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Model Manual
of
Energy Supply Planning Model

JICA Study Team

The Institute of Energy Economics, Japan

CONTENTS

1. The purposes and specification of the model

1.1 The purposes

The model makes energy supply and demand balance of short and medium terms in Egypt. The energy demand used for making energy balances and efficiencies are given from other models and energy database. The model calculates energy supply to meet the demand under the conditions of keeping the maximum profit in Egypt.

The following energies are targeted for analyzing and making balances in the model.

Table 1-1 Targeted energies made demand / supply balances in the model

Coal products	Oil &Gas products	Power	Others
Coal	Crude oil	Power distribution	Renewable
Coke	NGL	Hydro power	
	FD-LPG	Gas combined power	
	Natural gas	Coal steam power	
	LPG	Gas turbine power	
	LNG	Diesel engine power	
	Refinery Feed	Fuel oil steam power	
	Refinery Gas	Solar-Wind-Other power	
	RF-LPG		
	Gasoline		
	Jet fuel		
	Kerosene		
	Diesel		
	Fuel oil		
	Naphtha		
	Lubricants & additives		
	Bitumen		
	Petroleum Coke		
	Non specified products		

The model is designed for short–medium term energy plan in Egypt. Then the model calculates the energy balances for future 5 years. Usually LP model does not calculate the energy balance for actual terms, however the model includes the actual terms for check and evaluation of the model. (The actual terms in the Original model is from 1994 to 1998.)

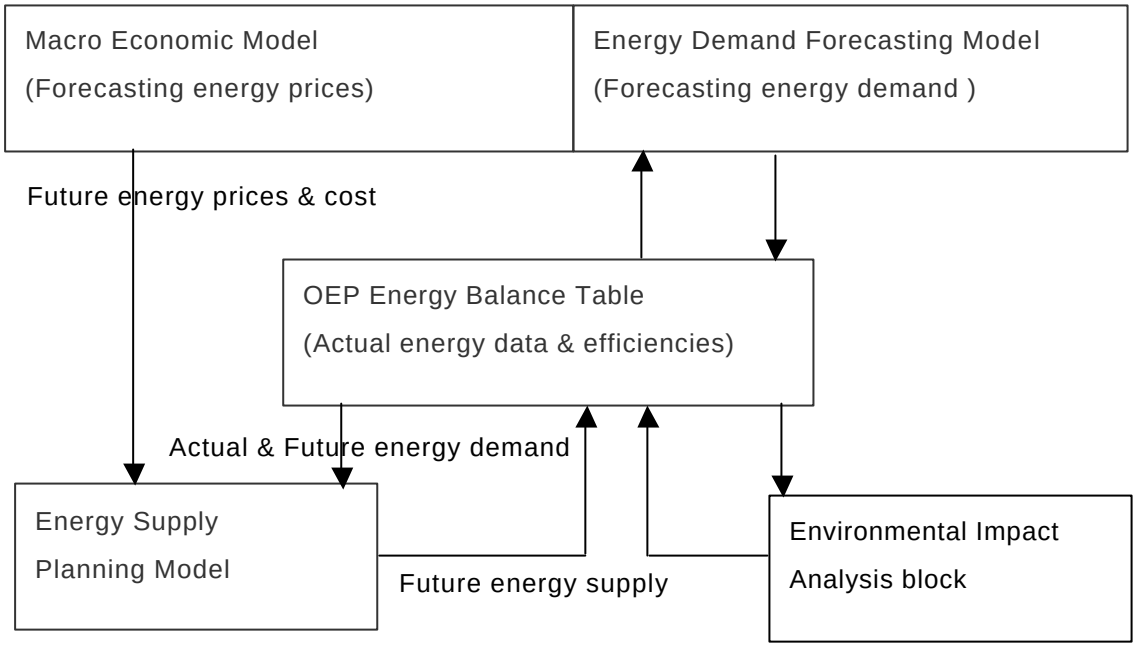
1.2 The structure of the model

The data are input to the energy supply planning model from other models and resources. Actual energy data & efficiency data are selected from the database (OEP Energy Balance Table), forecasting energy price data come from the Macro Economic Model, and forecasting demand data from the Energy Demand Forecasting Model.

Energy supply and energy consumption in future are computed in the energy supply planning model, after that, some environmental pollution emission are estimated in the Environmental Impact Analysis block. Then the results of the energy supply planning model

are passed to the Environmental Impact Analysis block.

Table 1-2 Block flow of Egyptian energy economic model



The energy supply planning model consists of the following 7 sheets(IDB sheet, PIM sheet, LIM sheet, LPM sheet, EBT sheet, GRT sheet and PEC sheet).

The first sheet is IDB sheet to receive the forecasting data from Energy Demand Forecasting Model. The data are connected to cells in PIM and LIM sheet

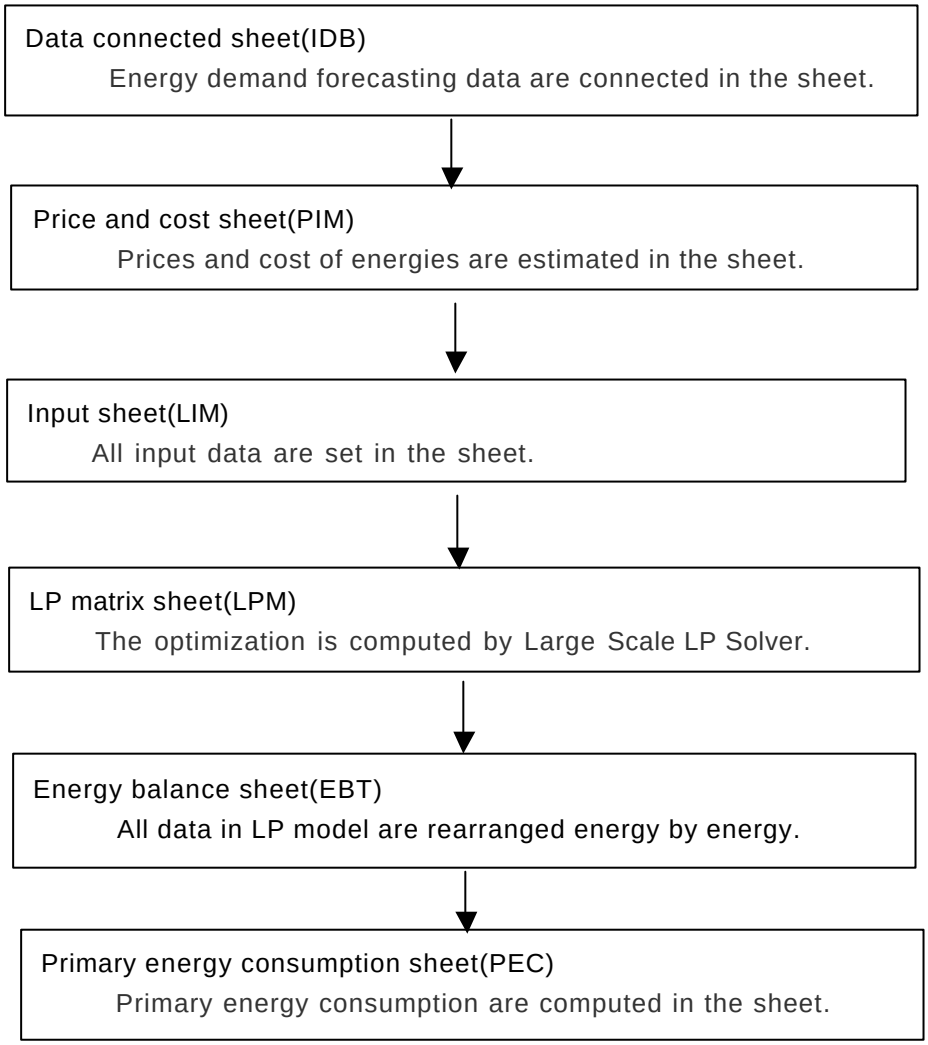
The second sheet is PIM(Price & cost) sheet to estimate the prices and cost of energies. The price and cost data are used in LIM sheet, LPM sheet and EBT sheet of ESPM.

The third sheet is LIM sheet(input sheet) to receive the data from IDB sheet and other resources. The input data are passed to LPM sheet.

The fourth (LPM) sheet has LP matrix for Energy Supply Planning Model. And the solutions are set in the each variables and an objective function cell. The matrix is controlled by Large Scale LP Solver add-in software. When energy flow is changed by some reasons, a new energy flow has to be prepared and the matrix has to be changed in line with the new energy flow.

When we analyze the solution as calculation results, it is difficult to analyze sentences on LPM sheet formation, because the data on LPM sheet formation are arranged by LP matrix formation. So the data are rearranged on Balance sheet in energy balance item order.

Table 1-3 EXCEL sheet configuration of the model



1.3 Computer environment

The model is operated on MS-EXCEL (Upper version of Office 97). The following software and computer resources are required for the model.

Table 1-4 Computer Environment

Software & Resources	Contents
MS-EXCEL	Office97 and Office 2000
Disk	6.2MB for original model 6.2MB for one case study
Memory	More than 64K
Large scale LP Solver	It is supplied by Frontline System Inc.. Standard Solver in MS-EXCEL can not solve the model.

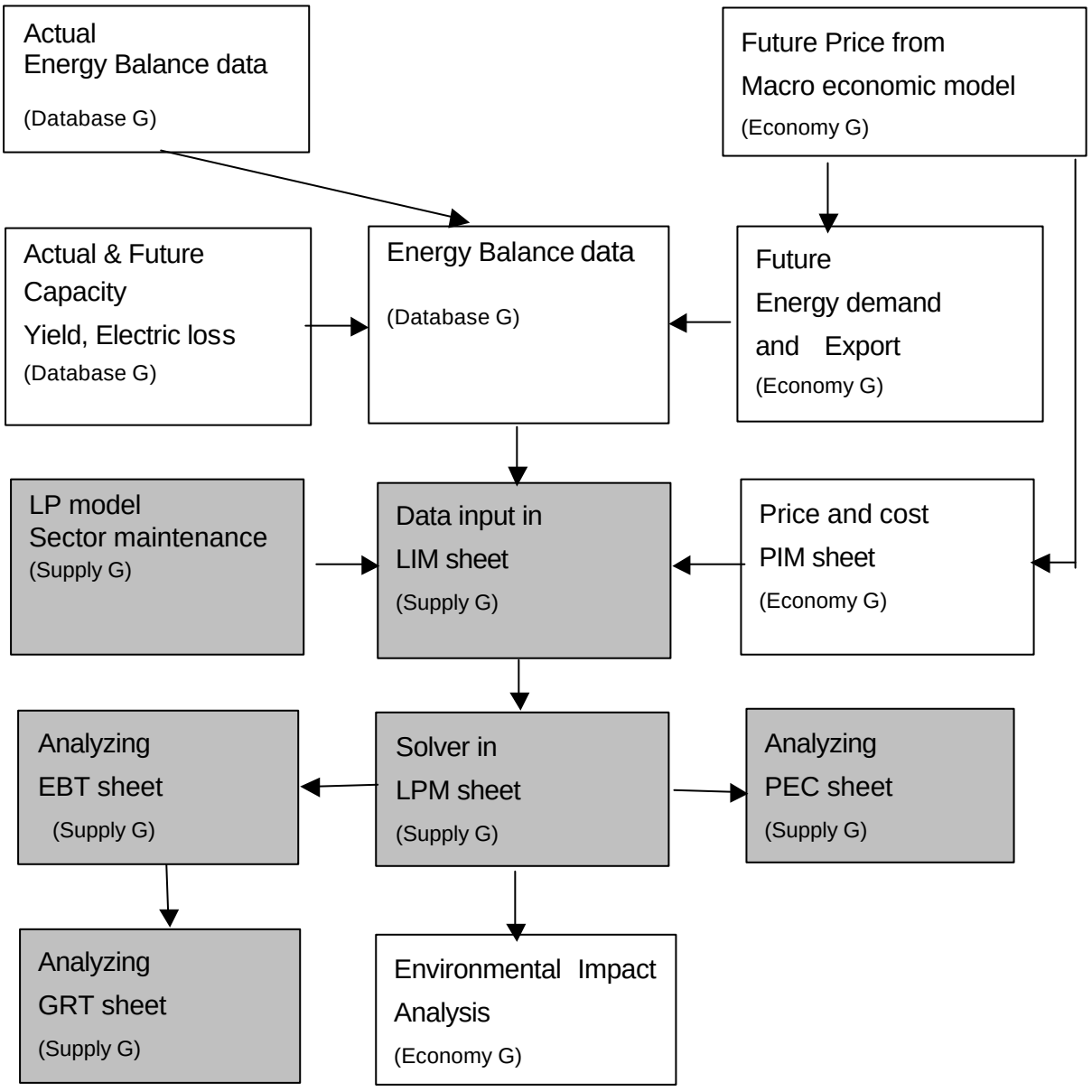
Caution: When you can not find Solver menu in "tool" in EXCEL sheet, you have to install Solver add-in software from MS-Office CD. At this time, you have to select not "Standard

installation", but "Custom installation" and "All installation".

1.4 Responsibility of Egyptian energy economic model

The followings are a figure which is showing the relation among ESPM, database, Energy Demand Forecasting Model. And the responsibility of the model maintenance and data gathering are as follows;

Figure 1-5 Responsibility of Egyptian energy economic model



Economy G : Economy Group
Supply G : Energy Supply Group
Database G : Database Group
(Gray blocks belong to ESPM.)

1.4 Installation of Large Scale LP Solver

Large Scale LP Solver is supplied by Frontline Systems Inc. in USA. It is filed in a FD.

The procedures of installation for Large Scale LP Solver are as follows;

(1) Make a new file (Ex. LargeLP) in a hard disk.

(2) Start Large Scale LP Solver from the FD.

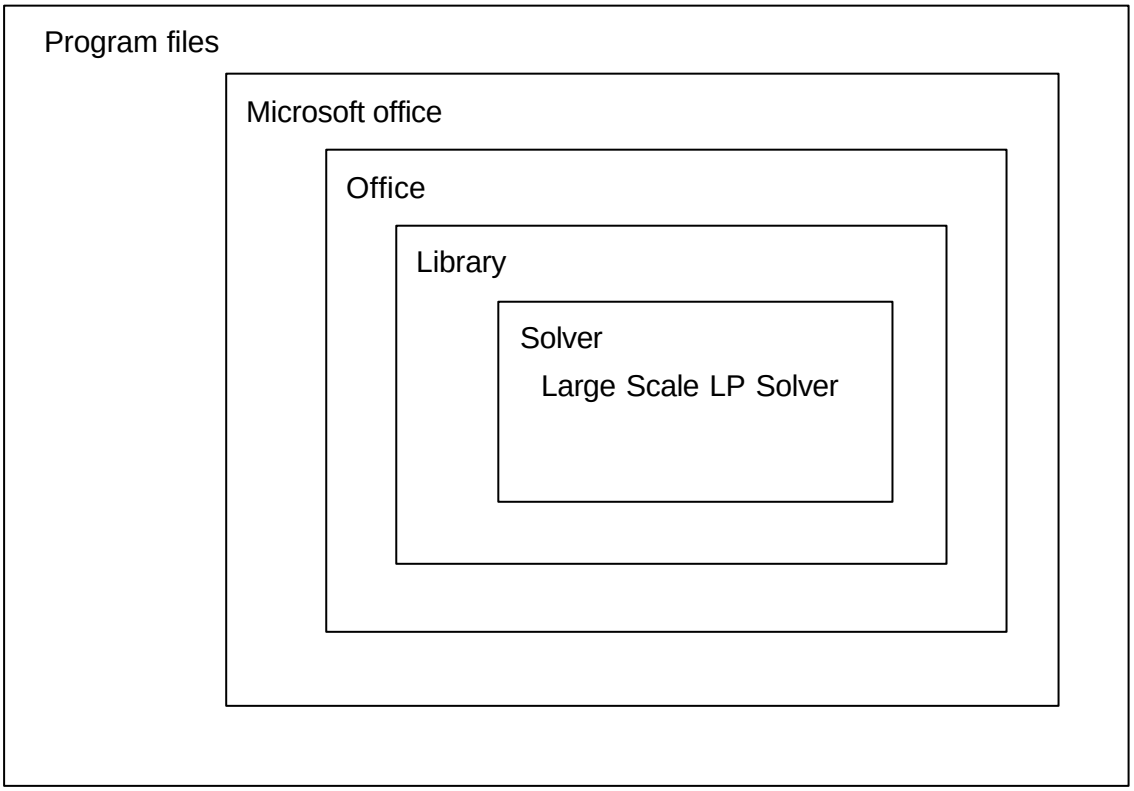
(3) When setup program requires directory and a new file, you have to indicate LargeLP file for keeping Large Scale LP Solver programs.

(4) After that, you have to operate the installation in line with the messages of the setup program.

(5) After installation operation, all files in LargeLP should be copied to Solver file. The Solver file exists in the following directories. When you can not find Solver file in Library, you have to make Solver file in Library.

Program files>>Microsoft office>>Office >>Library >>Solver>>Large Scale Solver files

Figure 1-6 Solver file location in Hard disk



2. Input data (LIM sheet)

2.1 Efficiency and yields

(1) Efficiency

In the efficiency area, efficiencies from coal to coke, co-production efficiencies of natural gas to natural Gas liquid , LNG and LPG. The efficiencies are defined by unit kton / kton and arranged year by year. These actual efficiencies are calculated in energy balance tables of energy database. And the future values of these efficiencies are estimated by the actual efficiencies, otherwise the same values as much as the actual data are set for the future.

Table 2-1 Efficiencies of Coke, NGL, FD-LPG, LNG

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Efficiencies	Coke	Coke / Coal		KTON/KTON	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100
	NGL	NGL / NG		KTON/KTON	0.1332	0.1292	0.1476	0.1591	0.1408	0.1408	0.1408
	FD-LPG	FD-LPG / NG		KTON/KTON	0.0913	0.0917	0.0880	0.0884	0.0940	0.0940	0.0940
	LNG	LNG/NG		KTON/KTON	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900

(2) Refinery yields to crude oil

Petroleum product yields of crude oil are defined by production share of petroleum products to crude oil. Then the summation of all yields to crude oil is near to 1.0. (Usually the summation of all yields is slightly greater than 1.0)

The actual petroleum product yields are calculated in energy balance tables of energy database.

For the future petroleum product yields, it is better that you set the same yields as the latest actual yields. However if it is happened some changes of the yields, you have to replace the yields with new ones.

Table 2-2 Efficiencies of Petroleum products to crude oil

2	ITEMS 1	ITEMS 2	SECTORS		UNIT	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01
7	Yields	Refinery from c	Refinery Gas		KTON/KTON	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8		Crude oil	RF-LPG		KTON/KTON	0.0160	0.0170	0.0160	0.0160	0.0160	0.0160	0.0160
9			Gasoline		KTON/KTON	0.0730	0.0730	0.0723	0.0736	0.0759	0.0759	0.0759
10			Jet fuel		KTON/KTON	0.0330	0.0310	0.0310	0.0300	0.0300	0.0300	0.0300
11			Kerosene		KTON/KTON	0.0450	0.0470	0.0450	0.0400	0.0400	0.0400	0.0400
12			Diesel		KTON/KTON	0.2060	0.2150	0.2070	0.2140	0.2140	0.2140	0.2140
13			Fuel oil		KTON/KTON	0.4590	0.4650	0.4530	0.4620	0.4620	0.4620	0.4620
14			Naphtha		KTON/KTON	0.0940	0.1000	0.1040	0.1080	0.1025	0.1025	0.1025
15			Lubricants & additives		KTON/KTON	0.0090	0.0080	0.0090	0.0090	0.0090	0.0090	0.0090
16			Bitumen		KTON/KTON	0.0260	0.0270	0.0260	0.0280	0.0280	0.0280	0.0280
17			Petroleum Coke		KTON/KTON	0.0050	0.0060	0.0050	0.0050	0.0050	0.0050	0.0050
18			Non specified products		KTON/KTON	0.0070	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
19			Crude oil		KTON/KTON	-0.9730	-0.9950	-0.9743	-0.9916	-0.9884	-0.9884	-0.9884
20												

(3) Petroleum product yields to NGL

NGL is one of law material for refinery plant. Then you have to be set the yields from NGL to petroleum products. Petroleum product yields of NGL are defined by production share of petroleum products to NGL. Then the summation of all yields to NGL is near to 1.0.

The actual petroleum products yields of NGL are calculated in energy balance tables of energy database.

For the future petroleum products yields, it is better that you set the latest actual yields as the future yields. However if it is happened some changes to the yields, you have to replace the yields with the new ones.

Table 2-3 Efficiencies of Petroleum products to NGL

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Yields	Refinery from N	Refinery Gas		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	NGL	RF-LPG		KTON/KTOI	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338
		Gasoline		KTON/KTOI	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338
		Jet fuel		KTON/KTOI	0.0210	0.0210	0.0210	0.0210	0.0210	0.0210	0.0210
		Kerosene		KTON/KTOI	0.1717	0.1717	0.1717	0.1717	0.1717	0.1717	0.1717
		Diesel		KTON/KTOI	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300
		Fuel oil		KTON/KTOI	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
		Naphtha		KTON/KTOI	0.3660	0.3660	0.3660	0.3660	0.3660	0.3660	0.3660
		Lubricants & additives		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Bitumen		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Petroleum Coke		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Non specified products		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		NGL		KTON/KTOI	-0.9697	-0.9697	-0.9697	-0.9697	-0.9697	-0.9697	-0.9697

In the refinery sector, petroleum product yields of crude oil and NGL are averaged in the model, and the average yields are used as the representative petroleum product yields for refinery raw materials (mixed raw material from crude oil and NGL)

Then when petroleum product yields of crude oil and NGL can not be defined separately, you should be set the same petroleum product yields for crude oil to petroleum products and NGL to petroleum products.

(4) Own use yields of refinery

Refinery plant consumes some petroleum products; they are diesel oil, fuel oil, refinery gas and lubricants & additives. Also the natural gas is used at starting up of refinery plant. Own use yields are defined by own use oil consumption to refinery feedstock (crude oil consumption and NGL consumption).

The own use yields are calculated by actual own use of oil products divided by actual refinery feedstock. For the future own use yields are set by the latest actual data.

Table 2-4 Efficiencies of own use oil product yields in refinery plants

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Yields	Refinery	Diesel to Refinery feed		KTON/KTON	0.0140	0.0140	0.0140	0.0150	0.0160	0.0160	0.0160
	Own use	Fuel oil to Refnery feed		KTON/KTON	0.0240	0.0260	0.0240	0.0210	0.0190	0.0190	0.0190
		Refinery Gas to Refinery Gas produc		KTON/KTON	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		Lubricants & additives to Lubricants p		KTON/KTON	0.0260	0.0260	0.0240	0.0270	0.0260	0.0260	0.0260
		Natural Gas to Refinery feed		KTON/KTON	0.0065	0.0057	0.0064	0.0084	0.0098	0.0098	0.0098

(5) Partner's shares

Regarding to production of crude oil, natural gas, NGL and FD-LPG, Egypt has contracts which are sharing the production with their partners. By the contracts, 40% of the crude oil production, 18% of natural gas production and 22% of NGL have to be shared to the partners.

And the plant maintenance fee is paid by production energies. Then the partner's shares are gradually going up. That is, for example, partner's share of crude oil in current year is greater than 40% of the total crude oil production.

Table 2-5 Partner's shares

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Partners	Shares	Crude oil		KTON/KTON	0.3500	0.3550	0.3580	0.3660	0.3710	0.4000	0.4000
		Natural Gas		KTON/KTON	0.1890	0.1840	0.2160	0.2620	0.2930	0.3000	0.3000
		NGL		KTON/KTON	0.2230	0.2160	0.2750	0.3070	0.3110	0.3200	0.3200
		FD-LPG		KTON/KTON	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

(6) Efficiencies of power

There are some types of power plants in Egypt. They are natural gas combined plants, natural gas turbine plants, diesel-thermal plants and fuel oil- thermal plants.
And in future coal steam power plants, solar, wind and other power plants will be installed. Then power efficiencies for the installed power plants are required in the model.

The power efficiencies unit used in the model are described by GWh / kton. The actual data are collected from energy balance data sheet. And the future power efficiencies are set by the latest actual data.

The power has distribution loss and own use power. The distribution loss is estimated by the actual data, and the estimated distribution loss is set in the following table. And own use power also can be computed in the same way, and they are set in the following table.

Table 2-6 Efficiencies of power

ITEMS 1	ITEMS 2	SECTORS	UNIT	1994	1995	1996	1997	1998	1999	2000
Efficiencies	Power	Power / Natural gas combined	GWh/KTON	5.5684	5.5684	5.5684	5.5684	5.5684	5.5684	5.5684
		Power / Coal(Thermal)	GWh/KTON	2.8358	2.8358	2.8358	2.8358	2.8358	2.8358	2.8358
		Power / Natural gas(Turbine)	GWh/KTON	3.0232	3.0232	3.0232	3.0232	3.0232	3.0232	3.0232
		Power / Diesel	GWh/KTON	3.9665	3.9665	3.9665	3.9665	3.9665	3.9665	3.9665
		Power / Fuel(Steam)	GWh/KTON	4.5000	4.1140	4.1140	4.1140	4.1140	4.1140	4.1140
		Distribution Loss	GWh/GWh	0.1250	0.1180	0.1130	0.1180	0.1359	0.1200	0.1200
		Own use of power	GWh/GWh	0.0300	0.0300	0.0300	0.0300	0.0200	0.0200	0.0200

2.2 Energy supply

In energy supply area of the model, there exist Capacity, Initial-Stock, Production, Import, Bought, Receivable and Supply total. The each category has three lines, upper limit line, solution line and lower limit line. Usually input data are set in upper limit line and lower limit line. The solution line gets the value from LPM solution area.

(1) Capacity

a. Upper limit capacity

In the upper limit line of capacity, the upper limit capacity is entered each year. When actual production are set in the upper limit of capacity in the actual years, the value in the upper limit of capacity constrains production variables in LP model. If there is no plant as coal sector, you should be set 0 as the upper limit of capacity. And if there is not any restriction upon production, you should be set “U” as the upper limit of capacity(“U” means infinite). In case of crude oil, you can set the reserves of crude oil instead of capacity. But at the same time, you should be set the maximum production-value in the maximum production line. Because, usually the reserves and the maximum production are very different.

b. Operation line

Operation line is operation load of a plant. Operation line is not input-area, its value is set from LP solution. Operation load is defined by “production / capacity * 100”. Then if capacity is set by 0 or “U”, the model can not calculate operation load. If you set reserves of crude oil in the capacity line, Operation load of the crude oil is calculated by “production / reserves * 100”.

c. Lower limit line

In the lower limit line of capacity, plant minimum load are entered each year. When actual capacity are set in the lower limit capacity, the values are lower limit of production in LP model. If there is no plant as coal sector, you have to set 0 for the lower limit capacity. And also if there is not any restriction on lower capacity, you have to be set 0 for the lower limit capacity. In most of the case, the lower limit capacity are set by 0.

Table2-7 Capacity data input energy by energy

Items	Contents
Capacity	1)Coal, LPG distribution and Power distribution sectors are set by all 0 in upper limit and lower limit of their capacity, because these sectors have no plants. 2)NGL, FD-LPG sectors are set by "U" in upper limit and 0 in lower limit of capacity, because production of NGL, FD-LPG are calculated by the model, as these sectors are co-products of Natural gas. 3) RF-gas, RF-LPG, Gasoline, Jet fuel, Kerosene, Diesel, Fuel oil, Naphtha, Lubricants & additives, Bitumen, Petroleum Coke, Non specified products sectors are set by "U" in upper limit and 0 in lower limit, because these sectors are co-products of refinery plant. 4) Coke, Crude oil, Natural gas, Feedstock, Hydro power, Gas combined, Coal steam power, Gas turbine, Diesel engine, Fuel oil steam power, Solar-Wind-Other, Renewable sectors are required values for upper limit and 0 in lower limit.

(2) Initial-stocks

a. Upper limit line

In the upper limit line of the initial-stock, maximum stocks are entered each year. When actual stocks are set in the upper limit line in the actual years, the value in the upper limit line are set to initial stock variables in LP model. If there are no initial-stock, the upper limit is 0. And if there is not any restriction on initial-stock, the upper limit is set by "U" (means infinite). Usually initial-stock line are set by "U". When there is stock change having plus sign in energy balance table, the value can be entered in the upper limit line of initial-stock.

b. Solution line

Solution line of initial-stock are not input-area, its value is set from LP model. Then if upper limit of initial-stock is set by 0, the solution is 0, if upper limit of initial stocks is set by "U", the solution line take 0 or a value.

c. Lower limit line

In the lower limit line of the initial-stock, minimum stocks are entered each year. When actual stock is set in the lower line, the value in actual stock line is set to initial-stock variable in LP model. In most of cases, the lower limit is set by 0.

Table2-8 Data input energy by energy

Items	Contents
Initial-Stock	1) You have to set 0 in upper limit and 0 in lower limit of first year for all sectors. 2) You have to set "U " in upper limit and 0 in lower limit for other years, unless any value is in initial-stock of energy balance table. If there is a value in energy balance table, you can set the value in upper limit and 0 in lower limit in the current years.

	3) If you do not want any initial stock in a sector, you have to sect 0 in upper limit and in lower limit of the final-stock. 4) Basically, you have to set 'U' in upper limit and 0 in lower limit of the future initial-stock.

(3) Production

a. Upper limit line

In the upper limit of the production, maximum production is entered each year. When actual production are set in the upper limit line of the actual term, the value in upper limit line are set to production variables in LP model. If there is no plant as coal sector, the upper limit of the production is 0. And if there is not any restriction on production, the upper limit line of the production is set by "U" (means infinite).

b. Solution

Solution line of the production is not input-area; its value is set from LP model. It is production volume calculated in LP model. And when you want to revise the upper limit and the lower limit of the production, you can refer the solution.

c. Lower limit line

In the lower limit line of the production, minimum production is entered each year. When actual production are set in the lower limit line of the production, the greater value than the actual production are set to production variables in LP model. If there is no plant as coal sector, the lower limit of the production is 0. And if there is not any restriction on lower production, the lower limit is set by 0. In most of cases, the lower limit line of the production is set by 0.

Table2-9 Data input energy by energy

Items	Contents
Production	1) Production of Coal, LPG distribution and Power distribution sectors are set by all 0, because these sectors have no plants. 2)NGL, FD-LPG sectors are set by U, because production of NGL, FD-LPG are calculated by the model, as these sectors are co-products of Natural gas. 3) RF-gas, RF-LPG, Gasoline, Jet fuel, Kerosene, Diesel, Fuel oil, Naphtha, Lubricants & additives, Bitumen, Petroleum Coke, Non specified products sectors are set by U, because these sectors are co-products of refinery plant. 4) The following energy sectors are required values in upper limit and 0 in lower limit of production. Coke, Crude oil, Natural gas, Feedstock, Hydro power, Gas combined, Coal

	steam power, Gas turbine, Diesel engine, Fuel oil steam power, Solar-Wind-Other, Renewable 5) In the above energy sectors, if you set values for their capacity, you can set 'U' for upper limit of production. In the case, the upper limit of their capacity are applied to upper limit of their production.

(4) Import

a. Upper limit line

In the upper limit line of the import, maximum import is entered each year. When actual import are set in the upper line in the actual term, the value smaller than the actual import are set to import variables in LP model. If there are no import, the upper limit of the import is 0. And if there is not any restriction on import, the upper limit of the import is set by "U" (means infinite). Usually upper limit of the import are set by "U".

b. Solution line

Solution line of the import is not input-area, its value is set from LP model. If upper limit of the import are set by 0, the solution gets 0, if upper limit of the import are set by "U", the solution take a value or 0.

c. Lower limit line

In the lower limit line of the import, minimum import are entered each year. When actual import are set in the lower limit line of the import, the greater value than the actual import volume are set to import variables in LP model. In most of cases, the lower limit of the import is set by 0.

Table2-10 Data input energy by energy

Items	Contents
Import	1) Basically you should be set 'U' in upper limit of the import and set 0 in lower limit of the import for all energies, because energy shortage sometimes happen, in the case, the energies can be imported as much as fulfilling the shortage. 2) Especially you have to set 'U' in upper limit and 0 in lower limit for all future years.

(5) Bought

a. Upper limit line

Egypt has to divide a part of energies such as Crude oil, Natural gas, NGL and FD-LPG to partners (foreign companies) in line with partner's shares contracts. Most of the partner's energy come back to Egypt market as special import called "Bought". Bought categories are area which the special import are processed.

In the upper limit line of the Bought, Maximum bought is entered each year. When actual Bought are set in the upper line in the actual years, the value smaller than the actual Bought are set to Bought variables in LP model. If there are no Bought, the upper limit of the Bought is 0. And if there is not any restriction on Bought, the upper limit of the Bought is set by "U" (means infinite). Usually upper limit of the Bought line are set by "U".

b. Solution line

Solution line of the Bought is not input-area, its value is set from LP model. If upper limit of Bought are set by 0, the solution gets 0, if upper limit of the Bought are set by "U", the solution take a value or 0.

c. Lower limit line

In the lower limit line of the Bought, the minimum Bought are entered each year. When actual Bought are set in the lower limit line, the greater value than the actual Bought volume are set to import/bought variables in LP model. In most of cases, the lower limit is set by 0.

Table2-11 Data input energy by energy

Items	Contents
Bought	Bought of crude oil is set with values in upper limit and lower limit. Natural gas and NGL are set with 'U' in upper limit and 0 in lower limit. But other sectors are set with 0 in upper limit and lower limit.

(6) Receivable

a. Upper limit line

In the upper limit line of the receivable, the maximum receivable is entered each year. When actual receivables are set in the upper line in the actual term, the smaller value than the actual receivables are set to receivable variables in LP model. If there are no receivables, the upper limit of the receivable is 0. And if there is not any restriction on receivables, the upper limit of the receivable is set by "U" (means infinite). When there are some value with plus sign in Transfer, Other sources, Difference category in energy balance table, the value can be entered in upper limit line of receivables.

Power distribution sector receive power from power generation sectors through Receivable. Also, LPG distribution sector receives LPG from FD-LPG and RF-LPG sectors through Receivable.

b. Solution line

Solution line of the receivable is not input-area, its value is set from LP model. If upper limit of the receivables are set by 0, the solution gets 0, if upper limit of the receivables are set by "U", the solution take smaller value than the upper limit or 0.

c. Lower limit line

In the lower limit line of the receivable, the minimum receivables are entered each year. When actual receivables are set in the lower line, the greater value than the actual receivables are set to receivable variables in LP model. In most of cases, the lower limit line of the receivable are set by 0.

Table2-12 Data input energy by energy

Items	Contents
Receivable	LPG distribution and Power distribution have receivable. Then the two sectors are set with 'U' in upper limit and 0 in lower limit of their receivables. Other sectors are set with 0 in upper limit and lower limit of their receivables.

(7) Total supply

a. Upper limit line

In the upper limit line of the total supply, the total value of upper limit is calculated in range of Initial-stocks, Production, Import, Bought and Receivable. When "U" is set in some upper limit line of Initial-stocks, Production, Import, Bought and Receivable, as the upper limit of the total supply are not contained "U" in the total area, the total supply is calculated except "U".

b. Total value line

In the total value line, the total value of each solution (Initial-stock, Production, Import, Bought, Receivable) are calculated.

c. Lower limit line

In the lower limit line of the total supply, the total value of lower limit are calculated. When "U" is set in some lower limit line of Initial-stock, Production, Import, Bought and Receivable, the lower limit of the total supply are not contained "U" in the total area.

Table 2-12 Input sheet of energy supply

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Crude oil	Supply	Capacity of production	Upper Limit	KTON	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
			Operation	%	100.0	100.0	100.0	97.5	95.5	98.8	99.6
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Initial-Stock=Stock Chanc	Upper Limit	KTON	0.0	U	U	U	U	U	U
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production=Indigenous(+)	Upper Limit	KTON	44,292.0	43,994.0	41,782.0	40,293.0	39,516.0	39,506.6	39,852.5
		1.00	Solution	KTON	40,000.0	40,000.0	40,000.0	39,001.3	38,186.3	39,506.6	39,852.5
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Import	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	Upper Limit	KTON	4,975.0	5,318.0	6,319.0	6,226.0	6,060.0	6,100.0	6,100.0
			Solution	KTON	4,975.0	5,318.0	6,319.0	6,226.0	6,060.0	6,100.0	6,100.0
			Lower Limit	KTON	4,975.0	5,318.0	6,319.0	6,226.0	6,060.0	6,100.0	6,100.0
		Receivables=Transfer(+),(	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		fm Differences	Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	Upper Limit	KTON	49267.0	49312.0	48101.0	46519.0	45576.0	45606.6	45952.5
			Solution	KTON	44975.0	45318.0	46319.0	45227.3	44246.3	45606.6	45952.5
			Lower Limit	KTON	4975.0	5318.0	6319.0	6226.0	6060.0	6100.0	6100.0

2.3 Energy consumption

(1) Final demand

a. Upper limit

In the upper limit line of the final demand, the maximum final demand are entered each year. When actual final demand are set in the upper line in the actual years, the smaller value than the actual final demand are set to final consumption variables in LP model. The upper limit line of the final demand have to be set by a value or 0. (It means that 'U' are not permitted in upper limit of the final demand) The upper limits of the final demand have to be fulfilled by values in "Total final consumption" of energy balance table.

b. Solution line

Solution line of the final demand is not input-area, its value is set from LP model. When you revise the upper limit of the final demand, you can refer the solution values for setting new upper limit of the final demand.

c. Lower limit line

In the lower limit line of the final demand, the minimum final demand are entered each year. When actual final demand are set in the lower line, the greater value than the actual final demand are set to final demand variables as LP solution. And if there is not any restriction on lower final demand, the lower limit line is set by 0. In most of cases, the lower limits of the final demand are set by 0.

Table2-13 Data input energy by energy

Items	Contents
Final demand	1)The following sectors do not have finial demand. Then upper limit and lower limit of final demand are set with 0. (Coal, Crude oil, NGL, LNG, FD-LPG, Feedstock, RF-gas, RF-LPG, Hydro power, Gas-combined, Coal steam power, Gas-turbine, Diesel engine and Fuel oil steam power. Power Solar- Wind- Other.) 2) The following sectors have finial demand. Then upper limit and lower limit are set with values. Usually, the same values are set in upper limit and in lower limit.(Coke, LPG distribution, Gasoline, Jet fuel, Kerosene, Diesel, Fuel oil, Naphtha, Lubricants & additives, Non specified products and Power distribution) 3) The Bitumen, Petroleum Coke, Renewable sectors have finial demand, but the values are depend on their production. Then upper limit are set with 'U' and lower limit are set with 0.

(2) Export

a. Upper limit line

In the upper limit line of the export, maximum export is entered each year. When actual export are set in the upper line in the actual years, the smaller value than the actual export are

set to export variables in LP model. The upper limit lines of the export can be set by a value or 0.

b. Solution line

Solution line is not input-area, its value is set from LP model. When you want to revise the upper limit of the export, you can refer the solution values for setting new upper limit of the export.

c. Lower limit line

In the lower limit line of the export, the minimum exports are entered each year. When actual exports are set in the lower line, the greater value than the actual exports are set to export variables as LP solution. And if there is not any restriction on lower export, the lower limit is set by 0. In most of cases, the lower limit line of the export are set by 0.

Table2-14 Data input energy by energy

Items	Contents
Export	1) If there are the export in energy balance table, the values have to be set in their upper limit and the lower limit have to be set with 0. 2) Upper limit have to be set with 'U' and lower limit have to be set with 0 in the future years. 3)Energy surplus are exported in the model, then energy sectors which energy surplus are expected have to be set with 'U' in upper limit and 0 in lower limit for actual term. 4) Crude oil and naphtha have the export with contract. Then upper limit and lower limit of their sectors have to be set with export-values.

(3) Bunker oil

a. Upper limit

In the upper limit line of the Bunker oil, the maximum value to the bunker oil are entered each year. When the actual value to bunker oil are set in the upper line in the actual years, the smaller value than the actual bunker oil are set to bunker oil variables in LP model. The upper limit line of the bunker oil have to be set by some value or 0.

b. Solution line

Solution line is not input-area, its value is set from LP model. When you want to revise the upper limit of the bunker oil, you can refer the solution values for setting new upper limit of bunker oil.

c. Lower limit line

In the lower limit of the Bunker oil, the minimum value to the Bunker oil are entered each

year. When actual value to the Bunker oil are set in the lower line, the greater value than the actual Bunker oil are set to bunker oil variables as LP solution. And if there is not any restriction on lower bunker oil, the lower limit of the Bunker oil are set by 0. In most of cases, the lower limit line of the Bunker oil are set by 0.

Table2-15 Data input energy by energy

Items	Contents
Bunkers	1) Gasoline, Diesel and fuel oil have Bunker oil, then the bunker oil-value has to be set in upper limit and the value has to be set in lower limit too. 2) Other sectors are set with 0 in upper limit and also 0 in lower limit.

(4) Payables

a. Upper limit

In the upper limit of the Payable, the maximum payable is entered each year. When actual payables are set in the upper limit line of the Payable in the actual years, the smaller value than the actual payables are set to payable variables in LP model. The upper limit line of Payables have to be set by a value or 0. When there are some value with minus sign in Transfer, Other sources, Difference category in energy balance table, the value can be entered in upper limit line of the Payable. Power generation sectors by generator have to send their power to Power distribution sector through their Payables. Also, FD-LPG and RF-LPG sectors produce LPG and they send their LPG to LPD distribution sector through their Payable.

b. Solution line

Solution is not input-area, its value is set from LP model. When you revise the upper limit line of Payables, you can refer the solution values for setting new upper limit of Payable.

c. Lower limit line

In the lower limit of the Payable, the minimum payables are entered each year. When actual payables are set in the lower line, the greater value than the actual payables are set to payable variables as LP solution. And if there is not any restriction on lower payables, the lower limit of the Payable is set by 0. In most of cases, the lower limit of the Payable are set by 0.

Table2-16 Data input energy by energy

Items	Contents
Payable	1) Crude oil, Natural gas and NGL have partner's shares. The partner's share is paid through payable. 2) FD-LPG and RF-LPG send their LPG to LPG distribution through Payable.

	3) Power generator sectors send their power to power distribution sector. The power are sent through payable.

(5) Transformation

a. Upper limit line

In the upper limit line of the Transformation, the maximum transformation is entered each year. When actual transformation are set in the upper line in the actual term, the smaller value than the actual transformation are set to transformation variables in LP model. The upper limit of the transformation can be set by a value.

b. Solution line

Solution line is not input-area, its value is set from LP model. When you want to revise the upper limit of the transformation, you can refer the solution values for setting new upper limit of the transformation.

c. Lower limit line

In the lower limit line of the Transformation, the minimum transformation are entered each year. When actual transformation are set in the lower line, the greater value than the actual transformation are set to transformation variables as LP solution. And if there is not any restriction on lower transformation, the lower limit is set by 0. In most of cases, the lower limit line are set by 0.

Table2-17 Data input energy by energy

Items	Contents
Transformation	Raw materials of plants are sent through transformation. Coal to Coke, Crude oil to refinery, Natural gas to power plants, NGL to refinery, Feedstock to petroleum products, Diesel to power and fuel oil to power.

(6) Energy own use (Own use)

a. Upper limit

In the upper limit line of the Energy own use, the maximum consumption in energy own use is entered each year. When actual consumption in energy own use are set in the upper line in the actual years, the smaller value than the actual consumption in energy own use are set to energy own use variables in LP model. The upper limit line of energy own use have to be set by a value.

b. Solution line

Solution line is not input-area, its value is set from LP model. When you want to revise the upper limit of energy own use, you can refer the solution values for setting new upper limit of the energy own use.

c. Lower limit line

In the lower limit line of the energy own use, the minimum consumption in energy own use are entered each year. When actual consumption in energy own use are set in the lower line, the greater value than the actual consumption in energy own use are set to energy own use variables as LP solution. And if there is not any restriction on lower limit of energy own use, the lower limit line is set by 0. In most of cases, the lower limit line are set by 0.

Table2-18 Data input energy by energy

Items	Contents
Energy own use	1) Natural gas, refinery plant and power generators have energy own use. 2)Natural gas is consumed in natural gas production sector. 3)Refiner gas, diesel fuel oil and lubricant are consumed in refinery plant. 4) Power own use is consumed in power distribution, hydro power, gas combined, Coal steam, gas turbine, diesel engine and fuel oil steam generators.

(7) Final-stocks

a. Upper limit line

In the upper limit line of the final-stock, the maximum stocks are entered each year. When actual stocks are set in the upper limit line in the actual years, the value in the upper limit line are set to final-stock variables in LP model. If there are no final-stock, the upper limit is 0. And if there is not any restriction on final-stock, the upper limit is set by "U" (means infinite). Usually final-stock line are set by "U". When there is stock change having minus sign in energy balance table, the value can be entered in the upper limit line of final-stock. And the final-stock in the final year of the LP model has to be set by 0, because the final stock is one of income item in the model. In some energies, it is sometimes happened that final-stock in the final year of LP model has a value. When the value is small, it is no problem, but when its value is large(more than 20 % of domestic demand), it is sometimes to make problems.

b. Solution line

Solution line of final-stock are not input-area, its value is set from LP model. Then if upper limit of final-stock is set by 0, the solution is 0, if upper limit of final-stocks is set by "U", the solution line take 0 or a value.

c. Lower limit line

In the lower limit line of the final-stock, minimum stocks are entered each year. When actual stock is set in the lower line, the value in actual stock line is set to final-stock variable in LP

model. In most of cases, the lower limit is set by 0.

Table2-20 Data input energy by energy

Items	Contents
Final- stock	Basically the sectors do not have any final-stock, If there are some products in the final-stock and the volume is over 20% of the domestic demand and export, the sectors can not be operated. In the case, you need reconsideration of the scenarios.

(8) Total consumption

a. Upper limit line

In the upper limit of the Total consumption, the upper limit of all consumption data are totalized. When "U" is set in some upper limit line, the total upper limit is not contained in the total value.

b. Total value line

In the total value line, each solution (Initial stock, Production, Import, Bought, Receivables) is totalized.

c. Lower limit line

In the lower limit of the total consumption, the total lower limit is calculated.

Table 2-19 Input sheet of energy consumption

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Crude oil	Consumption	Final Demand	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	Upper Limit	KTON	7,973.0	7,864.0	6,642.0	3,968.0	2,934.0	2,353.7	1,981.8
			Solution	KTON	7,973.0	7,864.0	6,642.0	3,968.0	2,934.0	2,353.7	1,981.8
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bunkers	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable=Transfer(-),Partn	Upper Limit	KTON	U	U	U	U	U	U	U
			Solution	KTON	14,000.0	14,200.0	14,320.0	14,274.5	14,167.1	15,802.7	15,941.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Transformation=Transforn	Upper Limit	KTON	U	U	U	U	U	U	U
			Solution	KTON	23,002.0	23,254.0	25,357.0	26,984.8	27,145.2	27,450.3	28,029.7
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Energy Sector =Energy Se	Input	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Final-Stock=Stock Chang	Upper Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Solution	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	Upper Limit	KTON	7973.0	7864.0	6642.0	3968.0	2934.0	2353.7	1981.8
			Solution	KTON	44975.0	45318.0	46319.0	45227.3	44246.3	45606.6	45952.5
		64916	Lower Limit	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2.4 Example for data input

(1) Coal sector

The following Table is energy balance table for coal sector. Each data of the lines in the energy balance table of coal sector is set in the input sheet of LP model.

Table 2-21 Energy balance table for coal sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners						
Import	1852	1987	1620	1972	1661	
Export						
International Marine Bunkers/Aviation						
Stock Changes						
Total Primary Energy Supply	1852	1987	1620	1972	1661	0
Transfers						
Statistical Differences						
Transformation Sector	-1852	-1987	-1620	-1972	-1661	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens	-1852	-1987	-1620	-1972	-1661	
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-22 Data input from energy balance table to the input sheet

To input sheet		Fm Energy balance table	From Other sources
Supply	Capacity of production		0
	Initial-Stock	0	
	Production	0	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final consumption	
	Export	Export	
	Bunkers	0	
	Payables	0	
	Transformation(to Coke)	U	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(2) Coke sector

The following table is energy balance table for coke sector. Each data of the lines in the energy balance table of coke sector is set in the input sheet of LP model.

Table 2-23 Energy balance table for coke sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners						
Import	78	1				
Export	-325	-478.3	-372		-279.5	
International Marine Bunkers/Aviation						
Stock Changes						
Total Primary Energy Supply	-247	-477.3	-372	0	-279.5	0
Transfers						
Statistical Differences						
Transformation Sector	1850	1468	1489	1440	1213	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens	1850	1468	1489	1440	1213	
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	1603	990.7	1117	1440	933.5	0
Total Final Consumption	886.7	729.6	1026.1	848.6	0	0

Table 2-24 Data input from energy balance table to the input sheet

To input sheet		Fm energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Transformation sector	
	Import	U	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final consumption	
	Export	Export	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(3) Crude oil sector

The following table is energy balance table for crude oil sector. Each data of the lines in the energy balance table of crude oil sector is set in the input sheet of LP model.

Table 2-25 Energy balance table for crude oil sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	44292	43994	41782	40293	39516	0
Partener Share	-15898	-15602	-14947	-14763	-14705	
From Partners	4975	5318	6319	6226	6060	0
Import						
Export	-7973	-7864	-6642	-3968	-2934	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes	184.9246	49.24623	210.0503	-415.075	-398.995	0
Total Primary Energy Supply	25580.92	25895.25	26722.05	27372.92	27538.01	0
Transfers						
Statistical Differences						
Transformation Sector	-25580.9	-25895.2	-26722.1	-27372.9	-27538	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	-25580.9	-25895.2	-26722.1	-27372.9	-27538	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-26 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	Stocks	
	Production	Indigenous production	
	Import	0	
	Bought	From partners	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final consumption	
	Export	Export	
	Bunkers	0	
	Payables	Partners	
	Transformation	U	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(4) Natural gas sector

The following table is energy balance table for natural gas sector. Each data of the lines in the energy balance table of natural gas sector is set in the input sheet of LP model.

Table 2-27 Energy balance table for natural gas sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	9710	10168	10349	10610	11872	
Partener Share	-1834	-1875	-2236	-2777	-3480	
From Partners	0	0	0	0	0	
Import	1833	1876	2320	2715	3479	
Export	0	0	0	0	0	
International Marine Bunkers/Aviation	0	0	0	0	0	
Stock Changes	0	0	0	0	0	
Total Primary Energy Supply	9709	10169	10433	10548	11871	0
Transfers						
Statistical Differences			-108			
Transformation Sector	-6635	-6943	-7034	-6974	-7417	0
Public Electricity Plants	-6214	-6322	-6584	-6506	-6908	0
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry	-421	-621	-450	-468	-509	
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-172	-155	-179	-243	-285	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use	-172	-155	-179	-243	-285	0
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suuply)	2902	3071	3112	3331	4169	0
Total Final Consumption	2854	2983	3112	3300	3818	0

Table 2-28 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Indigenous production	
	Import	0	
	Bought	From Partner shares	
	Receivables	0	
	Total		
Consumption	Final Demand	Petrochemical industry Total final consumption	
	Export	0	
	Bunkers	0	
	Payables	Partner's Share	
	Transformation	U	
	Energy Sector	Energy sector use	
	Final-Stock	U	
	Total		

(5) NGL(Natural gas liquid) sector

The following table is energy balance table for NGL sector. Each data of the lines in the energy balance table of NGL sector is set in the input sheet of LP model.

Table 2-29 Energy balance table for NGL sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	1293	1314	1527	1688	1672	
Partener Share	-288	-284	-420	-518	-520	
From Partners	46	58	170	232	363	
Import	0	0	0	0	0	
Export	0	0	0	0	0	
International Marine Bunkers/Av	0	0	0	0	0	
Stock Changes	0	0	0	0	0	
Total Primary Energy Supply	1051	1088	1277	1402	1515	0
Transfers						
Statistical Differences						
Transformation Sector	-1051	-1088	-1277	-1402	-1515	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	-1051	-1088	-1277	-1402	-1515	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-30 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock		
	Production	Indigenous production	
	Import		
	Bought	From partners	
	Receivables		
	Total		
Consumption	Final Demand		
	Export		
	Bunkers		
	Payables	Partner's share	
	Transformation	Transformation sector	
	Energy Sector		
	Final-Stock	Total final demand	
	Total		

(6) FD-LPG (LPG from gas fields)sector

The following Table is energy balance table for FD-LPG sector. Only transfer data in the energy balance table of LPG sector is set in the input sheet of LP model.

Table 2-31 Energy balance table for LPG sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share	0	0	0	0	0	
From Partners	0	0	0	0	0	0
Import	98	160	272.5	529	726	0
Export	0	0	0	0	0	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes		-7	-7	3	7	0
Total Primary Energy Supply	98	153	265.5	532	733	0
Transfers	817	927	984	983	1004	0
Statistical Differences			0			
Transformation Sector	437	451	445	461	436	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	437	451	445	461	436	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	1352	1531	1694.5	1976	2173	0
Total Final Consumption	1299	1475	1645	1868	2112	0

Table 2-32 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	0	
	Production	Transfer	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transfer	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(7) LPG distribution (LPG from FD-LPG and RF-LPG)sector

The following table is energy balance table for LPG sector. Some data in the energy balance table of LPG sector are set in FD-LPG input sheet of LP model.

Table 2-33 Energy balance table for LPG sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share	0	0	0	0	0	
From Partners	0	0	0	0	0	0
Import	98	160	272.5	529	726	0
Export	0	0	0	0	0	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes		-7	-7	3	7	0
Total Primary Energy Supply	98	153	265.5	532	733	0
Transfers	817	927	984	983	1004	0
Statistical Differences			0			
Transformation Sector	437	451	445	461	436	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	437	451	445	461	436	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	1352	1531	1694.5	1976	2173	0
Total Final Consumption	1299	1475	1645	1868	2112	0

Table 2-34 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		0
	Initial-Stock	0	
	Production	0	
	Import	U	
	Bought	0	
	Receivables	Transfer from oil refineries Transformation	
	Total		
Consumption	Final Demand	Total final consumption	
	Export	Export	
	Bunkers	0	
	Payables	0r	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(8) Refinery feedstock (Crude oil and NGL)sector

The following tables are energy balance tables for crude oil sector and NGL sector. Some data in the energy balance tables of them are set in refinery feedstock input sheet of LP model.

Table 2-35 Energy balance table for crude oil sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	44292	43994	41782	40293	39516	0
Partener Share	-15898	-15602	-14947	-14763	-14705	
From Partners	4975	5318	6319	6226	6060	0
Import						
Export	-7973	-7864	-6642	-3968	-2934	0
International Marine Bunkers/Avi	0	0	0	0	0	0
Stock Changes	184.9246	49.24623	210.0503	-415.075	-398.995	0
Total Primary Energy Supply	25580.92	25895.25	26722.05	27372.92	27538.01	0
Transfers						
Statistical Differences						
Transformation Sector	-25580.9	-25895.2	-26722.1	-27372.9	-27538	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	-25580.9	-25895.2	-26722.1	-27372.9	-27538	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suupl	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-36 Energy balance table for NGL sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	1293	1314	1527	1688	1672	
Partener Share	-288	-284	-420	-518	-520	
From Partners	46	58	170	232	363	
Import	0	0	0	0	0	
Export	0	0	0	0	0	
International Marine Bunkers/Av	0	0	0	0	0	
Stock Changes	0	0	0	0	0	
Total Primary Energy Supply	1051	1088	1277	1402	1515	0
Transfers						
Statistical Differences						
Transformation Sector	-1051	-1088	-1277	-1402	-1515	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	-1051	-1088	-1277	-1402	-1515	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-37 Data input from energy balance table to the input sheet

To input sheet		Fm energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Oil refineries from Crude oil Oil refineries from NGL	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables		
	Transformation	Oil refineries from Crude oil Oil refineries from NGL	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(9) Refinery gas sector

The following Table is energy balance table for refinery gas sector. Some data in the energy balance table of refinery gas sector are set in the input sheet of LP model.

Table 2-38 Energy balance table for refinery gas sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production				0		
Partener Share						
From Partners						
Import						
Export						
International Marine Bunkers/Av	0	0	0	0		
Stock Changes	0	0	0	0		
Total Primary Energy Supply	0	0	0	0	0	0
Transfers						
Statistical Differences						
Transformation Sector	0	0	0	0	0	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-39 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	0	
	Production	Transformation sector	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	Oil refineries	
	Final-Stock	0	
	Total		

(10) RF-LPG (LPG from refinery plants) sector

The following Table is energy balance table for RF-LPG sector. Only one data in the energy balance table of LPG sector is set in the input sheet of LP model.

Table 2-40 Energy balance table for LPG sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share	0	0	0	0	0	
From Partners	0	0	0	0	0	0
Import	98	160	272.5	529	726	0
Export	0	0	0	0	0	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes		-7	-7	3	7	0
Total Primary Energy Supply	98	153	265.5	532	733	0
Transfers	817	927	984	983	1004	0
Statistical Differences			0			
Transformation Sector	437	451	445	461	436	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	437	451	445	461	436	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	1352	1531	1694.5	1976	2173	0
Total Final Consumption	1299	1475	1645	1868	2112	0

Table 2-41 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	0	
	Production	Oil refinery	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Oil refinery	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(11) Gasoline sector

The following Table is energy balance table for gasoline sector. Some data in the energy balance table of gasoline sector are set in the input sheet of LP model.

Table 2-42 Energy balance table for gasoline sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners	0	0	0	0	0	
Import	0	1.2	1	85.1	73	
Export	-33	0	0	0	0	
International Marine Bunkers/Av	-0.13	-0.07	-0.08	-0.14	-0.09	
Stock Changes		-8	-18	29	48	
Total Primary Energy Supply	-33.13	-6.87	-17.08	113.96	120.91	0
Transfers						
Statistical Differences						
Transformation Sector	1934	1972	2024	2117	2205	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	1934	1972	2024	2117	2205	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	1900.87	1965.13	2006.92	2230.96	2325.91	0
Total Final Consumption	1934	1972	2024	2155	2205	0

Table 2-43 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	U	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	Export	
	Bunkers	International marine bunkers	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(12) Jet fuel sector

The following Table is energy balance table for Jet fuel sector. Some data in the energy balance table of jet fuel sector are set in the input sheet of LP model.

Table 2-44 Energy balance table for jet fuel sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	0	0	0	0	0	0
Partener Share						
From Partners	0	0	0	0	0	0
Import	0	0	0	0	0	0
Export	-215	-71	0	-104	-103	0
International Marine Bunkers/Av	-234	-251	-419	-366	-412	0
Stock Changes	0	0	0	0	0	0
Total Primary Energy Supply	-449	-322	-419	-470	-515	0
Transfers						
Statistical Differences			-25			
Transformation Sector	886	847	860	876	939	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	886	847	860	876	939	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	437	525	416	406	424	0
Total Final Consumption	378	445	416	408	418	0

Table 2-45 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	Import	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	Export	
	Bunkers	International marine bunkers	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(13) Kerosene sector

The following Table is energy balance table for Kerosene sector. Some data in the energy balance table of kerosene sector are set in the input sheet of LP model.

Table 2-46 Energy balance table for kerosene sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners						
Import						
Export						
International Marine Bunkers/Aviation						
Stock Changes		34	12	-32	-12	
Total Primary Energy Supply	0	34	12	-32	-12	0
Transfers						
Statistical Differences						
Transformation Sector	1199	1269	1260	1151	1072	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	1199	1269	1260	1151	1072	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	1199	1303	1272	1119	1060	0
Total Final Consumption	1380	1298	1228	1159	1074	0

Table 2-47 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	0	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(14) Diesel sector

The following Table is energy balance table for diesel sector. Some data in the energy balance table of diesel sector are set in input sheet of LP model.

Table 2-48 Energy balance table for Kerosene sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99
Indigenous Production				0	
Partener Share					
From Partners		0	0	0	
Import	74	380	720	958	1598
Export		0	0	0	
International Marine Bunkers/Av	-284	-306	-257	-236	-243
Stock Changes		31	-13	10	4
Total Primary Energy Supply	-210	105	450	732	1359
Transfers					
Statistical Differences					
Transformation Sector	5319.6	5629.7	5614.6	5946.6	5935.5
Public Electricity Plants	-168	-180	-184	-208	-121
Autoproducer Electricity Plants					
Coke Ovens					
Gas Works					
For Blast Furnace Gas					
Petrochemical Industry					
Oil Refineries	5487.6	5809.7	5798.6	6154.6	6056.5
Liquefaction					
Non-specified (Transformation)					
Energy Sector Use	-377	-376	-400	-437	-462
Coal Mines					
Oil and Gas Extraction					
Coke Ovens use					
Gas Works use					
Oil Refineries use	-377	-376	-400	-437	-462
Own Use in Electricity					
Used for Pumped Storage					
Nuclear Industry					
Non-specified (Energy)					
Distribution Losses					
Total Final Consumption (Suup	4732.6	5358.7	5664.6	6241.6	6832.5
Total Final Consumption	4769	5294	5639	6157	6612

Table 2-49 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Oil refinery	
	Import	Import	
	Bought		
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	0	
	Bunkers	International marine bunkers	
	Payables	0	
	Transformation	Public electricity plants	
	Energy Sector	Energy sector use	
	Final-Stock	U	
	Total		

(15) Fuel oil sector

The following Table is energy balance table for fuel oil sector. Some data in the energy balance table of fuel oil sector are set in the input sheet of LP model.

Table 2-50 Energy balance table for fuel oil sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production				0		
Partener Share						
From Partners	0	0	0	0		
Import	0	0	0	0		
Export	-3621	-2460	-2219	-1954	-1366	
International Marine Bunkers/Av	-1983	-2501	-2830	-2082	-2268	
Stock Changes		38	-47	26	-1	
Total Primary Energy Supply	-5604	-4923	-5096	-4010	-3635	0
Transfers						
Statistical Differences						
Transformation Sector	10041.9	9965.6	9759	9183	8444	0
Public Electricity Plants	-2170	-2591	-2926	-4101	-4329	
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	12211.9	12556.6	12685	13284	12773	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-652	-703	-655	-594	-559	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use	-652	-703	-655	-594	-559	
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	3785.9	4339.6	4008	4579	4250	0
Total Final Consumption	4560	5078	4841	5229	4909	0

Table 2-51 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Oil refinery	
	Import/Bought	U	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	Export	
	Bunkers	International marine bunkers	
	Payables	0	
	Transformation	Public electricity plants	
	Energy Sector	Energy sector use	
	Final-Stock	U	
	Total		

(16) Naphtha sector

The following Table is energy balance table for naphtha sector. Some data in the energy balance table of naphtha sector are set in the input sheet of LP model.

Table 2-52 Energy balance table for naphtha sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	0	0	0	0	0	0
Partener Share						
From Partners	0	0	0	0	0	0
Import	0	0	0	0	0	0
Export	-2452	-2602	-2911	-3041	-3003	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes		-44	-34	99	-41	0
Total Primary Energy Supply	-2452	-2646	-2945	-2942	-3044	0
Transfers						
Statistical Differences						
Transformation Sector	2495	2702	2910	3103	2977	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	2495	2702	2910	3103	2977	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	43	56	-35	161	-67	0
Total Final Consumption	0	0	0	0	0	0

Table 2-53 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	U	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	Export	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(17) Lubricants sector

The following Table is energy balance table for Lubricants sector. Some data in the energy balance table of lubricants sector are set in input sheet of LP model.

Table 2-54 Energy balance table for lubricant sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	0	0	0	0	0	0
Partener Share						
From Partners	0	0	0	0	0	0
Import	15	25	32	49	36	0
Export	-0.3	0	-0.15	0	0	0
International Marine Bunkers/Av	-0.07	-0.003	-0.053	-0.097	0	0
Stock Changes	0	0	0	0	0	0
Total Primary Energy Supply	14.63	24.997	31.797	48.903	36	0
Transfers						
Statistical Differences						
Transformation Sector	222	218	234	244	253	0
Public Electricity Plants	-10	-11	-11	-12	-13	0
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	232	229	245	256	266	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-6	-6	-6	-7	-7	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use	-6	-6	-6	-7	-7	0
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	230.63	236.997	259.797	285.903	282	0
Total Final Consumption	273	281	288	314	328	0

Table 2-55 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Oil refinery	
	Import	Import	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	Export	
	Bunkers	International marine bunkers	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(18) Bitumen sector

The following Table is energy balance table for Bitumen sector. Some data in the energy balance table of Bitumen sector are set in input sheet of LP model.

Table 2-56 Energy balance table for bitumen sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	0	0	0	0	0	0
Partener Share						
From Partners	0	0	0	0	0	0
Import	0	0	0	0	0	0
Export	-2.06	-0.18	-0.065	-0.27	-3.3	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes	0	0	0	0	0	0
Total Primary Energy Supply	-2.06	-0.18	-0.065	-0.27	-3.3	0
Transfers						
Statistical Differences						
Transformation Sector	690.6	727	714	807	954	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	690.6	727	714	807	954	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	688.54	726.82	713.935	806.73	950.7	0
Total Final Consumption	675	705	690	775	908	0

Table 2-57 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	Export	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(19) Petroleum coke sector

The following Table is energy balance table for petroleum coke sector. Some data in the energy balance table of petroleum coke sector are set in the input sheet of LP model.

Table 2-58 Energy balance table for petroleum coke sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	0	0	0	0	0	0
Partener Share						
From Partners	0	0	0	0	0	0
Import	0	0	0	0	0	0
Export	0	0	0	0	0	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes	0	0	0	0	0	0
Total Primary Energy Supply	0	0	0	0	0	0
Transfers						
Statistical Differences						
Transformation Sector	137.5	158	147.6	156.6	164	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	137.5	158	147.6	156.6	164	
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	137.5	158	147.6	156.6	164	0
Total Final Consumption	0	0	0	0	0	0

Table 2-59 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	U	
	Export	0	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(20) Petroleum Products Non- specified sector

The following Table is energy balance table for petroleum products non- specified sector. Some data in the energy balance table of petroleum products non- specified sector are set in the input sheet of LP model.

Table 2-60 Energy balance table for petroleum products non- specified

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	0	0	0	0	0	0
Partener Share						
From Partners	0	0	0	0	0	0
Import	28	28	155.4	210.4	187.4	0
Export	-52.07	-50.7	-51.38	-54.53	-38.2	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes	0	0	0	0	0	0
Total Primary Energy Supply	-24.07	-22.7	104.02	155.87	149.2	0
Transfers						
Statistical Differences						
Transformation Sector	173.2	174.7	170.5	170.1	181.5	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	173.2	174.7	170.5	170.1	181.5	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	149.13	152	274.52	325.97	330.7	0
Total Final Consumption	560.52	488.64	303	328	371	0

Table 2-61 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	U	
	Production	Transformation sector	
	Import	U	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	Total final demand	
	Export	Export	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	U	
	Total		

(21) Electricity sector

The following Table is energy balance table for electricity sector. Some data in the energy balance table of electricity sector are set in the input sheet of LP model.

Table 2-62 Energy balance table for electricity sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners	0	0	0	0	0	0
Import	0	0	0	0	0	0
Export	0	0	0	0	0	0
International Marine Bunkers/Av	0	0	0	0	0	0
Stock Changes	0	0	0	0	0	0
Total Primary Energy Supply	0	0	0	0	0	0
Transfers						
Statistical Differences						
Transformation Sector	51300	54444	57656	62336	68000	0
Public Electricity Plants	51300	54444	57656	62336	68000	0
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-1861.5	-1888.1	-2040.7	-2245	-2457.66	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity	-1861.5	-1888.1	-2040.7	-2245	-2457.66	
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses	-3040.3	-3022	-2836.6	-2984.78	-8900	
Total Final Consumption (Suup	46398.2	49533.9	52778.7	57106.22	56642.34	0
Total Final Consumption	43246	46338	49336	52977	56600	0

Table 2-63 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		U
	Initial-Stock	0	
	Production	0	
	Import	U	
	Bought	0	
	Receivables	Transformation sector	
	Total		
Consumption	Final Demand	Total final demand	
	Export	U	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	Distribution loss	
	Final-Stock	0	
	Total		

(22) Hydro electricity sector

The following Table is energy balance table for hydro electricity sector. Some data in the energy balance table of hydro electricity sector are set in the input sheet of LP model.

Table 2-64 Energy balance table for Hydro electricity sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	11413	11555	12000	12222	15000	0
Partener Share						
From Partners						
Import						
Export						
International Marine Bunkers/Aviation						
Stock Changes						
Total Primary Energy Supply	11413	11555	12000	12222	15000	0
Transfers						
Statistical Differences						
Transformation Sector	-11413	-11555	-12000	-12222	-15000	0
Public Electricity Plants	-11413	-11555	-12000	-12222	-15000	0
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-65 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Indigenous production	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transformation sector	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(23) Gas combined electricity sector

The following Table is energy balance table for gas combined electricity sector. Some data in the energy balance table of natural gas sector are set in the input sheet of LP model.

Table 2-67 Energy balance table for natural gas sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	9710	10168	10349	10610	11872	
Partener Share	-1834	-1875	-2236	-2777	-3480	
From Partners	0	0	0	0	0	
Import	1833	1876	2320	2715	3479	
Export	0	0	0	0	0	
International Marine Bunkers/Aviation	0	0	0	0	0	
Stock Changes	0	0	0	0	0	
Total Primary Energy Supply	9709	10169	10433	10548	11871	0
Transfers						
Statistical Differences			-108			
Transformation Sector	-6635	-6943	-7034	-6974	-7417	0
Public Electricity Plants	-6214	-6322	-6584	-6506	-6908	0
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry	-421	-621	-450	-468	-509	
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-172	-155	-179	-243	-285	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use	-172	-155	-179	-243	-285	0
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suuply)	2902	3071	3112	3331	4169	0
Total Final Consumption	2854	2983	3112	3300	3818	0

Table 2-68 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Public electricity Plants * Share of Gas combined* efficiency	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transformation sector	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(24) Coal steam electricity sector

The following Table is energy balance table for coal sector. Some data in the energy balance table of coal sector are set in the input sheet of coal steam electricity sector in LP model.

Table 2-69 Energy balance table for coal sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners						
Import	1852	1987	1620	1972	1661	
Export						
International Marine Bunkers/Aviation						
Stock Changes						
Total Primary Energy Supply	1852	1987	1620	1972	1661	0
Transfers						
Statistical Differences						
Transformation Sector	-1852	-1987	-1620	-1972	-1661	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens	-1852	-1987	-1620	-1972	-1661	
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-70 Data input from energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		0
	Initial-Stock	0	
	Production	0	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	U	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(25) Gas Turbine electricity sector

The following Table is energy balance table for natural gas sector. Some data in the energy balance table of natural gas sector are set in the input sheet of gas turbine electricity sector in LP model.

Table 2-71 Energy balance table for natural gas sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production	9710	10168	10349	10610	11872	
Partener Share	-1834	-1875	-2236	-2777	-3480	
From Partners	0	0	0	0	0	
Import	1833	1876	2320	2715	3479	
Export	0	0	0	0	0	
International Marine Bunkers/Aviation	0	0	0	0	0	
Stock Changes	0	0	0	0	0	
Total Primary Energy Supply	9709	10169	10433	10548	11871	0
Transfers						
Statistical Differences			-108			
Transformation Sector	-6635	-6943	-7034	-6974	-7417	0
Public Electricity Plants	-6214	-6322	-6584	-6506	-6908	0
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry	-421	-621	-450	-468	-509	
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-172	-155	-179	-243	-285	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use	-172	-155	-179	-243	-285	0
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suuply)	2902	3071	3112	3331	4169	0
Total Final Consumption	2854	2983	3112	3300	3818	0

Table 2-72 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Public electricity Plants * Share of Gas turbine* efficiency	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transformation sector	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(26) Diesel engine electricity sector

The following Table is energy balance table for diesel sector. Some data in the energy balance table of diesel sector are set in the input sheet of diesel engine electricity sector in LP model.

Table 2-73 Energy balance table for diesel sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99
Indigenous Production				0	
Partener Share					
From Partners		0	0	0	
Import	74	380	720	958	1598
Export		0	0	0	
International Marine Bunkers/Av	-284	-306	-257	-236	-243
Stock Changes		31	-13	10	4
Total Primary Energy Supply	-210	105	450	732	1359
Transfers					
Statistical Differences					
Transformation Sector	5319.6	5629.7	5614.6	5946.6	5935.5
Public Electricity Plants	-168	-180	-184	-208	-121
Autoproducer Electricity Plants					
Coke Ovens					
Gas Works					
For Blast Furnace Gas					
Petrochemical Industry					
Oil Refineries	5487.6	5809.7	5798.6	6154.6	6056.5
Liquefaction					
Non-specified (Transformation)					
Energy Sector Use	-377	-376	-400	-437	-462
Coal Mines					
Oil and Gas Extraction					
Coke Ovens use					
Gas Works use					
Oil Refineries use	-377	-376	-400	-437	-462
Own Use in Electricity					
Used for Pumped Storage					
Nuclear Industry					
Non-specified (Energy)					
Distribution Losses					
Total Final Consumption (Suup	4732.6	5358.7	5664.6	6241.6	6832.5
Total Final Consumption	4769	5294	5639	6157	6612

Table 2-74 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Public electricity Plants * efficiency	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transformation sector	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(27) Fuel oil steam electricity sector

The following Table is energy balance table for Fuel oil sector. Some data in the energy balance table of fuel oil sector are set in the input sheet of fuel oil steam electricity sector in LP model.

Table 2-75 Energy balance table for fuel oil sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production				0		
Partener Share						
From Partners	0	0	0	0		
Import	0	0	0	0		
Export	-3621	-2460	-2219	-1954	-1366	
International Marine Bunkers/Av	-1983	-2501	-2830	-2082	-2268	
Stock Changes		38	-47	26	-1	
Total Primary Energy Supply	-5604	-4923	-5096	-4010	-3635	0
Transfers						
Statistical Differences						
Transformation Sector	10041.9	9965.6	9759	9183	8444	0
Public Electricity Plants	-2170	-2591	-2926	-4101	-4329	
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries	12211.9	12556.6	12685	13284	12773	0
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	-652	-703	-655	-594	-559	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use	-652	-703	-655	-594	-559	
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suup	3785.9	4339.6	4008	4579	4250	0
Total Final Consumption	4560	5078	4841	5229	4909	0

Table 2-76 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Public electricity Plants * efficiency	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transformation sector	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(28) Solar and Wind electricity sector

The following Table is energy balance table for solar and wind electricity sector. Some data in the energy balance table of solar and wind electricity sector are set in the input sheet of LP model.

Table 2-77 Energy balance table for solar and wind sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners						
Import						
Export						
International Marine Bunkers/Aviation						
Stock Changes						
Total Primary Energy Supply	0	0	0	0	0	0
Transfers						
Statistical Differences						
Transformation Sector	0	0	0	0	0	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suupl	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-78 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Indigenous production	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	0	
	Export	0	
	Bunkers	0	
	Payables	Transformation sector	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

(29) Renewable sector

The following Table is energy balance table for renewable sector. Some data in the energy balance table of renewable sector are set in the input sheet of LP model.

Table 2-79 Energy balance table for renewable sector

Item	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000
Indigenous Production						
Partener Share						
From Partners						
Import						
Export						
International Marine Bunkers/Aviation						
Stock Changes						
Total Primary Energy Supply	0	0	0	0	0	0
Transfers						
Statistical Differences						
Transformation Sector	0	0	0	0	0	0
Public Electricity Plants						
Autoproducer Electricity Plants						
Coke Ovens						
Gas Works						
For Blast Furnace Gas						
Petrochemical Industry						
Oil Refineries						
Liquefaction						
Non-specified (Transformation)						
Energy Sector Use	0	0	0	0	0	0
Coal Mines						
Oil and Gas Extraction						
Coke Ovens use						
Gas Works use						
Oil Refineries use						
Own Use in Electricity						
Used for Pumped Storage						
Nuclear Industry						
Non-specified (Energy)						
Distribution Losses						
Total Final Consumption (Suupl	0	0	0	0	0	0
Total Final Consumption	0	0	0	0	0	0

Table 2-80 Data input from Energy balance table to the input sheet

To input sheet		From energy balance table	Fm Other resources
Supply	Capacity of production		Capacity
	Initial-Stock	0	
	Production	Indigenous production	
	Import	0	
	Bought	0	
	Receivables	0	
	Total		
Consumption	Final Demand	U	
	Export	0	
	Bunkers	0	
	Payables	0	
	Transformation	0	
	Energy Sector	0	
	Final-Stock	0	
	Total		

3. The optimization (LP sheet)

3.1 Logical structure of the model

(1) Matrix structure

The model uses linear programming method (LP method). Then the model consists of an objective function, variables and constrains. The variables are prepared for all supply and consumption items energy by energy and year by year. The constrains give some limitation to the variables. By the constrains, a feasible range for the variable is generated, and LP model searches the optimum solution in the range. The objective function is set in order to search the maximum profit by the LP model.

Table 3-1 Components of LP model in ESPM

Structure	Items	Contents
Constrains	Upper limit Lower limit Balance constrains	Constrain Supply and consumption items Constrain Supply and consumption items Co-products balance、Material balance Transformation, Own use, Stock balance
Variables	Initial stock Production Import Bought Receivable Domestic demand Export Bunker Payable Finial stock	Supply items Consumption items
Objective function	Prices & Cost Income Expense Profit	Prices and cost Calculated by sales and its price Calculated by energy consumption and cost Calculated by income and expense

(2) Definition of energies and energy conversion sectors

kinds of energies and energy sectors in the model are defined as the following table. Number of the energies is 30 and number of the energy sectors is 8 sectors. They are Coke, Crude oil, Natural gas, LPG, Refinery, Power, Renewable sector. The energy sectors consume several energies and produce other types of energies such as the following table.

Table 3-2 Energies and energy sectors

Sector	Consumption energies	30 energies
Coal sector		Coal
Coke sector	Coal	Coke
Crude oil sector		Crude oil
NG sector		Natural Gas, NGL, LPG(FD),LNG
LPG sector	LPG(FD)、LPG(RF)	LPG
Refinery sector	Crude oil NGL	Refinery feedstock, Refinery Gas、LPG (RF)、 Gasoline、Jet fuel、Kerosene、Diesel、Fuel oil, Naphtha、

		Lubricants & additives、Bitumen、Petroleum Coke, Non specified products
Power sector	Natural Gas Diesel Fuel oil	All electricity, Hydro, Gas combined, Gas Turbine, Diesel engine, Steam-coal Steam-Fuel oil, Solar-Wind-Other
Renewable		Renewable

LPG(FD) : field LPG, LPG(RF): Refinery LPG

(3) Definition of supply items and consumption items

Supply and consumption always keep equality through the buffer such as initial and final stocks. Other words, total energy supply strictly meet to total energy consumption including stock volume. In the model, five items such as initial stock, production, import, Bought and receivable are defined as supply side. And other seven items such as sales, export, bunker, payable, transformation, own use consumption and final stock are defined as consumption side. These items are generated the following expression.

Initial-Stock＋Production＋Import＋Bought + Receivable - (Sales＋Export＋Bunker +Payable＋Transformation +Own use + Final-Stock) = 0

And these items have upper limit and lower limit for generating their finite feasible area. The following table shows the relation of the above items (Variables), upper limits and lower limits.

Table 3-3 Components of supply and consumption side in ESPM

Side	Variables	Upper Limit	Lower Limit
Supply Side	Initial -Stock	Max stock value	Normally 0
	Production	Capacity Max production	Normally 0 Normally 0
	Import	Max import	Normally 0
	Bought	U (Except crude oil)	Normally 0
	Receivable	Decided internally	Normally 0
Consumption Side	Sales	Domestic demand	Normally 0
	Export	Max export	Normally 0
	Bunkers	Max Bunker sales	Normally 0
	Payable	Pay energy to partners Max payable	Pay energy to partners Normally 0
	Transformation	Decided internally	Normally 0
	Own use	Decided internally	Normally 0
	Final -Stock	Free	Normally 0

(4) Definition of Objective function

Income = Domestic sales value + Export value + Bunker value + Payable value
+ Transformation value + Own use value + Final stock

Expense =Production cost +Import cost +Bought cost+ Received cost + Initial stock cost

+ Tax

Profit value = Income - Expense

(5) LPM sheet

The LP model sheet has 12 blocks. The blocks are Efficiencies, Upper limit, Lower limit, Variable, Transformation, Energy sector use (Own use), Co-production, Receivable, Payable, Stock balance, Material balance and Profitability block. The each block has the above component matrix in their area.

Table 3-4 The structure of LP model sheet

Blocks	Number of lines
Efficiency & Yields	50 lines (Number of efficiencies & yields)
Upper limit	30 energies * 10 supply & consumption items
Lower limit	30 energies * 10 supply & consumption items
Variable	30 energies * 10 supply & consumption items
Transformation	30 energies
Energy sector use	30 energies
Co-production	30 energies
Receivable & Bought	30 energies
Payable	30 energies
Stock balance	30 energies
Material balance	30 energies
Profitability	30 energies

3.2 Setting efficiency

(1) Efficiency

In the efficiency area, efficiencies of coal to coke, natural gas to natural Gas liquid and LPG from Natural gas. Each Efficiency is defined by kton / kton and set year by year. These efficiencies are set from input sheet.

Table 3-5 Efficiency block in LIM

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Efficiencies	Coke	Coke / Coal		KTON/KTOI	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100
	NGL	NGL / NG		KTON/KTOI	0.1332	0.1292	0.1476	0.1591	0.1408	0.1408	0.1408
	FD-LPG	FD-LPG / NG		KTON/KTOI	0.0913	0.0917	0.0880	0.0884	0.0940	0.0940	0.0940
	LNG	LNG/NG		KTON/KTOI	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900

(2) Refinery yields from crude oil

Petroleum products yields from crude oil are defined by production share of petroleum products from crude oil. Then the summation of the all yields to crude oil is near to 1.0. These efficiencies are set from input sheet.

Table 3-6 Refinery Yield to crude oil in LIM

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Yields	Refinery from c	Refinery Gas		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Crude oil	RF-LPG		KTON/KTOI	0.0112	0.0121	0.0104	0.0100	0.0095	0.0095	0.0095
		Gasoline		KTON/KTOI	0.0705	0.0704	0.0694	0.0705	0.0727	0.0727	0.0727
		Jet fuel		KTON/KTOI	0.0335	0.0314	0.0315	0.0305	0.0305	0.0305	0.0305
		Kerosene		KTON/KTOI	0.0398	0.0418	0.0389	0.0333	0.0328	0.0328	0.0328
		Diesel		KTON/KTOI	0.2091	0.2186	0.2107	0.2183	0.2186	0.2186	0.2186
		Fuel oil		KTON/KTOI	0.4773	0.4840	0.4740	0.4850	0.4867	0.4867	0.4867
		Naphtha		KTON/KTOI	0.0828	0.0888	0.0915	0.0948	0.0880	0.0880	0.0880
		Lubricants & additives		KTON/KTOI	0.0094	0.0083	0.0094	0.0095	0.0095	0.0095	0.0095
		Bitumen		KTON/KTOI	0.0271	0.0281	0.0272	0.0294	0.0295	0.0295	0.0295
		Petroleum Coke		KTON/KTOI	0.0052	0.0063	0.0052	0.0053	0.0053	0.0053	0.0053
		Non specified products		KTON/KTOI	0.0062	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063
		Crude oil		KTON/KTOI	-0.9721	-0.9961	-0.9745	-0.9927	-0.9894	-0.9894	-0.9894

(3) Refinery yields from NGL

Petroleum product yields from NGL are defined by production share of petroleum products from NGL. Then the summation of the all yields to NGL is near to 1.0. These efficiencies are set from input sheet.

Table 3-7 Refinery Yield to NGL in LIM

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Yields	Refinery from N	Refinery Gas		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	NGL	RF-LPG		KTON/KTOI	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338
		Gasoline		KTON/KTOI	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338	0.1338
		Jet fuel		KTON/KTOI	0.0210	0.0210	0.0210	0.0210	0.0210	0.0210	0.0210
		Kerosene		KTON/KTOI	0.1717	0.1717	0.1717	0.1717	0.1717	0.1717	0.1717
		Diesel		KTON/KTOI	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300	0.1300
		Fuel oil		KTON/KTOI	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
		Naphtha		KTON/KTOI	0.3660	0.3660	0.3660	0.3660	0.3660	0.3660	0.3660
		Lubricants & additives		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Bitumen		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Petroleum Coke		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Non specified products		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		NGL		KTON/KTOI	-0.9697	-0.9697	-0.9697	-0.9697	-0.9697	-0.9697	-0.9697

(4) Own use yields of refinery

Refinery plant consumes some petroleum products, they are diesel oil, fuel oil, refinery gas, lubricants & additives and natural gas. The natural gas is used at starting up of refinery plant. Own use yields are defined by own use oil consumption to refinery feedstock (crude oil consumption + NGL consumption). These efficiencies are set from input sheet.

Table 3-8 Own use yield in LIM

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Yields	Refinery	Diesel to Refinery feed		KTON/KTOI	0.0140	0.0140	0.0140	0.0150	0.0160	0.0160	0.0160
	Own use	Fuel oil to Refnery feed		KTON/KTOI	0.0240	0.0260	0.0240	0.0210	0.0190	0.0190	0.0190
		Refinery Gas to Refinery Gas produce		KTON/KTOI	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		Lubricants & additives to Lubricants p		KTON/KTOI	0.0260	0.0260	0.0240	0.0270	0.0260	0.0260	0.0260
		Natural Gas to Refinery feed		KTON/KTOI	0.0065	0.0057	0.0064	0.0084	0.0098	0.0098	0.0098

(5) Partner's shares

Regarding to production of crude oil, natural gas and NGL, Egypt has contracts which are sharing the production with their partners. By the contracts, 40% of the crude oil production, 30% of natural gas production and 32% of NGL have to be shared to the partners. These efficiencies are set from input sheet.

Table 3-9 Partners share in LIM

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Partners	Shares	Crude oil		KTON/KTOI	0.3500	0.3550	0.3580	0.3660	0.3710	0.4000	0.4000
		Natural Gas		KTON/KTOI	0.1890	0.1840	0.2160	0.2620	0.2930	0.3000	0.3000
		NGL		KTON/KTOI	0.2230	0.2160	0.2750	0.3070	0.3110	0.3200	0.3200
		FD-LPG		KTON/KTOI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

.(6) Efficient of power

There are several types of power generators in Egypt. They are natural gas combined power generator, natural gas turbine power generator, diesel-engine power generator and fuel oil steam power generator. Power efficiencies for the power generators are required in the model.

The power efficiencies are described by Gwh / kton. The actual data are collected from energy balance data sheet. And the future power efficiencies are set by the latest actual data. The power also has distribution loss and own use power. The distribution loss is estimated by the actual data. These efficiencies are set from input sheet.

Table 3-10 Efficient of power in LIM

ITEMS 1	ITEMS 2	SECTORS		UNIT	1994	1995	1996	1997	1998	1999	2000
Efficiencies	Power	Power / Natural gas combined		GWh/KTON	5.5684	5.5684	5.5684	5.5684	5.5684	5.5684	5.5684
		Power / Coal(Thermal)		GWh/KTON	2.8358	2.8358	2.8358	2.8358	2.8358	2.8358	2.8358
		Power / Natural gas(Turbine)		GWh/KTON	3.0232	3.0232	3.0232	3.0232	3.0232	3.0232	3.0232
		Power / Diesel		GWh/KTON	3.9665	3.9665	3.9665	3.9665	3.9665	3.9665	3.9665
		Power / Fuel(Steam)		GWh/KTON	4.5000	4.1140	4.1140	4.1140	4.1140	4.1140	4.1140
		Distribution Loss		GWh/GWh	0.1250	0.1180	0.1130	0.1180	0.1359	0.1200	0.1200
		Own use of power		GWh/GWh	0.0300	0.0300	0.0300	0.0300	0.0200	0.0200	0.0200
Stock cost rate		Interest		%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Power / Coal : Coal steam power generator : There is no generator in current Egypt. But there is possibility for the generator to be installed in future.

3.3 Upper limit

(1) Upper limit of capacity

Upper limit of capacity is constrains for production variables as well as the upper limit of the maximum production. Upper limit of capacity can take tree type of value, 0, some value and 9999999.

Capacity value 0 shows that the sectors do not have any plant. Coal, LPG, Power distribution and Solar-Wind-Other sectors do not have plants. Then these sectors have value 0 for upper limit of capacity. If you set value 0 for capacity to the existing plants, the plants can not work in the year. That is, the production of the plants in the year are 0.

Capacity set by some value without 0 and 9999999 show that the sectors have capacity constrains. The production of the plants are calculated under the capacity. The value are set in input sheet. The value are passed from input sheet to LP matrix internally.

Capacity value 9999999 shows that the sectors are not set any upper limit of capacity. When you set “U” (means Unlimited) for capacity in input sheet, upper limit value of capacity in LP matrix are set by 9999999.

[Conditions of Upper limit]

IF plant does not exist

Then upper limit =0

Else upper limit = U or some value

Table 3- 11 Upper limit of capacity in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Capacity	Coal	KTON	53	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Coke	KTON	105	2000	2000	2000	2000	2000	2000	2000
		Crude oil	KTON	157	40000	40000	40000	40000	40000	40000	40000
		Natural gas	KTON	209	20000	20000	20000	20000	20000	20000	20000
		NGL	KTON	261	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		FD-LPG	KTON	313	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		LPG distribution	KTON	365	0	0	0	0	0	0	0
		LNG	KTON	417	0	0	0	0	0	0	0
		Feedstock	KTON	469	30000	30000	30000	30000	30000	30000	30000
		RF-Gas	KTON	521	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		RF-LPG	KTON	573	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Gasoline	KTON	625	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Jet fuel	KTON	677	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Kerosene	KTON	729	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Diesel	KTON	781	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Fuel oil	KTON	833	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Naphtha	KTON	885	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Lubricants & additives	KTON	937	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Bitumen	KTON	989	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Petroleum Coke	KTON	1041	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Non specified products	KTON	1093	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power distribution	GWh	1145	0	0	0	0	0	0	0
		Power Hydro	GWh	1197	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas combined	GWh	1249	24222	24642	25664	25360	26927	27000	27000
		Power Coal steam	GWh	1301	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1353	5636	5734	5971	5901	6265	7000	7000
		Power Diesel engine	GWh	1405	666	714	730	825	480	480	480
		Power Fuel oil steam	GWh	1457	9765	10659	12038	16872	17810	19591	21550
		Power Solar Wind Other	GWh	1509	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Renewable	KTON	1561	9999999	9999999	9999999	9999999	9999999	9999999	9999999

(2) Upper limit of initial stock

Upper limit of initial stock is constrains for initial stock . Upper limit of initial stock can take tree type of value, 0, a value and 9999999.

Value 0 of initial stock shows that the sectors can not have any initial stock. Usually, first year of the model has to be set by 0 and from the second year, it is better for initial stock to be set with 9999999.

A value of initial stock without 0 and 9999999 shows that the sectors have initial stock of the value.

Value 9999999 of initial stock shows that the sector is not set any upper limit of initial stock. When you set "U" (means Unlimit) for initial stock in input sheet, upper limit value of initial stock in LP matrix are set by 9999999.

[Conditions of Upper limit]

IF Upper limit (First year) = 0 and Upper limit(Other years) = 9999999

Then Normal,

IF Upper limit (First year) = 0 and Upper limit(Other years) = 0

Then abnormal, you can not stock any surplus energies.

Else Intentional set

Table 3- 12 Upper limit of initial stock in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Initial-Stock	Coal	KTON	56	0	0	0	0	0	0	0
		Coke	KTON	108	0	9999999	9999999	9999999	9999999	9999999	9999999
		Crude oil	KTON	160	0	9999999	9999999	9999999	9999999	9999999	9999999
		Natural gas	KTON	212	0	9999999	9999999	9999999	9999999	9999999	9999999
		NGL	KTON	264	0	9999999	9999999	9999999	9999999	9999999	9999999
		FD-LPG	KTON	316	0	9999999	9999999	9999999	9999999	9999999	9999999
		LPG distribution	KTON	368	0	9999999	9999999	9999999	9999999	9999999	9999999
		LNG	KTON	420	0	0	0	0	0	0	0
		Feedstock	KTON	472	0	9999999	9999999	9999999	9999999	9999999	9999999
		RF-Gas	KTON	524	0	9999999	9999999	9999999	9999999	9999999	9999999
		RF-LPG	KTON	576	0	9999999	9999999	9999999	9999999	9999999	9999999
		Gasoline	KTON	628	0	0	0	0	0	0	0
		Jet fuel	KTON	680	0	9999999	9999999	9999999	9999999	9999999	9999999
		Kerosene	KTON	732	0	9999999	9999999	9999999	9999999	9999999	9999999
		Diesel	KTON	784	0	9999999	9999999	9999999	9999999	9999999	9999999
		Fuel oil	KTON	836	0	9999999	9999999	9999999	9999999	9999999	9999999
		Naphtha	KTON	888	0	9999999	9999999	9999999	9999999	9999999	9999999
		Lubricants & additives	KTON	940	0	9999999	9999999	9999999	9999999	9999999	9999999
		Bitumen	KTON	992	0	9999999	9999999	9999999	9999999	9999999	9999999
		Petroleum Coke	KTON	1044	0	9999999	9999999	9999999	9999999	9999999	9999999
		Non specified products	KTON	1096	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power distribution	GWh	1148	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Hydro	GWh	1200	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas combined	GWh	1252	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Coal steam	GWh	1304	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas turbine	GWh	1356	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Diesel engine	GWh	1408	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Fuel oil steam	GWh	1460	0	9999999	9999999	9999999	9999999	9999999	9999999
		Power Solar Wind Other	GWh	1512	0	0	0	0	0	0	0
		Renewable	KTON	1564	0	9999999	9999999	9999999	9999999	9999999	9999999

(3) Upper limit of production

Upper limit of production means the max production of the plants, Production of each plant are constrained by upper limit of capacity as well as the max production. Upper limit of production can take tree type of value such as 0, some value and 9999999.

Value 0 of upper limit production shows that the energy sectors do not have a plant or can not produce any production.

Some value of upper limit production without 0 and 9999999 shows that the sectors have maximum production of the value.

Value 9999999 of upper limit production shows that max production is unlimited. In the case, production of the energy sector is constrained by the capacity or demand items.

[Conditions of Upper limit]

IF Upper limit = 9999999

Then Normal, Max production <= Capacity

IF Upper limit = 0

Then no production

Else intentional set

Table 3- 13 Upper limit of Production in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Production	Coal	KTON	59	0	0	34	93	0	40	50
		Coke	KTON	111	1361	1468	1460	1440	0	1499	1524
		Crude oil	KTON	163	44292	43994	41782	40293	39516	39507	39853
		Natural gas	KTON	215	9710	10168	10349	10610	11872	12884	13869
		NGL	KTON	267	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		FD-LPG	KTON	319	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		LPG distribution	KTON	371	0	0	0	0	0	0	0
		LNG	KTON	423	0	0	0	0	0	0	0
		Feedstock	KTON	475	26632	26983	27999	28775	29053	9999999	9999999
		RF-Gas	KTON	527	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		RF-LPG	KTON	579	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Gasoline	KTON	631	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Jet fuel	KTON	683	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Kerosene	KTON	735	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Diesel	KTON	787	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Fuel oil	KTON	839	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Naphtha	KTON	891	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Lubricants & additives	KTON	943	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Bitumen	KTON	995	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Petroleum Coke	KTON	1047	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Non specified products	KTON	1099	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power distribution	GWh	1151	0	0	0	0	0	0	0
		Power Hydro	GWh	1203	11413	11555	12000	12222	15000	15282	15550
		Power Gas combined	GWh	1255	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Coal steam	GWh	1307	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas turbine	GWh	1359	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Diesel engine	GWh	1411	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Fuel oil steam	GWh	1463	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Solar Wind Other	GWh	1515	22	28	23	24	25	67	445
		Renewable	KTON	1567	95	94	94	95	96	99	100

(4) Upper limit of Import

Upper limit of import shows the max import which the energy sector can import. Upper limit of import can take tree type of value, 0, a value and 9999999.

Value 0 of upper limit (Import) shows that the energy sectors can not import any energies.

A value of upper limit (Import) without 0 and 9999999 shows that the sectors have maximum import of the value.

Value 9999999 of upper limit (Import) shows that max import is unlimited. If you do not have any scenario related to import, it is better to set "U" in upper limit of import in LIM sheet. By doing so, upper limit of import has a value of 9999999 in LPM sheet.

[Conditions of Upper limit]

IF Upper limit = U

Then Normal, in

IF Upper limit = 0

Then Abnormal, you can not import shortage energies.

Else intentional set

Table 3- 14 Upper limit of Import in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Import	Coal	KTON	62	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Coke	KTON	114	9999999	9999999	9999999	9999999	9999999	0	0
		Crude oil	KTON	166	0	0	0	0	0	0	0
		Natural gas	KTON	218	0	0	0	0	0	0	0
		NGL	KTON	270	0	0	0	0	0	0	0
		FD-LPG	KTON	322	0	0	0	0	0	0	0
		LPG distribution	KTON	374	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		LNG	KTON	426	0	0	0	0	0	0	0
		Feedstock	KTON	478	0	0	0	0	0	0	0
		RF-Gas	KTON	530	0	0	0	0	0	0	0
		RF-LPG	KTON	582	0	0	0	0	0	0	0
		Gasoline	KTON	634	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Jet fuel	KTON	686	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Kerosene	KTON	738	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Diesel	KTON	790	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Fuel oil	KTON	842	0	0	0	0	0	0	0
		Naphtha	KTON	894	0	0	0	0	0	0	0
		Lubricants & additives	KTON	946	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Bitumen	KTON	998	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Petroleum Coke	KTON	1050	0	0	0	0	0	0	0
		Non specified products	KTON	1102	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power distribution	GWh	1154	0	0	0	0	0	9999999	9999999
		Power Hydro	GWh	1206	0	0	0	0	0	0	0
		Power Gas combined	GWh	1258	0	0	0	0	0	0	0
		Power Coal steam	GWh	1310	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1362	0	0	0	0	0	0	0
		Power Diesel engine	GWh	1414	0	0	0	0	0	0	0
		Power Fuel oil steam	GWh	1466	0	0	0	0	0	0	0
		Power Solar Wind Other	GWh	1518	0	0	0	0	0	0	0
		Renewable	KTON	1570	0	0	0	0	0	0	0

(5) Upper limit of Bought

Upper limit of Bought shows the max Bought from partners. Upper limit of Bought can take tree type of value such as 0, a value and 9999999.

Value 0 of upper limit (Bought) shows that the energy sectors can not buy any energy production from the partners. If the energy sector do not have partner's share, you should set value 0 for upper limit of Bought.

A value of upper limit (Bought) without 0 and 9999999 shows that the sectors have maximum bought of the value from partners. Only crude oil sector have this type of value. Bought of Natural gas and NGL are decided in LP model. The bought value equals to partner's shares.

Value 9999999 of upper limit (Bought) shows that max Bought is unlimited. This type of upper limit are set for only Natural gas and NGL.

[Conditions of Upper limit]

IF Upper limit = 0

Then Normal, in case of no partners

IF Upper limit = value in Crude oil

Then Normal

IF Upper limit = 999999999 in case of Natural gas and NGL

Then Normal

Else Then Abnormal

Table 3 -15 Upper limit of Bought in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Bought	Coal	KTON	65	0	0	0	0	0	0	0
		Coke	KTON	117	0	0	0	0	0	0	0
		Crude oil	KTON	169	4975	5318	6319	6226	6060	6100	6100
		Natural gas	KTON	221	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		NGL	KTON	273	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		FD-LPG	KTON	325	0	0	0	0	0	0	0
		LPG distribution	KTON	377	0	0	0	0	0	0	0
		LNG	KTON	429	0	0	0	0	0	0	0
		Feedstock	KTON	481	0	0	0	0	0	0	0
		RF-Gas	KTON	533	0	0	0	0	0	0	0
		RF-LPG	KTON	585	0	0	0	0	0	0	0
		Gasoline	KTON	637	0	0	0	0	0	0	0
		Jet fuel	KTON	689	0	0	0	0	0	0	0
		Kerosene	KTON	741	0	0	0	0	0	0	0
		Diesel	KTON	793	0	0	0	0	0	0	0
		Fuel oil	KTON	845	0	0	0	0	0	0	0
		Naphtha	KTON	897	0	0	0	0	0	0	0
		Lubricants & additives	KTON	949	0	0	0	0	0	0	0
		Bitumen	KTON	1001	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1053	0	0	0	0	0	0	0
		Non specified products	KTON	1105	0	0	0	0	0	0	0
		Power distribution	GWh	1157	0	0	0	0	0	0	0
		Power Hydro	GWh	1209	0	0	0	0	0	0	0
		Power Gas combined	GWh	1261	0	0	0	0	0	0	0
		Power Coal steam	GWh	1313	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1365	0	0	0	0	0	0	0
		Power Diesel engine	GWh	1417	0	0	0	0	0	0	0
		Power Fuel oil steam	GWh	1469	0	0	0	0	0	0	0
		Power Solar Wind Other	GWh	1521	0	0	0	0	0	0	0
		Renewable	KTON	1573	0	0	0	0	0	0	0

(6) Upper limit of Receivable

Upper limit of Receivable shows the max Receivable from other plants. Power distribution sector and LPG distribution sector have receivable. Upper limit of Receivable can take tree type of value such as 0, a value and 9999999.

Value 0 of upper limit (Receivable) shows that the energy sectors can not receive any energy production from other plants. All of the sectors have value 0 for upper limit of receivable without Power distribution and LPG distribution sector.

A value of upper limit (Receivable) without 0 and 9999999 shows that the sectors have maximum receivable of the value from other plants. Usually you do not set a value for upper limit of receivable in future terms.

Value 9999999 of upper limit of (Receivable) shows that max Receivable is unlimited. It is better to set "U" in upper limit of Receivable of power distribution and LPG distribution sector in future terms in LIM sheet.

[Conditions of Upper limit]

IF Receivable = 0 in case of sectors except Power distribution and LPG distribution
Then Normal
IF Receivable = 9999999 in case of Power distribution and LPG distribution
Then Normal
Else Abnormal

Table 3 - 16 Upper limit of Receivable in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Receivables	Coal	KTON	68	0	0	0	0	0	0	0
		Coke	KTON	120	0	0	0	0	0	0	0
		Crude oil	KTON	172	0	0	0	0	0	0	0
		Natural gas	KTON	224	0	0	0	0	0	0	0
		NGL	KTON	276	0	0	0	0	0	0	0
		FD-LPG	KTON	328	0	0	0	0	0	0	0
		LPG distribution	KTON	380	1254	1378	1429	1444	1440	9999999	9999999
		LNG	KTON	432	0	0	0	0	0	0	0
		Feedstock	KTON	484	0	0	0	0	0	0	0
		RF-Gas	KTON	536	0	0	0	0	0	0	0
		RF-LPG	KTON	588	0	0	0	0	0	0	0
		Gasoline	KTON	640	0	0	0	0	0	0	0
		Jet fuel	KTON	692	0	0	0	0	0	0	0
		Kerosene	KTON	744	0	0	0	0	0	0	0
		Diesel	KTON	796	0	0	0	0	0	0	0
		Fuel oil	KTON	848	0	0	0	0	0	0	0
		Naphtha	KTON	900	0	0	0	0	0	0	0
		Lubricants & additives	KTON	952	0	0	0	0	0	0	0
		Bitumen	KTON	1004	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1056	0	0	0	0	0	0	0
		Non specified products	KTON	1108	0	0	0	0	0	0	0
		Power distribution	GWh	1160	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Hydro	GWh	1212	0	0	0	0	0	0	0
		Power Gas combined	GWh	1264	0	0	0	0	0	0	0
		Power Coal steam	GWh	1316	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1368	0	0	0	0	0	0	0
		Power Diesel engine	GWh	1420	0	0	0	0	0	0	0
		Power Fuel oil steam	GWh	1472	0	0	0	0	0	0	0
		Power Solar Wind Other	GWh	1524	0	0	0	0	0	0	0
		Renewable	KTON	1576	0	0	0	0	0	0	0

(7) Upper limit of Domestic demand

Upper limit of Domestic demand shows the max domestic demand. Coke, natural gas, LPG distribution, Gasoline, Jet, Kerosene, Diesel, Fuel oil, Lubricants, Bitumen, Petroleum coke, None specified products and Power. Upper limit of domestic demand can take tree type of value such as 0, a value and 9999999.

Value 0 of upper limit (Domestic demand) shows that the energy sectors can not sell any energy production to domestic market.

A value of upper limit (Domestic demand) without 0 and 9999999 shows that the sectors have maximum domestic demand of the value. Usually you have to set a value for upper limit of domestic demand.

Value 9999999 of upper limit (Domestic demand) shows that the max domestic demand is unlimited. When the domestic demand is constrained by supply side, you can set "U" in Upper limit of domestic demand of future terms in LIM sheet.

[Conditions of Upper limit]

IF Upper limit = 0

Then no domestic demand

IF Upper limit =9999999

Then supply should have some constrain or error

IF Upper limit = value

Then intentional set

Table 3 - 17 Upper limit of Domestic demand in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Domestic Dema	Coal	KTON	74	0	0	0	0	0	0	0
		Coke	KTON	126	887	730	1026	849	0	923	957
		Crude oil	KTON	178	0	0	0	0	0	0	0
		Natural gas	KTON	230	2433	2362	2662	2832	3309	3487	3690
		NGL	KTON	282	0	0	0	0	0	0	0
		FD-LPG	KTON	334	0	0	0	0	0	0	0
		LPG distribution	KTON	386	1299	1475	1645	1868	2112	2313	2503
		LNG	KTON	438	0	0	0	0	0	0	0
		Feedstock	KTON	490	0	0	0	0	0	0	0
		RF-Gas	KTON	542	0	0	0	0	0	0	0
		RF-LPG	KTON	594	0	0	0	0	0	0	0
		Gasoline	KTON	646	1934	1972	2024	2155	2205	2346	2456
		Jet fuel	KTON	698	378	445	416	408	418	428	437
		Kerosene	KTON	750	1380	1298	1228	1159	1074	978	882
		Diesel	KTON	802	4769	5294	5639	6157	6612	7000	7413
		Fuel oil	KTON	854	3908	4375	4186	4635	4350	4388	4426
		Naphtha	KTON	906	0	0	0	0	0	0	0
		Lubricants & additives	KTON	958	283	292	299	326	341	355	370
		Bitumen	KTON	1010	675	705	690	775	908	928	951
		Petroleum Coke	KTON	1062	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Non specified products	KTON	1114	561	561	561	561	561	561	561
		Power distribution	GWh	1166	43246	46338	49336	52977	56600	60031	63686
		Power Hydro	GWh	1218	0	0	0	0	0	0	0
		Power Gas combined	GWh	1270	0	0	0	0	0	0	0
		Power Coal steam	GWh	1322	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1374	0	0	0	0	0	0	0
		Power Diesel engine	GWh	1426	0	0	0	0	0	0	0
		Power Fuel oil steam	GWh	1478	0	0	0	0	0	0	0
		Power Solar Wind Other	GWh	1530	0	0	0	0	0	0	0
		Renewable	KTON	1582	95	94	94	95	96	99	100

(8) Upper limit of Export

Upper limit of Export shows the max export. Coke, natural gas, Jet, Fuel oil, Naphtha, None specified products are have export. Future, LNG and/or Pipeline natural gas will be exported. Upper limit of domestic demand can take tree type of value such as 0, a value and 9999999.

Value 0 of upper limit (Export) shows that the energy sectors can not export any energy production to foreign countries.

A value of upper limit (Export) without 0 and 9999999 shows that the sectors have maximum export of the value. Usually you have to set a value for upper limit of export if it is possible to export.

Value 9999999 of upper limit (Export) shows that the maximum export is unlimited. If some energies are surplus stock, it is better to set "U" in Upper limit of export in LIM sheet. By doing so, the LP model will export the energies from the final stock.

[Conditions of Upper limit]

IF Upper limit = 0

Then no export

IF Upper limit =9999999

Then supply should have some constrain or error

IF Upper limit = value

Then intentional set

Table 3 - 18 Upper limit of Export in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Export	Coal	KTON	77	0	0	34	93	0	9999999	9999999
		Coke	KTON	129	325	466	512	464	0	9999999	9999999
		Crude oil	KTON	181	7973	7864	6642	3968	2934	2354	1982
		Natural gas	KTON	233	0	0	0	0	0	0	0
		NGL	KTON	285	0	0	0	0	0	0	0
		FD-LPG	KTON	337	0	0	0	0	0	0	0
		LPG distribution	KTON	389	0	0	0	0	0	0	0
		LNG	KTON	441	0	0	0	0	0	0	0
		Feedstock	KTON	493	0	0	0	0	0	0	0
		RF-Gas	KTON	545	0	0	0	0	0	0	0
		RF-LPG	KTON	597	0	0	0	0	0	0	0
		Gasoline	KTON	649	33	0	0	0	0	0	0
		Jet fuel	KTON	701	215	71	0	104	103	9999999	9999999
		Kerosene	KTON	753	0	0	0	0	0	9999999	9999999
		Diesel	KTON	805	0	0	0	0	0	9999999	9999999
		Fuel oil	KTON	857	3621	2460	2219	1954	1366	9999999	9999999
		Naphtha	KTON	909	2452	2602	2911	3041	3003	3123	3240
		Lubricants & additives	KTON	961	0	0	0	0	0	0	0
		Bitumen	KTON	1013	2	0	0	0	3	72	88
		Petroleum Coke	KTON	1065	0	0	0	0	0	0	0
		Non specified products	KTON	1117	52	51	51	55	38	0	0
		Power distribution	GWh	1169	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Hydro	GWh	1221	0	0	0	0	0	0	0
		Power Gas combined	GWh	1273	0	0	0	0	0	0	0
		Power Coal steam	GWh	1325	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1377	0	0	0	0	0	0	0
		Power Diesel engine	GWh	1429	0	0	0	0	0	0	0
		Power Fuel oil steam	GWh	1481	0	0	0	0	0	0	0
		Power Solar Wind Other	GWh	1533	0	0	0	0	0	0	0
		Renewable	KTON	1585	0	0	0	0	0	9999999	9999999

(9) Upper limit of Bunker

Upper limit of Bunker shows the max Bunker demand. Jet, Diesel and gasoline have Bunker demand. Bunker demand should be supplied preferentially, because Bunker demand have transportation fuel contract between two countries. Upper limit of domestic demand can take two type of value such as 0 and a value.

Value 0 of upper limit (Bunkers) shows that the energy sectors can not have bunker demand.

A value of upper limit (Bunkers) without 0 and 9999999 shows that the sectors have maximum bunker demand of the value. If energy sector has Bunker demand, the bunker demand should be set upper limit and lower limit of the Bunker demand. By doing so, the bunker demand is supplied preferentially by LP model.

Value 9999999 of upper limit (Bunkers) is not permitted.

[Conditions of Upper limit]

IF Upper limit = 0

Then No bunkers

IF Upper limit =U

Then supply should have some constrain or error

IF Upper limit = value

Then intentional set

Table 3 - 19 Upper limit of Bunkers in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Bunkers	Coal	KTON	80	0	0	0	0	0	0	0
		Coke	KTON	132	0	0	0	0	0	0	0
		Crude oil	KTON	184	0	0	0	0	0	0	0
		Natural gas	KTON	236	0	0	0	0	0	0	0
		NGL	KTON	288	0	0	0	0	0	0	0
		FD-LPG	KTON	340	0	0	0	0	0	0	0
		LPG distribution	KTON	392	0	0	0	0	0	0	0
		LNG	KTON	444	0	0	0	0	0	0	0
		Feedstock	KTON	496	0	0	0	0	0	0	0
		RF-Gas	KTON	548	0	0	0	0	0	0	0
		RF-LPG	KTON	600	0	0	0	0	0	0	0
		Gasoline	KTON	652	0	0	0	0	0	0	0
		Jet fuel	KTON	704	234	251	419	366	412	336	357
		Kerosene	KTON	756	0	0	0	0	0	0	0
		Diesel	KTON	808	284	306	257	236	243	243	243
		Fuel oil	KTON	860	1983	2501	2830	2082	2268	2333	2403
		Naphtha	KTON	912	0	0	0	0	0	0	0
		Lubricants & additives	KTON	964	0	0	0	0	0	0	0
		Bitumen	KTON	1016	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1068	0	0	0	0	0	0	0
		Non specified products	KTON	1120	0	0	0	0	0	0	0
		Power distribution	GWh	1172	0	0	0	0	0	0	0
		Power Hydro	GWh	1224	0	0	0	0	0	0	0
		Power Gas combined	GWh	1276	0	0	0	0	0	0	0
		Power Coal steam	GWh	1328	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1380	0	0	0	0	0	0	0
		Power Diesel engine	GWh	1432	0	0	0	0	0	0	0
		Power Fuel oil steam	GWh	1484	0	0	0	0	0	0	0
		Power Solar Wind Other	GWh	1536	0	0	0	0	0	0	0
		Renewable	KTON	1588	0	0	0	0	0	0	0

(10) Upper limit of Payable

Upper limit of Payable shows the max Payable. Crude oil, Natural gas and NGL have partner shares, the partner's shares pay through Payable. And LPG from FD-LPG and RF-LPG sector go to LPG distribution sector through Payable. Also, Power from Hydro power, Gas turbine, Gas combined, Diesel engine, fuel oil steam, Coal steam and Solar, Wind and Other is send to Power distribution sector through Payable. Upper limit of Payable can take tree type of value such as 0, a value and 9999999.

Value 0 of upper limit (Payable) shows that the energy sectors can not have any payable.

A value of upper limit (Payable) shows that the energy sector has payable. In the actual term, it is better to set a value in upper limit of Payable if the sector has payable.

Value 9999999 of upper limit (Payable) shows that the energy sector has payable and the value is calculated in LP model. In the future term, it is better to set 99999999 in upper limit of Payable if the sector has payable. Because all payable values are calculated in LP model.

[Conditions of Upper limit]

IF Upper limit = 0

Then no payable

IF Upper limit =9999999

Then supply should have some constrain or error

IF Upper limit = value

Then intentional set

Table 3 - 20 Upper limit of Payable in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Payable	Coal	KTON	83	0	0	0	0	0	0	0
		Coke	KTON	135	0	0	0	0	0	0	0
		Crude oil	KTON	187	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Natural gas	KTON	239	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		NGL	KTON	291	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		FD-LPG	KTON	343	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		LPG distribution	KTON	395	0	0	0	0	0	0	0
		LNG	KTON	447	0	0	0	0	0	0	0
		Feedstock	KTON	499	0	0	0	0	0	0	0
		RF-Gas	KTON	551	0	0	0	0	0	0	0
		RF-LPG	KTON	603	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Gasoline	KTON	655	0	0	0	0	0	0	0
		Jet fuel	KTON	707	0	0	0	0	0	0	0
		Kerosene	KTON	759	0	0	0	0	0	0	0
		Diesel	KTON	811	0	0	0	0	0	0	0
		Fuel oil	KTON	863	0	0	0	0	0	0	0
		Naphtha	KTON	915	0	0	0	0	0	0	0
		Lubricants & additives	KTON	967	0	0	0	0	0	0	0
		Bitumen	KTON	1019	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1071	0	0	0	0	0	0	0
		Non specified products	KTON	1123	0	0	0	0	0	0	0
		Power distribution	GWh	1175	0	0	0	0	0	0	0
		Power Hydro	GWh	1227	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas combined	GWh	1279	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Coal steam	GWh	1331	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas turbine	GWh	1383	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Diesel engine	GWh	1435	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Fuel oil steam	GWh	1487	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Solar Wind Other	GWh	1539	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Renewable	KTON	1591	0	0	0	0	0	0	0

(11) Upper limit of Final-stock

Upper limit of Final stock shows the max final stock. Upper limit of final stock can take tree type of value such as 0, a value and 9999999.

Value 0 of upper limit (Final-stock) shows that the energy sectors can not have any final stock and initial stock of the next year. Regarding to all energy sectors, the following expression is kept for initial stock and final stock.

The previous final stock = The current initial stock

A value of upper limit (Final stock) shows that the energy sector has final stock. In the actual yeras, it is sometimes happened to set a value in final stock.

Value 9999999 of upper limit (Final-stock) shows that the energy sectors can have final stock freely. Usually final stock is set by 9999999.

[Conditions of Upper limit]

IF Upper limit = 9999999

Then normal

Else Intentional set

Table 3 - 21 Upper limit of final-stock in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Upper Limit	Final-Stock	Coal	KTON	92	0	0	0	0	0	0	0
		Coke	KTON	144	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Crude oil	KTON	196	0	0	0	0	0	0	0
		Natural gas	KTON	248	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		NGL	KTON	300	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		FD-LPG	KTON	352	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		LPG distribution	KTON	404	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		LNG	KTON	456	0	0	0	0	0	0	0
		Feedstock	KTON	508	0	0	0	0	0	0	0
		RF-Gas	KTON	560	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		RF-LPG	KTON	612	0	0	0	0	0	0	0
		Gasoline	KTON	664	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Jet fuel	KTON	716	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Kerosene	KTON	768	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Diesel	KTON	820	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Fuel oil	KTON	872	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Naphtha	KTON	924	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Lubricants & additives	KTON	976	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Bitumen	KTON	1028	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Petroleum Coke	KTON	1080	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Non specified products	KTON	1132	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power distribution	GWh	1184	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Hydro	GWh	1236	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Gas combined	GWh	1288	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Coal steam	GWh	1340	0	0	0	0	0	0	0
		Power Gas turbine	GWh	1392	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Diesel engine	GWh	1444	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Fuel oil steam	GWh	1496	9999999	9999999	9999999	9999999	9999999	9999999	9999999
		Power Solar Wind Other	GWh	1548	0	0	0	0	0	0	0
		Renewable	KTON	1600	0	0	0	0	0	0	0

3.4 Lower limit

(1) Lower limit of capacity

What lower limit of capacity is 0 shows that the sectors do not have any constrain for capacity. Usually lower limit of capacity is set by 0. When a value is set in lower limit of capacity, the energy sector is operated more than the lower limit of capacity.

Table 3 - 22 Lower limit of capacity in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Capacity	Coal	KTON	55	0	0	0	0	0	0	0
		Coke	KTON	107	0	0	0	0	0	0	0
		Crude oil	KTON	159	0	0	0	0	0	0	0
		Natural gas	KTON	211	0	0	0	0	0	0	0
		NGL	KTON	263	0	0	0	0	0	0	0
		FD-LPG	KTON	315	0	0	0	0	0	0	0
		LPG distribution	KTON	367	0	0	0	0	0	0	0
		LNG	KTON	419	0	0	0	0	0	0	0
		Feedstock	KTON	471	0	0	0	0	0	0	0
		RF-Gas	KTON	523	0	0	0	0	0	0	0
		RF-LPG	KTON	575	0	0	0	0	0	0	0
		Gasoline	KTON	627	0	0	0	0	0	0	0
		Jet fuel	KTON	679	0	0	0	0	0	0	0
		Kerosene	KTON	731	0	0	0	0	0	0	0
		Diesel	KTON	783	0	0	0	0	0	0	0
		Fuel oil	KTON	835	0	0	0	0	0	0	0
		Naphtha	KTON	887	0	0	0	0	0	0	0
		Lubricants & additives	KTON	939	0	0	0	0	0	0	0
		Bitumen	KTON	991	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1043	0	0	0	0	0	0	0
		Non specified products	KTON	1095	0	0	0	0	0	0	0
		Power distribution	KTON	1147	0	0	0	0	0	0	0
		Power Hydro	KTON	1199	0	0	0	0	0	0	0
		Power Gas combined	KTON	1251	0	0	0	0	0	0	0
		Power Coal steam	KTON	1303	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1355	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1407	666	714	730	825	480	480	480
		Power Fuel oil steam	KTON	1459	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1511	0	0	0	0	0	0	0
		Renewable	KTON	1563	0	0	0	0	0	0	0

(2) Lower limit of initial-stock

What lower limit of initial stock is 0 shows that the energy sectors do not have any constrain. Usually lower limit of initial-stock is set by 0. When a value is set in lower limit of initial-stock, the energy sector has initial-stock more than the lower limit-value.

Table 3 - 23 Lower limit of initial stock in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Initial-Stock	Coal	KTON	58	0	0	0	0	0	0	0
		Coke	KTON	110	0	0	0	0	0	0	0
		Crude oil	KTON	162	0	0	0	0	0	0	0
		Natural gas	KTON	214	0	0	0	0	0	0	0
		NGL	KTON	266	0	0	0	0	0	0	0
		FD-LPG	KTON	318	0	0	0	0	0	0	0
		LPG distribution	KTON	370	0	0	0	0	0	0	0
		LNG	KTON	422	0	0	0	0	0	0	0
		Feedstock	KTON	474	0	0	0	0	0	0	0
		RF-Gas	KTON	526	0	0	0	0	0	0	0
		RF-LPG	KTON	578	0	0	0	0	0	0	0
		Gasoline	KTON	630	0	0	0	0	0	0	0
		Jet fuel	KTON	682	0	0	0	0	0	0	0
		Kerosene	KTON	734	0	0	0	0	0	0	0
		Diesel	KTON	786	0	0	0	0	0	0	0
		Fuel oil	KTON	838	0	0	0	0	0	0	0
		Naphtha	KTON	890	0	0	0	0	0	0	0
		Lubricants & additives	KTON	942	0	0	0	0	0	0	0
		Bitumen	KTON	994	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1046	0	0	0	0	0	0	0
		Non specified products	KTON	1098	0	0	0	0	0	0	0
		Power distribution	KTON	1150	0	0	0	0	0	0	0
		Power Hydro	KTON	1202	0	0	0	0	0	0	0
		Power Gas combined	KTON	1254	0	0	0	0	0	0	0
		Power Coal steam	KTON	1306	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1358	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1410	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1462	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1514	0	0	0	0	0	0	0
		Renewable	KTON	1566	0	0	0	0	0	0	0

(3) Lower limit of Production

What lower limit of production is 0 shows that the energy sectors do not have any constrain. Usually lower limit of production is set by 0. When a value is set in lower limit of production, the energy sector has production more than the lower limit-value.

Table 3 - 24 Lower limit of Production in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Production	Coal	KTON	61	0	0	0	0	0	0	0
		Coke	KTON	113	0	0	0	0	0	0	0
		Crude oil	KTON	165	0	0	0	0	0	0	0
		Natural gas	KTON	217	0	0	0	0	0	0	0
		NGL	KTON	269	0	0	0	0	0	0	0
		FD-LPG	KTON	321	0	0	0	0	0	0	0
		LPG distribution	KTON	373	0	0	0	0	0	0	0
		LNG	KTON	425	0	0	0	0	0	0	0
		Feedstock	KTON	477	0	0	0	0	0	0	0
		RF-Gas	KTON	529	0	0	0	0	0	0	0
		RF-LPG	KTON	581	0	0	0	0	0	0	0
		Gasoline	KTON	633	0	0	0	0	0	0	0
		Jet fuel	KTON	685	0	0	0	0	0	0	0
		Kerosene	KTON	737	0	0	0	0	0	0	0
		Diesel	KTON	789	0	0	0	0	0	0	0
		Fuel oil	KTON	841	0	0	0	0	0	0	0
		Naphtha	KTON	893	0	0	0	0	0	0	0
		Lubricants & additives	KTON	945	0	0	0	0	0	0	0
		Bitumen	KTON	997	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1049	0	0	0	0	0	0	0
		Non specified products	KTON	1101	0	0	0	0	0	0	0
		Power distribution	KTON	1153	0	0	0	0	0	0	0
		Power Hydro	KTON	1205	11413	11555	12000	12222	15000	15282	15550
		Power Gas combined	KTON	1257	0	0	0	0	0	0	0
		Power Coal steam	KTON	1309	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1361	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1413	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1465	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1517	22	28	23	24	25	67	445
		Renewable	KTON	1569	95	94	94	95	96	99	100

(4) Lower limit of Import

What lower limit of import is 0 shows that the energy sectors do not have any constrain. Usually lower limit of import is set by 0. When a value is set in lower limit of the import, the energy sector has to import more than the lower limit-value.

Table 3 - 25 Lower limit of Import in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Import	Coal	KTON	64	0	0	0	0	0	0	0
		Coke	KTON	116	0	0	0	0	0	0	0
		Crude oil	KTON	168	0	0	0	0	0	0	0
		Natural gas	KTON	220	0	0	0	0	0	0	0
		NGL	KTON	272	0	0	0	0	0	0	0
		FD-LPG	KTON	324	0	0	0	0	0	0	0
		LPG distribution	KTON	376	0	0	0	0	0	0	0
		LNG	KTON	428	0	0	0	0	0	0	0
		Feedstock	KTON	480	0	0	0	0	0	0	0
		RF-Gas	KTON	532	0	0	0	0	0	0	0
		RF-LPG	KTON	584	0	0	0	0	0	0	0
		Gasoline	KTON	636	0	0	0	0	0	0	0
		Jet fuel	KTON	688	0	0	0	0	0	0	0
		Kerosene	KTON	740	0	0	0	0	0	0	0
		Diesel	KTON	792	0	0	0	0	0	0	0
		Fuel oil	KTON	844	0	0	0	0	0	0	0
		Naphtha	KTON	896	0	0	0	0	0	0	0
		Lubricants & additives	KTON	948	0	0	0	0	0	0	0
		Bitumen	KTON	1000	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1052	0	0	0	0	0	0	0
		Non specified products	KTON	1104	0	0	0	0	0	0	0
		Power distribution	KTON	1156	0	0	0	0	0	0	0
		Power Hydro	KTON	1208	0	0	0	0	0	0	0
		Power Gas combined	KTON	1260	0	0	0	0	0	0	0
		Power Coal steam	KTON	1312	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1364	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1416	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1468	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1520	0	0	0	0	0	0	0
		Renewable	KTON	1572	0	0	0	0	0	0	0

(5) Lower limit of Bought

What lower limit of bought is 0 shows that the energy sectors do not have any constrain. Usually lower limit of bought is set by 0. When a value is set in lower limit of bought, the energy sector has bought more than the lower limit-value.

Table 3 - 26 Lower limit of Bought in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Bought	Coal	KTON	67	0	0	0	0	0	0	0
		Coke	KTON	119	0	0	0	0	0	0	0
		Crude oil	KTON	171	4975	5318	6319	6226	6060	6100	6100
		Natural gas	KTON	223	0	0	0	0	0	0	0
		NGL	KTON	275	0	0	0	0	0	0	0
		FD-LPG	KTON	327	0	0	0	0	0	0	0
		LPG distribution	KTON	379	0	0	0	0	0	0	0
		LNG	KTON	431	0	0	0	0	0	0	0
		Feedstock	KTON	483	0	0	0	0	0	0	0
		RF-Gas	KTON	535	0	0	0	0	0	0	0
		RF-LPG	KTON	587	0	0	0	0	0	0	0
		Gasoline	KTON	639	0	0	0	0	0	0	0
		Jet fuel	KTON	691	0	0	0	0	0	0	0
		Kerosene	KTON	743	0	0	0	0	0	0	0
		Diesel	KTON	795	0	0	0	0	0	0	0
		Fuel oil	KTON	847	0	0	0	0	0	0	0
		Naphtha	KTON	899	0	0	0	0	0	0	0
		Lubricants & additives	KTON	951	0	0	0	0	0	0	0
		Bitumen	KTON	1003	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1055	0	0	0	0	0	0	0
		Non specified products	KTON	1107	0	0	0	0	0	0	0
		Power distribution	KTON	1159	0	0	0	0	0	0	0
		Power Hydro	KTON	1211	0	0	0	0	0	0	0
		Power Gas combined	KTON	1263	0	0	0	0	0	0	0
		Power Coal steam	KTON	1315	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1367	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1419	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1471	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1523	0	0	0	0	0	0	0
		Renewable	KTON	1575	0	0	0	0	0	0	0

(6) Lower limit of Receivable

What lower limit of import is 0 shows that the energy sectors do not have any constrain. Usually lower limit of receivable is set by 0. When a value is set in lower limit of receivable, the energy sector have receivable more than the lower limit-value.

Table 3 - 27 Lower limit of Receivable in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Receivables	Coal	KTON	70	0	0	0	0	0	0	0
		Coke	KTON	122	0	0	0	0	0	0	0
		Crude oil	KTON	174	0	0	0	0	0	0	0
		Natural gas	KTON	226	0	0	0	0	0	0	0
		NGL	KTON	278	0	0	0	0	0	0	0
		FD-LPG	KTON	330	0	0	0	0	0	0	0
		LPG distribution	KTON	382	0	0	0	0	0	0	0
		LNG	KTON	434	0	0	0	0	0	0	0
		Feedstock	KTON	486	0	0	0	0	0	0	0
		RF-Gas	KTON	538	0	0	0	0	0	0	0
		RF-LPG	KTON	590	0	0	0	0	0	0	0
		Gasoline	KTON	642	0	0	0	0	0	0	0
		Jet fuel	KTON	694	0	0	0	0	0	0	0
		Kerosene	KTON	746	0	0	0	0	0	0	0
		Diesel	KTON	798	0	0	0	0	0	0	0
		Fuel oil	KTON	850	0	0	0	0	0	0	0
		Naphtha	KTON	902	0	0	0	0	0	0	0
		Lubricants & additives	KTON	954	0	0	0	0	0	0	0
		Bitumen	KTON	1006	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1058	0	0	0	0	0	0	0
		Non specified products	KTON	1110	0	0	0	0	0	0	0
		Power distribution	KTON	1162	0	0	0	0	0	0	0
		Power Hydro	KTON	1214	0	0	0	0	0	0	0
		Power Gas combined	KTON	1266	0	0	0	0	0	0	0
		Power Coal steam	KTON	1318	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1370	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1422	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1474	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1526	0	0	0	0	0	0	0
		Renewable	KTON	1578	0	0	0	0	0	0	0

(7) Lower limit of Domestic demand

What lower limit of domestic demand is 0 shows that the energy sectors do not have any constrain. Usually lower limit of domestic demand is set by the same value as the upper limit of Domestic demand.

Table 3 - 28 Lower limit of Domestic demand in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Domestic Dema	Coal	KTON	76	0	0	0	0	0	0	0
		Coke	KTON	128	887	730	1026	849	0	923	957
		Crude oil	KTON	180	0	0	0	0	0	0	0
		Natural gas	KTON	232	2433	2362	2662	2832	3309	3487	3690
		NGL	KTON	284	0	0	0	0	0	0	0
		FD-LPG	KTON	336	0	0	0	0	0	0	0
		LPG distribution	KTON	388	1299	1475	1645	1868	2112	2313	2503
		LNG	KTON	440	0	0	0	0	0	0	0
		Feedstock	KTON	492	0	0	0	0	0	0	0
		RF-Gas	KTON	544	0	0	0	0	0	0	0
		RF-LPG	KTON	596	0	0	0	0	0	0	0
		Gasoline	KTON	648	1934	1972	2024	2155	2205	2346	2456
		Jet fuel	KTON	700	378	445	416	408	418	428	437
		Kerosene	KTON	752	1380	1298	1228	1159	1074	978	882
		Diesel	KTON	804	4769	5294	5639	6157	6612	7000	7413
		Fuel oil	KTON	856	3908	4375	4186	4635	4350	4388	4426
		Naphtha	KTON	908	0	0	0	0	0	0	0
		Lubricants & additives	KTON	960	283	292	299	326	341	355	370
		Bitumen	KTON	1012	675	705	690	775	908	928	951
		Petroleum Coke	KTON	1064	0	0	0	0	0	0	0
		Non specified products	KTON	1116	561	561	561	561	561	561	561
		Power distribution	KTON	1168	0	0	0	0	0	60031	63686
		Power Hydro	KTON	1220	0	0	0	0	0	0	0
		Power Gas combined	KTON	1272	0	0	0	0	0	0	0
		Power Coal steam	KTON	1324	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1376	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1428	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1480	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1532	0	0	0	0	0	0	0
		Renewable	KTON	1584	0	0	0	0	0	0	0

(8) Lower limit of Export

What lower limit of export is 0 shows that the energy sectors do not have any constrain. Usually lower limit of export is set by 0. When some value is set in lower limit of export, the energy sector has to export more than the lower limit-value.

Table 3 - 29 Lower limit of Export in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Export	Coal	KTON	79	0	0	0	0	0	0	0
		Coke	KTON	131	0	0	0	0	0	0	0
		Crude oil	KTON	183	0	0	0	0	0	0	0
		Natural gas	KTON	235	0	0	0	0	0	0	0
		NGL	KTON	287	0	0	0	0	0	0	0
		FD-LPG	KTON	339	0	0	0	0	0	0	0
		LPG distribution	KTON	391	0	0	0	0	0	0	0
		LNG	KTON	443	0	0	0	0	0	0	0
		Feedstock	KTON	495	0	0	0	0	0	0	0
		RF-Gas	KTON	547	0	0	0	0	0	0	0
		RF-LPG	KTON	599	0	0	0	0	0	0	0
		Gasoline	KTON	651	0	0	0	0	0	0	0
		Jet fuel	KTON	703	0	0	0	0	0	0	0
		Kerosene	KTON	755	0	0	0	0	0	0	0
		Diesel	KTON	807	0	0	0	0	0	0	0
		Fuel oil	KTON	859	0	0	0	0	0	0	0
		Naphtha	KTON	911	0	0	0	0	0	0	0
		Lubricants & additives	KTON	963	0	0	0	0	0	0	0
		Bitumen	KTON	1015	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1067	0	0	0	0	0	0	0
		Non specified products	KTON	1119	0	0	0	0	0	0	0
		Power distribution	KTON	1171	0	0	0	0	0	0	0
		Power Hydro	KTON	1223	0	0	0	0	0	0	0
		Power Gas combined	KTON	1275	0	0	0	0	0	0	0
		Power Coal steam	KTON	1327	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1379	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1431	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1483	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1535	0	0	0	0	0	0	0
		Renewable	KTON	1587	0	0	0	0	0	0	0

(9) Lower limit of Bunker

What lower limit of bunker is 0 shows that the energy sectors do not have any constrain. Usually lower limit of bunker is set by 0. When a value is set in lower limit of the import, the energy sector has bunker more than the lower limit-value.

Table 3 - 30 Lower limit of Bunkers in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Bunkers	Coal	KTON	82	0	0	0	0	0	0	0
		Coke	KTON	134	0	0	0	0	0	0	0
		Crude oil	KTON	186	0	0	0	0	0	0	0
		Natural gas	KTON	238	0	0	0	0	0	0	0
		NGL	KTON	290	0	0	0	0	0	0	0
		FD-LPG	KTON	342	0	0	0	0	0	0	0
		LPG distribution	KTON	394	0	0	0	0	0	0	0
		LNG	KTON	446	0	0	0	0	0	0	0
		Feedstock	KTON	498	0	0	0	0	0	0	0
		RF-Gas	KTON	550	0	0	0	0	0	0	0
		RF-LPG	KTON	602	0	0	0	0	0	0	0
		Gasoline	KTON	654	0	0	0	0	0	0	0
		Jet fuel	KTON	706	234	251	419	366	412	336	357
		Kerosene	KTON	758	0	0	0	0	0	0	0
		Diesel	KTON	810	284	306	257	236	243	243	243
		Fuel oil	KTON	862	1983	2501	2830	2082	2268	2333	2403
		Naphtha	KTON	914	0	0	0	0	0	0	0
		Lubricants & additives	KTON	966	0	0	0	0	0	0	0
		Bitumen	KTON	1018	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1070	0	0	0	0	0	0	0
		Non specified products	KTON	1122	0	0	0	0	0	0	0
		Power distribution	KTON	1174	0	0	0	0	0	0	0
		Power Hydro	KTON	1226	0	0	0	0	0	0	0
		Power Gas combined	KTON	1278	0	0	0	0	0	0	0
		Power Coal steam	KTON	1330	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1382	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1434	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1486	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1538	0	0	0	0	0	0	0
		Renewable	KTON	1590	0	0	0	0	0	0	0

(10) Lower limit of Payable

What lower limit of payable is 0 shows that the energy sectors do not have any constrain. Usually lower limit of payable is set by 0. When a value is set in lower limit of Payable, the energy sector has to payable more than the lower limit-value.

Table 3 - 31 Lower limit of Bunkers in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Payable	Coal	KTON	85	0	0	0	0	0	0	0
		Coke	KTON	137	0	0	0	0	0	0	0
		Crude oil	KTON	189	0	0	0	0	0	0	0
		Natural gas	KTON	241	0	0	0	0	0	0	0
		NGL	KTON	293	0	0	0	0	0	0	0
		FD-LPG	KTON	345	0	0	0	0	0	0	0
		LPG distribution	KTON	397	0	0	0	0	0	0	0
		LNG	KTON	449	0	0	0	0	0	0	0
		Feedstock	KTON	501	0	0	0	0	0	0	0
		RF-Gas	KTON	553	0	0	0	0	0	0	0
		RF-LPG	KTON	605	0	0	0	0	0	0	0
		Gasoline	KTON	657	0	0	0	0	0	0	0
		Jet fuel	KTON	709	0	0	0	0	0	0	0
		Kerosene	KTON	761	0	0	0	0	0	0	0
		Diesel	KTON	813	0	0	0	0	0	0	0
		Fuel oil	KTON	865	0	0	0	0	0	0	0
		Naphtha	KTON	917	0	0	0	0	0	0	0
		Lubricants & additives	KTON	969	0	0	0	0	0	0	0
		Bitumen	KTON	1021	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1073	0	0	0	0	0	0	0
		Non specified products	KTON	1125	0	0	0	0	0	0	0
		Power distribution	KTON	1177	0	0	0	0	0	0	0
		Power Hydro	KTON	1229	0	0	0	0	0	0	0
		Power Gas combined	KTON	1281	0	0	0	0	0	0	0
		Power Coal steam	KTON	1333	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1385	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1437	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1489	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1541	0	0	0	0	0	0	0
		Renewable	KTON	1593	0	0	0	0	0	0	0

(11) Lower limit of Final stock

What lower limit of final stock is 0 shows that the energy sectors do not have any constrain. Usually lower limit of final stock is set by 0. When a value is set in lower limit of final-stock, the energy sector has to have final-stock more than the lower limit-value.

Table 3 - 32 Lower limit of Final stock in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Lower Limit	Final-Stock	Coal	KTON	94	0	0	0	0	0	0	0
		Coke	KTON	146	0	0	0	0	0	0	0
		Crude oil	KTON	198	0	0	0	0	0	0	0
		Natural gas	KTON	250	0	0	0	0	0	0	0
		NGL	KTON	302	0	0	0	0	0	0	0
		FD-LPG	KTON	354	0	0	0	0	0	0	0
		LPG distribution	KTON	406	0	0	0	0	0	0	0
		LNG	KTON	458	0	0	0	0	0	0	0
		Feedstock	KTON	510	0	0	0	0	0	0	0
		RF-Gas	KTON	562	0	0	0	0	0	0	0
		RF-LPG	KTON	614	0	0	0	0	0	0	0
		Gasoline	KTON	666	0	0	0	0	0	0	0
		Jet fuel	KTON	718	0	0	0	0	0	0	0
		Kerosene	KTON	770	0	0	0	0	0	0	0
		Diesel	KTON	822	0	0	0	0	0	0	0
		Fuel oil	KTON	874	0	0	0	0	0	0	0
		Naphtha	KTON	926	0	0	0	0	0	0	0
		Lubricants & additives	KTON	978	0	0	0	0	0	0	0
		Bitumen	KTON	1030	0	0	0	0	0	0	0
		Petroleum Coke	KTON	1082	0	0	0	0	0	0	0
		Non specified products	KTON	1134	0	0	0	0	0	0	0
		Power distribution	KTON	1186	0	0	0	0	0	0	0
		Power Hydro	KTON	1238	0	0	0	0	0	0	0
		Power Gas combined	KTON	1290	0	0	0	0	0	0	0
		Power Coal steam	KTON	1342	0	0	0	0	0	0	0
		Power Gas turbine	KTON	1394	0	0	0	0	0	0	0
		Power Diesel engine	KTON	1446	0	0	0	0	0	0	0
		Power Fuel oil steam	KTON	1498	0	0	0	0	0	0	0
		Power Solar Wind Other	KTON	1550	0	0	0	0	0	0	0
		Renewable	KTON	1602	0	0	0	0	0	0	0

3.5 Variables

The LP model has 10 variables per energy sector. These are Initial-stock, Production, Import, Bought, Receivable, Domestic demand, Export, Bunker, Payable and Final stock. These variables are under the following material balance equation.

Initial stock + Production + Import + Bought + Receivable
- (Domestic demand + Export + Bunker + Payable
+ Transformation + Own use + Final stock) = 0

These variables have each constrains (Upper limit and Lower limit), and the range of the movement are strictly limited by constrains. And also the variables never take negative value in LP model. For doing so, the variables have none negative constrains by Solver table (Solver >> Option >> None negative) LP model gets the solution after several iterations, the number of iteration is more than 100 (around from 2000 to 3000), then you have to change iteration number in Option of Solver table.

Default number (100) >> New number (10000)

3.6 Transformation

Some energy sectors have transformation. This is raw material for other energy sectors. Coal, Crude oil, Natural gas, NGL, Feedstock, Diesel and Fuel oil have transformation. These energy sectors send raw material energies to other energy sectors and power sectors.

Coal = (1/efficiency)*Coke Production +(1/efficiency)*Coal Power

Crude oil = Refinery feedstock – (NGL production + NGL import
+ NGL bought – NGL payable)

Natural gas = (1/efficeincy)*Power combination production
+(1/efficeincy)* Power Gas turbine production
+(1/efficeincy)*LNG production

NGL = NGL production +NGL import + NGL bought – NGL payable

Feedstock = Feedstock production

Diesel = (1/efficeincy)* Diesel engine power generator

Fuel oil = (1/efficeincy)*Fuel oil steam power generator

Table 3 - 33 Balance constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Balance co	Tranformation	Coal	KTON		1707	1684	2056	1849	0	2111	2147
	(As raw material	Coke	KTON		0	0	0	0	0	0	0
		Crude oil	KTON		23002	23254	25357	26985	27145	27450	28030
		Natural gas	KTON		6214	6322	6584	6506	6883	7164	7164
		NGL	KTON		1173	1140	1390	1524	1474	1540	1569
		FD-LPG	KTON		0	0	0	0	0	0	0
		LPG distribution	KTON		0	0	0	0	0	0	0
		LNG	KTON		0	0	0	0	0	0	0
		Feedstock	KTON		24175	24394	26747	28509	28620	28990	29599
		RF-Gas	KTON		0	0	0	0	0	0	0
		RF-LPG	KTON		0	0	0	0	0	0	0
		Gasoline	KTON		0	0	0	0	0	0	0
		Jet fuel	KTON		0	0	0	0	0	0	0
		Kerosene	KTON		0	0	0	0	0	0	0
		Diesel	KTON		168	180	184	208	121	121	121
		Fuel oil	KTON		2170	2591	2926	4101	4329	4762	5238
		Naphtha	KTON		0	0	0	0	0	0	0
		Lubricants & additives	KTON		0	0	0	0	0	0	0
		Bitumen	KTON		0	0	0	0	0	0	0
		Petroleum Coke	KTON		0	0	0	0	0	0	0
		Non specified products	KTON		0	0	0	0	0	0	0
		Power distribution	GWh		0	0	0	0	0	0	0
		Power Hydro	GWh		0	0	0	0	0	0	0
		Power Gas combined	GWh		0	0	0	0	0	0	0
		Power Coal steam	GWh		0	0	0	0	0	0	0
		Power Gas turbine	GWh		0	0	0	0	0	0	0
		Power Diesel engine	GWh		0	0	0	0	0	0	0
		Power Fuel oil steam	GWh		0	0	0	0	0	0	0
		Power Solar Wind Other	GWh		0	0	0	0	0	0	0
		Renewable	KTON		0	0	0	0	0	0	0

3.7 Energy own use sector

Some energy sectors have energy own use. This is own use energy for the current energy sectors. Natural gas, RF-gas, Diesel, Fuel oil, Lubricants & additives, Power distribution, Power Hydro, Power Gas combined, Power Coal steam, Power Gas turbine, Power Diesel engine and Power Fuel oil steam have energy own use.

Natural gas=efficiency*Feedstock

RF-Gas =efficiency*Refinery Gas production
Diesel =efficiency* Refinery Gas production
Fuel oil = efficiency* Refinery Gas production
Lubricants & additives = efficiency * Lubricants & additives production

Power distribution = efficiency Power distribution receivable
Power Hydro =efficiency*Power Hydro generation
Power Gas combined =efficiency* Power Gas combined power generator
Power Coal steam = efficiency*Coal steam power generator
Power Gas turbine = efficiency*Power Gas turbine power generator
Power Diesel engine = efficiency* Power Diesel engine power generator
Power Fuel oil steam = efficiency* Power Fuel oil steam power generator

Table 3 - 34 Energy own use constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Balance co	Energy Sector	Coal	KTON		0	0	0	0	0	0	0
	Use	Coke	KTON		0	0	0	0	0	0	0
		Crude oil	KTON		0	0	0	0	0	0	0
		Natural gas	KTON		157	139	171	239	280	284	290
		NGL	KTON		0	0	0	0	0	0	0
		FD-LPG	KTON		0	0	0	0	0	0	0
		LPG distribution	KTON		0	0	0	0	0	0	0
		LNG	KTON		0	0	0	0	0	0	0
		Feedstock	KTON		0	0	0	0	0	0	0
		RF-Gas	KTON		0	0	0	0	0	0	0
		RF-LPG	KTON		0	0	0	0	0	0	0
		Gasoline	KTON		0	0	0	0	0	0	0
		Jet fuel	KTON		0	0	0	0	0	0	0
		Kerosene	KTON		0	0	0	0	0	0	0
		Diesel	KTON		338	342	374	428	458	464	474
		Fuel oil	KTON		580	634	642	599	544	551	562
		Naphtha	KTON		0	0	0	0	0	0	0
		Lubricants & additives	KTON		6	5	6	7	7	7	7
		Bitumen	KTON		0	0	0	0	0	0	0
		Petroleum Coke	KTON		0	0	0	0	0	0	0
		Non specified products	KTON		0	0	0	0	0	0	0
		Power distribution	GWh		6272	6105	6185	7005	8847	8164	8471
		Power Hydro	GWh		342	347	360	367	300	306	311
		Power Gas combined	GWh		727	739	770	761	539	540	540
		Power Coal steam	GWh		0	0	0	0	0	0	0
		Power Gas turbine	GWh		169	172	179	177	124	140	140
		Power Diesel engine	GWh		20	21	22	25	10	10	10
		Power Fuel oil steam	GWh		293	320	361	506	356	392	431
		Power Solar Wind Other	GWh		0	0	0	0	0	0	0
		Renewable	KTON		0	0	0	0	0	0	0

3.8 Co-production

Some energy sectors have co-production. The some energies have several kinds of energy production, for example, when natural gas is produced, LPG and NGL also are produced together. We call LPG and NGL co-production of natural gas. The co-production of refinery are RF-Gas, RF-LPG, Jet, Kerosene, Diesel, Fuel oil, Naphtha, Lubricants & additives, Bitumen, Petroleum Coke and Non specified products.

NGL =efficiency * NG production – NGL production

FD-LPG = efficiency * NG production – FD-LPG production

Feedstock =Crude oil transformation
+ NGL transformation – Feedstock production

RF-Gas =efficiency * Crude oil transformation
+ efficiency * NGL transformation - RF- Gas production

RF-LPG = efficiency * Crude oil transformation
+ efficiency * NGL transformation - RF-LPG production

Gasoline = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Gasoline production

Jet fuel = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Jet Fuel production

Kerosene = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Kerosene production

Diesel = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Diesel production

Fuel oil = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Fuel oil production

Naphtha = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Naphtha production

Lubricants & additives = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Lubri. & addi. production

Bitumen = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Bitumen production

Petroleum Coke = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Petroleum Coke production

Non specified products = efficiency * Crude oil transformation
+ efficiency * NGL transformation – Non specified production

Table 3 - 35 Co-production constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRESS	1994	1995	1996	1997	1998	1999	2000
Balance cor	Co-Production	Coal	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Crude oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Natural gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		NGL	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		FD-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LPG distribution	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LNG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Feedstock	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-Gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Gasoline	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jet fuel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Kerosene	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Diesel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Fuel oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Naphtha	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Lubricants & additives	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bitumen	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Petroleum Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Non specified products	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power distribution	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Hydro	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas combined	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Coal steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas turbine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Diesel engine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Fuel oil steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Solar Wind Other	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Renewable	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.9 Receivable & Bought

Power distribution and LPG distribution sectors have receivable. Power distribution sector receive power from Power Gas combined, Power Coal steam payable, Power Gas turbine, Power Diesel engine, Power fuel oil steam. And LPG distribution sector receives LPG from FD-LPG and RF-LPG sector.

LPG distribution = (FD-LPG+RF-LPG)-LPG distribution receivable

Power distribution = Power Hydro payable + Power Gas combined payable
+Power Coal steam payable + Power Gas turbine payable
+Power Diesel engine payable + Power Fuel oil steam payable
+ Power Solar-Wind-Other payable

Also, crude oil, Natural gas and NGL have partners. And Natural gas and NGL have contract that Egypt have to buy all partners shares. Then in the case of Natural gas and NGL, the following Bought constrains are established.

Bought = payable in Natural gas

Bought = payable in NGL

Table 3 - 36 Receivable & Bought constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Balance co	Receivable	Coal	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	&	Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bought	Crude oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Natural gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		NGL	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		FD-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LPG distribution	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LNG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Feedstock	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-Gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Gasoline	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jet fuel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Kerosene	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Diesel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Fuel oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Naphtha	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Lubricants & additives	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bitumen	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Petroleum Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Non specified products	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power distribution	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Hydro	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas combined	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Coal steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas turbine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Diesel engine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Fuel oil steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Solar Wind Other	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Renewable	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.10 Payable

There are two kinds of payable. One is partner's share, another is energy payout to other energy sectors. Crude oil, natural gas and NGL have partner's shares. FD-LPG, RF-LPG, Power generating sectors have payable for sending their power to other sectors.

Crude oil = Partner shares * Crude oil production – Crude oil partner
Natural gas = Partner shares * NG production –NG partner
NGL =Partner *NGL production – NGL partner
FD-LPG =FD-LPG production –FD-LPG payable

RF-LPG =RF-LPG production-RF-LPG payable

Power Hydro Power Payable =Generation - Own use
Power Gas combined payable=Generation - Own use
Power Coal steam payable=Generation - Own use
Power Gas turbine payable= Generation - Own use
Power Diesel engine payable =Generation - Own use
Power Fuel oil steam payable = Generation - Own use
Power Solar Wind Other payable =Generation - Own use

Table 3 - 37 Payable constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Balance co	Pavable	Coal	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Crude oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Natural gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		NGL	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		FD-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LPG distribution	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LNG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Feedstock	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-Gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Gasoline	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jet fuel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Kerosene	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Diesel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Fuel oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Naphtha	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Lubricants & additives	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bitumen	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Petroleum Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Non specified products	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power distribution	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Hydro	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas combined	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Coal steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas turbine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Diesel engine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Fuel oil steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Solar Wind Other	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Renewable	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.11 Material Balance

Variables by energy sector are constrained by the material balance equations. The material balance means that supply total equals to consumption total.

Initial stock + Production + Import + Bought + Receivable
- (Final demand + Export + Bunker + Payable
+ Transformation + Own use + Final stock)=0

Material balance constrains for energies are very important equations. Under the constrains, all values of variables are decided with keeping supply and demand balance. In the equation,

Transformation and Own use are not independent variables, but the two items are included in the equation as dependent variable.

Regarding as the following table, All cells are fulfilled by zero. The zeros are right hand side of the above equation. If some values are appeared in the cell, there are any problems.

Table 3 - 38 Material balance constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Balance co	Material Balanc	Coal	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Crude oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Natural gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		NGL	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		FD-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LPG distribution	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LNG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Feedstock	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-Gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Gasoline	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jet fuel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Kerosene	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Diesel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Fuel oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Naphtha	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Lubricants & additives	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bitumen	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Petroleum Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Non specified products	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power distribution	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Hydro	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas combined	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Coal steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas turbine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Diesel engine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Fuel oil steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Solar Wind Other	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Renewable	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.12 Stock Balance

Initial-stock and final-stock by energy sector are constrained by the stock balance equations. The stock balance equation means that previous initial-stock equals to final stock.

In the first year(1994) (1994's) all column cells = 0.

In the second year(1995 -- 2005), Initial-stock of previous year

– Final-stock of current year = 0

Table 3 - 39 Material balance constrains in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	ADDRES	1994	1995	1996	1997	1998	1999	2000
Balance co	Stock Balance	Coal	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Crude oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Natural gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		NGL	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		FD-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LPG distribution	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		LNG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Feedstock	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-Gas	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		RF-LPG	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Gasoline	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Jet fuel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Kerosene	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Diesel	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Fuel oil	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Naphtha	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Lubricants & additives	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bitumen	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Petroleum Coke	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Non specified products	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power distribution	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Hydro	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas combined	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Coal steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Gas turbine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Diesel engine	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Fuel oil steam	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Power Solar Wind Other	GWh		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Renewable	KTON		0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.13 Profit

In LP model, there are some kinds of prices and costs, Sales price for Domestics, Sales price for Export, Sales price for Bunkers, Invoice cost, Import cost, Bought cost, and Production cost. The prices and costs are installed from LIM sheet.

(1) Income

Income is calculated by the following expression. Final-stock does not sell out actually, but the final stock has some values. Then we have to evaluate it by suitable prices. In this time, the final-stock has the worth of production cost. Then we are evaluated it by production cost.

Sales * Domestic price + Export * Export price + Bunker * Bunker price
+ Payable * Invoice price + Transformation * Invoice price
+ Own use * Invoice price + Final stock * Production cost

Table 3 - 40 Income in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT ADDRES	1994	1995	1996	1997	1998	1999	2000
Profitability	Income	Coal	MillionLE	173	183	240	216	0	181	185
		Coke	MillionLE	242	254	330	297	0	274	283
		Crude oil	MillionLE	12378	13127	13544	12975	12697	13899	14310
		Natural gas	MillionLE	1469	1540	1771	1951	2291	2485	2602
		NGL	MillionLE	317	320	439	509	507	552	578
		FD-LPG	MillionLE	129	137	144	147	176	188	197
		LPG distribution	MillionLE	243	290	332	380	440	498	554
		LNG	MillionLE	0	0	0	0	0	0	0
		Feedstock	MillionLE	5961	6338	7158	7731	7983	8474	8890
		RF-Gas	MillionLE	0	0	0	0	0	0	0
		RF-LPG	MillionLE	102	113	120	128	127	137	143
		Gasoline	MillionLE	2535	2722	2874	3097	3257	3620	3894
		Jet fuel	MillionLE	395	394	448	463	478	503	528
		Kerosene	MillionLE	685	679	629	600	605	680	674
		Diesel	MillionLE	2644	3075	3327	3652	3998	4382	4752
		Fuel oil	MillionLE	1527	1652	1814	1996	2063	2253	2300
		Naphtha	MillionLE	1160	1298	1519	1685	1672	1723	1807
		Lubricants & additives	MillionLE	148	161	169	187	200	217	232
		Bitumen	MillionLE	166	183	185	216	253	271	286
		Petroleum Coke	MillionLE	30	38	36	38	40	42	44
		Non specified products	MillionLE	152	160	165	167	172	180	185
		Power distribution	MillionLE	6930	7523	8145	8976	10264	10924	11876
		Power Hydro	MillionLE	1632	1736	1846	1890	2378	2489	2602
		Power Gas combined	MillionLE	2557	2730	2931	2943	3216	3319	3410
		Power Coal steam	MillionLE	0	0	0	0	0	0	0
		Power Gas turbine	MillionLE	668	713	769	777	841	980	1007
		Power Diesel engine	MillionLE	81	91	95	109	65	67	69
		Power Fuel oil steam	MillionLE	1115	1317	1525	2153	2323	2643	2987
		Power Solar Wind Other	MillionLE	2	3	2	3	3	8	52
		Renewable	MillionLE	5	5	5	5	5	5	5

(2) Expense

Expense is calculated by the following expression. But initial-stock is carried over from final-stock of last year. The cost of the initial-stock is higher than the other energies supplied. The initial stock should be own the interest as one year-stock cost.

Initial stock * Production cost*(1+ interest of short term loan)
+ Production * production cost + Import * Import cost
+ Bought * Bought cost+ Receivable * Production cost
+ Tax

If you set “U” in upper limit of import in energy sector, the energy sector sometimes imports the energy and stocks it in final stock. By doing so, total profit become greater than usual situation. But it can be considered that the behavior is not realized in Egypt.

For suppressing the phenomenon, you have to set a large interest rate for stock cost calculation. Usually interest rate is from 10% to 15% in Egypt. In the case, you need to set the interest rate from 50% to 100%.

Table 3 - 41 Expense in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT ADDRES	1994	1995	1996	1997	1998	1999	2000
Profitability	Expense	Coal	MillionLE	173	183	236	205	0	177	181
		Coke	MillionLE	230	242	314	283	0	261	269
		Crude oil	MillionLE	9266	9853	10351	10223	10288	11124	11515
		Natural gas	MillionLE	1272	1328	1534	1694	1997	2167	2269
		NGL	MillionLE	288	290	400	464	463	504	528
		FD-LPG	MillionLE	129	137	144	147	176	188	197
		LPG distribution	MillionLE	233	281	323	372	433	491	548
		LNG	MillionLE	0	0	0	0	0	0	0
		Feedstock	MillionLE	5961	6338	7158	7731	7983	8474	8890
		RF-Gas	MillionLE	0	0	0	0	0	0	0
		RF-LPG	MillionLE	102	113	120	128	127	137	143
		Gasoline	MillionLE	2323	2497	2623	2822	2966	3311	3570
		Jet fuel	MillionLE	359	359	408	421	435	457	480
		Kerosene	MillionLE	635	623	599	571	578	684	642
		Diesel	MillionLE	2557	2974	3220	3539	3863	4239	4601
		Fuel oil	MillionLE	1388	1502	1650	1814	1880	2104	2091
		Naphtha	MillionLE	1054	1180	1381	1535	1558	1567	1643
		Lubricants & additives	MillionLE	136	148	154	170	183	198	213
		Bitumen	MillionLE	168	184	185	216	261	275	289
		Petroleum Coke	MillionLE	30	38	36	38	40	42	44
		Non specified products	MillionLE	148	156	161	163	167	175	180
		Power distribution	MillionLE	6600	7165	7757	8549	9776	10406	11335
		Power Hydro	MillionLE	1484	1578	1678	1718	2161	2263	2366
		Power Gas combined	MillionLE	2324	2482	2665	2675	2924	3017	3100
		Power Coal steam	MillionLE	0	0	0	0	0	0	0
		Power Gas turbine	MillionLE	608	648	699	707	765	891	916
		Power Diesel engine	MillionLE	73	83	87	99	59	61	62
		Power Fuel oil steam	MillionLE	1013	1198	1386	1957	2112	2402	2715
		Power Solar Wind Other	MillionLE	2	3	2	3	3	8	52
		Renewable	MillionLE	5	5	5	5	5	5	5

(3) Profit & Objective function

The profit of energy sector is calculated by an expression of “Income – Expense”. And the total of profit of all energy sectors is the profit in a year. And the total of each year profit from the beginning year to the final year is objective function of the LP model.

Table 3 - 42 Profit & Objective function in LPM sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT ADDRES	1994	1995	1996	1997	1998	1999	2000
Profitability	Profit	Coal	MillionLE	0	0	4	11	0	3	4
		Coke	MillionLE	12	12	16	14	0	13	13
		Crude oil	MillionLE	3112	3274	3194	2752	2409	2774	2795
		Natural gas	MillionLE	197	212	238	257	294	318	333
		NGL	MillionLE	29	30	39	45	44	48	50
		FD-LPG	MillionLE	0	0	0	0	0	0	0
		LPG distribution	MillionLE	10	9	9	7	8	7	6
		LNG	MillionLE	0	0	0	0	0	0	0
		Feedstock	MillionLE	0	0	0	0	0	0	0
		RF-Gas	MillionLE	0	0	0	0	0	0	0
		RF-LPG	MillionLE	0	0	0	0	0	0	0
		Gasoline	MillionLE	212	225	251	275	292	309	324
		Jet fuel	MillionLE	36	36	40	42	43	46	48
		Kerosene	MillionLE	50	55	30	29	27	-4	32
		Diesel	MillionLE	88	101	107	113	135	143	151
		Fuel oil	MillionLE	139	150	165	181	183	149	209
		Naphtha	MillionLE	105	118	138	150	114	157	164
		Lubricants & additives	MillionLE	13	12	15	16	17	18	19
		Bitumen	MillionLE	-1	-1	0	0	-8	-3	-4
		Petroleum Coke	MillionLE	0	0	0	0	0	0	0
		Non specified products	MillionLE	4	4	4	5	5	5	5
		Power distribution	MillionLE	330	358	388	427	489	518	541
		Power Hydro	MillionLE	148	158	168	172	216	226	237
		Power Gas combined	MillionLE	232	248	266	268	292	302	310
		Power Coal steam	MillionLE	0	0	0	0	0	0	0
		Power Gas turbine	MillionLE	61	65	70	71	76	89	92
		Power Diesel engine	MillionLE	7	8	9	10	6	6	6
		Power Fuel oil steam	MillionLE	101	120	139	196	211	240	272
		Power Solar Wind Other	MillionLE	0	0	0	0	0	0	0
		Renewable	MillionLE	0	0	0	0	0	0	0
Profitability	Objective Function		MillionLE	4884	5194	5289	5040	4854	5364	5607
			MillionLE	64916						
		From 2000 to 2005	MillionLE	34291						

3.14 Solver table

In this model, “Large Scale Solver” is used, the basic menu are the same one as normal “Solver”.

Set Cell ($G$1524) : Objective function which is defined by the total profit.

Equal to (Max) : This means the model targets to maximize the objective function.

By Changing Variable Cells

$G$713:$S$1012 : This block indicates the range of Variable Cells.
$G$1013:$S$1042 >=0 : Transformation constrains
$G$1043:$S$1042 >=0 : Own use constrains
$G$1073:$S$1102=0 : Co-production constrains
$G$1103:$S$1132=0 : Receivable & Bought constrains
$G$1133:$S$1162=0 : Payable constrains
$G$1163:$S$1192=0 : Material balance constrains
$G$1193:$S$1222=0 : Stock balance constrains

$G$383:$S$412 <= $G$743:$S$772	Lower capacity <=Production
$G$53:$S$82 <= $G$743:$S$772	Production <= Upper capacity
$G$743:$S$772 <=$G$83:$S$382	Variables <= Upper limit
$G$743:$S$772 >= $413:$S712	Lower limit <= Variables
$G$805:$S$808 <= $955:$S958	Bought <= Payable(Partners)

And also you have to set the following “Option” menu in the Solver table.

Max time 1000 : This means the model calculates for 1000 seconds.

Iterations times 10,000 : This means the LP model can take maximum iteration times.

Assume Non-Negative : The all variables in the model never take negative value.

Table 3 - 43 Solver table in LPM sheet

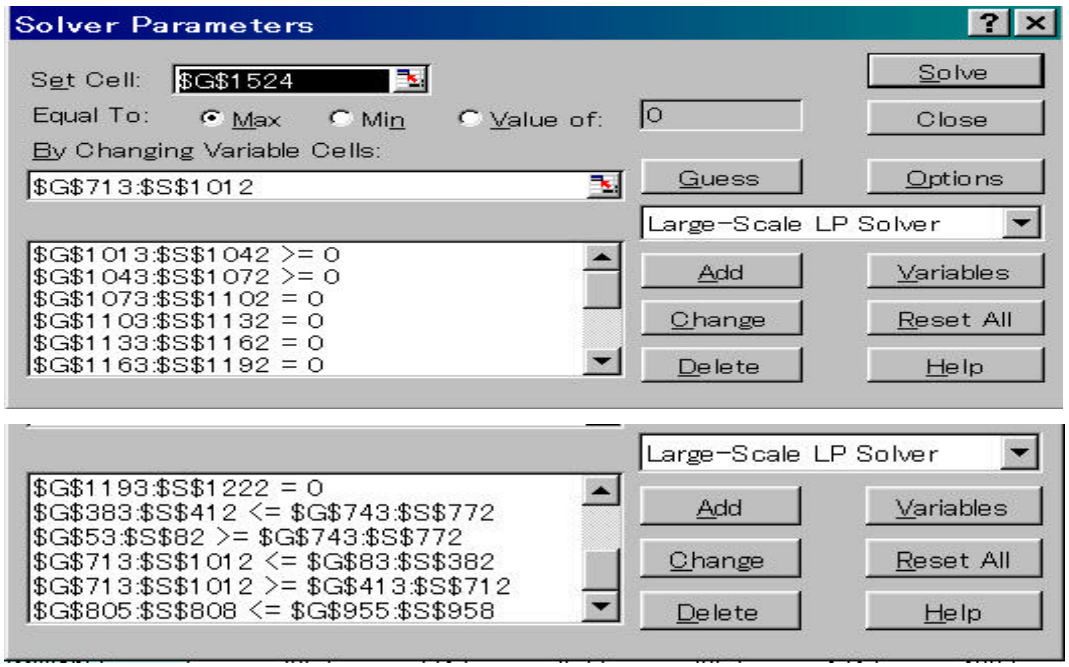
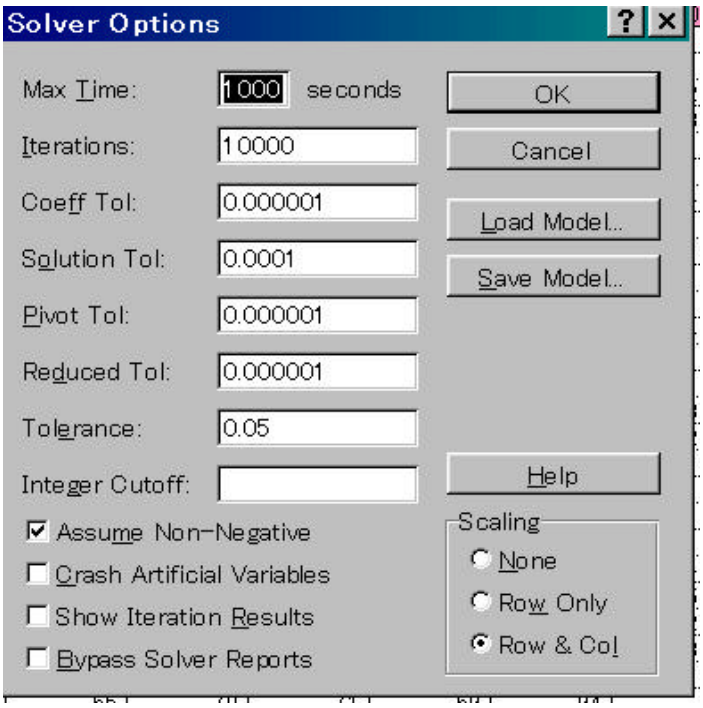


Table 3 - 44 Option menu in Solver table in LPM sheet



4. Energy Balance (EBT sheet)

4.1 Consumption

Domestic demand, Export, Bunkers, Payable, Transformation are arranged as energy consumption items. The values of these items come from variables in LPM sheet.

The total of consumption meets to the total of supply. If the two total do not meet, the LP model does not finish under well-balance. In this case, you have to check LIM and LPM sheet again.

Domestic demand, Export, Bunkers and Payable in the consumption items can have values of the upper limit. Then we can analyze the values of Domestic demand, Export, Bunkers and Payable comparing with the values of the upper limit.

Sufficient rate is defined by the following expressions. What sufficient rate is 100% means that the energy is supplied completely. Adversely sufficient rate 0% means that the energy is not supplied at all even though the upper limit of the energy is set.

Sufficient rate	Expressions
Domestic demand	Domestic demand from LP model / Domestic demand in Upper limit * 100.
Export	Export from LP model / Export in Upper limit *100
Bunkers	Bunkers from LP model / Bunker in Upper limit * 100
Payable	Payable from LP model / Payable in Upper limit * 100

Table 4 - 1 Consumption items in EBT sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Consumpti	Solution	Domestic demand	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	KTON	2,934.0	2,353.7	1,981.8	1,532.6	993.1	348.0	0.0	0.0
		Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable	KTON	14,167.1	15,802.7	15,941.0	15,887.2	15,504.0	15,048.0	14,787.5	14,756.0
		Transformation	KTON	27,145.2	27,450.3	28,029.7	28,398.2	28,362.9	28,324.1	28,281.3	28,233.9
		Own use	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	KTON	44,246.3	45,606.6	45,952.5	45,818.1	44,860.0	43,720.1	43,068.9	42,989.9
	UpperLimit	Domestic demand	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	KTON	2,934.0	2,353.7	1,981.8	1,532.6	993.1	348.0	0.0	0.0
		Bunkers	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable	KTON	U	U	U	U	U	U	U	U
	Sufficient ra	Domestic demand	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Export	%	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0
		Bunkers	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Payable	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4.2 Supply

Initial-Stock, Production, Import, Bought, Receivable and (-)Final-Stock are arranged as energy supply items. The final stock is considered as consumption item, in the table, the final stock is attributed as supply item with negative sign.
By doing so, we can easily analyze difference of initial stock and final stock. The values in the solution lines of the supply come from variables in LPM sheet.

The total of supply meets to the total of consumption. If the two total do not meet, the LP model does not finish under well balance. In this case, you have to check LIM and LPM sheet again.

Production, Import, Bought and Receivable in the supply items can have upper limit values. Then we can analyze the values of Production, Import, Bought and Receivable comparing with the values of the upper limit.

Sufficient rate is defined by the following expressions. What sufficient rate is 100% means that the energy is supplied completely. Adversely sufficient rate 0% means that the energy is not supplied at all even though the upper limit of the energy is set.

Capacity from LP model / Capacity in Upper limit * 100.
Production from LP model / Production in Upper limit *100
Import from LP model / Import in Upper limit * 100
Bought from LP model / Bought in Upper limit * 100
Receivable from LP model / Receivable in Upper limit * 100

Supply rate is defined by the following expressions. For example what supply rate of production is 100% means that the all energy is supplied from production, and what supply rate of import is 100% means that the all energy is supplied from import.

Production rate = Production / Total supply * 100
Import rate = Import / Total supply * 100
Bought rate = Bought / Total supply *100
Receivable rate = Receivable / Total supply * 100

Table 4 - 2 Supply items in EBT sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Supply	Solution	Initial-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Production	KTON	38,186.3	39,506.6	39,852.5	39,718.1	38,760.0	37,620.1	36,968.9	36,889.9
		Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
		Receivable fm Differen	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Final-Stock	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	KTON	44,246.3	45,606.6	45,952.5	45,818.1	44,860.0	43,720.1	43,068.9	42,989.9
	UpperLimit	Capacity	KTON	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0	40,000.0
		Production	KTON	39,516.0	39,506.6	39,852.5	40,165.5	40,454.2	40,725.0	40,982.8	41,231.2
		Import	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	KTON	6,060.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
		Receivables	KTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sufficient ra	Capacity	%	95.5	98.8	99.6	99.3	96.9	94.1	92.4	92.2
		Production	%	96.6	100.0	100.0	98.9	95.8	92.4	90.2	89.5
		Import	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Receivables	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Supply rate	Production rate	%	86.3	86.6	86.7	86.7	86.4	86.0	85.8	85.8
		Import rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Bought rate	%	13.7	13.4	13.3	13.3	13.6	14.0	14.2	14.2
		Receivable rate	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4.3 Profitability

Income, Expense and Profit are arranged in Profitability. The values of income and expense come from LPM sheet. The profitability are calculated by “Income – Expense”.

Price and cost items displayed blow the profitability. The items come from LPM sheet. And profit per unit is calculated in this sheet.

ROI(Return on investment) is an index which show the profitability on total investment , but in the model, ROI is calculated by Profit per unit / production cost * 100. On the energy issues, ROI is expected with 10% -- 20%. (World bank supports ROI with 15%)

Table 4 - 3 Profitability items in EBT sheet

ITEMS 1	ITEMS 2	SECTORS	UNIT	1998	1999	2000	2001	2002	2003	2004	2005
Profitability	Profit	Income	millionLE	12,697.1	13,898.6	14,310.1	14,559.6	14,531.2	14,417.4	14,534.6	14,949.3
		Expense	millionLE	10,288.1	11,124.2	11,515.3	11,790.5	11,858.3	11,880.2	12,042.9	12,386.8
		Profit	millionLE	2,409.0	2,774.4	2,794.7	2,769.1	2,672.9	2,537.2	2,491.7	2,562.5
	Price & Unit	Sales price of Domesti	LE/TON	374.3	417.4	428.8	440.4	452.2	464.7	478.1	492.6
		Sales price of Export	LE/TON	374.3	491.0	504.5	518.1	532.0	546.7	562.5	579.6
		Sales price of Bunkers	LE/TON	397.7	417.4	428.8	440.4	452.2	464.7	478.1	492.6
		Invoice cost	LE/TON	280.8	294.6	302.7	310.8	319.2	328.0	337.5	347.7
		Import cost	LE/TON	212.2	339.1	459.0	490.0	523.1	558.3	596.0	636.3
		Bought cost	LE/TON	252.3	264.8	272.0	279.3	286.9	294.8	303.3	312.5
		Production cost	LE/TON	229.4	240.7	247.3	254.0	260.8	268.0	275.7	284.1
		Profit per unit	LE/TON	54.4	60.8	60.8	60.4	59.6	58.0	57.9	59.6
		ROI	%	23.7	25.3	24.6	23.8	22.8	21.7	21.0	21.0

4.4 Check items for EBT sheet

(1) Total Balance check

IF Consumption. Solution. Total = Supply. Solution. Total
Then Normal
Else Something wrong

(2) Consumption items check

IF Solution items (Domestics, Export, Bunkers, Payable)= Upper limit items
Then Normal
Else Supply shortage
IF Sufficient rate = 0, 100%,
Then Normal
Else Supply shortage or Sometimes wrong

(3) Supply check

IF Solution items (Production, Import, Bought, Payable)= Upper limit items
Then Normal
Else Raw material shortage or Something wrong
IF Sufficient rate = 100%
Then Normal
Else Raw material shortage or Something wrong
IF Sufficient rate = 0%
Then Normal (when upper limit =U)
Else Supply items is not used or Something wrong
IF Supply rate of Import is big (greater than 50%)
Then you recommend investment.
Else maybe normal

(4) Profitability check

IF Sector is Cost center,
Then Profit is small or 0 and ROI is small or 0..
Else Price & cost set error
IF Sector is Profit center,
Then Profit is big and ROI is big.(5<=ROI<=30)

5. Growth rate sheet(GRT sheet)

5.1 Year to year growth rate

The formula of this growth rate is defined by the following expression

IF Previous value Not = 0 or U

Then growth rate = (Current value / Previous value –1) *100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Gn=0,0, IF(EBT!Hn="U","U",(EBT!Hn/EBT!Gn-1)*100))

n: line number

5.2 Average growth rate in actual data (1994—1998)

The formula of this growth rate is defined by the following expression

IF 1994 value Not = 0 or U

Then growth rate ={ (1998 value / 1994 value) ^(1/4)-1}*100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Gn=0,0,IF(EBT!Kn="U","U",((EBT!Kn/EBT!Gn)^(1/4)-1)*100))

n: line number

5.3 Average growth rate in estimation data (1998—2005)

The formula of this growth rate is defined by the following expression

IF 1998 value Not = 0 or U

Then growth rate ={ (2005 value / 1998 value) ^(1/7)-1}*100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Kn=0,0,IF(EBT!Rn="U","U",((EBT!Rn/EBT!Kn)^(1/7)-1)*100))

n: line number

5.3 Average growth rate in future data (2000—2005)

The formula of this growth rate is defined by the following expression

IF 2000 value Not = 0 or U

Then growth rate ={ (2005 value / 2000 value) ^(1/5)-1}*100

Else growth rate = 0

For example in GRT sheet

=IF(EBT!Mn=0,0,IF(EBT!Rn="U","U",((EBT!Rn/EBT!Mn)^(1/5)-1)*100))

n: line number

6. Primary Energy Consumption (PEC sheet)

6.1 Indigenous Production

Indigenous productions in Egypt are Crude oil, Natural gas, NGL, FD-LPG, Hydro power, Solar-Wind-Other power and Renewable energy. Other energies are not indigenous energies.

Table 6-1 Indigenous production in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Indigenous Production	Coal	KTON		22	39.7	49.6	53.5	43.6	46.6	48.3	48.0
	Coke	KTON		78							
	Crude oil	KTON		134	39,506.6	39,852.5	39,718.1	38,760.0	37,620.1	36,968.9	36,889.9
	Natural gas	KTON		190	10,935.3	11,144.7	11,376.1	11,627.0	11,902.8	12,206.5	12,543.1
	NGL	KTON		246	1,539.7	1,569.2	1,601.8	1,637.1	1,675.9	1,718.7	1,766.1
	FD-LPG	KTON		302	1,027.9	1,047.6	1,069.3	1,092.9	1,118.8	1,147.4	1,179.0
	LPG distribution	KTON		358							
	LNG	KTON		414							
	Feedstock	KTON		470							
	RF-Gas	KTON		526							
	RF-LPG	KTON		582							
	Gasoline	KTON		638							
	Jet fuel	KTON		694							
	Kerosene	KTON		750							
	Diesel	KTON		806							
	Fuel oil	KTON		862							
	Naphtha	KTON		918							
	Lubricants & additives	KTON		974							
	Bitumen	KTON		1030							
	Petroleum Coke	KTON		1086							
	Non specified products	KTON		1142							
	Power distribution	GWh		1198							
	Power Hydro	GWh		1254	15,282.0	15,549.5	15,804.0	16,046.6	16,278.5	16,500.4	16,713.3
	Power Gas combined	GWh		1310							
	Power Coal steam	GWh		1366							
	Power Gas turbine	GWh		1422							
	Power Diesel engine	GWh		1478							
	Power Fuel oil steam	GWh		1534							
	Power Solar Wind Othe	GWh		1590	66.9	445.1	913.7	1,288.5	2,047.9	3,406.7	0.0
	Renewable	KTON		1646	98.9	100.2	280.5	282.8	283.2	284.5	0.0

6.2 Partners

Crude oil, Natural gas and NGL have partners. Then These energies have to pay some energies to the partners. The following is the partners' share of the energies.

Table 6-2 Partners share in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Partners	Coal	KTON		6							
	Coke	KTON		62							
	Crude oil	KTON		118	15,802.7	15,941.0	15,887.2	15,504.0	15,048.0	14,787.5	14,756.0
	Natural gas	KTON		174	3,280.6	3,343.4	3,412.8	3,488.1	3,570.8	3,662.0	3,762.9
	NGL	KTON		230	492.7	502.1	512.6	523.9	536.3	550.0	565.1
	FD-LPG	KTON		286							
	LPG distribution	KTON		342							
	LNG	KTON		398							
	Feedstock	KTON		454							
	RF-Gas	KTON		510							
	RF-LPG	KTON		566							
	Gasoline	KTON		622							
	Jet fuel	KTON		678							
	Kerosene	KTON		734							
	Diesel	KTON		790							
	Fuel oil	KTON		846							
	Naphtha	KTON		902							
	Lubricants & additives	KTON		958							
	Bitumen	KTON		1014							
	Petroleum Coke	KTON		1070							
	Non specified products	KTON		1126							
	Power distribution	GWh		1182							
	Power Hydro	GWh		1238							
	Power Gas combined	GWh		1294							
	Power Coal steam	GWh		1350							
	Power Gas turbine	GWh		1406							
	Power Diesel engine	GWh		1462							
	Power Fuel oil steam	GWh		1518							
	Power Solar Wind Othe	GWh		1574							
	Renewable	KTON		1630							

6.3 Import

Some energies are imported from foreign countries. The imported energies are as the following table.

Table 6 - 3 Import in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Import	Coal	KTON		23	2,071.0	2,097.5	2,134.6	2,189.9	2,237.1	2,290.5	2,351.2
	Coke	KTON		79	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Crude oil	KTON		135	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural gas	KTON		191	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NGL	KTON		247	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	FD-LPG	KTON		303	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON		359	817.3	978.5	1,134.4	1,291.6	1,449.0	1,610.1	1,778.6
	LNG	KTON		415	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON		471	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON		527	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON		583	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON		639	144.0	207.9	275.7	367.6	456.2	541.6	626.7
	Jet fuel	KTON		695	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Kerosene	KTON		751	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Diesel	KTON		807	1,626.8	1,918.2	2,273.1	2,738.1	3,240.5	3,790.7	4,399.8
	Fuel oil	KTON		863	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Naphtha	KTON		919	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Lubricants & additives	KTON		975	101.2	110.6	122.7	139.6	157.7	177.5	199.3
	Bitumen	KTON		1031	117.6	122.7	137.8	169.0	205.1	247.0	295.8
	Petroleum Coke	KTON		1087	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON		1143	386.8	383.1	380.8	381.0	381.2	381.5	381.8
	Power distribution	GWh		1199	162.2	1,564.6	3,043.6	4,835.3	8,729.2	13,033.5	22,213.6
	Power Hydro	GWh		1255	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas combined	GWh		1311	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh		1367	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh		1423	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh		1479	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh		1535	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh		1591	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Renewable	KTON		1647	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.4 Bought

Crude oil, Natural gas and NGL are bought from partners. All natural gas and all NGL and part of crude oil paid to partners are come back to domestic market.

Table 6 - 4 Bought in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Bought	Coal	KTON		24							
	Coke	KTON		80							
	Crude oil	KTON		136	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0	6,100.0
	Natural gas	KTON		192	3,280.6	3,343.4	3,412.8	3,488.1	3,570.8	3,662.0	3,762.9
	NGL	KTON		248	492.7	502.1	512.6	523.9	536.3	550.0	565.1
	FD-LPG	KTON		304	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON		360							
	LNG	KTON		416							
	Feedstock	KTON		472							
	RF-Gas	KTON		528							
	RF-LPG	KTON		584							
	Gasoline	KTON		640							
	Jet fuel	KTON		696							
	Kerosene	KTON		752							
	Diesel	KTON		808							
	Fuel oil	KTON		864							
	Naphtha	KTON		920							
	Lubricants & additives	KTON		976							
	Bitumen	KTON		1032							
	Petroleum Coke	KTON		1088							
	Non specified products	KTON		1144							
	Power distribution	GWh		1200							
	Power Hydro	GWh		1256							
	Power Gas combined	GWh		1312							
	Power Coal steam	GWh		1368							
	Power Gas turbine	GWh		1424							
	Power Diesel engine	GWh		1480							
	Power Fuel oil steam	GWh		1536							
	Power Solar Wind Othe	GWh		1592							
	Renewable	KTON		1648							

6.5 Export

Coke, crude oil, kerosene, naphtha are exported. In the table, fuel oil are exported, but it is the surplus fuel oil in domestic market.

Table 6 - 5 Export in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Export	Coal	KTON		4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coke	KTON		60	575.3	567.9	560.8	554.1	547.7	541.5	535.6
	Crude oil	KTON		116	2,353.7	1,981.8	1,532.6	993.1	348.0	0.0	0.0
	Natural gas	KTON		172	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NGL	KTON		228	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	FD-LPG	KTON		284	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON		340	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LNG	KTON		396	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON		452	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON		508	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON		564	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON		620	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Jet fuel	KTON		676	105.1	93.4	74.8	73.3	62.9	61.4	46.0
	Kerosene	KTON		732	254.2	305.8	414.2	502.7	583.9	657.9	725.0
	Diesel	KTON		788	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fuel oil	KTON		844	1,720.2	1,033.2	664.0	123.8	0.0	0.0	0.0
	Naphtha	KTON		900	2,979.3	3,041.0	3,085.4	3,095.2	3,106.0	3,117.9	3,131.1
	Lubricants & additives	KTON		956	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bitumen	KTON		1012	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Petroleum Coke	KTON		1068	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON		1124	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power distribution	GWh		1180	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Hydro	GWh		1236	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas combined	GWh		1292	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh		1348	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh		1404	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh		1460	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh		1516	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh		1572	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Renewable	KTON		1628	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.6 Bunkers

Some part of gasoline, Jet fuel and diesel are brought to Bunker use.

Table 6 - 6 Bunkers in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Bunkers	Coal	KTON		5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coke	KTON		61	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Crude oil	KTON		117	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural gas	KTON		173	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NGL	KTON		229	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	FD-LPG	KTON		285	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LPG distribution	KTON		341	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LNG	KTON		397	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON		453	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON		509	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON		565	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON		621	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Jet fuel	KTON		677	336.4	356.9	378.1	369.9	370.6	362.4	367.6
	Kerosene	KTON		733	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Diesel	KTON		789	243.0	243.0	243.0	243.0	243.0	243.0	243.0
	Fuel oil	KTON		845	2,332.8	2,402.8	2,383.1	2,293.7	2,336.1	2,349.7	2,353.1
	Naphtha	KTON		901	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Lubricants & additives	KTON		957	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bitumen	KTON		1013	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Petroleum Coke	KTON		1069	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON		1125	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power distribution	KTON		1181	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Hydro	KTON		1237	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas combined	GWh		1293	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh		1349	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh		1405	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh		1461	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh		1517	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh		1573	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Renewable	KTON		1629	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.7 Primary energy consumption

Primary energy consumption is defined by the following expression**.**

Indigenous production + Import + Bought – Partner – Export -Bunkers

In the following table, energies with plus sign are net consumption in domestic market and energies with minus sigh are net export. The total of the following energies after conversing to TOE is primary energy consumption in Egypt.

Table 6 - 7 Primary Energy Consumption in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
Primary Energy Consu	Coal	KTON			2,110.7	2,147.1	2,188.1	2,233.6	2,283.8	2,338.9	2,399.2
	Coke	KTON			-575.3	-567.9	-560.8	-554.1	-547.7	-541.5	-535.6
	Crude oil	KTON			27,450.3	28,029.7	28,398.2	28,362.9	28,324.1	28,281.3	28,233.9
	Natural gas	KTON			10,935.3	11,144.7	11,376.1	11,627.0	11,902.8	12,206.5	12,543.1
	NGL	KTON			1,539.7	1,569.2	1,601.8	1,637.1	1,675.9	1,718.7	1,766.1
	FD-LPG	KTON			1,027.9	1,047.6	1,069.3	1,092.9	1,118.8	1,147.4	1,179.0
	LPG distribution	KTON			817.3	978.5	1,134.4	1,291.6	1,449.0	1,610.1	1,778.6
	LNG	KTON			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feedstock	KTON			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-Gas	KTON			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RF-LPG	KTON			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gasoline	KTON			144.0	207.9	275.7	367.6	456.2	541.6	626.7
	Jet fuel	KTON			-441.5	-450.2	-452.8	-443.2	-433.6	-423.7	-413.5
	Kerosene	KTON			-254.2	-305.8	-414.2	-502.7	-583.9	-657.9	-725.0
	Diesel	KTON			1,383.8	1,675.2	2,030.1	2,495.1	2,997.5	3,547.7	4,156.8
	Fuel oil	KTON			-4,053.0	-3,435.9	-3,047.1	-2,417.6	-2,336.1	-2,349.7	-2,353.1
	Naphtha	KTON			-2,979.3	-3,041.0	-3,085.4	-3,095.2	-3,106.0	-3,117.9	-3,131.1
	Lubricants & additives	KTON			101.2	110.6	122.7	139.6	157.7	177.5	199.3
	Bitumen	KTON			117.6	122.7	137.8	169.0	205.1	247.0	295.8
	Petroleum Coke	KTON			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non specified products	KTON			386.8	383.1	380.8	381.0	381.2	381.5	381.8
	Power distribution	GWh			162.2	1,564.6	3,043.6	4,835.3	8,729.2	13,033.5	22,213.6
	Power Hydro	GWh			15,282.0	15,549.5	15,804.0	16,046.6	16,278.5	16,500.4	16,713.3
	Power Gas combined	GWh			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Coal steam	GWh			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Gas turbine	GWh			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Diesel engine	GWh			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Fuel oil steam	GWh			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Power Solar Wind Othe	GWh			66.9	445.1	913.7	1,288.5	2,047.9	3,406.7	0.0
	Renewable	KTON			98.9	100.2	280.5	282.8	283.2	284.5	0.0

6.8 TOE Conversion

The following table is TOE conversion factors for energies. Renewable energy is just assumption.

Table 6 - 8 TOE factors in PEC sheet

ITEMS 1	SECTORS	UNIT			1999	2000	2001	2002	2003	2004	2005
TOE	Coal	KTOE/KTON			0.6700	0.6700	0.6700	0.6700	0.6700	0.6700	0.6700
Coversion	Coke	KTOE/KTON			0.6700	0.6700	0.6700	0.6700	0.6700	0.6700	0.6700
	Crude oil	KTOE/KTON			0.9950	0.9950	0.9950	0.9950	0.9950	0.9950	0.9950
	Natural gas	KTOE/KTON			1.1110	1.1110	1.1110	1.1110	1.1110	1.1110	1.1110
	NGL	KTOE/KTON			1.1030	1.1030	1.1030	1.1030	1.1030	1.1030	1.1030
	FD-LPG	KTOE/KTON			1.1250	1.1250	1.1250	1.1250	1.1250	1.1250	1.1250
	LPG distribution	KTOE/KTON			1.1250	1.1250	1.1250	1.1250	1.1250	1.1250	1.1250
	LNG	KTOE/KTON			1.1110	1.1110	1.1110	1.1110	1.1110	1.1110	1.1110
	Feedstock	KTOE/KTON			0.9950	0.9950	0.9950	0.9950	0.9950	0.9950	0.9950
	RF-Gas	KTOE/KTON			1.1110	1.1110	1.1110	1.1110	1.1110	1.1110	1.1110
	RF-LPG	KTOE/KTON			1.1250	1.1250	1.1250	1.1250	1.1250	1.1250	1.1250
	Gasoline	KTOE/KTON			1.1030	1.1030	1.1030	1.1030	1.1030	1.1030	1.1030
	Jet fuel	KTOE/KTON			1.0860	1.0860	1.0860	1.0860	1.0860	1.0860	1.0860
	Kerosene	KTOE/KTON			1.0860	1.0860	1.0860	1.0860	1.0860	1.0860	1.0860
	Diesel	KTOE/KTON			1.0660	1.0660	1.0660	1.0660	1.0660	1.0660	1.0660
	Fuel oil	KTOE/KTON			0.9720	0.9720	0.9720	0.9720	0.9720	0.9720	0.9720
	Naphtha	KTOE/KTON			1.1030	1.1030	1.1030	1.1030	1.1030	1.1030	1.1030
	Lubricants & additives	KTOE/KTON			1.0660	1.0660	1.0660	1.0660	1.0660	1.0660	1.0660
	Bitumen	KTOE/KTON			0.9720	0.9720	0.9720	0.9720	0.9720	0.9720	0.9720
	Petroleum Coke	KTOE/KTON			0.9720	0.9720	0.9720	0.9720	0.9720	0.9720	0.9720
	Non specified products	KTOE/KTON			0.9720	0.9720	0.9720	0.9720	0.9720	0.9720	0.9720
	Power distribution	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Hydro	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Gas combined	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Coal steam	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Gas turbine	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Diesel engine	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Fuel oil steam	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Power Solar Wind Othe	KTOE/GWh			0.0860	0.0860	0.0860	0.0860	0.0860	0.0860	0.0860
	Renewable	KTOE/KTON			0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

7. Prices and costs estimation

The LP model uses some types of prices and costs. Then, before calculation of the model, you have to set the prices and costs of energies. The prices and costs estimation sheet (PIM) are prepared for the purposes. The basic concept of the estimation is "**Price net back method**". That is, primary energy and intermediate petroleum product prices are estimated by final demand energy prices.

7.1 Exogenous variables

Crude oil Price($/bbl), Coal Price($/ton), WPI(1996=100), Exchange rate(LE/$) are used as exogenous variables in the model. The exogenous variables are estimated in macro economic model.

For calculating the difference between domestic energy prices and international energy prices, the difference of the domestic crude oil price and international crude oil price is calculated here.

7.2 Efficiencies and Yields

Efficiencies and Yields used in the model are follows;

Table 7 - 1 Efficiencies and Yields in PIM sheet

G	H	I	J	1994	1995	1996	1997	1998	1999	2000	2001
Efficiencies	Coke	Coke / Coal		0.7100	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100	0.7100
	NGL	NGL / NG		0.1332	0.1292	0.1476	0.1591	0.1408	0.1408	0.1408	0.1408
	FD-LPG	FD-LPG / NG		0.0913	0.0917	0.0880	0.0884	0.0940	0.0940	0.0940	0.0940
	LNG	LNG/NG		0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900
Own use	Refinery	Diesel to Refinery feed	KTON/KT	0.0140	0.0140	0.0140	0.0150	0.0160	0.0160	0.0160	0.0160
		Fuel oil to Refnery feed	KTON/KT	0.0240	0.0260	0.0240	0.0210	0.0190	0.0190	0.0190	0.0190
		Refinery Gas to Refinery	KTON/KT	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		Lubricants & additives to	KTON/KT	0.0260	0.0260	0.0240	0.0270	0.0260	0.0260	0.0260	0.0260
		Natural Gas to Refinery fi	KTON/KT	0.0065	0.0057	0.0064	0.0084	0.0098	0.0098	0.0098	0.0098
Partners	Shares	Crude oil		0.3500	0.3550	0.3580	0.3660	0.3710	0.4000	0.4000	0.4000
		Natural Gas		0.1890	0.1840	0.2160	0.2620	0.2930	0.3000	0.3000	0.3000
		NGL		0.2230	0.2160	0.2750	0.3070	0.3110	0.3200	0.3200	0.3200
		FD-LPG		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Efficiencies o	Power	Power / Natural gas com		5.5684	5.5684	5.5684	5.5684	5.5684	5.5684	5.5684	5.5684
		Power / Coal(Thermal)		2.8358	2.8358	2.8358	2.8358	2.8358	2.8358	2.8358	2.8358
		Power / Natural gas(Turb		3.0232	3.0232	3.0232	3.0232	3.0232	3.0232	3.0232	3.0232
		Power / Diesel		3.9665	3.9665	3.9665	3.9665	3.9665	3.9665	3.9665	3.9665
		Power / Fuel(Steam)		4.5000	4.1140	4.1140	4.1140	4.1140	4.1140	4.1140	4.1140
		Distribution Loss		0.1250	0.1180	0.1130	0.1180	0.1359	0.1200	0.1200	0.1200
		Own use of power		0.0300	0.0300	0.0300	0.0300	0.0200	0.0200	0.0200	0.0200

7.3 Netback prices and cost

(1) Coal

Coal is not produced domestically, then variable, plant cost do not arise.
The country imports all coal from foreign countries, then import cost have to be estimated.

Import cost can be estimated by international coal price (the coal price in PIM is Australia coal export price).

As coal sector is defined as a cost center, all ROI (ROI of Invoice price, Domestic price, Export price, Bunker price) are set by zero.

Table 7 - 2 Coal price and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Coal CC	Cost	Variable cost	LE/TON	0.0	0.0	0.0
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	0.0	0.0	0.0
		Import cost	LE/TON	85.7	86.4	International coal price * Exchange rate
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	85.7	86.4	Import cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	85.7	86.4	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	85.7	86.4	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	85.7	86.4	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	85.7	86.4	Average cost*(1+ROI/100)

(2) Coke

Variable cost is invoice price of coal. And plant cost is calculated under an assumption on domestic price of coke as much as invoice price of crude oil by calorie equivalence. The procedure of the plant cost is follows;

Table 7 - 3 Coke plant cost estimation in PIM sheet

Items	Value	Unit	Comments
Crude oil invoice piece in 1999	300	LE/TON	
Coke price equal to crude oil	180	LE/TON	300*(6000Kcal/10000Kcal)
Variable cost of Coke in 1999	120	LE/TON	
Plant cost in 1999	60	LE/TON	

Coke sector is an energy which new big markets are not expected in future. Then all ROI is set by 5%.

Table 7 - 4 Coke prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Coke PC	Cost	Variable cost	LE/TON	120.7	121.6	Coal invoice price / Efficiency of Coke
		Plant cost	LE/TON	53.5	55.0	Equal to crude oil worth by calorie
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	174.2	176.6	Partners cost +Plant cost + Other cost
		Import cost	LE/TON	191.7	194.3	Production cost*international / domestic of crude oil
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	174.2	176.6	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	183.0	185.5	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	5.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	183.0	185.5	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	
		Sales price of Export	LE/TON	183.0	185.5	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	
		Sales price of Bunkers	LE/TON	183.0	185.5	Average cost*(1+ROI/100)

(3) Crude oil

Partner cost is defined by Plant cost * Partner share. Plant cost is calculated by the following table. At first, we can estimate that the crude oil production cost in 1999 is 10 US$/bbl. The calculation starts from the cost of 10 US$/bbl in 1999.

Table 7 - 5 Crude oil plant cost estimation in PIM sheet

Items	Unit in 1999	Comments
Estimated crude oil production cost, 10US$/bbl		
LE/bbl	34LE/bbl	10US$*Exchange
LE/TON	250LE/TON	34/0.159/0.85
Plant cost	178LE/TON	250/(1+patner share)
Partner share cost	70LE/TON	

Import cost is calculated by international crude oil price. Bought cost is calculated from expression of “Production cost *1.1”. And ratio of domestic production crude oil and bought crude oil is 0.8:0.2.

Table 7 - 6 Crude oil prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Crude oil PC	Cost	Partner cost	LE/TON	70.2	74.1	Plant cost * Partners share
		Plant cost	LE/TON	175.5	185.1	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	245.7	259.2	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	339.1	459.0	International coal price * Exchange rate
		Bought cost	LE/TON	270.3	285.1	Production cost *1.1
		Average cost	LE/TON	250.6	264.4	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	20.0	20.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	300.7	317.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	70.0	70.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	426.1	449.5	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	100.0	100.0	
		Sales price of Export	LE/TON	501.2	528.8	Average cost*(1+ROI/100)
		ROI for Bunkers	%	70.0	70.0	
		Sales price of Bunkers	LE/TON	426.1	449.5	Average cost*(1+ROI/100)

(4) Natural Gas

Domestic market price in 1999 is 185LE/TON. Then we can estimate plant cost and partner share cost in line with the following table.

Table 7 - 7 Natural gas plant cost estimation in PIM sheet

Items	Unit in 1999	Comments
Domestic market price in 1999	185LE/TON	
Average cost (before ROI=15%)	160LE/TON	185/(1+0.2)
Production cost	157LE/TON	160=P*0.8+1.1*P*0.2
Plant cost	120LE/TON	157/(1+0.3): Partner share
Partner share cost	37LE/TON	

Import cost is calculated by international crude oil price / domestic crude oil price. Bought cost is calculated from expression of “Production cost * 1.1”. And ratio of domestic natural gas and bought natural gas is 0.8:0.2.

Table 7 - 8 Natural gas prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Natural gas PC	Cost	Partner cost	LE/TON	38.0	40.1	Plant cost * Partners share
		Plant cost	LE/TON	126.8	133.7	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	164.8	173.8	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	181.3	191.2	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	181.3	191.2	Production cost *1.1
		Average cost	LE/TON	168.1	177.3	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	15.0	15.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	193.3	203.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	15.0	15.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	193.3	203.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	15.0	15.0	
		Sales price of Export	LE/TON	193.3	203.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	15.0	15.0	
		Sales price of Bunkers	LE/TON	193.3	203.9	Average cost*(1+ROI/100)
		Slaes price of Domestic market		186.6	198.3	

(5) NGL

We set an assumption that NGL domestic price in 1999 equals to crude oil price of 10US$/bbl in 1999. Under the assumption, we can calculate NGL plant cost and partner share cost.

Table 7 - 9 NGL plant cost estimation in PIM sheet

Items	Unit in 1999	Comments
NGL domestic price (Assumption)	10US$/bbl	
LE/bbl	34LE/bbl	10US$*Exchange
LE/TON	250LE/TON	34/0.159/0.85
Plant cost	190LE/TON	250/(1+0.32patner share)
Partner share cost	60LE/TON	

Table 7 - 10 NGL prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
NGL PC	Cost	Partner cost	LE/TON	58.7	60.3	Plant cost * Partner share
		Plant cost	LE/TON	183.4	188.4	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	242.1	248.7	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	266.3	273.6	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	266.3	273.6	Production cost *1.1
		Average cost	LE/TON	246.9	253.7	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	271.6	279.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	271.6	279.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	271.6	279.1	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	271.6	279.1	Average cost*(1+ROI/100)

(6) FD-LPG

Plant cost of FD-LPG is defined by equivalence to plant cost of NGL. Partner share of LPG

disappear in this model, then partner share cost is zero.

Table 7 -11 FD-LPG prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
FD-LPG CC	Cost	Partner cost	LE/TON	0.0	0.0	Plant cost * Partner share
		Plant cost	LE/TON	178.8	188.6	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	178.8	188.6	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	196.6	207.4	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	196.6	207.4	Production cost *1.1
		Average cost	LE/TON	178.8	188.6	Production cost *0.8+ Bought cost *0.2
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	178.8	188.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	178.8	188.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	178.8	188.6	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	178.8	188.6	Average cost*(1+ROI/100)

(7) LPG distribution

LPG comes from FD-LPG and RF-LPG. Then variable cost of LPG distribution is the weighted average of the two LPG.

Table 7 -12 LPG distribution prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
LPG distribut PC	Cost	Variable cost	LE/TON	202.4	213.6	0.8*FD-LPG invoice price + 0.2*RF-invoice price
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	202.4	213.6	Partner cost + Plant cost + Other cost
		Import cost	LE/TON	222.7	234.9	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	202.4	213.6	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	212.6	224.2	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	5.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	212.6	224.2	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	
		Sales price of Export	LE/TON	212.6	224.2	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	
		Sales price of Bunkers	LE/TON	212.6	224.2	Average cost*(1+ROI/100)
		Slaes price of Domestic market		213.2	226.6	

(8) LNG

The variable cost of LNG is natural gas. The plant cost is calculated by the following table.

Table 7 -13 LNG plant cost estimation in PIM sheet

Items	Unit in 1999	Comments
LNG plant investment	340 million LE	100 million US$
Capacity of LNG	300,000 TON	
Depreciation years of the plant	10 years	
Depreciation	34 million LE	
Fixed cost	113.3LE/TON	Depreciation/Capacity
Plant cost	120LE/ton	

Table 7 - 14 LNG prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
LNG PC	Cost	Variable cost	LE/TON	217.2	229.1	Natural gas invoice price / Efficiency
		Plant cost	LE/TON	123.5	130.3	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	340.7	359.4	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	0.0	0.0	0.0
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	340.7	359.4	Production cost
	Prices	ROI for Invoice	%	20.0	20.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	408.8	431.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	20.0	20.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	408.8	431.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	20.0	20.0	
		Sales price of Export	LE/TON	408.8	431.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	20.0	20.0	
		Sales price of Bunkers	LE/TON	408.8	431.3	Average cost*(1+ROI/100)

(9) Refinery Feedstock

The variable cost of Refinery Feedstock is invoice price of crude oil and NGL. Refinery feedstock consists of 90% crude oil and 10%NGL. Then the variable cost is calculated by the weighted average of the two energies.

Table 7 - 15 Refinery Feedstock prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Feedstock CC	Cost	Variable cost	LE/TON	292.3	300.3	Crude oil invoice price *0.9+NGL invoice price *0.1
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	292.3	300.3	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	0.0	0.0	0.0
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	292.3	300.3	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	292.3	300.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	292.3	300.3	Average cost*(1+ROI/100)

(10) Refinery gas

The variable cost of Refinery gas is invoice price of Refinery feedstock. While, Refinery gas is by-product(Refer to Gasoline), then refinery gas does not add up the plant cost of refinery plant.

Table 7 -16 Refinery gas prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
RF-Gas CC	Cost	Variable cost	LE/TON	292.3	300.3	Feedstock invoice price
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	292.3	300.3	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	0.0	0.0	0.0
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	292.3	300.3	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	292.3	300.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	292.3	300.3	Average cost*(1+ROI/100)

(11) RF-LPG

The variable cost of RF-LPG is invoice price of Refinery feedstock. RF-LPG is By-product(Refer to gasoline), then RF-LPG does not add up the plant cost of refinery plant.

Table 7 - 17 RF-LPG prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
RF-LPG CC	Cost	Variable cost	LE/TON	292.3	300.3	Feedstock invoice price
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	292.3	300.3	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	0.0	0.0	0.0
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	292.3	300.3	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	292.3	300.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	292.3	300.3	Average cost*(1+ROI/100)

(12) Gasoline

Petroleum products are separated to Co-products and By-products. The main petroleum products (gasoline, Jet fuel, kerosene, diesel, naphtha, lubricants & additives) are classified in Co-products. Others are By-products. Co-products can add up full cost (variable cost and plant cost) of refinery plant, but By-products can not add up full cost of refinery plant. Then By-products usually add up only variable cost.

Table 7 - 18 Refinery plant cost estimation in PIM sheet

Items	Unit	Comments
Plant investment	3400 million LE	1000 million US$
Capacity	3 million TON	
Depreciation years	10 years	
Depreciation	340 million LE	
Fixed cost	239LE/TON	Depreciation/Capacity/Co-products
Plant cost	240LE/ton	

Table 7 - 19 Refinery cost distribution in PIM sheet

Energies	Yields	By-Co	By-yields	Co-yields	PlantCost	VariableCost(Even)		VariableCost(Weighted)	
Refinery Gas	0.0000	BY	0.0000			280	0.0	280	0.0
RF-LPG	0.0160	By	0.0160			280	4.5	280	4.5
Gasoline	0.0730	Co		0.0730	240.0	280	20.4	1120	81.8
Jet fuel	0.0330	Co		0.0330	240.0	280	9.2	280	9.2
Kerosene	0.0450	Co		0.0450	240.0	280	12.6	280	12.6
Diesel	0.2060	Co		0.2060	240.0	280	57.7	280	57.7
Fuel oil	0.4590	By	0.4590			280	128.5	140	64.3
Naphtha	0.0940	C0		0.0940	240.0	280	26.3	280	26.3
Lubricants & additives	0.0090	Co		0.0090	240.0	280	2.5	280	2.5
Bitumen	0.0260	By	0.0260			280	7.3	280	7.3
Petroleum Coke	0.0050	By	0.0050			280	1.4	280	1.4
Non specified produc	0.0060	By	0.0060			280	1.7	280	1.7
Total	0.972		0.512	0.460		3360	272.2		269.2
Total=1.000	1.000		0.527	0.473					

Plant cost(240LE/TON) is added up to Co-product(Gasoline, Jet fuel, Kerosene, Diesel, Naphtha, Lubricants & additives), but it is not added up by By-products. Variable cost is mainly crude oil price, all petroleum products have to add it. But fuel oil can not add up only half of variable cost. Then gasoline have to add up its variable cost and half of variable cost of fuel oil.

Variable cost of gasoline is 1120LE/TON

Variable cost of Fuel oil is 140LE/TON.

Variable cost of Others are 280LE/TON.

Table 7 - 20 Gasoline prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Gasoline PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	240.3	253.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost(Fuel oil V	LE/TON	742.9	783.7	(Feedstock invoice price)*2.5
		Production cost	LE/TON	1,280.3	1,350.6	Partner cost + Plant cost + Other cost
		Import cost	LE/TON	1,408.3	1,485.7	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	1,280.3	1,350.6	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	1,408.3	1,485.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	1,408.3	1,485.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	1,408.3	1,485.7	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	1,408.3	1,485.7	Average cost*(1+ROI/100)
		Slaes price of Domestic market		1,391.3	1,478.8	

(13) Jet fuel

In the model, jet fuel oil is defined as Co-product. Then jet fuel oil adds up plant cost as well as gasoline. Regarding to variable cost, gasoline adds up its variable cost and part of variable cost of fuel oil, however jet fuel oil adds up only its variable cost(feedstock invoice price)

Table 7 - 21 Jet fuel prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Jet fuel PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	240.3	253.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	537.4	567.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	591.2	623.7	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	537.4	567.0	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	591.2	623.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	591.2	623.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	591.2	623.7	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	591.2	623.7	Average cost*(1+ROI/100)

(14) Kerosene

In the model, kerosene is defined as Co-product. Then kerosene adds up plant cost as well as gasoline. Regarding to variable cost, gasoline adds up its variable cost and part of variable cost of fuel oil, however kerosene adds up only its variable cost(feedstock invoice price)

Table 7 - 22 Kerosene prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Kerosene PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	240.3	253.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	537.4	567.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	591.2	623.7	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	537.4	567.0	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	564.3	595.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	15.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	564.3	652.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	
		Sales price of Export	LE/TON	564.3	595.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	
		Sales price of Bunkers	LE/TON	564.3	595.3	Average cost*(1+ROI/100)
		Slaes price of Domestic market		537.3	571.1	

(15) Diesel

In the model, diesel is defined as Co-product. Then diesel adds up plant cost as well as gasoline. Regarding to variable cost, gasoline adds up its variable cost and part of variable cost of fuel oil, however diesel adds up only its variable cost(feedstock invoice price)

Table 7 - 23 Diesel prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Diesel PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	240.3	253.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	537.4	567.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	591.2	623.7	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	537.4	567.0	Production cost
	Prices	ROI for Invoice	%	-50.0	-50.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	268.7	283.5	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	591.2	623.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	591.2	623.7	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	591.2	623.7	Average cost*(1+ROI/100)
		Slaes price of Domestic market		537.3	571.1	

(16) Fuel oil

In the model, fuel oil is defined as By--product. Then fuel oil do not add up any plant cost. Regarding to variable cost, fuel oil market price is very low, then fuel oil can not add up the full variable cost. In the model, variable cost of fuel cost is half of feedstock invoice cost. By doing so, fuel oil can have market competitiveness as fossil energy.

Table 7 - 24 Fuel oil prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Fuel oil PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost(Subsidy)	LE/TON	-118.9	-125.4	-(Feedstock invoice price)/2.5
		Production cost	LE/TON	178.3	188.1	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	196.1	206.9	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	178.3	188.1	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	196.1	206.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	196.1	206.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	196.1	206.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	196.1	206.9	Average cost*(1+ROI/100)
		Slaes price of Domestic market		194.0	206.2	

(17) Naphtha

In the model, naphtha is defined as Co-product. Then naphtha adds up plant cost as well as gasoline. Regarding to variable cost, gasoline adds up its variable cost and part of variable cost of fuel oil, however naphtha adds up only its variable cost(feedstock invoice price)

Table 7 - 25 Naphtha prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Naphtha PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	240.3	253.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	537.4	567.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	591.2	623.7	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	537.4	567.0	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	591.2	623.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	591.2	623.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	591.2	623.7	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	591.2	623.7	Average cost*(1+ROI/100)

(18) Lubricants & additives

In the model, Lubricants & additives is defined as Co-product. Then Lubricants & additives adds up plant cost as well as gasoline. Regarding to variable cost, gasoline adds up its variable cost and part of variable cost of fuel oil, however Lubricants & additives accounts only its variable cost(feedstock invoice price)

Table 7 -26 Lubricants & additives prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Lubricants & PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price *(1+Own use yield)
		Plant cost	LE/TON	240.3	253.5	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	537.4	567.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	591.2	623.7	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	548.2	578.3	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	603.0	636.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	603.0	636.1	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	603.0	636.1	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	603.0	636.1	Average cost*(1+ROI/100)

(19) Bitumen

In the model, bitumen is defined as By--product. Then bitumen does not adds up any plant cost. Regarding to variable cost, bitumen takes its feedstock invoice cost.

Table 7 - 27 Bitumen prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Bitumen PC	Cost	Variable cost	LE/TON	297.1	313.5	Feedstock invoice price
		Plant cost	LE/TON	0.0	0.0	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	297.1	313.5	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	326.9	344.8	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	297.1	313.5	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	297.1	313.5	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	297.1	313.5	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	297.1	313.5	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	297.1	313.5	Average cost*(1+ROI/100)

(20) Petroleum Coke

In the model, petroleum coke is defined as By--product. Then petroleum coke does not add up any plant cost. Regarding to variable cost, petroleum coke takes its feedstock invoice cost.

Table 7 - 28 Petroleum Coke prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Petroleum Co	Cost	Variable cost	LE/TON	292.3	300.3	Feedstock invoice price
PC		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	292.3	300.3	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	0.0	0.0	0.0
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	292.3	300.3	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	292.3	300.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	292.3	300.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	292.3	300.3	Average cost*(1+ROI/100)

(21) Non specified products

In the model, Non specified products is defined as By--product. Then non specified products do not add up any plant cost. Regarding to variable cost, non specified products petroleum coke take its feedstock invoice cost.

Table 7 - 29 Non specified products prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Non specified PC	Cost	Variable cost	LE/TON	292.3	300.3	Feedstock invoice price
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	292.3	300.3	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	321.5	330.4	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	292.3	300.3	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	321.5	330.4	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/TON	321.5	330.4	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/TON	321.5	330.4	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/TON	321.5	330.4	Average cost*(1+ROI/100)

(22) Power distribution

Power distribution receive power from Hydro power generator, Gas combined power generator, Coal steam power generator, Diesel engine power generator, Fuel oil steam power generator and Solar-Wind-Other power generator. The weight of power in 1999 is the follows;

Hydro power generator ---------- 0.2

Gas combined power generator ---------- 0.4

Coal steam power generator ---------- 0.0

Diesel engine power generator ---------- 0.1

Fuel oil steam power generator ---------- 0.3

Solar-Wind-Other power generator ---------- 0.0

Variable cost of power distribution sector is invoice cost from these power generators. And fixed cost is not accounted.

Table 7 -30 Power distribution prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power distrib PC	Cost	Variable cost	LE/MWh	152.6	156.8	Hydroinvoice *0.2+Gas combined invoice*0.4+Coal ste
		Plant cost	LE/MWh	0.0	0.0	0.0
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	152.6	156.8	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	167.8	172.4	Production cost *I-crude oil price / D-crude oil price
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	152.6	156.8	Production cost
	Prices	ROI for Invoice	%	5.0	5.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	160.2	164.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	5.0	5.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	160.2	164.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	5.0	5.0	
		Sales price of Export	LE/MWh	160.2	164.6	Average cost*(1+ROI/100)
		ROI for Bunkers	%	5.0	5.0	
		Sales price of Bunkers	LE/MWh	160.2	164.6	Average cost*(1+ROI/100)
		Slaes price of Domestic market (fo		141.5	150.4	

(23) Power Hydro

Variable cost of Hydro power generator is nothing. And it is estimated that the plant cost of Hydro power generator is very high comparing with other power generators. Then it is estimated by using plant cost of other types of power generators.

Table 7 -31 Power generator plant cost estimation in PIM sheet

Generators	Unit in 1999	Comments
Power fee in Egypt (for industry)	132LE/MWh	
Power production cost in Egypt	115LE/MWh	132/(1+0.15) ,0.15=ROI
Variable cost of Gas combined	34LE/MWh	
Variable cost of Coal steam	31LE/MWh	
Variable cost of Gas turbine	62LE/MWh	
Variable cost of Diesel engine	72LE/MWh	
Variable cost of Fuel oil	43LE/MWh	
Variable cost of Hydro	0LE/MWh	
Plant cost of Gas combined	80LE/MWh	Round number
Plant cost of Coal steam	90LE/MWh	Round number
Plant cost of Gas turbine	70LE/MWh	Round number
Plant cost of Diesel engine	60LE/MWh	Round number
Plant cost of Fuel oil	80LE/MWh	Round number
Plant cost of Hydro	150LE/MWh	Double of other plant cost

By the above table, it is estimated that plant cost of hydro is 150LE/MWh.

Table 7 -32 Hydro power generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Hydro PC	Cost	Variable cost	LE/MWh	0.0	0.0	0.0
		Plant cost	LE/MWh	148.1	152.1	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	148.1	152.1	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	148.1	152.1	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	162.9	167.4	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	162.9	167.4	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/MWh	162.9	167.4	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/MWh	162.9	167.4	Average cost*(1+ROI/100)

(24) Power gas combined

Variable cost of Power gas combined is natural gas invoice price. And according to the power plant cost calculation table in the above, plant cost of Power gas combined is 80LE/MWh.

Table 7 -33 Gas combined generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Gas c	Cost	Variable cost	LE/MWh	32.0	32.9	Natural gas invoice price / Efficiency *(1+Own use yiel
PC		Plant cost	LE/MWh	79.7	81.9	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	111.7	114.8	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	111.7	114.8	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	122.9	126.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	122.9	126.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/MWh	122.9	126.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/MWh	122.9	126.3	Average cost*(1+ROI/100)

(25) Coal steam power

Variable cost of Coal steam power is coal invoice price. And according to the power plant cost calculation table in the above, plant cost of Coal steam power is 90LE/MWh.

Table 7 -34 Coal steam generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Coal s	Cost	Variable cost	LE/MWh	30.8	31.1	Coal invoice price / Efficiency *(1+Own use yield)
PC		Plant cost	LE/MWh	79.7	81.9	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	110.6	113.0	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	110.6	113.0	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	121.6	124.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	121.6	124.3	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/MWh	121.6	124.3	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/MWh	121.6	124.3	Average cost*(1+ROI/100)

(26) Gas turbine power

Variable cost of Gas turbine power is natural gas invoice price. And according to the power plant cost calculation table in the above, plant cost of Gas turbine power is 70LE/MWh.

Table 7 - 35 Gas turbine generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Gas tu	Cost	Variable cost	LE/MWh	59.0	60.6	Natural gas invoice price / Efficiency *(1+Own use yiel
PC		Plant cost	LE/MWh	68.3	70.2	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	127.3	130.8	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	127.3	130.8	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	140.0	143.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	140.0	143.9	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/MWh	140.0	143.9	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/MWh	140.0	143.9	Average cost*(1+ROI/100)

(27) Diesel engine power

Variable cost of Diesel engine power generator is diesel invoice price. And according to the power plant cost calculation table in the above, plant cost of Diesel engine power generator is 60LE/MWh.

Table 7 - 36 Diesel engine generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Diesel	Cost	Variable cost	LE/MWh	68.2	70.1	Diesel invoice price / Efficiency *(1+Own use yield)
PC		Plant cost	LE/MWh	58.1	59.7	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	126.3	129.8	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	126.3	129.8	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	138.9	142.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	138.9	142.7	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/MWh	138.9	142.7	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/MWh	138.9	142.7	Average cost*(1+ROI/100)

(28) Fuel oil steam power

Variable cost of Fuel oil steam power is fuel oil invoice price. And according to the power plant cost calculation table in the above, plant cost of Fuel oil steam power is 80LE/MWh.

Table 7 - 37 Fuel oil steam generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Fuel o	Cost	Variable cost	LE/MWh	40.6	41.7	Fuel oil invoice price / Efficiency *(1+Own use yield)
PC		Plant cost	LE/MWh	82.0	84.3	(Plant cost (-1) +Plant cost (-1)*(WPI/WPI(-1))/2
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	122.6	126.0	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	122.6	126.0	Production cost
	Prices	ROI for Invoice	%	10.0	10.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	134.9	138.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	10.0	10.0	
		TAX rate for Domesti	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	134.9	138.6	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	10.0	10.0	
		Sales price of Export	LE/MWh	134.9	138.6	Average cost*(1+ROI/100)
		ROI for Bunkers	%	10.0	10.0	
		Sales price of Bunkers	LE/MWh	134.9	138.6	Average cost*(1+ROI/100)

(29) Solar- Wind- Other power

Variable cost of Power Solar, Wind and Other power is nothing. And it is considered that the plant cost of these generators is very high. In the model, 1200LE/MWh in 1999 is assumed.

Table 7 - 38 Solar- Wind- Other power generator prices and cost estimation in PIM sheet

G	H	I	J	1999	2000	
Power Solar PC	Cost	Variable cost	LE/MWh	0.0	0.0	0.0
		Plant cost	LE/MWh	113.9	117.0	Exogenous
		Other cost	LE/MWh	0.0	0.0	0.0
		Production cost	LE/MWh	113.9	117.0	Partners cost + Plant cost + Other cost
		Import cost	LE/MWh	0.0	0.0	0.0
		Bought cost	LE/MWh	0.0	0.0	0.0
		Average cost	LE/MWh	113.9	117.0	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/MWh	113.9	117.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domestic	%	0.0	0.0	
		Sales price of Domestics	LE/MWh	113.9	117.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/MWh	113.9	117.0	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/MWh	113.9	117.0	Average cost*(1+ROI/100)

(30) Renewable

Variable cost of renewable energies are so variety. In the model, it is assumed that variable cost is 50LE/TON. In future, you can find a suitable estimated variable cost for renewable energies, you should replace it.

Table 7 - 39 Renewable prices and cost estimation in PIM sheet

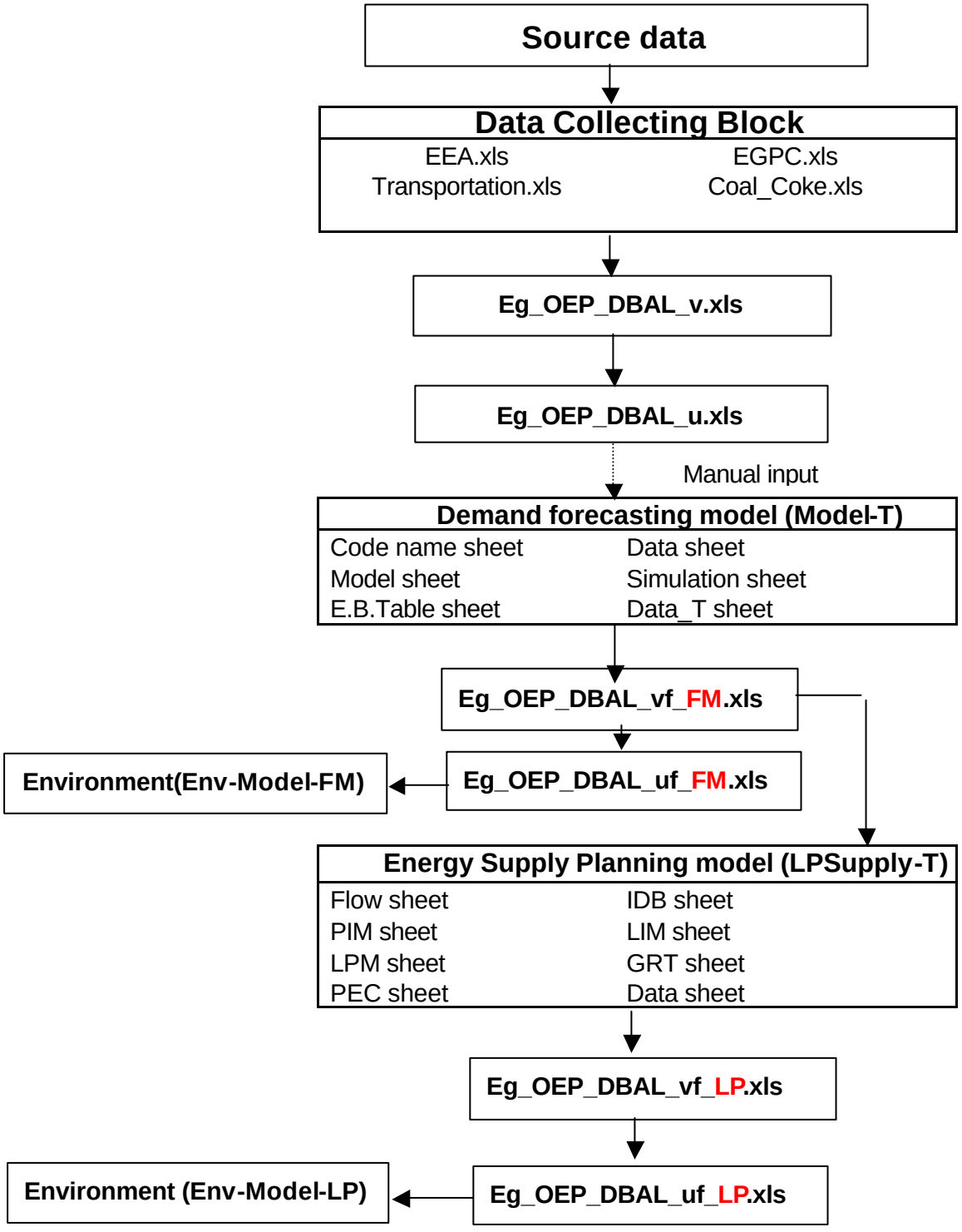
G	H	I	J	1999	2000	
Renewable PC	Cost	Variable cost	LE/TON	50.0	50.0	0.0
		Plant cost	LE/TON	0.0	0.0	0.0
		Other cost	LE/TON	0.0	0.0	0.0
		Production cost	LE/TON	50.0	50.0	Partners cost + Plant cost + Other cost
		Import cost	LE/TON	0.0	0.0	0.0
		Bought cost	LE/TON	0.0	0.0	0.0
		Average cost	LE/TON	50.0	50.0	Production cost
	Prices	ROI for Invoice	%	0.0	0.0	
		TAX rate for Invoice	%	0.0	0.0	
		Invoice price	LE/TON	50.0	50.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Domestics	%	0.0	0.0	
		TAX rate for Domestic	%	0.0	0.0	
		Sales price of Domestics	LE/TON	50.0	50.0	Average cost*(1+ROI/100+TAX/100)
		ROI for Export	%	0.0	0.0	
		Sales price of Export	LE/TON	50.0	50.0	Average cost*(1+ROI/100)
		ROI for Bunkers	%	0.0	0.0	
		Sales price of Bunkers	LE/TON	50.0	50.0	Average cost*(1+ROI/100)

8. Data connection

8.1 Relation between database sheet and ESPM

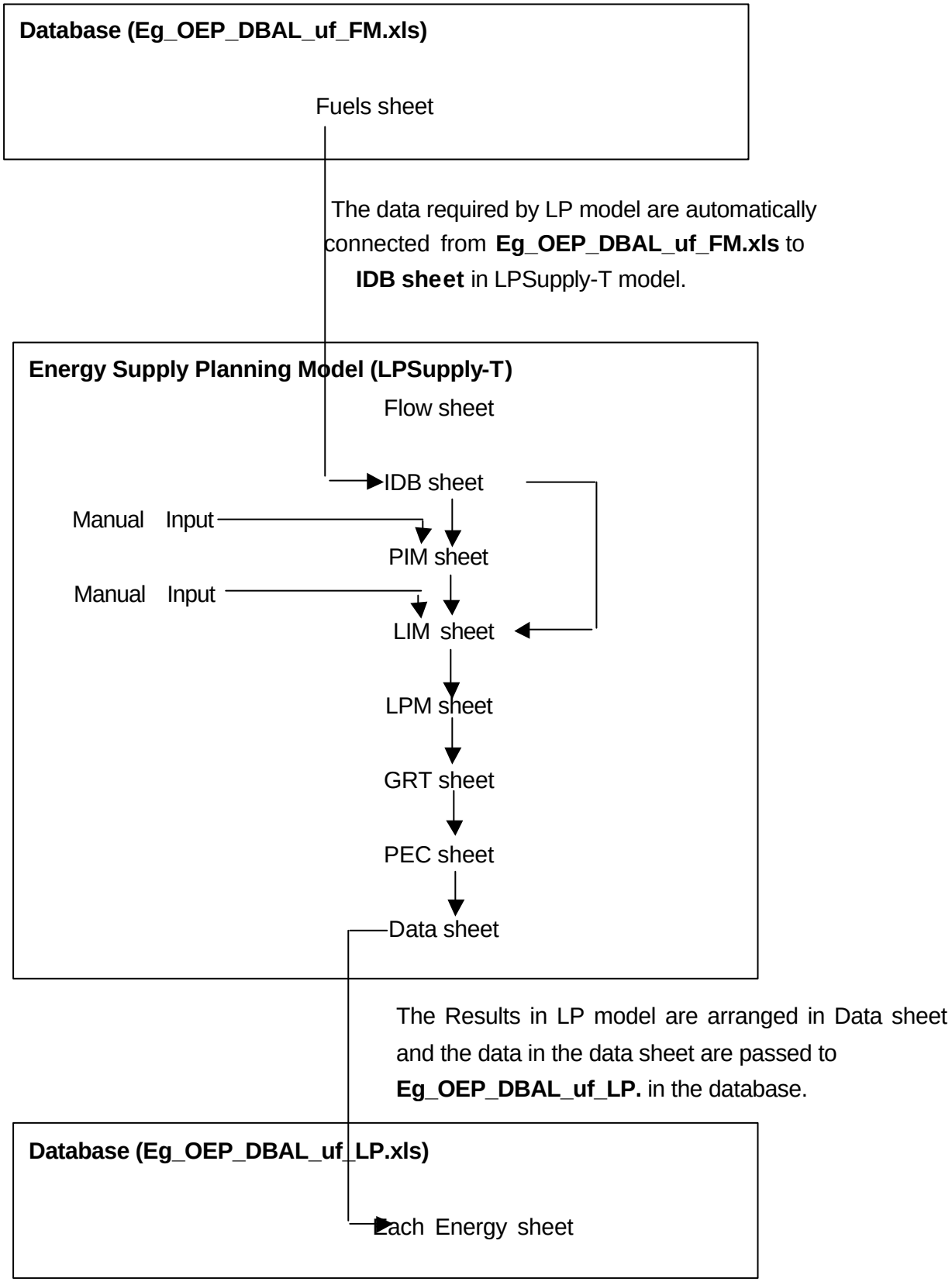
The energy economic model which includes the all models built by OEP and JICA team is handled by the following data flow.

Figure 8-1 Relation between database sheet and ESPM



8.2 Procedures of data connection

Data connection between the database and LP model are the follows figures.



8.3 Chaining cell address of PIM sheet

The chaining cell address of PIM sheet are lines with "=IDB!Fxxx" in the following tables.

Table 8-2 Chaining cell address of PIM sheet

G	H	I	J	TIME	1999	2000	2001	2002	2003	2004	2005
Natural gas	Prices	ROI for Invoice	%		15.0	15.0	15.0	15.0	15.0	15.0	15.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON		174.8	179.6	184.4	189.4	194.6	200.2	206.3
		ROI for Domestics	%		15.0	15.0	15.0	15.0	15.0	15.0	15.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON		174.8	179.6	184.4	189.4	194.6	200.2	206.3
		ROI for Export	%		15.0	15.0	15.0	15.0	15.0	15.0	15.0
		Sales price of Export	LE/TON		174.8	179.6	184.4	189.4	194.6	200.2	206.3
		ROI for Bunkers	%		15.0	15.0	15.0	15.0	15.0	15.0	15.0
		Sales price of Bunkers	LE/TON		174.8	179.6	184.4	189.4	194.6	200.2	206.3
		Slaes price of Domestic market		=IDB!F487	186.6	198.3	210.4	223.4	237.4	253.0	270.5
LPG distribut	Prices	ROI for Invoice	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON		215.4	221.3	227.3	233.4	239.9	246.8	254.3
		ROI for Domestics	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON		215.4	221.3	227.3	233.4	239.9	246.8	254.3
		ROI for Export	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Export	LE/TON		215.4	221.3	227.3	233.4	239.9	246.8	254.3
		ROI for Bunkers	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Bunkers	LE/TON		215.4	221.3	227.3	233.4	239.9	246.8	254.3
		Slaes price of Domestic market		=IDB!F486	213.2	226.6	240.5	255.3	271.3	289.2	309.2
Gasoline	Prices	ROI for Invoice	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON		1,543.0	1,585.4	1,628.0	1,671.9	1,718.0	1,767.5	1,821.3
		ROI for Domestics	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON		1,543.0	1,585.4	1,628.0	1,671.9	1,718.0	1,767.5	1,821.3
		ROI for Export	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Export	LE/TON		1,543.0	1,585.4	1,628.0	1,671.9	1,718.0	1,767.5	1,821.3
		ROI for Bunkers	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Bunkers	LE/TON		1,543.0	1,585.4	1,628.0	1,671.9	1,718.0	1,767.5	1,821.3
		Slaes price of Domestic market		=IDB!F481	1,391.3	1,478.8	1,569.2	1,665.6	1,770.4	1,886.7	2,017.5
Kerosene	Prices	ROI for Invoice	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON		552.1	567.3	582.5	598.2	614.7	632.4	651.7
		ROI for Domestics	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON		552.1	567.3	582.5	598.2	614.7	632.4	651.7
		ROI for Export	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Export	LE/TON		552.1	567.3	582.5	598.2	614.7	632.4	651.7
		ROI for Bunkers	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Bunkers	LE/TON		552.1	567.3	582.5	598.2	614.7	632.4	651.7
		Slaes price of Domestic market		=IDB!F482	537.3	571.1	606.0	643.3	683.7	728.7	779.2
Diesel	Prices	ROI for Invoice	%		-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON		265.2	272.5	279.9	287.4	295.3	303.8	313.1
		ROI for Domestics	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON		583.5	599.6	615.7	632.3	649.7	668.4	688.8
		ROI for Export	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Export	LE/TON		583.5	599.6	615.7	632.3	649.7	668.4	688.8
		ROI for Bunkers	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Bunkers	LE/TON		583.5	599.6	615.7	632.3	649.7	668.4	688.8
		Slaes price of Domestic market		=IDB!F484	537.3	571.1	606.0	643.3	683.7	728.7	779.2
Fuel oil	Prices	ROI for Invoice	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/TON		163.8	168.3	172.8	177.5	182.4	187.7	193.4
		ROI for Domestics	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/TON		163.8	168.3	172.8	177.5	182.4	187.7	193.4
		ROI for Export	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Export	LE/TON		163.8	168.3	172.8	177.5	182.4	187.7	193.4
		ROI for Bunkers	%		10.0	10.0	10.0	10.0	10.0	10.0	10.0
		Sales price of Bunkers	LE/TON		163.8	168.3	172.8	177.5	182.4	187.7	193.4
Power distrib	Prices	ROI for Invoice	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Invoice	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Invoice price	LE/MWh		160.2	164.6	169.0	173.6	178.4	183.5	189.1
		ROI for Domestics	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		TAX rate for Domestic	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Sales price of Domestics	LE/MWh		160.2	164.6	169.0	173.6	178.4	183.5	189.1
		ROI for Export	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Export	LE/MWh		160.2	164.6	169.0	173.6	178.4	183.5	189.1
		ROI for Bunkers	%		5.0	5.0	5.0	5.0	5.0	5.0	5.0
		Sales price of Bunkers	LE/MWh		160.2	164.6	169.0	173.6	178.4	183.5	189.1
		Slaes price of Domestic market (for		=IDB!F488*10	141.5	150.4	159.6	169.4	180.0	191.9	205.1

8.4 Chaining cell address of LIM sheet

In LIM sheet, the connecting data are Production, Domestic demand, Export, Bunker and Bought. These data are connected as follows;

IND: Indigenous production, TFC: Total Final demand, COK: Coke Oven, EX: Export

PC: Petrochemicals, PT : from Partner, BU: Bunker

Table 8-3 The connection of Production, Domestic demand and Export

Energies	Production	Domestic demand	Export
Coal	Hard-C in IND	Hard-C, Coke-C in TFC	Hard-C, Coke-C in EX
Coke	COC in CKO	COC in TFC	COC in EX
Crude oil	Crude Oil in IND	Crude Oil in TFC	Crude Oil in EX
Natural gas	NG in IND	NG in TFC, Ng in PC	NG in EX
NGL		NGL in TFC	NGL in EX
FD-LPG			
LPG		LPG in TFC	LPG in EX
Refinery Feed	Crude oil, NGL in TPES		
Refinery Gas		R-gas in TFC	R-gas in EX
RF-LPG			
LNG			
Gasoline		Gasoline in TFC	Gasoline in EX
Jet fuel		Jet in TFC	Jet in EX
Kerosene		Kero in TFC	Kero in EX
Diesel		Diesel in TFC	Diesel in EX
Fuel oil		Res Fo in TFC	Res Fo in EX
Naphtha		Naphtha in TFC	Naphtha in EX
Lubricants& additives		Lub in TFC	Lub in EX
Bitumen			
Petroleum Coke			
Non specified products			
Power distribution		Elec in TFC	
Power Hydro	Hydro in IND		
Power Gas combined			
Power Coal steam			
Power Gas turbine			
Power Diesel engine			
Power Fuel oil steam			
Power Solar-Wind-Other	Solar, Wind in IND		
Renewable	Ren and Bio in IND	Ren and Bio in TFC	Ren and Bio in EX

Table 8-4 The connecting of Bunker and Bought and Export

Energies	Bunker	Bought	Others
Crude oil		Crude Oil in PT	
Natural gas			
NGL			
LNG			
Gasoline	Gasoline in BU		
Jet fuel	Jet in Bu		
Kerosene	Kero in BU		
Diesel	Diesel in BU		
Fuel oil	Res Fo in BU		

9. Correcting error in the model

9.1 Solver message after calculating the model

After calculating the model or stopping the model, you get the following messages. Some of these messages have a slightly different interpretation depending on which Solver "engine" you are using (Large Scale Solver is the same as the linear Simplex Solver)

(1) Solver found a solution. All constraints and optimality conditions are satisfied.

This means that the Solver has found the optimal or "best" solution under the circumstances. The exact meaning depends on whether you are solving a linear, nonlinear, or integer programming problem:
If you are solving a linear programming problem with no integer constraints, the Simplex Solver has found the globally optimal solution: There is no other solution satisfying the constraints which has a better value for the objective (Target Cell). It is possible that there are other solutions with the same objective value, but all such solutions are linear combinations of the current decision variable values.

If you are solving a nonlinear programming problem with no integer constraints, the GRG Solver has found a locally optimal solution: There is no other set of values for the decision variables close to the current values and satisfying the constraints which yields a better value for the objective (Target Cell). In general, there may be other sets of values for the variables, far away from the current values, which yield better values for the objective.

If you are solving a mixed-integer programming problem (any problem with integer constraints) using one of the enhanced Solvers, this message means that the Branch & Bound method has found a solution satisfying the constraints (including the integer constraints) with the "best possible" objective value (but see the next paragraph). If the problem is linear or quadratic, the true integer optimal solution has been found. If the problem is nonlinear, the Branch & Bound process has found the best of the locally optimal solutions found for sub-problems by the GRG method.

In the standard Microsoft Excel Solver, this message also appears for mixed-integer problems where the Solver stopped because the solution was within the range of the true integer optimal solution allowed by the Tolerance value in the Solver Options dialog (5% by default). In the enhanced Solvers, when the Branch & Bound process stopped due to a nonzero Tolerance without "proving optimality," the message "Solver found an integer solution within tolerance. All constraints are satisfied" (result code 14) is displayed to distinguish this condition (see below).

(2) Solver has converged to the current solution. All constraints are satisfied.

This message appears only when the GRG Solver is used. It means that the Solver stopped because the objective function value is changing very slowly for the last few iterations or trial solutions. More precisely, the GRG Solver stops if the absolute value of the relative change in the objective function is less than the value of the Convergence box in the Solver Options dialog. A poorly scaled model is more likely to trigger this stopping condition, even if the Use Automatic Scaling box in the Solver Options dialog is checked. If you are sure that your model is well scaled, you should consider why it is that the objective function is changing so slowly. For more information, see the discussion of "GRG Solver Stopping Conditions" below.

(3) Solver cannot improve the current solution. All constraints are satisfied.

This message appears only when the GRG Solver is used, and occurs only rarely. It means that the model is degenerate and the Solver is probably cycling. One possibility worth checking is that some of your constraints are redundant, and should be removed. For more information, see the discussion of "GRG Solver Stopping Conditions" below.

(4) Stop chosen when the maximum iteration limit was reached.

This message appears when (i) the Solver has completed the maximum number of iterations, or trial solutions, allowed in the Iterations box in the Solver Options dialog and (ii) you clicked on the Stop button when the Solver displayed the Show Trial Solution dialog. You may increase the value in the Iterations box (to a maximum of 32767) or click on Continue instead of Stop in the Show Trial Solution dialog. But you should also consider whether re-scaling your model or adding constraints might reduce the total number of iterations required.

(5) The Set Target Cell values do not converge.

This message appears when the Solver is able to increase (if you are trying to Maximize) or decrease (for Minimize) without limit the value calculated by the objective or Target Cell, while still satisfying the constraints. Remember that, if you've selected Minimize, the Target Cell may take on negative values without limit unless this is prevented by constraints on the Target Calls or other cells.

If the objective is a linear function of the decision variables, it can always be increased or decreased without limit (picture it as a straight line), so the Solver will seek the extreme value which still satisfies the constraints. If the objective is a nonlinear function of the variables, it

may have a "natural" maximum or minimum (for example, =A1*A1 has a minimum at zero), or no such limit (for example, =LOG(A1) increases without limit).

If you receive this message, you may have forgotten a constraint, or failed to anticipate values for the variables that allow the objective to increase or decrease without limit. The final values for the adjustable cells, the constraint left hand sides and the objective should provide a strong clue about what happened.

(6) Solver could not find a feasible solution.

This message appears when the Solver could not find any combination of values for the decision variables which allows all of the constraints to be satisfied simultaneously. If you are using the linear Simplex Solver, and the model is well scaled, the Simplex method has determined for certain that there is no feasible solution. If you are using the nonlinear GRG Solver, the GRG method was unable to find a feasible solution, starting from the initial values of the variables; however it is possible that there is a feasible solution far away from these initial values, which the Solver might find if you run it with different initial values for the variables. In either case, you should first look for conflicting constraints, i.e. conditions which cannot be satisfied simultaneously. Most often this is due to choosing the wrong relation (e.g. <= instead of >=) on an otherwise appropriate constraint.

(7) Solver stopped at user's request.

This message appears only if you press ESC to display the Show Trial Solution dialog, and then click on the Stop button. If you are writing a macro, the user may do this unless you disable the ESC key in your code, so be sure to test for this return code value (6) and take action appropriate for your application.

(8) The conditions for Assume Linear Model are not satisfied.

This message appears if you have selected the linear Simplex Solver "engine," but the Solver's numeric test to ensure that the objective and constraints were indeed linear functions of the decision variables was not satisfied. (The wording of this message may be slightly different in the enhanced Solver products, which don't use the Assume Linear Model check box.) To understand exactly what is meant by a linear model, read the chapter "Solver Basics."
If you receive this message, examine the formulas for the objective (Target Cell) and constraints for nonlinear or discontinuous functions or operators applied to the decision

variables or adjustable cells. You can always write a linear function using only SUM and SUMPRODUCT, or the DOTPRODUCT function included with your enhanced Solver product.

(9) The problem is too large for Solver to handle.

This message appears when the Solver determines that there are too many decision variables or constraints in your model. In many cases you will first see a message such as "Too many adjustable cells" or "Too many constraints" when you set up the model using the Solver Parameters dialog. This message appears after you click Solve and the Solver analyzes the model for cases not checked earlier.

(10) Solver encountered an error value in a target or constraint cell.

This message appears when the Solver recalculates your worksheet using a new set of values for the decision variables (adjustable or changing cells), and discovers an error value (such as #VALUE!, #NUM!, #DIV/0! or #NAME?) in the cell calculating the objective (Target Cell) or one of the constraints. Inspecting the worksheet for error values like these will usually indicate the source of the problem. If you have entered formulas for the right hand sides of certain constraints, the error might have occurred in one of these formulas rather than in a cell on the worksheet. For this and other reasons, we recommend that you use only constants and cell references on the right hand sides of constraints.

If you see #VALUE!, #N/A or #NAME?, look for names or cell references to rows or columns that you have deleted. If you see #NUM! or #DIV/0!, look for unanticipated values of the decision variables which lead to arguments outside the domains of your functions -- such as a negative value supplied to SQRT. You can often add constraints to avoid such domain errors; if you have trouble with a constraint such as $A$1 >= 0, try a constraint such as $A$1 >= 0.00001 instead.

(11) Stop chosen when the maximum time limit was reached.

This message appears when (i) the Solver has run for the maximum time (number of seconds) allowed in the Max Time box in the Solver Options dialog and (ii) you clicked on the Stop button when the Solver displayed the Show Trial Solution dialog. You may increase the value in the Max Time box (to a maximum of 32767 seconds) or click on Continue instead of Stop in the Show Trial Solution dialog. But you should also consider whether re-scaling your model or adding constraints might reduce the total solution time required.

(12) There is not enough memory available to solve the problem.

This message appears when the Solver could not allocate the memory it needs to solve the problem. In addition to situations where the Solver problem itself requires too much memory, this message can appear if you have too many workbooks open in Microsoft Excel or if you have too many open applications besides Excel. Close these workbooks or applications and try again.

(13) Another Excel instance is using SOLVER.DLL. Try again later.

This message should appear only if you are running more than one instance of Microsoft Excel, and you click on Solve while another Excel instance is also running the Solver. Wait for the other Excel instance to finish solving and then try again. If this message appears under any other circumstances (most likely due to previous problems with Excel), you should restart Windows and then try again.

(14) Error in model. Please verify that all cells and constraints are valid.

This message means that the internal "model" (information about the adjustable cells, target cell, constraints, Solver options, etc.) which is created by the SOLVER.XLA add-in and passed to SOLVER.DLL is not in a valid form. You might receive this message if you are using the wrong version of either SOLVER.XLA or SOLVER.DLL, or if you have modified the values of certain hidden defined names used by the Solver, either interactively or in a VBA or macro language program. To guard against this possibility, you should avoid using any defined names beginning with "solver" in your own application.

(15) Solver found an integer solution within tolerance. All constraints are satisfied.

If you are solving a mixed-integer programming problem (any problem with integer constraints) using one of the enhanced Solver products, with a non-zero value for the integer Tolerance setting in the Solver Options dialog, the Branch & Bound Solver "engine" has found a solution satisfying the constraints (including the integer constraints) whose objective value is within at least 5% of the true optimal objective value. This may actually be the true integer optimal solution; however, the Branch & Bound method did not take the extra time to search all possible remaining sub-problems to "prove optimality" for this solution. If all sub-problems were explored (which can happen even with a non-zero Tolerance in some cases), the enhanced Solvers will produce the message "Solver found a solution. All constraints are satisfied" (result code 0).

9.2 Error examples and cause determination

The following are error types and cause determination of the model. The following error are break though by checking of LIM and LPM sheets.

(1) Solver could not find a feasible solution.

1) Some data in LIM sheet have error, then LP matrix got non numeric data such as “#REF” or “#Value”.

2) Upper limit and lower limit do not have good combination. The following is no good combination.
   Upper limit of production =54.0
   Lower limit of production= 54.1

3) Upper limit of capacity and Upper limit of max production do not have reasonable constrains.
   Upper limit of capacity = 0
   Lower limit of production= 2000
   In the case, energy is not produced, because capacity =0. However, when the energy is strictly required in the down flow, the model can not calculate.

4) When upper limit and lower limit of production and domestic demand, export and final-stock, the following expression should be required.
   Production = Domestic demand + Export

5) Material balance matrix are set by all 0 when getting optimal solution. When finished in infeasible solution(Abnormal end), some value appears in material balance matrix. The energy which contains some value in material balance matrix causes the error.

(2) Objective function value is too large

The model has the following preconditions. All domestic energy demand must be supplied preferentially, when it is happened energy supply shortage, Egypt can import the energies and when it is happened energy supply surplus, Egypt can export the energies. By the preconditions, it is sometimes happened that infinite export is made by infinite import. Then large profit is calculated in the model. For stopping the phenomenon, you have to set some constrain to upper limit of import or export.

(3) Final-stock has value in the final year

The final-stock of the model does not have any penalty. The penalty(it means stock cost) is paid in initial-stock of the next year. But the final-stock of the final year does not have the initial-stock of the next year, then the model set some value in the final stock unless the upper limit of the final stock in the final year has any value. For avoiding the phenomenon, you have to set 0 in the final-stock of the final year.

(4) Plant operation rate is very low.

Crude oil production and Natural gas sector have low operation rate. It is caused that

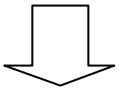
co-products of the energies have some constrains which those products can not produce enough. When happened the phenomenon, you have to check the supply and demand balance in LIM sheet from the down flow products.

9.3 Method for finding the error

when you can not the error easily, it is better for you to make the model matrix small for finding the error easily. The procedures are as follows;

Table 9-5 The LP matrix in LPM sheet from 1994 to 2005

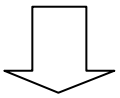
1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Constrain	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
Variable	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
Objective	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value



The error exists in matrix from 1994 to 2005, then you have to cut 2005 year's column. At this time, Solver table is adjusted automatically. After the operation, click Solver.

Table9-6 The LP matrix in LPM sheet from 1994 to 2004

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Constrain	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
Variable	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
Objective	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value



When you can not get an optimum solution after cutting 2005 year's column, you have to cut 2004 year's column. The error exists in matrix from 1994 to 2004.

Table 9-7 The LP matrix in LPM sheet from 1994 to 2004

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Constrain	Value	Value	Value	Value	Value	Value	Value	Value	Value
Variable	Value	Value	Value	Value	Value	Value	Value	Value	Value
Objective	Value	Value	Value	Value	Value	Value	Value	Value	Value

By cutting the columns step by step, you can check the error in smaller range than the original matrix range.

Appendix

Scenario setting and simulation for Policy issues By Energy Supply planning model

1. Forecasting energy balance without energy policies

For finding the problems related to future energy supply, it is needed to forecast future energy balance (2005) including the current energy policies. And the future policies and future plans should be examined for finding future energy supply problems. The Base case of the energy supply planning model (ESPM) are prepared for the purpose.

(1) Making the Base Case

For forecasting future energy balance (2005) including the current energy policies, at first, the Base case should be prepared. The planned capacities and forecasting demand are set in the Base case. The following conditions are set for the Base case of energy supply planning in Egypt.

Table 1-1 The conditions of the base case

Items	Unit	2000	2001	2002	2003	2004	2005
Crude oil Capacity	KTON	40,000	40,000	40,000	40,000	40,000	40,000
Natural gas Capacity	KTON	20,000	20,000	20,000	20,000	20,000	20,000
Refinery Capacity	KTON	35,000	35,000	35,000	35,000	35,000	35,000
GCC Capacity	GWh	27,000	27,000	27,000	27,000	27,000	27,000
Power Capacity	GWh	72,000	76,000	81,000	86,000	91,000	96000
Power Demand	GWh	63,686	67,655	72,031	76,888	82,333	88,481
LPG Demand	KTON	2,503	2,688	2,874	3,062	3,257	3,463
Gasoline Demand	KTON	2,456	2,555	2,649	2,740	2,828	2,916
Diesel Demand	KTON	7,413	7,846	8,308	8,807	9,353	9,958

(2) The results of the base case

The above data are set in Energy Supply Planning Model (ESPM) and the model is simulated. The simulation results are as the following table.

Table 1-2 The solutions of the base case

Solution	Unit	2000	2001	2002	2003	2004	2005
Crude oil production	KTON	39,853	40,000	40,000	40,000	40,000	40,000
Natural gas Production	KTON	13,625	14,423	15,289	16,230	17,250	18,355
Refinery Production	KTON	29,948	30,598	31,260	32,037	32,529	32,684
GCC Generation	GWh	31,407	33,920	36,633	39,564	42,729	46,148
Solar-Wind-Other Generation	GWh	445	914	1,289	2,048	3,407	4,000
Power shortage	GWh	0	0	0	0	0	0
LPG Import	KTON	699	789	871	947	1,024	1,105
Gasoline Import	KTON	161	206	244	271	314	381
Diesel Import	KTON	1,878	2,190	2,529	2,882	3,341	3,928
Profit	Mill LE	6,149	6,542	7,139	7,547	8,075	8,749

In the Base case, LPG, Gasoline and Diesel are shortage for their demand and the energies are imported to meet their demand. To decease the shortage of the energies are the important issues for Egypt energy policy. Egypt is supposed to be unable to produce crude oil more than the current level. However fortunately natural gas has potential to be produced more than the current. And also Egypt will have technologies to improve refinery plant yields and power generator efficiencies. Then the following scenarios are set for simulating the energy supply after improving the issues.

Table 1-3 Scenario setting for Egyptian Energy Supply Policy

Scenarios	CONTENTS
Base case	Including the current energy policies.
Scenario 1	After improving the yields of refinery plants, what is the effect to energy supply after improving the yields?
Scenario 2	Egypt cannot produce crude oil more than the current level. However Egypt can buy crude oil from partners. How to utilize crude oil from partner?
Scenario 3	After improving the yields, how to utilize crude oil from partner?
Scenario 4	LNG business is planed in future. How much profit is it?
Scenario 5	The roles of renewable energies are expected. How much profit is it?

2. Scenario 1: Improving refinery yields

For resolving the shortage of several energies, it can be considered to improve the technical changes. Technical changes in energy production and transformation sectors mean the efficiency improvement of crude oil production and natural gas, yields of refinery and efficiencies of power generators in future. For simulating the effects, the efficiencies and the yields should be changed in ESPM, and the model is run.

(1) Data setting

a. The yields of RF-LPG, Gasoline and Diesel are 10% up from 2001.
b. Efficiency of FD-LPG is 10% up from 2001
c. The yield of Fuel oil is 7% down and Naphtha is 11% down from 2001

(2) Results in 2005

Import of LPG, Gasoline and Diesel decreased little. But the domestic energy supply is not enough to their demand in 2005 as the following table.

Table 2-1 Results of Scenario 1 in 2005

Solution	Unit	Base Case	Scenario 1	Rate
Crude oil production	KTON	40,000	40,000	0
Natural gas production	KTON	18,355	18,355	0
GCC Generation	KTON	46,148	46,148	0
LPG import	KTON	1,105	869	-21%
Gasoline import	KTON	381	128	-66%
Diesel import	KTON	3,928	3,237	-18%
Profit	Million LE	8,749	8,819	1%

3. Scenario 2 : Increase crude oil from partners

For decreasing import of petroleum products, assume to increase crude oil from partners at 20% to 2000.

(1) Data setting

The data of crude oil from partners are changed to 7,320 KTON from 2001 to 2005 instead of 6100 KTON in 2000.

(2) Results in 2005

a. In Scenario 2, LPG, Gasoline and Diesel still have the supply shortage.
b. When crude oil from partners is increased more than 20%, the profit is decreased, it means that surplus petroleum products are increased.
c Then, Egypt can not make well-balance of petroleum products under the current demand structure of petroleum products.

Table 3-1 Results of Scenario 2 in 2005

Solution	Unit	Base Case	Scenario 2	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	7,320	0
Natural gas production	KTON	18,355	18,378	0
GCC Generation	KTON	46,148	46,148	0
LPG import	KTON	1,105	1,092	-1%
Gasoline import	KTON	381	293	-23%
Diesel import	KTON	3,928	3,681	-6%
Profit	Million LE	8,749	8,858	1%

4. Scenario 3 : Increase crude oil from partner and yields

For decreasing import of petroleum products, assume to increase crude oil from partner at 20% to 2000 and yields at 10% up.

(1) Data setting

a. The yields of RF-LPG, Gasoline and Diesel are 10% up from 2001.
b. The efficiency of FD-LPG is 10% up from 2001
c. The yield of Fuel oil is 7% down, Naphtha is 11% down from 2001
d. The data of crude oil from partners are changed to 7,320 KTON from 2001 to 2005 instead of 6,100 KTON in 2000.

(2) Results in 2005

a. In Scenario 3, LPG and Diesel still have the supply shortage.
b. But Gasoline shortage is resolved.
c. Egypt should be tried to improve the yields of refinery plants, it will make more well-balance of petroleum products.

Table 4-1 Results of Scenario 3 in 2005

Solution	Unit	Base Case	Scenario 3	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	7320	20%
Natural gas production	KTON	18,355	18,371	0
GCC Generation	KTON	46,148	46,184	0
LPG import	KTON	1,105	855	-23%
Gasoline import	KTON	381	0	-100%
Diesel import	KTON	3,928	2,963	-25%
Profit	Million LE	8,749	8,930	2%

5. Scenario 4 : Installation of LNG plant

Make a plan to install a LNG plant consumed Natural gas and make foreign trade surplus increase.

(1) Data setting

a. Natural gas capacity is increased at 10% up per year from 2001 to 2005.

b. LNG plant is operated with 5 million ton capacity from 2001 to 2005.

Table 5-1 Data setting for Scenario 4

Capacity	Unit	2000	2001	2002	2003	20004	2005
Natural gas	KTON	20,000	22,000	24,200	26,620	29,282	32,210
LNG	KTON	0	5000	5000	5000	5000	5000

(2) Results in 2005

a. The profit increases by installing LNG Plant.

Base case 8,749 million LE in 2005

Scenario4 9,533 million LE in 2005

Balance + 784 million LE in 2005

b. By exporting LNG, Egypt can increase the profit at level of 9% to the Base case.

Table 5-2 Results of Scenario 4 in 2005

Solution	Unit	Base Case	Scenario 4	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	6100	0
Natural gas production	KTON	18,355	23,981	31%
LNG production	KTON	0	5000	
GCC Generation	KTON	46,148	46,148	0
LPG import	KTON	1,105	470	-57%
Gasoline import	KTON	381	276	-28%
Diesel import	KTON	3,928	3,838	-2%
Profit	Million LE	8,749	9,533	9%

6. Scenario 5 : Renewable energies substitute LPG import

Renewable energies is supplied with 285 Kton in 2005, and the renewable energies substitute LPG domestic demand. As the results, it is expected that LPG import decreases.

(1) Data setting

a. Renewable energies is supplied with 285 Kton in 2005 and is consumed in residential sector.

b. LPG demand is decreased as much as the supply of renewable energy

(2) Results in 2005

a. The profit increases with substitution of renewable energy.

Base case 8,749 million LE in 2005

Scenario4 8,818 million LE in 2005

Balance + 69 million LE in 2005

b. By the substitution, Egypt can get higher profit at 1% than the Base case.

Table 6-1 Results of Scenario 5 in 2005

Solution	Unit	Base Case	Scenario 5	Rate
Crude oil production	KTON	40,000	40,000	0
Crude oil Bought	KTON	6,100	6,100	0
Natural gas production	KTON	18,355	18,355	0
Renewable production	KTON	285	285	0
LPG import	KTON	1,105	822	-26%
Profit	Million LE	8,749	8,818	1%

7. Comparison of Strategy indicators

(1) Comparison of the Base case, and Scenario 1 to 5.

The following table is the comparison with strategy indicators of the Base case, and Scenario 1 to 5. The strategy indicators are value added, foreign trade and CO2 emission.

Table 7-1 Comparison of the Base case and Scenario 1 to 5.

Scenarios	Value added in Energy sectors (million LE)	Energy foreign trade balance (million LE)	CO2 emission From all energies (Million ton as CO2)
Base case	8,749	-4,819	145.7
Scenario 1 Yields	8,819	-4048	145.7
Scenario 2 Bought	8,858	-4562	145.8
Scenario 3 Yield+Bought	8,930	-3763	145.8
Scenario 4 LNG	9,533	-1618	145.7
Scenario 5 Renewable	8,818	-4732	145.7
Comments	Profit in LP model = Value Added	Energy Export - import - Bought	CO2 emission From-En- model-LP

a Value added : Defined by Profit in LP model

The value added of each Scenario are higher than the base case. And the good conditions of the value added are Scenario 3 and 4.

b Foreign trade : Defined by 'Export-Import-Bought'

Foreign trade of Scenario 3 and 4 are also the good conditions.

c CO2 emission : Come from Environmental model

CO2 emission of Scenario 2 and 3 is comparably rather high than other scenarios. But the increase is small.

(2) Information for energy supply policy

Scenario 3 and 4 are attractive Scenarios for Egypt, if the CO2 emission of the Scenarios is permitted by the regulation of Egypt. The Scenario 3 and/or 4 should be selected as Egyptian Energy policy from 2000 to 2005.

Table 7-2 Comparison of the Base case and Scenario 3 and 4 in 2005

Solution	Unit	Base Case	Scenario 3	Scenario 4	3 + 4
Crude oil production	KTON	40,000	40,000	40,000	38,205
Crude oil Bought	KTON	6,100	7320	6100	7,320
Natural gas production	KTON	18,355	18,371	23,981	23,981
LNG production	KTON	0	0	5,000	5,000
GCC Generation	KTON	46,148	46,184	46,148	46,148
LPG import	KTON	1,105	855	470	169
Gasoline import	KTON	381	0	276	0
Diesel import	KTON	3,928	2,963	3,838	3,104
Profit	Million LE	8,749	8,930	9,533	9,566

The right column of '3+4' is one scenario that is implemented under the conditions of scenario 3 and scenario 4.

The increase of crude oil from partners and LNG production are required in the scenario 3 and 4. The energy policy will make the profit with 9.3% up to the base case.

As further energy policy, substitution of diesel and LPG demand can be considered. Which is another scenario that LPG residential demand and diesel transportation demand be substituted by natural gas.

This model is built by cooperative works of Office Energy Planning of Egypt and Japan International Cooperation Agency team in 2000.