Part 4 Tools for Energy Assessment

Chapter 13 Energy Database

13.1 Structure of Database

The overview of energy database that developed in this study is shown below.

Data base management system is adopted relational data base management system (RDBMS) which is the most popular one in the world right now. RDBMS have mainly two dimensions as follows,

- Data is displayed as a tabular form and is able to link information from separate database tables,
- Database is operated by using the standardized SQL (structured query language).

On the RDBMS, it is able to access a database server from the internet, and operate the energy database on the website. Therefore it has several advantages as follows,

- A number of users are simultaneously able to access to the database,
- A number of users are simultaneously able to update the data,
- No need to pay any license fee for the software,
- It tightens the security.

For data processing such as data retrieval, data sorting, and creating graph, etc, it has functions rarely different from commercially available software depending on setting in a program.

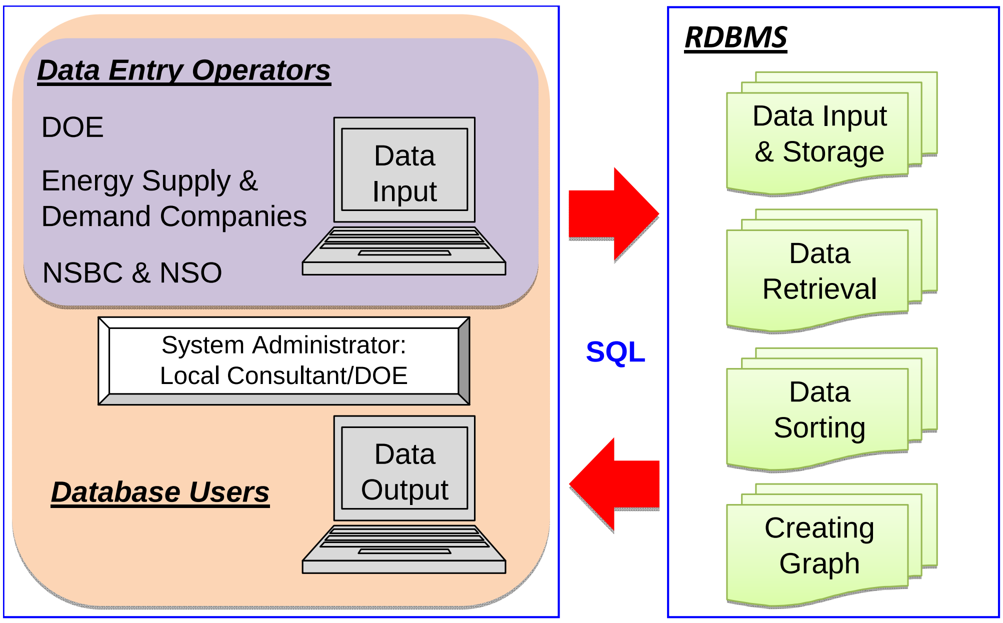


Figure 13.1-1 System Configurations

13.1.1 Data Items

In designing the energy balance table of the Philippines, we have adopted a format that DOE currently uses, and also added some energy supply and demand items in response to the request of EPPB. Total data entry cell is 1,682, (energy sources items 29 × supply and demand items 58). Table 13.1-1 shows items listed in the energy balance table of the Philippines.

Table 13.1-1 Items of Energy Balance Table of the Philippines

No.	Energy Source Items	Energy Supply and Demand Items
1	Coal	Indigeneous
2	Natural Gas	Imports (+)
3	Crude Oil	Exports (-)
4	NGL	Bunkering (-)
5	Premium Gasoline	Stock Change (+/-)
6	Regular Gasoline	Primary Energy Supply
7	Kerosene	Refinery (Crude Run)
8	Diesel Oil	Power Generation
9	Fuel Oil	Fuel Input (-)
10	LPG	Electricity Generation
11	Jet Kerosene	Gas Manufacture
12	Aviation Gasoline	Transmission/Distribution Loss (-)
13	Naphtha	Energy Sector Use & Loss (-)
14	Asphalt	Net Domestic Supply
15	Lubes & Greases	Statistical Difference
16	Other Petroleum Product	% Statistical Difference
17	Electricity	Net Domestic Consumption
18	Wind	INDUSTRY
19	Solar	Manufacturing
20	Geothermal	Beverages
21	Hydro	Tobacco
22	Ricehull	Coco/Vegetable Oil
23	Charcoal	Sugar
24	Fuelwood	Other Food Processing
25	Bagasse	Textiles/Apparel
26	Coco Residue	Wood Prod/Furniture
27	Animal Waste	Paper Prod/Printing
28	Ethanol	Chemicals Except Fertilizer
29	CME	Fertilizer
30		Rubber/ Rubber Products
31		Glass/Glass Products
32		Cement
33		Lube Refining
34		Other Non-Metlc Minerals
35		Basic Metal
36		Machinery/Equipment
37		Other Manufacturing
38		Mining
39		Construction
40		TRANSPORT
41		Railway
42		Road Transport
43		Water Transport
44		Domestic Air Transport
45		International Civic Aviation
46		RESIDENTIAL
47		COMMERCIAL
48		Public Services
49		Hotels and Restaurants
50		Hospitals
51		AGRICULTURE
52		Agri Crops Product
53		Livestock/Poultry
54		Agri Services
55		Forestry
56		Fishery
57		OTHERS, NON-ENERGY USE
58		Sefl-sufficiency

DOE provides regulatory energy data against IEA and APEC, but energy source items and energy supply and demand items of energy balance tables of IEA and APEC are different with that of DOE. In the IEA energy balance table, there are 61 energy sources and 82 supply and demand items. Total number of data entry cell is about 5,000 (61×82=5,002). However, we may not need all of them as some energy sources and/or energy plants do not exist in the country. In case of the Philippines, for example, there is no coking coal plant, CHP plant, liquefied coal plant, etc.

13.1.2 Retrieval and Sorting

Number of items of energy and socio-economic data put in the energy database is about 1,700. In addition to these cross section items, there are time series data from 1990 to 2006. So, total number of data reaches about 29,000. We are developing database program for data retrieval and sorting system so that it is easy to find necessary data from among these huge data package. This program was developed by local system engineering company for convenience of future maintenance. Graph generation function also was developed in response to a request from the Counter Part of DOE. However, it may be necessary to modify the database program further because the system development period was too short.

13.1.3 Energy Balance Table

The energy balance table is made to grasp the comprehensive energy supply and demand of the country. This table shows energy flow of the whole country converting from physical unit to oil equivalent ton (toe) unit. As mentioned earlier, this balance table follows the IEA Energy Balance Table.

13.2 Data Collection System of Database

For data collection system, data owners and providers may access to the energy database in the DOE website, and they should individually conduct input and updating of data. Thus, energy data will be consolidated on the DOE's server that is exclusively used for database compilation.

There is also a plan to build one-stop service center of energy database inside DOE by 2010 according to the Philippine Statistical Development Program 2005-2010. Realizing this plan, it is expected that database system should be integrated to collect data on the network as wide area network as well as local area network inside DOE optimizing use of the server computer of DOE.

13.2.1 Energy Data

Five bureaus of DOE are collecting energy data on monthly, quarterly and annual basis from energy production and/or supply companies these bureaus are covering. DOE also utilizes the outcome of the questionnaire survey by NSCB/NSO.

13.2.2 Socio-Economic Data

DOE is also collecting socio-economic data on daily, monthly and annual basis from organizations that release these data, such as NEDA, BSP, NSCB/NSO and PIP.

13.3 Function and Operation of Database

The database program is developed for data handling. The functions and the operations of the database program are as follows.

13.3.1 Data Input & Update

a) Under Edit Data. Select Resource and Year to update/edit.

b) User can now navigate and edit the EBT per section by using the left navigation bar.

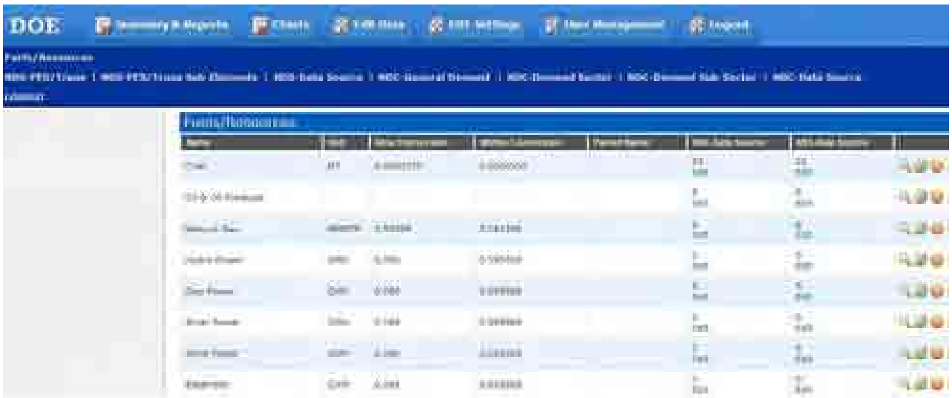
c) When the User chooses a section to edit (ex. primary energy supply), the elements of the section will be displayed.

d) The user can choose which element of the chosen section to edit (ex. indigenous) and can input/edit data by month, by quarter, or by year.

13.3.2 Addtional Elements/Items on Energy Balance Table

Energy Balance Table (EBT) Settings:

The user can see a control panel where all the sections of the EBT are, accordingly, the user can choose which section to edit/add an item, and how to assign them conversion factors and parent categories. As shown (Fuels/Resources), the user can see all the resources, their original units, their conversion factors, and their sub-elements/branches.



13.3.3 Energy Balance Table

a) Summary & Reports.

The user can simply select a year to view and the EBT for that year will be displayed (admin can view full EBT, researchers can only view EBT summary report).

b) The user can choose a resource/source to view and the EBT for that resource will display (screenshot to follow).

Chapter 14 Energy Demand Forecasting Model

14.1 Simulation Models for Building Energy Plan

Today, various econometric models are developed by academies and research institutions as a tool to project future energy outlook, to analyze issues in the energy field, to evaluate effects of energy policies and responses, to construct energy plans and so on. Energy outlook models used by International Energy Agency (IEA) and The Institute of Energy Economics, Japan (IEEJ) are generally composed of threes engines, namely, 1) the macro-economy model, 2) the energy demand forecasting model, and 3) the energy demand/supply optimization model as shown in Figure 14.1-1.

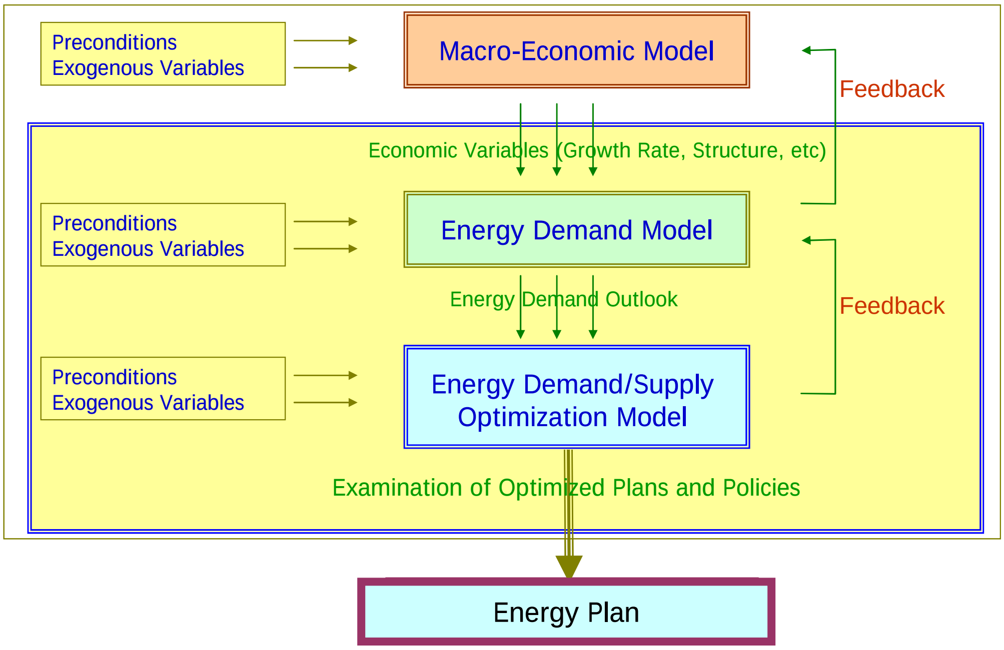


Figure 14.1-1 General Model for Energy Outlook Analysis

The macro-economic model is a tool to forecast economic outlook based on investigation and analysis on national and international economic circumstance and socio-economic policies. Economic variables forecasted there such as economic growth rate and economic structure shall be input into the energy demand forecasting model as given assumptions. The energy demand forecasting model is a tool to forecast energy demand based on the economic variables and incorporating investigation and analysis on energy system, domestic and international energy circumstance and energy policies. The energy demand/supply optimization model is a tool to derive the optimum energy supply pattern against the forecasted energy demand incorporating supply possibilities and price movements of various energy sources, energy policies and other preconditions. In general, these three engines are used to examine effects of various policies and to construct an optimized energy plan under the forecasted world energy movement and political and economic circumstance inside and outside the country.

Since energy supply and consumption are a part of economic activities, various activities analyzed by these three models are interdependent by nature. For example, when economic activities are vigorous, energy demand may increase. This would incur energy price hike to curb the economic activities. If energy supply is affluent, price would remain stable. But, if energy supply had restrictions or bottlenecks in its system, price may surge in the early stage of demand upturn. These movements would also be affected by policies on energy supply, price and market and so on. Thus, theoretically speaking, it is desirable to assemble these three sections into one simultaneous model.

Although it is not technically impossible to construct such a simultaneous model, it would become quite big in size. Enormous efforts would be required to keep consistency, and operability would deteriorate extremely. Therefore, we usually divide the model into three sections and construct analytical engines independently. Although energy activities are a part of economic activities, their effects on the aggregate economy are relatively limited in the real world except such historical periods we experienced after the oil crises. And we can consider impacts of important energy policies in prior when we examine the general economic outlook using the macro-economic model. During the model building stage, we can fine tune the models to ascertain that consistent answers are obtained from the macroeconomic and the demand forecasting models. Thus, we do not need to design a feedback loop on the model. We will be able to achieve our purpose designing the system as one way flow from the macro-economic model to the demand forecasting model.

While the theoretical relationship of each section is as discussed above, construction of the macro-economic model requires enormous efforts though not the purpose of this study. Therefore, we omit construction of the macro-economic model in this system. We give all the economic variables for the demand forecasting model as given assumptions.

In addition, since energy data and information are limited at present, we give priorities to the following points in designing the above models, they are, 1) to express consistently the energy systems on both demand and supply sides, 2) to consider operability of the model simplifying the calculation logics as much as possible, and 3) to construct energy balance tables which explains clearly the different effects of scenarios and policy selections. Afterwards when more data and information become available and operation capability is improved, the model may be upgraded to consider more detail analysis on each energy sector.

14.2 Energy Demand Forecasting Model

14.2.1 Structure of Energy Demand Forecasting Model

The energy demand forecasting model is composed of the two blocks as shown in Figure 14.2-1: the macro economic block and the energy demand block.

As explained in the previous section, economic indicators are in principle given to the model referring to those announced by the government and/or projected by relevant offices as external variables. Thus, the model reflects various economic and industrial policies stipulated under the Socio-economic Development

Plan and other plans. However, it is not possible in this manner to obtain all the input data required at the demand forecasting block. Therefore, we calculate in the macro-economic block those future values of other indicators as internal variables, which are not available from government plans and projections. They are, for example, sectoral energy consumption coefficients.

Then, in the Energy Demand Block, the final energy demand is divided into the transportation fuel such as gasoline and diesel gas oil and other general energy. The latter will be estimated by sector such as agriculture, industry, commercial, households and others. Then, they will be divided into two categories of power demand and fossil energy demand applying sectoral power ratios. The fossil fuel demand will be further divided into energy resources such as coal, oil, natural gas and renewable energies. In the

Figure 14.2-1 Outline of the Energy Demand Forecasting Model

electric power sector, fuel consumption at thermal power stations will be calculated applying the power flow system in generation and transmission processes. The calculated results will be entered into the energy supply optimization model. Energy balance tables are compiled in the optimization model.

In building the model, as much data as generally available are used to make model maintenance and operation easier. In this study, however, we conducted energy demand survey to supplement not available data to a minimal extent. Since the data obtained through the survey is essential to grasp the fundamental unit energy consumption of Philippines, it is required to establish a data collecting system and amplify the energy database. In line with the continued economic development, the energy demand of Philippines will be affected greatly by impacts of changes in industrial energy consumption pattern, changes in life style, energy conservation policies and so on. Therefore, it is strongly recommended to establish a data collection system to continuously watch indicators of these trends.

14.2.2 Functions of Energy Demand Forecasting Model

In the demand forecasting model developed in this study, the forecasting period is set for 2008 through 2030 and the following functions are considered.

1) Model linked to the changes of socio-economic activities

   Energy demand should be forecasted on the scenarios such as Reference Case, High Growth Case, etc, considering socio-economic changes in trends of population, economic structure, economic growth rate and so on.

2) Demand forecast considering energy conservation policies.

   The Philippine Government is promoting policies of enhancing energy conservation institutions. The model should incorporate these activities with quantified inputs of their effectiveness.

3) Demand forecast incorporating energy price effects

   Increase of crude oil price usually induces increase in prices of natural gas and petroleum products. Generally speaking, when prices of fuel such as petroleum products and natural gas rise, energy saving activity comes up (price effect on demand). The model should reflect such energy saving effect induced by price hike in the energy demand forecast.

4) Demand forecast incorporating the new and renewable energy development policy

   In Philippines, development of new and renewable energies such as biomass, wind power and nuclear is promoted. The model should reflect these development plans.

14.2.3 Test and Evaluation of Model Equations

The demand forecasting model is an econometric model and is formulated with regression equations and arithmetic equations. For selection and evaluation of regression equations, there are several kinds of testing methods. In this model, the following tests are conducted for selection of the regression equations.

1) Evaluation of energy demand forecasting equations

   - Determination coefficient (more than 0.85)
   - T-value test of parameters (more than 2.0)
   - Durbin Watson ratio test ($1<DW<3$)

- Sign test of the regression coefficient (logical according to economic theory)

2) Evaluation of macro economic forecast

- Real GDP growth rate
- GDP per capita (US$ base with international comparison)
- Vehicle ownership per thousand people

3) Evaluation of energy demand forecast

- Energy demand growth rate
- Energy consumption per GDP (GDP elasticity with international comparison)
- Energy consumption per capita
- Fuel consumption per vehicle

At this stage, we should also be careful about the following points.

1) Representativeness and Hetero-schedasity of the data used

As statistical coefficients obtained by regression analysis are those calculated on the given data, we should also take note of various errors that are inherent in them. In particular, we should pay attention if the data keeps consistency over the collection period and have sufficient representativeness of the population examining whether the number of the sample is small and/or the data is biased or not. In such a case, we can supplement the analysis by cross-section analysis and/or international comparison.

2) Divergence of the model

Although multi co-linearity test is conducted on the coefficients of the forecasting equations with Durbin-Watson Ratio, we often encounter parameters to cause divergence of the forecasting values. For avoiding the phenomenon, the forecasting equations have to be checked in the manner such as to evaluate stableness of parameters applying different regression period, to evaluate prediction ability of the equation extrapolating it for the past record, and to evaluate movement of the solution operating the model as the total test. The magnitude of parameters could also be known to some extent from empirical knowledge[31] and by technical analysis.

3) Adjustment of error

We often encounter discrepancy of an estimated value and the latest actual data, even though the forecasting equation has double-nine determination coefficient (0.99+). In such a case, if the equation32 is applied without adjustment, it would produce odd and discontinuous forecast values.

[31] The magnitude and signs of parameters can be estimated from investigations into income elasticity, price elasticity, unit consumption and energy efficiencies of energy demand.

[32] According to the definition, determination coefficient is the ratio of the deviation of the regression equation and the deviation of the actual data. For a high economic growth period , the determination coefficient of a regression equation tends to become high because the total deviation of the dependent variable is large. And we should be careful that, when a lagged subjective variable is used as an explanatory variable, we can generally obtain higher determination coefficient, however, it sometimes happens that predictive capability would be seriously damaged to cause divergence of the forecast values. In the extreme, regression analysis tries to explain the changes in the subjective variable with a combination of several explanatory variables. However, there is no guarantee that the parameters from regression analysis represent the true values, namely, true relationships of them. When selecting the regression equation, therefore, we should always give priority to consideration on what the true relationship of the subjective and explanatory variables is. Analysts are sometimes required not to apply equations obtained by regression analysis but, with brave, to apply logically constructed equations.

Therefore, such equation needs to be adjusted considering the tendency of the error. It is possible to install a measure to equation adjustment in advance, however, since the reasons of errors are different but not simple such as abnormal weather, accidents and so on, it is recommended that adjustment should be made one by one at the time of defining the equations.

Here, we should note that, regression equations are calculated on the past statistical figures, that is, on the past trend, but *our future should not be a simple copy of the past*. In Philippines, experiencing a rapid developing stage now, economic structure and people's life style will change quickly. We could not foresee the future simply extrapolating the past trend. We need to carry out versatile analysis with regard to shift of the economic development stage, change in the economic structure, life cycle of popular commodities, etc.

14.2.4 Calculation Procedure of Demand Model

In the model, as explained in Chapter 6, energy demand is forecasted by sector, namely, agriculture, manufacturing (energy intensive industries and general manufacturing industry), transportation, commercial, and residential. First, the model estimates energy demand by sector with BAU (business as usual). After that, case study is examined by changing price elasticity, annual EEC (Energy Efficiency & Conservation) promotion, and GDP growth rate based on BAU case. Amount of energy supply is obtained from optimization model. However, the demand model can also calculate total primary supply by assuming generation mix, transmission and distribution losses, plant own use, and thermal efficiency. The forecasting procedure of each sector as explained in detail in Chapter 6 is same among sectors excluding transportation fuel and is summarized as below;

- Forecast fossil fuel demand by sector with BAU
- Forecast electricity demand by sector with BAU
- Calculate fossil fuel demand by sector after price elasticity and EEC promotion
- Calculate electricity demand by sector after price elasticity and EEC promotion
- Calculate final energy demand
- Calculate fuel consumption for power plants
- Calculate total primary energy supply

Since it is difficult to obtain accurate parameters indicating progress of energy conservation applying regression analysis on the past data, this model is set up to consider the energy conservation (EEC) introducing EEC factor referring to Japanese experiences, national energy conservation targets and so on. That is, we first estimate the energy demand before EEC, and calculate the energy demand after EEC multiplying annual energy conservation rate. As estimation based on the past trend is adopted as it is in the BAU Case assuming that no particular energy conservation efforts would be promoted, progress of annual 0.5% energy conservation is assumed in the Reference Case. Higher rates are applied in the EEC accelerated cases. In the model, suppose that annual energy conservation rate is X%, the cumulative EEC factor for a specific year can be calculated as Yt = Yt-1 x (1 - Xt). In this model, it is possible to apply different EEC rates among different sectors with annual changes.

Price elasticity in Philippines was calculated in our trials at very low level with -0.01 to –0.02. This may be because the Philippines enjoyed relatively stable energy prices for the period of 1990 through 2003, most part of the data period applied this time from 1990 through 2006, and thus least price effect appeared on the actual energy consumption. After that, the recent drastic energy price hake has not been fully reflected in the energy consumption trend. Under the circumstance, this model adopts the method to introduce the price effect as exogenous variables.

In the model, suppose that price elasticity is At and annual price increase ratio is Bt, a cumulative price factor Yt = Yt-1 x (1 - At x Bt) will be calculated and applied to express the price effect. In this study, the price effect is assumed to be zero for the BAU Case and "-0.1." for all other cases. In this model, it is possible to apply different price effects among different sectors with annual changes.

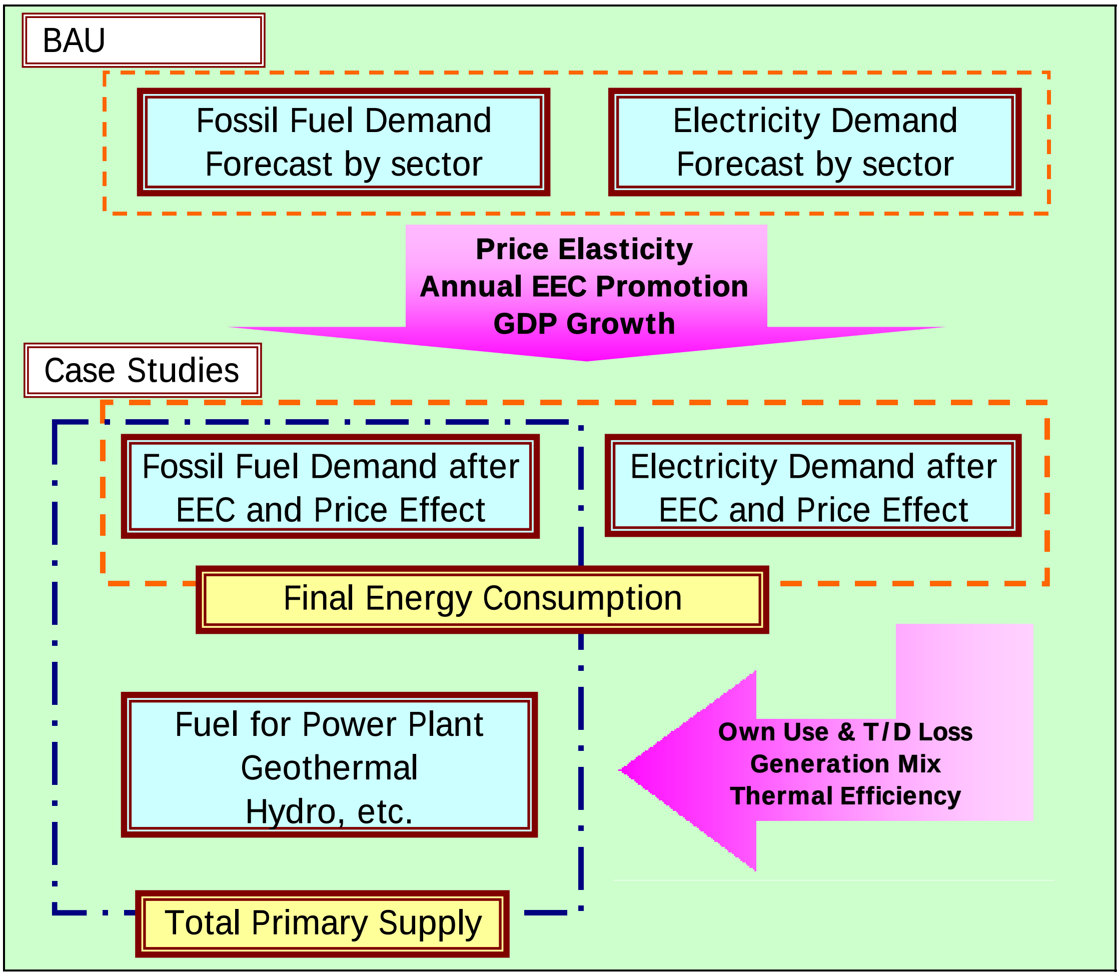


Figure 14.2-2 Calculation Procedure of Demand Model

14.3 Theory of Consumption Function and Demand Forecasting Equations

As the demand forecasting equations explained above are applied in this model, we would like to touch upon some important points for improving it and/or building short term models. Energies are consumed in all aspects of the economic activities. As styles and efficiencies of energy consumption are diverse among sectors, big difference may be observed among behaviors of the high energy consumption industries who are strongly conscious of energy cost, behaviors of the sectors with a low energy ratio over the total cost and behaviors of households. Nevertheless, the common truth is that, for consuming energies, energy equipment and/or appliances such as factories, automobiles, kitchen, bath, air conditioner, etc, are required. That is, energy consumption shall be built-in to a considerable extent at the time of purchasing equipments and appliances at factories or households.

In the theory of consumption function, it is discussed that consumption level at households are determined by permanent income, liquid asset and prices. In energy demand forecasting, it is important to recognize that there are such *demand built-in* and *ratchet effec*t. Then, in the energy intensive industry where energy prices are strongly considered, the price factor will work strongly in determination of the demand and selection of energy source. On the other hand, in low energy intensive sectors, there are many other priority factors than energy, and the energy consumption pattern may be determined subject to decisions on producing new products, opening additional shops and so on. At households, people give priorities to improving their living standard, and hence the energy consumption is generally characterized as 1) income effect is rather high, 2) ratchet effect is strong and 3) price effect is relatively low. The energy efficiency may be examined to some extent but would not be given the first priority in selecting air-conditioners and automobiles. Thus, energy consumption is built-in at the time of purchasing equipment and appliances. Unfortunately, energy efficiencies would not be considered with the first priority. This is an important fact in considering energy conservation.

As a general consumption function to express consideration on the above factors and penetration speeds of income effect and price effect, the flowing style equation with a lagged subjective variable is often used.

$$C_t = a\, C_{t-1} + b\, Y_t - c\, P_t + d$$

where C_t is Consumption, Y_t is Income and P_t is prices.

As Y_t is the variable to explain the effect of income, there are discussions such as to consider the permanent income to incorporate the inertia of income for a certain period and/or the liquid assets like saving deposit that should represent the total available fund to purchase durable goods. Anyway, a consumption function is a stable function and we do not need to stick to these discussions excessively in building a demand forecasting model. Rather, more difficult issues would arise in case when a logistic curve would become important for considering durable goods such as household appliances and automobiles, and in case a peculiar relationship exists in selection of energy sources for cocking fuel such as superior and inferior goods like progressing from woods/charcoal, via kerosene and finally to gas/electricity. Then, we may need to create some devices like expressing the parameter b in a non-linear mode.

Secondly, in the above equation, $1/(1-a)$ is defined as the demand adjustment speed, $b/(1-a)$ is the log term income effect and $-c/(1-a)$ is the long term price effect. For example, when a=0.7, demand adjustment speed is 1/(1 - 0.7)=3.3, which means the adjustment against changes in income and price takes

3 years to complete in case of annual data.[33] However, since use of a lagged subjective variable would sometimes incur divergence of the model, such functions are used to a minimal extent in the model.

14.4 Model Building and Simulation Procedure

In constructing the energy demand forecasting model, "Simple.E" is used as the model development engine, which is developed by The Institute of Energy Economics, Japan and provided for international cooperative projects free of charge. Simple.E is developed as "add-in" software to Microsoft Excel and is used to develop an econometric model integrating three spreadsheets named "Data", "Model" and "Simulation". For details, please refer to the operation manual attached as Appendix-3 and also try to directly operate the model on your computer.

The model is developed in accordance with the following procedure and has functions for simulation, analysis and output data transfer to the demand/supply optimization model to follow up the analysis.

(1) Procedures for making model structures
- a) Data entry
- b) Description of the structure
- c) Adequate allocation of the simulation area

(2) Procedures for test and simulation
- a) Data consistency check
- b) Regression analysis and tests
- c) Calculation of forecast values

(3)Procedures for analyzing simulation results
- a) Comprehensive evaluation of forecasting equations
- b) Evaluation of macro economic forecast values
- c) Evaluation of energy demand forecast values

(4)Procedures for output data transfer
- a) Making summary tables
- b) Making reporting tables
- c) Data transfer to the Supply/Demand Optimization Model

14.4.1 Functions and Roles of Sheets in Simple-E

The energy demand forecasting model is created by Simple-E and one book consists of 19 work sheets. The Data sheet, the Model sheet and the Simulation sheet are created by Simple-E. Other sheets are firstly those that analyze outcome of the simulation by the energy demand forecasting model and secondly the post-procedure sheet to transfer the necessary output to the Energy Supply/Demand Optimization

33 By using the methodologies, IEA calculates the elasticity as follows. Oil demand elasticity on income is 0.09, and on prices is –0.15 for short term and –0.44 for long term. Power demand elasticity on income is 0.4 to 12 and on price is -0.04 to -0.14. However they are greatly different according to the economic development stages. (IEA World Energy Outlook 2006 Chapter 11)

Model. Their functions and roles are summarized in the Table 14.4-1.

Once a simulation is run by the Demand Forecasting Model, its output will be entered in the "Summary" sheet for transfer to the Supply Optimization Model. However, as the "Summary" sheet is prepared to use it again at the later stage for compiling the final report, this sheet is not filled up at this stage and there are several columns left as blank. This sheet will be completed after the simulation by the Supply Optimization Model is run, which procedure will be explained later in section 15.4.

Table 14.4-1 Functions of Sheets

Sheet	Role and Function
Data Sheet	Enter data to be used in the model
	1. Data name, source, and comments
	2. Socio-economic data such as population, economic variables, prices, energy consumption records, etc.
	3. Processed data via summation or transformation of the above such as unit energy consumption and energy intensity
	4. Future value of external data to be given to the model to explain economic scenarios and/or policy options such as economic variables, energy prices and biofuel ratio
Model Sheet	Construct the model
	1. Model equations (definision equations and regression equations)
	2. Statistical values to evaluate regression analysis after simulation
Simulation Sheet	Illustrate simulation result
	1. Actual and forecasted figures
	2. Applied equation and average growth rates on the past and future
Summary Sheet	Sum up the simulation result
	1. Data to be transferred to the Supply Optimization Model
	2. Summary of the simulation result (Temporary output at this moment)
Analytical Sheets	Illustrate sectoral outcome
	1. Final energy demand by sector, 2. Final energy demand by energy, 3. TPE (temporal
	Sectoral energy demand: 4.Agriculture, forestry & fishery, 5. Energy intensive industry, 6.General manufacturing industry, 7.Commercial/services sector, 8.Residentail sector,
	14.Biomass

14.4.2 1 Sectors and Energies forecasted in the Model

Sectors and Energies prepared in the Model are as follows;

<u>Classification of Sector:</u>

Following sectors are set in the model for power and energy demand forecasting.

1) Agriculture, Forestry and Fishery Sector

2) Energy Intensive Industry

Energy demand in Cement, Food Processing, Sugar, Chemicals, Basic Metals and Paper & Pulp industries are individually forecasted and aggregated.

3) General Manufacturing Industry

Electric, Machinery, Automotive and other less energy intensive, hi-tech type industries and construction sector

4) Commercials & Services sector

Trading, Communication, Private Services and Government sectors

5) Residential

Energy consumption at household

6) Transport Sector

Energy consumption for transport by road, railway, marine and aviation

Energy Demand Forecasted in the Model

Future demand is estimated separately on energy types as per

1) Electricity

2) Fossil Fuels: Coal

Natural Gas

Petroleum Products (LPG, Gasoline, Jet Fuel, Kerosene, Diesel and Fuel Oil)

3) Renewable Energies: Biofuel (as replacing with petroleum products)

4) Non-commercial energies: Rice hull, Charcoal, Fuel wood, Bagasse, Coconut residue and Animal waste

In order to run quick check of the outcome on the total primary energy supply (TPE), power sector balance is calculated in the Demand Forecasting Model estimating the total power generation quantity applying transmission loss and plant own use and power generation distribution among power sources. Please note that this is a temporary outcome and the final answer should be prepared after simulation by the Supply Optimization Model.

Chapter 15 Energy Demand and Supply Optimization Model

15.1 Objective

The objective of the energy demand and supply optimization model (optimization model) is to calculate a logically correct and consistent demand and supply balance of various energies. Demand is forecasted by the demand forecasting model and given to this model as input data. This optimization model decides the amount of each energy supply with minimum total cost under the condition that the given demand should be satisfied. Linear Programming theory is used as the optimization method.

Furthermore, this optimization model can be used as a tool for examination how the energy balance would change under various conditions. In order to facilitate easy comparison study, the program is designed to produce summary sheets of the calculation results.

15.2 Outline of Energy Demand and Supply Optimization Model

15.2.1 Basic Framework of Modeling

At first the basic framework of the model should be determined. There are two big issues to be defined to decide the framework. The first point is whether the model should be a whole country model or a regional model, and the second point is how the investment issue should be handled.

1) Construction of whole country model

Philippines is the archipelago country with different regional economic backgrounds and different energy resource distribution. In order to reflect the reality of the nation accurately, it is necessary to have a model dividing the nation into regions with different backgrounds, which in turn requires incorporation of transfer of energy among them into the model. However, various issues as below would arise if we would construct a regional model. In view of the objectives of this study and limited time, we have decided to construct a whole country model this time.

a. The objective of this model is to assist and give a suggestion for formulation of a long term energy plan projecting for 25 years, but not to make detail analysis for short-term energy administration.

b. In order to make the optimization model, huge amount of data of many kinds are required. They all relate to various conditions on future supply conditions, prices and etc., estimating which is not easy even for a whole nation model. In view of the current status of statistical data in Philippines, substantial difficulties may be encountered should a regional model be constructed.

c. In case the optimization model should be a three-region model, the scale of the model becomes greater than three times, since transportation among regions should be added in the model. Thus, confining the projection only to one year, it would not be possible to handle the model by the student version of GAMS; the tool of making the optimization model will be described later. As the Counter part does not have experiences of making an optimization model using GAMS, technical transfer is another objective of this project. To promote this objective too, it would be appropriate to limit the model within a size that could be handled by the student version of GAMS.

2) Exclude investment issue

When we discuss on a long-term plan, it always becomes a problem how and when investments on new plants should be made. It is theoretically extremely difficult to simultaneously decide the timing and scale of a new investment applying Linear Programming. If we are allowed to assume, for example, that the investment amount is proportional to the load required for each year, but not the total capacity, of the new plant, a pure LP model could be applicable to decide scale and timing of a new investment. In reality, however, a new plant will be constructed at a specified scale and timing, and the total investment amount shall start to be counted from the same year as cost distributed by depletion for a specified period. In order to accurately express this real logic, the scale of a new construction should be given applying a 0-1 variable. Then, LP model can decide the optimal timing to construct a new plant. Even in this case, however, the size and cost of the new plant should be given to the model as a precondition. Such model is called MIP (Mixed Integer Programming). In handling the MIP model, highly advanced experience on Linear Programming is required; Counterpart would be confused if the MIP were adopted in this model in this preliminary stage.

There is another method to handle the investment issue. We may give the timing and scale of a new plant construction as input data for a case, and calculate an optimal solution. We can compare economic merits of several cases and comparing such simulation results we can find the optimal solution. In this manner, combining the optimization and simulation methods, we can handle the investment problem with a much simple model.

As discussed above, the optimization model of this project is designed as a whole country model and does not directly handle the investment problem within it.

15.2.2 Objectives of Optimization Model

1) Objective energies

Since the objective of developing the optimization model is to provide basis for formulating the Energy Master Plan of Philippines, any energy to be used in the country in principle becomes the objective of this optimization model. Thus, 36 types of energy are incorporated in this model, which are as follows.

- Crude oil : Domestic crude oil
  Import crude oil
- Coal : domestic coal
  import coal
- Gas : domestic natural gas and import (PNG, LNG)
- Petroleum products: LPG, gasoline, jet fuel, kerosene, diesel gas oil, fuel oil
- Electricity
- Others

2) Objective facilities (plants)

Four kinds of energy transforming facilities are planned to be incorporated in the model; they are oil refinery, power plant, coal plant (preparation) and gas processing plant.

- Oil refinery

  An oil refinery composes of topper (atmospheric pressure distillation unit), vacuum distillation unit, reformer, cracking unit, hydro-desulfurization unit, and etc. They make up an oil refinery as a package. Now the constitution of oil refinery is being considered..

- Power Plants

  Power plants are classified into many kinds based on the energy source such as

  Hydro, domestic coal, import coal, gas, fuel oil, diesel, geothermal, nuclear, and renewable energies

- Coal Preparation Plant (coal processing)

  Now the kind of coal to be produced is being considered.

- Gas Processing Plant

  At the gas processing plant, raw natural gas sent from offshore is processed. At first, condensate (C5+) is extracted and then the rest of the gas will be natural gas (C1, C2).

3) Objective period

The objective period is 25 years from 2006 through 2030 to be covered by the Master Plan.

4) Decision items

These items are called as variables in the optimization model. The optimization model shall decide the value of these variables in order that the objective function gives the optimum value. These variables are typically production, consumption, import, export and cost of each energy items. The energy consumption quantity calculated by the model indicates the quantity fed to each transformation plant plus those straightly directed to the final consumption.

5) Objective function

In the standard cases such as the Reference Case, the objective function is defined as the net present value at 2006 of the total cost incurred during the projection period. This objective function can be defined applying other criterion subject to the purpose of analysis.

15.2.3 Energy Flow

(1) Energy Flow Chart

Energy flow is the basic information in compiling an optimization model and is supposed to explain the current and future energy flow of Philippines. Of course, consideration is made on simplification and easiness to understand. Primary energy is produced from mines or oil/gas fields and transformed to secondary energies before delivered to the users via several routes and finally consumed. The energy flow chart illustrates such flow of energy such as Figure 15.2-1-Figure 15.2-2. Figure 15.2-1 shows the total flow incorporated in this optimization model. This figure shows that demand data is given as input from the

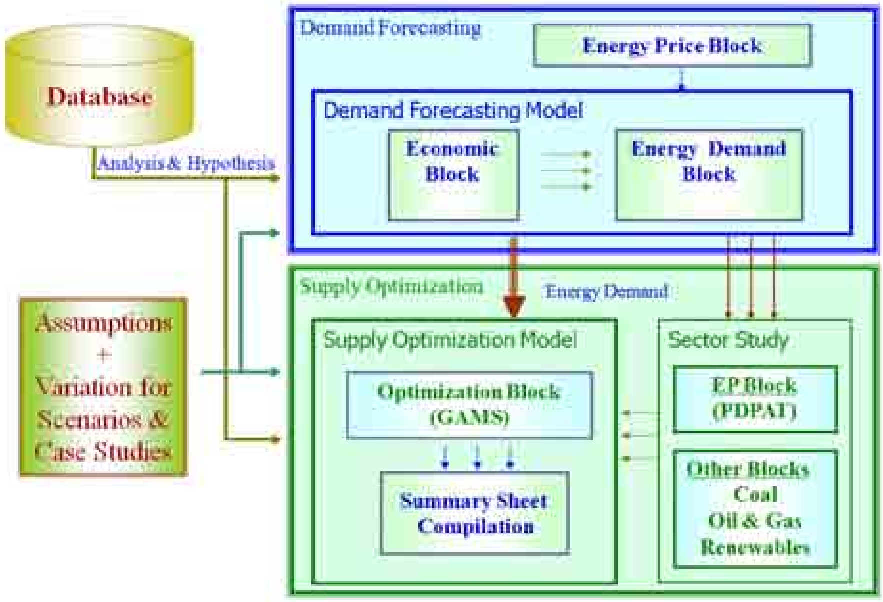


Figure 15.2-1 Flow of Energy Demand and Supply Optimization Model

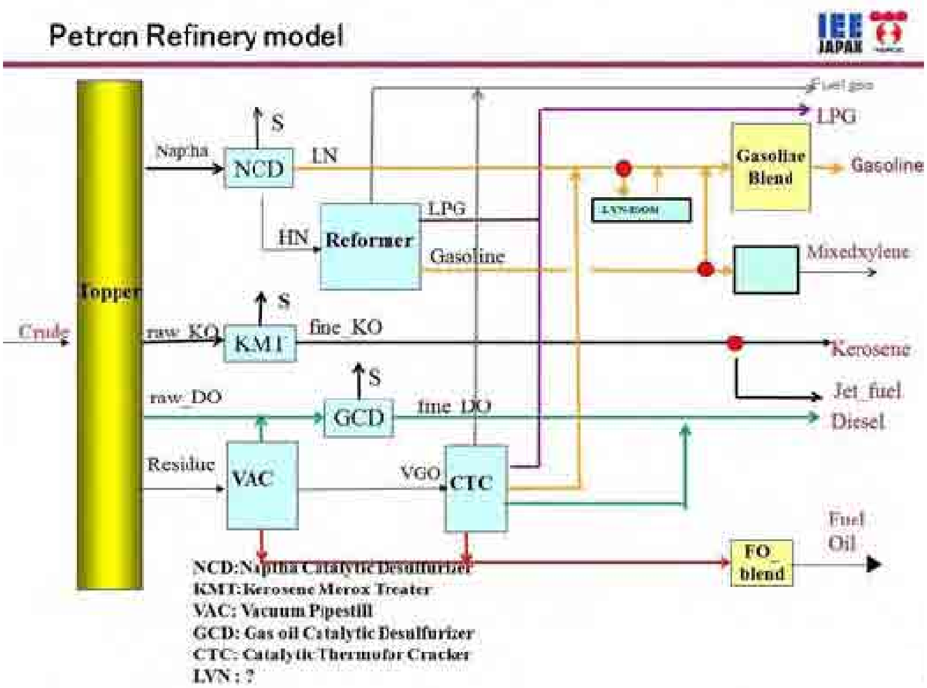


Figure 15.2-2 Petron Oil Refinery

result separately forecasted by the demand forecasting model. The refinery part is composed of Petron oil refinery and Shell oil refinery. Figure 15.2-2 represents the process flow of Petron oil refinery.

It is of course possible that, subject to future study, items and types of input/output energies and composition of transforming plants would be changed and the energy flow chart should be modified. Then, the supply optimization model should also be revised to these adjustments, accordingly.

15.2.4 Basic Constraints

As the flow chart shows the relations among energies, these relations should be represented in the form of linear equations in order to facilitate LP method. Aside from these relations, various constraints like plant capacity should also be represented by linear equations. These linear equations are called constraints. Typical constraints are as follows.

a. Production from topper = yield x crude oil feed

b. Crude oil feed into topper <= topper capacity

c. Fuel consumption=power generation x 860 / (heat value of fuel x heat efficiency)

d. Basic balance: production + import = consumption + export

e. Oil stockpiling: stockpiling = consumption of crude oil per day x stockpiling day

f. Total emission of CO_2 <= maximum emission permitted

15.2.5 Input Data

There are about 30 items of data handled in the model. All of them are stored in one book of an EXCEL file, where one sheet compiles one kind of data. Representative items of data are as follows.

- Maximum production of primary energy
- Demand by energy and by sector
- Max/min of import and export
- Technical information of plant (capacity, yield, heat efficiency)
- Property of energy (specific gravity, heat value)
- Generation amount and fuel consumption by power plant
- Oil stockpiling days
- Various cost data (production, import/export, operation cost etc)
- Currency exchange rate, interest rate, etc

The listed items of the data may be changed according to changes in the model.

For example, among data items to be input, energy demand may greatly increase and if domestic supply shrinks in future, the solution might become infeasible. Therefore, the maximum amount of import should be set at an adequately big value in order to decrease the chance of infeasibility. Then, if results of import on the solution are extraordinary big, we need to examine the result and the model if such solutions are properly induced. If not, we need to find the cause and amend the model.

As such, in the early stage of model building, it is necessary to fine tune the setting of assumptions, model logics and the objective function so that the model operates to give rational and stable solutions.

15.2.6 Output Table

GAMS generates automatically a text file which includes all information. But the volume of this text file is very big but is not sorted nicely. Therefore, it is not suitable to conduct comparative analyses using this file. In order to facilitate easier analysis, a function is added to this program to generate 15 kinds of output tables. Typical output tables are as follows.

a. Energy balance table

b. Work sheet (summary for analysis by energy)

c. Summary sheet (for whole country during 25 years)

15.2.7 Modeling Tool

The basic theory of modeling is LP (linear Programming). In this LP model, all constraints and one objective function should be represented in the form of linear equation. The solution in which an objective function is maximum or minimum under conditions of satisfying all constraints is called the optimum solution. In case of linear analysis, the solution is mathematically guaranteed as optimal. In case of non-linear analysis, however, there is no mathematical assurance of optimum.

GAMS is used as a modeling tool. GAMS stands for General Algebraic Modeling System and is a product of GAMS Company. A commercial contract is required to use the GAMS official version, while the company distributes a student version GAMS as a free ware soft. As we can handle a huge model with the official version, there is a limitation on size for the student version, maximum 300 variables and 300 constraints. This model is designed that if we operate it only for one year, we can handle it by the student version for demonstration. This aims to make the technical transfer easier and familiarization of the Counterpart faster.

Input file is written in EXCEL. One sheet contains one data item. These sheets are housed in one book and there are many kinds of sheets. As GAMS cannot directly handle a book form of EXCEL, we need to convert them from an EXCEL sheet to a CSV (Comma Separated Value) file one by one. To make this easier, a macro program is added in this input EXCEL book with a function to automatically convert one sheet to one CSV file by one click.

Regarding the output file, over 10 output tables are generated in the CSV file form so that it is easy to read the output tables by EXCEL. The configuration of these tools is shown in Figure 15.2-3.

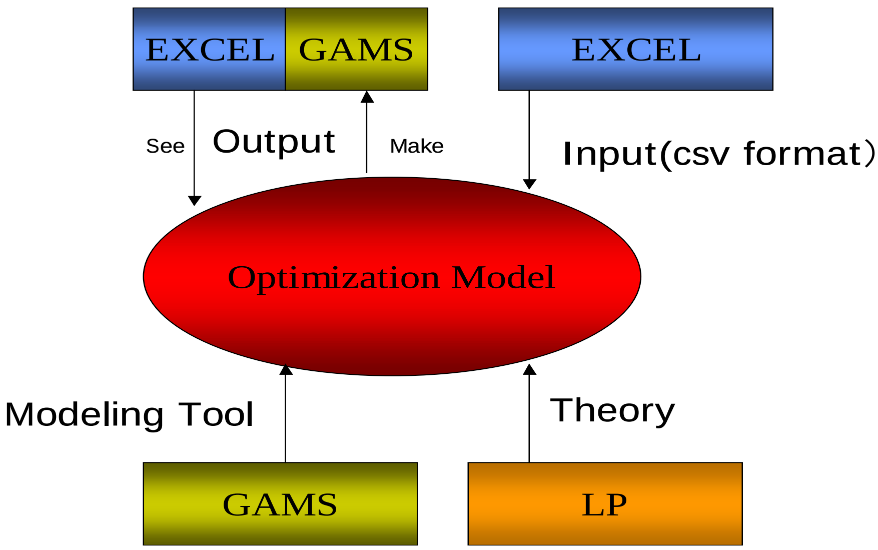


Figure 15.2-3 Modeling Tool

15.2.8 Block Flow of Model System

Figure 15.2-4 shows the system block flow from receiving the demand forecast results to obtaining the final solutions.

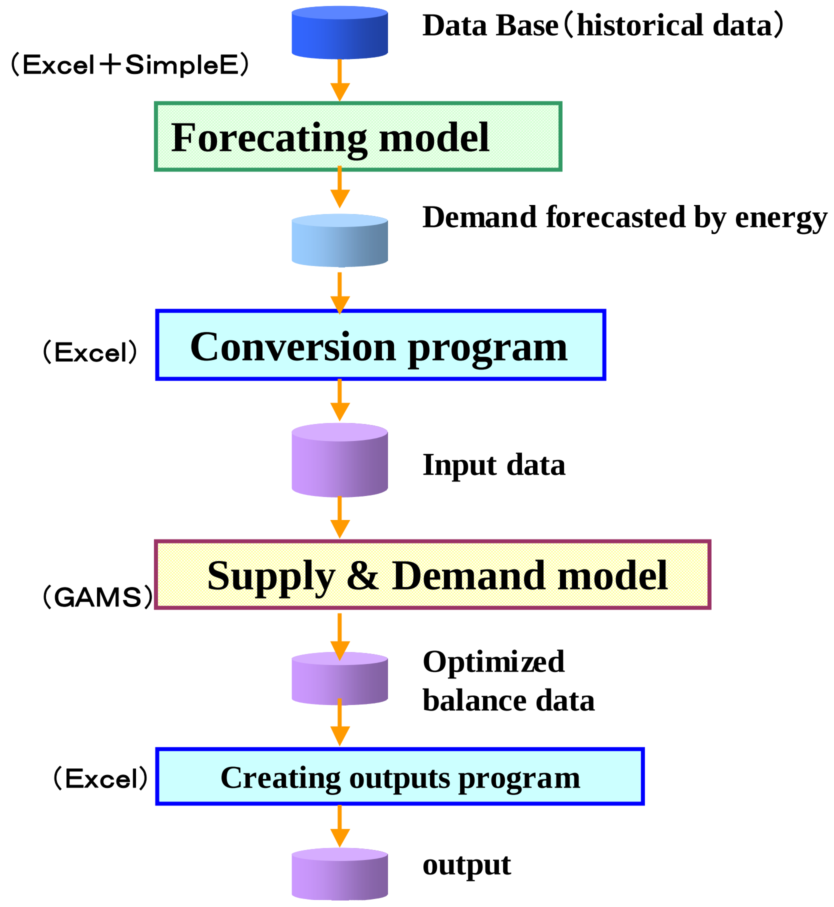


Figure 15.2-4 System Flow

15.3 Functions and Operations of Optimization Model

This energy supply optimization model has following functions.

1) Information created (main function)

a. To calculate the logically correct demand and supply balance of each energy comprehensively satisfying the energy demands given as input data. They are for example,

- Raw material feed amount into each facility at oil refinery
- Petroleum products production amount
- Converted amount of petroleum products to another energy, e.g., from kerosene to jet fuel or diesel gas oil

b. To calculate the minimum total cost as the net present value at 2006

2) Service functions for convenience of users

c. To automatically convert from a sheet in a book of EXCEL to a CSV file (EXCEL macro)

d. To output tables to show the optimum solutions in various forms (CSV file)

e. To output four summary sheets for comparison study (EXCEL)

3) Functions of GAMS itself

f. To make a text file including all information of the model. The first file houses the following information.

- Original program created by model builder
- Input data
- Developed constraints
- Various statistics on the model (scale, execution time, etc)
- Solution itself

g. To show grammatical error message

h. To point an infeasible constraint or a variable as a cause of infeasible solution

i. To show the number of infeasibility if infeasible

j. To show name of the output table created

k. etc

With regard to the operation and maintenance method of this Energy Supply/Demand Optimization Model, please refer to the manual to be separately prepared.

15.4 Outlook Summary: Final Summary of Simulation

Upon completion of the simulation by the Supply/Demand optimization Model, a "Supply" sheet will be prepared on Microsoft Excel sheet carrying necessary information to compile the final "Outlook Summary". Entering this "Supply" sheet into the "Outlook Summary" book, the final report will be completed combining the outcome of the Demand Forecasting Model and the Supply/Demand Optimization Model. The contents of the Outlook Summary report comprises 4 sheets as shown in Table 15.4-1, the "Summary" sheet that illustrates major energy indicators calculated based on the "Simulation" sheet transferred from the Demand Forecasting Model and the "Supply" sheet transferred from the Optimization Model, and the "Overview" sheet is attached as a more brief summary of the Summary report. Samples of these three additional sheets are attached as Appendix-1, 2 and 5 for your reference.

In this final book of the Outlook Summary, contents of the "Simulation" sheet referring to the outcome of the energy demand forecast are same with those that were referred to in Table 14.4-1. However, since the new result of supply optimization is introduced by the "Supply" sheet here, the contents of the "Summary" sheet are different from those previously shown.

Various examinations on scenarios and policy options will be carried out comparing the Outlook Summary to be produced on each case. We have tried to pick up most of the important energy indicators in the Summary sheet here so that features of scenarios or cases could be easily identified and compared referring to the "Summary" sheets only. However, if you need to compare the indices not listed there, it may be necessary to look into the more complicated outputs on the "Simulation" sheet. If you want to further examine assumptions, hypothesis and/or model structure, it is necessary to look into the models deeply, and you may need to amend them. We hope that models and summary sheets prepared here will be improved day by day up to accuracy and your convenience.

Table 15.4-1 Contents of Outlook Summary

Sheet	Role and Function
Simulation	Illustrate simulation result
	1. Actual and forecasted figures
	2. Applied equation and average growth rates on the past and future
Supply	Major output from the Supply/Demand Optimization Model
	1. Electricity Sector: Power generation by energy source
	2. General Sector: Domestic production, export and import of fossil fuels (coal, natural gas, petroleum products)
	3. CO2 emission
Summary	Overall result of the simulation for every year of 2005 - 2030 with 5 year growth rates
	1. Major energy indicators: Primary Energy Supply, Final Demand, Import/Export, etc.
	2. Major indices on each sector: Oil & Gas, Electricity, Coal, Non-commercial energies
Overview	5 year brief summary on major indicators
	1. Primary Energy Supply and Final Demand
	2. Energy Prices, Per capita energy consumption, CO2 emission, etc.

Postscript

During a period of slightly over one year since we started this survey in September 2007, the world has experienced drastic changes in energy price. Although failure of the sub-prime loans was reported in the summer of 2007, pushed by various factors such as Nigerian turmoil, WTI futures continued to edge upward and broke through the $100 per barrel marker on January 2, 2008. After then, the movement was accelerated by huge inflow of fund into the commodity market, and the WTI futures hit the record high of $147 on July 11. In early August, mass-medias reported extensively that WTI cut down $120, but the market was still calm considering the downward trend as adjustment of overshooting. However, upon the Lehman-shock of September 15, crude oil price plunged to $60 per barrel. In early November, it is hovering around $70.

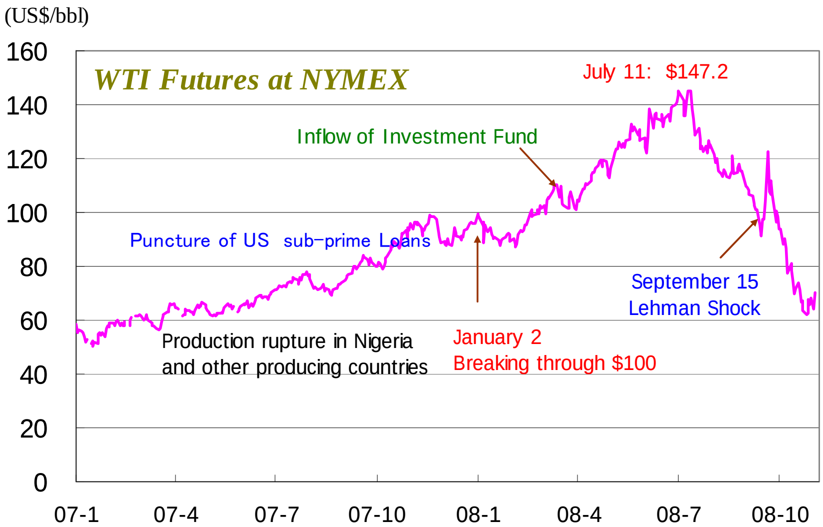


Figure 16.1-1 WTI Futures at NYMEX

As we set out the preconditions for the analysis in this survey around the end of May 2008 when the oil price was still on the upward trend, we adopted a hypothesis that oil price would increase upward starting from $120 per barrel. Looking at the recent happening, however, everybody may wonder that the price projection was excessively high and what would happen under a lower price scenario. In reality, changes in the long term energy demand outlook caused by changes in price scenarios would not be very large. Nevertheless, it is quite natural the people wonders like this. Therefore, in this postscript we run a supplemental case that price scenario starts from $70 per barrel and examine its implication.

In this study, we aimed to construct a comprehensive energy analysis model to project long-term energy outlook as a basis for compilation of the Philippine Energy Plan and conduct technical transfer on it. We also intended to produce recommendations for the current energy plan formulation running the model cases. After the study of one year plus, we have completed the model that we had aimed at the very outset. Then, we identified important issues to be considered and illustrated possible direction of energy policies. We believe that we have successfully achieved the original objective, yet there are many points to be improved. We hope that the system shall be repeatedly tested and upgraded by the hands of Filipino colleagues. Toward this end, we would like to memorize several hinting as follows.

Energy Outlook under Revised Price Scenario

As the average crude oil price for 2008 may settle down at about $100 per barrel[34], it may be natural to consider the immediate crude oil price of $70 will become the basis for the price of 2009. After the, we assume that the oil price would climb up gradually to $100/Bbl in 2030 reflecting tightening trend of the world oil market. Energy prices other than crude oil price may follow the same trend.

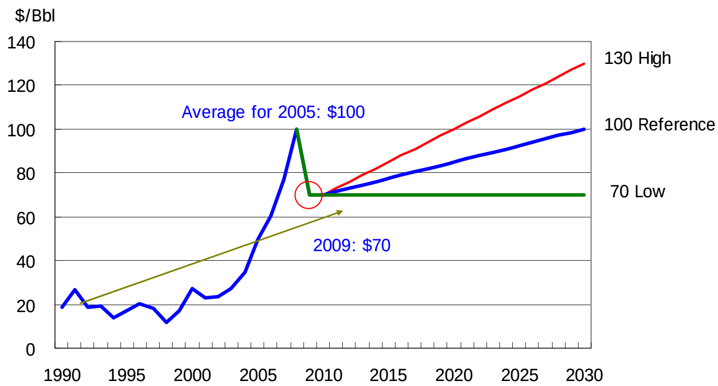


Figure 16.1-2 Crude Oil Price Scenario

It is also anticipated that the world economy may plunge facing the global financial crisis. The Philippines could not be free from the effect. Thus, we set out another scenario that the economic growth rate for the period of 2008 – 2010 may slow down from the original assumption of annual 6.4% to the half of 3.2% and that for the overall projection period from 5.0% to 4.0%. In this case, the size of economy or GDP may become lower than the former Low growth case (4% growth) for the time being, but it will catch up the latter at around 2020.

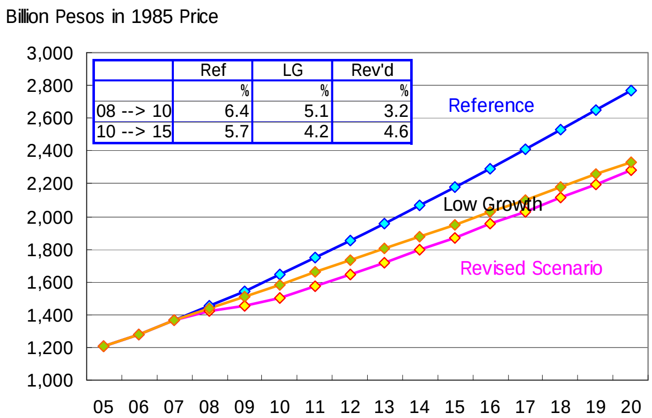


Figure 16.1-3 Revised Scenario for Economic Growth

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[34] The average of WTI futures for January to October 2008 is $104/Bbl.

In Figure 16.1-4 is shown demand outlook for the three cases, namely, 1) Reference Case starting with crude price of 120/Bbl, 2) Revised Price Scenario case starting with $70/Bbl, and 3) Revised economic scenario case that economic growth of the Philippines would slow down reflecting world recession. Energy import quantities and import ratios are also shown in Table 16.1-1.

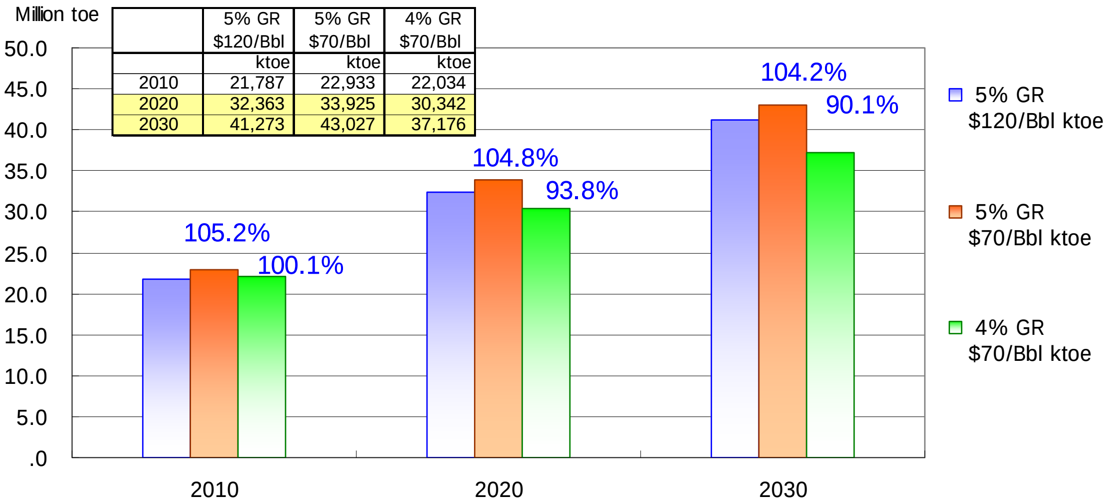

Figure 16.1-4 Final Energy Demand Outlook

Table 16.1-1 Energy Balance and Import Quantity

Case	GDP Growth	Primary Energy 2020	Primary Energy 2030	Import Quantity/Ratio 2020		Import Quantity/Ratio 2030	
(Original)	%	Mtoe	Mtoe	Mtoe	%	Mtoe	%
Reference	5.0	63.4	78.5	32.3	56.2	44.3	60.9
Low Growth	4.0	56.9	67.4	26.9	52.4	34.9	56.2
(Reviesed)							
Price	5.0	57.2	80.7	34.2	57.3	46.5	61.9
Price+GR	4.0	54.2	71.4	29.5	54.5	38.6	58.3

From the above case studies, it is noticed that the variances of these cases is within the variance range of the various cases as studies in this report[35] although substantial changes are introduced into the price scenario. With downward change of crude oil price from $120 to $70 per barrel, the final energy demand may increase 4 – 5% compared with the Reference Case. On the other hand, as economic growth slows down, energy demand increase in the long run would be curbed even under the lower price scenario. However, comparing the two cases of same average economic growth of annual 4%, the former low growth case and this time revised economic growth scenario case, we observe that energy demand in the near future would slow down but, in the later time when economic growth rate goes up higher than the former case, energy demand in the revised scenario case will overtake that of the former scenario. Though price is an important factor when we consider energy policy, we observe that those elements such as economic trend and energy conservation efforts shall have greater impact in the long run.

[35] As shown in Table 6.1-1, final energy consumption outlooks of various cases for 2030 range between 32.7 to 49.7 million toe.

As observed above, it is possible to examine wide range of scenarios with the model developed under this study. We hope that experts of the Philippines will try to examine various cases with this tool, get familiar with and improve it.

Method of Approach

It is needless to say that continuous improvement should be made on the database and model developed under this study, additional studies and improvements to this end may be classified into following categories.

Category-1: Further studies on important factors, preconditions and/or scenarios to be considered or incorporated into the comprehensive energy plan.

Caterogy-2: Detail studies on sectoral demand and supply trends, which are important components of sectoral plans as well as important elements of the overall national plan.

Category-3: In-depth analyses on various themes that should support sectoral plans.

Subjects classified under Catergory-1 are the fundamental issues to formulate comprehensive energy plan. Because of time constraints, it was not possible to incorporate those changes and/or analyses in the study that occurred after May 2008 when we finalized the preconditions for this study, such as drastic changes in the global economy and energy. As we have added preliminary supplemental analysis in the previous section, it is necessary to look into economic trend and other elements more in detail. In addition, we think that amplification on the subjects under Categories 2 and 3 should be considered in the next step study. We expect that further studies will be conducted on the Philippine side, while we are pleased to provide every support.

Analytical Tools

As analytical tools, we constructed energy database, energy demand forecasting model and energy supply/demand forecasting model.

First of all, data is the starting point of every analysis. As we have constructed the energy database as a container of data, it is a serious challenge how to put high quality data in it. The global trend toward better energy efficiency and conservation will require collection of more elaborate data. They are the platform essential for creation of better society and market, and in this sense social assets. It is necessary to establish a mechanism in which society shall share data as the common asset with recognition that it is the obligation of market participants to report accurate and transparent data to the society for appropriate market design and policy making, save that private rights on information and knowledge should be properly protected.

Secondly, though the energy demand forecasting model is completed covering all energy sectors, we still face with problems such as insufficiency of data or difficulties to forecast future simply based on the past data. The energy model is designed in a top-down style with macro-analysis approach. In order to satisfy completeness, it has become a bit bigger while time was limited for trial and tune-up. For operational efficiency, it is desirable to downsize it.

The greatest issue is how to figure out the future industrial structure and resultant energy trend more precisely. For example, we may carry out bottom-up approaches compiling data by sector, verification by sub-models on diffusion of durable goods and automotive vehicles, and improvement of analytical logics and accuracy. In particular, in the industrial sector, plants of energy intensive industries such as steel, cement, chemicals and paper and pulp are generally large in scale sharing major part of the industrial energy use. Thus their energy demand increases stepwise, and therefore bottom-up approach is an important method. In other aspects, there are very influential factors on the energy demand tendency how the Philippines would design the future transportation system and life style. We hope that our colleagues will understand these problems contained in the energy demand forecasting model and try ceaseless efforts to improve it.

Thirdly, we have tried to simplify the energy supply/demand optimization model as much as possible to improve operationality. In the electricity sector we use PDPAT as a sub-model to check and verify if the simplified electricity block of the general model produces rational answer. With regard to coal, oil and gas and renewable energies, it is necessary to establish similar systems to check and verify the answers of the general model using sub-models and/or supplemental analyses since it is difficult to conduct in-depth analysis by the general model. Especially as the current model tends to be too much elaborating on the oil-refining sector, if we could simplify that part by way of sub-model, operationality of the general model will be substantially improved.

Specific knowledge is necessary for operation of the Linear Programming method used for the supply/demand optimization model and accumulation of operation experience is necessary since, being an LP model, it is not easy to grasp the relationship between the logic incorporated in the model and the solution. In short, it is necessary to train up experts with knowledge and skill to command the model.

We should note that we have given up regional study that was proposed at the stage of pre-study. Regional analysis is not very difficult in terms of model building. However, it is difficult to collect ample and accurate regional data and fabricate them into meaningful patterns. Among others, an extremely difficult issue is that we need to give the model very accurate inter-regional transportation costs on every energy sources. Model operation would also become complicated. We believe that it is better to consider separately the objectives to study national strategy/policy and to construct consistent regional plans. Apparently, the former is the main purpose of this study as the first step. When similar studies will be formed in future, it is necessary to set out clear objectives but not to pursue every general ones at the same time.

With regard to regional analysis, it is not very difficult as logic but collection of accurate regional data and derivation of meaningful output is not an easy task. When we use LP model, we need to incorporate transportation costs among regions, which is extremely troublesome. Therefore, it is recommended to use different analytical methods according to the purpose, preparing tools for examining national strategies and policies on one hand, and coherent regional plans on the other.

Study on Energy Policy

In part 3, starting from various analyses developed in Part 2, we tried to identify issues and challenges anticipated in the energy field referring to experiences and discussions in Japan and the world and discussed direction of basic policy. We regret, however, that time was too short to thoroughly exchange views and opinions with our Filipino counterpart either on the overall framework or individual subjects. It is the future task to elaborate on how to assemble the outcome of the model analysis into meaningful and practicable policies. Thus, we would like to comment as follows.

Firstly, the basic energy policy should be established with consistent balance of priorities among other socio-economic policies. Then, in order to formulate energy and environment policies with accuracy and maturity that are required in the contemporary administration, it is necessary to set out other relevant policies with one more step deeper considerations, for example, with regard to industrial structure reform and/or life standard improvement. At least, there should be calculations on targets of production and consumption quantity of major materials and products. In the energy policy as well, it is easier to understand numerical goals rather than expressions in words.

Secondly, energy policy should be based upon reality and practicability, and be adjusted in due course from time to time reviewing changes in circumstances. For example, when we consider the characteristics of energy as a strategic commodity, long lead time and huge amount of fund required to construct energy system, effect of economics of scale, consistency of energy policy among the overall social policy and so on, it is not necessarily right to go forward straightly toward liberalization of the energy market. We should learn from the historical lessons that American and European economies have experienced serious energy market failures. Though construction of energy efficient economy is an ideal, the Philippines as a developing country still constructing its economy needs feed of fundamental materials and energies to build industries, residences, public transportation system and social infrastructure. Individual policy should not prejudice the overall goal of the society. To avoid such situation, it is important to establish the country's long-term goal and proceed with economic construction considering the consistent balance of various sectors.

Thirdly, according to the analysis in this report, it is anticipated that the Philippine's dependence on imported fossil fuels will further progress. Then, it is a quite reasonable response to try to enhance development of domestic energy resources. To this end, we should make it the principle that practicable plans with high possibility of materialization should be considered. To develop indigenous energy such as geothermal and biomass, it is necessary to construct large scale transmission system or to review and reform institution on land ownership and agricultural policy. We should note that it takes long time to establish comprehensive and coherent plans.

At the same time, however, it is necessary to prepare against the situation that import dependence would progress. Since the share of the Philippines's energy consumption is only about 1% among East Asian countries even in 2020, and compared with the fact that Japan and China are importing huge amount of energy, it is not necessary for the country to worry too much about international procurement. Nevertheless, three major principles should be observed for the stable procurement, that is, 1) to procure them at international prices, 2) to prepare import facilities compatible with international standard (size and quality), and 3) to establish contact channels with energy exporting countries and enterprises. From the viewpoint of the energy security and size of country's energy industry, it is appropriate to consider cooperation with neighboring countries on development of energy industries such as refineries, LNG and PNG.

Fourthly, in the contemporary world, environmental issues could not be decoupled from energy policy. In addition to improving air and water quality, as global concern and discussion on the Post-Kyoto Protocol mechanism are rising, it is necessary for the Philippines to discuss how to cope with the matter and set out its firm stance against the global warming issue, although the country's energy consumption is relatively small in the world.

Now our friends will start operating the model by your own hands and discuss the outcome for evaluation of policy options among yourselves. Then, you will realize that there are far more approaches to evaluate and structure various energy policies than considered in this report. This report is just a starting point of such trials. We look forward to the day when our friends will take in these models as your own tool and improve them for formulation of the Philippine Energy Plan.

November 2008

K. Kanekiyo on behalf of the JICA Study Team