTOE	DEDKER	212.0	218.0	409.0	411.5				
	Diesel demand	KTOE	DEDDIE	1,087.0	1,033.0	3,709.0	4,434.6				
	Fuel oil demand	KTOE	DEDFUE	282.0	324.0	1,540.0	1,598.9				
	Petroleum total	KTOE	DEDSTO	2,327.0	2,258.0	8,534.0	9,516.6				
	Natural gas demand	KTOE	DEDNG	0.0	9.0	19.0	18.0				
	Renewable energy demand	KTOE	DEDREW	12,659.9	12,984.3	15,576.7	16,055.1				
	Power	KTOE	DEDPOW	531.9	566.2	2,550.6	2,998.0				
	Total(Coal+Petro+Renew+Power)	KTOE	DEDTOT	16,842.8	17,388.6	30,677.3	33,254.7				
Power supply	Power distribution loss	S%	PWGELOR	25.4	25.5	16.7	14.1	12.1	11.5	8.5	7.5
	Power distribution loss (GWh)	GWh	PWLOSSG	2,204.5	2,348.3	5,621.9	5,530.7				
	Own use in Power sector(GWh)	GWh	PWOWNG	289.4	276.9	515.3	532.8				
	Power distribution loss (KTOE)	KTOE	PWLOSST	189.6	202.0	483.5	475.6				
	Own use in Power sector(KTOE)	KTOE	PWOWNT	24.9	23.8	44.3	45.8				
	Power from Hydro	GWh	PWGEHYD	5,368.7	6,318.7	18,197.7	18,886.1	18,435.4	20,056.0	59,270.2	59,270.2
	Power from Fossil	GWh	PWGEFOS	3,310.6	2,892.3	15,486.8	20,374.0				
	Power foreign trade balance	GWh	PWGFRAT	0.0	0.0	0.0	0.0	0.0	0.0	27,716.6	28,575.1
	Power from Renewable energy	GWh	PWGENEW	0.0	0.0	0.0	0.0	0.0	200.6	3,556.2	3,556.2
	Power from Nuclear	GWh	PWGENCL	0.0	0.0	0.0	0.0	0.0	0.0	49,050.0	49,050.0
	Total of power generation	GWh	PWGETOT	8,679.3	9,209.0	33,683.5	39,360.1				
	Power from Thermal(Coal)	GWh	PWGECOA	2,023.8	1,226.1	3,418.6	4,829.3				
	Power from Thermal(FO)	GWh	PWGEFOT	988.1	1,222.0	1,137.3	1,209.9				
	Power from Gasturbine(FO)	GWh	PWGEFOB	53.0	53.0	1,187.0	1,630.0				
	Power from Gasturbine(GAS)	GWh	PWGEGAB	6.0	48.0	5,714.9	6,945.5				
	Power from Gas steam	GWh	PWGEGAS	0.0	0.0	2,598.0	3,578.0				
	Power from Diesel	GWh	PWGEDIE	410.8	366.5	88.2	46.8				
	Power from Fossil	GWh	PWGEFTT	3,481.7	2,915.7	14,144.1	18,238.6				
Power resources	Coal consumption for Thermal	KTOE	PWCCCOA	888.0	538.0	1,500.0	2,119.0	2,172.0			
	FO consumption for Thermal	KTOE	PWCCFOT	245.0	303.0	282.0	300.0				
	FO consumption for Gasturbine	KTOE	PWCCFOB	9.0	9.0	214.0	294.7				
	NG & AG consumption for Turbin	KTOE	PWCCGAT	1.2	9.6	1,137.7	1,382.7				
	NG & AG consumption for Gas st	KTOE	PWCCGAB	0.0	0.0	620.6	854.7				
	Diesel consumption for Diesel	KTOE	PWCCDIE	96.7	88.3	20.8	11.0				
	Total	KTOE	PWCCTOT	1,240.5	946.4	3,775.7	4,962.1				
0.0	Power from Thermal(Coal)	S% of KTOE	PWSCCOA	58.1	42.1	24.2	28.5	24.3	23.1	36.9	34.8
0.0	Power from Thermal(FO)	S% of KTOE	PWSCFOT	28.4	41.9	8.0	6.6	7.6	6.7	1.3	1.3
0.0	Power from Gasturbine(FO)	S% of KTOE	PWSCFOB	1.5	1.8	8.4	8.9	5.1	4.5	0.9	0.8
0.0	Power from Gasturbine(GAS)	S% of KTOE	PWSCGAT	0.2	1.6	40.4	38.1	50.9	55.1	58.8	61.1
0.0	Power from Gas steam	S% of KTOE	PWSCGAB	0.0	0.0	18.4	19.6	12.0	10.5	2.1	2.0
0.0	Power from Diesel	S% of KTOE	PWSCDIE	11.8	12.8	0.6	0.3	0.1	0.1	0.0	0.0
0.0	Power from Fossil	S% of KTOE	PWSCTOT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Evaluation factors	Energy demnad per capita	KOE/persons	EDPERCAP	255.1	258.6	384.8	411.6				
	Energy demnad per uGDP	KOE/US$	EDPERGDP	2.2	2.2	0.9	0.9				
	Power demand per capita	KWh/person	POPERCAP	93.7	97.9	372.0	431.4				
	Power demand per uGDP	KWh/US$	POPERGDP	0.8	0.8	0.9	0.9				
LF	Load Factor(Demand / Peak demand)		PINLOADF			63.2	63.5	64.0	64.2	69.0	69.0
Pmax	Peak demand (Total gen / (365*24)/LF	MW	PINPMAX			6552	7408	8283			

a. Power demand in final use

The power demands by sector are already forecasted in power demand forecasting blocks. For making the total power demand in a country, the power demand of all sectors such as Agriculture&Forestry&.Fishery, Industry, Transportation, Commercial&Banking&Services, Residential and other sector are summed up. The power demand of all sectors is power demand in final use.

b. Energy Demand

The energy demands by sector are already forecasted in power demand forecasting blocks. For making the total energy demand in a country, the energy demand of all sectors are summed up by energy. The energies are Coal, LPG, Gasoline, Jet-fuel, Kerosene, Diesel, Fuel oil, Natural gas and Renewable energy.

c. Power distribution loss & Own use in Power sector

The relation of Generation, Dispatch, Demand, Transmission & Distribution loss rate (T/D loss rate) and Own use rate are follow;

Dispatch = Generation *(1 – Own use rate)
Demand = Generation *(1 – Own use rate)* (1 – T/D loss rate) = Dispatch(1 – T/D loss rate)

T/D loss are calculated by using T/D lose rate and power demand. The T/D lose rate is exogenous and the future rates planned by EVN are selected.
The actual values of T/D loss are input in the actual term. The future power distribution losses are calculated by the following expression.

T/D loss = f(Power demand, Power loss rate)
T/D loss is shown in the units of TOE and GWh.

The actual values of power own use are input in the actual term. The future power own-use is calculated by the following table.

Power consumed in the generators are decided by the generation types:
Hydro power plant is 0.5% of the generation
Nuclear power plant is 5.0% of the generation
Coal fired Power plant is 7.0% of the generation.
Fuel oil fired power plant is 5.0% of the generation.

Gas turbine power plant is 4.5% of the generation.

Gas steam power plant is 5.0% of the generation

Diesel engine is 5.0% of the generation

The power generation by generator is calculated under the estimated future capacities.

Table 2-3-17 Own use rate calculation block in Power sheet

			2005	2010	2015	2020	2025
Generation	Power from Hydro	0.5	20,056	28,282	45,933	59,270	59,270
	Nuclear power	5.0				24,528	49,056
	Power from Thermal(Coal	7.0	8,376	29,856	43,074	48,772	48,772
	Power from Thermal(FO)	5.0	2,420	2,420	2,420	2,420	2,420
	Power from Gasturbine(FC	5.0	1,630	1,630	1,630	1,630	1,630
	Power from Gasturbine(G	4.5	19,992	29,899	46,640	69,081	101,503
	Power from Gas steam	5.0	3,826	3,826	3,826	3,826	3,826
	Power from Diesel	5.0	47	47	47	47	47
	Total generation		56,346	95,960	143,570	209,575	266,524
	Total own use		1,982	3,973	5,740	8,442	11,127
	Own use rate		3.5	4.1	4.0	4.0	4.2

The own use rates calculated are 3.5 in 2005, 4.1 in 2010, 4.0 in 2015, 4.0 in 2020 and 4.2 in 2025. The power own use is shown in the units of TOE and GWh

d. Power supply

At first, the total power generation is calculated by the following expression.

The total power generation = the power demand + Power distribution loss + Power own use

As Hydro power, Nuclear power, Renewable energy power and Purchasing power from abroad are exogenous, thermal power generation is calculated by the following expression.

Thermal power generation = Total power generation - hydro power generation

- Nuclear power generation
- Renewable energy power generation
- Purchasing power from abroad

e. Thermal power generation by generator

Thermal power generation by generator is calculated by using the thermal power generation and the shares of the thermal power generators. As the thermal power generator, the six thermal power generators that are Coal fired power station, Fuel oil fired power station, Fuel oil gas –turbine, Gas turbine, Gas steam and Diesel engine are prepared.

f. Shares of Thermal power generation by generator

The shares of thermal power generator are already calculated in Power sheet. And the values are set in the future area. The thermal power generation is shared in line with the share of the thermal power generators.

g. Evaluation factors

As evaluation factors, energy demand per capita, energy demand per uGDP, power demand per capita and power demand per uGDP are prepared.

Energy demand per capita = Energy demand in whole / Population

Energy demand per uGDP = Energy demand in whole / GDP based on $

Power demand per capita = Power demand in whole / Population

Power demand per uGDP = Power demand in whole / GDP based on $

h. Load factor and Peak demand(P-max)

Load factor is exogenous. The load factor is input after referring daily load curve forecasting model. Peak demand is calculated by “Power demand/(365*24) /Load factor”.

(11) Energy balance

Final demands of Coal, LPG, Gasoline, Jet-fuel, Kerosene, Diesel, Fuel oil, Natural gas, Renewable energy , Fuel consumption in power sector and domestic demand are calculated.

Table 2-3-18 Energy balance table in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
423	Coal total demand	Final demand	KTOE	COACDEM	1,324.0	1,600.0	4,016.0	4,685.0	5,708.0			
424		Consumption in Power sector	KTOE	COACPOW	888.0	538.0	1,500.0	2,110.0	2,172.0			
425		Domestic total	KTOE	COACDTO	2,212.0	2,138.0	5,516.0	6,804.0	7,970.0			
426												
427	LPG demand	Final demand	KTOE	LPGCDEM	0.0	0.0	441.0					
428		Consumption in Power sector	KTOE	LPGCPOW	0.0	1.0	12.0					
429		Domestic total	KTOE	LPGCTOT	0.0	1.0	453.0					
430												
431	Gasoline demand	Final demand	KTOE	GASCDEM	648.0	572.0	2,145.0					
432		Consumption in Power sector	KTOE	GASCPOW	0.0	0.0	0.0					
433		Domestic total	KTOE	GASCTOT	648.0	572.0	2,145.0					
434												
435	Jetfuel demand	Final demand	KTOE	JETCDEM	100.0	111.0	284.0					
436		Consumption in Power sector	KTOE	JETCPOW	0.0	0.0	0.0					
437		Domestic total	KTOE	JETCTOT	100.0	111.0	284.0					
438												
439	Kerosene demand	Final demand	KTOE	KERCDEM	212.0	218.0	409.0					
440		Consumption in Power sector	KTOE	KERCPOW	0.0	0.0	0.0					
441		Domestic total	KTOE	KERCTOT	212.0	218.0	409.0					
442												
443	Diesel demand	Final demand	KTOE	DIECDEM	1,087.0	1,033.0	3,709.0					
444		Consumption in Power sector	KTOE	DIECPOW	410.8	366.5	88.2					
445		Domestic total	KTOE	DIECTOT	1,497.8	1,399.5	3,797.2					
446												
447	Fuel oil demand	Final demand	KTOE	FULCDEM	282.0	324.0	1,546.0					
448		Consumption in Power sector	KTOE	FULCPOW	254.6	312.6	496.6					
449		Domestic total	KTOE	FULCTOT	536.6	636.6	2,042.6					
450												
451	NG & AG demand	Final demand	KTOE	NAGCDEM	0.0	9.0	19.0					
452		Consumption in Power sector	KTOE	NAGCPOW	0.0	0.0	620.6					
453		Domestic total	KTOE	NAGCTOT	0.0	9.0	639.6					
454												
455	Renewable & Other Energy	Final demand	KTOE	OTHCDEM	12,659.9	12,964.3	15,576.7					
456		Consumption in Power sector	KTOE	OTHCPOW	0.0	0.0	0.0					
457		Domestic total	KTOE	OTHCTOT	12,659.9	12,964.3	15,576.7					
458												
459	Energy Demand	Domestic final demand	KTOE	EGSCDFD	16,310.9	16,831.3	28,145.7					
460		Consumption in Power sector	KTOE	EGSCPOW	2,015.1	1,761.3	4,282.5					
461		Domestic Energy Demand	KTOE	EGSCTOT	18,326.0	18,592.7	32,428.1					
462												

(12) Power demand forecast in North region

The future power demand in whole country is shared to North, Center and South regions by regional GDP. The regional GDP and sector GDP are exogenous. Sectoral nominal GDP is calculated by the sectoral real GDP and GDP deflator. The shares of sectoral nominal GDP are calculated, and regional power demands are calculated by the sectoral nominal GDP shares.

Table 2-3-19 Power demand forecast in North region in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
465	<Northern region >											
466	(1) Census	Population	Million	NPOP	30.0	30.9	37.1	37.5				
467		G.R. of Population	G%	NPOPX		3.0	1.3	1.3	1.4	1.40	0.75	0.75
468												
469	(3) NGDP nominal	NGDP	Million Dong	NGNTL	15,537.9	28,878.3	193,991.3	218,826.5				
470		Industry	Million Dong	NGNIN	3,312.4	6,470.2	63,874.6	74,073.2				
471		Commercial	Million Dong	NGNCO	6,911.9	13,085.4	86,001.5	96,585.1				
472		Agriculture	Million Dong	NGNAG	5,313.7	9,120.7	44,315.2	48,268.2				
473												
474		Share of NGDP	%	NGNTLX	37.0	37.4	36.2	36.2				
475		Share of Industry	%	NGNINX	31.4	32.9	31.8	31.8				
476		Share of Commercial	%	NGNCOX	38.3	39.1	39.4	39.4				
477		Share of Agriculture	%	NGNAGX	39.8	38.7	37.9	37.9				
478												
479	(4) RGDP 1994 price	RGDP	Million Dong	NGRTL	48,874.0	52,201.0	113,422.0	121,464.0				
480		Industry	Million Dong	NGRIN	10,419.0	11,778.0	37,229.0	41,097.0				
481		Commercial	Million Dong	NGRCO	21,741.0	23,820.0	50,283.0	53,587.0				
482		Agriculture	Million Dong	NGRAG	16,714.0	16,803.0	25,910.0	26,780.0				
483												
484		G.R. of RGDP	%	NGRTLX		6.8	6.5	7.1	7.9	7.9	8.2	8.2
485		G.R. of Industry	%	NGRINX		13.0	12.1	10.4	11.5	11.5	8.8	8.8
486		G.R. of Commercial	%	NGRCOX		9.6	3.8	6.6	7.7	7.7	8.4	8.4
487		G.R. of Agriculture	%	NGRAGX		-0.7	4.1	3.4	2.3	2.3	2.1	2.1
488												
489		GDP E.V. to RGDP		NEVTLX		1.2	1.0	1.0	1.00	1.00	1.03	1.03
490		Industry E.V. to RGDP		NEVINX		2.2	1.9	1.4	1.46	1.46	1.11	1.11
491		Commercial E.V. to RGDP		NEVCOX		1.8	0.8	0.9	0.98	0.98	1.06	1.06
492		Agriculture E.V. to RGDP		NEVAGX		-0.1	0.8	0.5	0.29	0.29	0.30	0.30
493												
494	(5) Power demand in final u	N-total	GWh	NWDTOT	3,162.5	3,280.4	11,421.4	13,572.9				
495		Agriculture.Forestry.Fishery	GWh	NWDMAG	139.9	144.8	279.9	286.0				
496		Industry & Construction	GWh	NWDMIN	1,468.8	1,444.9	4,380.8	5,232.3				
497		Commercials & Services.	GWh	NWDMCO	31.1	33.0	365.4	401.4				
498		Office & Residentials	Gwh	NWDMRE	1,443.7	1,585.7	5,835.9	6,981.3				
499		Others	GWh	NWDMOT	79.2	82.0	559.4	671.9				
500												
501	(6) Power demand in final u	N-total	GWh	NADTOT	3,162.5	3,280.4	11,421.4	13,572.9				
502	Adjusted	Agriculture.Forestry.Fishery	GWh	NADMAG	139.9	144.8	279.9	286.0				
503		Industry & Construction	GWh	NADMIN	1,468.8	1,444.9	4,380.8	5,232.3				
504		Commercials & Services.	GWh	NADMCO	31.1	33.0	365.4	401.4				
505		Office & Residentials	GWh	NADMRE	1,443.7	1,585.7	5,835.9	6,981.3				
506		Others	GWh	NADMOT	79.2	82.0	559.4	671.9				
507												
508	(7) Load factor	LF	%	NLOADF			57.0	58.0	58.3	58.5	63.7	64.0
509		Peak demand	MW	NPMAX			2,880.0	3,221.0	3,494.0			
510												
511												

a. Census

Population in North region is calculated by the growth rate of the population in North region. The Growth rate is exogenous.

b. NGDP nominal

Nominal GDP is calculated by real GDP and GDP deflator. The sectoral nominal GDP are

consisted of Industry, Commercial and Agriculture sector. The sectoral GDP also are calculated by sectoral real GDP and GDP deflator. The share of the sectoral nominal GDP are calculated.

c. RGDP 1994 price

Real GDP and sectoral real GDP in North region are exogenous. The actual data are input and the growth rates of the real GDP are calculated. The growth rates of the real GDP are exogenous. The growth rates are referred to Social Economic Development Plan.

d. Power demand in final use

Power demand in final use in North region are input. The power demand is classified to Agriculture & Forestry & Fishery, Industry & Construction, Commercials & Services Office & Residential and Other sectors.

The power demand in Agriculture & Forestry & Fishery sector in North region is calculated by The following expression.

The power demand in Agriculture sector in North

= The power demand in Agriculture sector in the whole country

* Agriculture GDP share in North

The power demand in Industry & Construction sector in North region is calculated by the following expression.

The power demand in Industry & Construction sector in North

= The power demand in Industry & Construction sector in whole country

* Industry & Construction GDP share in North

The power demand in Commercial & Service sector in North region is calculated by the following expression.

The power demand in Commercial & Service sector in North

= The power demand in Commercial & Service sector in whole country

* Commercial & Service GDP share in North

The power demand in Industry & Construction sector in North region is calculated by the following expression.

The power demand in Office & Residential sector in North

= The power demand in Office & Residential sector in whole country

* GDP share in North

The power demand in Other sector in North region is calculated by The following expression.

The power demand in Other sector in North

= The power demand in Other sector in the whole country

* GDP share in North

(Other sector in North region included transportation demand.)

e. Power demand in final use Adjusted

When summing sectoral power demands by region, the total of the sectoral power demands do not meet to the power demand in sectoral forecasting. Therefore, the sector power demands by region have to be adjusted by the following expressions.

Power demand in Agriculture sector in North

= Power demand in Agriculture in North / Power demand in Agriculture in regional total

* power demand in Agriculture in sector forecasting

Power demand in Industry sector in North

= Power demand in Industry in North / Power demand in Industry in regional total

* power demand in Industry in sector forecasting

Power demand in Commercial sector in North

= Power demand in Commercial in North / Power demand in Commercial in regional total

* power demand in Commercial in sector forecasting

Power demand in Residential sector in North

= Power demand in Residential in North / Power demand in Residential in regional total

* power demand in Residential in sector forecasting

Power demand in Other sector in North

= Power demand in Other in North / Power demand in Other in regional total

* power demand in Other in sector forecasting

Agriculture means Agriculture & Forestry & Fishery

Industry means Industry & Construction

Commercial means Commercials & Services.

Residential means Office & Residential

(13) Power demand forecast in Center region

The future power demand is shared to North, Center and South regions by regional GDP. The regional GDP and sector GDP are exogenous. Sectoral nominal GDP are calculated by the sectoral real GDP and GDP deflator. The shares of sectoral nominal GDP are calculated and power demand are shared by the sectoral nominal GDP shares.

Table 2-3-20 Power demand forecast in Center region in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
512	<Central region >											
513	(1) Consus	Population	Milliom	CPOP	9,632.5	9,925.1	12,608.6	12,772.5				
514		G.R. of Population	G%	CPOPX		3.0	1.3	1.3	1.4	1.40	0.75	0.75
515												
516	(3) GDP nominal	NGDP	Million Dong	CGNTL	3,646.2	6,662.4	51,893.7	58,186.8				
517		Industry	Million Dong	CGNIN	628.5	1,131.6	13,202.2	15,358.2				
518		Commercial	Million Dong	CGNCO	1,467.2	2,697.3	20,197.5	22,685.0				
519		Agriculture	Million Dong	CGNAG	1,550.5	2,833.5	18,494.0	20,143.6				
520												
521		Share of NGDP	%	CGNTLX	8.7	8.7	9.7	9.8				
522		Share of Industry	%	CGNINX	6.0	5.8	6.8	6.8				
523		Share of Commercial	%	CGNCOX	8.1	8.1	9.2	9.2				
524		Share of Agriculture	%	CGNAGX	11.6	12.0	15.8	15.8				
525												
526	(4) RGDP 1994 price	RGDP	Million Dong	CGRTL	11,469.0	12,128.0	30,341.0	32,283.0				
527		Industry	Million Dong	CGRIN	1,977.0	2,060.0	7,719.0	8,521.0				
528		Commercial	Million Dong	CGRCO	4,615.0	4,910.0	11,809.0	12,586.0				
529		Agriculture	Million Dong	CGRAG	4,877.0	5,158.0	10,813.0	11,176.0				
530												
531		G.R. of RGDP	%	CGRTLX		5.7	6.8	6.4	8.2	8.2	9.3	9.3
532		G.R. of Industry	%	CGRINX		4.2	14.0	10.4	11.2	11.2	10.8	10.8
533		G.R. of Commercial	%	CGRCOX		6.4	4.5	6.6	8.0	8.0	9.5	9.5
534		G.R. of Agriculture	%	CGRAGX		5.8	4.6	3.4	5.7	5.7	3.8	3.8
535												
536		GDP E.V. to RGDP		CEVTLX		1.0	1.1	0.9	1.04	1.04	1.18	1.18
537		Industry E.V. to RGDP		CEVINX		0.7	2.2	1.4	1.42	1.42	1.39	1.39
538		Commercial E.V. to RGDP		CEVCOX		1.1	0.7	0.9	1.02	1.02	1.22	1.22
539		Agriculture E.V. to RGDP		CEVAGX		1.0	0.7	0.5	0.72	0.72	0.54	0.54
540												
541	(5) Power demand in final u	C-total	GWh	CWDTOT	434.2	469.1	3,095.0	3,512.3				
542		Agriculture.Forestry.Fishery	GWh	CWDMAG	11.4	12.4	85.8	73.5				
543		Industry & Construction	GWh	CWDMIN	178.4	187.2	1,058.3	1,250.2				
544		Commercials & Services.	GWh	CWDMCO	29.5	32.7	113.6	124.1				
545		Office & Residentials	Gwh	CWDMRE	206.5	228.9	1,636.4	1,867.8				
546		Others	GWh	CWDMOT	7.4	7.9	200.9	196.7				
547												
548	(6) Power demand in final u	C-total	GWh	CADTOT	434.2	469.1	3,095.0	3,512.3				
549	Adjusted	Agriculture.Forestry.Fishery	GWh	CADMAG	11.4	12.4	85.8	73.5				
550		Industry & Construction	GWh	CADMIN	178.4	187.2	1,058.3	1,250.2				
551		Commercials & Services.	GWh	CADMCO	29.5	32.7	113.6	124.1				
552		Office & Residentials	Gwh	CADMRE	206.5	228.9	1,636.4	1,867.8				
553		Others	GWh	CADMOT	7.4	7.9	200.9	196.7				
554												
555	(7) Load factor	LF	%	CLOADF			58.0	61.0	61.1	61.3	63.9	64.0
556		Peak demand	MW	CPMAX			684.0	773.0	853.0			
557												
558												

a. Census

Population in Center region is calculated by the growth rate of the population in Center region. The Growth rate is exogenous.

b. NGDP nominal

Nominal GDP is calculated by the variables of Real GDP and GDP deflator. The sectoral Nominal GDP is consisted of Industry, Commercial and Agriculture sector. The sectoral GDP

also is calculated by the variables of Sectoral Real GDP and GDP deflator. The shares of the sectoral nominal GDP are calculated.

c. RGDP 1994 price

Real GDP and sectoral real GDP in Center region are exogenous. The actual data are input and the growth rates of the actual real GDP are calculated. The growth rates of the future real GDP are exogenous. The growth rates are input after referring Social Economic Development Plan.

d. Power demand in final use

Power demand as final use in Center region are input, The power demand is classified to Agriculture & Forestry & Fishery, Industry & Construction, Commercials & Services Office & Residential and Other sector.

The power demand in Agriculture & Forestry & Fishery sector in Center region is calculated by the following expression.

The power demand in Agriculture sector in Center

= The power demand in Agriculture sector in the whole country

* Agriculture GDP share in Center

The power demand in Industry & Construction sector in Center region is calculated by the following expression.

The power demand in Industry & Construction sector in Center

= The power demand in Industry & Construction sector in the whole country

* Industry & Construction GDP share in Center

The power demand in Commercial & Service sector in Center region is calculated by the following expression.

The power demand in Commercial & Service sector in Center

= The power demand in Commercial & Service sector in the whole country

* Commercial & Service GDP share in Center

The power demand in Industry & Construction sector in Center region is calculated by the following expression.

The power demand in Office & Residential sector in Center

= The power demand in Office & Residential sector in the whole country

* GDP share in Center

The power demand in Other sector in Center region is calculated by the following expression.

The power demand in Other sector in Center

= The power demand in Other sector in the whole country

* GDP share in Center

e. Power demand in final use Adjusted

When summing sector power demands by region, the total of the sector power demands do not meet to the power demand in sector forecasting. Therefore, the sector power demands by region have to be adjusted by the following expressions.

Power demand in Agriculture sector in Center

= Power demand in Agriculture in Center / Power demand in Agriculture in regional total

* Power demand in Agriculture in whole country

Power demand in Industry sector in Center

= Power demand in Industry in Center / Power demand in Industry in regional total

* Power demand in Industry in whole country

Power demand in Commercial sector in Center

= Power demand in Commercial in Center / Power demand in Commercial in regional total

* Power demand in Commercial in whole country

Power demand in Residential sector in Center

= Power demand in Residential in Center / Power demand in Residential in regional total

* Power demand in Residential in whole country

Power demand in Other sector in Center

= Power demand in Other in Center / Power demand in Other in regional total

* Power demand in Other in whole country

(14) Power demand forecast in South region

The future power demand is shared to North, Center and South regions by regional GDP. The regional GDP and sectoral GDP are exogenous. Sectoral nominal GDP are calculated by the variables of the sectoral real GDP and GDP deflator. The shares of sectoral nominal GDP are calculated, and the power demands are shared by the shares of the sectoral nominal GDP.

Table 2-3-21 Power demand forecast in South region in Data sheet

F	H	I	J	TIME	1990	1991	2002	2003	2004	2005	2024	2025
559	<Southern region >											
560	(1) Census	Population	Milliom	SPOP	24.5	24.8	28.2	28.5				
561		Population share	S%	SPOPX		0.5	1.3	1.3	1.4	1.40	0.75	0.75
562												
563	(3) GDP nominal	NGDP	Million Dong	SGNTL	22,770.9	41,368.3	289,883.7	328,472.7				
564		Industry	Million Dong	SGNIN	8,620.8	12,055.3	123,374.4	143,523.2				
565		Commercial	Million Dong	SGNCO	9,660.9	17,691.1	112,332.4	126,157.1				
566		Agriculture	Million Dong	SGNAG	8,489.3	11,021.9	53,976.9	58,792.4				
567												
568		Share of NGDP	%	SGNTLX	54.3	53.9	54.1	54.2				
569		Share of Industry	%	SGNINX	62.7	61.3	61.6	61.6				
570		Share of Commercial	%	SGNCOX	53.6	52.9	51.4	51.4				
571		Share of Agriculture	%	SGNAGX	48.6	49.3	46.2	46.2				
572												
573	(4) RGDP 1994 price	RGDP	Million Dong	SGRTL	71,625.0	75,305.0	160,371.0	182,242.0				
574		Industry	Million Dong	SGRIN	20,825.0	21,945.0	72,134.0	79,629.0				
575		Commercial	Million Dong	SGRCO	30,388.0	32,204.0	65,678.0	69,994.0				
576		Agriculture	Million Dong	SGRAG	20,412.0	21,156.0	31,559.0	32,619.0				
577												
578		G.R. of RGDP	%	SGRTLX		5.1	7.5	7.8	7.7	7.7	7.8	7.8
579		G.R. of Industry	%	SGRINX		5.4	7.7	10.4	9.8	9.8	7.9	7.9
580		G.R. of Commercial	%	SGRCOX		6.0	9.1	6.6	7.3	7.3	8.0	8.0
581		G.R. of Agriculture	%	SGRAGX		3.6	3.9	3.4	3.9	3.9	2.1	2.1
582												
583		GDP E.V. to RGDP		SEVTLX		0.9	1.2	1.0	0.98	0.98	0.94	0.94
584		Industry E.V. to RGDP		SEVINX		0.9	1.2	1.4	1.24	1.24	0.99	0.99
585		Commercial E.V. to RGDP		SEVCOX		1.0	1.4	0.9	0.92	0.92	1.00	1.00
586		Agriculture E.V. to RGDP		SEVAGX		0.6	0.6	0.5	0.50	0.50	0.30	0.30
587												
588	(5) Power demand in final u	S-total	GWh	SWDTOT	2,588.7	2,824.3	15,142.3	17,775.3				
589		Agriculture.Forestry.Fishery	GWh	SWDMAG	38.5	36.2	115.3	153.3				
590		Industry & Construction	GWh	SWDMIN	1,227.6	1,448.1	7,215.2	8,827.2				
591		Commercials & Services.	GWh	SWDMCO	68.3	67.2	942.1	1,025.2				
592		Office & Residentials	Gwh	SWDMRE	1,127.8	1,142.9	6,221.4	6,977.7				
593		Others	GWh	SWDMOT	126.5	129.9	648.3	791.9				
594												
595	(6) Power demand in final u	S-total	GWh	SADTOT	2,588.7	2,824.3	15,142.3	17,775.3				
596	Adjusted	Agriculture.Forestry.Fishery	GWh	SADMAG	38.5	36.2	115.3	153.3				
597		Industry & Construction	GWh	SADMIN	1,227.6	1,448.1	7,215.2	8,827.2				
598		Commercials & Services.	GWh	SADMCO	68.3	67.2	942.1	1,025.2				
599		Office & Residentials	Gwh	SADMRE	1,127.8	1,142.9	6,221.4	6,977.7				
600		Others	GWh	SADMOT	126.5	129.9	648.3	791.9				
601												
602	(7) Load factor	LF	%	SLOADF			69.0	69.0	69.1	69.3	71.9	72.0
603		Peak demand	MW	SPMAX			3,112.0	3,529.0	4,073.0			
604												
605												

a. Census

Population in South region is calculated by the growth rate of the population in South region. The Growth rate is exogenous.

b. NGDP nominal

Nominal GDP is calculated by the variables of real GDP and GDP deflator. The sectoral Nominal GDP is consisted of Industry, Commercial and Agriculture sector. The sectoral GDP also are calculated by the variables of sectoral real GDP and GDP deflator. The shares of the

sectoral nominal GDP are calculated.

c. RGDP 1994 price

Real GDP and sectoral real GDP in South region are exogenous. The actual data are input and the growth rates of the real GDP are calculated. The growth rates of the real GDP are exogenous. The v growth rates are input after referring Social Economic Development Plan.

d. Power demand in final use

Power demand as final use in South region are input. The power demand is classified to Agriculture & Forestry & Fishery, Industry & Construction, Commercials & Services Office & Residential and Other sector.

The power demand in Agriculture & Forestry & Fishery sector in South region is calculated by the following expression.

The power demand in Agriculture sector in South

= The power demand in Agriculture sector in whole country

* Agriculture GDP share in South

The power demand in Industry & Construction sector in South region is calculated by the following expression.

The power demand in Industry & Construction sector in South

= The power demand in Industry & Construction sector in whole country

* Industry & Construction GDP share in South

The power demand in Commercial & Service sector in South region is calculated by the following expression.

The power demand in I Commercial & Service sector in South

= The power demand in Commercial & Service sector in whole country

* Commercial & Service GDP share in South

The power demand in Industry & Construction sector in South region is calculated by the following expression.

The power demand in Office & Residential sector in South

= The power demand in Office & Residential sector in whole country

* GDP share in South

The power demand in Other sector in South region is calculated by the following expression.

The power demand in Other sector in South

= The power demand in Other sector in whole country
* GDP share in South

e. Power demand in final use Adjusted

When summing sectoral power demands by region, the total of the sectoral power demands do not meet to the power demand in whole country. Therefore, the sectoral power demands by region have to be adjusted by the following expressions.

Power demand in Agriculture sector in South
= Power demand in Agriculture in South / Power demand in Agriculture in regional total
* power demand in Agriculture in whole country

Power demand in Industry sector in South
= Power demand in Industry in South / Power demand in Industry in regional total
* power demand in Industry in whole country

Power demand in Commercial sector in South
= Power demand in Commercial in South / Power demand in Commercial in regional total
* power demand in Commercial in whole country

Power demand in Residential sector in South
= Power demand in Residential in South / Power demand in Residential in regional total
* power demand in Residential in whole country

Power demand in Other sector in South
= Power demand in Other in South / Power demand in Other in regional total
* power demand in Other in whole country

2.4 Model sheet

Model sheet is created by SimpleE. The model structures consisted of definition equation and regression equations are set in the Model sheet.

"=" in Option type means Definition equation. Variable names in "Internal Y" are defined by the expressions in X1 area.

"$CA" in Option type means a regression equation. $CA is a command to keep the

continuation of the forecasting values and the latest actual values. Examples;

Variable name YY in Internal Y”

Variable name AA in X1 area, BB in X2 area

“YY= a*AA + b*BB +c” is defined as regression equation by “$CA”.

(“$CA” means “$CA $LS”, $LS is a command to make a regression analysis, it can be omitted, then $CA” and “$CA $LS” are same meaning.)

The variables are arranged in line with the data processing orders (model structure orders). Then calculation of the model is basically performed from the upper variables to below variables. It is possible that the upper variables are calculated by using the results of the below variables. Especially, if the model contains the simultaneous equations in the model structure, the SimpleE can solve the equations.

The Model sheet has the following model structures

Table 2-4-1 Model structure in Model sheet.

NO.	CONTENTS	Line numbers
1	Social forecasting	5～30
2	Economic forecasting	30～120
3	Coefficient& Energy prices	121～163
4	Power demand forecasting in Africulture.Forestry.Fishry sector	164～376
5	Power demand forecasting in Industry sector	
6	Power demand forecasting in Transportation sector	
7	Power demand forecasting in Commercial & Services sector	
8	Power demand forecasting in Residential	
9	Power demand forecasting in Other sector	
10	Power supply forecasting	377～422
11	Energy balance	423～462
12	Power demand in North region	
13	Power demand in Center region	
14	Power demand in South region	463～637

(1) Social indicator forecasting

Social indicators are forecasted by the following expressions.

Table 2-4-2 Social indicator forecasting in Model sheet

F	G	H	I	J	Y	Type	X1	X2	X3	X4	X5
5	IE data	Economic data	Exchange rate	Dn/US$	ECEXC	=	ECEXC				
6											
7	IE data	Population	Country number	Million per	POPNUM	=	Lag1.POPNUM*(1+POPNGR/100)				
8			Growth rate	G%	POPNGR	=	POPNGR				
9			Urban number	Million per	POPUBN	=	POPNUM*POPUGR/100				
10			Urban population share	S%	POPUGR	=	POPUGR				
11											
12	IE data	Household	County Number	Million HH	HHNUM	=	Lag1.HHNUM*(1+HHNGR/100)				
13			Growth rate	G%	HHNGR	=	POPNGR				
14			Urban number	Million HH	HHUBN	=	HHNUM*HHUGR/100				
15			Urban HH rate	S%	HHUGR	=	POPUGR				
16											
17	ADB	Labor number	Agriculture	Million per	LABAGR	=	POPNUM*LABSHP/100*LASAGR/100				
18	ADB		Manufacturing & Mining	Million per	LABMAN	=	POPNUM*LABSHP/100*LASMAN/100				
19	ADB		Services & Others	Million per	LABOTH	=	POPNUM*LABSHP/100*LASOTH/100				
20	ADB		Unemployed	Million per	LABUNE	=	POPNUM*LABSHP/100*LASUNE/100				
21			Total	Million per	LABTOT	=	LABAGR+LABMAN+LABOTH+LABUNE				
22											
23			Labor force share to Pop	%	LABSHP	$DL	POPNUM				
24											
25		Labor shares	Agriculture & Forestry	S%	LASAGR	=	100-LASMAN-LASOTH-LASUNE				
26			Manufacturing & Mining	S%	LASMAN	$CA	RGPMAN/RGDP	DUM2002Z	DUM2003T		
27			Services & Others	S%	LASOTH	$CA	(RGPTRA+RGPTRN+RGPSER)/F	DUM2002Z	DUM2003T		
28			Unemployed	S%	LASUNE	=	LASUNE				
29			Total	S%	LASTOT	=	100				
30											

a. Exchange rate

The exchange rates are exogenous.

b. Population

Population in whole country = Population in whole country(1)* (1+ GR of population)

The GR of population are exogenous.

(Population in whole country(1) means Population in whole country in the previous year)

Urban population = Population in whole country* Share of Urban population

Shares of Urban population are exogenous.

c. Household

Households in whole country = Households in whole country(1)*(1+GR of Households)

GR of Households is exogenous.

Household in urban = Households in whole country * Shares of Households in urban

GR of Households in urban are exogenous.

d. Labor number

Agriculture labor force = Population in whole country* Share of Labor force

* Share of Agriculture labor force

Manufacturing & Mining = Population in whole country* Share of Labor force

* Share of Manufacturing & Mining labor force

Services & Other labor force = Population in whole country* Share of Labor force

* Share of Services & Other labor force

Unemployed = Population in whole country* Share of Labor force * Share of Unemployed

e. Labor shares

Agriculture labor share = The total - Manufacturing - Services - Unemployed

Manufacturing labor share = f(Manufacturing GDP / real GDP)

Services & Others=f((Transportation+Services+Trade)/ real GDP)

Unemployed is exogenous.

(f(Manufacturing GDP / real GDP) means regression analysis.)

(2) Economic forecasting

In the economic forecasting block, the forecasting values required for energy and power demand forecasting are calculated. For setting the economic indicators and the growth rates from the Social Economic Development Plan as the preconditions of the model, the endogenous variables are calculated by using the economic indicators and the growth rates.

a. nGDP at current price

Nominal GDP = Real GDP * GDP deflator

b. uGDP on US $ base

GDP on US$ base = Nominal GDP / Exchange rate.

c. uGDP per capita on US$ base

GDP per capita on US$ base = GDP on US$ base / Population.

d. rGDP at 1994 price

Real GDP = Real GDP(1) * (1+ GR of real GDP)

GR of real GDP is exogenous.

(GDP(1) is GDP in the previous year)

e. GDP deflator 1994 price

GDP deflator 1994 price = GDP deflator 1994 price(1) * (1+ GR of GDP deflator)

GR of GDP deflator is exogenous.

Table 2-4-3 Economic forecasting block in Model sheet

F	G	H	I	J	Y	Type	X1	X2	X3
33	IE data	GDP	nGDP at current price	Billion Dn	GDNOM	=	RGDP*GDFLT/100		
34			Growth rate	G%	GDNGR	=	(GDNOM/Lag1.GDNOM-1)*100		
35									
36			uGDP on US $ base	Million US$	GDDOL	=	GDNOM/ECEXC*1000		
37			Growth rate	G%	GDDGR	=	(GDDOL/Lag1.GDDOL-1)*100		
38									
39			uGDP per capita on US$ base	US$ per capita	GDPDOL	=	GDDOL/POPNUM		
40			Growth rate	C%	GDPDGR	=	(GDPDOL/Lag1.GDPDOL-1)*100		
41									
42			rGDP at 1994 price	Billion Dn	RGDP	=	Lag1.RGDP*(1+RGDPGR/100)		
43	IE data		Growth rate	G%	RGDPGR	=	RGDPGR		
44									
45	ADB		GDP deflator 1994 price	1994=100	GDFLT	=	Lag1.GDFLT*(1+GDFGR/100)		
46			Growth rate	C%	GDFGR	=	GDFGR		
47									
48	ADB		rGross Domestic Savings	Billion Dn	GDSAV	=	GDSHA*RGDP/100		
49			Share to GDP	%	GDSHA	=	GDSHA		
50			Elasticity to Private Con		GDEVPC	=	GDEVPC		
51									
52			rLabor productivity in Manuf	1000 Dn /perso	LAPMAN	=	(RGDP)/(LABAGR+LABMAN+LABOTH)		
53			Growth rate	G%	LAPMGR	=	(LAPMAN/Lag1.LAPMAN-1)*100		
54									
55									
56	IE data	nGDE at the current p	Final consumption	Billion Dn	NGEFC	=	RGEFC*GDFLT/100		
57	IE data		Gross fixed capital formatio	Billion Dn	NGEGF	=	RGEGF*GDFLT/100		
58	IE data		Exports of goods and service	Billion Dn	NGEEX	=	RGEEX*GDFLT/100		
59	IE data		Import of goods and services	Billion Dn	NGEIM	=	RGEIM*GDFLT/100		
60	IE data		Statistical discrepancy	Billion Dn	NGESD	=	RGESD*GDFLT/100		
61			Total	Billion Dn	NGETOT	=	NGEFC+NGEGF+NGEEX-NGEIM+NGESD		
62									
63		rGDE at 1994 price	Final consumption	Billion Dn	RGEFC	$CA	RGDP/POPNUM*1000	LABMAN+LABOTH	
64			Gross fixed capital formatio	Billion Dn	RGEGF	$CA	GDSAV+0.4*(Lag1.RGEEX-Lag1.RGEIM)		
65			Exports of goods and service	Billion Dn	RGEEX	=	RGDP-RGEFC-RGEGF+RGEIM-RGESD		
66			Import of goods and services	Billion Dn	RGEIM	$CA	RGDP		
67			Statistical discrepancy	Billion Dn	RGESD	=	0.9*Lag1.RGESD		
68			Total	Billion Dn	RGETOT	=	RGEFC+RGEGF+RGEEX-RGEIM+RGESD		
69									
70		Shares of rGDE	Final consumption	%	RREFC	=	RGEFC/RGETOT*100		
71			Gross fixed capital formatio	%	RREGF	=	RGEGF/RGETOT*100		
72			Exports of goods and service	%	RREEX	=	RGEEX/RGETOT*100		
73			Import of goods and services	%	RREIM	=	RGEIM/RGETOT*100		
74			Statistical discrepancy	%	RRESD	=	RGESD/RGETOT*100		
75			Total	%	RRETOT	=	RGETOT/RGETOT*100		
76									
77	IE data	nGDP at the current p	Agriculture & Forestry	Billion Dn	NGPAGR	=	RGPAGR*GDFLT/100		
78	IE data		Manufacturing & Mining	Billion Dn	NGPMAN	=	RGPMAN*GDFLT/100		
79	IE data		Commercial & Trade	Billion Dn	NGPTRA	=	RGPTRA*GDFLT/100		
80	IE data		Transport and communications	Billion Dn	NGPTRN	=	RGPTRN*GDFLT/100		
81	IE data		Service & Others	Billion Dn	NGPSER	=	RGPSER*GDFLT/100		
82			Total	Billion Dn	NGPTOT	=	RGPTOT*GDFLT/100		
83									
84		rGDP at 1994 price	Agriculture & Forestry	Billion Dn	RGPAGR	=	WRKAGR/WRKTOT*RGDP		
85			Manufacturing & Mining	Billion Dn	RGPMAN	=	WRKMAN/WRKTOT*RGDP		
86			Commercial & Trade	Billion Dn	RGPTRA	=	WRKTRA/WRKTOT*RGDP		
87			Transport and communications	Billion Dn	RGPTRN	=	WRKTRN/WRKTOT*RGDP		
88			Service & Others	Billion Dn	RGPSER	=	WRKSER/WRKTOT*RGDP		
89			Total	Billion Dn	RGPTOT	=	WRKTOT/WRKTOT*RGDP		
90									
91		Shares of rGDP	Agriculture & Forestry	S%	SHPAGR	=	RGPAGR/RGPTOT*100		
92			Manufacturing & Mining	S%	SHPMAN	=	RGPMAN/RGPTOT*100		
93			Commercial & Trade	S%	SHPTRA	=	RGPTRA/RGPTOT*100		
94			Transport and communications	S%	SHPTRN	=	RGPTRN/RGPTOT*100		
95			Service & Others	S%	SHPSER	=	RGPSER/RGPTOT*100		
96			Total	S%	SHPTOT	=	RGPTOT/RGPTOT*100		
97									
98		Sector growth rate in	Agriculture & Forestry		RRPAGR	=	RRPAGR		
99			Manufacturing & Mining		RRPMAN	=	RRPMAN		
100			Commercial & Trade		RRPTRA	=	RRPTRA		
101			Transport and communications		RRPTRN	=	RRPTRN		
102			Service & Others		RRPSER	=	RRPSER		
103			Total		RRPTOT	=	RRPTOT		
104									
105		Elasticity	Agriculture & Forestry		ELAAGR	=	RRPAGR/RGDPGR		
106			Manufacturing & Mining		ELAMAN	=	RRPMAN/RGDPGR		
107			Commercial & Trade		ELATRA	=	RRPTRA/RGDPGR		
108			Transport and communications		ELATRN	=	RRPTRN/RGDPGR		
109			Service & Others		ELASER	=	RRPSER/RGDPGR		
110			Total		ELATOT	=	RRPTOT/RGDPGR		
111									
112									
113		rGDP by Elasticity	Agriculture & Forestry		WRKAGR	=	Lag1.RGPAGR*(1+ELAAGR*RGDPGR/100)		
114			Manufacturing & Mining		WRKMAN	=	Lag1.RGPMAN*(1+ELAMAN*RGDPGR/100)		
115			Commercial & Trade		WRKTRA	=	Lag1.RGPTRA*(1+ELATRA*RGDPGR/100)		
116			Transport and communications		WRKTRN	=	Lag1.RGPTRN*(1+ELATRN*RGDPGR/100)		
117			Service & Others		WRKSER	=	Lag1.RGPSER*(1+ELASER*RGDPGR/100)		
118			Total		WRKTOT	=	WRKAGR+WRKMAN+WRKTRA+WRKTRN+WRKSER		
119									

f. rGross Domestic Savings

rGross Domestic Saving = Real GDP * Shares of rGross Domestic Saving

Shares of rGross Domestic Saving is exogenous.

g. rLabor productivity in Manufacturing at 1994 price

rLabor productivity in Manufacturing

= Real GDP / (Agriculture labor force + Manufacturing labor force + Other labor force)

GR of rLabor productivity in Manufacturing

=. rLabor productivity in Manufacturing /. rLabor productivity in Manufacturing(1) -1

h. nGDE at the current price

Final consumption = Real Final consumption * GDP deflator

Gross fixed capital formation = Real Gross fixed capital formation * GDP deflator

Exports = Exports * GDP deflator

Import = Import * GDP deflator

Statistical discrepancy = Statistical discrepancy* GDP deflator

Nominal GDE= Final consumption +Gross fixed capital formation

+ Exports - Import + Statistical discrepancy

i. rGDE at 1994 price

Real Final consumption = f(Real GDP / Population, Manufacturing and Other labor force)

Real Gross fixed capital formation =f(Saving + 0.4*(Export(1)- Import(1))

Real Exports = Real GDP- Real Final consumption

– Real Gross fixed capital formation + Real Import

Real Import = f(Real GDP)

Real Statistical discrepancy = 0.9* Real Statistical discrepancy(1)

j. Shares of rGDP

Share of Real Final consumption = Real final consumption / Real GDP

Share of Real Gross fixed capital formation = Real Gross fixed capital formation / Real GDP

Share of Real Exports = Exports / Real GDP

Share of Real Import = Import / Real GDP

Share of Real Statistical discrepancy = Real Statistical discrepancy / Real GDP

k. nGDP at the current price

Nominal GDP of Agriculture & Forestry

= Real GDP of Agriculture & Forestry * GDP deflator

Nominal GDP of Manufacturing & Mining

= Real GDP of Manufacturing & Mining * GDP deflator

Nominal GDP of Commercial & Trade

= Real GDP of Commercial & Trade * GDP deflator

Nominal GDP of Transport and communications

= Real GDP of C Transport and communications * GDP deflator

Nominal GDP of Service & Others

= Real GDP of C T Service & Others * GDP deflator

Nominal GDP is the summation of the above items.

l. rGDP at 1994 price

Real GDP of Agriculture & Forestry = Real GDP of Agriculture & Forestry in work area / Real GDP in work area * Real GDP

Real GDP of Manufacturing & Mining = Real GDP of Manufacturing & Mining in work area / Real GDP in work area * Real GDP

Real GDP of Transport & Communication= Real GDP of Transport & Communication in work area / Real GDP in work area * Real GDP

Real GDP of Service & Others = Real GDP of Service & Others in work area / Real GDP in work area * Real GDP

Real GDP is the summation of the above items.

(Sector GDP in work area are calculated in the below.)

m. Shares of rGDP

The share of Agriculture & Forestry = Real GDP of Agriculture & Forestry / Real GDP

The share of Manufacturing & Mining = Real GDP of Manufacturing & Mining / Real GDP

The share of Commercial & Trade = Real GDP of Commercial & Trade / Real GDP

The share of Transport & Communication

= Real GDP of Transport & communication / Real GDP

The share of Service & Others = Real GDP of Service & Others / Real GDP

n. Sector average growth rate in 5 years

GR of Agriculture & Forestry is exogenous.

GR of Manufacturing & Mining is exogenous.

GR of Commercial & Trade is exogenous.

GR of Transport & Communication is exogenous.

GR of Service & Others is exogenous

o. Elasticity

Elasticity of Agriculture & Forestry = GR of Agriculture & Forestry / GR of Real GDP

Elasticity of Manufacturing & Mining = GR of Manufacturing & Mining / GR of Real GDP

Elasticity of Commercial & Trade = GR of Commercial & Trade / GR of Real GDP

Elasticity of Transport & Communication = GR of Transport & Communication / GR of Real GDP

Elasticity of Service & Others = GR of Service & Others / GR of Real GDP

P. rGDP by Elasticity

Real GDP of Agriculture & Forestry in work area

= Real GDP of Agriculture & Forestry in work(1)

(1+ Elasticity of Agriculture & Forestry * GR of Real GDP)

Real GDP of Manufacturing & Mining in work area

= Real GDP of Manufacturing & Mining in work(1)

(1+ Elasticity of Manufacturing & Mining * GR of Real GDP)

Real GDP of Commercial & Trade in work area

= Real GDP of Commercial & Trade in work(1)

(1+ Elasticity of Commercial & Trade * GR of Real GDP)

Real GDP of Transport & Communication in work area

= Real GDP of Transport and Communication in work(1)

(1+ Elasticity of Transport and Communication * GR of Real GDP)

Real GDP of Service & Others in work area

= Real GDP of Service & Others in work(1)

(1+ Elasticity of Service & Others * GR of Real GDP

Real GDP in work area is the summation of the above items.

(3) Coefficient and Energy prices

In the block, energy conversion factors, power efficiencies, energy prices and power tariffs that are needed for energy forecasting are calculated.

Table 2-4-4 Coefficient and Energy prices table in Model sheet

F	G	H	I	J	Y	Type	X1	X2	X3	X4	X5
122	IE data	Conversion factor to	Standard Oil(10000Kcal/kg)	10000	COFASCO	=	COFASCO				
123	IE data		Coal(5600Kcal/kg)	5600	COFACOA	=	COFACOA				
124	IE data		Gasoline(10500Kcal/kg)	10500	COFAGAS	=	COFAGAS				
125	IE data		Kerosene (10320Kcal/kg)	10320	COFAKER	=	COFAKER				
126	IE data		Diesel (10150Kcal/kg)	10150	COFADIE	=	COFADIE				
127	IE data		Petroluem Products	11500	COFAPET	=	COFAPET				
128	IE data		Fuel oil (9910Kcal/Kg)	9910	COFAFUE	=	COFAFUE				
129	IE data		Natural gas (9000Kcal/m3)	9000	COFANAG	=	COFANAG				
130	IE data		Renewable energy (3302Kcal/K	3302	COFAREW	=	COFAREW				
131	IE data		Electricity (860Kcal/KWh)	860	COFAELE	=	COFAELE				
132											
133	IE data	Power efficiency	Power from Thermal(Coal)		COPOCOA	=	COPOCOA				
134	IE data		Power from Thermal(FO)		COPOFOT	=	COPOFOT				
135	IE data		Power from Gasturbine(FO)		COPOFOB	=	COPOFOB				
136	IE data		Power from Gasturbine(GAS)		COPOGAB	=	COPOGAB				
137	IE data		Power from Gas steam		COPODAS	=	COPODAS				
138	IE data		Power from Diesel		COPODIE	=	COPODIE				
139											
140	IEEJ	Energy price	WTI crude oil price	US$/bbl	EPRCWTI	=	EPRCWTI				
141	IE data		Crude oil Price in Vietnam	1000Dn/bbl	EPRORD	=	EPRCWTI*ECEXC/1000				
142	IE data		NG price in Vietnam	$/MMBTU	EPRNG	=	Lag1.EPRNG*1.02*IF(EPRCWTI/Lag1.EPRCWTI>1.02,(1+EPRCWTI/Lag1.EPRCWTI-1.0				
143	IE data		Gasoline price in Vietnam	Dong/kg	EPRGAS	=	LAg1.EPRGAS*(1+0.70*(GRPRCRD/100)+0.30*(LAPMGR/100))				
144	IE data		Kerosene price in vietnam	Dong/kg	EPRKER	=	LAg1.EPRKER*(1+0.70*(GRPRCRD/100)+0.30*(LAPMGR/100))				
145	IE data		Diesel price in Vietnam	Dong/kg	EPRDIE	=	LAg1.EPRDIE*(1+0.70*(GRPRCRD/100)+0.30*(LAPMGR/100))				
146	IE data		Fuel oil price in Vietnam	Dong/kg	EPRFO	=	LAg1.EPRFO*(1+0.70*(GRPRCRD/100)+0.30*(LAPMGR/100))				
147	IE data		Electricity for Agriculture	Dn/KWh	EPRELA	=	Lag1.EPRELA*(1+0.60*GRPRFO/100+0.40*LAPMGR/100)				
148	IE data		Electricity for Residential	Dn/KWh	EPRELR	=	Lag1.EPRELR*(1+0.60*GRPRFO/100+0.40*LAPMGR/101)				
149	IE data		Electricity for Industry use	Dn/KWh	EPRELI	=	Lag1.EPRELI*(1+0.60*GRPRFO/100+0.40*LAPMGR/102)				
150	IE data		Electricity for Commercial u	Dn/KWh	EPRELC	=	Lag1.EPRELC*(1+0.60*GRPRFO/100+0.40*LAPMGR/103)				
151											
152		G.R of Eneergy prices	WTI crude oil price	%	GRPRWTI	=	IF(Lag1.EPRCWTI>0,(EPRCWTI/Lag1.EPRCWTI-1)*100,0)				
153			Crude oil Price in Vietnam	%	GRPRORD	=	IF(Lag1.EPRCRD>0,(EPRCRD/Lag1.EPRCRD-1)*100,0)				
154			NG price in Vietnam	%	GRPRNG	=	IF(Lag1.EPRNG>0,(EPRNG/Lag1.EPRNG-1)*100,0)				
155			Gasoline price in Vietnam	%	GRPRGAS	=	IF(Lag1.EPRGAS>0,(EPRGAS/Lag1.EPRGAS-1)*100,0)				
156			Kerosene price in vietnam	%	GRPRKER	=	IF(Lag1.EPRKER>0,(EPRKER/Lag1.EPRKER-1)*100,0)				
157			Diesel price in Vietnam	%	GRPRDIE	=	IF(Lag1.EPRDIE>0,(EPRDIE/Lag1.EPRDIE-1)*100,0)				
158			Fuel oil price in Vietnam	%	GRPRFO	=	IF(Lag1.EPRFO>0,(EPRFO/Lag1.EPRFO-1)*100,0)				
159			Electricity for Agriculture	%	GRPRAGR	=	IF(Lag1.EPRELA>0,(EPRELA/Lag1.EPRELA-1)*100,0)				
160			Electricity for Residential	%	GRPRELR	=	IF(Lag1.EPRELR>0,(EPRELR/Lag1.EPRELR-1)*100,0)				
161			Electricity for Industry use	%	GRPRELI	=	IF(Lag1.EPRELI>0,(EPRELI/Lag1.EPRELI-1)*100,0)				
162			Electricity for Commercial u	%	GRPRELC	=	IF(Lag1.EPRELC>0,(EPRELC/Lag1.EPRELC-1)*100,0)				
163											

a. Conversion factor to KTOE

Physical energy units such as kg, m3 and kWh are converted to KTOE. The factors are exogenous.

Table 2-4-5 Conversion factor table in Model sheet

Energies	KTOE	Exogenous value
Standard Oil	1000t=1KTOE	1.000
Coal	1000t=0.56KTOE	0.560
Gasoline	1000t=1.05KTOE	1.05
Kerosene	1000t=1.032KTOE	1.032
Diesel	1000t=1.015KTOE	1.015
Fuel oil	1000t=0.991KTOE	0.991
Natural gas	Million m3=0.9KTOE	0.900
Renewable energy	1000t=0.3300KTOE	0.330
Electricity	1GWh=0.086KTOE	0.086

b. Power efficiency

Thermal power efficiencies are given by thermal power generation types such as coal fired power generator, fuel oil fired power generator, fuel oil gas turbine, gas turbine, gas steam and diesel. The efficiencies are used at time of calculating the energies used in the generators.

Table 2-4-5 Power efficiency table in Model sheet

Thermal power generator	Fuels	Efficiency	Expressions
Power from Thermal(Coal)	Coal	35%	2.28(GWh/1000t)=5600*0.35/860
Power from Thermal(FO)	Fuel oil	35%	4.03(GWh/1000t)=9910*0.35/860
Power from Gas-turbine(FO)	Fuel oil	48%	5.53(GWh/1000t)=9910*0.48/860
Power from Gas-turbine(GAS)	NG	48%	5.02(GWh/1000t)=9000*0.48/860
Power from Gas steam	NG	40%	4.19(GWh/Mil m3)=9000*0.40/860
Power from Diesel	Diesel	36%	4.25(GWh/1000t)=10,150*0.36/860

c. Energy price

WTI crude oil price is exogenous.

Crude oil price in Vietnam = WTI crude oil price is exogenous * Exchange rate / 1000

NG price in Vietnam

GR of WTI crude oil price > 2%,

NG price in Vietnam= NG price in Vietnam(1)*(1+ GR of WTI crude oil price)

GR of WTI crude oil price <= 2%,

NG price in Vietnam= NG price in Vietnam(1)*1.02

Gasoline price in Vietnam

= Gasoline price in Vietnam(1)*((1+0.7*GR of Crude oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

Kerosene price in Vietnam

= Kerosene price in Vietnam(1) *((1+0.7*GR of Crude oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

Diesel price in Vietnam

=Diesel price in Vietnam(1) *((1+0.7*GR of Crude oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

Fuel oil price in Vietnam

=Fuel oil price in Vietnam(1) *((1+0.7*GR of Crude oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

Electricity for Agriculture use

=Electricity for Agriculture use(1) *((1+0.6*GR of Fuel oil price in Vietnam)

+ 0.3 *GR of Labor productivity))

Electricity for Residential use

=Electricity for Residential use(1) *((1+0.6*GR of Fuel oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

Electricity for Industry use

=Electricity for Industry use (1) *((1+0.6*GR of Fuel oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

Electricity for Commercial use

=Electricity for Commercial use (1)*((1+0.6*GR of Fuel oil price in Vietnam)
+ 0.3 *GR of Labor productivity))

d. Growth rate of Energy prices

The annual growth rate of the energy prices are calculated for energy demand forecasting, especially those have the relation to energy conservation indices.

(4) Power demand forecasting in Agriculture & Forestry & Fishery sector

Table 2-4-6 Power demand forecasting in Agriculture sector in Model sheet

164	Agriculture.Forestry.A	Energy conservation rate	%	PAENCOR	=	Lag1.PAENCOR*(1+PAENTEC/100)*IF(GRPRFO>0, (1+PAENEVP*GRPRFO/100), (1+(PA					
165		Technical Improvement	%	PAENTEC	=	PAENTEC					
166		Elasticity to Energy price		PAENEVP	=	PAENEVP					
167		Energy intensity to GDP	TOE/Bil Don 1994	PAENEFF	=	PAENDEA/RGDP*1000					
168		Energy demand before E.save	KTOE	PAENDEM	$CA	RGPAGR	DUM1994Z				
169		Energy demand after E.save	KTOE	PAENDEA	=	PAENDEM*PAENCOR/100					
170		Electricity ratio	%	PAENELR	=	PAENELR					
171		Power demand (kTOE)	KTOE	PAENELT	=	PAENDEA*PAENELR/100					
172		Power demand (GWh)	GWh	PAENELE	=	PAENELT/0.086					
173											
174		Coal demand	KTOE	PADMCOA	=	PADMTOT*PASMCOA/100					
175		LPG demand	KTOE	PADMLPG	=	PADMTOT*PASMLPG/100					
176		Gasoline demand	KTOE	PADMGAS	=	PADMTOT*PASMGAS/100					
177		Jetfuel demand	KTOE	PADMJET	=	PADMTOT*PASMJET/100					
178		Kerosene demand	KTOE	PADMKER	=	PADMTOT*PASMKER/100					
179		Diesel demand	KTOE	PADMDIE	=	PADMTOT*PASMDIE/100					
180		Fuel oil demand	KTOE	PADMFUL	=	PADMTOT*PASMFUL/100					
181		Natural gas demand	KTOE	PADMNG	=	PADMTOT*PASMNG/100					
182		Renewable energy demand	KTOE	PADMREW	=	PADMTOT*PASMREW/100					
183		Total	KTOE	PADMTOT	=	PAENDEA-PAENELT					
184											
185		Coal demand	%	PASMCOA	=	PASMCOA					
186		LPG demand	%	PASMLPG	=	PASMLPG					
187		Gasoline demand	%	PASMGAS	=	PASMGAS					
188		Jetfuel demand	%	PASMJET	=	PASMJET					
189		Kerosene demand	%	PASMKER	=	PASMKER					
190		Diesel demand	%	PASMDIE	=	PASMDIE					
191		Fuel oil demand	%	PASMFUL	=	PASMFUL					
192		Natural gas demand	%	PASMNG	=	PASMNG					
193		Renewable energy demand	%	PASMREW	=	PASMREW					
194		Total	%	PASMTOT	=	PASMTOT					
195											

a. Energy conservation rate

Energy conservation rate in the sector

GR of fuel oil price >0

= Energy conservation rate in the sector (1)*(1+Technical improvement in the sector)

*(1+ Elasticity of energy price in the sector * GR of fuel oil price)

GR of fuel oil price < 0

= Energy conservation rate in the sector (1)*(1+Technical improvement in the sector)

*(1+ Elasticity of energy price in the sector /2 * GR of fuel oil price)

b. Technical Improvement

Technical Improvement in the sector is exogenous.

c. Elasticity to Energy price

Technical Improvement in the sector is exogenous.

d. Energy intensity to GDP

Energy intensity to GDP in the sector = Energy demand in the sector / Real GDP

e. Energy demand before Energy saving

. Energy demand before Energy saving in the sector = f (Agriculture GDP)

f. Energy demand after energy saving

Energy demand after energy saving in the sector

=Energy demand before Energy saving in the sector* Energy conservation rate in the sector

g. Electricity ratio

Electricity ratio is exogenous.

h. Power demand（k TOE）

Power demand in the sector = Energy demand after energy saving in the sector * Power ratio.

i. Power demand（GWh）

Power demand with (GWh)= Energy demand (kTOE)* 0.086.

j. Fossil energy demand

Coal demand = Total fossil energy demand * Coal demand share

LPG demand= Total fossil energy demand * LPG demand share

Gasoline demand= Total fossil energy demand * Gasoline demand share

Jet-fuel demand= Total fossil energy demand * Jet-fuel demand share

Kerosene demand= Total fossil energy demand * Kerosene demand share

Diesel demand= Total fossil energy demand * Diesel demand share

Fuel oil demand= Total fossil energy demand *Fuel oil demand share

Natural gas demand =Total fossil energy demand * Natural gas demand share

Renewable energy demand= Total fossil energy demand * Renewable energy demand share

Total fossil energy demand = Energy demand in agriculture – Power demand

k. **Fossil energy demand ratio**

Coal demand ratio is exogenous.

LPG demand ratio is exogenous

Gasoline demand ratio is exogenous

Jetfuel d demand ratio is exogenous

Kerosene demand ratio is exogenous

Diesel demand ratio is exogenous

Fuel oil demand ratio is exogenous

Natural gas demand ratio is exogenous

Renewable energy demand ratio is exogenous

(5) Power demand forecasting in Industry sector

Table 2-4-7 Power demand forecasting in Industry sector in Model sheet

196	Industry	Energy conservation rate	S%	MANNCOR	=	Lag1.MANNCOR*(1+MANNTEC/100)^IF(GRPRFO>0, (1+MANNEVP*GRPRFO/100), (1+(
197		Technical Improvement	%	MANNTEC	=	MANNTEC
198		Elasticity to Energy price		MANNEVP	=	MANNEVP
199		Energy intensity to GDP	TOE/Bil Don	MANNEFF	=	MANNDEA/RGDP*1000
200		Energy demand before E.save	KTOE	MANNDEM	$CA	RGPMAN
201		Energy demand after E.save	KTOE	MANNDEA	=	MANNDEM*(MANNCOR/100)
202		Electricity ratio	S%	MANNELR	=	MANNELR
203		Power demand (kTOE)	KTOE	MANNELT	=	MANNDEA*MANNELR/100
204		Power demand (GWh)	GWh	MANNELE	=	MANNELT/0.086
205						
206		Coal demand	KTOE	MANMCOA	=	MANMTOT*MASMCOA/100
207		LPG demand	KTOE	MANMLPG	=	MANMTOT*MASMLPG/100
208		Gasoline demand	KTOE	MANMGAS	=	MANMTOT*MASMGAS/100
209		Jetfuel demand	KTOE	MANMJET	=	MANMTOT*MASMJET/100
210		Kerosene demand	KTOE	MANMKER	=	MANMTOT*MASMKER/100
211		Diesel demand	KTOE	MANMDIE	=	MANMTOT*MASMDIE/100
212		Fuel oil demand	KTOE	MANMFUL	=	MANMTOT*MASMFUL/100
213		Natural gas demand	KTOE	MANMNG	=	MANMTOT*MASMNG/100
214		Renewable energy demand	KTOE	MANMREW	=	MANMTOT*MASMREW/100
215		Total	KTOE	MANMTOT	=	MANNDEA-MANNELT
216						
217		Coal demand	S%	MASMCOA	=	MASMCOA
218		LPG demand	S%	MASMLPG	=	MASMLPG
219		Gasoline demand	S%	MASMGAS	=	MASMGAS
220		Jetfuel demand	S%	MASMJET	=	MASMJET
221		Kerosene demand	S%	MASMKER	=	MASMKER
222		Diesel demand	S%	MASMDIE	=	MASMDIE
223		Fuel oil demand	S%	MASMFUL	=	MASMFUL
224		Natural gas demand	S%	MASMNG	=	MASMNG
225		Renewable energy demand	S%	MASMREW	=	MASMREW
226		Total	S%	MASMTOT	=	MASMTOT
227						

a. Energy conservation rate

Energy conservation rate in the sector

GR of fuel oil price >0

= Energy conservation rate (1)*(1+Technical improvement)

*(1+ Elasticity of energy price * GR of fuel oil price)

GR of fuel oil price < 0

= Energy conservation rate (1)*(1+Technical improvement)

*(1+ Elasticity of energy price /2 * GR of fuel oil price)

b. Technical Improvement

Technical Improvement is exogenous.

c. Elasticity to Energy price

Technical Improvement is exogenous.

d. Energy intensity to GDP

Energy intensity to GDP = Energy demand in Industry / Real GDP

e. Energy demand before Energy saving

. Energy demand before Energy saving = f (Industry GDP)

f. Energy demand after energy saving

Energy demand after energy saving =Energy demand before Energy saving

* Energy conservation rate

g. Electricity ratio

Electricity ratio is exogenous.

h. Power demand（k TOE）

Power demand (kTOE)= Energy demand after energy saving * Power ratio.

i. Power demand（GWh）

Power demand with (GWh) = Energy demand f(kTOE) * 0.086.

j. Fossil energy demand

Coal demand = Total fossil energy demand * Coal demand share

LPG demand= Total fossil energy demand * LPG demand share

Gasoline demand= Total fossil energy demand * Gasoline demand share

Jet-fuel demand= Total fossil energy demand * Jet-fuel demand share

Kerosene demand= Total fossil energy demand * Kerosene demand share

Diesel demand= Total fossil energy demand * Diesel demand share

Fuel oil demand= Total fossil energy demand *Fuel oil demand share

Natural gas demand =Total fossil energy demand * Natural gas demand share

Renewable energy demand= Total fossil energy demand * Renewable energy demand share

Total fossil energy demand = Energy demand in Industry – Power demand

k. Fossil energy demand ratio

Coal demand ratio is exogenous.

LPG demand ratio is exogenous

Gasoline demand ratio is exogenous

Jet-fuel d demand ratio is exogenous

Kerosene demand ratio is exogenous

Diesel demand ratio is exogenous

Fuel oil demand ratio is exogenous

Natural gas demand ratio is exogenous

Renewable energy demand ratio is exogenous

(6) Power demand forecasting in Transportation sector

Table 2-4-8 Power demand forecasting in Transportation sector in Model sheet

F	H	I	J	Y	Type	X1	X2	X3	X4	X5
228	Transportation	Energy conservation rate	S%	TRENCOR	=	Lag1.TRENCOR*(1+TRENTEC/100)*IF(GRPRFO>0, (1+TRENEVP*GRPRFO/100), (1+(TF				
229		Technical Improvement	%	TRENTEC	=	TRENTEC				
230		Elasticity to Energy price		TRENEVP	=	TRENEVP				
231		Energy intensity to GDP	TOE/Bil Don	TRENEFF	=	TRENDEA/RGDP*1000				
232		Energy demand before E.save	KTOE	TRENDEM	$CA	Lag1.TRENDEM*(1+2*(RGPTRN/Lag1.RGF	DUM2003T	DUM2002Z		
233		Energy demand after E.save	KTOE	TRENDEA	=	TRENDEM*(TRENCOR/100)				
234		Electricity ratio	S%	TRENELR	=	TRENELR				
235		Power demand (kTOE)	KTOE	TRENELT	=	TRENDEA*TRENELR/100				
236		Power demand (GWh)	GWh	TREENELE	=	TRENELT/0.086				
237										
238		Coal demand	KTOE	TREMCOA	=	TREMTOT*TRSMCOA/100				
239		LPG demand	KTOE	TREMLPG	=	TREMTOT*TRSMLPG/100				
240		Gasoline demand	KTOE	TREMGAS	=	TREMTOT*TRSMGAS/100				
241		Jetfuel demand	KTOE	TREMJET	=	TREMTOT*TRSMJET/100				
242		Kerosene demand	KTOE	TREMKER	=	TREMTOT*TRSMKER/100				
243		Diesel demand	KTOE	TREMDIE	=	TREMTOT*TRSMDIE/100				
244		Fuel oil demand	KTOE	TREMFUL	=	TREMTOT*TRSMFUL/100				
245		Natural gas demand	KTOE	TREMNG	=	TREMTOT*TRSMNG/100				
246		Renewable energy demand	KTOE	TREMREW	=	TREMTOT*TRSMREW/100				
247		Total	KTOE	TREMTOT	=	TRENDEA-TRENELT				
248										
249		Coal demand	S%	TRSMCOA	=	TRSMCOA				
250		LPG demand	S%	TRSMLPG	=	TRSMLPG				
251		Gasoline demand	S%	TRSMGAS	=	TRSMGAS				
252		Jetfuel demand	S%	TRSMJET	=	TRSMJET				
253		Kerosene demand	S%	TRSMKER	=	TRSMKER				
254		Diesel demand	S%	TRSMDIE	=	TRSMDIE				
255		Fuel oil demand	S%	TRSMFUL	=	TRSMFUL				
256		Natural gas demand	S%	TRSMNG	=	TRSMNG				
257		Renewable energy demand	S%	TRSMREW	=	TRSMREW				
258		Total	S%	TRSMTOT	=	TRSMTOT				
259										

a. Energy conservation rate

Energy conservation rate in the sector

GR of fuel oil price >0

= Energy conservation rate (1)*(1+Technical improvement)

*(1+ Elasticity of energy price * GR of fuel oil price)

GR of fuel oil price < 0

= Energy conservation rate (1)*(1+Technical improvement)

*(1+ Elasticity of energy price /2 * GR of fuel oil price)

b. Technical Improvement

Technical Improvement is exogenous.

c. Elasticity to Energy price

Technical Improvement is exogenous.

d. Energy intensity to GDP

Energy intensity to GDP = Energy demand in Transportation / Real GDP

e. Energy demand before Energy saving

. Energy demand before Energy saving

= f (Energy demand before Energy saving (1)*(1+2*GR of Transportation GDP)

f. Energy demand after energy saving

Energy demand after energy saving =Energy demand before Energy saving

* Energy conservation rate

g. Electricity ratio

Electricity ratio is exogenous.

h. Power demand（k TOE）

Power demand (kTOE)= Energy demand after energy saving * Power ratio.

i. Power demand（GWh）

Power demand with (GWh) = Energy demand f(kTOE) * 0.086.

j. Fossil energy demand

Coal demand = Total fossil energy demand * Coal demand share

LPG demand= Total fossil energy demand * LPG demand share