Chapter 2 Energy Outlook of Vietnam through 2005

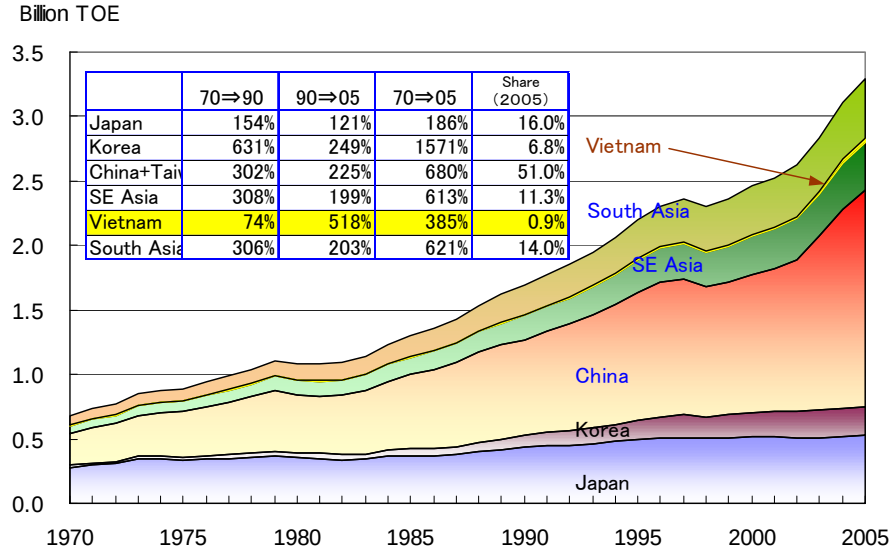
In Chapter 2, we will conduct fundamental analysis for formulation of the National Energy Master Plan running various case studies using the Energy Database, the Energy Demand Forecasting Model and the Energy Supply Optimization Model that were constructed for this study, and will examine different forecast results on energy outlook and their implications under various socio-economic development scenarios, effects of different energy policy options for securing energy supply, impacts on environment and so on.

2.1 Procedure of Energy Outlook Formulation

First of all, fundamental understanding and assumptions in conducting this study will be explained such as the world energy situation, crude oil price trend, issues facing Vietnam as well as some technical aspects such as composition of the analytical tools, major preconditions, setting of the fundamental scenario and directions of case studies.

International Circumstance and Issue of Concerns on Energy

As the world economy is growing steadily, many questions are raised whether we could continue this trend into the future or not consistently securing sufficient energy supply and environment protection. For example, IEA begins its World Energy Outlook 2006 with the following words: "The world is facing twin energy-related threats: that of not having adequate and secure supplies of energy at affordable prices and that of environmental harm caused by consuming too much of it".



	70⇒90	90⇒05	70⇒05	Share (2005)
Japan	154%	121%	186%	16.0%
Korea	631%	249%	1571%	6.8%
China+Tai	302%	225%	680%	51.0%
SE Asia	308%	199%	613%	11.3%
Vietnam	74%	518%	385%	0.9%
South Asia	306%	203%	621%	14.0%

Source: Compiled from the BP Statistical Review of World Energy 2006

Figure 2.1-1 Asian Energy Consumption (excluding Middle East)

Looking to the recent world trend of energy that is the baseline of the above outlook, energy

demand is increasing rapidly in the emerging countries such as China, India and Southeast Asian countries, who are leading the world economic growth. During the five years from 2000 through 2005, the energy demand in Asia (excluding Japan and Korea) increased 25% while the world energy consumption increased 14%. Among them, China recorded 60% increase in the energy consumption. As its domestic oil production is nearing peak, China's oil import increased outrageously to 127 million tons in 2005, overtaking South Korea. Energy consumption of Vietnam has also increased at an annual average rate of over 11% since the 1990s, and its speed is accelerating recently. Despite the fact, the absolute quantity of the Vietnamese energy consumption shares only 0.9% among Asian countries. Though energy is a big issue for Vietnam, it is apparent that the matter should be considered along with the world current.

Looking around the world, oil peaking and global climate change have become particular objective of energy policy. However, Vietnam, currently being still low in its economic development with less than 1/10 of energy consumption of developed countries, shall need a big amount of incremental energy for its construction of the economy. Its per capita energy consumption would increase along with economic development, as the international trend is against the increase of energy consumption. While UNFCCC stipulates "common but differentiated responsibilities" of nations toward the global warming, it is a very important policy issue for Vietnam how to accept and digest such circumstance in the course of constructing the economy.

Since commencement of Doi Moi (economic Reform) policy in 1986, the Vietnamese economy was put on a track of extraordinary high economic growth and the domestic energy consumption also recorded rapid increase. Despite the fact, Vietnam steadily developed its indigenous energy resources and realized energy self-sufficiency as a total balance. At present, however, its energy demand, in particular the electricity demand is not satisfied and therefore it is highly possible that the domestic energy demand may increase faster than past. On the other hand, its domestic energy production is approaching the peak. As a result, Vietnam would change from an energy exporting to an importing country. This suggests that energy issues of Vietnam will change its nature from those confined within the country to those exposed to rough turbulence of the international market.

Then, anticipating internationalization of energy structure, what elements should we keep in mind in formulating the energy policy? Energy is a global issue in the contemporary world and the major points considered in energy discussions may be summarized as follows.

1) Assurance of social development under good coordination among 3S, namely, Economy, Energy and Environment
2) Strengthening of 3S in energy, namely, Security, Sustainability and Stability
3) Rational energy use and energy conservation
4) Best mix of energy supply

Economic Development and Energy Conservation

Long-term economic trend and energy conservation are the key elements to give great impacts on the future energy trend of Vietnam. This study assumes the following fundamental understanding on them.

Regarding the long-term economic outlook of Vietnam, the latest official plan is "The Five Year Socio-economic Development Plan 2006-2010" and, for longer-term, there is an outlook "Economic Development Forecast serving Study on Development for the period up to 2050" (hereinafter called as "EDF2050"). This was used as the economic development scenario of the Sixth Power Development Plan (PDP6), and hence could be considered as semi-official one. These projections foresee that the long-term economic growth at over 8% will continue.

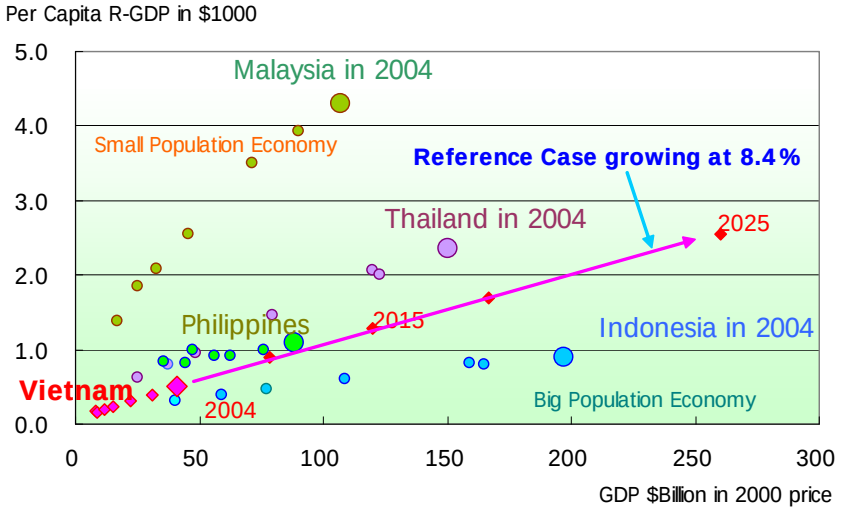


Figure 2.1-2 ASEAN and Economic Development of Vietnam

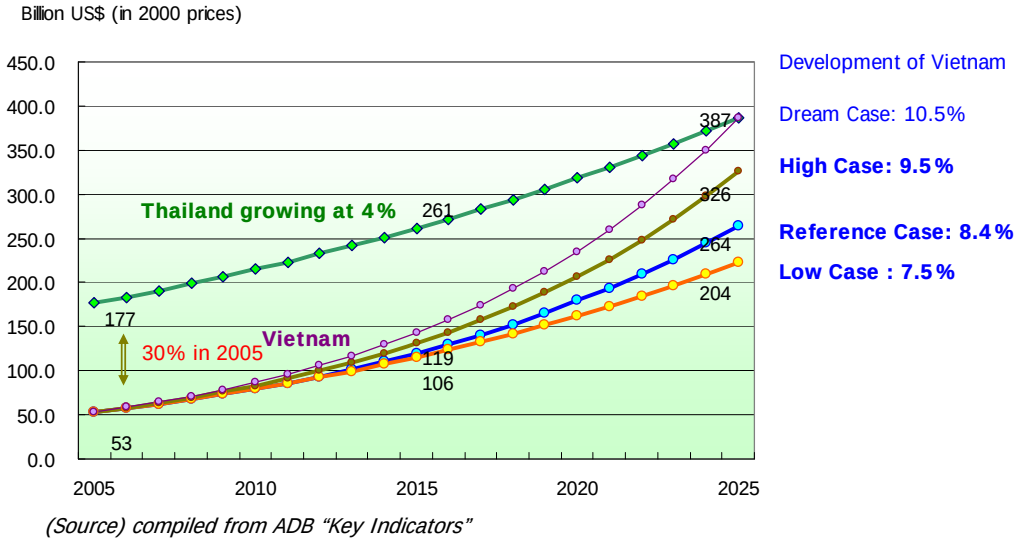
The recent rapid increase of FDI indicates that Vietnam has come out of the first stage preparing for development and entered into the second stage for take-off. Globalization and marketization of the economy have accelerated the inflow of FDI into Vietnam. Likewise, progress of tighter linkage and unitization with neighboring countries, Asian developed countries like Japan and US and European markets through accession to WTO would possibly accelerate economic growth of Vietnam. Transfer of industries from neighboring countries is already progressing substantially in labor-intensive industries as projected in EDF2050. However, the agriculture sector, which shared 20.9% of GDP and 56.9% of the labor force in 2005, will continue to supply labor forces to manufacturing and service industries for a long period.

From the above viewpoint, it may be appropriate to think that Vietnam will continue high economic growth exceeding annual 8% in future, and hence we will adopt the socio-economic development outlook of EDF2050 in this study for the Reference Case.

In the *dream case* that Vietnam would catch-up Thailand in aggregate GDP, its growth rate shall be 10.5%. Then, as the population of Vietnam is greater than Thailand, the per capita GDP of Vietnam still remains at 73% ($3,705) of that of Thailand. The above discussion may suggest that the high growth case for this study may be considered to be 9.5%, a half way between the dream case and the Reference Case.

Then, while we can not avoid increase of energy consumption accompanying economic growth, it is very important to consider Energy Efficiency and Conservation (EEC) as a measure to mitigate issues of energy security and environment to be incurred. EEC is important in a sense that it is a measure to

create “negative demand” and compares to discoveries of giant oil fields.



(Source) compiled from ADB “Key Indicators”

Figure 2.1-3 Vietnam Catching-up Thailand

From various observations, annual 1% energy conservation may be realized as a natural trend, while nationwide promotion of EEC is required to enhance the energy conservation further. It is needless to say that efforts in every sector are required to promote such program, while the role of economic structure change is also large. In case of Vietnam, since the economy is going to expand 5 fold in the coming 20 years, we need to appropriately set out the position of the energy efficiency and conservation policy constructing the *grand design* of the future economic society.

Crude Oil Price Scenario

On the future crude oil price trend, we set out for the “Reference Scenario” that, referring to studies run by IEA and other research institutes, the average import crude oil price (FOB) of IEA countries for the first ten months of 2007 ($65 per barrel) will continue through 2005 in real term. We also examine scenarios such as “High Price Scenario” and “Super-High-Price Scenario” to examine what situation would appear in Vietnam when the crude oil price rises and “Low Price Scenario” on the other extreme.

We estimate the domestic energy prices based on each crude oil scenario. The domestic energy prices will follow the trend of the international energy prices and keep the linkage in future. The current domestic energy prices, except for petroleum products, remain at 1/2 or 1/3 of the international market prices. Such low energy prices would hamper efficient use and lead to wasteful use of energy. In order to promote reasonable development of domestic energy resources introducing necessary technology and fund into the energy sector, it is required to move to a pricing system following the international market. In this study, it is assumed that the domestic energy prices will reach the international market price levels in 2015.

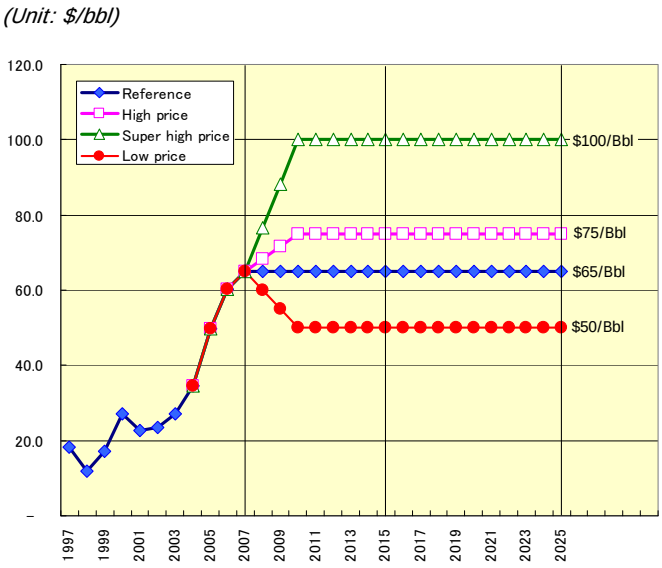


Figure 2.1-4 Actual world average import price (FOB) and forecast by scenario

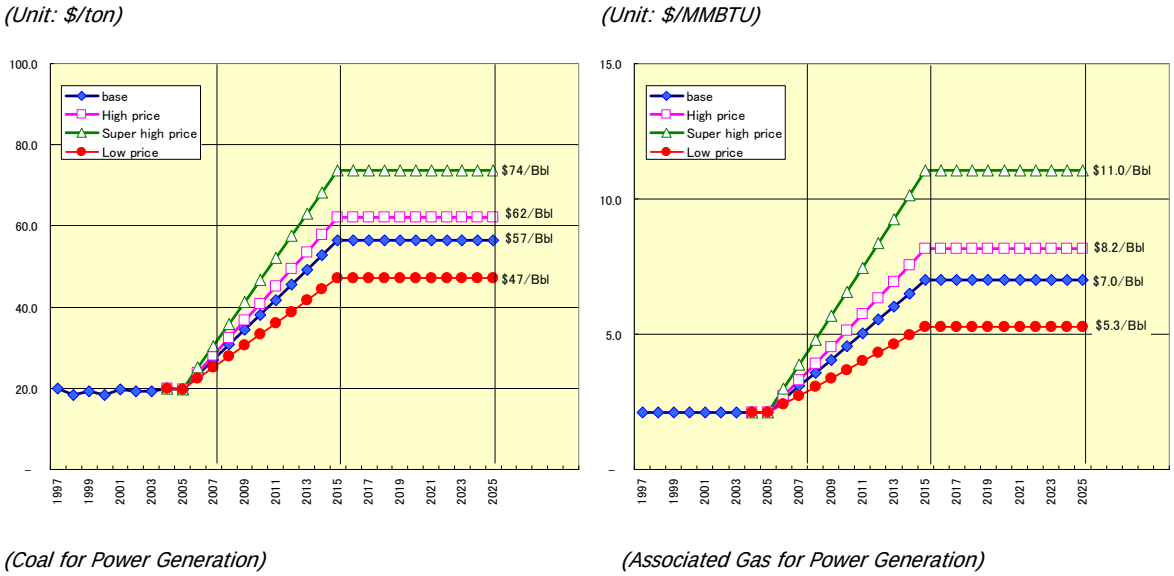


Figure 2.1-5 Domestic Energy Prices by Case

2.2 Composition of the Long-term Energy Model

Analytical tools used in this study are composed of three blocks, namely, Energy Database, Demand Forecasting Model and Supply Optimization Model. The energy database is designed applying the IEA method as the standard. The database shall be operated independently from the analytical models; the data compiled and aggregated in the database are used from time to time being copied to these models.

The long-term energy model is divided into two blocks, the Demand Forecasting Model and the Supply/Demand Optimization Model, in view of operational convenience, and adopts a one-way flow method “from demand forecasting to supply optimization.” The first priority is given to how

appropriately express the energy system of Vietnam in the models, and then simplification is pursued to the maximum extent to avoid excess enlargement of them.

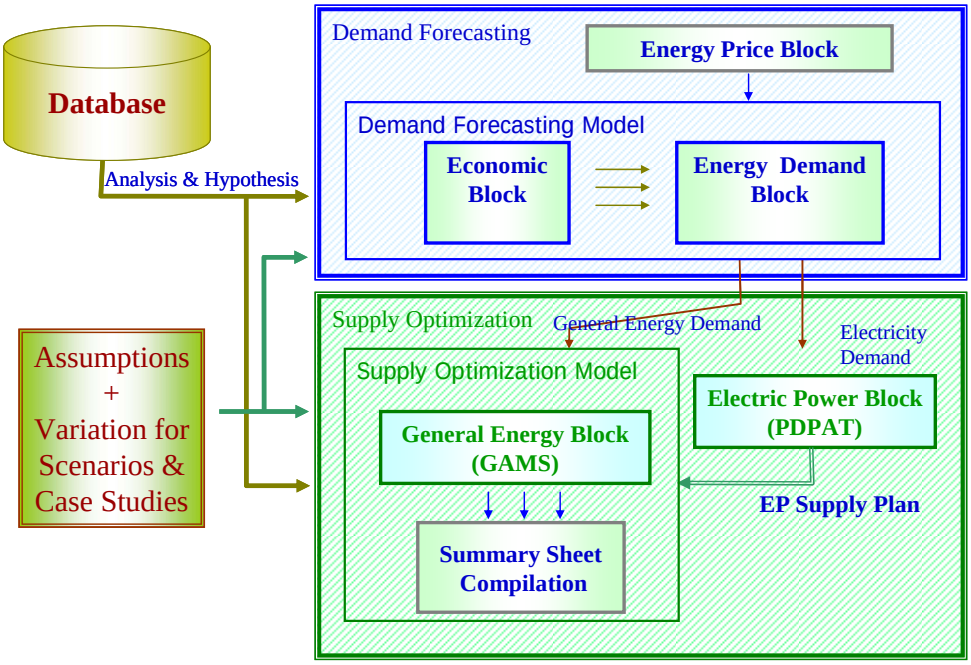


Figure 2.2-1 Composition of Long-term Energy Model

The demand forecasting model and the supply optimization model are further divided as follows. In the demand forecasting model, an energy price sub-model is attached which at first calculates the domestic energy price movement in Vietnam referring to given assumptions on the world energy price trend. The outcome shall be used by copying the estimates into the demand forecasting model. The demand forecasting model is composed of the economic block and the energy demand block, while they are combined in the model. Energy demand estimation results will be obtained by giving major assumptions on economic and price elements. The results are output on an EXCEL summary sheet to be further given to the supply model as inputs.

The supply block is composed of the electric power block and the general energy block. Optimization calculation shall be conducted in the following procedure.

1) Against the electricity demand estimated by the demand forecasting model, power generation quantity and fuel consumption shall be decided by type of power stations (coal, fuel oil, natural gas, nuclear, etc.) using the electric power supply/demand analysis model “PDPAT”.
2) In the general energy block excluding the power sector, the optimized pattern of the energy supply shall be calculated using the Energy Supply/Demand Optimization Model (the “Supply Model”) developed for the purpose of this study.
3) Then, calculated estimates as above shall be aggregated to give the Total Primary Energy Supply. The aggregated result is output on an EXCEL summary sheet for easy comparison of cases. A brief summary table of the calculation results is also output.

As the work procedure, in case to change the price conditions, it is necessary to run four models in

the order of 1) price model → 2) demand forecasting model → 3) PDPAT → 4) energy supply model. In case assumptions on the demand forecasting were changed, three models after 2) shall be run. Likewise, in case of changing the conditions for the electric power sector, the last two models after 3) and in case of changing energy supply conditions, the last model under 4) shall be run. As the case study procedure is a little bit complicated like this, it is designed to improve the operational convenience by dividing the model into several blocks.

Scenario Setting and Case Studies

Implementing the various analyses in this study, setting of assumptions for the Reference Case is the most important job to be carefully worked out since it represents the fundamental direction of the National Energy Master Plan. In this study, the BAU case was studied at first extending the current energy demand structure into the future. The future energy outlook is simulated there under the scenario that the Vietnamese economy would grow at a speed of annual 8.4% for the coming 20 years and the world energy price would remain at the current level through out the simulation period. The result is summarized as follows.

1) The final energy demand will increase at annual 8.6%, reaching 5.2 fold of that of 2005.
2) Due to resource constraints, the domestic energy production will peak out around 2015 unless large-scale discoveries were made.
3) As a result, the self-sufficiency ratio of energy supply will decrease rapidly. Vietnam would become a net energy import country by 2015 and the import dependence ratio would further deteriorate to 50% by 2025.

In terms of the relation of the per capita energy consumption and per capita GDP, Vietnamese energy consumption trend is substantially higher than those of ASEAN counties. Under the circumstance that Vietnam changes from an energy exporting to an importing country while the world energy balance is tightening, it is necessary to avoid the situation that energy issue would become the constraint for the sustainable economic growth. To this end, it is required to mitigate the stress arising from the above trends as much as possible.

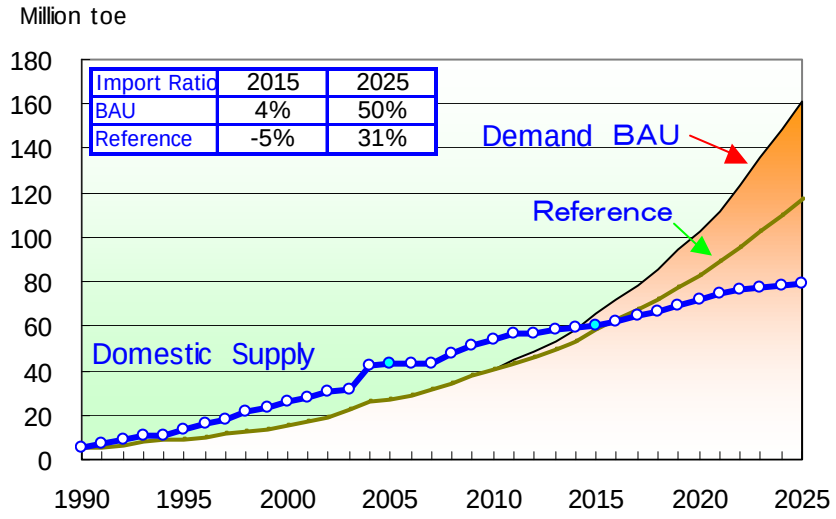


Figure 2.2-2 BAU Case versus Reference Case

Based on a preliminary review as above, the Reference Case for this study is set out that, with enhanced energy conservation, energy consumption would be decreased by 10% in 2015 and by 25-30% in 2025 from the BAU Case. In addition, as shown in the Figure 2.2-3, various case studies are run regarding changes in economic growth rate, energy prices and supply side conditions.

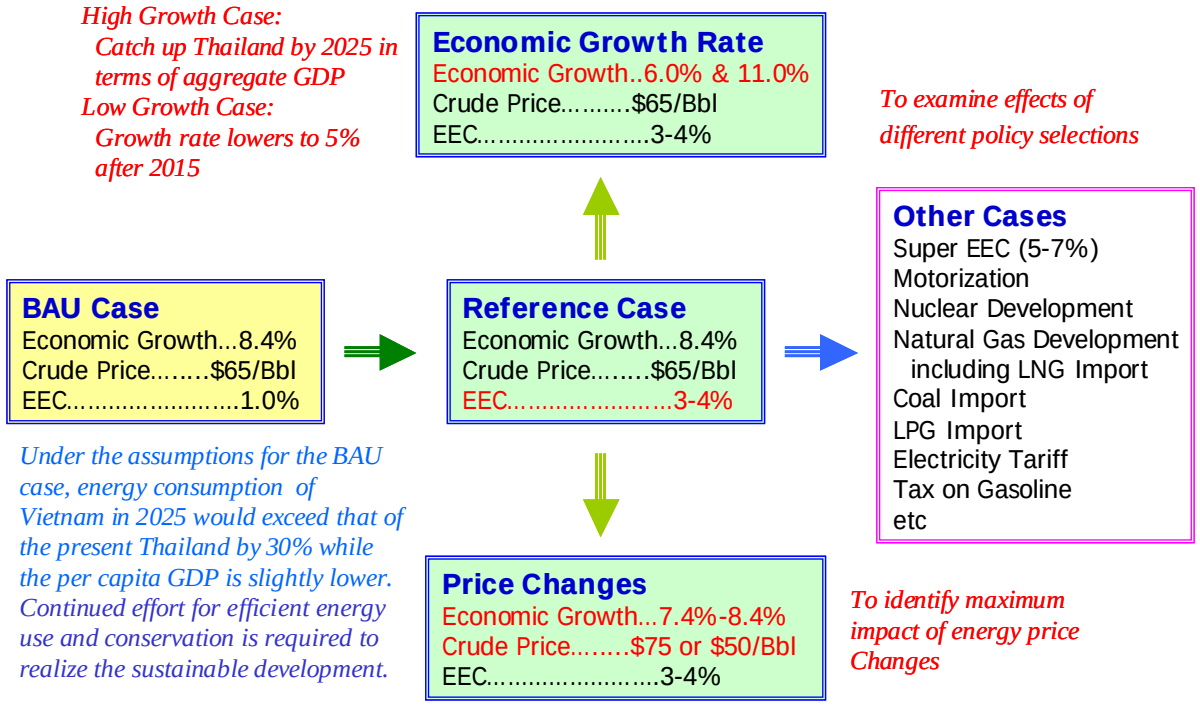


Figure 2.2-3 Case Setting

2.3 Energy Demand Forecast

In this section, outcome of the demand analysis using the Demand Forecasting Model will be presented. Case setting and estimation results will be explained on the cases relating to changes of the energy demand, that is, on the Reference Case, “High economic growth case” (Low economic growth case as an additional study), “High energy price case” (Low energy price case as an additional study) and “Super EEC case”, respectively.

Reference Case as the Standard Scenario

With regard to the middle-long term economic outlook of Vietnam, we follow in this study the projections made in the present Socio-Economic Development Plan and EDF2050 and assume that annual 8.5% economic growth will continue through 2020 and this will slightly slow down to 8.0% afterwards.

Table 2.3-1 Economic growth outlook in the middle and long term

This project		2006-2020	2020-2025
	Reference case	8.5	8.0
EDF2050		2011-2020	2021-2030
	High growth case	8.5	8.0
	Predicted case	7.2	7.0

(Note) Please refer to Chapter 12 on estimation of the individual economic variables

Other major assumptions are as follows.

Table 2.3-2 Population growth rate

	Unit	2010/2005	2015/2010	2020/2015	2025/2020
G.R. of Population	%	1.1	1.1	1.1	0.8

(Source) EDF2050

Table 2.3-3 Exchange Rate Outlook: VND vs. US$

	2005	2010	2015	2020	2025
VND/US$	15,916	16,856	17,947	19,609	21,168

(Source)EDF2050

Table 2.3-4 Petroleum product prices in Reference case

Products	Unit	2005	2010	2015	2020	2025
IEA world export price	US$/bbl	50	65	65	65	65
Crude oil export price of Vietnam	US$/bbl	54	70	70	70	70
Coal FOB	$/ton	20	38	57	57	57
Asian LNG CIF	$/MMBTU	6.4	7.5	7.5	7.5	7.5
Natural Gas (Domestic price)	$/MMBTU	3.3	5.1	7.0	7.0	7.0
Gasoline retail price	Dong/liter	8,933	11,885	13,010	13,820	14,257
Kerosene retail price	Dong/liter	6,300	11,266	12,348	13,126	13,547
Diesel retail price	Dong/liter	6,500	10,897	11,943	12,696	13,102
Fuel oil price in Vietnam	Dong/liter	4,633	6,761	7,410	7,877	8,129
LPG price in Vietnam	Dong/kg	13,800	20,484	22,451	23,866	24,630
Electricity for Agriculture use	Dn/KWh	660	1,012	1,118	1,236	1,365
Electricity for Residential use	Dn/KWh	695	1,065	1,177	1,301	1,437
Electricity for Industry use	Dn/KWh	829	1,271	1,405	1,553	1,716
Electricity for Commercial use	Dn/KWh	1,359	2,083	2,302	2,544	2,811

Major Factors to incur Demand Change

Elements to give certain influence on demand trend are 1) economic growth rate, 2) energy price, 3) progress of energy efficiency and conservation and 4) motor vehicle ownership.

1) Suppose that a dream case would be that the aggregate GDP catches up Thailand in 2025 (average growth rate through 2025 will be 10.5%), the high growth case may be set at middle between the dream case and the Reference case. Then, the average economic growth rate will be 9.5%. The low growth case is set to be one percent lower than the Reference Case as follows.

Table 2.3-5 Economic Growth Rates for Case Study

Years	High Case	Reference Case	Low Case
2005	8.4	8.4	8.4
2006	8.5	8.5	8.5
2007	8.5	8.5	8.5
2008	9.5	8.5	8.5
2009	9.5	8.5	8.5
05-10	8.9	8.5	8.5
10-15	9.5	8.5	7.8
15-20	9.5	8.5	7.0
20-25	9.5	8.0	6.5
05-25	9.4	8.4	7.4

2) With regard to energy price, we set the High Price Case as the world crude oil price soars up to $75 per barrel. Prices of petroleum products and natural gas will follow this trend. Since coal is endowed widely and affluently worldwide, its supply would increase in response to demand increase and therefore its price increase may be slower, at a half pace of crude oil.

3) Two cases will be examined on EE&C, namely, the BAU Case where energy conservation may progress at a speed of the current trend, and the Reference Case where the main industries will make substantial efforts on energy conservation strongly backed by the Government. Considering the time lag for the effect of energy conservation efforts to materialize, the study period is divided into three steps as below.

Step 1: Preparation and Trial

Step 2: Partial implementation to the energy users selected from each sector

Step 3: Full scale implementation

4) Motorbikes are used widely in Vietnam as popular transportation vehicle with 19 million units registered in 2005. They are owned one for one household already, though its sale is running at a high level. On the other hand, the number of four-wheel-vehicles is only 577,000, among which passenger cars were only 195,000 units in 2005. However, as income level improves, it is possible that the passenger car ownership would rapidly increase as we have seen in other Asian countries, triggering abrupt increase of gasoline and diesel consumption at certain timing.

Energy demand in the Reference Case

In Vietnam, it is considered that modernization of energy will progress in Manufacturing, Commercial and Services, and Residential sectors. In these sectors, use of non-commercial energies will decrease, while the demand of substituting energies such as LPG and electricity will increase rapidly. In the transportation sector, diesel gas oil demand for automobile will increase greatly. However, as the prevalence of motorbike nears to its peak while four-wheeled passenger car is yet slow to increase, growth of gasoline demand would be rather moderate. On the other hand, reflecting increase of freight transport by motor vehicles, the diesel gas oil demand is expected to grow fast.

Energy conservation rate is set at annual 1%for the BAU Case, as generally expected, and at 3-4% for the Reference Case where EEC efforts should be strengthened. In the BAU Case, the current high energy elasticity to GDP (1.6 in 2005) is expected to lower to 1.2 by 2025, a moderate level observed

in neighboring countries. However the per capita electricity consumption is still extremely high compared to neighboring ASEAN countries. The past and current energy supply system in Vietnam excessively depends on electricity, and this system would not change much. Though the current power shortage is serious, it is necessary to examine carefully whether the high energy elasticity and electricity dependence would continue to the future or not.

In the Reference Case, the final energy demand will be lower than BAU case by 9% for 2015 and 23% for 2025, and the energy elasticity in the scenario would become 0.9 in 2025 near to the value generally seen in other developing countries.

Table 2.3-6 Energy Demand Outlook in Reference Case

		2005	2010	2015	2020	2025	25/05
Power demand (TWh)	Reference Case	46	86	132	203	293	9.8
	BAU Case	46	87	148	252	400	11.6
	Gap%	0%	-2%	-11%	-19%	-27%	
	Elasticity	2.0	1.6	1.1	1.1	0.9	
Final energy demand (MTOE)	Reference Case	23	33	47	67	91	7.2
	BAU Case	23	34	51	80	118	8.6
	Gap%	0%	-2%	-9%	-16%	-23%	
	Elasticity	1.6	1.0	0.8	0.9	0.9	

(Note) Final Energy Demand does not include energy consumption in Transformation sectors and Power stations.

Energy Demand Trend by Sector

1) Agriculture Sector

The final energy demand in the Agriculture sector increases from 395 ktoe in 2005 to 833 ktoe in 2015 and 1,163 ktoe in 2025, and the annual average growth rate will be 3.6% per year from 2005 to 2025. The average growth rates are Coal: 0.9%, Oil products: 3.0%, Gas: 0% and Electricity: 8.0%; growth of the electricity demand is significantly high in this sector.

(unit: kTOE)

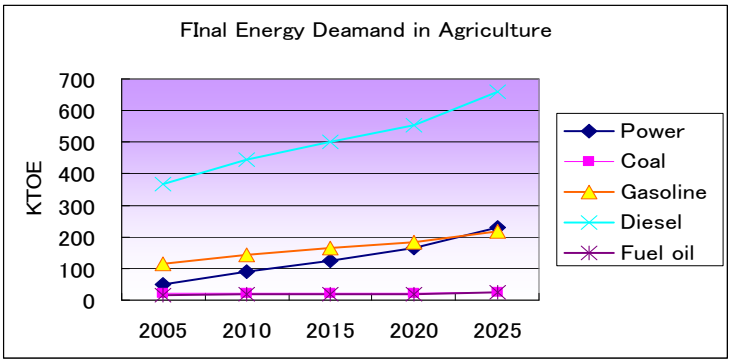


Figure 2.3-1 Final Energy Demand in Agriculture sector

2) Light Industry Sector

The Light industry sector is the main industry that shall lead the future Vietnamese economy, and thus its energy demand will show the highest growth among sectors. The final energy demand of the

sector is forecast to increase from 8,800ktoe in 2005 (including electricity demand and non-commercial energy) to 17,600ktoe in 2015 and 39,800ktoe in 2025. The demand elasticity to the sector GDP is estimated at a relatively low level of 0.52 for the period from 2005 to 2025 with the average growth rate at 7.9%.

(Unit :kTOE)

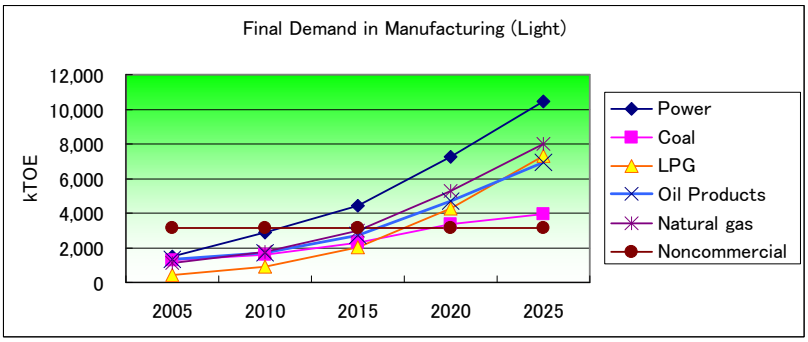


Figure 2.3-2 Final Energy Demand in Light Industry Sector

In the Light industry sector, a special attention should be paid to LPG, a kind of petroleum products, which has recorded an abrupt growth of 38% per year in the last 5 years. The high growth rate of LPG has started since 1999 in accordance with the growth of the light industry; LPG is used in production lines and welfare facilities at these factories.

Since the domestic supply of LPG is limited in Vietnam, most of the LPG must be imported in future. However, the international LPG market is quite unstable and its price is vulnerable. Therefore, it is better to consider that the LPG supply would be limited at a certain level, and that a best mix with other substituting energy sources such as gas, coal and oil products should be studied seriously.

3) Heavy Industry Sector

The final energy demand in the heavy industry sector is forecast to increase from 4,900 ktoe (including electricity demand) in 2005 to 9,000 ktoe in 2015 and 13,300 ktoe.

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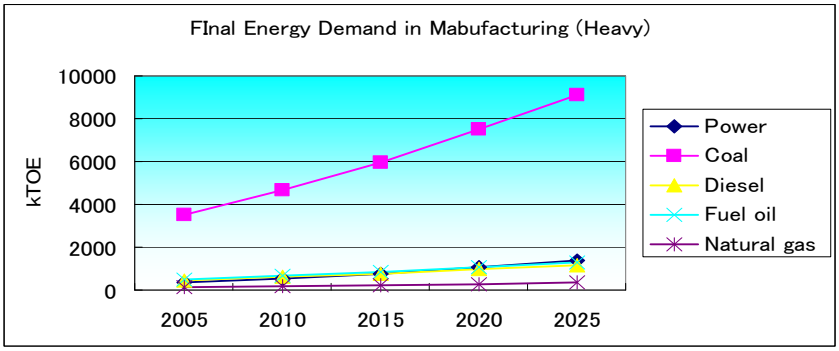


Figure 2.3-3 Final Energy Demand in Heavy Industry Sector

The growth of the heavy industry sector may remain relatively moderate in Vietnam as the government aims at construction of a less energy intensive economic structure. The average growth rate of the final energy demand in the sector will be 5.1% per year from 2005 to 2025: growth rates by energy are Coal: 4.9%, Oil products: 5.1%, Gas: 4.8%, electricity: 7.1%. The growth rate of electricity is comparatively high in this sector. Likewise the light industry sector, natural gas has a possibility to grow faster pending development of infrastructure.

4) Transportation Sector

Today, motorbike is the most popular passenger transportation means among the Vietnamese citizens, while truck, railway and ships are the major mass freight transportation system. As the railway is on the narrow gauge with single truck system, we could not expect much on this sector. Motorbike ownership was one for four persons (total 20 million units) in 2006, and the plateau may be something like one for three persons (total 30 million units plus in 2025). Instead, passenger car may begin fast increase around 2010, and reach 3 million units, or 23 fold of the current number, in 2025. The final energy demand in the transportation sector is forecast to increase from 3,900ktoe (including electricity demand) in 2005 to 12,900ktoe in 2015 and 13,900ktoe in 2025.

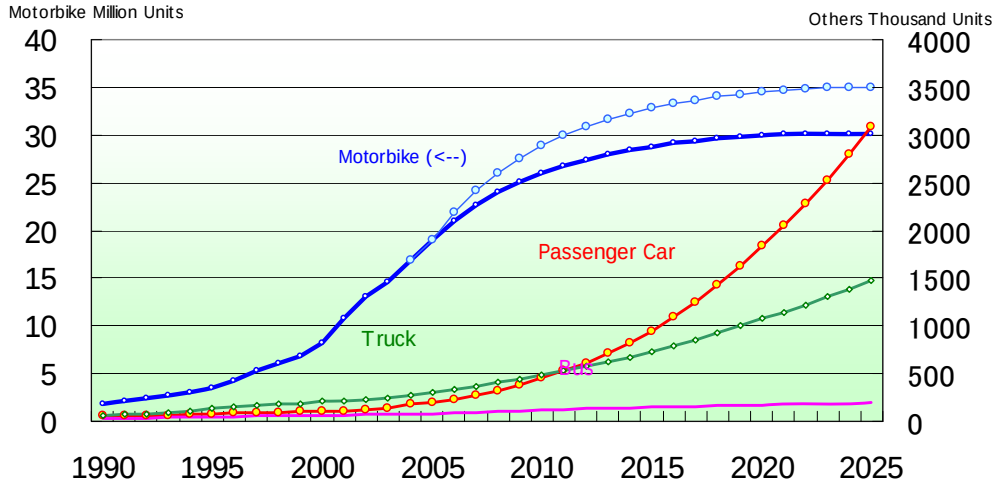


Figure 2.3-4 Prevails of Motorbikes, Cars, Buses and Trucks

The average growth rate of the transportation fuels from 2005 to 2025 will be 5.9% per year. By energy source, they are gasoline: 4.8%, diesel gas oil: 6.7%, jet-fuel: 6.5% and fuel oil: 4.7%. The growth rate of diesel oil is highest among them, while that of gasoline is rather moderate as increase of passenger car and peaking out of motorbike are offsetting. However, we need to watch carefully any indication that passenger car ownership may spur after 2025. On the other hand, diesel gas oil demand is forecast to increase steadily as the main energy to support the economic development, while electricity demand may increase reflecting construction of subways in future.

(Unit:kTOE)

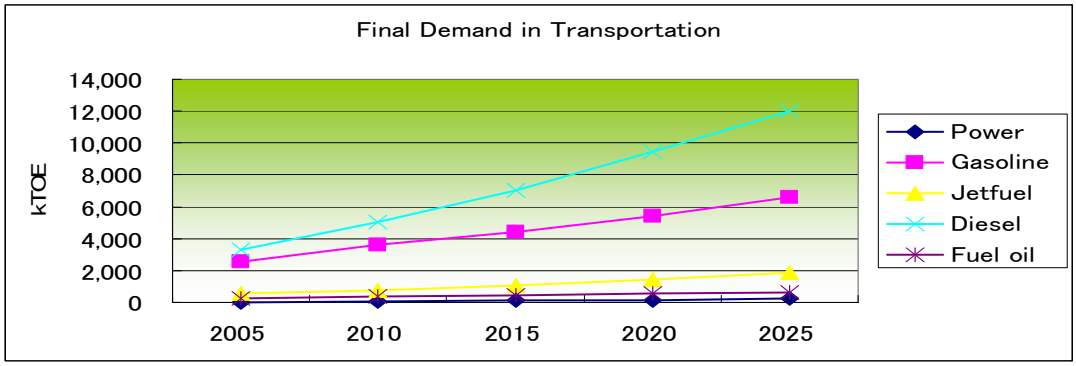


Figure 2.3-5 Final Energy Demand in Transportation Sector

5) Commercial Sector

Final energy demand in the Commercial sector is forecast to increase from 1,300 ktoe (including electricity demand) in 2005 to 2,400 ktoe in 2015 and 3,900 ktoe in 2025. The average growth rate of the final energy demand will be 5.5% per year from 2005 to 2025. The growth rates of the final demand by energy source are coal: 1.92%, LPG: 5.7%, oil products (kerosene, gas oil and fuel oil): 3.6% and electricity: 11.3%. The growth rate of electricity demand is highest.

(Unit:kTOE)

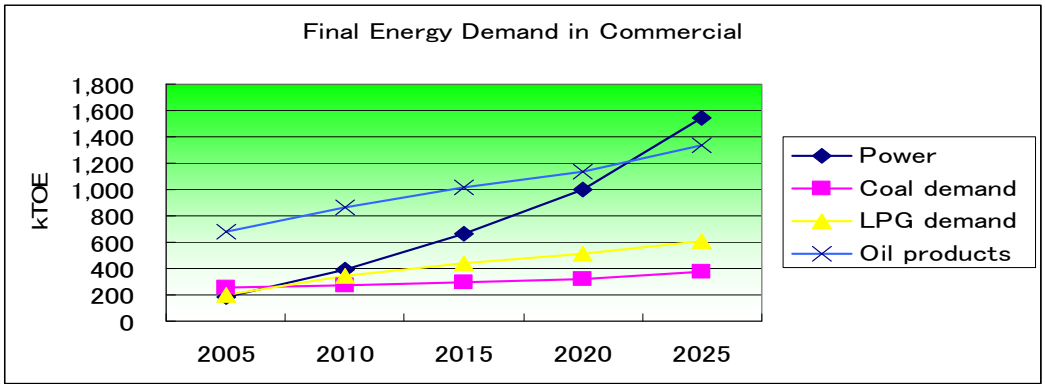


Figure 2.3-6 Final Energy Demand in Commercial Sector

Specific feature of the Commercial sector for the last 5 years is the high growth of LPG increasing at 16% per annum, followed by electricity demand at 12%. Consumption of fuel oil and kerosene has decreased in the same term, being replaced with LPG. Likewise in the light industry sector, demand for LPG, which is clean and easy to use, will increase greatly. It is necessary to investigate what kind of energy should be selected and how they should be supplied to such sector.

6) Residential Sector

The final energy demand in the Residential sector is forecast to increase from 14,900 ktoe to 18,400 ktoe and 23,700 ktoe in 2025. The average growth rate of the final energy demand in the sector will

be 2.3% per year from 2005 to 2025. Growth rates of the final demand by energy source are coal: minus 2.3%, LPG: 10.4%, oil products (kerosene, gas oil and fuel oil): 3.8%, electricity: 9.8% and non- commercial energy: minus 1.3%.

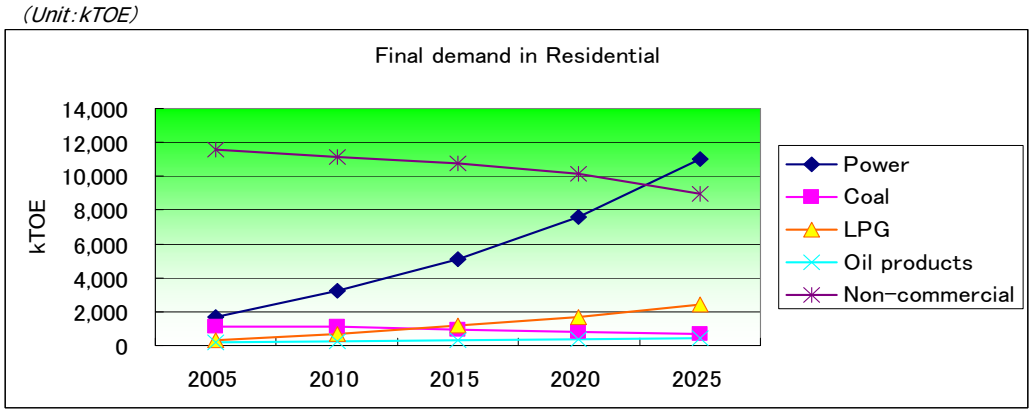


Figure 2.3-7 Final Energy Demand in Residential Sector

The significant issue in the Residential sector is very high growth of electricity and oil products, especially LPG. Supported by strong GDP growth, demands for electricity (mainly for refrigerator and air conditioner) and LPG (mainly for cocking) are increasing rapidly reflecting increase of municipal workers and improvement of their life styles in recent years. On the other hand, non-commercial energies like woods and charcoal are decreasing as the rural population declines and kitchen style in municipal residences are changed.

Petroleum Product Demand

Table 2.3-7 Petroleum Products Demand Outlook

Products	2005	2010	2015	2020	2025	2005	2015	2025	15/05	25/15
LPG	963	1,971	3,641	4,342	4,418	8.3	16.1	10.1	14.2	2.0
LPG Substituted	0	0	0	2,133	5,937	0.0	0.0	13.6		
Gasoline	2,687	3,697	4,516	5,491	6,657	23.2	19.9	15.2	5.3	4.0
Kerosene	332	342	373	423	511	2.9	1.6	1.2	1.2	3.2
Jetfuel	534	736	1,031	1,415	1,872	4.6	4.5	4.3	6.8	6.2
Diesel	5,162	7,456	10,294	14,089	18,301	44.5	45.4	41.8	7.1	5.9
for General	5,149	7,456	10,294	14,089	18,301	44.4	45.4	41.8	7.2	5.9
for Power	13	0	0	0	0	0.1	0.0	0.0		
Fuel oil	2,214	2,096	2,807	4,329	6,090	19.1	12.4	13.9	2.4	8.1
for General	1,616	2,020	2,742	3,939	5,295	13.9	12.1	12.1	5.4	6.8
for Power	598	76	65	390	795	5.2	0.3	1.8	-19.9	28.5
Total Oil demand	11,598	16,298	22,662	32,223	43,786	100.0	100.0	100.0	6.9	6.8

1) LPG

LPG is consumed in the manufacturing, commercial and household sectors. As introduction of natural gas is not transparent at present, extraordinary demand increase is expected for LPG compared to other petroleum products. As the national average demand increase is expected at annual 12.6%,

major demand sectors will be Light manufacturing: 15.3%, Household: 10.4% and Commercial sector: 5.7%. The potential demand of LPG is estimated to increase from the actual record of 1,000 ktoe in 2005 to 10,000 ktoe in 2025, indicating that serious supply problem would be incurred.

2) Gasoline

Gasoline is mainly consumed by motorbikes and other motor vehicles, while certain quantity is also used for driving small boats in Vietnam. According to the current classification, gasoline for small boats is classified for the agriculture and fishery sector, and gasoline for motorbike and motor vehicles for the transportation sector. However, the consumption in the transportation sector is overwhelmingly big. Thus, the overall growth rate of annual 4.6% is very close to the demand growth for motorbike and passenger car at 4.7%. Gasoline demand is projected to grow from 2,700 ktoe in 2005 to 6,700 ktoe in 2025 by 2.5 times, and 97% of which will be for motorbike and cars.

3) Kerosene

Kerosene including jet fuel is used by aviation industry, light manufacturing sector as well as commercial and residential sectors. Among them jet fuel demand shows 6.5% growth reflecting internationalization and vigorous domestic economic activities. Kerosene may be extensively consumed in the manufacturing sector as well, showing 6.8% annual growth during the projection period. On the other hand consumption in the commercial and residential sectors may be replaced by electricity and LPG, and consumption growth in these sectors may remain modest at 1.6% and 2.3%, respectively. The total kerosene consumption is estimated to increase from 900 ktoe in 2005 to 2,400 ktoe in 2025 by 2.8 times.

4) Diesel Gas oil

As diesel gas oil is widely used in transportation, manufacturing, agriculture, commercial and residential sectors, the consumption in the transportation sector shares big amount. Since most of the consumption in the manufacturing sector may be used for transportation of own cargos, diesel gas oil may be deemed as mostly for transportation use. Consumption in the power sector is decreasing and may be limited for use at independent local diesel generators in future. Demand in manufacturing and transportation sectors will be large and their demands are estimated to increase at annual 8.0% and 6.5%, respectively, between 2005 and 2025. Consumption in residential and commercial sectors will be also active to grow at 5.9% and 4.3%, respectively. The total diesel gas oil demand will increase from 5,100 ktoe in 2005 to 18,000 ktoe in 2025 by 3.6 times.

5) Fuel Oil

Fuel oil is widely used in manufacturing, electric power, transportation, commercial and residential sectors. In particular, demand in manufacturing and power sectors are large, sharing 54% and 28%, respectively, followed by transportation sector at 12%. These three are the major demand sectors, while the aggregate share of agriculture, commercial and residential sectors is small at 7%. The same tendency continues through 2025, and the demand composition then will be manufacturing 65%, electric power 22% and transportation 9%. Average growth rates for 2005–2025 will be manufacturing 6.7%, transportation 4.7% and electric power 4.3%; fuel oil consumption is estimated to grow accompanying high growth of the manufacturing sector.

Electric Power Demand

While the economic assumptions in the Base case of PDP6 are same to that of the Reference Case, power demand forecasts are substantially different. The power demand forecasted in PDP6 is substantially excessive compared to neighboring countries. This may have been caused because hydropower ratio is high in Vietnam and people depended on the cheap hydropower supply excessively while supply system of other modern energies such as oil products and city gas was poor. If this situation continues, Vietnam would be keeping substantially higher dependence on it compared to other countries. However, since cheap hydropower resources are limited, increase of electricity tariff would become unavoidable sooner or later leading to dissolution of the over dependence on electricity. Per capita electricity consumption would become similar to the level of neighboring counties (2,000-3,000kWh per person in 2005). At the same time, natural gas use at residential and industry sectors would progress in due course.

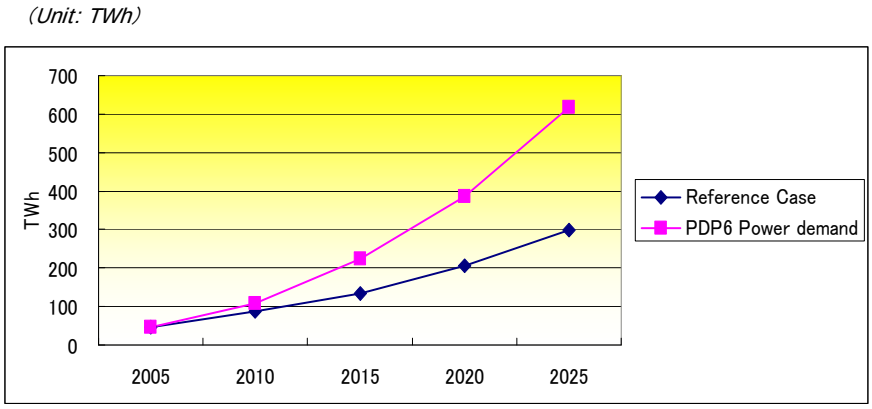


Figure 2.3-8 Comparison of Power Demand between Reference Case and PDP6

Energy Demand under Other Scenarios

The High Economic Growth Case assumes an economic growth rate higher than that for the Reference case; 9.5% vs. 8.4% for the entire period of 2008-2025. The differences in the final energy demand between two cases are 9% for 2015 and 34% for 2025. The final energy demand for the High Growth Case is substantially active in all sectors such as Industry, Commercial and Residential sectors as the GDP growth rate is assumed at a considerably higher level.

Table 2.3-8 Energy Demand in High Economic Growth and Reference Cases

		2005	2010	2015	2020	2025	25/05
Power demand (TWh)	High Growth Case	46	89	145	237	389	11.3
	Reference Case	46	86	132	203	293	9.8
	Gap(%)	0%	3%	9%	16%	33%	
	Elasticity	2.0	1.6	1.1	1.1	1.1	
Final energy demand (MTOE)	High Growth Case	23	34	51	78	121	8.8
	Reference Case	23	33	47	67	91	7.2
	Gap(%)	0%	3%	9%	17%	34%	
	Elasticity	1.7	1.0	0.9	0.9	1.0	

As a reference, the Low Economic Growth Case is set as shown below. The final energy demand in the Low Growth Case is 17% lower than the Reference case for 2015 and 41% for 2025. Power demand is 19% lower for 2015 and 44% lower for 2025. In contrast to the high growth case, the conceivable lowest case is calculated here. As its probability may be low, it may be thought as criteria for the floor value. In such a case, it is important to refrain from excessive investment and try to establish an efficient energy system.

Table 2.3-9 Low Economic Growth Case and Reference Cases

		2005	2010	2015	2020	2025	25/05
Power demand (TWh)	Low Growth	46	86	126	176	233	8.5
	Reference	46	86	132	203	293	9.8
	Gap(%)	0%	-4%	-19%	-35%	-44%	
	Elasticity	2.0	1.6	0.9	0.8	0.9	
Final energy demand (MTOE)	Low Growth	23	33	44	57	71	5.9
	Reference	23	33	47	67	91	7.2
	Gap(%)	0%	-3%	-17%	-33%	-41%	
	Elasticity	1.7	1.0	0.6	0.6	0.7	

In the High Energy Price Case, we examine a scenario that energy prices increase, economic activity is depressed by the high energy prices, and economic growth rate fall 0.5% lower from the Reference Case.

Table 2.3-10 High Energy price Case and Reference case

		2005	2010	2015	2020	2025	25/05
Power demand (TWh)	High Price Case	46	83	124	186	261	9.1
	Reference Case	46	86	132	203	293	9.8
	Gap(%)	0%	-3%	-6%	-9%	-11%	
	Elasticity	2.0	1.6	1.1	1.0	0.9	
Final energy demand (MTOE)	High Price Case	23	32	44	61	80	6.5
	Reference Case	23	33	47	67	91	7.2
	Gap(%)	0%	-4%	-6%	-9%	-12%	
	Elasticity	1.7	0.9	0.8	0.8	0.8	

(Note) Final energy demand does not include energies consumed in Transformation sector and power sector

Summary of Implications

1) Energy demand increase in the manufacturing and the household sectors

The final energy demand is forecast to increase at annual 8.1% in Manufacturing sector and 7.2% in Residential sector, uplifting the nation's average demand increase of annual 7.2%. In the Reference Case, energy conservation is scheduled to progress at 2% per year faster than the BAU Case. Suppose this target were achieved, demand increase in manufacturing and residential sectors would still be steep as above. In view of the domestic and world energy supply tightening in future, the government is required to seriously consider promotion of energy conservation.

2) Rapid increase of LPG demand

Potential demand for LPG is forecast to increase substantially in Manufacturing, Commercial and Residential sectors. However, since domestic as well as international LPG supply is not abundant, it

is inevitable to face supply shortage if the demand continues to increase as projected in the Reference Case, at annual 12% between 2005 and 2025. In many countries, natural gas is supplied in place of or in addition to LPG as fuel for manufacturing, commercial and residential sectors. However, construction of natural gas pipeline and delivery network requires long lead time and huge investment. In Vietnam, it is necessary to study soonest possible on its future design toward creation of multi-mode gas delivery system suitable for the geography.

3) Increase of motor vehicles and gasoline and diesel oil demand

Motorbike is widely used in Vietnam as important transport measure of citizens. Although car ownership is curbed under the national policy, those new type cars like INOVA of Toyota (7 seater) with tax benefit are showing explosive sale. As passenger cars of 1,500 –2,000 cc class consume ten-fold more gasoline compared with motorbike, it is inevitable that demand for gasoline and diesel gas oil will increase rapidly as car ownership increases.

Once motor vehicle upsurge begins, serious traffic congestions may occur in big cities like Hanoi and HCMC due to narrow and complicated road system. It is well known from experiences of Japan and other countries that traffic congestion also causes air pollution and gives serious impact on the health of citizens along the roads. In addition to securing stable supply of motor fuel, construction of rational transport system and improvement of gasoline and diesel gas oil qualities are among the important issues to be tackled with.

2.4 Energy Supply Analysis

In this section, we analyze changes in energy supply pattern corresponding to different demand forecasts and supply conditions. On the supply side, case studies are made relating to those with greater impact such as nuclear power, natural gas, advancement of second and third refineries, increase of renewable energy supply, restriction on CO2 emission, etc.

Assumptions on Energy Supply Conditions

1) Electric Power Sector

Power resource composition of each case is set based on the annual development plan made by IE following the Power Development Master Plan. Nuclear power plant will start operation in 2020 and the generating capacity will reach 4000MW in 2025.

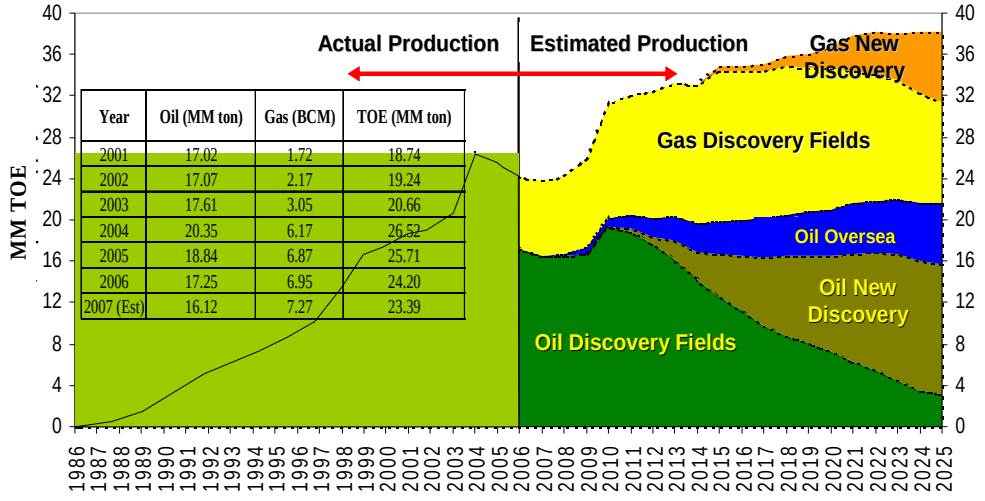
2) Coal Sector

Domestic coal production capacity is set at 67.5 million tons at maximum in 2025 based on the outlook of coal production projected in “Sustainable Development Strategy of Coal Industry” released by VINACOMIN in May 2007. Among domestic coal, high quality coal will be exported if beneficial in price, and any supply deficit against domestic demand will be imported.

3) Oil and natural Gas Sector

Vietnamese oil and gas production forecast are quoted from the information presented at the IEA workshop entitled as “Oil Security and National Emergency Preparedness” held in Bangkok, September 2007. Oil production is anticipated to decrease gradually till around 2010, then, the 300,000 barrels per day level will be maintained up to 2025, i.e., 320,000 BD from 2015 to 2020,

300,000 BD for 2025, but this would require substantial efforts. On natural gas, already discovered new fields will be developed and production will increase to 15 billion cubic meters per year in 2015, and 16 billion cubic meters in 2025, from the current level of 7 billion cubic meters.



Year	Oil (MM ton)	Gas (BCM)	TOE (MM ton)
2001	17.02	1.72	18.74
2002	17.07	2.17	19.24
2003	17.61	3.05	20.66
2004	20.35	6.17	26.52
2005	18.84	6.87	25.71
2006	17.25	6.95	24.20
2007 (Est)	16.12	7.27	23.39

(Sourse) Tran Huu Truong Son, Ministry of Industry and Trade, Vietnam, "VIETNAM OIL SECURITY POLICIES", Oil Security and National Emergency Preparedness, IEA, Bangkok: 17-18 September 2007

Figure 2.4-1 Crude oil and gas Production Past and Forecast

In the downstream sector, the first refinery now under construction in Dung Quat will come into operation in 2009. At first, the feedstock is scheduled 100% with domestic crude oil, though 15% will be shifted from 2020 to imported high-sulfur crude that is the maximum acceptable design limit. The second refinery scheduled on stream in 2015 is planned to receive imported crude oil for 50% of the feedstock from starting. In addition, strategic oil stockpiling will start from 2010 storing imported crude oil.

4) Renewable Energy

With regard to renewable energy development for power generation, the projection by IE will be applied. Alternative motor fuel will be supplied that, by 2025, 30% of gasoline demand will be substituted by E5 gasohol and 10% of diesel gas oil demand will be substituted by B5 bio-diesel.

Energy Supply/Demand Balance of Reference Case

Energy supply/demand balances for major sectors for the Reference Case are as follows.

1) Crude Oil

As no oil refinery is operating for the first four years from 2005, all the crude oil production goes to export. The first oil refinery starts operation in 2009 and runs at full load through 2025. National oil stockpiling starts from 2010 and increases stepwise. The second refinery starts in 2015 and operates at full lord from the beginning. A half of the feedstock for the second refinery will be imported crude oil, thus crude oil import starts from 2015 excluding those for oil stockpiling. At the first refinery, 15% of the feedstock will be switched to import crude oil from 2020, increasing the total

import quantity. Strategic oil stockpiling will increase, based on the domestic petroleum consumption, from 30 days in 2010 to 60 days in 2020 and reach 90 days in 2025. In between the key years, it increases slightly corresponding to annual consumption increase.

(Unit: Million ton)

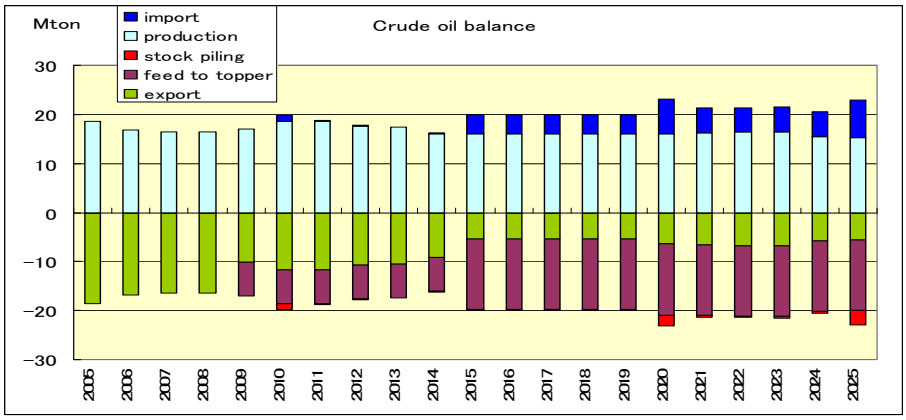


Figure 2.4-2 Crude oil supply and demand balance

2) LPG

Domestic production of LPG comes from oil refineries and natural gas processing facilities, and any shortage will be supplied via import. However, we should note that LPG supply in the international market is not very affluent.

(Unit: Million ton)

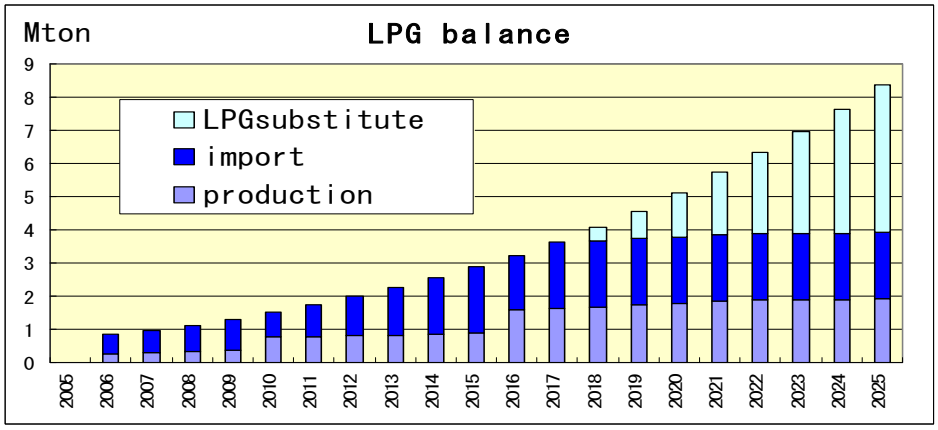


Figure 2.4-3 LPG supply and demand balance

In this model, therefore, it is assumed that the maximum production from the domestic refineries will be 1.1 million ton per year and the maximum import quantity will be two million tons per year in addition to the production at gas processing plants. LPG demand in Vietnam will be increasing fast every year and the domestic production and import would become unable to satisfy the demand sooner or later. To give a temporary solution in the model, we assume that the gap may be filled with some LPG substitute fuel. Import kerosene is tentatively considered as the LPG substitute fuel here,

though it is necessary to consider it seriously how to satisfy the potential demand of L PG which will be mainly required by many users in industry, commercial and residential sectors. It is most desirable to substitute the supply with city gas in view of the needs on the demand side. if we could develop natural gas delivery system in time.

3) Coal

As domestic coal production steadily grows to 67.5 Mt by 2025, it adequately satisfies the aggregate demand for power plants and general users and also provide enough capacity to direct high quality coal such as coal for PCI as well as low quality coal in surplus into export. As import coal-fired power plants are supposed to use imported coal only, despite surplus capacity of domestic coal, import volume will increase gradually after 2015 but would not exceed 14 million tons even in 2025.

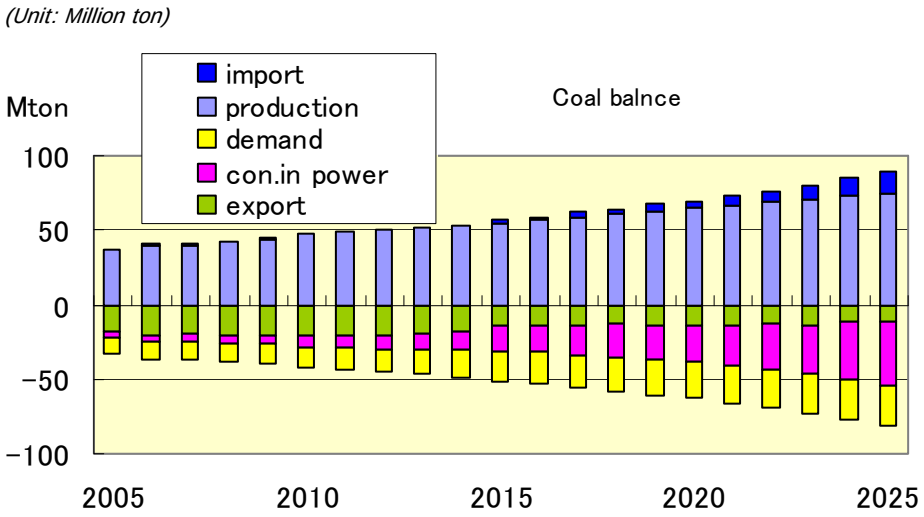


Figure 2.4-4 Coal Balance

4) Natural Gas

The domestic production of natural gas is estimated based on the current proved reserve, which is not very big compared with those in neighboring countries. In case the aforementioned LPG shortage would be supplemented by natural gas supply, start up timing of natural gas import needs to be advanced substantially.

(Unit: Million ton)

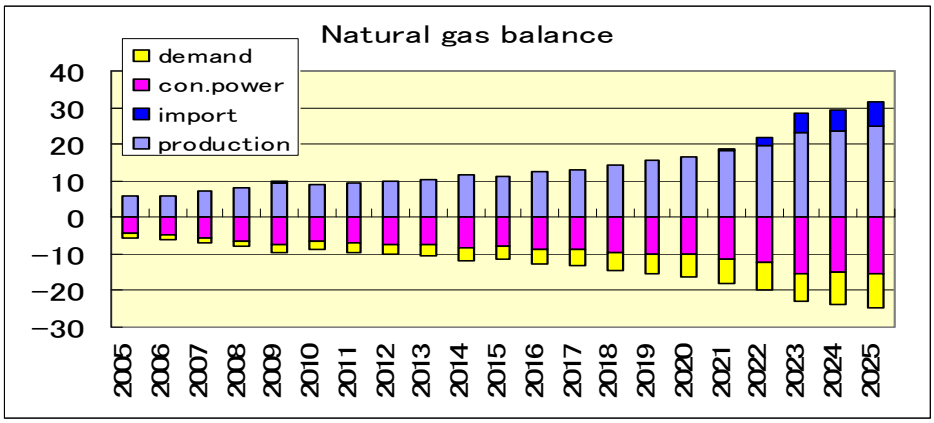


Figure 2.4-5 Natural gas balance

5) Electricity Supply

All the output data on the fuel consumption for power generation are estimated by PDPAT. The freedom on selection of power sources among nuclear, hydro and renewable energy power plants is relatively small because of various constraints on availability of resources and construction sites. As a result, coal (domestic and import) and natural gas, which have relatively greater flexibility, will share high portions over the total power generation and always exceeds 50% in aggregate. Nuclear power plants are scheduled to start from 2020. The estimated power supply in 2025 is, in the descending order, natural gas, domestic coal, hydro, import coal, import electricity, nuclear, renewable energy and fuel oil.

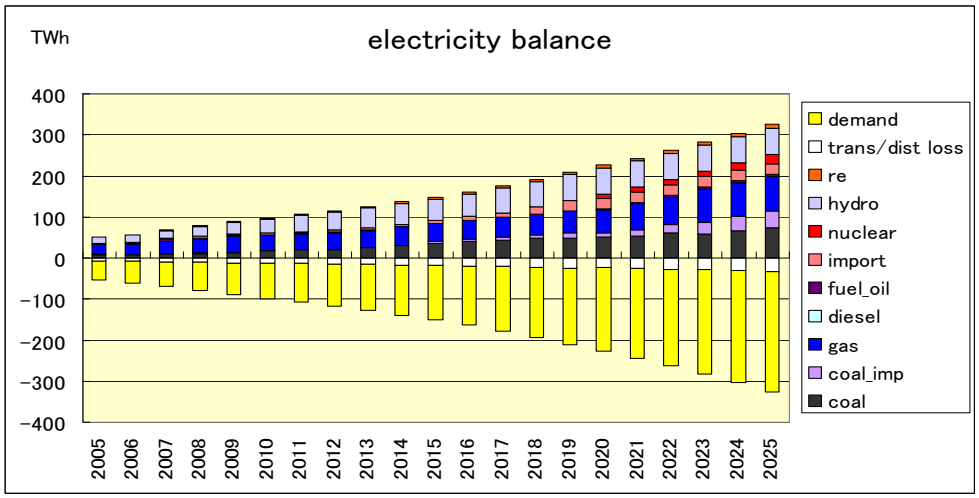


Figure 2.4-6 Electricity balance

6) CO_2 Emission

The estimated amount of CO_2 emission is almost equal to the figure calculated by a relevant organization in Vietnam. Most of the future incremental energy demand will be supplied by fossil fuel such as coal, oil and natural gas, which will increase CO_2 emission.

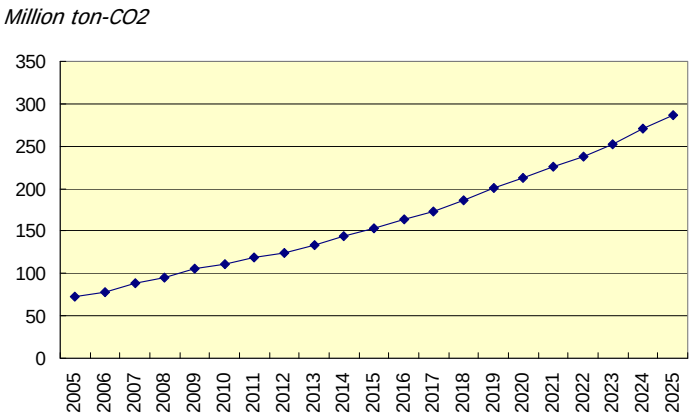


Figure 2.4-7 CO_2 emission

Energy Supply Patterns in Main Cases

The most remarkable difference among the six cases appears in the energy import quantity and the energy import ratio. This is because the future energy demand fluctuates subject to outlook on economic growth and energy price, while the domestic production has certain limit and the same energy supply scenario is applied to the six cases.

In the Reference Case, Vietnam will become a net energy importing country in 2017 save for oil stockpiling. This will occur earliest in 2015 for the High Growth Case, BAU case, Low Price case and latest in 2020 for the Low Growth Case. Anyway, Vietnam will shift from an energy exporting to an energy importing country sooner or later, and it is the most important issue in the energy sector to consider how to cope with such new position. Please refer to the principal report for detail analysis on impacts on each energy sector.

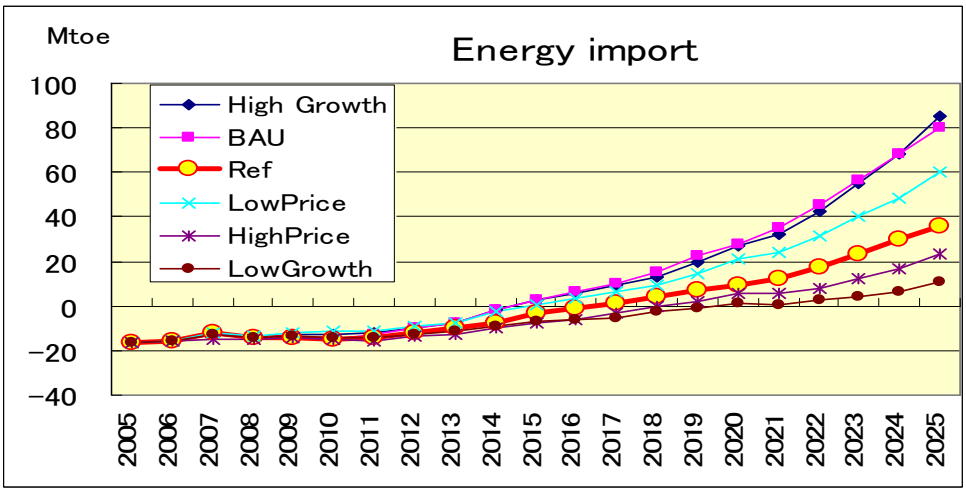


Figure 2.4-8 Energy Import

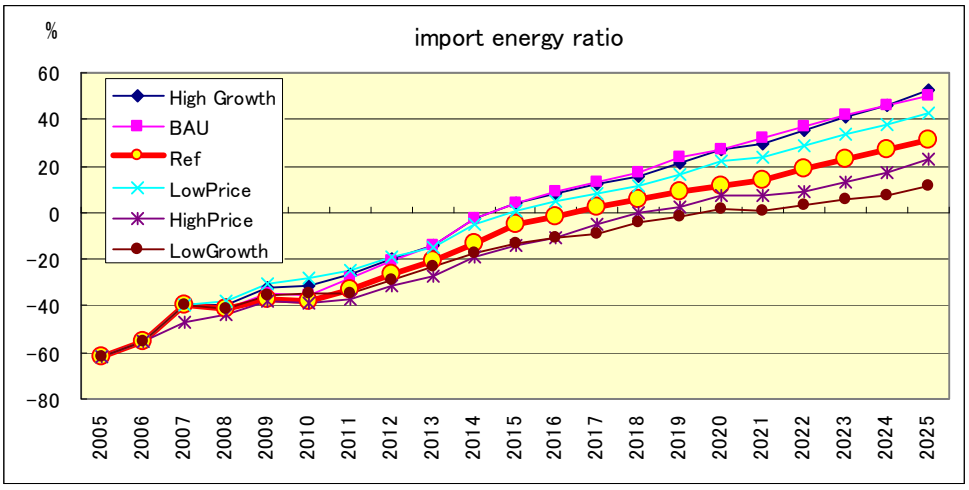


Figure 2.4-9 Energy Import Ratio

Change of Conditions and Energy Supply

1) Energy Conservation

Comparing the effect of EEC between the BAU Case and the Reference Case, the top three items are all regarding the domestic and import coal used for power plant. The progress of EEC leads to decrease of electricity demand, then generation by domestic and import coal, and consumption of such fuel. As a result, decrease of coal import occurs.

Table 2.4-1 Effect of EEC on Individual Supply Items (at 2025)

order	energy	term	unit	reference	BAU	diffrence	ratio vs BAU %
1	coal	import	kton	14,226	53,026	-38,800	-73.2
2	power	import coal fuel	GWh	41,461	125,696	-84,235	-67.0
3	coal	for power	kton	43,716	85,785	-42,069	-49.0
4	LPG	LPGsubstitute	kton	5,259	9,099	-3,841	-42.2
5	natural gas	import	MMm3	6,911	10,781	-3,869	-35.9
6	naptha	to gasoline	kton	1,260	1,944	-684	-35.2
7	CO2	emission	Mton	345	508	-163	-32.1
25	crude oil	import	kton	7,805	8,537	-732	-8.6
26	natural gas	for power	MMm3	15,512	15,472	40	0.3
27	power	natural gas	GWh	85,186	84,889	298	0.4
28	coal	export	kton	13,203	5,250	7,953	151.5
29	naptha	export	kton	844	160	684	427.3

Following these items, the demand of LPG would decrease by 29.4% leading to decrease of LPG substitute's import by 42.2%. In case of natural gas, demand decrease leads to decrease of import by 35.9%.

2) Economic Growth Rate

In the High Growth Case, increase of electricity demand creates fuel consumption increase at coal power plants, increase of coal import, and then increase of coal consumption. Increase of import of

natural gas and LPG substitute follow them. Changes in the economic growth rate by 1% would substantially undermine the effect of EEC promotion at annual 2-3%.

Table 2.4-2 Effect of Growth Rate Changes (at 2025): High Growth

order	energy	term	unit	High Growth	reference	difference	increase ratio (vs reference%)
1	coal	import	kton	48,300	14,226	34,074	239.5
2	power	imoprt coal fuel	GWh	109,213	41,461	67,752	163.4
3	natural gas	import	MMm3	12,385	6,911	5,474	79.2
4	naptha	to gasoline	kton	2,104	1,260	844	67.0
5	coal	for power	kton	80,412	43,716	36,697	83.9
6	LPG	LPGsubstitute	kton	9,302	5,259	4,044	76.9
9	CO2	emission	Mton	507	345	162	46.9
31	coal	export	kton	5,250	13,203	-7,953	-60.2
32	naptha	export	kton	0	844	-844	-100.0

Table 2.4-3 Effect of Growth Rate Changes (at 2025): Low Growth

order	energy	term	unit	Low Groth	reference	difference	ration (vs reference%)
1	natural gas	import	MMm3	480	6,911	-6,432	-93.1
2	naptha	to gasoline	kton	420	1,260	-840	-66.7
3	power	imort coal fuel	GWh	16,270	41,461	-25,191	-60.8
4	coal	import	kton	5,686	14,226	-8,540	-60.0
5	LPG	LPGsubstitute	kton	2,947	5,259	-2,311	-43.9
6	coal	for power	kton	27,239	43,716	-16,477	-37.7
7	diesel	import	kton	8,598	12,958	-4,360	-33.6
9	CO2	emission	Mton	252	345	-94	-27.1
30	naptha	export	kton	1,684	844	840	99.5
31	coal	export	kton	26,724	13,203	13,521	102.4

3) Energy Price

In the High Price Case, as energy price increases, energy demand decreases and thus the energy supply will be affected. The greatest effect appears in Naphtha. As gasoline demand is suppressed because of high price, naphtha, otherwise to be blended into gasoline, goes for export. Then, decrease of power generation by import coal leads to coal import reduction.

Table 2.4-4 Comparison between High Price and Reference Cases

order	energy	term	unit	High price	reference	difference	ratio vs reference)
1	naptha	to gasoline	kton	701	1,260	-559	-44.4
2	poer	import coal fue	GWh	25,838	41,461	-15,623	-37.7
3	coal	import coal fue	kton	8,920	14,226	-5,306	-37.3
4	natural gas	import coal fue	MMm3	4,663	6,911	-2,248	-32.5
5	coal	for poweer	kton	31,892	43,716	-11,824	-27.0
6	LPG	LPG substitute	kton	3,974	5,259	-1,284	-24.4
7	power	coal fuel	GWh	56,884	73,138	-16,254	-22.2
30	naptha	export	kton	1,403	844	559	66.2
31	coal	export	kton	23,133	13,203	9,931	75.2

As the energy demand change from the Reference Case is small in the Low Price Case, there would be least changes in the energy supply pattern between them.

Table 2.4-5 The comparison between Low Price and Reference Cases

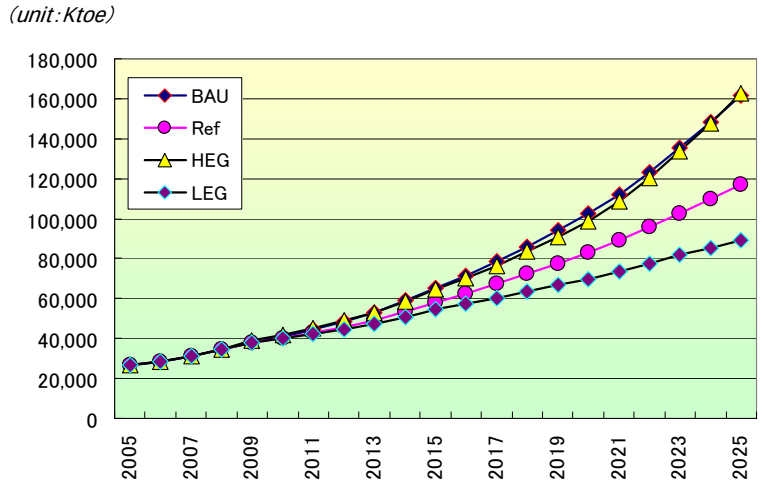
order	energy	term	unit	Low Price	reference	difference	raio vs reference %
1	coal	import	kton	31,241	14,226	17,015	119.6
2	power	import coal	GWh	82,178	41,461	40,716	98.2
3	coal	for power	kton	63,790	43,716	20,074	45.9
4	LPG	LPG substit	kton	7,301	5,259	2,043	38.8
5	CO2	emission	Mton	429	345	84	24.3
35	coal	emssion	kton	5,250	13,203	-7,953	-60.2

Challenges in the Long-Term Energy Supply

Today, harmonization of 3E (Economic development, Energy supply and Environment) and reinforcement of 3S (Security, Sustainability and Stability) have become common objectives of energy policy in the world. As integration with the world economy becomes stronger, Vietnam could not be free from these policy challenges common in the world. Straightforward, promotion of energy conservation and establishment of stable energy supply system are indispensable in order to materialize the sustainable economic development.

Challenge 1 : Efficient use of energy and promotion of energy conservation :

In the BAU case, the economy will grow at annual 8.4% through to 2025. Primary energy supply increases six-fold from 28.12 Mtoe in 2005 to 161.38 Mtoe in 2025. Vietnam will change from a net energy exporting country to a *net energy importing country* and dependence on the importing energy will be about 50%. In the Reference Case, therefore, energy conservation effort will be strengthened by 2-3% more than the BAU case and curb the increase of energy consumption in order to reduce the dependence on importing energy. As a result, the primary energy supply decreases by 27% to 117.06 Mtoe and dependence on importing energy could reduce down to 30%.



(note)BAU: Business As Usual Case、Ref:reference Case、HEG:High Economic Growth Case、LEG:Low Economic Growth Case

Figure 2.4-10 Comparison of estimated results of energy demand by case

In a case economic growth rate increases by 1% to 9.5% as the Vietnamese economy is growing quite actively, the primary energy supply will be almost same as the BAU case. Dependence on import energy exceeds 50% to highlight the energy security as a serious issue. In terms of primary energy supply, the effect of one point percent change of economic growth rate almost counterbalances to 2-3% improvement of energy conservation. On the contrary, in a case in which the economic growth rate decreases by 1% to 7.4%, the primary energy supply is calculated to be 89.17 Mtoe in 2025. The 1% point decrease of economic growth rate has effected to 24% decrease in primary energy supply from the Reference Case. Dependence of importing energy is greatly improved to 11%. Energy supply required to meet the High Growth Case would be extremely huge and cause big issues of energy security, although it is a desirable selection that high economic growth will serve for improving people's life standard. In this sense, slowdown of the economic growth rate to that of the Low Growth Case could be another desirable selection. In order to achieve the policy objectives of 3E and 3S, the conservation targets set out in the Reference Case should be realized by whatever means.

Challenge 2 : Establishment of Reliable and Efficient Energy Supply System

In the primary energy supply mix, share of oil goes down and share of coal goes up as the economic growth rate becomes higher. The natural gas more or less maintains the same share. The share of hydropower decreases gradually because of constraints on resources, although it increases occasionally during the projection period. Nuclear and renewable energy are highly important but their shares are still small in 2025 over the primary energy supply. These trends reflect the different conditions on energy resources as the precondition for their supply, such as relatively rich coal resources, some constraints on oil resources and possibility of gas development, and constraints on the demand side may also be reflected at the same time. Coal supply changes most greatly among cases because electric power demand reacts to the change of the total demand first and greatest, and then coal-fired thermal power will be influenced most.

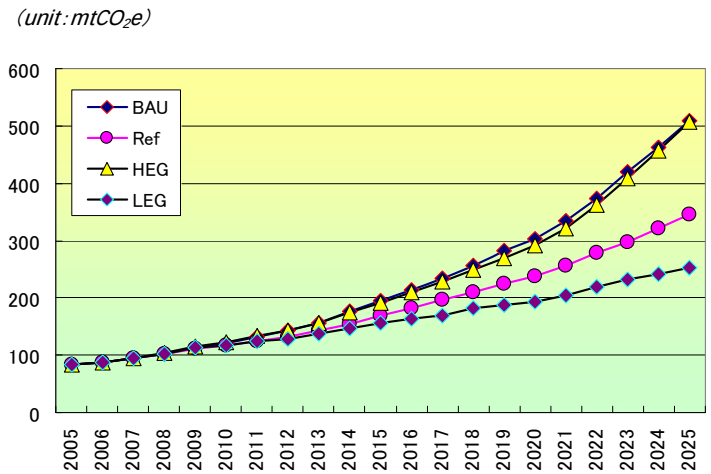


Figure 2.4-11 Comparison of CO_2 Emission by case

From the global warming point of view, CO_2 emission will increase by 6-times from 87mtCO_2e

(million ton of CO_2 equivalent) in 2005 to about 500mtCO_2e in 2025 in the BAU. On the contrary, in the Low Growth Case, the CO_2 emission decreases to 3-times of the current level, a half of the BAU Case, or 250mtCO_2e in 2025. In the Reference Case, it decreases by 4.2-times or to 345mtCO_2e which is in the middle of these cases. Considering the global warming issues, Vietnam may be requested to lower the CO_2 emission at least to the level of the Reference Case.

Challenge 3 : Stable Supply of Importing Energy and Strengthening of Energy Security

As it is inevitable that Vietnam changes into a net energy importing country around 2015, stable supply of import energy and reinforcement of energy security are the third challenge.

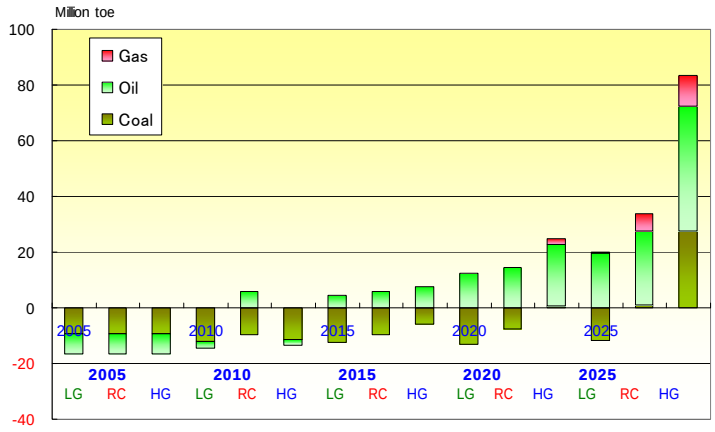


Figure 2.4-12 Net Energy Import

Since economics of scale works strongly in energy sector, world-class importing system should be constructed in the oil and coal sectors. In addition, as the dependence on the global market increases, it is necessary to promote energy supply enterprises, which will be able to overcome the rough turbulences in the international market, as well as reinforcement of national emergency response ability such as state oil stockpiling.

Challenge 4 : Energy Sector Reform and Modernization of Energy Market

It is desirable that policy objectives such as energy conservation and reinforcement of the energy supply system should be realized through market mechanism based on economic principles. In the modern society where size of economy has become tremendously huge and international linkage become extremely closer, use of market mechanism is the strongest method to materialize various economic objectives. However, market failures have been experienced in many countries in the 1990s. To proceed with marketization, we need to develop an appropriate market design.

In order to find solutions to various issues and challenges inferred from the foregoing analyses on the long term energy demand forecast and supply outlook, it is necessary to identify the fundamental direction of the energy policy, to formulate realistic roadmaps and action plans on energy conservation, energy supply and marketization, and to implement them.

2.5 Strategic Environment Assessment

Background of applying Strategic Environment Assessment

Human activities based on goodwill, whether they are policy formulation, preparation of a plan, or a development project, aim at bringing benefits in society and environment. However, most people may have known the possibility that those activities might be accompanied by negative side-effects. When plans and projects with physical transformation and by-products of pollutants are prepared and implemented, it is nowadays a global common sense that they must be accompanied with the activities for 'environmental and social considerations (ESC)'.

While EIA system is the most well known ESC activity internationally, it is not quite fitting to a broad ranged planning activity and considerations in the very upstream of development plans. Vietnam became actually a front runner among developing countries in requiring SEA by legislation when she enforced it with the revised law on environmental protection in July 2006. However, methods of SEA to treat energy master plan of a country as a whole like this study are yet to be fully developed; this is the first trial in Vietnam.

Indicators and aggregation of environmental and social impact

Analysis of environmental and social impact is conducted on each energy sub-sector of various cases to be considered in the energy master plan study, and comparative study on alternative cases is carried out using the common indicators as explained below.

The extent of the environmental and social impacts to be inferred on each alternative scenario such as BAU Case, Reference Case or cases on different supply conditions shall be evaluated by the formula shown as below relating to common indicator, weighting on indicators and the extent of difficulties of mitigation on each alternative scenarios.

Table 2.5-1 Common indicators consistent to the respective sub-sectors

① Order of the size in total amount of **greenhouse gas emission**
② Load (Impacts) on **air pollution**（SOx, NOx, Dust, etc.）
③ Load on **water environment and resources** (water consumption, water pollution, disturbance of surface and coastal water, etc.）
④ Load on **forest resources** （forest decrease, degraded function of disaster prevention）
⑤ **Social Fairness** (Uneven distribution of development area, Load on the socially vulnerable groups)
⑥ **Transformation** potential **of living space** (resettlement issues, land occupation & transformation, etc.)

Source: The Study Team, The Inception Report, December 2006
Note: Load = Burden or Potential Impacts by the Project

The magnitude of environmental and social impacts assumed for each alternative scenario will be given through the evaluation work based on the formula below, the combination of common indicators with weights on indicators and mitigation difficulties for respective scenarios.

$$\mathbf{ESI} = \sum_{i=1}^{n} Vi * Wi * Mi$$

$$Wi = Wi(significance)\sum_{j=1}^{3} Wij \qquad Mi = \sum_{k=1}^{3} Mik$$

ESI: **the magnitude of environmental and social impacts** to be possibly caused **by a corresponding case**

Vi: **the value** (the relative rank in alternative cases) for **the indicator-i** given on the corresponding case

Wi: **the weight** on **the indicator-i**

Mi: **the mitigation difficulty** for **the indicator-i** corresponding to the respective case

n: the number of the indicators(set as 6)

Evaluation of Weights and Mitigation Terms are given on the points below.

Weights

- *reach of impact area (in space)*
- *duration of impact (in time)*
- *irreversibility of impact*
- *significance (or seriousness) of potential impact in the sub-sector concerned*

level of difficulty for mitigation measures

- *technical difficulty (to find any effective measures to avoid or alleviate adverse impacts)*
- *economic difficulty (due to a large amount of cost for necessary measures)*
- *socio-political difficulty (due to social and political hurdles in realizing and taking necessary measures)*

Index for evaluation of sub-sectors

As for the six main cases considered in this study, magnitude of environmental and social impacts is compared based on the results on changes in economic indicators, energy demand/supply structure, CO2 emission, etc., calculated by the supply optimization model and weighting coefficients (Wi and Mi). The magnitudes of environmental and social impacts for 6 cases are evaluated by three sectors (oil & gas, coal, and electricity including renewable energy).

Environmental and social impacts of 6 cases

Range of ESI (Environmental and Social Index), which is used for assessment of overall impact of environmental and social impact, is between 0 and 8,100 theoretically. Maximum ESI with 8,100 is the worst-case scenario with “score 5” of weighting coefficient and level of difficulty, which indicates that all of six indicators show worst number of five in weight (Wi: distance、continuing time, difficulty of restoring to the original and frequency of impact) and mitigation difficulty (difficulty to mitigate the impact). This implies a society facing destructive environment impact that would not happen in the real world.

When scores of Wi and Mi are 3, we have to consider countermeasures to reduce the effects on the environment. In general, if Vi, Wi, and Mi give scores of 3.5, 2, and 2 respectively, ESI becomes 756. In this case, it is said that the environmental problems are appearing.

Comparing environmental and social impacts by each indicator, BAU Case shows the maximum score of indicator at 5079 as a sum on all energy sectors. Result for the High Growth case of 9.5% economic growth, as a sub-case of the Reference Case that assumes 3-4% energy conservation, is 5068, slightly lower than the result for the BAU Case.

On the lower sector, maximum level is seen in the BAU Case and High Growth Case for the power sector, 1,963 and 1,964, respectively. Maximum score for coal sector was seen in BAU case at 1,705 and for oil sector High Growth Case at 1,442.

The score 1,964 is the second or third largest one among the six cases in terms of environment burden, and corresponds to the case where evaluation of weighting indicator and mitigation difficulty are all at level three. On the other hand, the minimum impact case among six cases was Low Growth Case of 1,839 for the total energy sector and coal for Low Growth Case at 299 among the lower sectors.

Table 2.5-2 Environmental and Social Index (ESI) by 6 Cases

Sub Sector \ Case	BAU Case	Reference Case	High Growth	Low Growth	High Price Case	Low Price Case
	BAU	**R**	**HG**	**LG**	**HP**	**LP**
Oil and Gas	1410	893	1442	439	725	1211
Coal	1705	915	1663	299	618	1292
Electric Power	1963	1510	1964	1101	848	1209
Total of all energy sectors	**5079**	**3318**	**5068**	**1839**	**2191**	**3712**

Table 2.5-3 Range of ESI

0 < Range of ESI ≦ 8100 = 6*6*15*15 ＝ (6 indicators)*(Max Vi)*(Max Wi)*(Max Mi)			
4320 = 6*5*12*12	1944 = 6*4*9*9	1701 = 6*3.5*9*9	756 = 6*3.5*6*6

Impacts by indicator

Comparing environmental and social impacts by each indicator, G-indicator (Global warming factor) is the most effective factor in all sectors (refer to Table 2.5-4).

Table 2.5-4 Value of Vi, Wi, Mi, and ESI by sub-sector

Oil & Gas Sector Vi,Wi,Mi Value for respective indicators

	Vi						Wi	Mi
	BAU	R	HG	LG	HP	LP		
G	5.8	3.4	6.0	1.0	2.1	4.7	10.6	10.1
A	5.8	3.2	6.0	1.0	3.0	5.1	7.8	9.2
W	5.1	3.1	5.2	1.8	2.6	4.3	3.3	7.1
F	3.5	3.5	3.5	3.5	3.5	3.5	1.7	9.0
S	3.5	3.5	3.5	3.5	3.5	3.5	3.7	8.0
T	4.2	3.3	4.3	2.7	3.1	3.9	2.7	8.5

Oil & Gas Sector ESI for respective indicators

	ESI					
	BAU	R	HG	LG	HP	LP
G	620.7	363.0	639.0	106.5	223.7	503.1
A	415.4	225.1	424.7	71.0	210.3	360.2
W	120.3	72.8	122.3	41.8	61.8	100.6
F	54.6	54.6	54.6	54.6	54.6	54.6
S	104.4	104.4	104.4	104.4	104.4	104.4
T	94.8	73.6	97.0	60.9	70.2	87.7

Coal Sector **Vi,Wi,Mi Value for respective indicators**

	Vi						Wi	Mi
	BAU	R	HG	LG	HP	LP		
G	6.0	3.2	5.9	1.0	1.8	4.6	7.2	9.8
A	6.0	3.2	5.9	1.0	2.7	4.9	7.3	7.1
W	6.0	3.2	5.8	1.0	2.1	4.4	6.4	7.3
F	6.0	3.2	5.8	1.0	2.1	4.4	4.1	9.0
S	5.6	3.2	5.4	1.4	2.4	4.2	3.8	7.9
T	6.0	3.2	5.8	1.0	2.1	4.4	6.1	8.4

Coal Sector **ESI for respective indicators**

	ESI					
	BAU	R	HG	LG	HP	LP
G	418.3	223.9	413.3	69.7	122.2	319.0
A	310.3	166.6	302.8	51.7	137.2	252.7
W	281.6	148.8	272.7	46.9	100.1	206.3
F	219.6	116.0	212.7	36.6	78.0	160.9
S	166.9	96.4	162.2	42.3	70.5	126.9
T	308.8	163.1	299.1	51.5	109.7	226.2

Electric Power Sector Vi,Wi,Mi Value for respective indicators

	Vi						Wi	Mi
	BAU	R	HG	LG	HP	LP		
G	5.9	3.5	6.0	1.0	2.1	4.8	10.7	10.1
A	5.5	4.1	5.5	2.9	1.5	2.2	7.7	8.1
W	4.8	4.1	4.7	3.6	2.3	2.5	6.1	8.3
F	5.4	4.7	5.3	4.1	1.6	1.8	5.9	9.5
S	3.5	3.5	3.5	3.5	3.5	3.5	5.2	8.6
T	4.4	4.0	4.3	3.8	2.6	2.7	6.1	10.2

Electric Power Sector ESI for respective indicators

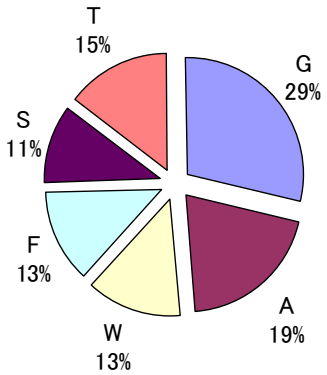
	ESI					
	BAU	R	HG	LG	HP	LP
G	640.2	376.0	649.4	108.2	228.0	517.6
A	347.8	254.7	344.4	180.2	91.2	137.9
W	240.1	206.3	238.3	182.7	113.7	127.5
F	302.5	261.8	300.1	233.0	91.5	98.7
S	158.6	158.6	158.6	158.6	158.6	158.6
T	273.9	252.8	272.7	238.0	164.9	168.6

Maximum scores of 639, 418, and 649 respectively for oil & gas, coal and electric power sectors appear on G-indicator (Global warming factor). The reason of such outcome is that Wi factor (affected area, affected time, difficulty of recovery, and appearance ratio of effect) and Mi factor (level of difficulty) appears greater in G-indicator than other indicators.

Table 2.5-5 Contribution of Six Indicators in Reference Case

	Oil and Gas	Coal	Electric Power	Total Energy
G	363.0	223.9	376.0	962.8
A	225.1	166.6	254.7	646.4
W	72.8	148.8	206.3	427.9
F	54.6	116.0	261.8	432.4
S	104.4	96.4	158.6	359.3
T	73.6	163.1	252.8	489.5

	Oil and Gas	Coal	Electric Power	Total Energy
G	40.6	24.5	24.9	29.0
A	25.2	18.2	16.9	19.5
W	8.2	16.3	13.7	12.9
F	6.1	12.7	17.3	13.0
S	11.7	10.5	10.5	10.8
T	8.2	17.8	16.7	14.8
Total	100.0	100.0	100.0	100.0



Magnitude of indicator depends on energy sector. In oil and gas sector, F-indicator (effect of forest and ecology) is low in all alternative cases. Minimum index in oil and gas sector is W-indicator (effect of water environment) of Low Growth Case. In coal sector, S-indicator (effect of social

justice) is low in all alternative cases. Minimum index in coal sector shows F-indicator of Low Growth Case. In power sector, there is no low indicator.

Focusing on Reference Case, G-indicator shows a high effect in all sub-sectors and 29% of the total impacts come from G-indicator (refer to Table 2.5-5) followed by W-indicator with 19%, T-indicator (effect of housing) with 15%.

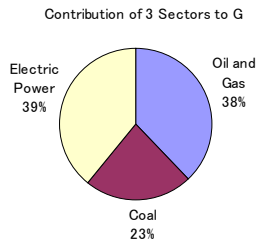
Contribution of three Lower Sectors on the Total energy Sector

Contribution of lower three sectors over the total energy sector is as follows. Regarding G-indicator (global warming factor), power sector contributes most while oil and gas sector does almost same. Same trend is observed on A-indicator (air quality factor), though contribution of coal sector increases slightly. Regarding W-indicator (water quality factor), power sector will be responsible for almost half followed by coal sector. Same trend is seen on F-indicator (forest and ecology factor), yet power sector contribution substantially increases to 60%. Same trend is also seen on T-indicator (factor to represent increasing burden or risk on transforming living sphere), and power sector is responsible over 50%. In S-indicator (social fairness and equality factor), social impacts are greater in the order of electric power sector, oil & gas sector and coal sector.

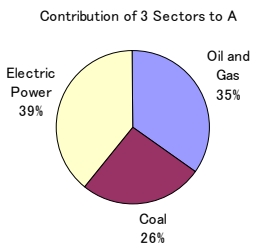
Table 2.5-6 Effects of 3 Sub-sectors (%) in Reference Case

	Oil and Gas	Coal	Electric Power	Total Energy
G	37.7	23.3	39.0	100.0
A	34.8	25.8	39.4	100.0
W	17.0	34.8	48.2	100.0
F	12.6	26.8	60.5	100.0
S	29.0	26.8	44.1	100.0
T	15.0	33.3	51.6	100.0
Total	26.9	27.6	45.5	100.0

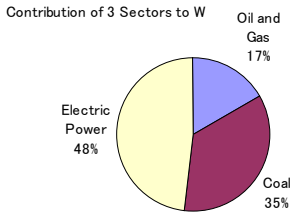
G-indicator



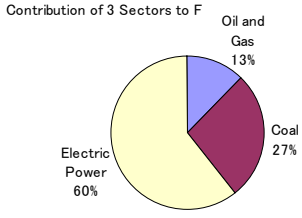
A-indicator



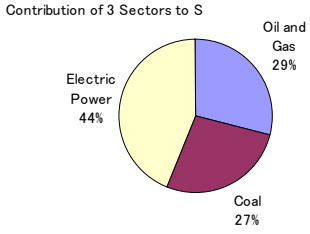
W-indicator



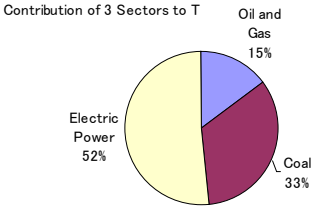
F-indicator



S-indicator



T-indicator



As seen above, impact of energy consumption increase is greatest. Among energy sectors, impact of the electric power sector is greatest followed by the coal sector, while the high activity of the latter is induced by high demand for electricity. Thus, promotion of energy efficiency and conservation (EEC) and non-fossil power supply should be considered seriously in the energy policy from environmental impact viewpoint.

2.5.4 Mitigation Method and Monitoring Plan

From the foregoing analysis, we need to consider mitigation measures to ease anticipated impacts. The following are the major mitigation measures based on the Reference Case analysis, which is the standard case for the draft National Energy Master Plan.

1) G-indicator requiring mitigation measures

Common for three sectors on activities to emit certain amount of CO_2, methane, mono oxide nitrogen and other greenhouse gases

2) A-indicator requiring mitigation measures

- Common for three sectors on activities to emit certain amount of air polluting substances such as SOx, NOx, particulates, dusts (including heavy metals such as nickel and vanadium), hydrocarbons and hydrogen sulfide.
- For power sector, nuclear power plant plan that needs monitoring of radioactive level of the exhaust gas during operation.

3) W-indicator requiring mitigation measures

For power sector, cases of creating dam lake or water reservoir for hydropower, and also nuclear power plant plan that needs monitoring radioactive level of the wastewater during operation.

4) F-indicator requiring mitigation measures

- For coal sector, big scale development requiring cutting down of primary jungles and tropical natural forests widely.
- For power sector including renewable energy sector, development plans to be located within natural reserves, habitat of extinctive species, and habitat of ecologically important creations such as coral reef, mangroves and lagoons, and nuclear power plant plan that needs monitoring of radioactive level of the surrounding environment during operation.

5) S-indicator requiring mitigation measures

For power sector, nuclear power plant plan that needs concurrence of IAEA and understanding of international society and other organizations.

6) T indicator requiring mitigation measures

- For coal sector, development plans close to world heritage and important cultural heritages (archaeological, historical, cultural and religious) and development plans to be located on or to give serious impact to famous and/or precious scenic spots. In addition, site after closure of mine that needs appropriate environment protection such as land reclamation, reforestation and processing of mine wastewater and also candidate dump site for waste mud and stone or waste mine processing ponds that would be vulnerable for collapse of slope and soil wash away

- For power sector including renewable energy sector, site selection plan to secure land and system to appropriately process and dispose wastes. Technical background to secure safe operation that should be prepared in the nuclear power plant plan with regard to necessary institution (law and regulation, safety standard, guidelines), development of organization and workforce, and accumulation of knowledge on worldwide accident record in the sector. Site selection of nuclear power station with regard to thorough and proper survey of geology, hydrogeology and geography and securing of unloading port, transport route and storage of nuclear fuel. Carefully worked out plan on disposal process of nuclear fuel including final disposal site of nuclear fuel waste, processing cost, transportation and temporary storage. Study on final closure plan of power station after expiration of facility life.

In the course of implementing the National Energy Master Plan, we should monitor and audit performance of environmental factors as discussed above. To this end, we need to define the concept of environment management system relating to energy activities. Then, we should construct database, monitoring and auditing system for evaluation and analysis of environmental elements. For the overall management, it is desirable to establish multi-layer system comprising national and regional energy-environment committees to periodically review status of environmental and social considerations on general energy policy as well as major energy projects.

Chapter 3 Draft for National Energy Master Plan

3.1 Direction and goal of National Energy master Plan

Goal of Socio-economic Development

The Vietnamese economy has kept high economic growth of over annual 8% in these years and the per capita GDP reached US$724 in 2006, though the country is still among the late developing group of the ASEAN countries. It is aimed to increase same to US$1,100 under the current Socio-economic Development Plan. In this outlook, we focus on the fact that the economic differences with ASEAN countries and China are the cause of the current high FDI inflow and thus the driver of the high economic growth, this trend may continue well into the future. The economic growth scenario in this study is set forth that the Vietnamese economy will continue to grow at the current trend of annual 8.5% by 2020 and then slightly slowdown to 8.0%. Consequently, the average economic growth rate will be 8.5% for Phase-1 period of 2006 through 2015, 8.2% for Phase-2 period of 2016 through 2025 and 8.4% for the entire projection period.

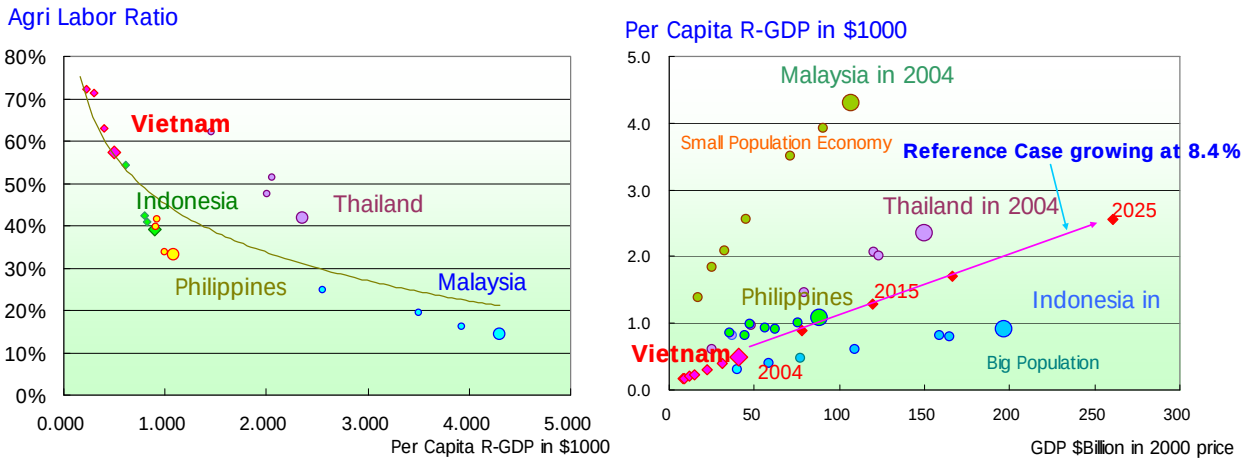


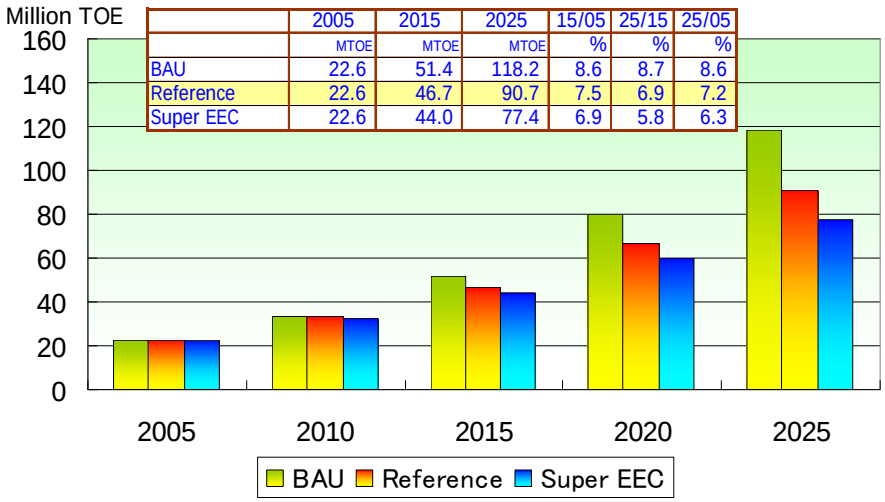
Figure 3.1-1 Economic Outlook of Vietnam

By 2015, Vietnam will catch up the current Philippine in terms of per capita GDP, and exceed it in aggregate GDP amount. Further, by 2025, Vietnam will catch up the current Thailand in terms of per capita GDP, and exceed it in aggregate GDP amount. The size of the economy will expand five-fold in real term and sixteen-fold in nominal term. When we talk about future of such fast expanding economy, it is important not to simply extend the past trend but to invite thorough discussion on desirable industry structure and life style, and set forth a *Grand Design* of our future. As we set out in this study that Vietnam will pursue construction of economic structure giving value on energy efficiency and value-added- type industries, it is necessary to identify what kind of society it is and draw a practical plan to reach there.

Energy Demand Will Increase Steadily

Energy demand of Vietnam will increase steadily. In the BAU case projecting the current trend,

final energy consumption will increase from 22.6 million toe in 2005 to 118.2 million toe in 2025. However, to realize sustainable development under the circumstance that the world energy supply is turning tighter, it is necessary to establish development strategy that makes it possible to avoid the situation that energy demand increase would become serious constraints.



	2005	2015	2025	15/05	25/15	25/05
	MTOE	MTOE	MTOE	%	%	%
BAU	22.6	51.4	118.2	8.6	8.7	8.6
Reference	22.6	46.7	90.7	7.5	6.9	7.2
Super EEC	22.6	44.0	77.4	6.9	5.8	6.3

Figure 3.1-2 Outlook of Final Energy Demand

Under the circumstance, we set out the standard scenario (Reference Case) for the draft National Energy Master Plan that, compared to the BAU Case, energy conservation efforts should be enhanced to curb demand increase. Even in this case, the final energy demand will increase four-fold by 2025. If possible, it is desirable to realize Super EEC.

Among energy types, electricity and oil will share the core part of energy demand in line with modernization of life and industry. Gas demand will also increase as clean and convenient fuel. Coal consumption will also increase in the industrial sector, while it may decline in the household sector. The non-commercial energy currently sharing 1/3 of the energy consumption would not decrease in absolute volume, but will sharply decrease its share.

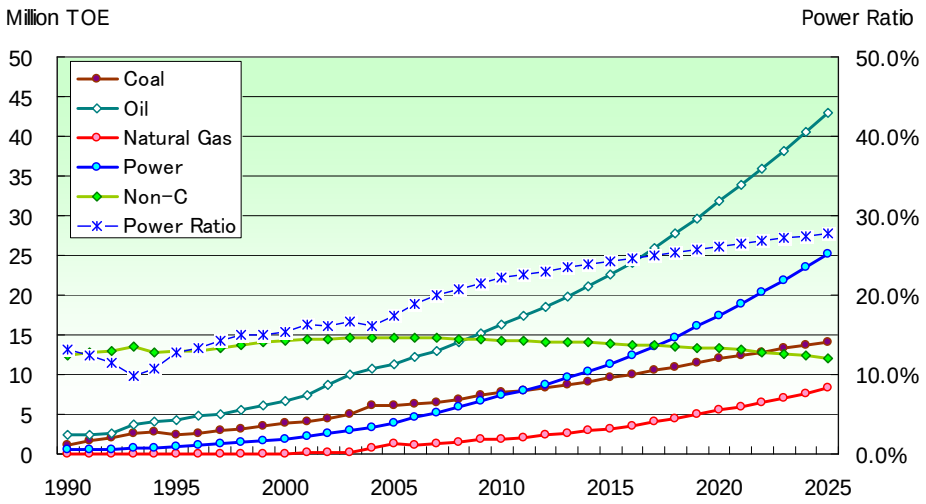


Figure 3.1-3 Final Energy Demand by Energy Type

Table 3.1-1 Final Energy Demand Outlook

	2005	2010	2015	2020	2025	15/05	25/15	25/05
	MTOE	MTOE	MTOE	MTOE	MTOE	%	%	%
Coal	6.1	7.7	9.6	12.0	14.1	4.5	4.0	4.2
Oil (incl. LPG)	11.3	16.2	22.6	31.8	43.0	7.2	6.6	6.9
Natural Gas	1.3	1.9	3.2	5.5	8.3	9.8	10.0	9.9
Electricity	3.9	7.4	11.4	17.5	25.2	11.2	8.3	9.8
Commercial Energ	22.6	33.2	46.7	66.9	90.7	7.5	6.9	7.2
Non-Commercial	14.7	14.3	13.9	13.3	12.1	-0.6	-1.4	-1.0
Total	37.3	47.5	60.6	80.2	102.8	5.0	5.4	5.2
	%	%	%	%	%	%	%	%
Coal	27.1	23.2	20.4	18.0	15.5	-2.8	-2.7	-2.7
Oil (incl. LPG)	49.9	48.9	48.4	47.6	47.4	-0.3	-0.2	-0.3
Natural Gas	5.6	5.8	6.9	8.3	9.2	2.1	3.0	2.6
Electricity	17.4	22.2	24.3	26.2	27.8	3.4	1.4	2.4
Commercial Energ	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0
Non-Commercial	65.0	43.1	29.8	19.9	13.4	-7.5	-7.7	-7.6
Electricity Ratio	17.4%	22.2%	24.3%	26.2%	27.8%	3.4	1.4	2.4

When we compare the above energy outlook with ASEAN countries, in terms of total energy consumption, the demand of the Reference Case slightly undershoots the trend of ASEAN countries. However, while substantially lower than the previous forecasts, electricity demand trend of Vietnam still overshoot the ASEAN trend considerably. In Vietnam, electricity used to be supplied at relatively cheaper tariff based on the abundant hydropower while supply system of other modern energies such as petroleum products and city gas were poor. It is one of the important energy issues how to improve the resultant high electricity consumption rate.

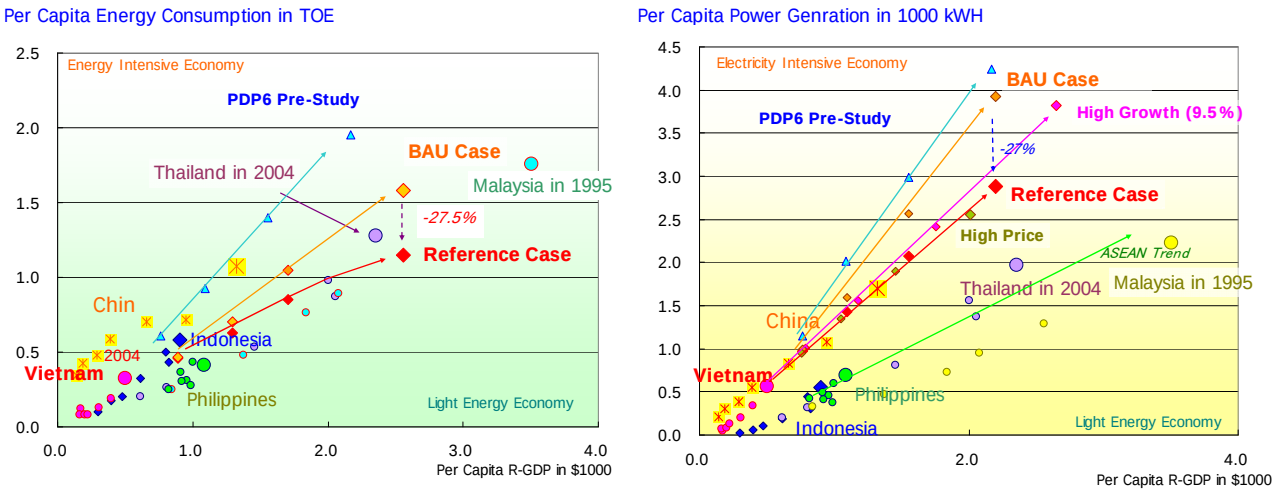


Figure 3.1-4 International Comparison of Energy Demand

In the other sectors, large increases are forecast in the less energy intensive general manufacturing industry and the residential and commercial sectors. In these general manufacturing industries, however, although energy intensity is low, its energy demand growth rate will be highest among sectors reaching almost annual 10%. In these industries where energy is not the main input, electricity and gas will be preferred as they are clean and convenient to use. Then, we should note

that energy conservation might not be given priorities. In order to forecast energy demand trend in these sectors and make appropriate supply plans, it is important to draw the *Grand Design* of the industry structure with regard to what type of economic structure Vietnam should aim at and which sector Vietnam should give priority in the future economic development.

Table 3.1-2 Final Energy Demand by Sector

	2005	2010	2015	2020	2025	05-15	15-25	05-25
	kTOE	kTOE	kTOE	kTOE	kTOE	%	%	%
Final Demand (excl. Non-Com)	22,590	33,199	46,717	66,880	90,655	7.5	6.9	7.2
Agriculture	570	716	830	946	1,159	3.8	3.4	3.6
Industry	10,549	15,540	23,038	35,705	49,957	8.1	8.0	8.1
Materials	5,626	8,903	14,452	24,822	36,661	9.9	9.8	9.8
Non-materials	4,922	6,638	8,586	10,883	13,296	5.7	4.5	5.1
Transportation	6,687	9,592	12,708	16,549	20,781	6.6	5.0	5.8
Commercial & Services	1,322	1,874	2,410	2,974	3,868	6.2	4.8	5.5
Residentail & Others	3,462	5,477	7,731	10,706	14,890	8.4	6.8	7.6
Composition	%	%	%	%	%			
Agriculture	2.5	2.2	1.8	1.4	1.3			
Industry	46.7	46.8	49.3	53.4	55.1			
Materials	24.9	26.8	30.9	37.1	40.4			
Non-materials	21.8	20.0	18.4	16.3	14.7			
Transportation	29.6	28.9	27.2	24.7	22.9			
Commercial & Services	5.9	5.6	5.2	4.4	4.3			
Residentail & Others	15.3	16.5	16.5	16.0	16.4			
Total	100.0	100.0	100.0	100.0	100.0			

Vietnam will become a Net Energy Importing Country around 2015

The primary energy supply excluding the non-commercial energy would increase during the Phase-1 period up to 2015 from 28.2 million toe in 2005 to 5.82 million toe in 2015 or 2.2 fold, and further expand double in the Pahse-2 up to 2025 to reach 117 million toe. Fossil fuels such as coal, oil and gas are supposed to supply the major portion of it. It is not easy to materialize such huge increase of energy supply. On top of it, the big structural change facing Vietnam is that the country is going to shift from an energy exporting to an energy importing country.

At present, Vietnam is a net energy exporting country selling coal and crude oils in the international market. However, while the domestic energy demand is forecast to increase dramatically, the indigenous energy production would be maturing due to constraints of the energy resources. As a result, Vietnam is anticipated to turn into an energy net import country at around 2015 as follows.

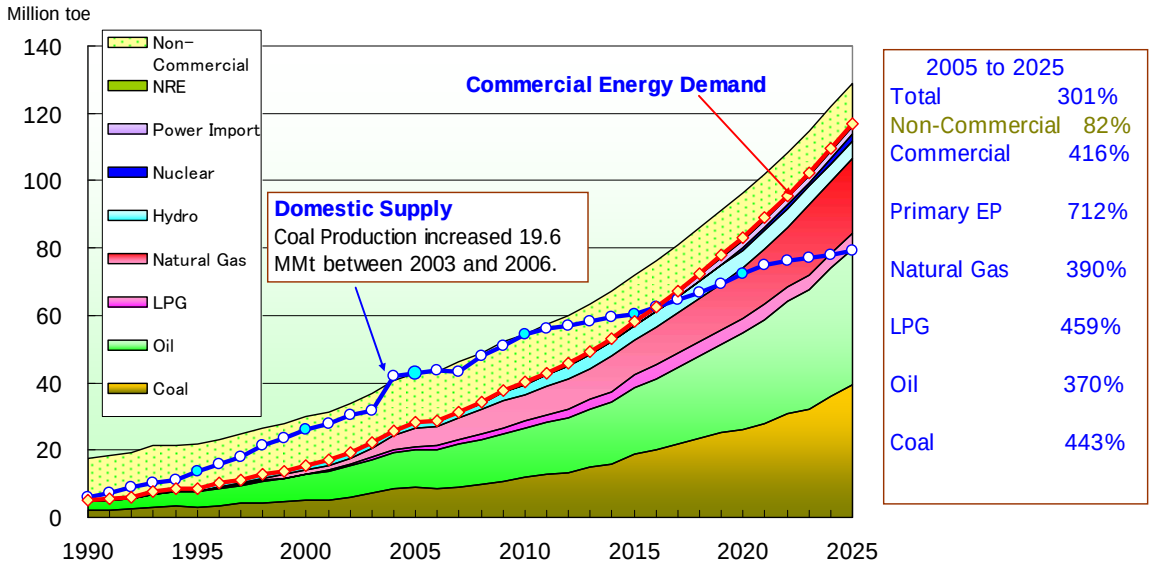


Figure 3.1-5 Primary Energy Consumption of Vietnam (Reference Case)

Table 3.1-3 Import Dependence Ratio of Energy

	2005	2010	2015	2020	2025
Net Import	MTOE	MTOE	MTOE	MTOE	MTOE
Coal	-9.2	-12.1	-9.5	-7.5	0.9
Oil	-7.5	-3.5	5.7	14.6	26.8
Natural Gas	0.0	0.0	0.0	0.0	6.2
Power	0.0	0.4	0.7	2.1	2.1
Total	-16.6	-15.1	-3.1	9.2	36.0
Import Ratio	%	%	%	%	%
Refference	-58.8%	-37.6%	-5.3%	11.1%	30.8%
BAU	-58.8%	-35.9%	4.3%	27.3%	49.8%

Vietnam may turn into a net energy importing country around 2015 and its import dependence would further progress as the domestic energy demand increases. In the BAU case, it would increase closer to 50% by 2025. This is a particularly serious issue in view of stable energy supply as well as national security. In this consideration, the Reference Case is set forth in this study in which energy conservation should be thoroughly promoted and the energy import dependence should be controlled at around 1/3 in 2025. Nevertheless, the increasing trend of import dependence continues to be dominant in the background. We need to project the long-term energy plan with a definite assumption that the energy structure of Vietnam shall turn into an import dependent type.

Table 3.1-4 Primary Energy Supply of Vietnam (Reference Case)

	2005	2010	2015	2020	2025	15/05	25/15	25/05
	MTOE	MTOE	MTOE	MTOE	MTOE	%	%	%
Coal	8.9	12.1	18.8	26.0	39.6	7.7	7.7	7.7
Oil	11.1	14.5	19.9	28.8	40.2	6.0	7.3	6.6
LPG	1.0	2.0	3.6	4.3	4.4	14.2	2.0	7.9
Natural Gas	5.7	7.9	10.2	14.8	22.3	6.0	8.1	7.0
Hydro	1.4	3.0	4.5	5.5	5.5	12.4	2.0	7.1
NRE	0.1	0.2	0.4	0.7	0.9	20.2	8.3	14.1
Nuclear	0.0	0.0	0.0	0.9	2.1	***	***	***
Total	28.2	40.1	58.2	83.1	117.1	7.5	7.2	7.4
	%	%	%	%	%	%	%	%
Coal	31.7	30.3	32.3	31.3	33.8	0.6	1.5	2.1
Oil	39.3	36.2	34.2	34.6	34.3	-5.2	0.1	-5.0
LPG	3.4	4.9	6.3	5.2	3.8	2.8	-2.5	0.4
Natural Gas	20.3	19.7	17.5	17.8	19.1	-2.8	1.5	-1.3
Hydro	5.0	7.4	7.7	6.6	4.7	2.8	-3.1	-0.3
NRE	0.2	0.5	0.7	0.8	0.8	0.5	0.1	0.5
Nuclear	0.0	0.0	0.1	1.1	1.8	0.1	1.7	1.8
Total	100.0	100.0	100.0	100.0	100.0	***	***	***

Major Issues in Energy Supply / Demand

(1) Electric Power Demand and Primary Energy Supply

In the power sector, although aggressive development of hydro and nuclear station will be implemented, most part of the electricity demand increase needs to be supplied by thermal power burning coal and natural gas. Among others, use of the imported coal is forecast to increase substantially reflecting its ample availability at reasonable price in the international market. It is necessary to construct facilities and business systems to import these fuels for power generation in due course.

(2) LPG Supply

It is widely observed in Vietnam that use of LPG is developing in the commercial and residential

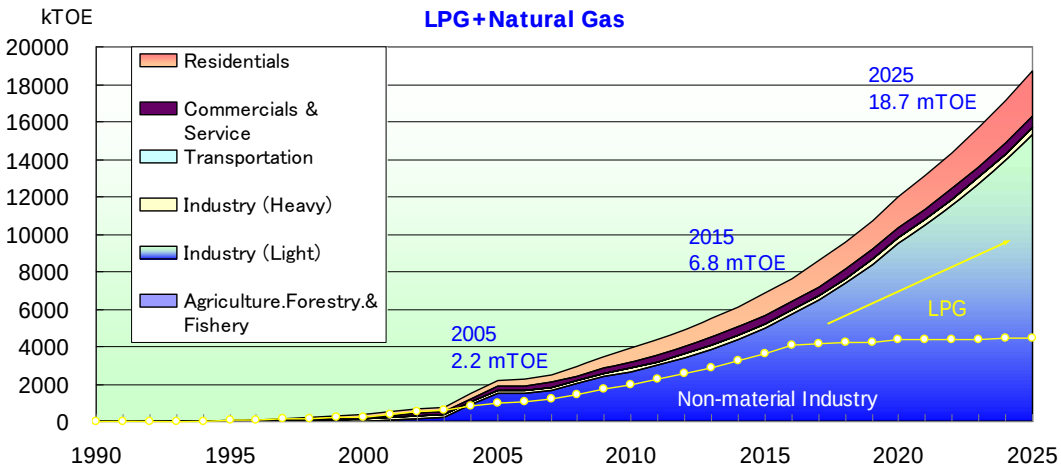


Figure 3.1-6 Potential demand of “LPG + Natural Gas” and LPG supply

sectors as well as in the less energy intensive general industries. As LPG is a fuel easy to transport and use and friendly for environment, if we apply the current trend, the LPG demand would increase four fold by 2015 and nine fold by 2025. Since its domestic supply is limited, the rest has to be imported. However, the LPG supply in the international market is unstable and its price is quite vulnerable. Under the circumstance, considering that increase of LPG supply would sooner or later face constraints, we need to establish appropriate alternative supply policies such as below.

1) Priorities of LPG supply should be given to the household and the services sectors where use of LPG is most beneficial in modernizing life standard and improving health of house wives.
2) Natural gas delivery network should be constructed utilizing the domestic natural gas and/or imported piped gas or LNG to accommodate energy demand.
3) In the industrial sector, energy supply best mix should be considered including use of coal, petroleum products like burning kerosene or gas oil and natural gas.

(3) Supply of Middle Distillates

In the motor fuel sector of Vietnam, gasoline consumption would increase at a moderate rate.

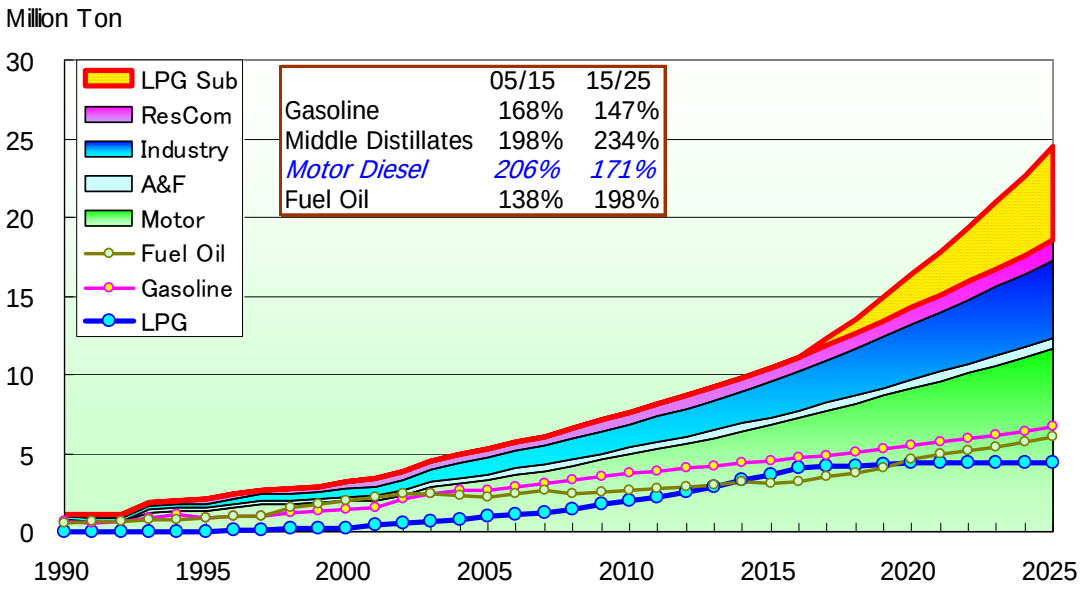


Figure 3.1-7 Petroleum Demand Trend

Problem is that if the above mentioned LPG substitute were to be supplied by middle distillates like burning kerosene or gas oil, the total middle distillate demand would increase 4.7-fold by 2025. In particular after 2015 when LPG supply constraints would become apparent, steep demand increase of middle distillates would occur. It is necessary to further investigate into the demand movement of this section and possible solutions to accommodate it.

Fundamental Energy Policy

Looking to the coming 20 years, Vietnam is anticipated to undergo unprecedented changes in the field of energy such as substantial increase of energy demand and shifting to an energy import dependent structure. In order to adapt to such changes and realize sustained socio-economic

development, the following five policies shall be set forth as the fundamental objectives of the National Energy Master Plan.

1) Promotion of energy efficiency and conservation
2) Construction of reliable and efficient energy supply system
3) Securing stable energy import and reinforcement of energy security
4) Energy sector reform and modernization of energy market
5) Establishment of measures to raise fund necessary for implementation of energy policies

3.2 Roadmap for the Fundamental Energy Policy

The fundamental objectives of the energy policy set out as above may be classified into the following three categories.

1) Measures to implement the comprehensive energy policy
2) Promotion of energy efficiency and conservation
3) Modernization of the energy market and energy industry policy

On the above each category, we will try to identify important measures to be promoted and propose roadmaps to implement them. Required investment amount in each sector will also be presented.

Comprehensive Energy Policy

Energy is an essential material being used in every sector of the economy and it is indispensable for socio-economic development to secure stable energy supply. To secure this requirement, it is considered necessary to establish an institutional system to implement consistent and coherent energy policies taking the following measures.

1) Establish the organization responsible for energy policy planning
2) Review the long term energy outlook and set forth the fundamental energy policy
3) Review or newly set up laws and regulations and responsible organizations for implementation of energy policy

In order to implement energy supply stabilization policy, it is necessary to secure the fund to back up the construction of energy infrastructure and provide subsidies as a part of energy policy campaign, though it is also important to mobilize the vital power of the private sector. The followings may show candidate sources for such fund.

1) Fund from OPA/PPP for sub-commercial projects
2) Fund generated under international schemes such as CDM
3) Fund procured through issuance of national bond
4) Tax on energy such as petroleum product tax

Among the above candidates, various conditions are put on those provided from overseas. As they should be properly expended subject to the purposes and supply conditions, it is not possible to meet all requirements by these funds being provided under certain conditions, since, for example, construction of energy infrastructure may require huge investments but some of them might not qualify for the international aid criteria. While such fund is presently being procured through issuance of national bond, it may be appropriate to consider generating funds through taxation on

energy, as widely adopted in developed countries, with due consideration on the tax bearing capacity of the society.

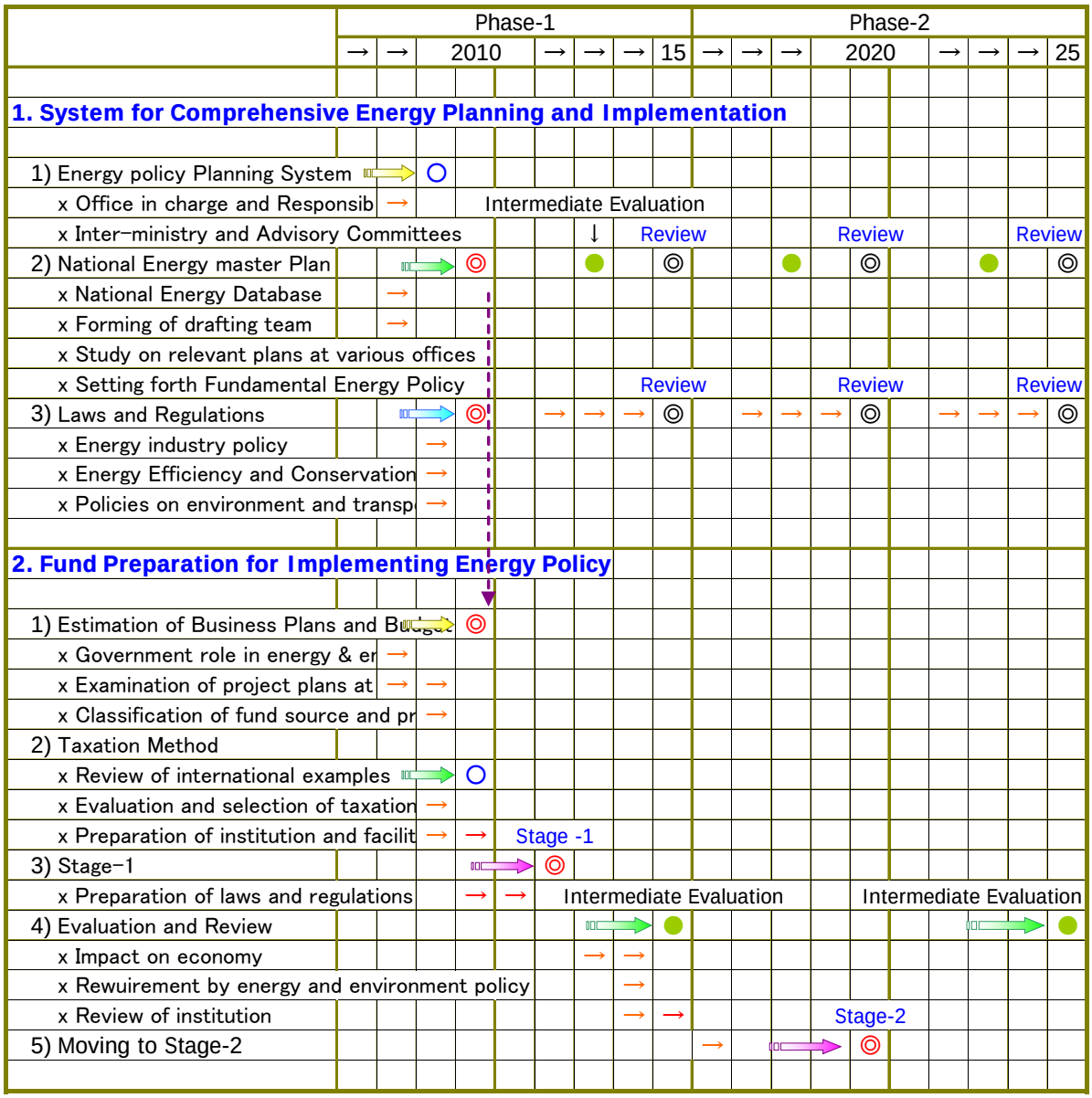


Figure 3.2-1 Roadmap-1: Construction of System for Comprehensive Energy Policy and Its Implementation

Promotion of Energy Efficiency and Conservation

In the draft Energy Master Plan, the target energy efficiency and conservation is set forth to reduce the energy consumption by 10% in 2015 and 25% plus in 2025 compared with the amount forecast in the BAU Case. This is a very ambitious plan to reduce the primary energy consumption form 161 million toe of the BAU Case to 117 million. Considering the current oil production level of Vietnam being at 17.0 million tons, achievement of this target is a big business compares to discoveries of huge oil fields. However, since effect of energy conservation efforts can be obtained only cumulatively, it is required to steadily pile up daily persevering efforts. The proposed roadmap for achievement of

the foregoing target is shown as follows.

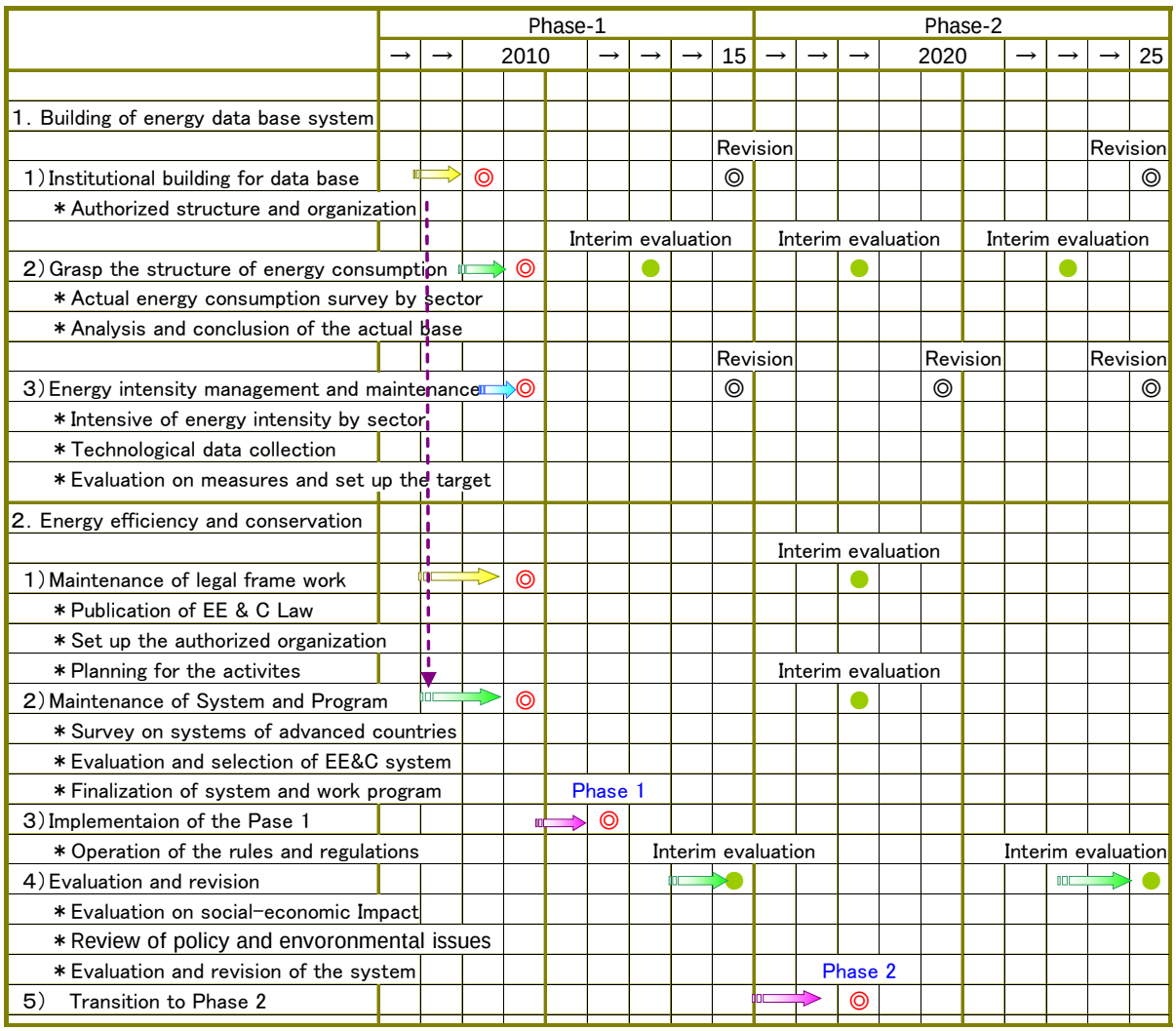


Figure 3.2-2 Road map 2: Promotion of Energy Efficiency and Conservation

Modernization of Energy Sector and Energy Industry Policy

For the purpose to secure stable and sufficient balance of energy demand and supply and improve energy efficiency, while the country's energy sector transforms from energy exporting to importing structure, core principles of the national energy policy shall be changed from those of state controlled to market controlled and create/modernize the energy market.

To this end, identifying the role of government sector as the national leader to show the grand design of social development and the regulation administration and the role of the private sector as active players in the market, appropriate measures should be taken in the following areas.

1) Government roles and businesses in the energy sector

2) Energy sector reform and modernization

3) Energy price policy to promote rational and efficient energy market

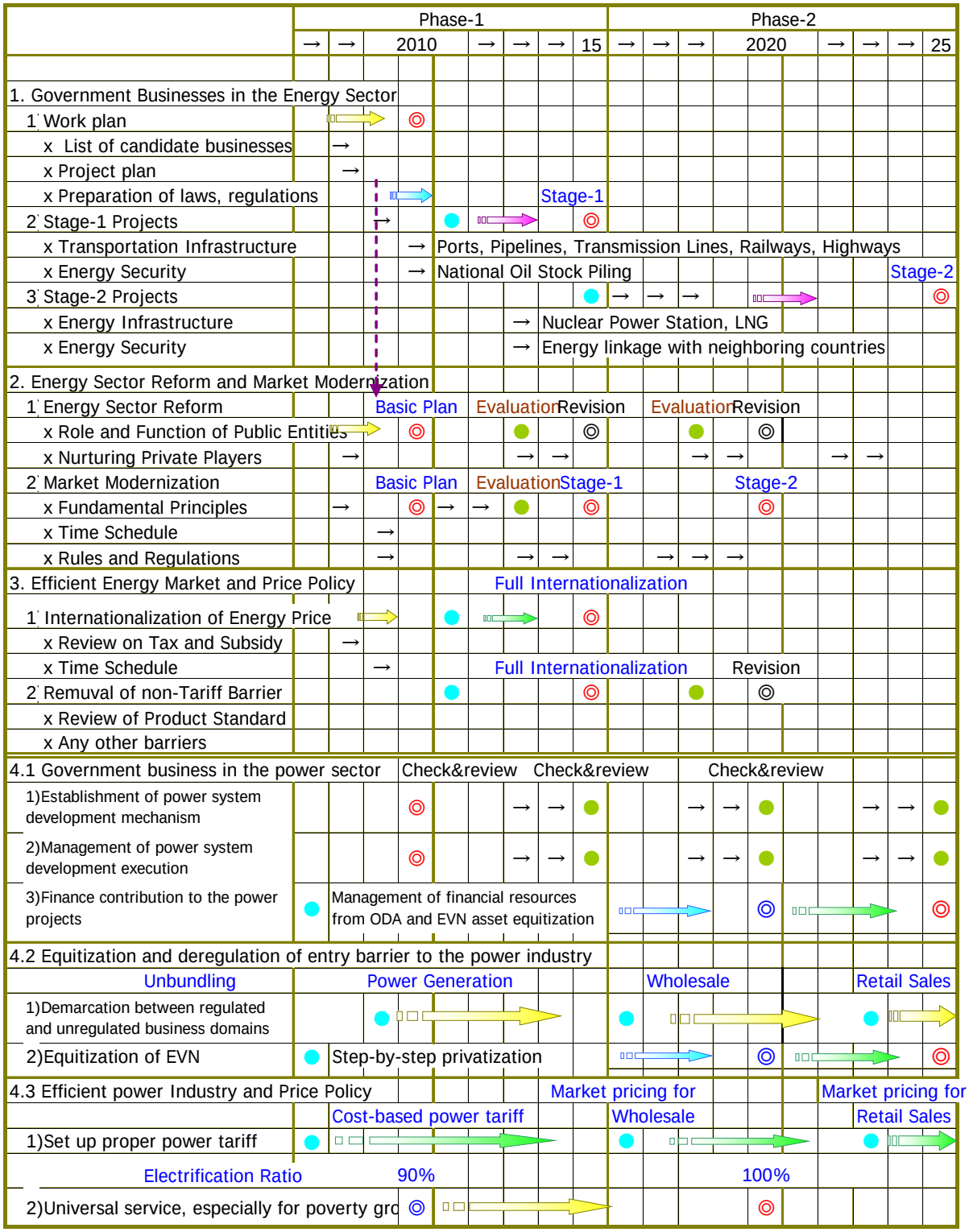


Figure 3.2-3 Road map 3: Modernization of Energy Market and Energy Industry Policy

Major Investment in the Energy Sector

Preliminary amount and timing of required investments in energy facilities of coal, power, oil, and renewable energy sector are examined as shown in Figure 3.2-4. Required investment of the facilities to meet the future energy demand is calculated based on the Reference Case. Required

investment for energy efficiency and conservation centers and energy database are not examined because they do not need large facilities. As for required investment for energy resource development, only coal sector is estimated based on the coal reserve and coal production plan. Required investments for upstream block of oil and gas sectors, however, are excluded in the estimation since there are too many uncertain items such as exploration cost, location and amount of reserves of new oil and gas fields and so on.

(Unit: million US$)

	→ → 2010	→ → → 15	→ → → 2020	→ → → 25	Total
1. Energy resource development (Coal)					**7,150**
1) Expansion of production capacity including infrastructure	5 million ton/y expansion 1200	11 million ton/y expansion 2000	10 million ton/y expansion 1500	10 million ton/y expansion 1500	6,200
2) Coal preparation plants	50	300	300	300	950
2. Power sector					**97,400**
1) Coal-fired power plants for domestic coa	2900	3600	1800	4300	12,600
2) Coal-fired power plants for import coal	commissioning 2015	700	1300	5400	7,400
3) Gas-fired power plants	1600	700	1000	3500	6,800
4) Nuclear power plants		commissioning 2020	5000	5000	10,000
5) Hydro power plants including power development in neighboring country	7000	6600	5700		19,300
6) Pumped storage power plants		commissioning 2019	600	2700	3,300
7) Renewable energy (mini hydro, wind)	600	1200	700	800	3,300
8) Transmission line including import power	7200	8500	9200	9000	33,900
9) Coal terminal including loading facilities	100	350	350	15 million ton/y coal terminal	800
		15 million ton/y coal terminal			
3. Oil sector		7 million ton/y No.2 refinery	7 million ton/y No.3 refinery		**12,190**
1) Refinery		5000	5000		10,000
2) Oil stockpiling excluding reserved oil		1.7 mil. kl for crude 0.3 mil. kl for products 430	0.6 mil. kl for crude 2.3 mil. kl for products 880	2.6 mil. kl for products 880	2,190
4. Renewable energy sector					**75**
1) Bio-ethanol plants	4	5	7	23	39
2) Bio-diesel plants	0	10	11	15	36
Total	20,654	29,395	33,348	33,418	**116,815**

Note: The above amount does not include oil & gas upstream investment.

Figure 3.2-4 Roadmap-4: Required Investment of Energy Sector

As the required investment amount shown in Figure 3.2-4 does not include those for the oil & gas upstream sector since they are quite uncertain, a ball park figure estimation may be that the annual exploration investment would be in the range of $100 - 200 million and the development cost for an oil or gas field $500 - 2000 million, and thus the rough estimate of the aggregate investment would be $5 - 20 billion for the 20 year projection period.

As shown in the table, the aggregate investment amount for the twenty years exceeds $116billion, 90% of it is going to be required in the electricity sector. That is, planning rational development of the electricity sector is most important in the energy policy. To this end, the following may be the most important actions to be taken.

1) Rationalize the energy structure leaning excessively on electricity with introduction of natural gas delivery system, utilization of co-generation and so on.

2) Promote optimal distribution of power sources and minimize investment in the trunk transmission lines.

On the other hand, as the investment amount for the renewable energies such as bio-fuel is not scheduled at a big amount here, should 5 to 10 fold amount be required to realize the government goal, that would be still not huge. Considering its substantial effect on the energy import ratio and environment, it is important to promote investment in renewable energies systematically.

3.3 Energy Action Plan

Sectoral action plans on key issues will be proposed below for further discussion to elaborate work plans projected in roadmaps explained as above.

Action Plan for promotion of Energy Efficiency and Conservation

In order to promote EE&C activities nationwide, it is necessary in addition to the governmental efforts to establish a comprehensive action plan covering various implementing bodies such as non-government organizations and private businesses. At present, development of legal framework, institutions and nationwide promotion system as well as engagement of experts are all in halfway and facing delay. At first, it is necessary to set up legal framework and institution and develop database as the fundamental information for planning of the EE&C action plan.

Since oil and electricity share three quarters of the total primary energy supply and electricity will increase its share as modernization of society progresses, it is important to consider energy conservation in terms of oil and electricity consumption quantity.

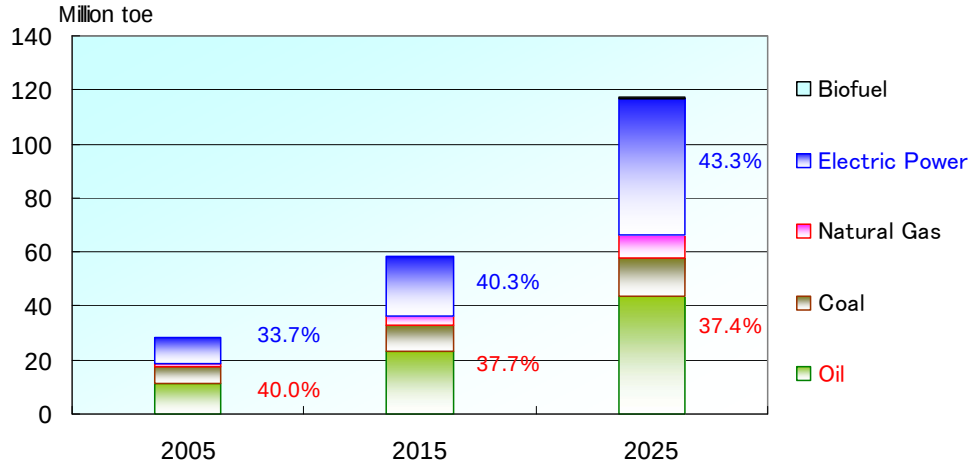


Figure 3.3-1 Primary Energy Supply: Electricity and Others

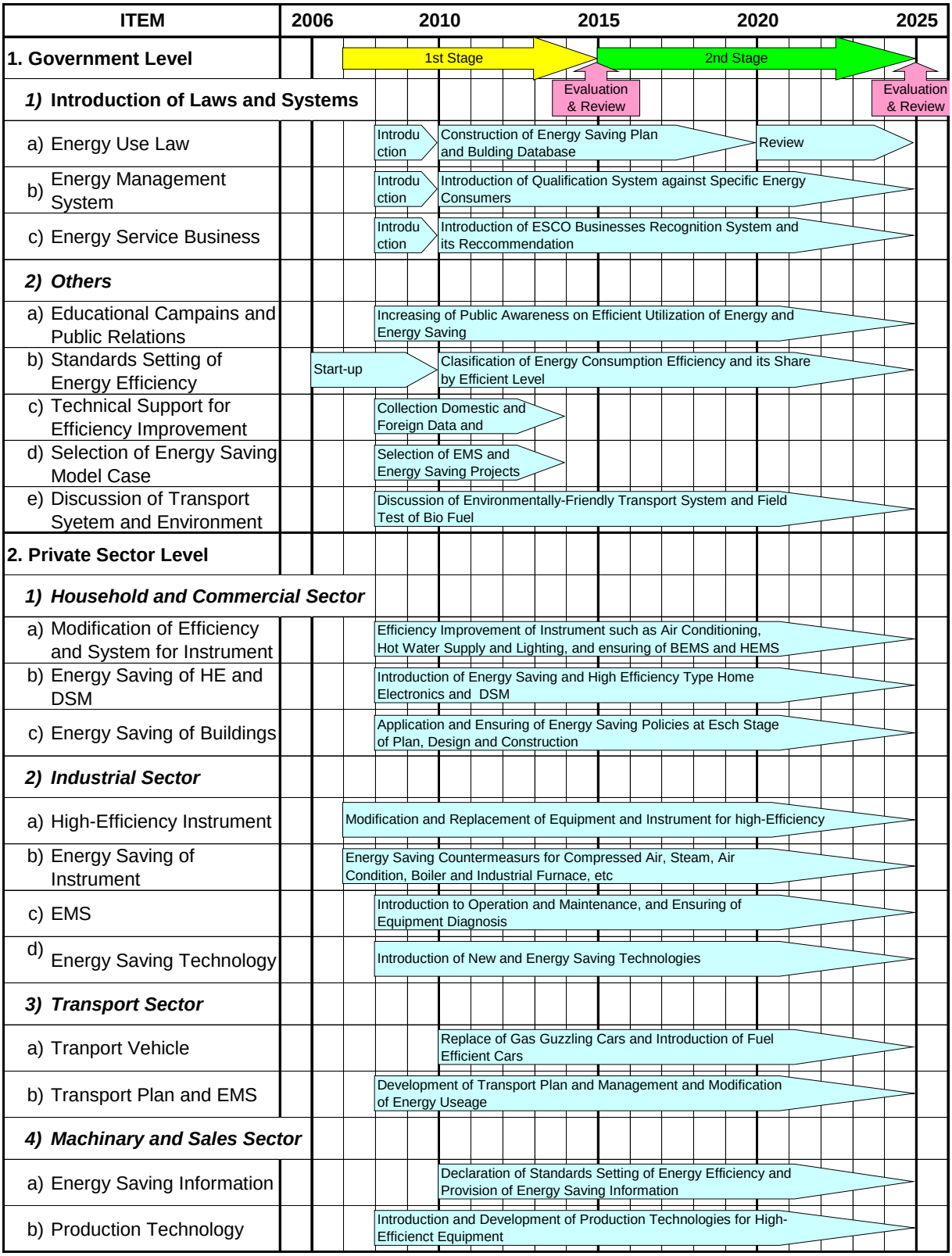


Figure 3.3-2 Action plan for the Energy Efficiency and Conservation

Action Plan for Power Sector

In the power sector, establishment of long-term development plan and its implementation is most important to assure stable power supply. In order to secure efficient implementation, it is necessary

to progress industry reform/deregulation and pricing policy in an appropriate manner.

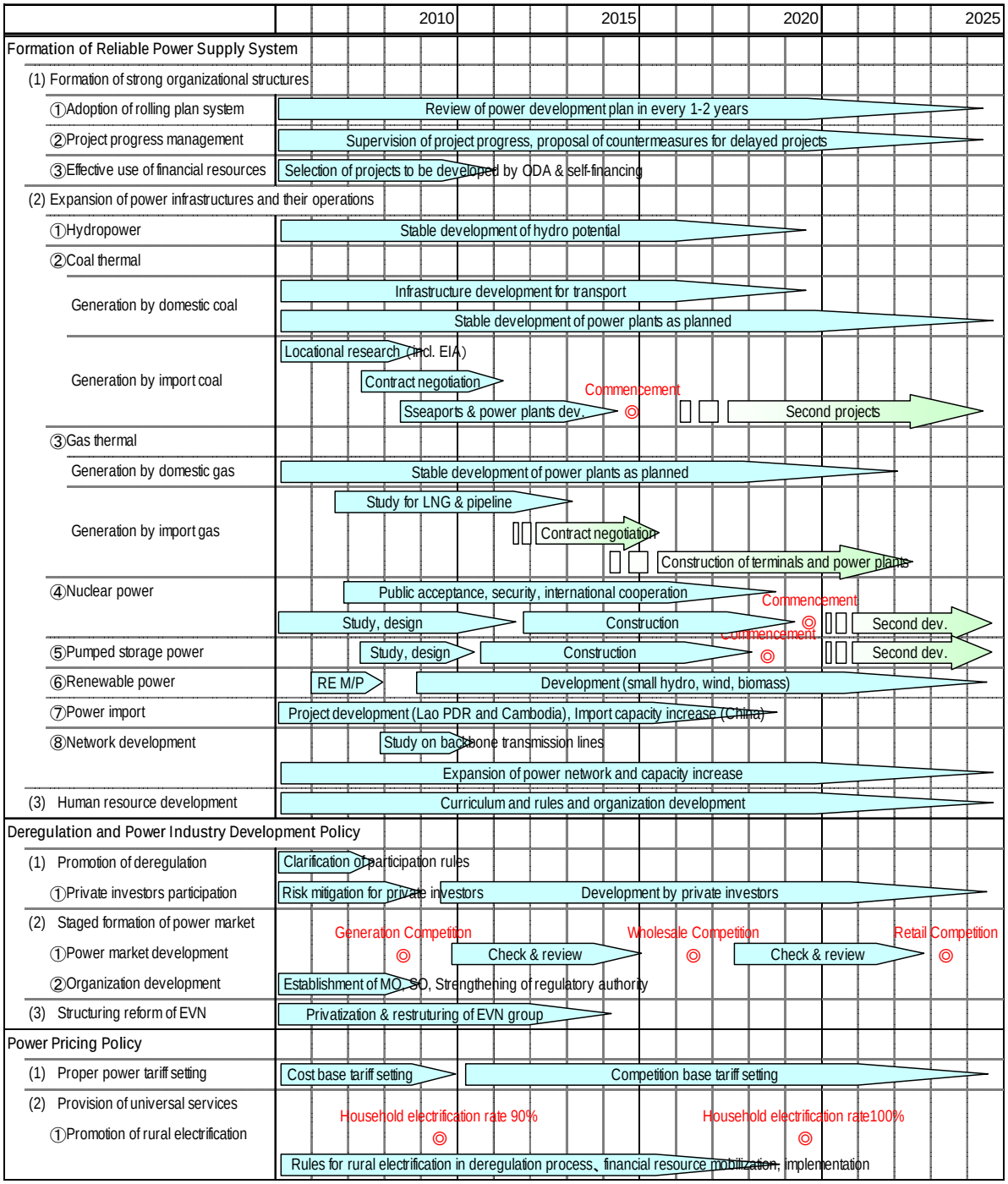


Figure 3.3-3 Action Plan of Power Sector

Coal Sector

While most of the coal supply in Vietnam comes from domestic sources at present, it is necessary to construct new coal supply system to correspond to future demand increase. In construction of such system, it is necessary to consider the following features. Firstly, almost of the domestic resources and production are centered in Quang Ninh Province in the north, secondly coal demand also is

centered in the northern provinces while some are developing in the central and southern provinces, and thirdly the coal quality may be divided into two, namely, domestic coal and imported coal.

Regional feature of coal demand/supply balance may be described that domestic coal will be supplied to both power generation and general industry in the north, mix of domestic and import coal for power generation in the central, and mainly import coal for power generation in the south. While domestic coal will be supplied utilizing the existing system to the maximum extent in the north, construction of import-coal burning power stations is scheduled in the central and southern regions so that new coal supply system should be constructed to accommodate them.

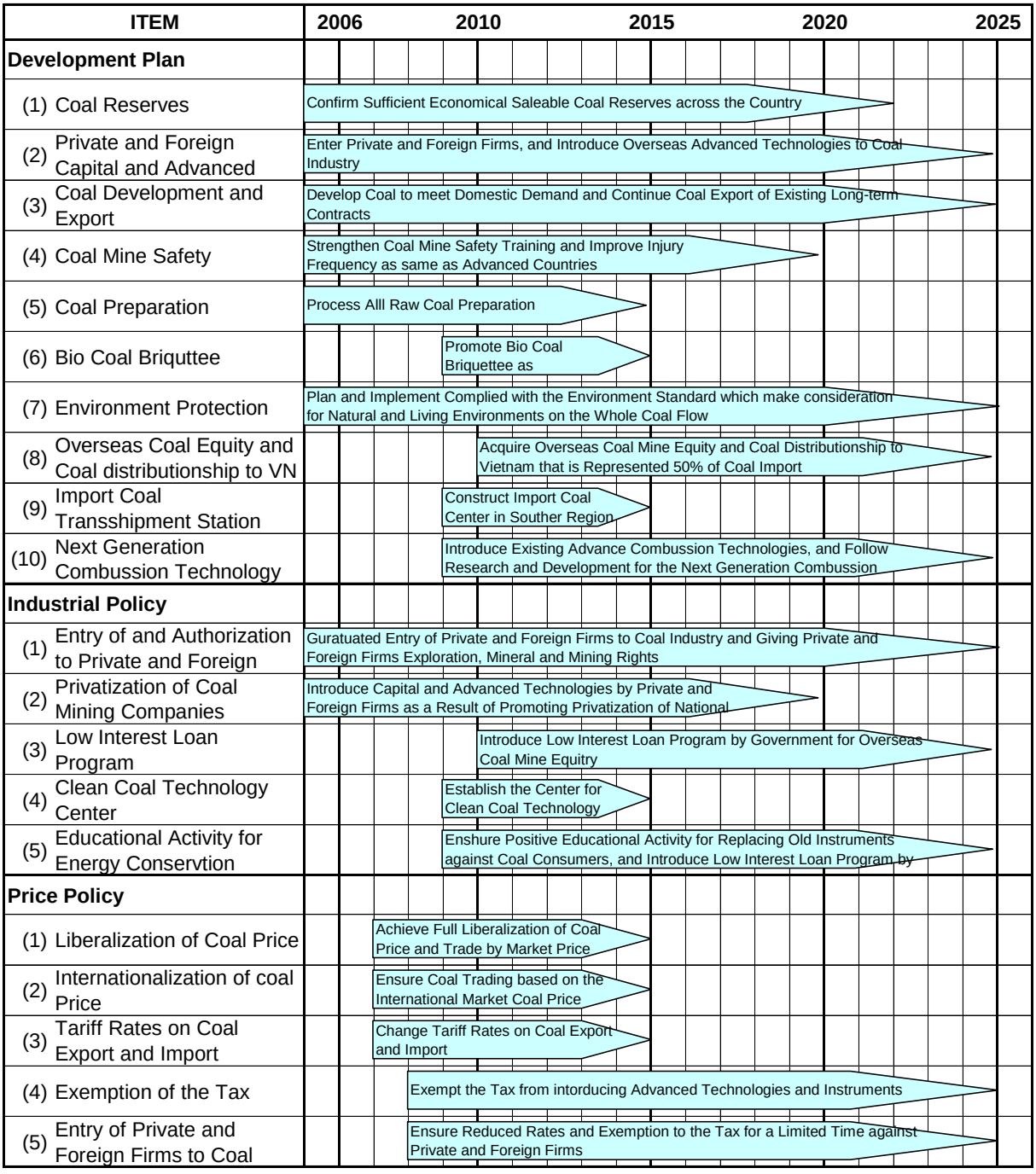


Figure 3.3-4 Action Plan on the Coal Sector

Action Plan for Oil and Natural Gas Sectors

In the oil and gas sector, in addition to accelerated exploration and efficient development of upstream sector, enhanced actions are required on 1) development of oil and gas supply system, 2) deregulation of the oil and gas market and energy industry policy, and 3) efficient oil and gas market and pricing policy. Among others, construction of natural gas delivery network and establishment of product standard for petroleum products are the most important issues for urgent implementation.

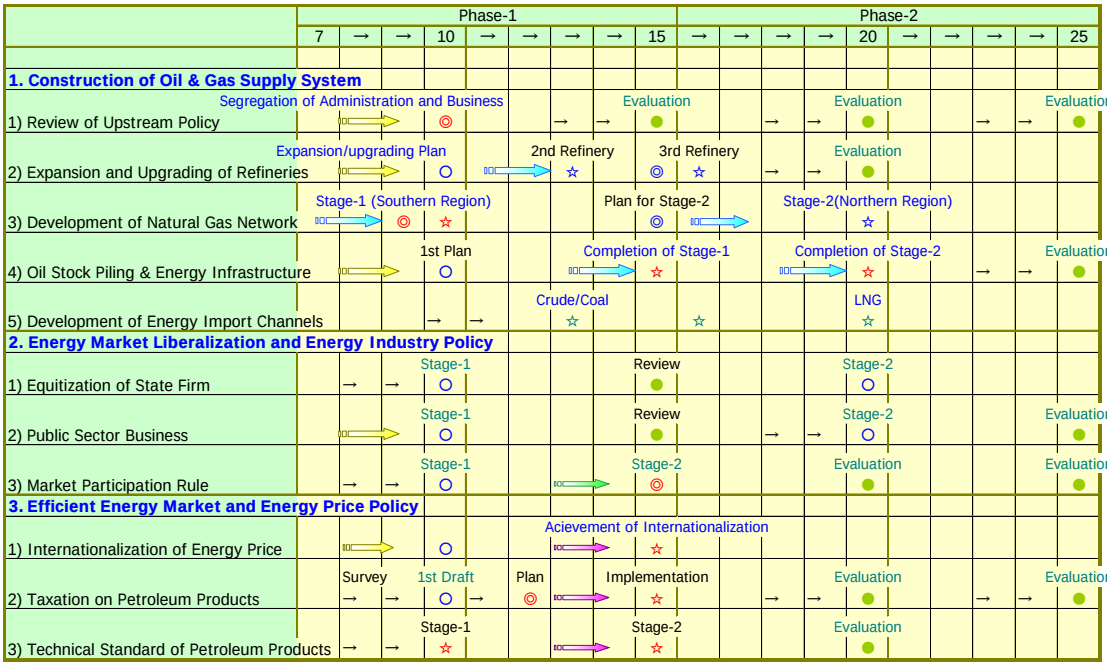


Figure 3.3-5 Action Plan for Oil and Gas Sector

Action Plan for Renewable Energy Sector

In the renewable energy sector, action plans may diverse between power source development and bio-fuel. It is also desirable to set out the procedure for utilizing international schemes to enhance development of renewable energies.

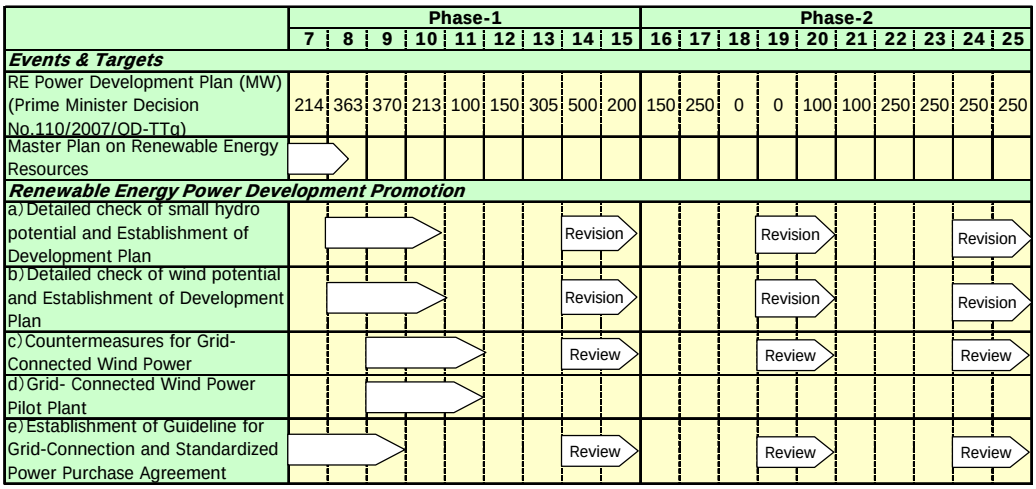


Figure 3.3-6 Action Plan for Renewable Energy Power Development Promotion

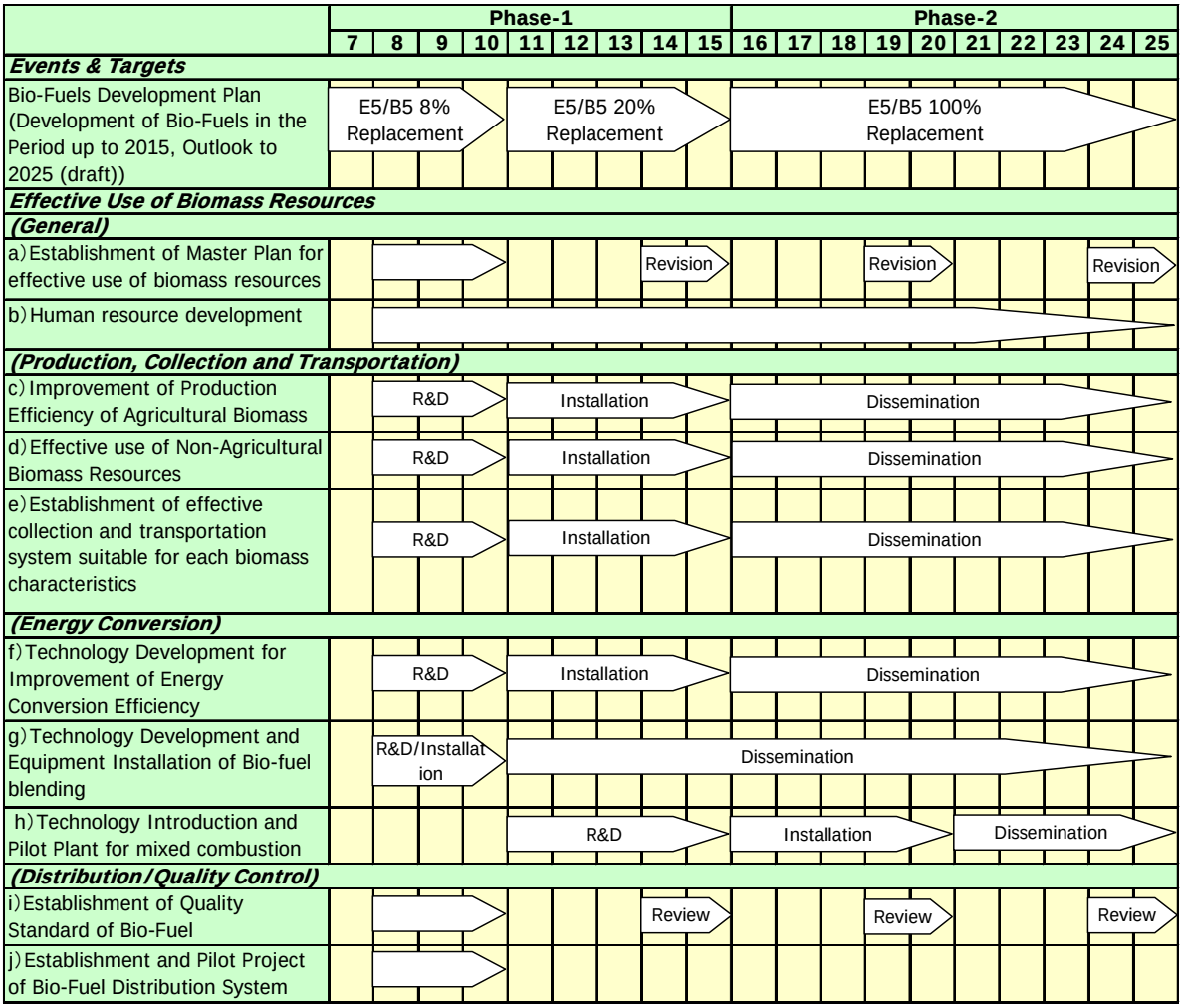


Figure 3.3-7 Action Plan for Effective Use of Biomass Resources

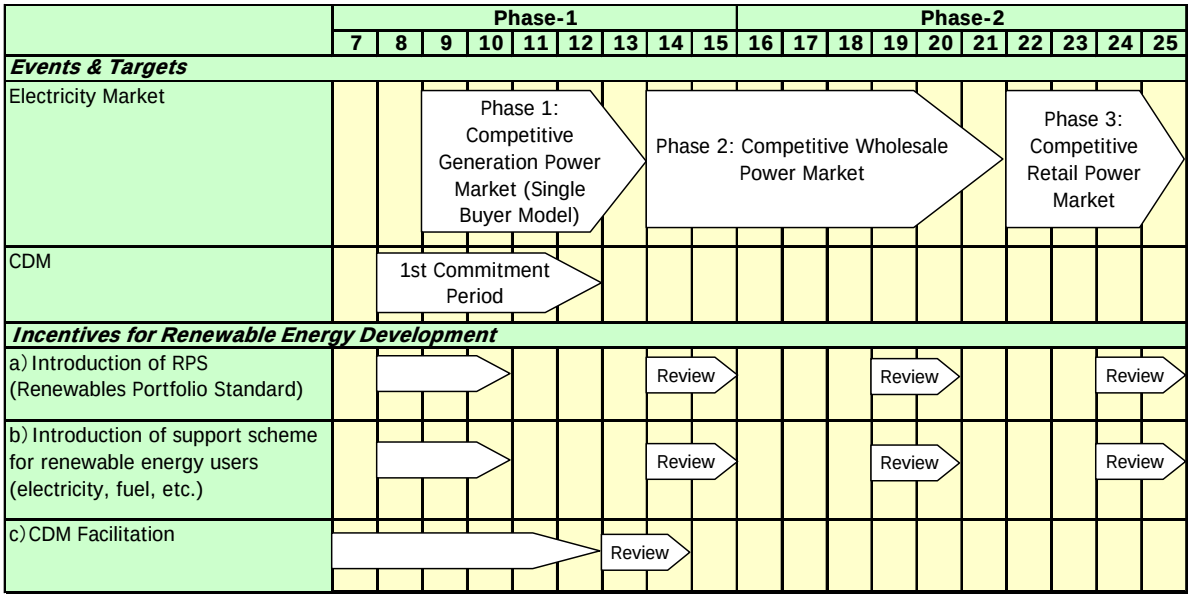


Figure 3.3-8 Action Plan for Incentives for Renewable Energy

Construction of Energy Database

In order to grasp the exact record of energy supply and demand for energy policy making, it is highly important to create the National Energy Database. At present, there is no organization in Vietnam responsible for comprehensive energy database. For creating energy database, it is important to define the purpose of the database, necessary data items, and how to collect necessary data and create institution and organization for management and maintenance of the database. In view of the current administration system in Vietnam, collaboration of MOIT and GSO is recommended. It is also important to pay attention to implementation possibility, operability and confidentiality of the required work.

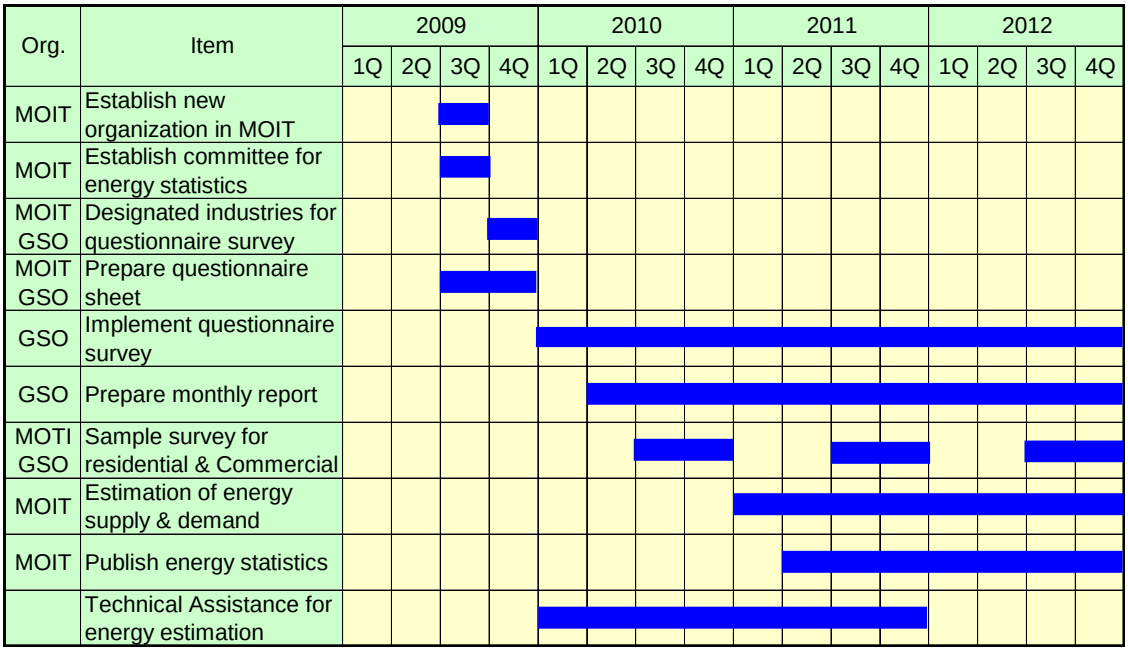


Figure 3.3-9 Action Plan for Energy Statistics Development

Closing Remarks

In this study, we aimed to construct a comprehensive energy analysis model of Vietnam to project long-term energy outlook and to produce an example of National Energy Master Plan through various studies using the model. After the study of almost two years, 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 Vietnamese colleagues.

At the workshop held on January 23, 2008, there were many opinions that we need to conduct further analyses and studies to formulate a firm master plan. The study team also thinks that we need additional studies, which 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.

In addition, because of time constraints, those changes that occurred after October 2007 are not incorporated in the study, such as changes in the global economy and energy in particular abrupt rise of crude oil price and financial instability that followed. Models also need to be reviewed to better reflect the national and global change of circumstance. We hope that studies will be continued on these points, since this report is just a starting point. We look forward to the day when people of Vietnam will take in these models as your own tool, improve them and establish the process to construct your own National Energy Master Plan.

Appendix 1： Summary of Case Study

1. BAU Case

	Unit	2005	2010	2015	2020	2025	Growth Rate 05-15	15-25	05-25
Economic Indicators							%	%	%
Population	Million	83.10	87.76	92.69	97.90	101.88	1.1%	0.9%	1.0%
Real GDP in 2005 price	$ Billion	52.50	78.94	118.71	178.49	262.26	8.5%	8.2%	8.4%
RGDP per capita	$	632	900	1,281	1,823	2,574	7.3%	7.2%	7.3%
Material Industry Ratio	%	9.0	9.0	9.1	9.0	8.7			
Energy Prices									
Crude Oil ;FOB	$/Bbl	50	65	65	65	65			
Coal; Steaming, FOB	$/ton	20	38	57	57	57			
Asian LNG CIF	$/MMBTU	6.4	7.5	7.5	7.5	7.5			
Energy Indicators									
TPE per capita	Toe	0.34	0.47	0.70	1.05	1.58	7.6%	8.4%	8.0%
TPE per GDP	Toe/$1000	0.54	0.52	0.55	0.57	0.62	0.2%	1.1%	0.7%
Electricity per capita	kWh	549	995	1,599	2,569	3,926	11.3%	9.4%	10.3%
Motorbike	million unit	19	26	29	30	30	4.2%	0.5%	2.3%
Passenger Car	1000 unit	195	449	950	1,835	3,084	17.2%	12.5%	14.8%
CO2 Emission	Million CO2-t	87	120	195	303	508	8.4%	10.1%	9.2%
Total Primary Energy Demand	kToe	*28,172*	*40,880*	*65,277*	*102,419*	*161,383*	*8.8%*	*9.5%*	9.1%
Coal	kToe	8,935	12,420	23,030	35,196	69,155	9.9%	11.6%	10.8%
Oil (excl. Stockpiling)	kToe	12,045	16,696	25,395	38,363	55,786	7.7%	8.2%	8.0%
Gas	kToe	5,727	8,175	11,208	19,690	25,790	6.9%	8.7%	7.8%
Hydro	kToe	1,396	2,976	4,502	5,477	5,477	12.4%	2.0%	7.1%
Nuclear	kToe	0	0	0	883	2,113	---	---	---
Renewables	kToe	64	185	402	571	704	20.2%	5.8%	12.8%
Power Import	kToe	6	418	688	2,134	2,135	61.6%	12.0%	34.5%
Non-commercial Energy	*kToe*	*14,694*	*14,262*	*13,585*	*12,562*	*10,779*	*-0.8%*	*-2.3%*	*-1.5%*
Coal	*%*	*31.7*	*30.4*	*35.3*	*34.4*	*42.9*			
Oil	*%*	*42.8*	*40.8*	*38.9*	*37.5*	*34.6*			
Gas	*%*	*20.3*	*20.0*	*17.2*	*19.2*	*16.0*			
Fossil Fuel	*%*	*94.8*	*91.2*	*91.4*	*91.0*	*93.4*			
Others	*%*	*5.2*	*8.8*	*8.6*	*8.9*	*6.5*			
Non-commercial Energy	*%*	*52.2*	*34.9*	*20.8*	*12.3*	*6.7*			
Final Demand (excl. Non-Com	kToe	*22,590*	*33,725*	*51,384*	*79,975*	*118,195*	8.6%	8.7%	8.6%
Agriculture	kToe	570	716	830	946	1,159	3.8%	3.4%	3.6%
Industry	kToe	10,549	15,852	25,834	43,949	67,532	9.4%	10.1%	9.7%
Light	kToe	5,626	9,151	16,743	31,859	52,029	11.5%	12.0%	11.8%
Heavy	kToe	4,922	6,701	9,091	12,090	15,503	6.3%	5.5%	5.9%
Transportation	kToe	6,687	9,660	13,285	18,029	23,645	7.1%	5.9%	6.5%
Others	kToe	4,784	7,498	11,434	17,051	25,859	9.1%	8.5%	8.8%
Electriciry (ex-PS)	GWh	51,730	99,376	166,346	279,085	442,786	12.4%	10.3%	11.3%
Gasoline	kToe	2,687	3,713	4,650	5,847	7,386	5.6%	4.7%	5.2%
Diesel Gas Oil	kToe	5,314	7,550	11,099	16,215	22,525	7.6%	7.3%	7.5%
Energy Import	*kToe*	*-16,564*	*-14,666*	*2,823*	*27,962*	*80,333*			
Coal	kToe	-9,142	-11,785	-5,295	1,721	30,530			
Oil	kToe	-7,428	-3,299	7,430	19,723	37,966			
Gas	kToe	0	0	0	4,384	9,703			
Electricity	kToe	6	418	688	2,134	2,135			
Energy Import Ratio	*%*	*-58.8*	*-35.9*	*4.3*	*27.3*	*49.8*			
Coal	%	-32.5	-28.8	-8.1	1.7	18.9			
Oil	%	-26.4	-8.1	11.4	19.3	23.5			
Gas	%	0.0	0.0	0.0	4.3	6.0			
Electricity	%	0.0	1.0	1.1	2.1	1.3			

Appendix 1.2 Summary of Case Study

2. Reference Case

	Unit	2005	2010	2015	2020	2025	Growth Rate 05-15	15-25	05-25
Economic Indicators							%	%	%
Population	Million	83.10	87.76	92.69	97.90	101.88	1.1%	0.9%	1.0%
Real GDP in 2005 price	$ Billion	52.50	78.94	118.71	178.49	262.26	8.5%	8.2%	8.4%
RGDP per capita	$	632	900	1,281	1,823	2,574	7.3%	7.2%	7.3%
Material Industry Ratio	%	9.0	9.0	9.1	9.0	8.7			
Energy Prices									
Crude Oil ;FOB	$/Bbl	50	65	65	65	65			
Coal; Steaming, FOB	$/ton	20	38	57	57	57			
Asian LNG CIF	$/MMBTU	6.4	7.5	7.5	7.5	7.5			
Energy Indicators									
TPE per capita	Toe	0.34	0.46	0.63	0.85	1.15	6.4%	6.2%	6.3%
TPE per GDP	Toe/$1000	0.54	0.51	0.49	0.47	0.45	-0.9%	-0.9%	-0.9%
Electricity per capita	kWh	549	995	1,599	2,569	3,926	11.3%	9.4%	10.3%
Motorbike	million unit	19	26	29	30	30	4.2%	0.5%	2.3%
Passenger Car	1000 unit	195	449	950	1,835	3,084	17.2%	12.5%	14.8%
CO2 Emission	Million CO2-t	87	118	169	238	345	6.9%	7.4%	7.1%
Total Primary Energy Demand	kToe	*28,172*	*40,145*	*58,212*	*83,052*	*117,060*	*7.5%*	*7.2%*	7.4%
Coal	kToe	8,935	12,148	18,818	26,007	39,561	7.7%	7.7%	7.7%
Oil (excl. Stockpiling)	kToe	12,045	16,489	23,539	33,106	44,572	6.9%	6.6%	6.8%
Gas	kToe	5,727	7,919	10,215	14,780	22,307	6.0%	8.1%	7.0%
Hydro	kToe	1,396	2,976	4,502	5,477	5,477	12.4%	2.0%	7.1%
Nuclear	kToe	0	0	0	883	2,113	---	---	---
Renewables	kToe	64	185	402	571	704	20.2%	5.8%	12.8%
Power Import	kToe	6	418	688	2,134	2,135	61.6%	12.0%	34.5%
Non-commercial Energy	*kToe*	*14,694*	*14,262*	*13,585*	*12,562*	*10,779*	*-0.8%*	*-2.3%*	*-1.5%*
Coal	*%*	*31.7*	*30.3*	*32.3*	*31.3*	*33.8*			
Oil	*%*	*42.8*	*41.1*	*40.4*	*39.9*	*38.1*			
Gas	*%*	*20.3*	*19.7*	*17.5*	*17.8*	*19.1*			
Fossil Fuel	*%*	*94.8*	*91.1*	*90.3*	*89.0*	*90.9*			
Others	*%*	*5.2*	*8.9*	*9.6*	*10.9*	*8.9*			
Non-commercial Energy	*%*	*52.2*	*35.5*	*23.3*	*15.1*	*9.2*			
Final Demand (excl. Non-Com	kToe	*22,590*	*33,725*	*51,384*	*79,975*	*118,195*	8.6%	8.7%	8.6%
Agriculture	kToe	570	716	830	946	1,159	3.8%	3.4%	3.6%
Industry	kToe	10,549	15,852	25,834	43,949	67,532	9.4%	10.1%	9.7%
Light	kToe	5,626	9,151	16,743	31,859	52,029	11.5%	12.0%	11.8%
Heavy	kToe	4,922	6,701	9,091	12,090	15,503	6.3%	5.5%	5.9%
Transportation	kToe	6,687	9,660	13,285	18,029	23,645	7.1%	5.9%	6.5%
Others	kToe	4,784	7,498	11,434	17,051	25,859	9.1%	8.5%	8.8%
Electriciry (ex-PS)	GWh	51,730	97,524	148,346	225,807	325,217	11.1%	8.2%	9.6%
Gasoline	kToe	2,687	3,697	4,516	5,491	6,657	5.3%	4.0%	4.6%
Diesel Gas Oil	kToe	5,314	7,456	10,294	14,089	18,301	6.8%	5.9%	6.4%
Energy Import	*kToe*	*-16,564*	*-15,102*	*-3,082*	*9,219*	*36,042*			
Coal	kToe	-9,142	-12,057	-9,507	-7,468	936			
Oil	kToe	-7,428	-3,463	5,738	14,553	26,751			
Gas	kToe	0	0	0	0	6,220			
Electricity	kToe	6	418	688	2,134	2,135			
Energy Import Ratio	*%*	*-58.8*	*-37.6*	*-5.3*	*11.1*	*30.8*			
Coal	%	-32.5	-30.0	-16.3	-9.0	0.8			
Oil	%	-26.4	-8.6	9.9	17.5	22.9			
Gas	%	0.0	0.0	0.0	0.0	5.3			
Electricity	%	0.0	1.0	1.2	2.6	1.8			

Appendix 2： Sample of Summary Report Sheets

2.1 Overall energy Outlook: Reference Case

reference	Summary sheet								Growth Rate			
TERM 1	TERM 2	TERM 3	Unit	2005	2010	2015	2020	2025	10/05	15/10	20/15	25/20
Economic Indicat	Exchange rate		VND/US$	15,959	16,856	17,947	19,610	21,168	1.1	1.3	1.8	1.5
	Population		Million	83	88	93	98	102	1.1	1.1	1.1	0.8
	GDP at current price on US $ base		Million US$	52,502	100,022	189,032	348,122	634,122	13.8	13.6	13.0	12.7
	GDP at 2005 price on US $ base		Million US$	52,502	78,944	118,705	178,492	262,263	8.5	8.5	8.5	8.0
	GDP at 2005 price on VND base		Trillion VND	838	1,260	1,894	2,848	4,185	8.5	8.5	8.5	8.0
	GDP per capita on 2005 US$ base		US$/person	632	900	1,281	1,823	2,574	7.3	7.3	7.3	7.1
	Material Industry at 2005 price		Trillion VND	76	114	173	256	362	8.5	8.8	8.1	7.2
	Material Industry Ratio		%	9.0	9.0	9.1	9.0	8.7	0.0	0.2	-0.3	-0.7
Energy Indicators	World Energy Price	IEA Crude Oil FOB	$/Bbl	49.9	65.0	65.0	65.0	65.0	5.4	0.0	0.0	0.0
	World Energy Price	Coal FOB	$/ton	19.7	38.1	56.5	56.5	56.5	14.1	8.2	0.0	0.0
	World Energy Price	Asian LNG CIF	$/MMBTU	6.4	7.5	7.5	7.5	7.5	3.2	0.0	0.0	0.0
	TPE per capita		TOE / person	0.3	0.5	0.6	0.8	1.1	6.2	6.5	6.7	6.8
	TPE per GDP		TOE/$1000	0.5	0.5	0.5	0.5	0.4	-1.1	-0.7	-0.6	-0.5
	Electricity per capita		kWh / person	549	995	1,599	2,569	3,926	12.6	9.9	10.0	8.9
	Vehicle number	Motorbike	1000Unit	19,073	25,985	28,801	29,941	30,141	6.4	2.1	0.8	0.1
		Car	1000Unit	195	449	950	1,835	3,084	18.2	16.2	14.1	10.9
		Motorbike per person	unit/1000psn	229.5	296.1	310.7	305.8	295.8	5.2	1.0	-0.3	-0.7
		Car per person	unit/1000psn	2.3	5.1	10.2	18.7	30.3	16.9	14.9	12.8	10.1
	Energy Efficiency Factor	Industry (Light)	%	100	94	88	83	79	-1.2	-1.3	-1.2	-1.1
		Industry (Heavy)	%	100	93	83	74	67	-1.4	-2.3	-2.2	-2.1
		Commercial	%	100	97	90	84	78	-0.7	-1.4	-1.4	-1.4
		Residential	%	100	98	92	87	82	-0.4	-1.2	-1.2	-1.2
	CO2 Emission		CO2-Mton	87	118	169	238	345	6.3	7.5	7.0	7.7
			SO2-Kton	239	337	607	841	1114	7.1	12.5	6.8	5.8
	Total Primary Energy	Commercial Total	**kTOE**	*28,172*	*40,145*	*58,212*	*83,052*	*117,060*	*7*	*7.7*	*7.4*	*7.1*
	Domestic Requirement	Coal	**kTOE**	8,935	12,148	18,818	26,007	39,561	6.3	9.1	6.7	8.8
	excluding Stockpiling	Oil(incl.LPG)	**kTOE**	12,045	16,489	23,539	33,106	44,572	6.5	7.4	7.1	6.1
		Gas	**kTOE**	5,727	7,919	10,215	14,780	22,307	6.7	5.2	7.7	8.6
		Fossil total	**kTOE**	26,707	36,556	52,572	73,893	106,439	6.5	7.5	7.0	7.6
		Fossil rate	**%**	94.8	91.1	90.3	89.0	90.9	-0.8	-0.2	-0.3	0.4
		Hydro	**kTOE**	1,396	2,976	4,502	5,477	5,477	16.3	8.6	4.0	0.0
		Nuclear	**kTOE**	0	0	0	883	2,113	0.0	0.0	0.0	19.1
		Renewable EP	**kTOE**	64	185	402	571	704	23.8	16.7	7.3	4.3
		Import	**kTOE**	6	418	688	2,134	2,135	136.2	10.5	25.4	0.0
		EP Total	**kTOE**	1,465	3,579	5,592	9,065	10,429	19.6	9.3	10.1	2.8
		Bio Fuel	kTOE	0	9	48	94	191	0.0	39.2	14.2	15.3
		Non-Commercials	**kTOE**	14,694	14,262	13,585	12,562	10,779	-0.6	-1.0	-1.6	-3.0
		Total	**kTOE**	*42,866*	*54,407*	*71,797*	*95,614*	*127,839*	*-0.6*	*-0.6*	*-0.9*	*-1.9*
	Final Energy Demand	Total	**kTOE**	22,590	33,725	51,384	79,975	118,195	8.3	8.8	9.3	8.1
		Agricluture	**kTOE**	570	716	830	946	1,159	4.6	3.0	2.6	4.2
		Industry (Light)	**kTOE**	5,626	9,151	16,743	31,859	52,029	10.2	12.8	13.7	10.3
		Industry (Heavy)	**kTOE**	4,922	6,701	9,091	12,090	15,503	6.4	6.3	5.9	5.1
		Transportation	**kTOE**	6,687	9,660	13,285	18,029	23,645	7.6	6.6	6.3	5.6
		Commercial	**kTOE**	1,322	1,913	2,724	3,723	5,362	7.7	7.3	6.4	7.6
		Residential	**kTOE**	3,341	5,434	8,508	13,058	20,142	10.2	9.4	8.9	9.1
		Others	**kTOE**	120	152	203	270	355	4.8	5.9	5.9	5.6
	Energy Net Import	Total	**kTOE**	*-16,564*	*-15,102*	*-3,082*	*9,219*	*36,042*	*0.0*	*0.0*	*0.0*	*31.3*
		Coal	**kTOE**	-9,142	-12,057	-9,507	-7,468	936	0.0	0.0	0.0	0.0
		Oil	**kTOE**	-7,428	-3,463	5,738	14,553	26,751	0.0	0.0	20.5	12.9
		Gas	**kTOE**	0	0	0	0	6,220	0.0	0.0	0.0	0.0
		Electricity	**kTOE**	6	418	688	2,134	2,135	136.2	10.5	25.4	0.0
		(Electricity)	GWh	66	4,858	7,997	24,815	24,830	136.3	10.5	25.4	0.0
	Import Ratio	Total	%	*-58.8*	*-37.6*	*-5.3*	*11.1*	*30.8*	*0.0*	*0.0*	*0.0*	*22.6*
	(excl. oil stockpiling)	Coal	%	-32.5	-30.0	-16.3	-9.0	0.8	0.0	0.0	0.0	0.0
		Oil	%	-26.4	-8.6	9.9	17.5	22.9	0.0	0.0	12.2	5.5
		Gas	%	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
		Electricity	%	0.0	1.0	1.2	2.6	1.8	120.1	2.6	16.8	-6.6

Note: Sample sheets are attached to illustrate items included in the summary sheets, while estimation is made for all the years from 2005 through 2025. Please refer to annual figures, if necessary, developed on the Excel spread sheet on computer screen.

2.2 Oil and Gas Sector Outlook: Reference Case

reference	Oil and Gas Sector								G R O W T H R A			
TERM 1	TERM 2	TERM 3	Unit	2005	2010	2015	2020	2025	10/05	15/10	20/15	25/20
Economic Indicat	Population		Million	83	88	93	98	102	1.1	1.1	1.1	0.8
	GDP at current price on US $ base		Million US$	52,502	100,022	189,032	348,122	634,122	13.8	13.6	13.0	12.7
	GDP at 2005 price on US $ base		Million US$	52,502	78,944	118,705	178,492	262,263	8.5	8.5	8.5	8.0
	GDP at 2005 price on VND base		Trillion VND	838	1,260	1,894	2,848	4,185	8.5	8.5	8.5	8.0
	GDP per capita on 2005 US$ base		US$/person	632	900	1,281	1,823	2,574	7.3	7.3	7.3	7.1
	Real Private consumption per capita		US$/person	76	114	173	256	362	8.5	8.8	8.1	7.2
	Material Industry Ratio		%	9.0	9.0	9.1	9.0	8.7	0.0	0.2	-0.3	-0.7
Energy Indicators	World Energy Price	IEA Crude Oil FOB	$/Bbl	49.9	65.0	65.0	65.0	65.0	5.4	0.0	0.0	0.0
	World Energy Price	Coal FOB	$/ton	19.7	38.1	56.5	56.5	56.5	14.1	8.2	0.0	0.0
	World Energy Price	Asian LNG CIF	$/MMBTU	6.4	7.5	7.5	7.5	7.5	3.2	0.0	0.0	0.0
	TPE per capita		TOE / person	0.3	0.5	0.6	0.8	1.1	6.2	6.5	6.2	6.3
	TPE per GDP		TOE/$1000	0.5	0.5	0.5	0.5	0.4	-1.1	-0.7	-1.0	-0.8
	Vehicle fuel per capita	Do : Car & Bus per C	Liter/Unit/Yea	3197	3150	3135	3126	3121	-0.3	-0.1	-0.1	0.0
		Gaso : Car per capita	Liter/Unit/Yea	1866	1805	1788	1777	1771	-0.7	-0.2	-0.1	-0.1
		Do : Truck per capita	Liter/Unit/Yea	8745	8447	8369	8318	8291	-0.7	-0.2	-0.1	-0.1
		Gaso : Bike per capit	Liter/Unit/Yea	174	173	172	172	171	-0.2	-0.1	0.0	0.0
	Vehicle number	Motorbike	1000Unit	19,073	25,985	28,801	29,941	30,141	6.4	2.1	0.8	0.1
		Passenger Car	1000Unit	195	449	950	1,835	3,084	18.2	16.2	14.1	10.9
	Tax on Oil products	Gasoline										
		DO										
		FO										
		LPG										
Oil sector	Final oil demand	Total	kTOE	*12,045*	*16,298*	*22,662*	*32,223*	*43,786*	*6.2*	*6.8*	*7.3*	*6.3*
		LPG	kTOE	963	1,971	3,641	4,342	4,418	15.4	13.1	3.6	0.3
		LPG substitute	kTOE	0	0	0	2,133	5,937	0.0	0.0	0.0	22.7
	including Bio-Fuel	Gasoline	kTOE	2,687	3,697	4,516	5,491	6,657	6.6	4.1	4.0	3.9
		Kerosene	kTOE	332	342	373	423	511	0.6	1.8	2.6	3.8
		Jet fuel	kTOE	534	736	1,031	1,415	1,872	6.6	7.0	6.5	5.8
	including Bio-Fuel	Diesel	kTOE	5,314	7,456	10,294	14,089	18,301	7.0	6.7	6.5	5.4
		General	kTOE	5,149	7,456	10,294	14,089	18,301	7.7	6.7	6.5	5.4
		EP	kTOE	165	0	0	0	0	-100.0	0.0	0.0	0.0
		Fuel oil	kTOE	2,215	2,096	2,807	4,329	6,090	-1.1	6.0	9.1	7.1
		General	kTOE	1,616	2,020	2,742	3,939	5,295	4.6	6.3	7.5	6.1
		EP	kTOE	599	76	65	390	795	-33.8	-3.1	43.1	15.3
	Crude oil	Production	kTOE	18,530	18,649	16,120	16,120	15,172	0.1	-2.9	0.0	-1.2
		(included condensate	kTOE	613	848	1,094	1,582	1,722	6.7	5.2	7.7	1.7
		Import	kTOE	0	1,208	3,813	7,043	7,805	0.0	25.8	13.1	2.1
		Processing	kTOE	0	6,950	14,396	14,396	14,396	0.0	15.7	0.0	0.0
		StockPiling	kTOE	0	1,208	90	2,277	3,039	0.0	-40.5	90.9	5.9
		Export	KTOE	18,530	11,699	5,447	6,490	5,542	-8.8	-14.2	3.6	-3.1
		Net Balance	KTOE	18,530	10,492	1,635	-553	-2,263	-10.8	-31.1	-180.5	0.0
	Oil product net import	Total	KTOE	*11,102*	*8,236*	*7,462*	*16,277*	*27,528*	*-5.8*	*-2.0*	*16.9*	*11.1*
		LPG	KTOE	633	1,103	1,849	2,258	2,258	11.7	10.9	4.1	0.0
		LPG substitute	KTOE	0	0	0	2,133	5,937	0.0	0.0	0.0	22.7
		Light Naptha	KTOE	0	-90	-1,578	-1,853	-886	0.0	0.0	0.0	
		Gasoline	KTOE	2,074	0	-889	0	0	-100.0	0.0	0.0	0.0
		Kerosene	KTOE	332	342	373	423	511	0.6	1.8	2.6	3.8
		Jet fuel	KTOE	534	294	245	630	1,087	-11.3	-3.5	20.8	11.5
		Diesel	KTOE	5,314	4,738	5,298	8,979	13,152	-2.3	2.3	11.1	7.9
		Fuel oil	KTOE	2,215	1,849	2,164	3,707	5,468	-3.6	3.2	11.4	8.1
Gas sector	Demand	Total	KTOE	*5,727*	*7,919*	*10,215*	*14,780*	*22,307*	*6.7*	*5.2*	*7.7*	*8.6*
		Power consumption	KTOE	4,473	6,003	7,011	9,246	13,961	6.1	3.2	5.7	8.6
		Others	KTOE	1,254	1,916	3,204	5,534	8,346	8.8	10.8	11.6	8.6
	Supply	Total	KTOE	*5,727*	*7,919*	*10,215*	*14,780*	*22,307*	*6.7*	*5.2*	*7.7*	*8.6*
		Production	KTOE	5,727	7,919	10,215	14,780	16,087	6.7	5.2	7.7	1.7
		Import	KTOE	0	0	0	0	6,220	0.0	0.0	0.0	0.0
LPG Sector	Potential Demand		KTOE	963	1,971	3,641	6,475	10,355	15.4	12.2	10.4	9.8
	Supply	**Supply Total**	kTOE	*963*	*1,971*	*3,641*	*4,342*	*4,418*	15.4	5.6	0.7	0.3
		Production	KTOE	330	868	1,792	2,084	2,159	21.4	15.6	3.1	0.7
		Gas Field	KTOE	330	456	588	851	926	6.7	5.2	7.7	1.7

2.3 Electric Power Sector Outlook: Reference Case

reference	Electric Power Sector								GROWTH RA			
TERM 1	TERM 2	TERM 3	Unit	2005	2010	2015	2020	2025	10/05	15/10	20/15	25/20
Economic Indicat	Population		Million	83	88	93	98	102	1.1	1.1	1.1	0.8
	GDP at current price on US $ base		Million US$	52,502	100,022	189,032	348,122	634,122	13.8	13.6	13.0	12.7
	GDP at 2005 price on US $ base		Million US$	52,502	78,944	118,705	178,492	262,263	8.5	8.5	8.5	8.0
	GDP at 2005 price on VND base		Trillion VND	838	1,260	1,894	2,848	4,185	8.5	8.5	8.5	8.0
	GDP per capita on 2005 US$ base		US$/person	632	900	1,281	1,823	2,574	7.3	7.3	7.3	7.1
	Material Industry Ratio		%	9.0	9.0	9.0	9.0	9.0	0.0	0.0	0.0	0.0
Energy Indicators	Power Generation		GWh	51,770	99,376	166,346	278,858	440,734	13.9	10.9	10.9	9.6
	Peak Demand	(estimated)	MW	8,443	16,206	27,128	45,476	71,874	13.9	10.9	10.9	9.6
	Electricity Tariff	Agriculture use	VND/kWh	660	1,012	1,118	1,236	1,365	8.9	2.0	2.0	2.0
		Residential use	VND/kWh	695	1,065	1,177	1,301	1,437	8.9	2.0	2.0	2.0
		Industry use	VND/kWh	829	1,271	1,405	1,553	1,716	8.9	2.0	2.0	2.0
		Commercial use	VND/kWh	1,359	2,083	2,302	2,544	2,811	8.9	2.0	2.0	2.0
	Electricity per capita		kWh/person	549	995	1,599	2,569	3,926	12.6	9.9	10.0	8.9
	Sectoral Demand	Total	GWh	45,603	87,350	148,207	251,541	400,003	13.9	11.2	11.2	9.7
		Agriculture	GWh	574	1,034	1,441	1,916	2,683	12.5	6.9	5.9	7.0
		Industry (Light)	GWh	17,248	34,465	58,057	105,871	168,840	14.8	11.0	12.8	9.8
		Industry (Heavy)	GWh	4,054	6,172	9,357	13,654	18,920	8.8	8.7	7.9	6.7
		Transportation	GWh	337	745	1,216	1,971	3,010	17.2	10.3	10.2	8.8
		Commercial	GWh	2,162	4,659	8,683	14,599	24,859	16.6	13.3	11.0	11.2
		Residential	GWh	19,831	38,512	67,099	110,387	177,562	14.2	11.7	10.5	10.0
		Others	GWh	1,397	1,764	2,355	3,144	4,129	4.8	5.9	5.9	5.6
	Power Supply	Total	GWh	*51,730*	*97,524*	*148,346*	*225,807*	*325,217*	*13.5*	*8.8*	*8.8*	*7.6*
		Domestic Coal	GWh	8,472	18,198	36,618	49,818	73,138	16.5	15.0	6.4	8.0
		Imported Coal	GWh	567	857	4,347	12,423	41,461	8.6	38.4	23.4	27.3
		Oil	GWh	2,174	269	230	2,149	4,162	-34.2	-3.0	56.3	14.1
		Natural Gas	GWh	23,480	36,582	42,128	56,007	85,186	9.3	2.9	5.9	8.7
		Hydro	GWh	16,230	34,604	52,351	63,689	63,691	16.3	8.6	4.0	0.0
		Nuclear	GWh	0	0	0	10,268	24,566	0.0	0.0	0.0	19.1
		Renewables	GWh	741	2,157	4,675	6,637	8,181	23.8	16.7	7.3	4.3
		Power Import	GWh	66	4,858	7,997	24,815	24,830	136.3	10.5	25.4	0.0
	Power Capacity	Total	MW	*11,001*	*21,380*	*30,674*	*41,025*	*57,420*	*14.2*	*13.0*	*9.8*	*11.2*
		Domestic Coal	MW	1,345	3,865	7,075	8,675	12,470	23.5	22.7	14.8	23.5
		Imported Coal	MW	150	150	750	1,950	6,750	0.0	0.0	0.0	0.0
		Oil	MW	871	946	524	1,184	1,184	1.7	-8.7	0.3	0.3
		Diesel	MW	341	131	0	0	0	-17.4	-8.2	-7.2	-6.2
		Natural Gas	MW	4,089	6,484	7,534	9,034	14,284	9.7	6.8	1.2	5.1
		Hydro	MW	4154	9,337	13,524	16,465	16,465	17.6	19.7	16.4	13.2
		Nuclear	MW	0	0	0	2,000	4,000	0.0	0.0	0.0	0.0
		Renewables	MW	50	467	1,267	1,717	2,267	56.3	21.8	19.9	15.1

2.4 Coal and Renewable Energy Outlook: Reference Case

reference	Coal & Renewable Energy Sector								GROWTH RA			
TERM 1	TERM 2	TERM 3	Unit	2005	2010	2015	2020	2025	10/05	15/10	20/15	25/20
Economic Indicat	Population		Million	83	88	93	98	102	1.1	1.1	1.1	0.8
	GDP at current price on US $ base		Million US$	52,502	100,022	189,032	348,122	634,122	13.8	13.6	13.0	12.7
	GDP at 2005 price on US $ base		Million US$	52,502	78,944	118,705	178,492	262,263	8.5	8.5	8.5	8.0
	GDP at 2005 price on VND base		Trillion VND	838	1,260	1,894	2,848	4,185	8.5	8.5	8.5	8.0
	GDP per capita on 2005 US$ base		US$/person	632	900	1,281	1,823	2,574	7.3	7.3	7.3	7.1
	Material Industry Ratio		%	9.0	9.0	9.1	9.0	8.7	0.0	0.2	-0.3	-0.7
Energy Indicators	World Energy Price	IEA Crude Oil FOB	$/Bbl	49.9	65.0	65.0	65.0	65.0	5.4	0.0	0.0	0.0
	World Energy Price	Coal FOB	$/ton	19.7	38.1	56.5	56.5	56.5	14.1	8.2	0.0	0.0
	World Energy Price	Asian LNG CIF	$/MMBTU	6.4	7.5	7.5	7.5	7.5	3.2	0.0	0.0	0.0
	TPE per capita		TOE / person	0.3	0.5	0.6	0.8	1.1	6.2	6.5	6.2	6.3
	TPE per GDP		TOE/$1000	0.5	0.5	0.5	0.5	0.4	-1.1	-0.7	-1.0	-0.8
Coal sector	Demand	Total	1000ton	*31,882*	*42,739*	*51,125*	*62,880*	*81,726*	*6.0*	*8.1*	*4.5*	*4.0*
		Domestic use	1000ton	13,895	18,932	30,319	42,235	65,541	6.4	8.7	12.2	9.6
		Power	1000ton	5,042	8,027	16,555	24,645	43,716	9.7	15.2	15.5	16.6
		Domestic	1000ton	4,751	7,588	14,930	20,265	29,490	9.8	16.2	16.3	18.0
		Import	1000ton	291	439	1,625	4,380	14,226	8.6	3.2	4.3	-3.0
		other sectors	1000ton	8,853	10,905	13,764	17,591	21,825	4.3	4.8	10.4	6.0
		Export	1000ton	17,987	23,807	20,806	20,645	16,185	5.8	7.6	-1.6	-2.2
	Supply	Total	1000ton	*31,882*	*42,739*	*51,125*	*62,880*	*81,726*	*6.0*	*3.6*	*4.2*	*5.4*
		Production	1000ton	31,591	42,300	49,500	58,500	67,500	6.0	3.2	3.4	2.9
		High quality coal	1000ton	8,775	11,750	13,750	16,250	18,750	6.0	3.2	3.4	2.9
		Middle quality co	1000ton	15,795	21,150	24,750	29,250	33,750	6.0	3.2	3.4	2.9
		Low quality coal	1000ton	7,020	9,400	11,000	13,000	15,000	6.0	3.2	3.4	2.9
		Import	1000ton	291	439	1,625	4,380	14,226	8.6	29.9	21.9	26.6
		Production	KTOE	18,077	24,205	28,325	33,475	38,625	6.0	3.2	3.4	2.9
Renewable	Power supply	Total	GWh	*741*	*2,157*	*4,675*	*6,637*	*8,181*	*23.8*	*16.7*	7.3	4.3
		Solar	GWh									
		Wind	GWh									
		Small Hydro	GWh									
		Biomass	GWh									
	Fuel Supply	Total	1000kl	0.0	33.6	89.1	176.3	448.8		21.5	14.6	20.5
		Bio-fuel(Etharnol)	1000kl	0.0	11.9	29.0	52.9	128.3		19.6	12.8	19.4
		Bio-fuel(Diesel)	1000kl	0.0	21.8	60.1	123.3	320.4		22.5	15.5	21.0
		ratio(Ethanol)	%	0.0	5.0	10.0	15.0	30.0		14.9	8.4	14.9
		ratio(Diesel)	%	0.0	0.0	5.0	7.5	10.0		0.0	8.4	
		Bio-fuel(Etharnol)	kTOE	0.0	9.2	22.6	41.2	99.9		19.6	12.8	19.4
		Bio-fuel(Diesel)	kTOE	0.0	0.0	25.7	52.8	91.5		0.0	15.5	11.6