Chapter 9 Roadmap for the Fundamental Energy Policy

Five policies are set forth in the previous chapter as the fundamental objectives of the energy policy. They 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

In this chapter, we will try to identify important measures to be promoted in each category and propose roadmaps to implement them.

9.1 Comprehensive Energy Policy

In the category of implementing comprehensive policy, important objectives are to establish an institutional system for policy planning and implementation, formulation of the National Energy Master Plan as the basis of comprehensive energy policy and measures to generate the necessary fund for implementation of these policies. The proposed roadmap on these objectives is shown in Figure 9.1-1, in which the following items should be examined in each stage.

9.1.1 Institutional System for Policy Planning and Implementation

Energy is an essential material being used in every sector of the economy and its stable supply is indispensable for socio-economic development. To secure this requirement, it is necessary to establish an institutional system for implementation of 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.

(1) Organization for Policy Planning

There are various ministries and offices responsible for the government roles relating to production, transportation and consumption of energy. To control these diversified actions under a consistent policy, it is necessary to nominate an office or leading group such as national energy committee with clear authority responsible for planning the comprehensive energy policy. Such office should be provided with strong power and contact channel with leaders and senior experts of different ministries, sectors and local authorities.

In establishing this system, it is important to clearly identify the roles of the government to set forth policies and rules and the roles of players such as state entities, private firms and individuals to conduct energy businesses under the policies and rules. Then, the roles and responsibilities of the office in charge should be explicitly defined. Establishment of systematic linkage with other ministries and offices is also important. Policies and plans should be effective and practicable. To this end, it is also desirable to have a vehicle to invite comments and opinions on the national energy policy from multiple stakeholders including government offices, state and private enterprises, experts and researchers.

At the same time, however, in order to avoid corpulence of the administration system, it may be appropriate to set out advisory committees/groups comprising experts and academies as well as research institutes or consultants to collect and analyze necessary data and information, conduct studies and prepare draft plans.

As we will discuss mainly on domestic energy policies and plans hereunder, we need to pay due attention on the fact that international relationship is extremely important in the contemporary world. In compilation and implementation of the national energy policy, it is important to closely analyze international movement and construct national policies and plans coherent to international linkage and commitment. In addition, in order to promote introduction of technology and funds from abroad and/or implementation of collaborative studies and joint projects, it is necessary that the government should prepare an office with appropriate function to maneuver international energy affairs.

(2) Master Plan

The National Energy Master Plan shall be the long-term plan as the basis of the comprehensive energy policy to orient the energy consumption of the society to an appropriate direction and establish stable and secured supply of necessary energy. As its platform, the *Grand Design* of the socio-economic development shall be examined and established through across the board discussion at the government, where energy and environment issues as its important elements should be consistently aligned with other socio-economic policies.

In constructing the National Energy Master Plan, it is necessary to prepare sufficient energy data, to examine the grand design of the socio-economic development from energy viewpoint, to prepare relevant plans at various government offices and check their consistency and practicability. To this end, it is desirable that the formulation system and then the draft of the National Energy Master Plan should be widely reviewed and discussed among multiple stakeholders before finalization. After implementation, it should also be reviewed periodically to adjust the direction of energy policies taking account of the global energy trend. We should note a risk here that, if the review were scheduled too frequently, the office in charge would become too busy, being engaged only in updating the record, to develop fundamental discussions on policy. The appropriate review cycle may be five years with an intermediate review in the third year.

(3) Laws and Regulations and Implementation System

In order to implement various energy policies, which are based on the Master Plan, it is necessary to prepare laws and regulations and implementation system. These policies may be classified as follows.

1) Energy industry policy
2) Energy efficiency and conservation policy
3) Policies at energy related sectors such as environment, transportation and science technologies
4) Raising fund for implementation of energy policies
5) Laws and regulations relating to preparation and collection of energy data

9.1.2 Preparing Fund for Implementation of Energy Policies

In order to implement energy supply stabilization policy, it is necessary to secure the fund to back up the construction of energy infrastructure and/or to provide subsidies as a part of energy policy campaign. Though it is important to mobilize the vital power of the private sector, private funds are often fickle and limited, and would not necessarily flow to the required direction. The followings may show candidate sources for such fund to support government activities.

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 these candidates, various conditions are put on the funds provided from overseas. As they need to be properly expended subject to the purposes and supply conditions, it is not possible to meet nation's every requirements with these funds. 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 not provided by international aid program is presently 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.

It is of course necessary to carry out a comprehensive investigation before institutionalizing this to identify in which sector and what amount such public fund should be invested and how and from which sources such fund should be raised.

(1) Business Plan and Required Amount

As a guideline to set forth the energy fund plan, it is necessary to establish a plan regarding what kind of activities should be conducted in the area of energy and environment at the responsibility of the government and how much amount would be required for them. The following items are the candidates of which the government should be responsible for providing various measures, supports and/or preparing infrastructure relating to energy, environment and transportation.

1) Promotion of energy resource development
2) Construction and development of energy infrastructure such as trunk transmission lines, pipelines, import terminals and delivery depots
3) Energy security measures such as strategic oil stockpiling
4) Promotion of energy efficiency and conservation
5) Research and development of new technologies and new and renewable energies
6) Construction and development of roads, railways, ports, etc.

The fund shall be allocated and provided to these projects in the following form considering the nature and size of the project.

1) Budget expenditure by the central and/or local governments
2) Subsidy for research and development
3) Interest support, back guarantee and/or subsidy for development/construction financing
4) Capital investment in project implementation bodies such as third sector organizations

The fund plan should be compiled at first examining the business plans in particular on the importance of the project and its priority. The fund plan shall be divided into categories where provision of overseas fund could be expected in the form of ODA, CDM or institutional lending and where the fund should be prepared through self-procurement. The total budget should be confined within the amount of which stable self-fund procurement is possible. After implementation of projects, periodical audit, evaluation, re-studies and, if necessary and appropriate, review of the business plan should be conducted.

(2) Measures to Raise Fund

Regarding the fund procurement plan, it is necessary to set forth a coherent and realistic plan classifying the projects into the categories where overseas funds could be expected as a form of ODA, CDM or institutional borrowing, and where self provision is appropriate.

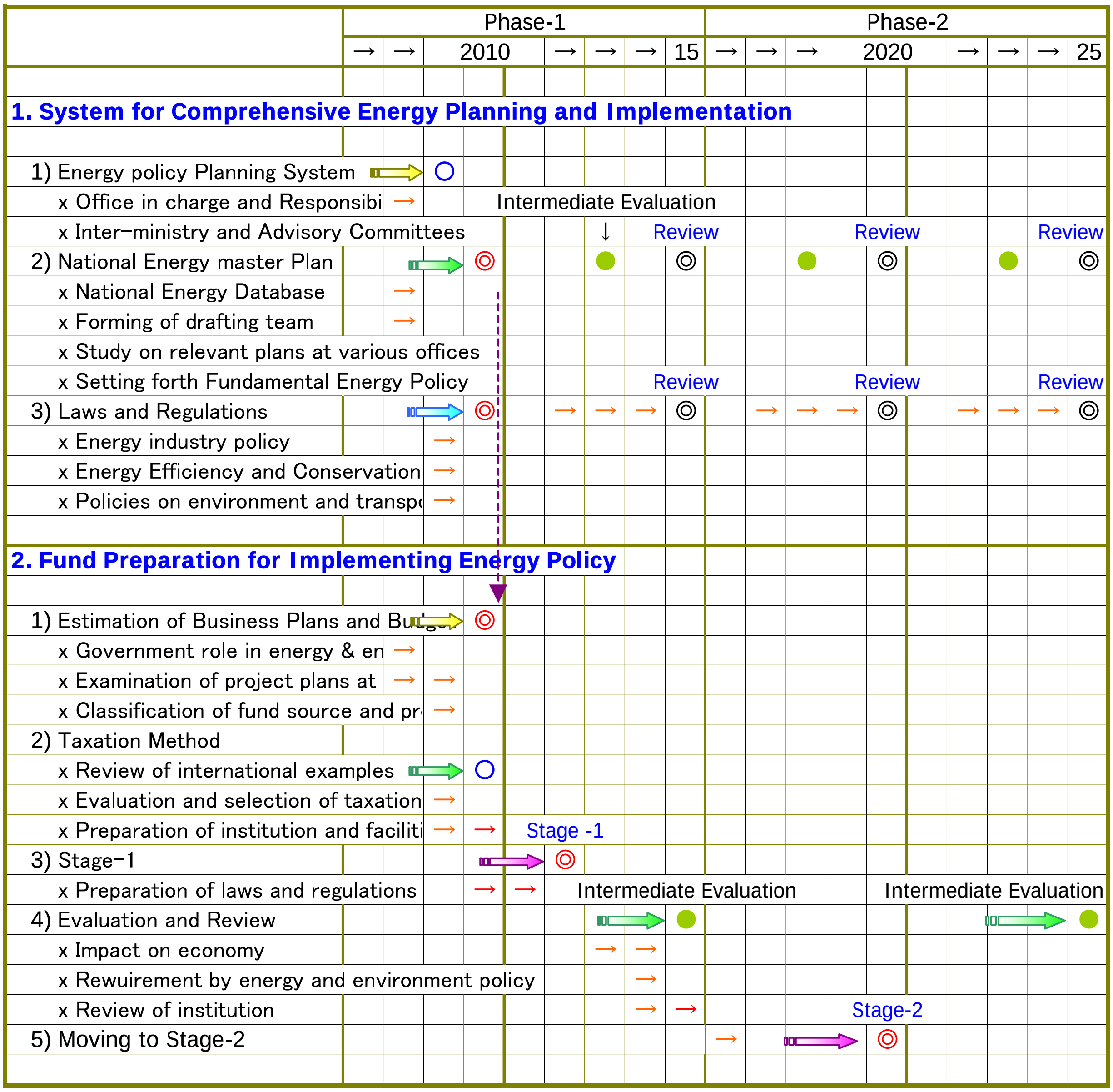


Figure 9.1-1 Roadmap-1: Construction of System for Comprehensive Energy Policy and Its Implementation

For the amount of which self generation is necessary, the government needs to ask the nationals to bear it eventually. Tax on gasoline and/or diesel gas oil is the general pattern in the world in view of tax bearing capacity and convenience in tax collection. In deciding the method and scale of such taxation, it should be appropriate to study examples of other countries and pay due attention to the impact on the economy and consideration on the socially week people.

We should also note that a considerable lead time is necessary in applying such taxation system for preparation of storage facilities, measurement equipments and training of taxation experts.

9.2 Promotion of Energy Efficiency and Conservation

In the National Energy Efficiency Program issued by the Prime Minister of Vietnam in April 2006 (Decision No. 79/2006/QD-TTg), the national target of energy efficiency and conservation was set out to reduce the energy consumption by 3-5% from the BAU case forecast for the period of 2006-2010 and 5-8% for the period of 2011 - 2015. In contrast, in our draft Master Plan, the target energy efficiency and conservation is set forth to reduce the energy consumption by 10% in 2015 and 25% plus in 20205 compared with the amount forecast for 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.

9.2.1 Target of Energy Conservation

In the National Energy Efficiency Program, the target for promoting energy efficiency and conservation (EE&C) is set to reduce the energy intensity over GDP as shown in Figure 9.2-1, by taking measures such as efficient energy use in the process of production and transport, and/or replacement of obsolete facilities. The target of the Reference Case set forth in this study is close to this plan

Table 9.2-1 Energy Intensity to GDP

	Previous Target	Reference Case
2000 - 2005	1.46	1.46
2005 - 2010	1.00	0.95
2010 - 2020	0.90	0.90
2020 --	0.80	0.87

In the National Energy Strategy drafted by MOIT in 2005, the national target of energy efficiency and conservation was set out as to reduce the energy consumption by 3-5% from the BAU case forecast for the period of 2006-2010 and 5-8% for the period of 2011-2015.

Sectoral targets are also set out such that the target of energy conservation in the manufacturing sector is to reduce energy consumption by 5% for the period of 2006-2010 and 8% for 2011-2015. For the residential and commercial sector, it is set to reduce 20% for all new buildings to be constructed in and after 2006. The summary of counter measures for the main sectors is as follows.

a) Industry sector

Key measures for the designated factories having a total energy consumption equal or more than 1,000 toe per annum, or having an electric capacity equal to or more than 500 kW or an electricity consumption equal or more than 3,000 MWh are;

(1) Introduce new technologies, improve energy management and replace and upgrade equipments

(2) Introduce high efficient equipments and replace low efficient ones

(3) Improve technologies and convert to high efficient equipments

(4) Develop technologies to manufacture low energy consumption equipment and devices

(5) Introduce tax incentive for energy saving

b) Transport and Communication sectors

Key measures on the planning and policy making for transportation and communication are;

(1) Promote transport by railway and waterway instead of road

(2) Construct subway and overhead railway systems in Ha Noi and Ho Chi Minh cities

(3) Develop transportation network such as road, waterway, railway and pipelines

(4) Promote use of high efficiency vehicles, and remove low efficient ones

(5) Promote developing LPG transport networks with tax incentives for investment

c) Residential and Commercial sectors

Key measures for the designated commercial buildings (supper market, hotel, office building, etc) or residential buildings of multiple stories with electricity supplied by a substation with capacity of 750kVA or more, or with consumption of total commercial energy equal or more than 10 million MJ are;

(1) Develop plans for introducing efficient use of energy on design and construction of new buildings

(2) Implement DSM programs

In addition to the energy conservation on the demand side, energy conservation and efficient use on the supply side is also important. In particular, in the electric power sector where certain supply capacity is established and substantial addition will be required in future, there are many subjects to be considered such as reduction of loss in transmission and distribution, own-use at power plants, efficiency improvement of generation system, and so on. However, these subjects on the supply side should better be discussed as the target of energy industry rationalization.

9.2.2 Plans for Promoting EE&C (Energy Efficiency and Conservation)

The following six (6) elements are defined in the National Program with regard to promotion of EE&C; their objectives are as follows.

1) To strengthen the government control on economic and effective use of energy, organizing the management system to effectively promote and manage EE&C.

2) To enhance education, public relations, public awareness for promotion of effective use of energy

and environment protection.

3) To develop energy efficient and high-productivity facilities and eliminate low-productivity facilities step by step.

To reduce the national energy consumption by 3-5% for the period of 2006 - 2010 and 5-8% for the period of 2011 - 2015 compared with the BAU case (namely, 5 million toe in 2006 - 2010 and 13 million toe in 2011 - 2015) in the Base Case.

4) To implement EE&C campaign in the industrial sector.

To reduce energy consumption by 5% or 2.6 million toe in 2006-2010 and 8% or 5 million toe in 2011-2015

5) To promote EE&C campaign in the building and construction sector.

To introduce rules and regulations regarding energy efficiency and to tighten the standard to achieve 20% energy conservation at new buildings. Building rules should be applied to all the buildings to be constructed in and after 2006.

6) To promote EE&C campaign in the transport sector.

9.2.3 Recommendations for promotion of Energy Conservation Plan

(1) International support on major projects

Several programs and studies on national energy efficiency and conservation were carried out since 1990s, though legal framework and institutions required for promotion of EE&C activities in Vietnam are just being considered in an initial stage. MOIT and concerning authorities are already working on the implementation of the National Program for EE&C, and about 20 projects amounting to one million dollars will start from 2007 funded by the national budget. However, in view that the current state is insufficient in terms of institutional building, human resource capacity and database for planning and implementation, it is apparent that technical cooperation and financial assistances from abroad are needed for the successful promotion of EE&C projects in Vietnam.

In view of the current status, it is strongly desired that Japan and other countries or international bodies should provide assistances on the following points.

1) Construction of a comprehensive EE&C promotion plan including realistic implementation programs

2) Construction of database on sectoral energy consumption

3) Reinforcement of EE&C management and audit ability at business entity level

4) Capability enhancement at business entity level on planning and management of energy consumption

5) Financial support for building-up of EE&C management system, enhancement of implementing ability, and strengthening of organization

(2) National and Sectoral Targets

At present, the measures taken by different sectors on energy efficiency and conservation and their effectiveness could not be assessed properly due to lack of data relevant to the energy consumption from each sub-sector. As the national target is set out to reduce energy consumption at 3%-5% by 2006-2010 and 5%-8% by 2011-2015 mainly with energy conservation efforts in the industry and transport sectors, we assume in this Study that, compared with BAU case, 10% energy conservation should be implemented by 2015 and 25% by 2025 in the Reference case. Nevertheless, the final energy consumption in the Reference Case is forecast to grow fast from 22.6 million toe in 2005 to 90.7 million toe in 2025 at annual 7.2%.

In 2005, energy consumption was distributed among industries as follows: manufacturing industry 46.7%, transport and communications 29.6%, residential 14.8%, commercial and services 5.9% and agriculture 2.5%. The composition is forecast to change in 2025 to 56.1%, 22.9%, 16.0%, 4.3% and 1.3%, respectively. The industrial sector will further increase its share. In addition, the electricity demand, which was 3.9 million toe and sharing 17.4% of the final energy consumption in 2005 is forecast to increase to 25.2 million toe in 2025 at annual 9.8%. Thus, the total amount of the energy required for power generation will increase substantially from 9.5 million toe in 2005 to 50.7 million toe in 2025 and its share in the total primary energy consumption from 33.7% to 43.3%.

From this observation, industry sector and power sector are the most important targets for the energy conservation policy of Vietnam. As we are not able to compare our study cases with the existing national target calculation, it is very important to establish a comprehensive energy conservation plan covering every important sector with coherent practicable implementation plans.

(3) Recommendations for promotion of the EE&C Plan

The EE&C activities may be able to achieve the goal through close collaboration of the government and the private sectors. It is essential to develop the following activities nationwide in order to reach the goal scheduled in the National Program and keep continuous follow-up activities.

a) Development of database system

According to the national program, the database needed for EE&C will be starting from 2007. At present, due to lack of know how on the method of data collection, contents and kinds of data, only insufficient data and information are available on the sectoral energy consumption as well as EE&C measures and examples of saving. In order to make it possible to evaluate the effect of energy conservation measures by comparison with other examples, it is necessary to establish EE&C database as soon as possible.

b) Implementation of nationwide EE&C and human resources/staff training

Strategies including a road map specified by the Energy Efficiency and Conservation Office of the MOTI, call for establishment of EE&C Offices by 2008 as a part of a government organization in eight (8) provinces and cities, together with the establishment of a network for the implementation and operation, and also a network for testing of electric appliances in the north, central and south regions.

At present there are some centers such as the Energy Conservation Center in Ho Chi Minh City and Science Technology Progress Application Center in Da Nang City operating on EE&C. However, even such active centers are facing lack of personnel/staff suitable for technical support, and this has in turn delayed implementation of the plans that had been scheduled.

Therefore, priorities should be given to securing necessary work force and career development of personnel to conduct technical education and training on EE&C management and use of EE&C equipments and apparatus. The trained personnel would then be allocated to other EE &

C centers to promote the campaign further.

c) Model case selection and performance evaluation

For comparison and evaluation on the results of EE&C activities by sector, it is recommended to select some model programs or projects applicable to the industry and commercial/residential sectors, as mentioned in the National Program. This shall accompany establishment of models for energy saving at households and establishment of energy management (EM) system at enterprises.

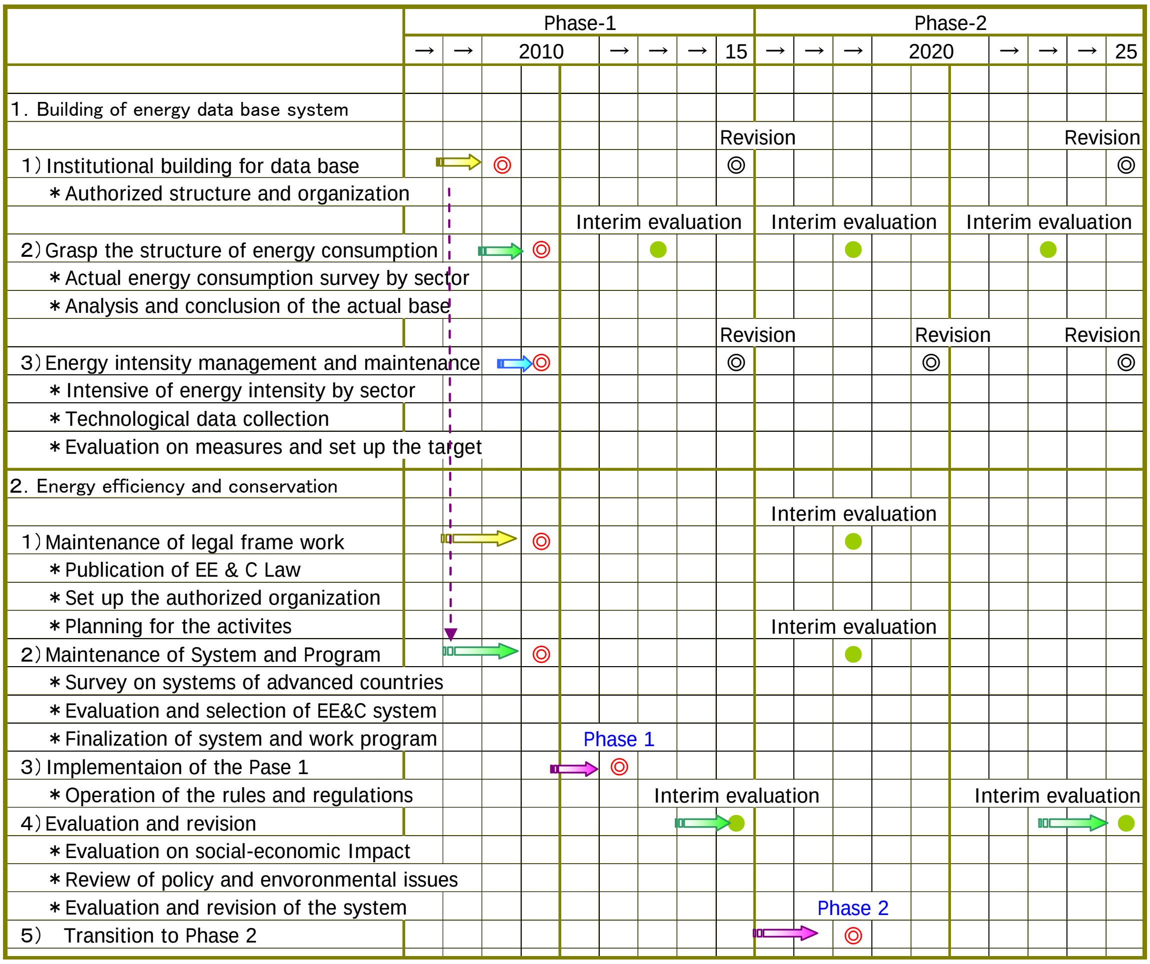


Figure 9.2-1 Road map 2: Promotion of Energy Efficiency and Conservation

At present, a region-wide campaign is being promoted in ASEAN countries on the labelling program for home appliances and energy efficiency products. Together with these programs, it is important to evaluate outcome of the model projects and set out energy efficiency standard of equipments and appliances in Vietnam, which will surely contribute to establishment of models for energy conservation and energy management systems.

d) Promotion of public awareness on energy efficiency and conservation

Although education and publication of information relevant to EE&C are being promoted, it has not yet reached a sufficient level of penetration into the end-users and/or energy consumers.

In parallel with the "education on energy efficiency and conservation in the national education system", as indicated in the National Program, it is recommended to enforce activities for presentation and provision of additional information to end users and consumers. Furthermore, it would be effective should power companies, gas/oil companies and home appliances manufactures collaborate providing information on energy efficiency and conservation to the public at their sales shops or business centers.

9.3 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 energy industry 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 the 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 player in the market, appropriate measures should be taken in the following areas.

1) Government role and businesses in the energy sector
2) Energy sector reform and modernization
3) Energy price policy to promote rational and efficient energy market

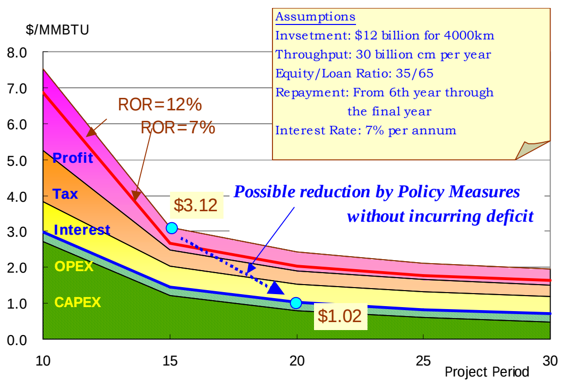
9.3.1 Government Role and Businesses in the Energy Sector

As discussed in the previous chapter, in considering policies to realize stabilized energy supply/demand balance and efficient use of energy such as promotion of indigenous resource development, construction and development of energy supply infrastructure, measures to prepare for energy import increase, energy related technical research and development, energy efficiency and conservation, and so on, it is most important to clearly divide and define the roles of the government and the private sectors in implementing these measures. Then, the both sectors should collaborate to implement them.

In this consideration, the roles of the government sector will be as follows. [30]

1) To set forth the Grand Design of socio-economic development and the goals of sectoral development plans

[30] For example, the following chart shows economics of a long distance gas pipeline that is very capital intensive. In such cases of constructing energy infrastructure, there is a big room for the government sector to assist improving economics for example provision of low interest loans and back guarantees, etc.



2) To set forth strategies, policies and guidelines to realize these goals

3) To pave the way for introduction of necessary technology and fund, and to promote research and development

4) To implement or assist businesses with high social requirement but low commerciality

As we have discussed on the above in 9.1, it is necessary to prepare comprehensive policies sorting out the process to follow and the role of the government on core and gigantic energy supply projects that the government sector should implement; on the latter, candidate projects may be those that require longer time, huge funds and high technology as follows.

1) Development of Energy Infrastructure

- Development of the transportation/delivery system of domestic and import coal such as ports, coal centers, railways, waterways, etc.
- Development of the transportation/delivery of petroleum products such as ports, oil import terminals and depots, railways, waterways, etc.
- Construction of natural gas pipelines and LNG import terminals
- Development of trunk transmission lines

2) Reinforcement of Energy Security

- Efficient development of domestic energy resources
- Construction of strategic oil stockpiling
- Development of oil and coal import terminals that are technically compatible with those in neighboring countries for accommodation in emergency response
- Reinforcement of international cooperation and cross-border energy exchange including natural gas pipeline and power interconnection

3) Harmonization with environment

- Development of hydro and thermal power station sites
- Promotion of nuclear power generation
- Promotion of new and renewable energies

With regard to these businesses, it is desirable to set out the principal government policy and implement them in due course by around 2010. It is desirable to introduce vital power of the private sector effectively and minimize the role of the government sector.

9.3.2 Energy Sector Reform and Modernization

As energy demand of Vietnam is expected to grow substantially in future, in order to ensure sustainable development of its economy, it is essential to secure stable supply and effective use of energy. To realize this, it is desired to conduct energy sector reform and modernization taking account of the global trend. At present, equitization of state energy enterprises are in progress though minimum 51% stake is withheld by the state; everybody is watching out to what extent equitization or privatization would be implemented.[31] In Vietnam where the energy sector is still in infant stage, existence of powerful energy enterprises is very important that own seaworthiness against rough

[31] It is also an issue how to treat the state shares in the various subsidiaries of the state firms.

fluctuation of the international market and work to stabilize the domestic market. On the other hand, it is another concern how private firms would be brought up to be competent for competition or complements with state firms such as VINACOMIN, Petrovietnam and EVN, or how participation of foreign firm would be progressed.

In assessing the issue, it is important to clearly define the roles of government sector to respond to social needs and the role of non-government (private) entities. And it is also important to utilize market principles to a maximum extent in promoting efficiencies. For example, one of the vital roles of government in the power sector is formation of strong organizational structures to guarantee development of power infrastructures to accommodate increasing power demand, supervision and periodical review of project development progresses, and selection & development of projects by ODA or self-financing that is difficult to be developed by private entities. In terms of deregulation, decision is already made in the Prime Minister Decision in 2006 on expansion of the deregulated business areas by three steps and orientation of power market. In this deregulation process, EVN is going to be equitized and split up. Too rapid deregulation and structuring reform may, however, disturb stable and reliable power supply, and thus, special attentions should be paid to the following two specific characteristics of the power sector.

1) Scale economy strongly works in power business

2) Power supplier shall have capability to meet different requirements of the base, middle and peak demands comprehensively assuring the nationwide balance

3) Provision of universal service as social goal shall be set and guaranteed

In addition, development of power sector brings great impacts on various aspects of society, i.e. creation of natural gas market, promotion of renewable energy utilization, energy import policy from national security's point of view and regional economy development policy. Therefore, power sector development shall be examined from national point of view rather than from viewpoint of individual projects or the power sector only.

In case public entities prevail as a business operator, the following problems are generally considered as anticipated obstacles to realization of the rational and efficient market;

1) Government directives might be made neglecting efficiency and fairness.
2) While it is quite common that conflicts of interests exist between the regulating and the regulated bodies, they would be compromised within the same organization. Thus, it would be hard to produce a transparent and rational solution.
3) The state enterprise would continue to be dominant as a huge monopoly body with an advantage of controlling the existing business and having market penetrated information.

Despite these anxieties, it is true that the Vietnamese state energy enterprises are playing important roles for securing stable energy supply and developing the country's energy sector. Thus, reform of the energy sector should be implemented paying careful consideration on the following points.

1) To consider an appropriate speed that dispersion of strength of state enterprises should not prejudice the stable operation and development of the energy system.
2) As economics of scale works strongly in the energy sector, appropriate government guidance is necessary in the sector until the energy market reaches certain scale.

As the eventual goal of the energy sector reform may be creation of liberal market that assures free activities of business players, it would not be very difficult or remote as the Vietnamese energy market is expanding rapidly. In this process, it is necessary to clearly divide and define the business areas and business styles between the businesses under control and support of the government and the general private businesses with fair and transparent rules. Progressing energy market deregulation via equitization and privatization, we should at first set out the goal and the implementation process, and, after implementation, should conduct periodical review and adjust the policy goal and implementation schedule, if necessary.

9.3.3 Price Policy to Promote Rational and Efficient Energy Market

As we move from the system of direct market control via state firms to the system to let the market decide the energy demand and supply balance, we need to set out clear rules to assure fair and efficient competition under a guideline to propagate the norm assumed according to the social requirement. As the energy import dependence increases, Vietnam would be put under increasing impact of the international energy market. In order for the Vietnamese economy to reinforce the resistant ability against it, it is desirable to advance internationalization of the domestic energy price and enhance power of businesses under more competitive conditions. Any barriers to this purpose, such as import duties, differentiated quality standard, limitation of access to transportation infrastructure, etc., should be phased out as far as possible.

At the same time, rules on the product standard and environment regulation should also be applied strictly. At present, the Vietnamese market is infested with imitation goods neglecting copyright and license, such as in the motorbike market, allowing extremely low energy efficiency. The petroleum products supplied in the local market are far behind the global standard causing air pollution and inefficiency. If all the market participants were not to observe the common rules, bad money would expel good money, and we would not be able to achieve the ultimate social goal. To thoroughly enforce these rules, it is a general approach to control the supply channels, and therefore the energy supply companies should be put under strict surveillance and observation.

At present in Vietnam, prices of coal and natural gas that are produced locally are at substantially low levels compared with international prices, while prices of petroleum products that are procured entirely from abroad are at the international level. Such distorted energy price system would in turn distort the market system and the energy structure. In view that Vietnam will sooner or later turn into a net energy importing country, and considering the aforesaid impacts, it is essential to internationalize the energy price.

The electricity tariff system of Vietnam has deeply maintained the social policy aspect of guaranteeing life of people above the subsistence level. This aspect is of course important in providing universal services to people, while, in view of the recent quantitative and qualitative changes in the power demand, it is required to gradually adopt such tariff system that reflects economic principles in order to realize rational and efficient power consumptions and achieve sustainable development. As the first step, the electricity tariff shall adequately cover the development cost of power infrastructures. As the second step, competitive principles shall be introduced to the tariff system along with progress of deregulation.

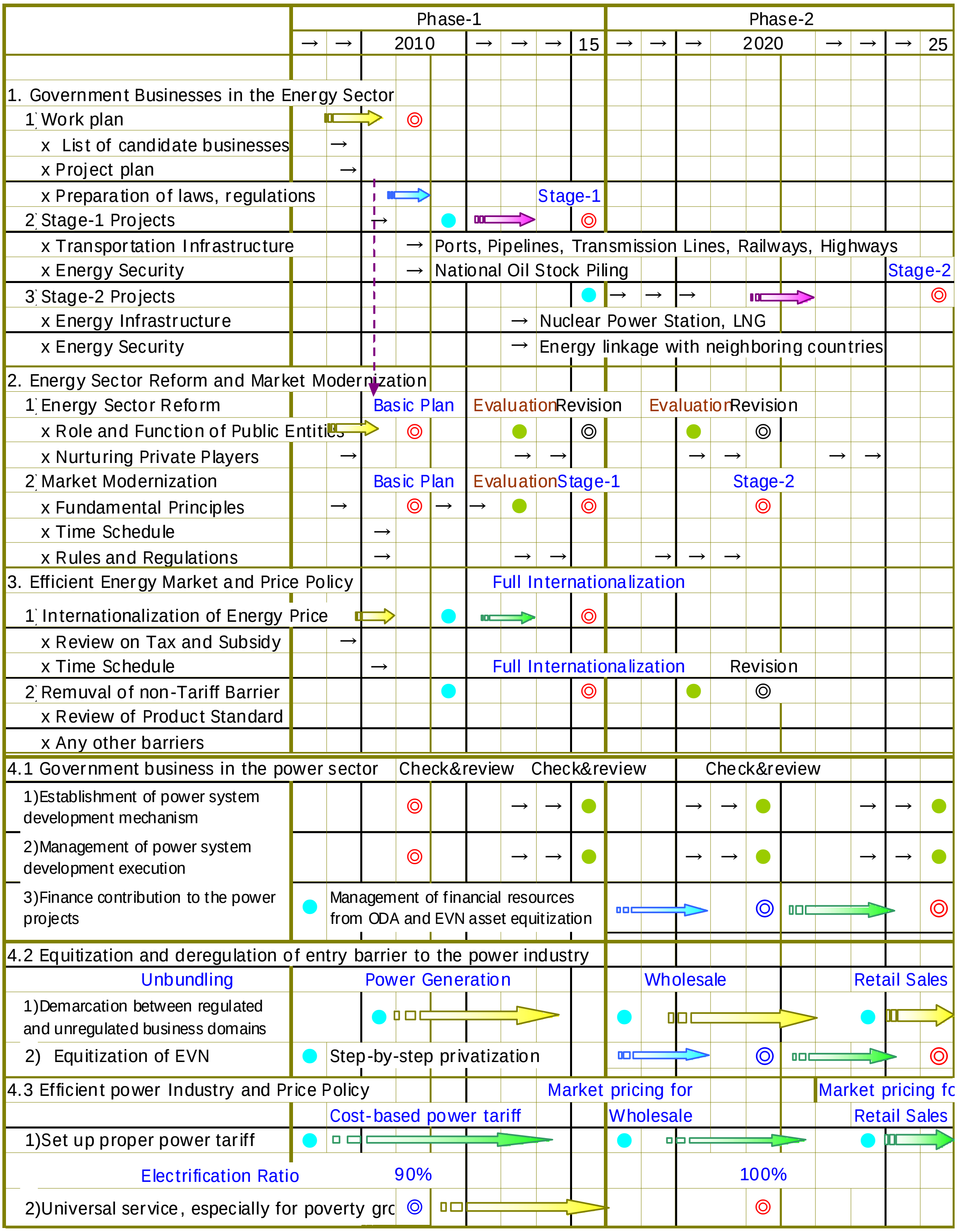


Figure.9.3-1 Road map 3: Modernization of Energy Market and Energy Industry Policy

From this viewpoint, it is set as a goal of this Master Plan to achieve the internationalization of the energy price by 2015. Toward this target, we need to conduct study on review of the tax and subsidy system, and prepare the price adjustment schedule.

Incorporating the foregoing investigation, the roadmap for modernization of energy market and energy industry policy is prepared as shown in Figure 9.3-1.

9.4 Major Investment in the Energy Sector

In this section, preliminary amount and timing of required investments in energy facilities of coal, power, oil, and renewable energy sectors are examined. 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 coal reserve and coal production plan. Required investments for 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.

9.4.1 Coal Sector

(1) Expansion of Coal Production Capacity

The goal of expanding coal production capacity is set to target only the Quang Ninh coalfield in the northern region, excluding new coal development of the Red River coalfield. Capacity will be increased 35 Mtpa from the current 45 Mtpa to 80 Mtpa in 2025, one third of which comes from expansion of the existing coal mines, and a half from new coal mine development. Expansion and construction of coal mines will continue through to 2025, and the total investment is estimated to be approximately US$ 4.6 billion. The investment amount includes a cost for expansion of the existing mines, development of new mines, resources exploration, land reclamation, equipment for mining, roadway development, machinery and electricity, transportation infrastructure, power and water supply, and so on.

(2) Coal Preparation

Direct burning of raw coal brings various problems at utilization, as it accompanies ash as unburned matter and emission such as SOx, NOx and PM. There are numerous benefits in coal preparation such as improving heat efficiency, decreasing emissions and so on by removing foreign materials as much as possible.

Coal preparation equipment should be expanded with a major target on the Quang Ninh coalfield in the northern region. Preparation system should install the advanced wet type preparation equipment as same as the second plant of the Cua Ong preparation plant with raw coal preparation capacity of 6.5 Mtpa. In addition to expansion of the existing preparation plants, it is assumed that seven preparation equipments in total with raw coal preparation capacity of 10 Mtpa each will be installed. A term of construction is 2009 to 2025, and the amount of construction cost is estimated to be about US$ 840 million, or US$ 120 million each times seven units. The estimated cost includes those required to construct facilities on coal preparation, wastewater treatment, waster rock processing, and coal transportation infrastructure such as rail, road and belt conveyor inside of the site.

(3) Environmental and Social Consideration in Coal Development

Coal development in Vietnam is mainly open-cut system and gives certain impact on forestry resources, agricultural lands and, in some cases, residential areas. In addition, as impacts on air and water quality by dust is anticipated near coal mines and terminals, coal development should be promoted with utmost care.

9.4.2 Power Resource Development

(1) Generation Facilities

Data on construction cost per kW by fuel type obtained from IE and the total capacity of the Reference Case is referred to in order to calculate the total investment cost for 20 years from 2006 to 2025. Among costs for power plants, hydropower and coal thermal are very large. However, all the hydropower potential may be developed by 2020 and domestic coal thermal development will not increase due to constraints on the domestic coal production capacity. After 2025, nuclear, import coal and import gas through pipeline or LNG shall be the major power resources.

(2) Network Facilities

Cost for constructing the transmission lines, distribution lines and substations are obtained from the PDP6 Pre-Study and they are used in the calculation for Table 9.4-3. This amount may be a bit excessive against the power demand of the Reference Case (323TWh in 2025), since the total investment amount is estimated against the power demand of more than 400TWh in 2025. To estimate the cost more accurately for the Reference Case, a specific analysis should be conducted incorporating various data and information on generation capacities, locations, start-up year, demand distribution and so on.

(3) Coal Terminal

Coal Terminals will be constructed basically at seacoast and/or island in the southern region as coal transshipment stations for the import coal-fired power stations. The scale of a coal terminal should be sufficiently large to receive and transship overseas coal of 20 Mtpa or so. Construction schedule will be research and design in 2009 to 2010 and construction in 2011 to 2019. The construction period may be divided into two stages; for the first stage of 2011 to 2013 the handling capacity will be 10 Mtpa and it will be expanded in the second stage of 2017 to 2019 by additional 10 Mtpa, bringing the final handling capacity to 20 Mtpa. The amount of construction cost is estimated at approximately US$ 500 million by reference to a coal terminal project in Australia. It includes a berth which is able to accommodate two cape sized vessels of 150,000 DWT and three handy sized ships of 15,000 DWT simultaneously, dredging work along the berth and of the shipping route, coal stock yards, unloaders and stackers for unloading, reclaimers and ship loaders for loading, belt conveyers for transportation.

(4) Environmental and Social Consideration in Power Facility Development

Construction of power stations gives great impact on environment and regional society. Among them, hydropower and renewable energy power stations may cause impacts on agricultural and forestry resources and removal of residential land for construction of dams or other preparatory work. They may, however, contribute for electrification of remote provinces as well as curbing fossil energy consumption and GHG emission. Construction of thermal power stations will accompany the greatest burden on the air and water quality in the adjacent area, together with another concern on GHG emission. However, such large scale facilities are definitely required to ensure stable electricity supply essential for regional industrialization, development of commercial sector and social facilities, and better quality of life. In case of nuclear stations, prevention of radioactive contamination, disposal of used fuel and radioactive wastes are the most important issue, while they are beneficial compared with thermal stations in terms of stable fuel supply and GHG emission control. Electric power development plan should be formulated examining pros and cons of sources including their impact on environment and social consideration.

9.4.3 Oil Sector

(1) Refinery

Following the 1st refinery currently under construction at Dung Quat in the central region, scheduled to start in 2009, 2nd and 3rd refineries[32] are planned in Vietnam. The 2nd refinery will start in 2015, and its construction cost is estimated to be about US $2.5 billion. Currently, start up schedule of the 3rd refinery is not uncertain.

Construction cost of additional refineries will substantially increase compared with the 1st refinery in order to install production facilities for high quality motor fuel and hydro-cracking or hydro-desulfurization units to cope with increasing import of the Middle East high-sulfur, heavier crude oils. Suppose that the refinery capacity would be upgraded to 200 thousand BPSD to be fully competitive internationally, and that the product composition is same as the 1st refinery, construction cost will increase by $700 million to around US$ 3 billion each for the 2nd and 3rd refineries.[33] As discussed in Chapter 6, since the petroleum products supply balance will remain as export position after start-up of the 2nd refinery, star-up timing and plant size of new refineries should be carefully examined taking account of the market condition in the neighboring countries.

(2) Strategic Oil Stockpiling

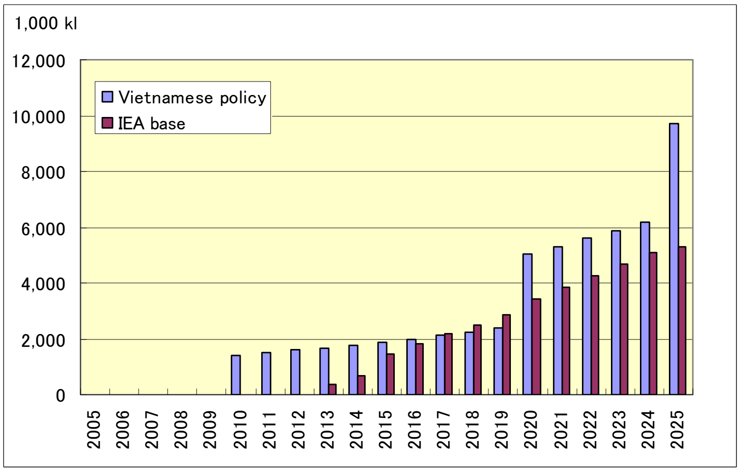
The amount of strategic oil stockpiling that is examined in Chapter 6, is calculated in line with the plan of “National Energy Policy”[34] (please refer to 3.1.2.1) and its volume is calculated based on the daily oil consumption of Vietnam. As the result of the calculation, the volume of strategic oil stockpiling in 2025 reaches about 10 million kl (m^3). On the other hand, IEA member countries have legal obligation to hold emergency oil reserves equivalent to at least 90 days of net oil imports of the previous year. The Vietnamese target of oil stockpiling is higher than the IEA’s obligation standard. Figure 9.4-1 shows a comparison between Vietnamese target and IEA based quantity. According to Figure 9.4-1, the target of Vietnam is almost double the IEA standard. Though strategic oil stockpiling is very important for energy security, it cannot generate income unlike power plants and

[32] While the 1st refinery is designed and under construction with the capacity of 6.5 million ton per year (148 thousand BPSD) basis, the 2nd refinery is planned in Nghi Son, Northern region of the country, and the Detailed Feasibility Study has been executed based on 7 million ton per year (155 thousand BPSD)capacity. The 3rd refinery, though timing is still pre-mature, is said to be constructed near HCM area in the South.

[33] As cost estimation run in 2006 is used in this report, construction cost of oil related facilities is soaring fast.

[34] Target of Strategic Oil Stockpiling in Vietnam is 30 days of daily oil consumption up to 2010, 60 days of daily consumption up to 2020, and 90 days of daily consumption after 2020.

refineries. Moreover, there is a possibility that it would strangle the government finance because of huge investment and maintenance costs. Therefore, in this section, required investment of strategic oil stockpiling is estimated roughly based on the IEA standard reducing the financial burden of Vietnamese government. In case the Vietnamese target were applied, the total required investment would be about double of this estimation.



(Note) Target of oil reserve in 2025 is assumed as 90 days (In Vietnamese policy, 90 days of daily consumption after 2020)

Figure 9.4-1 Comparison between Vietnamese target and IEA base

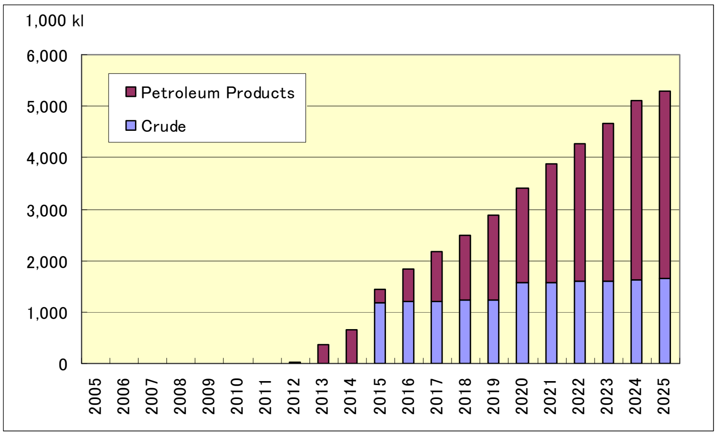


Figure 9.4-2 Share of Oil Stockpiling

Table 9.4-1 Share of Oil Stockpiling

1,000 kl

	Crude	Petroleum Products	Total
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	0
2010	0	0	0
2011	0	0	0
2012	0	21	21
2013	0	354	354
2014	0	662	662
2015	1,187	251	1,438
2016	1,198	624	1,822
2017	1,214	967	2,181
2018	1,228	1,268	2,496
2019	1,244	1,637	2,881
2020	1,563	1,841	3,404
2021	1,573	2,297	3,869
2022	1,587	2,688	4,274
2023	1,604	3,069	4,673
2024	1,623	3,492	5,115
2025	1,642	3,640	5,282

Tanks for crude oil are larger than those for petroleum products and the construction cost of crude oil tank is about a half of that for petroleum products because of scale merit. For calculation of the investment amount, the ratio of crude oil and petroleum products for oil stockpiling is assumed that the quantity equivalent to the 90 days processing of the imported crude oil at the 2nd refinery should be crude oil and the balance should be petroleum products (please refer to Table 9.4-1 and Figure 9.4-2). It should also be noted that the necessary tank capacity for oil stockpiling is about 1.3 times of the actual volume to be stored considering the storage ratio at 80% and the dead stock[35] at 10% of the capacity as shown in Table 9.4-2.

Table 9.4-2 Necessary Tank Capacity of Oil Stockpiling

1,000 kl

	Crude	Petroleum Products	Total
2015	1,700	350	2,050
2020	2,300	2,600	4,900
2025	2,300	5,200	7,500

The construction cost of the oil stockpiling facility is estimated based on the Japanese experience and local factors of Vietnam. These costs including incidental facilities such as oil fence and others are US$340/kl for petroleum products and US$180/kl for crude oil. The oil stockpiling is assumed to be located in adjacent refineries as the facilities of refinery such as berth, terminal, and safety equipments could be shared. Therefore, the above costs do not include berth, terminal, and safety equipments that would be required for construction at independent locations. Table 9.4-3 shows the necessary tank capacity and required investment costs for oil stockpiling.

Table 9.4-3 Necessary Tank Capacities and Required Investment of Oil Stockpiling

	Crude		Petroleum Products		Total	
	Tank Capacity (1,000 kl)	Required Invest (million US$)	Tank Capacity (1,000 kl)	Required Invest (million US$)	Tank Capacity (1,000 kl)	Required Invest (million US$)
～2015	1,700	310	350	120	2,050	430
2016～2020	600	110	2,250	770	2,850	880
2021～2025	0	0	2,600	880	2,600	880
Total	2,300	420	5,200	1,770	7,500	2,190

The costs mentioned in Table 9.4-3 do not include purchasing costs of crude oil and petroleum products. Purchasing costs of the oil per kilo-litter is higher than the construction cost of the oil stockpiling facility. The FOB price of crude oil is about three times as much as the construction cost of crude oil tank and the FOB price of petroleum products is about two times of the tank cost for petroleum products.

(3) Environmental and Social Consideration for Oil Related Facility Development

In case of constructing oil refineries and depots, issues relating to environmental and social consideration may arise in conversion of agricultural land for industrial use, burden on air and water quality during land reclamation, facility construction and operation, and GHG emission. These facilities on the other hand contribute greatly to stable supply of good quality fuel to the society, and regional promotion of relevant industries such and chemicals and increase of employment. In

[35] A part of oil tank under the bottom shipping valve.

developing oil related facilities, they should be designed to minimize their environmental burden through EIA and in harmony with regional development plans.

9.4.4 Renewable Energy Facility

As investment cost for Bio-Ethanol/Bio-Diesel plants depends heavily on kind of biomass as feedstock, conversion technology and future technology development, it is not easy to estimate the necessary investment amount from long term viewpoint. In this chapter, though an example of investment cost is presented referring to examples in Europe, it is necessary to conduct the detail analysis and periodical review to be more accurate.

At present, while no serious environmental impact is anticipated in Vietnam with regard to development of renewable energy, power generation by wind, micro hydro and PV is expected to contribute for electrification of non-electrified provinces and control of fossil energy consumption. However, in developing them, proper consideration should be paid on impacts on agricultural land forest, and, in case of biomass project in particular, on water quality.

Table 9.4-4 Investment Cost of Bio-Ethanol/Bio-Diesel

	Year	2010	2015	2020	2025
Bio-Ethanol	Supply Volume (kl/year)	11,879	29,023	52,934	128,340
	Unit Investment Cost (US$/kl-year)	303			
	Investment Cost (Million US$)	2007-2010	2011-2015	2016-2020	2021-2025
		4	5	7	23
Bio-Diesel	Supply Volume (kl/year)	-	30,040	61,673	106,815
	Unit Investment Cost (US$/kl-year)	340			
	Investment Cost (Million US$)	2007-2010	2011-2015	2016-2020	2021-2025
		-	10	11	15

(Source) Compile from "EUROPIAN COMMISION: Energy Scientific and Technological Indicators and References" and "Department for Transport, U.K.: International resource costs of biodiesel and bioethanol"

9.4.5 Investment Amount in the Energy Sector

Based on the above discussion, the roadmap and the required amount of investment in the energy sector are summarized in Figure 9.4-3. As the indicated investment amount 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 $100 billion, 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 system 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, it is still not huge. Considering the substantial effect on the energy import ratio and environment, it is important to promote investment in renewable energies systematically.

(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** 15 million ton/y coal terminal	**350**	15 million ton/y coal terminal	800
3. Oil sector					**12,190**
1) Refinery		7 million ton/y No.2 refinery **5000**	7 million ton/y No.3 refinery **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 9.4-3 Roadmap-4: Required Investment of Energy Sector

Chapter 10 Action Plans for Energy Sector

In this chapter, sectoral action plans on key issues will be proposed for further discussion to delineate work plans projected in roadmaps as explained in the previous chapter.

10.1 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.

10.1.1 Goal of Energy Conservation

In the Government Program on EE&C promotion, energy conservation of annual 1%-2% is applied to the BAU case demand forecast, which will reduce the energy consumption by 3%-5% during the period of 2006-2010 and 5%-8% during the period of 2011-2015, and to reduce the energy intensity to GDP to 0.8 after 2021as its goal. In the BAU Case of this study annual 1% energy consumption is assumed, which is similar to the foregoing government goal. As discussed in Chapter 4, however, energy conservation of this level may progress naturally in the light of experiences in developed countries. Then, further energy conservation efforts of annual 3 - 4% is assumed for the Reference Case via promotion of EE&C campaign and introduction of advanced technologies and facilities. In this case, the goal of energy conservation is to reduce energy consumption by 10% in 2010 and 25% plus in 2025.

At present, we do not have objective data to decide if the foregoing goal is appropriate. However, as shown in Figure 8.2-3, this goal is targeting to lower the energy intensity of Vietnam, which is relatively high, only to the average trend of ASEAN countries and hence not unrealistic. Nevertheless, it is desirable to set out more realistic and reliable goal. To this end, we recommend formulation of an EE&C master plan examining the current plan and further developing discussion on sectoral potential, economic structural change, evolution of life style and other factors.

In order to materialize the above goal, it is necessary to pave the way for action by 2010 on the following items.

1) Construction of database on energy consumption by sector
2) Capacity development on planning, administration and auditing at the government
3) Capacity development on energy management at enterprises and firms
4) Preparation of system/institution for R&D of EE&C
5) Human resource development and training for EE&C administration
6) Setting up of bodies responsible for public relations and education

After the above preparation, action plans should be implemented one by one in the Phase-1 period of 2007-2015. Then, reviewing the result and enhanced program, the EE&C activities shall move into Phase-2 period of 2016-2025.

When we look at the energy supply for electricity and other energy supply for direct use, oil and electricity share three quarters of the total primary energy supply and electricity will increase its share as modernization of society progresses. In this sense, it is important to consider energy conservation in terms of oil and electricity consumption quantity.

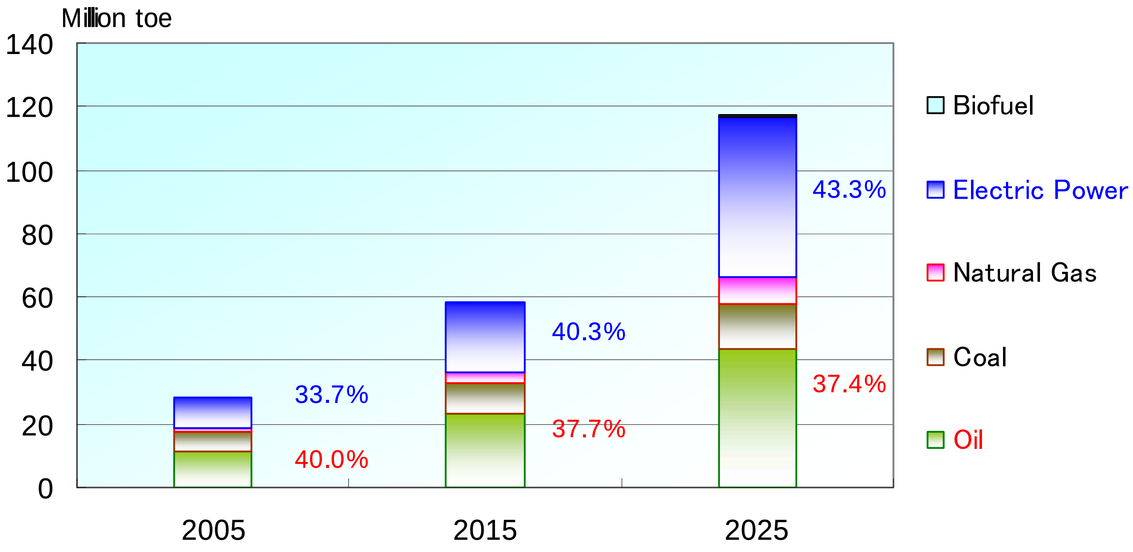


Figure 10.1-1 Primary Energy Supply: Electricity and Others

10.1.2 Institutional Framework for Promotion of Energy Conservation

At present, both of the core government offices, Energy Efficiency and Conservation Office of MOIT and local Energy Conservation Centers, are suffering from shortage in manpower for promotion and administration of the EE&C activities. In order to establish an appropriate implementing system, it is at first necessary to conduct human resources training and enhance capabilities on planning, administration and auditing. In addition, to promote the activity under collaboration of government and private sectors, it is also necessary to develop organizations in the private sector that shall be responsible for implementation and administration of EE&C activities. ESCO companies may be able to contribute with their professional know-how and services on EE&C, too. As such, it is needed to establish the promoting system under government/private collaboration earliest possible by establishing organizations and training manpower at various levels.

10.1.3 Major Action Plans

For materialization of the foregoing goal, the following actions should be taken elsewhere in government and private sectors.

(1) Government Sector

At the government level, policies and institutions for EE&C should be prepared in accordance with the policy objectives and timetable set out in the EE&C plan to promote efforts of the private sector as well as to give appropriate advices and instructions. Major items of the action plan may include followings.

a) Formulation of legal framework on EE&C applicable to all activities.

During the period of 2008 - 2010, EE&C Law should be enforced, EE&C plans formulated and database created for implementation of EE&C. The legal system on EE&C covering every sector such as government, private firms and public services should be completed during the period.

b) Campaign to increase awareness on EE&C

Public awareness should be promoted through school education and community activities on energy efficiency and conservation. At the same time, EE&C information should be provided to energy consumers by energy related enterprises such as power, oil and gas companies and home appliances/equipment manufactures and sales shops.

c) Development of efficiency standards and energy labeling programs

During 2007-2010, launching program and testing system on energy efficiency, survey on energy consuming appliances shall be conducted to classify them by type and efficiency levels. In particular, Minimum Energy Performance Standard (MEPS) should be set out targeting specific products (fluorescent lamps, ballasts for fluorescent lamps, electric fans, electric motors, air conditioners, refrigerators) and the list of high efficiency products should be publicized.

d) Education and training courses for designated energy users on EE&C

Designated energy consumers should appoint qualified energy management personnel for implementation and operation of EE&C program and ensure effective use of high efficiency equipments. A qualification system for energy management personnel should be prepared by 2010, and, at the same time, system to provide periodical training or seminar for technological update should be established.

e) Technical assistance for energy users

By 2014, information system should be established to collect data and information on high efficiency equipment and EE&C technologies, dissemination of experiences from domestic and overseas on energy saving and effective use. Also, the conditions should be set out for introduction of new equipment and/or application of new technologies to be applied in the latest national standard.

f) Establishment, selection and evaluation on EE&C model cases

By 2014, applicable energy management (EM) systems for the industrial sector and EE&C project for buildings in commercial and residential sector should be set out. Analysis on these models should be publicized and recommendations shall be made to boost adoption of efficient systems and models and/or renewable energies.

g) Introduction of Energy Services Company (ESCO) business

Introducing ESCO business, consulting services should be provided to energy users on facility/equipment/system diagnosis, operation system maintenance and appraisal of effective measures to achieve EE&C. It is recommended to introduce a national qualification system for the ESCO businesses by 2010.

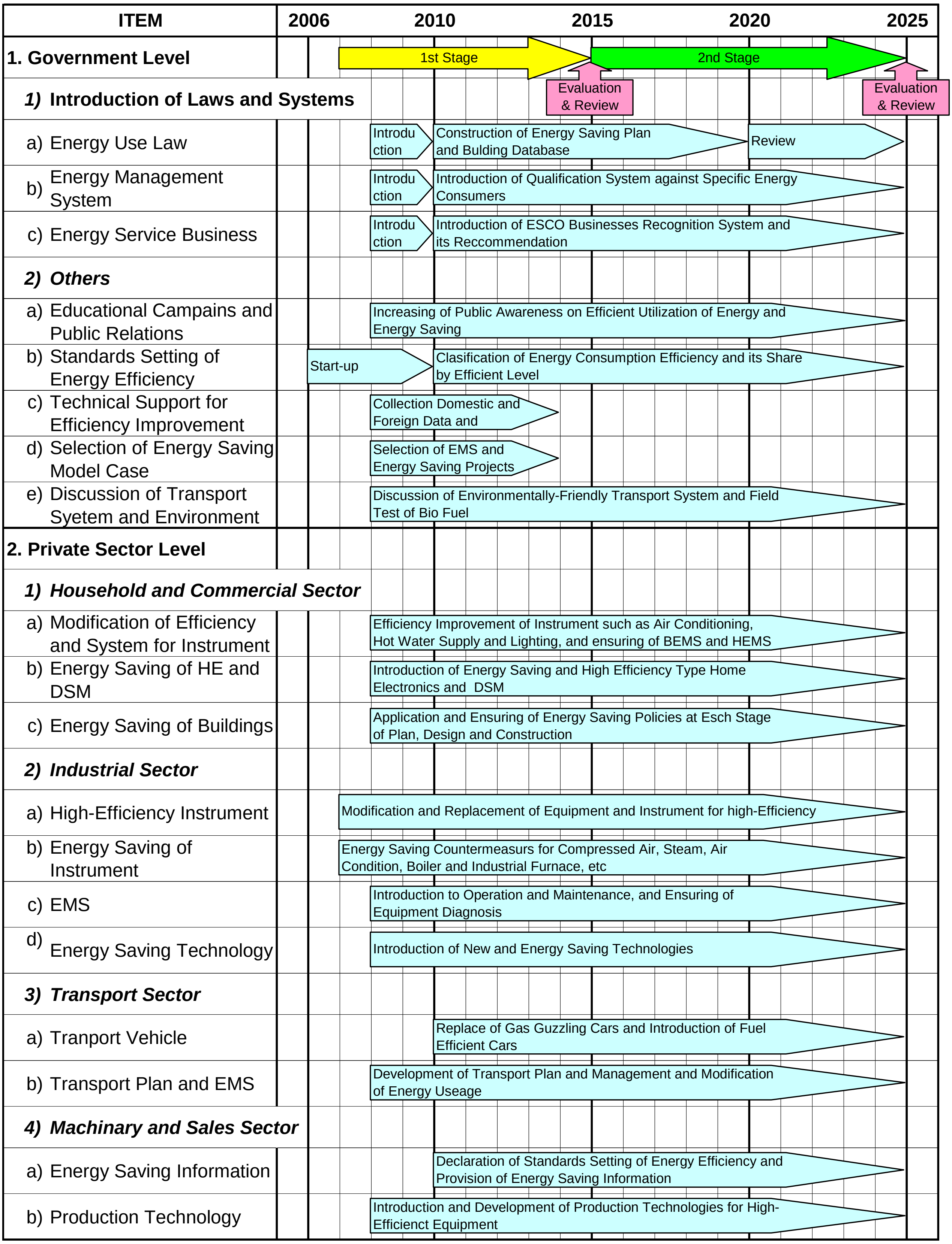


Figure 10.1-2 Action plan for the Energy Efficiency and Conservation

h) Study on transport infrastructure to minimize fuel consumption and reduce emissions

Studies should be carried out on energy saving through effective use of transport network, including roads, waterways, railways, airports and ocean ports, rationalization of transport infrastructure, and development of high-capacity facilities for cargo and passenger transport. A trial model project should be developed for use of bio-fuels as an alternative energy to reduce air pollution.

(2) Private Sector

In materialization of EE&C, government-private collaboration is essential. In order to realize the national goal, the private sector should implement EE&C measures as set out below during the period up to 2010 following legal and institutional preparation to be made.

a) Residential and Commercial Sector: Designated Buildings

1) Improvement on cooling, heating, ventilation and lighting system (Building Energy Management System: BEMS and Home Energy Management System: HEMS) for designated buildings and residential projects.

2) Introduction of energy-saving appliances into household and commercial buildings, along with implementation of DSM system.

3) Design, construction and operation and maintenance (O/M) of designated buildings in compliance to the Building Code.

b) Industrial Sector: Designated Factories

1) Renewal and renovation of existing equipment and facilities to high efficiency ones.

2) Introduction of energy saving technology and other EE&C measures on boiler and industrial furnace as well as equipments on steam supply system, compressed air system and air conditioning system.

3) Introduction of Energy Management system into designated factories.

4) Introduction of new EE & C technologies and advanced expertise into designated factories.

c) Transport Sector: Carriers and Cosigners

1) Replacement of low efficiency vehicles and introduction of low fuel vehicles

2) Improvement of transport and communication system

d) Machinery and Equipment Manufactures, Sellers and Importers

1) Publication of EE&C criteria and information on commercialized equipments such as Energy Performance Standard and Energy efficiency, etc.

2) Introduction and development of manufacturing technologies of high-efficiency products

At business entities as well as households, the most important principle for realization of energy efficiency and conservation is to establish a customary to keep people always conscious of it and try to act toward this goal. Every stakeholder is requested to implement EE&C measures as stipulated above based on respective position. Table 10.1-1 summarizes the EE&C action plan including stepwise procedures.

10.2 Action Plan for Power Sector

10.2.1 Formation of Reliable Power Supply System

(1) Formation of Strong Organizational Structures

In order to achieve stable power supply, concrete power supply system development plan is required taking into account nationwide energy demand, energy source structure and electricity supply/demand balance with power supply capacity identified in the National Energy Master Plan. So far the Vietnamese Government has set the National Power Development Master Plan in every five years. However, looking at the globalization of energy market, many variable factors in demand and supply balance and required long lead-time of 5-10 years for plans, surveys and constructions of power supply system infrastructures, it may be better to consider change of the current planning system to a "rolling plan system" where power development plan is reviewed in every one or two years. This system enables to monitor progress of project implementation and to propose alternative plans or countermeasures for delayed projects.

In order to effectively and efficiently allocate limited financial resources, it is also important to classify projects into ones that shall be developed by foreign and domestic investors and ones that shall be developed through national budget, ODA and self-financing of EVN. Latter projects include large-scale hydropower with multi purpose dam, gas thermal power that shall be developed with growing of domestic natural gas market, first imported coal thermal complex and nuclear power projects.

Prospecting the future power market orientation and the expansion of power infrastructure, roles and responsibilities of various players in power sector such as regulatory authority (for approvals of business and projects, power system planning and supervision of power market), market operator, power system operator, power suppliers including EVN and transmission and distribution companies shall be clarified and, if necessary, supplementary training and education shall be provided to strengthen their capacities. At the same time, related legislation for these organizational structures is required.

(2) Expansion of Power Infrastructure and their Operation

In the power infrastructure development planning, rational and effective planning method has been introduced through support from JICA aiming to achieve an economical and functional best mix of generation capacity composition in the whole system. To realize the optimal development, therefore, steady and assured construction and commencement following the development schedule in the plan is important. That is, human resource development, technology transfer and acquisition of public consensus shall be properly scheduled to follow the plan.

In particular, nuclear power development requires a well-prepared plan and a long lead-time for construction. It shall be kept in mind that scheduled development is almost impossible without acquisition of public acceptance, establishment of security system and strengthening of international cooperation. Future potential risks of price hike of uranium ore and its procurement shall also be taken into account since countries who have expressed their willingness to develop their own nuclear power are increasing nowadays.

From national economy's point of view, natural gas demand for gas thermal power plants as an anchor demand will play a key role in the formation and development of domestic natural gas market. In coming years in Vietnam where energy demand for industrial, commercial and domestic purposes is increasing significantly, a role of natural gas as a clean and easy energy will become more important particularly in urban areas. Therefore, harmonized development of gas thermal power plants and gas supply for urban demands is indispensable.

Pumped storage power as well as nuclear power is one of the new power resources. Toward the commercial operation in 2019, necessary studies and surveys shall certainly be implemented from now on. In addition, since pumped storage power has ancillary service functions such as voltage and frequency control of the power system, capacity building on effective utilization know-how of pumped storage power is required in the rapidly expanding and becoming complex power system.

The master plan on renewable power resources (mainly small-scale hydro, wind and biomass), including evaluation of renewable energy development potentials, shall be established as early as possible. In addition, promotion of renewable power resource shall be further focused on not only as environmental impact mitigation measures but also as promising power resources for rural electrification in remote areas.

(3) Securing Stable Supply of Energy Import

It is forecasted that Vietnam is going to be a net energy import country around 2015. Coal and gas have been domestically procured so far, but procurement of fossil fuels from foreign countries will become one of the big issues very soon. Hence, not only infrastructure development necessary for energy import such as seaports and storage facilities, but also capacity buildings in software experience and know-how such as fuel procurement in the international market, establishment of business models and contracts to mitigate risks etc. are required.

Since direct electricity import from neighboring countries beyond sovereignty can be realized only by mutual consent of both countries, negotiation and development shall be made in a planned and staged manner.

These energy import plans very much depend on the development timing of individual new power plants and future power demand trends, and would require more consideration on elements such as classification of power plants for base, middle or peak load. Hence, constant fine-tuning of long term plan considering these variable factors is important.

(4) Development of High Voltage Transmission Lines

It is vitally important for Vietnam extending north and south where natural resources are unevenly distributed to develop backbone transmission lines connecting north and south. Therefore, further increase of transmission capacity is required with rapid power demand growth. Furthermore, establishment of a comprehensive development plan of transmission lines will be required in order to form highly reliable and efficient power systems, since power facilities with gigantic capacities such as nuclear, import coal thermal complex and gas thermal complex will be constructed.

(5) Energy Conservation and Efficient Management

In the course of the above facility development, energy conservation and efficient management of the power system should always be considered in a desirable linkage with the existing system. Major issues are reduction of transmission and distribution loss, own-used energy at power plants, efficiency increase of generating system including, boiler, turbine and generation, and so on. Operation mode of the system plays extremely important role in this regard. In addition to facility upgrading, optimum operation and good maintenance are indispensable to produce best efficiency.

(6) Human Resources Development

Even in the reference case, total power capacities shall be increased five times in the next 20 years. Consequently, human resource development of designers, engineers and plant operators is an urgent issue and an important theme to be considered. In view of the advancement of equitization and independent management of generation companies, training on business management as well as technical training shall also be provided. Possible training themes in addition to the design, operation and maintenance technology training for general hydro and thermal power plants are listed as follows. These training shall be provided not only for companies under Vietnam Electricity Holding Group, but also for engineers of IPPs. It is required to organize a fair and nationwide human resource development system in the power sector.

Business management skills for power companies

Cascade hydropower plants management and operation in a river system

Operation & Maintenance technologies of nuclear power

Operation & Maintenance technologies of renewable power such as small hydro, wind and biomass for local people

10.2.2 Deregulation and Power Industry Development Policy

(1) Staged Formation of Power Market

Deregulation of the power sector is an essential policy to promote domestic and foreign investors, secure financial resources for development and achieve efficient power supply. In the Prime Minister Decision issued on 26 January 2007 on "Roadmap, condition to establish and develop levels of Power Market in Vietnam", staged deregulation process from the creation of power market to complete competition of power retails and it is appropriate to follow this process for a time being.

On the other hand, monitoring and assessment of deregulation performance shall be promptly implemented, and the institutional and organizational arrangement for the periodical review and redesign shall be considered. This function may be developed mainly at Electricity Regulatory Board.

(2) Issues in the Promotion of Deregulation

Successful invitation of foreign and domestic investors to power business in the process of deregulation is a key to success for timely power infrastructure development that meets rapid power demand increase. On the other hand, participation of many new investors who have few technologies and experiences in the development and management of power infrastructure makes stable and reliable power supply come under threat. Thus, some rules and regulations to fairy evaluate and guarantee capabilities of new participants in power business should be set out, while such rules and regulations shall not hinder participation of new comers and it is important to continue to make efforts in removing investment barriers in power business. Main risks in the process of deregulation are, i) fuel procurement risk, ii) off-taker risk, and iii) political risk. Politically controlled low power tariff and uncertainties in power trade rule in the power market, fate of PPA in the deregulation and power market orientation process constitute major barriers for investors.

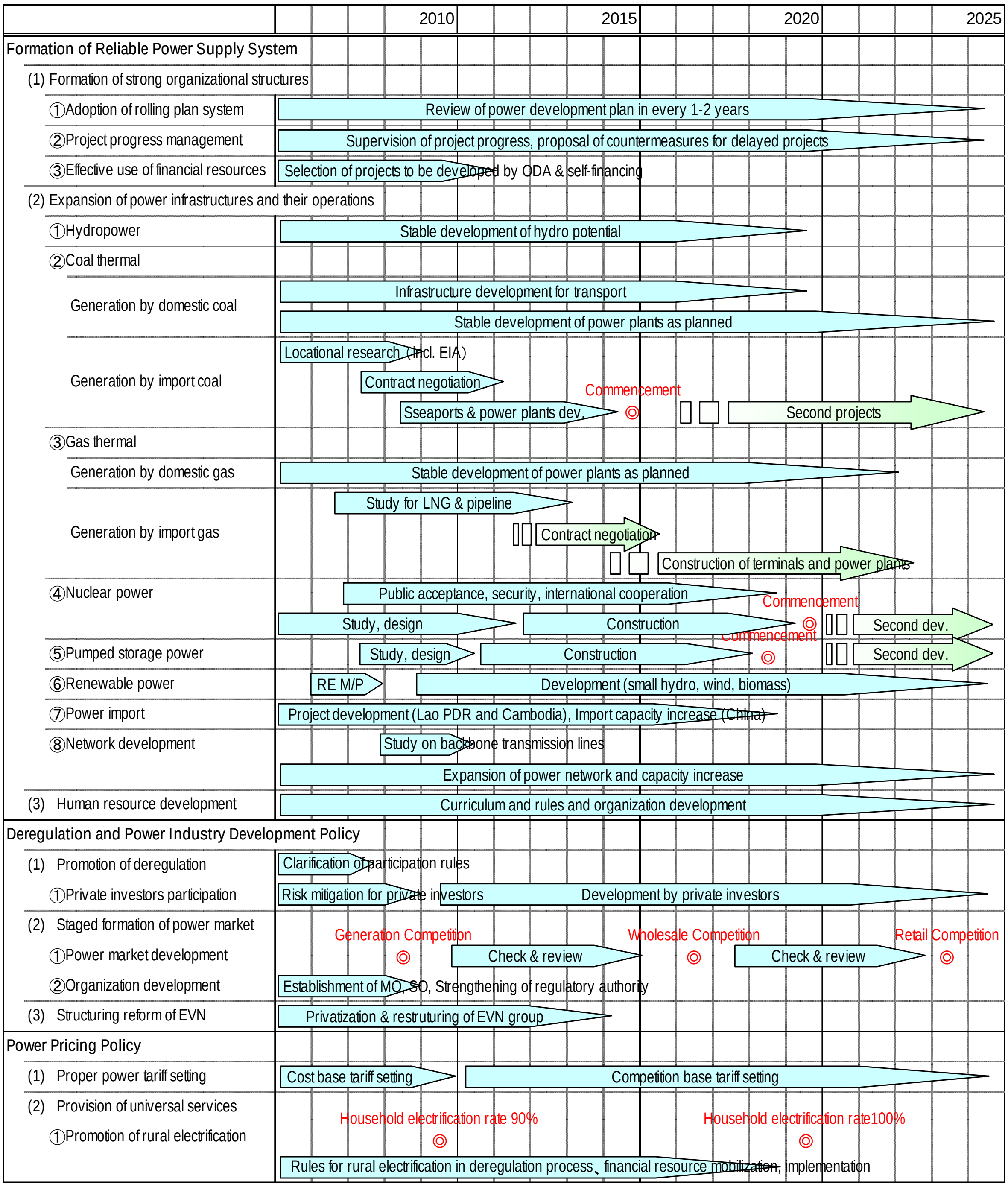


Figure 10.2-1 Action Plan of Power Sector

(3) Structural Reform of EVN

Power industry of Vietnam so far had been structured by vertically integrated and monopolized supply system. Following the creation of power market, however, restructuring of organizational arrangement of the EVN group has been required in order to realize effective and substantial competition among market participants. Fundamental plan of this restructuring has been introduced in the Prime Minister Decision on "Establishment of a mother company – Vietnam Electricity Holding Company" in June 2006, and assured implementation in accordance with this Decision is necessary.

On the other hand, an issue of "who shall have the ultimate responsibility for power supply after deregulation of the power industry" has always been a room for argument in many countries. Accordingly, it is important to have a deep discussion about this issue among all the stakeholders in Vietnam, and a mechanism to assure stable electricity supply from both software and hardware sides shall be considered in the design of restructuring process. So far, Vietnam Electricity Holding Company (former EVN) is supposed to take the power supply responsibility. However, considering that management authorities of equitized generation companies will be transferred from EVN to the management board of each generation company, it is desirable for the transmission company that remains as a 100% public company under the Vietnam Electricity Holding Company to possess pumped storage power plants that have functions to stabilize the whole power system, and thus constructing an organizational structure that enables a power system supervisor to physically control demand and supply balance.

10.2.3 Power Pricing Policy

Electricity tariff shall be properly set to reduce burdens of customers and, at the same time, tariff shall be set to cover the costs of power infrastructure development and a certain level of profits of power industry participants. Introduction of fuel cost adjustment system may be required in the future to properly reflect the fluctuation of energy prices in the international market with a start of fossil fuel import for power. Furthermore, with a creation of power market, some additional fees such as a service charge of power trading will be newly coming up. How to share these costs shall be rationally decided. New fees to be considered would include access fee to the network, and transmission, load dispatching and ancillary fee, settlement fee for power trade, access fee to power market and broker fee. Accordingly, in the design of power market and deregulation, it is important to balance both economic rationality of market participants and customers' interests. Standing on national economy's point of view, on the other hand, introduction of power tariff table that leads customers to rationally consume electricity shall also be considered.

It is important to expand the distribution networks to provide universal services for all the Vietnamese people, so that rural electrification in remote and island areas shall be facilitated in parallel with deregulation. Thus, in the residential electricity tariff setting, considerations to the poor through providing a preferential tariff for the first some quantity of electricity consumption shall continue to be adopted. Since it becomes difficult after deregulation to mobilize funds through cross subsidies within power companies as before, new financial resources shall be prepared for rural electrification, support to the poor and renewable energy development. These social considerations and philosophy of universal services shall be included in the grand design of deregulation and power market orientation as a basic principle of power sector in order to achieve fair and orderly advancement of deregulation.

Incorporating the above discussion, a draft action plan for major issues in the power sector is summarized in Figure 10.2-1.

10.3 Coal Sector

10.3.1 Goal of Coal Supply System Development

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 number 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.

10.3.2 Development Plan of Coal Supply System

(1) Domestic Coal

In production and supply of domestic coal, it is most important not to incur supply shortage in accommodating the demand. In order to realize stable supply of domestic coal in the long run, it is at first necessary to confirm sufficient quantity of recoverable coal reserve conducting detail geological exploration and evaluation on the reserve potential. At present Japan and Vietnam are conducting a joint survey on the coal resource potential in Quang Ninh province and reserves increase is expected via the project.

In addition, in order to accommodate increasing domestic coal demand, it is planned to promote expansion of existing coal mines and new coal mine development to achieve 70 million tons per year production capacity by 2025. It is also planned to continue coal export for existing long-term contracts since PCI coal as high quality anthracite for steel mills has high requirement from foreign users and is sold at higher price compared with the domestic market. Then, medium and low quality coal may be exported only when there is surplus so that supply shortage should not occur in the domestic coal market.

Coal mine safety is essential for stable production of domestic coal. It is anticipated that incident frequency would increase as ratio of underground mining and unskilled workers increases in future. It is essential to strengthen coal mine safety training for workers and managers so as to consistently achieve coal mine safety and productivity improvement at the same time.

In view of environment protection, it is required to implement strict compliance with environmental standard making consideration on natural and living environment for the whole coal flow chain including preparation and transport during the whole life of coal mine from development to production completion.

(2) Import Coal

Supplying import coal, it is the most important issue if it is possible to secure long run stable supply of coal with quality suitable for domestic use. To this end, it is customary in the foreign trade that coal user should make long tem contract with overseas producers to cover major part of the requirement and supplement the deficit by spot purchase. In order to secure procurement of coal for the import coal burning power stations scheduled to start in the southern region around 2025, it is important that coal users should start discussion with foreign suppliers and try to establish good relationship toward reliable contract. It should also be considered as a strategic target to acquire overseas coal mine equity and coal distribution ships to Vietnam covering 50% of the coal import for stable procurement.

In the provinces where construction of large coal power plants is scheduled, construction sites are located along shallow seacoast or river. Currently it is difficult to use large ocean going ships, but smaller boats or barges may have to be used. Should transport using lager ships be materialized by whatever means, pending ship size and distance, $5 - 20 per ton cost saving may be possible, which in turn contribute curbing electricity tariff. As a measure to procure import coal stably at minimum transportation cost, and with due consideration to minimize environmental burden, it is appropriate to construct an import coal transshipping terminals and establish efficient coal transport system that combines ocean going vessels and domestic small boats and barges. Study on this plan should be commenced as early as possible from long term viewpoint of stable coal supply considering not an individual large power station but targeting a package of multiple power stations slated in the PDP6.

(3) CCT and Energy Conservation

It is also necessary to improve coal supply/demand balance greatly not only from the supply side but also on the consumer side applying various Clean Coal Technologies that will enable yield increase and efficient use, reduction of unit consumption, improvement of heat efficiency, emission reduction and so on. Application of CCT is still limited in Vietnam, and hence CCT has great potential to improve efficiency widely in coal use.

CCT ready for easy application on the supply side may be application of coal preparation on the all produced raw coal aiming at improvement of coal yield and efficient use, reduction of unit coal consumption with increased heat value, improvement of heat efficiency and emission reduction.

CCT on the demand side may be introduction of coal-biomass briquette into household sector which will enable utilization of low quality coal, reduction of unit consumption and emission reduction. Utilizing the ample biomass resources mixing into coal briquette, it is possible to significantly reduce emission of CO2, NOx, SOx and particulates.

As the import coal power stations scheduled in the southern region assume the super critical pressure type (SC) technology, it is appropriate to conduct research and development for the next generation combustion technology such as ultra super critical pressure (USC) as well as integrated gasification combined cycle (IGCC) for future introduction.

10.3.3 Development of Coal Industry and Market

As a measure to secure long term stable supply of domestic coal, it should be considered to invite new participation of private and foreign firms in addition to the existing ones and promote technical cooperation. Engaging new private and/or foreign firms as contractor elsewhere in the coal flow chain from resource exploration to exploitation and preparation, it would be possible to upgrade the productivity by introduction of latest equipment and technology.

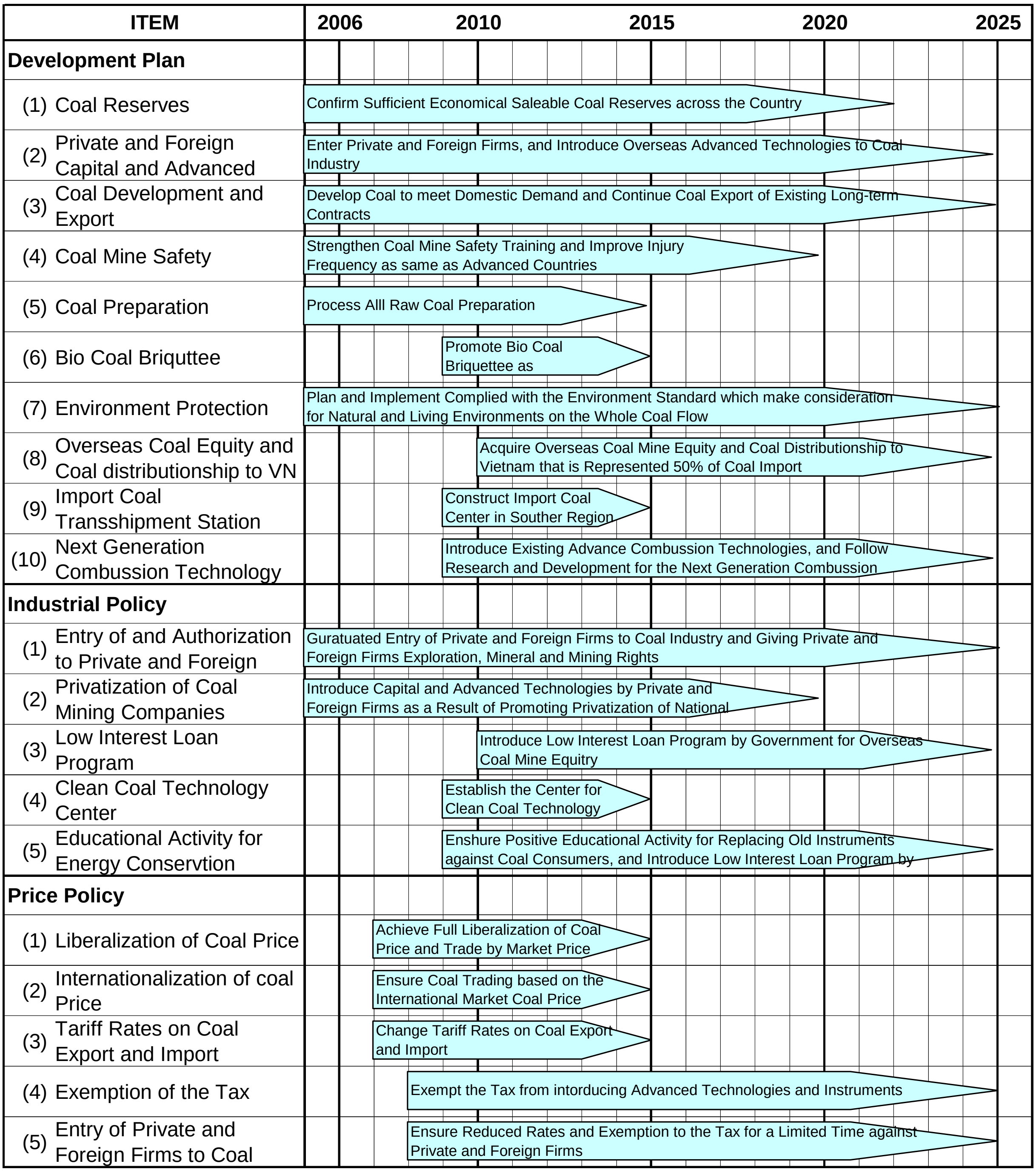


Figure 10.3-1 Action Plan on the Coal Sector

It is also conceivable to open the mining rights to private and/or foreign firms, first stepwise and finally as a complete package of exploration, mining and exploitation rights. Inviting capital participation by private and/or foreign firms in the existing coal industry, and progressing privatization of coal companies under VINACOMIN, it would also become possible to divert the so injected fund for introduction of latest equipment and technology for productivity improvement.

As another mean to enhance stable procurement of import coal, government may be able to provide financial assistances such as low interest loan when users or traders acquire overseas assets.

As a measure to promote CCT and energy efficiency, it is appropriate to establish a CCT Center aiming at R&D and training on CCT, and selection and materialization of CCT deemed preferable to apply in Vietnam. For example, technologies on coal combustion, treatment of exhaust gas, ash treatment and coal preparation especially relating to coal burning power station are urgent subjects for study. From viewpoint of EE&C, combustion efficiency and emission reduction, it is also recommended to promote campaigns on replacement of obsolete boilers, and introduce financial assistances such as provision of low interest loans to medium and small firms facing difficulty for such action.

10.3.4 Coal Price Policy

In the past practice in Vietnam, coal price for some large consumers was decided by the government and, based on this standard price, producers and users concluded contracts and thus transaction were made. However, the domestic price was below the production cost and producers were making minimal profit from export. Therefore, it is necessary to consider ways to promote production increase in this regard, too.

In order that producers make fair profit and generate fund for reinvestment, it is necessary to progress marketization of coal in the domestic market, and after certain period of familiarization, move to fully internationalized price. Thus, realizing fair and transparent price deregulation and transaction based on market price, it is possible to create a system where producers are able to receive fair return.

As another measure to expand domestic coal supply inviting new participation of private and/or foreign firms, temporary exemption may be applied on corporate tax and other tax items. It is also effective to apply exemption of import duty and/or value added tax on introduction of latest technologies and equipments for production expansion.

Based on the above investigation, draft action plan for the coal sector is summarized in Figure 10.3-1. As the coal demand trend is greatly affected by electricity demand, it is necessary to adjust the action plan of the coal sector closely watching the electricity demand movement.

10.4 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.

10.4.1 Development of Oil & Gas Supply System

(1) Domestic Energy Resource Development

a) Roles of government and private sectors in petroleum exploration and development

In order to promote efficient exploration and development in the oil and gas sector, the role of the public authorities and private sectors i.e. administration and business players have to be clearly divided and defined. With a precondition that natural resources are the asset of the nation and its people, business activities such as exploration, development and production should be in principle carried out by the private sector, while the government sector should be responsible to set out guidelines, structures and rules in accordance with national objectives. It is desirable that selection and supervision of petroleum contractors should be handled by specific body under transparent rules.

In creating such system and nominating the specific body, it is necessary to make a clear distinction between its function and functions of PetroVietnam to conduct business activities. Nevertheless, it is also important to pay attention to the following points with regard to functions of PetroVietnam.

1) High expertise and business experiences are necessary to examine and formulate policies and institutions on oil and gas development and production
2) Data and information regarding the upstream sector needs to be kept confidential to certain extent for protection of the national interest
3) It is necessary to have an arm of the government to conduct strategically important projects such as research and development and experimental geological drilling which would be sub-commercial under general condition.

Functions of the administration and players should be reviewed keeping the above elements in mind. Administration system of oil and gas exploration and development should be periodically reviewed, say every five years or so, to incorporate global movements.

b) Review of conditions to promote exploration and development

Petroleum geology of Vietnam is complex for both oil and gas, but the reserves are not very rich. Future exploration is being extended to more difficult deep water areas. Although the worldwide investment boom is seen in the oil and gas sector induced by recent price hike, costs of materials are also soaring and supply of workforce and equipments are getting tighter; promotion of upstream activities is not a straight easy road. To promote oil exploration under the condition, it is essential to prepare the ground to invite investment, modern technology and unique ideas widely from the world. From this viewpoint, it is desirable to set up a system to prudently consider the contract conditions reviewing the global movement.

Such system needs to be deemed as functioning fair and sound, and hence there should be certain distinction from the function of PetroVietnam as a player.

(2) Expansion and Upgrading of Refineries

Considering the increasing trend of motor fuel demand, it is recommended to consider advancing construction of the 2nd and 3rd refineries in addition to the 1st one that is under construction in Dung

Quat. As the starting timing, 2013 for the second refinery and 2016 for the third refinery may be conceivable. These refineries should be designed at a globally competitive level including the demand of neighboring countries in their scopes, for example, more than 200,000 barrels per day. It is also appropriate to consider installation of upgrading facilities such as desulfurization and cracking units in view of the world demand tendency toward lighter products.

(3) Construction of Natural Gas Delivery Grid and Market

As discussed in chapter 8, it is an important task in considering the long term energy supply of Vietnam how to supply the increasing demand in the general industry and residential/commercial sectors. Apart from the motor fuel that assumes movement and should be portable, natural gas and electricity are attractive clean energies easy to handle at fixed users such as factories and households. That is why demand for electricity and LPG are increasing rapidly.

Despite the convenience, however, it is necessary to consider in making a long term plan that circumstance for LPG procurement in the international market may turn to tight after 2010 after completion of the huge Qatar LNG projects. Although introduction of city gas is yet to start in Vietnam, it is desirable to construct natural gas delivery network in the southern provinces with Ho Chi Minh City as its core market utilizing indigenous gas production as fast as possible. Developing natural gas utilization will contribute to improve the air pollution as well as to enhance energy security reducing energy import. In addition, development of natural gas market may encourage exploration aimed at natural gas, which was relatively stagnant, leading to increase of gas reserves.

Construction of natural gas network is quite capital intensive and time consuming business. When installing such system brand new, as seen in the precedence of South Korea and Malaysia, it is a general approach to design the trunk system with the power generation use as its anchor demand and add-up large and medium size users. Then, the gas grid would be extended gradually to take up smaller users. In this context, the gas fired power stations should not be considered for its economics as power source only, but should be considered in an integral manner to constitute the regional energy structure and natural gas development, as they are closely linked to the overall regional plan.

In the southern provinces in and adjacent HCM city, the first batch of users may be power stations, industrial outlets such as fertilizer plants, and general users like factories and large scale shopping centers located along the pipeline route. New residential development projects may be linked pending their location and condition. On the other hand, in Northern Hanoi area, possibility to utilize CO2 rich gas discovered in the Tonkin Gulf might be considered for development adopting CO2 reforming technology to produce synthesis gas such as GTL/DME (mostly used as synthesized diesel fuel) and fertilizer. It is also conceivable to introduce LNG and dilute the CO2 containing gas adjusting heat value to an allowable level for city gas supply.

It is strongly recommended to set forth natural gas development plan for the southern provinces aiming at its operation by 2010. For the northern region, it would be appropriate to draft the second natural gas utilization plan to start at around 2020 with consideration on progress of exploration activities and possibility of LNG import.

(4) Construction of National Oil Stock Piling and Efficient Transportation System

In preparation for the energy import increase in future, national oil stockpiling should be prepared in due course.

In addition, expansion and development of import and domestic distribution facilities should be implemented. In particular, deep water ports shall be constructed to accommodate VLCCs for import of long-haul Middle East crude oils and large scale ocean going product tankers with a scope on increasing trade with neighboring countries. Such facilities may be constructed in combination with coal and other receiving facilities to rationalize transportation system in an integrated manner.

(5) Supply Security of Energy Import

As crude oil import is expected to increase steady and firm, it is recommended to develop reliable channels with suppliers as well as to establish collaboration with neighboring countries concerning cargo accommodation, joint procurement and other elements.

For consideration of national oil stock piling, it is important to pay attention to the fact that, in an emergency incident, we need petroleum products rather than crude oil. Therefore, in case the stockpiling were planned with crude oil, such storage should be closely linked to refineries for the convenience of producing petroleum products. In addition, the ASEAN Emergency Support System that is not very much active at present should be revamped to be an effective preparedness system.

10.4.2 Deregulation of the Oil and Gas Market and Energy Industry Policy

(1) Equitization of State Firm

Surveying prior cases in the world energy market-reform and system-design, it is recommended to consider redistribution of the function and equitization of the commercial business of PetroVietnam as they are presently facilitated together at the state company. The criteria are discussed under item 10.4.1. It is important, however, to maintain an integral national enterprise covering upstream through downstream considering the strategic importance as the national oil company to represent the will of the government.

(2) Creation of Public Sector Body to Implement Government Controlled Project

In order to conduct activities which the government is responsible such as national oil stockpiling for security strategy and/or development of sub-commercial energy infrastructure, appropriate public sector company should be established. However, it is desirable to limit the government direct business engagement as small as possible. In cases there are least choices, clear declaration of transfer schedule to the third party or private sector with certain timetable is desirable to avoid corpulence of government organization. Upon finalization of project plans, laws and regulations should be prepared toward materialization by 2010, followed by periodical review for streamlining.

(3) Transparent Rules for Market participation

The current system on import and sale of petroleum products should be realigned to fair and transparent ones. Direction of market liberalization should be indicated in principle allowing participation of those who qualify for certain criteria regarding business promoting ability, energy efficiency, safety and environment protection on their products and so on. However, to avoid disorder of market, clear rules should be prepared and arbitrariness regarding permission and licensing should be eliminated to the maximum extent. Rules should be set out aiming at first enforcement by 2010. After then, deregulation should be widened stepwise with periodical monitoring and review.

At the same time, it is important to set up a system to propagate the government guidelines on the petroleum policy to the relevant industries and the public.

10.4.3 Efficient Energy Market and Price Policy

(1) Internationalization of Energy Price

As the petroleum products are totally imported at present, they are traded at more or less international price level. Natural gas price presently set at considerably low levels compared to the international price should be raised stepwise to reach the international level at latest by 2015. This will normalize the distortion in the energy structure as well as induce further natural gas development. As discussed in chapter 9, it is desirable to reinforce the energy supply and consumption structure by applying the international level price to the domestic energy market.

(2) Taxation on Petroleum Products

For the purpose to secure funds for construction of energy infrastructure, research and development of non-fossil energy, environment protection and so on, taxation on gasoline and diesel gas oil should be studied for early implementation. It is appropriate to survey examples of preceding countries and realize fair and sound burden among member of the society. Consideration and assistances for the socially weak people should be made outside the energy price as the social welfare policy to avoid distortion of the energy structure, though its fund could be supplied from these taxes.

For implementation, it is necessary to prepare proper supply facilities and product specification standard of the objective petroleum products. The time schedule should be drafted considering this procedure. It is also necessary to prepare rules for handling of bio-fuels which would increase in future.

(3) Technical Standard of Petroleum Products

In order to realize efficient competition in the market, it is essential to set out unified technical standard or specification of petroleum products such as gasoline and diesel gas oil. It is important in particular to materialize energy conservation and environment protection. At the new refineries being constructed, the product specification are aimed to clear Euro-III or even Euro-IV standard, but quality of those presently imported are considerably inferior. This is causing confusion at auto makers as well as air pollution. It will be appropriate to set out product technical standard taking account of advanced circumstance in the international market and may be considering ASEAN standard or East Asia standard to be applied in future.[36]

It is also beneficial to equalize the standard among the neighboring countries, which enables to increase the flexibility for selection of export destination or accommodation in case of emergency response.

In consideration of the above discussion, a draft action plan for the oil and gas sector is shown in Figure 10.4-1

[36] Japan started supply of sulfur-free gasoline and diesel gas oil with sulfur content less than 10 ppm as of January 2005. South Korea will follow this in a mean time. China is behind them but planning to realize Euro-III or IV. It is verified that the low sulfurization also improves fuel efficiency keeping catalysts from deterioration.

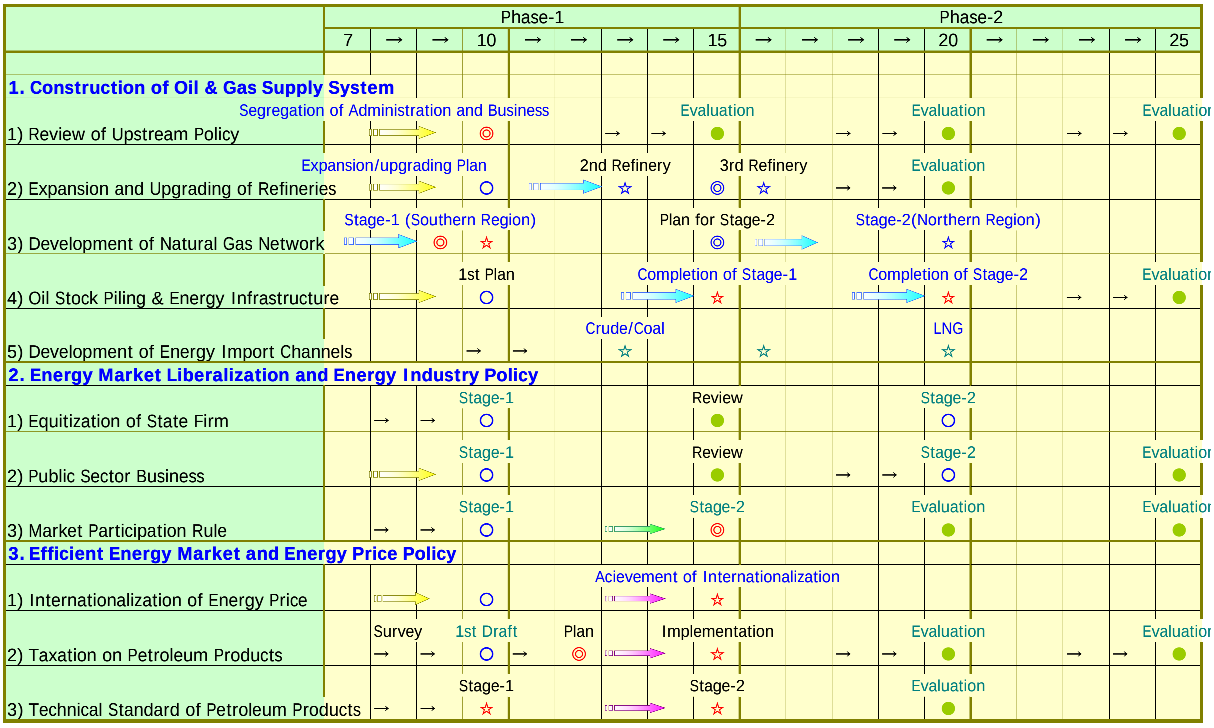


Figure 10.4-1 Action Plan for Oil and Natural Gas Sectors

10.5 Renewable Energy Sector

10.5.1 Development Plan

(1) Renewable Energy Power Development Plan

According to "Prime Minister Decision No.110/2007/QD-TTg", grid-connected renewable energy power development is planned as follows.

- 2006-2015: 2,451MW
- 2016-2025: 1,600MW

However, at present, only small hydro power plants (49 sites with total capacity: 64MW, unit capacity: 100kW-10MW) are developed as gird-connected renewable energy power plant[37], and there are presently no grid-connected wind power plants, which are considered as the most promising renewable energy power.

(2) Bio-Fuel Development Plan

In May 2007, "Development of Bio-Fuels in the Period up to 2015, Outlook to 2025" was produced and is under approval process by the prime minister.

<Viewpoint of Development>

- Development of bio-fuel for ensuring energy security and environmental protection
- Dissemination of Gasohol E5 and Bio-Diesel B5 by 2025
- Human resource development, Stable supply of biomass resources, Improvement of energy conversion rate and Establishment of bio-fuel distribution system

[37] *JEPIC: Electricity Power Industry of Foreign Countries, 2006*

<Development Target>

- 2007-2010: Installation of pilot plants (Gasohol E5: 100,000ton/year, Bio-Diesel B5: 50,000ton/year), 8% of gasoline demand will be replaced by gasohol E5
- 2011-2015: 20% of gasoline and diesel demand will be replaced by gasohol E5 and bio-diesel B5
- By 2025: 100% of gasoline and diesel demand will be replaced by gasohol E5 and bio-diesel B5

10.5.2 Action Plan

(1) Renewable Energy Power Development Promotion

According to "Prime Minister Decision No.110/2007/QD-TTg", grid-connected renewable energy power development is planned as follows.

- 2006-2015: 2,451MW
- 2016-2025: 1,600MW

However, around 2020, the small hydropower development would peak out due to depletion of the resource potential[38]. Therefore, the development of "New" renewable energy other than small hydro, e.g. "Wind", is the challenge for sustainable development of renewable energy. In addition, since it is scheduled that renewable energy power shall be developed by Independent Power Producers (IPP), incentives for IPPs will be an important issue.

Considering the above, the following actions are necessary.

a） Detail delineation of small hydro potential and Establishment of Development Plan

It is necessary to evaluate the small hydro potential in detail and establish the development plan considering the improvement of competitiveness of renewable energy power incurred by steep rise of crude oil price and increasing importance of global warming prevention and energy security.

b） Detail check of wind potential and establishment of Wind Power Development Plan

Although wind is considered as the most promising "New" renewable energy source, its potential is NOT grasped sufficiently due to lack of the wind speed data covering the whole country. Therefore, it is necessary to support the detail wind potential survey being conducted by IE in order to delineate the potential and establish the development plan.

c） Countermeasures for Grid-Connected Wind Power

It is necessary to take the counter measures against problems of grid-connected wind power as below referring to the good practices of advanced countries such as Japan.

- Frequency fluctuation: Wind power generation output fluctuates in accordance with wind condition
- Shortage of transmission line capacity: Wind power potential site is located far from the main power grid and the transmission line capacity is low in general.

d） Grid- Connected Wind Power Pilot Plant

Considering that there is no plan for grid-connected wind power in Vietnam, it may be appropriate to implement a gird-connected wind power pilot plant.

[38] IE: 6th power development master plan (Draft), 2007

	Phase-1									Phase-2									
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Events & Targets																			
RE Power Development Plan (MW) (Prime Minister Decision No.110/2007/QD-TTg)	214	363	370	213	100	150	305	500	200	150	250	0	0	100	100	250	250	250	250
Master Plan on Renewable Energy Resources																			
Renewable Energy Power Development Promotion																			
a) Detailed check of small hydro potential and Establishment of Development Plan								Revision					Revision					Revision	
b) Detailed check of wind potential and Establishment of Development Plan								Revision					Revision					Revision	
c) Countermeasures for Grid-Connected Wind Power								Review					Review					Review	
d) Grid- Connected Wind Power Pilot Plant																			
e) Establishment of Guideline for Grid-Connection and Standardized Power Purchase Agreement								Review					Review					Review	

Figure 10.5-1 Action Plan for Renewable Energy Power Development Promotion

e) Establishment of Guideline for Grid-Connection and Standardized Power Purchase Agreement

In order to facilitate the renewable energy power development by IPPs, it is necessary to establish the followings.

- Guideline for Grid Connection: Defines the technical requirement for grid connection
- Standardized Power Purchase Agreement: Defines the transparent and fair electricity tariff for simplification of negotiation

(2) Effective Use of Biomass Resources

As mentioned in the "Development of Bio-Fuels in the Period up to 2015, Outlook to 2020; Draft", for effective use of biomass resources, comprehensive action is necessary as shown below with regard to overall strategy, human resource development, power production, collection and transportation, energy conversion and distribution.

(General)

a) Establishment of Master Plan for effective use of biomass resources

In accordance with the "Development of Bio-Fuels in the Period up to 2015, Outlook to 2020, Draft", it is necessary to establish the master plan for effective use of biomass resources, which thoroughly covers comprehensive land use plan including utilization of wasteland and salty land, biomass resources production, collection and transportation, allocation of labor force, energy conversion (heat, electricity, fuel, etc.), and distribution.

b) Human resource development

It is necessary to implement human resource development via university education, training of technicians and technology transfer from abroad.

(Production, Collection and Transportation)

c) Improvement of production efficiency of agricultural biomass

It is desirable to implement the agricultural technology development for improvement of production efficiency and introduction/development of crops with high yield/biomass volume.

d) Effective use of non-agricultural biomass resources

It is desirable to consider the non-agricultural biomass resources such as wood residue, food waste, livestock excreta and marine biomass (e.g. fish processing residue), from the viewpoint of potential and energy conversion technology.

e) Establishment of effective collection and transportation system suitable against characteristics of biomass resources

In general, biomass resources have the following characteristics, which increase the cost of collection and transportation.

- Source of biomass are distributed broadly and each production volume is small
- High moisture content
- Voluminous

Therefore, it is necessary to establish effective collection and transportation system suitable for each biomass characteristics

(Energy Conversion)

f) Technology development for improvement of energy conversion efficiency

For improvement of energy conversion efficiency, it is necessary to introduce and develop energy conversion technology from biomass to electricity and/or fuel using physical and chemical processes (heat, pressure and/or chemical treating, etc.) and biochemical processes. In particular, development of the second generation biofuel technology will be extremely important to change the "food-fuel trade off" into "food-fuel complimentary development".

g) Technology development and introduction of biofuel blending facility

It is desirable to develop the bio-fuel blending technology such as below and install biofuel blending equipment.

- Direct blending of bio-ethanol and gasoline
- Blending ETBE (Ethyl Tertiary Butyl Ether) and gasoline
- Blending Bio-diesel and diesel oil

h) Introduction of technology and pilot plant for mixed combustion with coal or other fuels

It is desirable to conduct pilot plant level experimentation to evaluate the prospect of mixed combustion of biomass at coal fired thermal power plant.

(Distribution/Quality Control)

i) Establishment of quality standard of biofuel

In order to secure quality and safety, it is necessary to establish the quality standard of Bio-Ethanol and Bio-Diesel. Also it is necessary to explore for possibilities to establish the regional common standard such as ASEAN standard on these products.

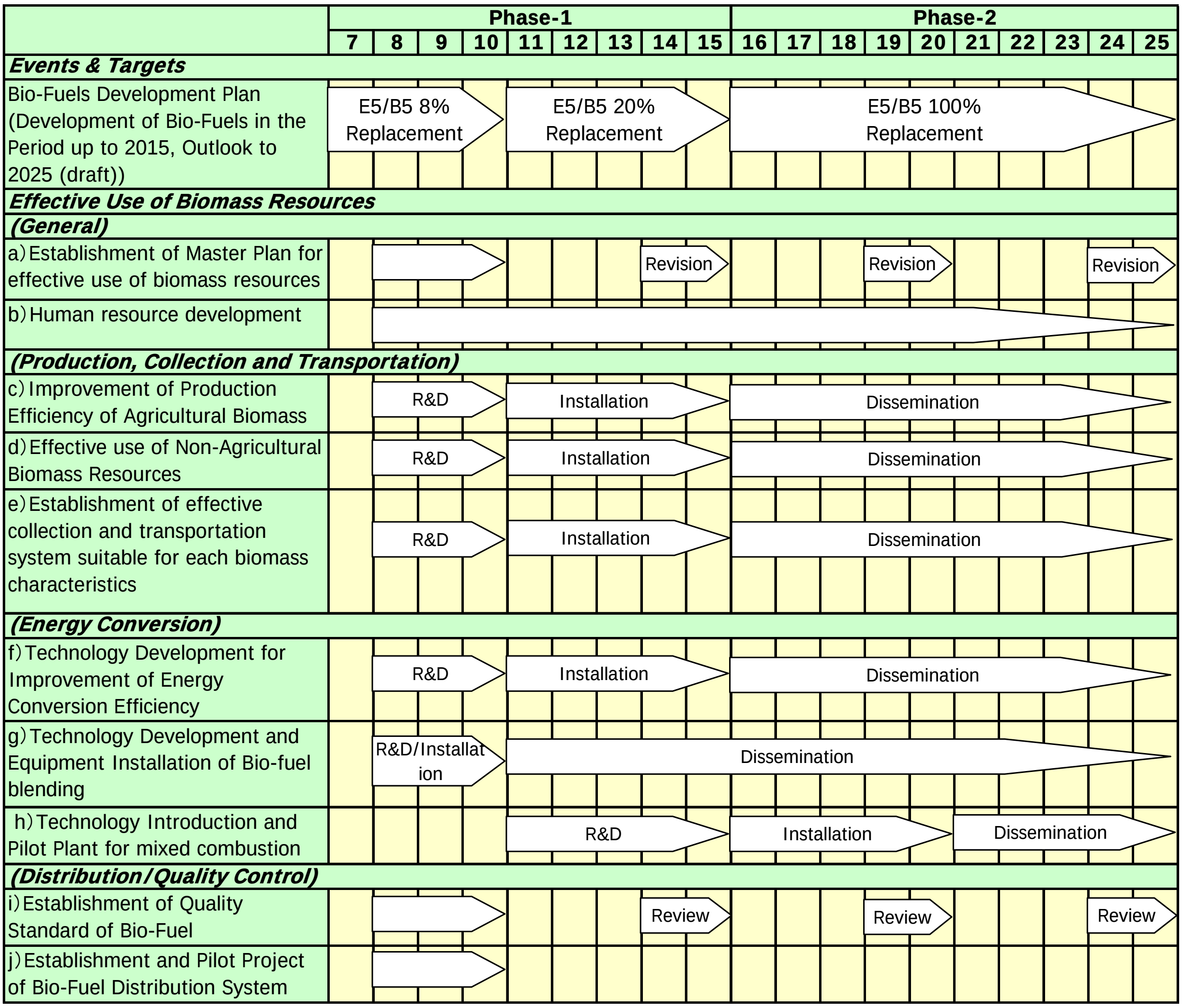


Figure 10.5-2 Action Plan for Effective Use of Biomass Resources

j) Establishment of biofuel distribution system with pilot project

It is necessary to establish the distribution system for bio-ethanol and bio-diesel, such as "Production – Storage – Filling Station" via implementation of pilot projects.

(3) Incentives for Renewable Energy

In order to facilitate use of renewable energy, it is necessary to establish incentives for renewable energy development. In particular, regarding the renewable energy power generation, when the electricity market is established as scheduled to start from 2009 as a part of the electricity sector reform, each power producing company will be put in competitive environment. Because renewable energy power is less competitive in cost than conventional power, installation of renewable energy power is anticipated to slow down unless effective incentives.

a) Introduction of RPS (Renewables Portfolio Standard)

It is necessary to introduce RPS which obligates power companies to generate/purchase electricity from renewable energy power producers for certain percent of their total power generation. The same system may be applied to petroleum product marketers as lifting quota of biofuel.

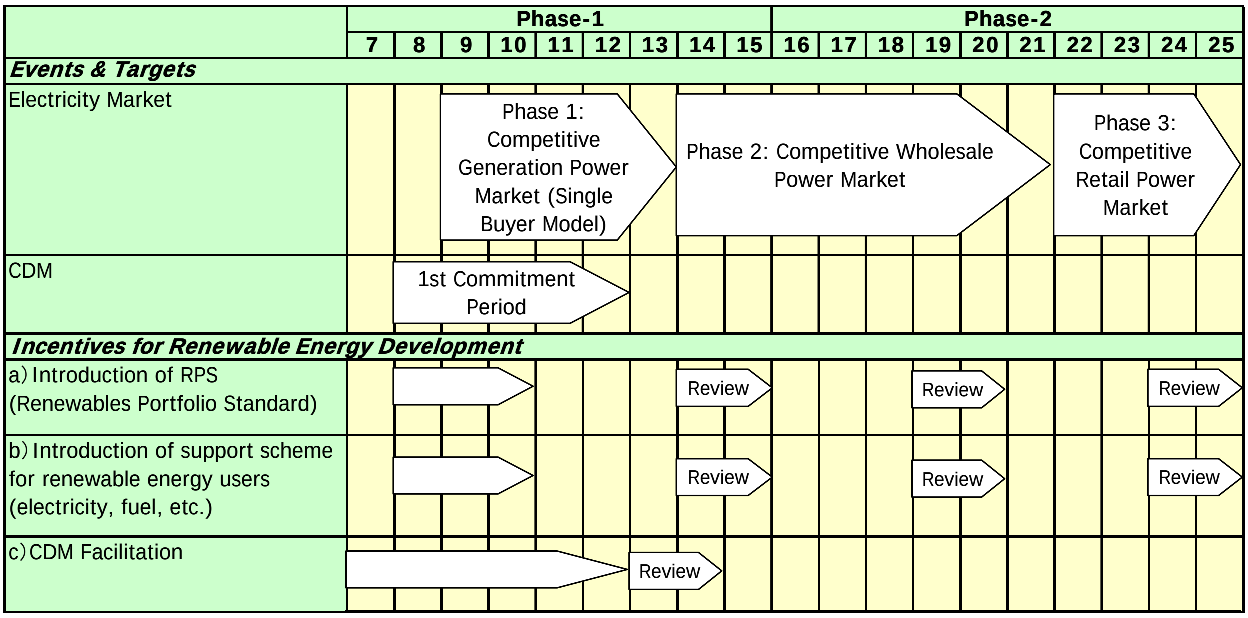


Figure 10.5-3 Action Plan for Incentives for Renewable Energy

b) Introduction of support scheme for renewable energy users (electricity, fuel, etc.)

It is necessary to introduce the support scheme for renewable energy users as follows.

- Debt guarantee by public agency and Investment/Loan with favorable conditions
- Subsidy and Preferential Taxation

c) CDM Facilitation

It is necessary to establish specific rules for incentives (preferential taxation, reduction of land use fee, financing, subsidy, etc.) and obligations (registration of project, commission for CERs Selling, etc.) of CDM project participants defined in Financial Mechanisms and Policies on CDM Projects (Prime Minister Decision No.130/2007/RD-TTg).

Also, it is necessary to review and improve the above rules periodically, in order to facilitate CDM projects.

10.6 Environmental and Social Consideration in Energy Development

Energy development projects are generally of large size and likely to give great impact on natural environment and regional society. Their influences extend wide range as seen in Chapter 7 affecting air and water quality, forest, agricultural land, seashore and residential environment as well as global warming issues. While energy supply is essential for development of society, yet adequate considerations need to be paid on natural environment and socially weak people at the same time.

Issues to be considered in promoting energy development on elements of environmental and social consideration are listed in detail in Appendix-6 “Method of Strategic Environment Assessment”. Gist of them may be summarized as follows.

1) Upstream Sector

Those projects such as construction of dam for hydropower, development of coalmine or oil field closely relate to land, and therefore should be implemented with utmost care on their impact on natural environment and residents of the region. As upstream development generally engages vast land, major concerns may be found relating to diversion of agricultural, forestry and residential lands, air and water quality, noise level, disposal of soil and wastes and accidents in construction and operation of production systems, and changes in transportation condition and/or residential circumstance in the adjacent area. In case minority inhabitants are affected, we should also consider social frictions to be incurred by moving.

2) Middle stream Sector

In the transportation sector such as port, road, railway, waterway, pipeline and transmission lines, concerns mainly relate to traffic jam, noise and water quality during construction phase, and explosion, fire and water contamination in case of accident. It should be noted here that energy transportation via pipeline or railway is far more efficient and safer, and effective to curb GHG emission compared with road transportation.

3) Downstream Sector

Downstream facilities such as power stations and refineries are generally built in designated industrial zones. Concerns may arise on land reclamation at seacoast or agricultural land diversion, air and water quality, noise level, waste disposal and/or accidents during construction and operation, transportation of fuel, feedstock and products, construction of ports and other transportation measures. In addition, as energy related facilities in general accompany huge amount of GHG emission, they should be distributed in an optimum pattern from national point of view.

As energy and environment often fall in a trade off relationship, energy is essential for social development. Therefore, not only emphasizing the negative aspects of energy development, it is necessary to invite wide discussion on construction of society with harmony of energy and environment, and draw up a *Grand Design* for developing such a desirable society. It is also necessary to harmoniously resolve contradictions between development target of the whole society and impacts regional society may have to accept. To this end, it is desirable to set out fair and transparent system to coordinate interests among stakeholders.

10.7 Establishment and Maintenance of Energy Database

10.7.1 Objectives

In order to understand the exact record of energy supply and demand for energy policy making, it is highly important to create the National Energy Database, which contains all relevant data and information necessary for energy analysis. At present, there is no organization responsible for construction and operation of a comprehensive energy database in Vietnam. For creating energy database, it is important to consider the following elements.

- Purpose of the database, necessary data items, and measures how to collect them.

- Institution and organization for management and maintenance of the database.
- In creating such institution, attention should be paid to capability and operability of implementation and confidentiality of the required work.
- Data items and data collection frequency shall be set out considering purpose, convenience and available timing

One of the purposes to create energy database is to delineate and manage energy supply and demand of the country, and thus to contribute to compilation of national energy policy. The other requirement is to provide more transparent information to the international society. Currently, world oil market is far from stable. As a result, the international oil market is exposed to a significant volatility of oil prices. To cope with the situation, efforts have started to improve the availability and reliability of oil data engaging oil producing and consuming countries in the world. Ministers at the 7th International Energy Forum held in Riyadh in 2000 made clear their support for better data and urged global responses to this challenge.

Now, six international organizations – APEC, EU, IEA, OLADE, OPEC and UN – have taken up this challenge, combined their efforts, involved their Member Countries and, in April 2001, launched the Joint Oil Data Exercise. After the 8th International Energy Forum held in Osaka in 2002, the Exercise was renamed as the Joint Oil Data Initiative (JODI). Vietnam is a member of JODI, too. At present, however, Vietnam is not able to submit monthly oil data timely due to lack of data collection system.

For energy management, policymaking and requirement of JODI, Vietnam should start collecting and maintaining energy statistics as requested as soon as possible.

APEC/EUROSTAT/OECD-IEA/OLADE/OPEC/UN

JOINT DATA EXERCISE

Member Economy: ____________

Year : *2005*

Month : ____________ *Unit :* ____________

		Crude Oil
Production		
Imports		
Exports		
Stocks	Closing	
	Change	
Refinery Intake		

		Petroleum Products					
		LPG	Gasoline	Kerosene	Gas/Diesel Oil	Fuel Oil	Total Oil
Refinery Output							
Imports							
Exports							
Stocks	Closing						
	Change						
Demand							

	Crude Oil	NGL	Other	Total (1)+(2)+(3)
	(1)	(2)	(3)	(4)
+ Production				
+ From Other sources				
+ Imports				
- Exports				
+ Products Transferred /Backflows				
- Direct Use				
- Stock Change				
- Statistical Difference	0	0	0	0
= Refinery Intake				
Closing stocks				

	Petroleum Products						
	LPG	Naphtha	Gasoline	Total Kerosene	*Of which: Jet Kerosene*	Gas/ Diesel Oil	Fuel Oil
	(5)	(6)	(7)	(8)	*(9)*	(10)	(11)
+ Refinery Output							
+ Receipts							
+ Imports							
- Exports							
- Products Transferred							
+ Interproduct Transfers							
- Stock Change							
- Statistical Difference	0	0	0	0	0	0	0
= Demand							
Closing stocks							

Figure 10.7-1 Monthly Oil Format for JODI

10.7.2 Energy Statistics Development

Energy statistics is highly important for proper implementation of national energy management and energy policy making. In addition, energy statistics provide valuable information for market players, for example, an industry average energy intensity (energy consumption per product) of all participants, which is useful to check and compare own energy intensity or performance at individual factories. If an energy intensity of a factory is higher than the average, such factory will try to reduce it. Eventually, the total energy consumption of Vietnam may be curbed. The expected roles of energy statistics are as follows.

1) Storing and updating time series data on energy supply and demand
2) Evaluation and analysis of the past energy trend
3) Evaluation and analysis of the energy consumption structure of the country
4) Estimation of energy intensity or unit energy consumption (national and sectoral)
5) Cross-country comparison of energy intensity unit energy consumption
6) Provision of data for energy supply and demand model
7) Submission of energy data to the international organization
8) Provision of information for energy efficiency & conservation policy and environmental policy
9) Provision of information for energy policy making

Figure 10.7.2 shows an example flow of energy statistics development.

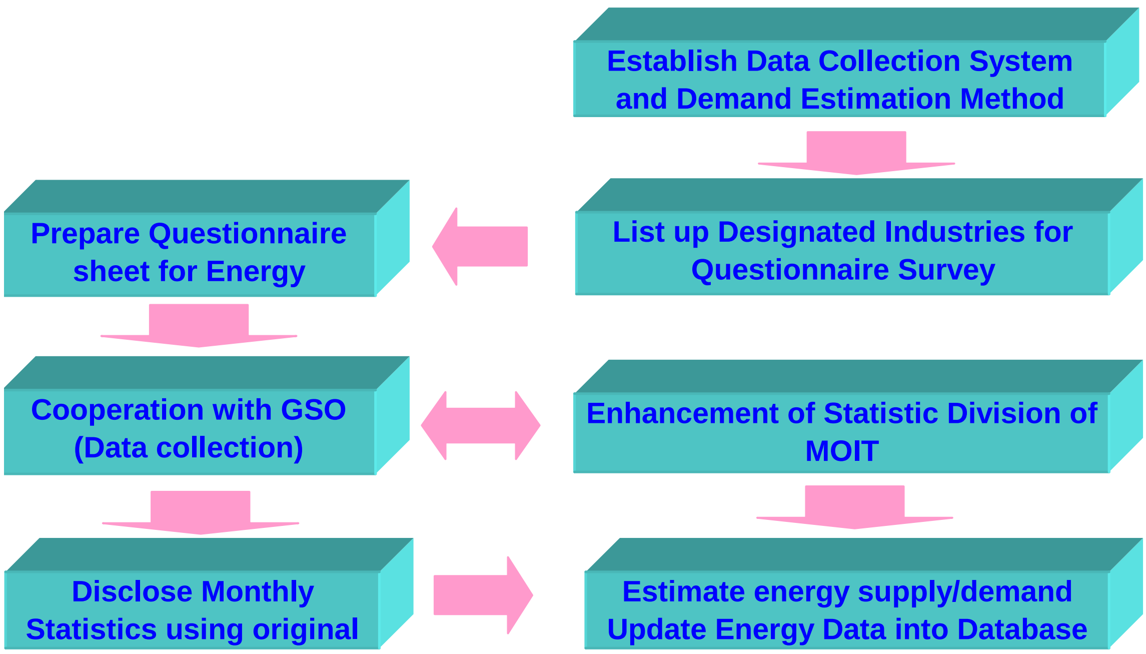


Figure 10.7-2 Flow of Energy Statistics Development

(1) Organization

In order to prepare energy statistics system, it is necessary to establish two organizations for data collection and data evaluation/analysis.

Considering the present situation in Vietnam as the starting point, it is preferable that an organization to collect energy consumption data from individual companies should be created at Industry and Construction Department of GSO, because this department is handling industry statistics in Vietnam and has accumulated good expertise to handle statistics collection. At present, Industry and Construction Department of GSO is collecting production data of major industries using questionnaire sheets. In addition to these questionnaire sheets, GSO may be able to prepare questionnaire sheets on energy, and distribute and collect them. In doing so, it is possible to gather statistics on energy data at least cost. GSO should aggregate the original data and disclose or publish the aggregated data as monthly report.

On other hand, it is desirable that analysis and evaluation of energy statistics should be conducted by Ministry of Industry and Trade (MOIT), since the Energy and Petroleum Department of MOIT is responsible for energy policy. We propose to establish "Energy Information Center" within MOIT and the center should maintain energy statistics. As the government may want to avoid administrative corpulence, data processing work would be outsourced to outside organizations. Moreover, we propose to create Advisory Committee for Developing Energy Statistics that may be composed of relevant organizations such as MOIT, Ministry of Transport, GSO, Ministry of Natural Resources and Environment, Ministry of Construction, and academic experts for supporting the Center.

(2) Designation of subject industries and enterprises and questionnaire sheet

In Japan, Minister of Internal Affairs and Communications designates important statistics as "Designated Statistics" and these statistics are legally compulsory for designated industries and enterprises to report. To develop energy statistics of Vietnam, it is necessary to designate major industries and enterprises in a list for the "Designated Statistics" on energy and legally oblige them to report based on the Vietnam Statistical Law. Taking energy consumption record is also beneficial for individual enterprises to promote energy efficiency and conservation. Once the system is set on its way, demerit of nuisance may be more than offset.

(3) Training of Statisticians

At present, experts on energy statistics are insufficient for maintaining the energy database. Statisticians handling the energy data will be required basic knowledge on energy such as energy flow, heat value, energy conversion factor and other elements. Thus, it is important to provide training for statisticians by energy experts.

(4) Data collection system and demand estimation

Developing energy statistics, we generally collect energy supply data first. Supply data is easier to collect than consumption data. Supply data is more reliable than consumption data, too. First of all, it is important to create a system for collecting energy supply data accurately. As for the major industries and factories that are consuming a large amount of energy, it is relatively easy to collect their energy consumption records by questionnaire sheets, because they are also concerned and mostly keep records. As for minor industries and small factories, we may have to estimate their energy consumption periodically running supplemental data survey. It is also difficult to estimate energy consumption at residential, commercial and transport sectors. Their energy consumption is generally estimated in the form of energy intensity per capita, unit or household. Therefore, we need to carry out sample survey on regular basis for accurate estimation of energy intensity at each sector. Familiarization with know-how and methods of conducting sample survey and estimating energy intensity at residential and commercial sectors may be promoted through assistances expected from international organizations including Japanese institutions.

10.7.3 Action Plan

In order to develop energy statistics, it is necessary to establish the implementing body and promote coordination with relevant organizations, which will require enforcement power, technical assistance, budget, data disclosing system, etc. This is a time consuming process. In order to develop the energy statistics system, the following work should be implemented earliest possible but taking step by step approach.

1) Establishment of Energy Information Center in MOIT
2) Establishment of Advisory Committee for energy statistics in MOIT
3) Budget request for energy statistics system at MOIT and GSO
4) Request of designated industrial statistics from MOIT to GSO
5) Preparation of questionnaire sheets by MOIT
6) Implementation of questionnaire survey by GSO
7) Preparation of monthly report by GSO
8) Implementation of sample survey for residential and commercial sectors by MOIT or GSO
9) Estimation of energy supply and demand by MOIT
10) Publication of energy statistics by MOIT

Figure 10.7-3 shows draft action plan for energy statistics development based on the above consideration.

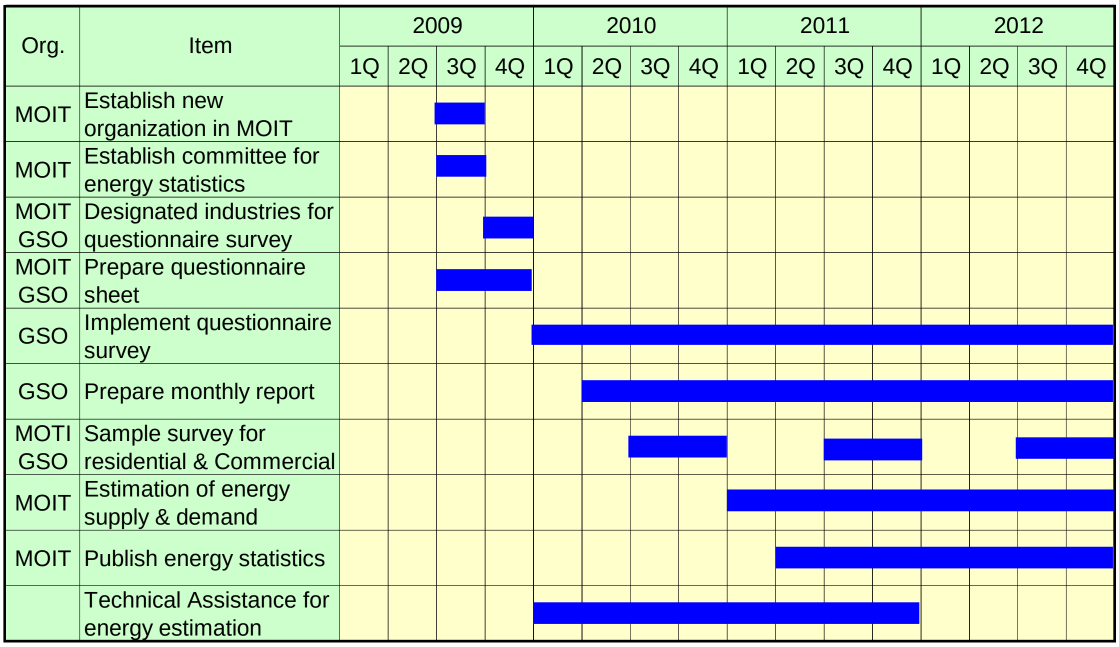


Figure 10.7-3 Action Plan for Energy Statistics Development

Part4 Database and Analytical Tools

Chapter 11 National Energy Database

11.1 Structure of National Energy Database

Data of energy database that is developed in this study are entered into Microsoft Excel and stored in Microsoft Access as the latter is suitable for data handling such as retrieval and sorting than Excel. Also Access is suitable for future expansion, for example, sharing data on network through database server. Data stored in Access are handled by database program and are displayed to a PC screen with Excel and/or PDF format in addition to functions of retrieval, sorting, and graph generation.

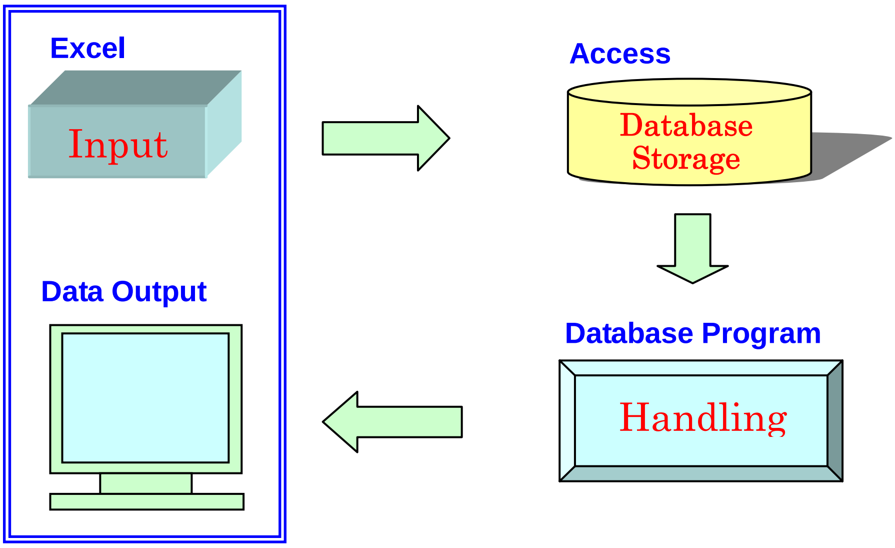


Figure 11.1-1 System Configurations

11.1.1 Data items

In the IEA energy balance table, there are 61 energy sources and 82 supply and demand items. Total number of data entry cell is about 4,500 (61×75=4,575). However, we may not need all of them if any energy sources and/or energy plants do not exist in the country. In case of Vietnam, for example, there is no coking coal plant, geothermal plant, CHP plant, liquefied coal plant, etc. In the energy balance table of Vietnam, we have reduced data items to meet the actual energy situation considering future development plans of refineries, nuclear power plants, renewable energies, etc. Thus, the total number of data entry cell is 1,372 (28×49=1,372). Table 11.1-1 shows items of the energy balance table of Vietnam.

Table 11.1-1 Items of Energy Balance Table of Vietnam

Energy Source Item	Supply & Demand Item
Hard Coal	Indigenous production
Brown Coal	Import
Anthracite	Export
Coking Coal	International Marine Bunkers
Other Bituminous Coal	Stock Changes
Sub-Bituminous Coal	Transfer (Gas Processing)
Lignite/Brown Coal	Statistical Discrepancy
Fat coal	Transformation Sector
Briquette	Main Activity Producer Electricity Plants（EVN)
Combust. Renewables+Wastes	Autoproducer Electricity Plants
Natural Gas	Patent Fuel Plants
Crude Oil	Petroleum Refineries
Associated Gas	Non-specified Transformation
LPG	Coal Mine
Motor Gasoline	Oil and Gas Extraction
Kerosene Type Jet fuel	Patent Fuel Plants
Kerosene	Petroleum Refineries
Gas/Diesel Oil	Own Use in Electricity
Residual Fuel Oil	Non-specified Energy Sectors
Naphtha	Distribution Loss
Non-specified Petroleum Products	Iron and Steel
Nuclear	Chemical and Petrochemical
Hydro	Non-Ferrous Metals
Solar Photovoltaics	Non-Metallic Minerals
Solar Thermal	Transport Equipment
Wind	Machinery
Electricity	Food and Tobacco
Other Sources	Paper, Pulp and Print
	Wood and Wood Products
	Construction
	Textile and Leather
	Non-specified Industry
	International Aviation
	Domestic Aviation
	Road
	Rail
	Domestic Navigation
	Non-specified Transport
	Residential
	Total Commercial and Public Services
	Agriculture/Forestry
	Fishing
	Non-specified Others

11.1.2 Retrieval and Sorting

Number of items on energy data and socioeconomic data in the energy database is about 1,700. In addition to them, there are time series data from 1990 to 2005. Thus, the total number of data becomes about 27,000. We have developed the database program for data retrieval and sorting system aiming to make it easy to find necessary data from among these huge data sets. This program is developed by a local system engineering company. Graph generation function is also developed in response to a request from the Study Working Group.

11.1.3 Energy balance table

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

Table. Thus, Vietnam can use this table for submission as the energy balance table requested by IEA every year.

11.2 Function and Operation of Database

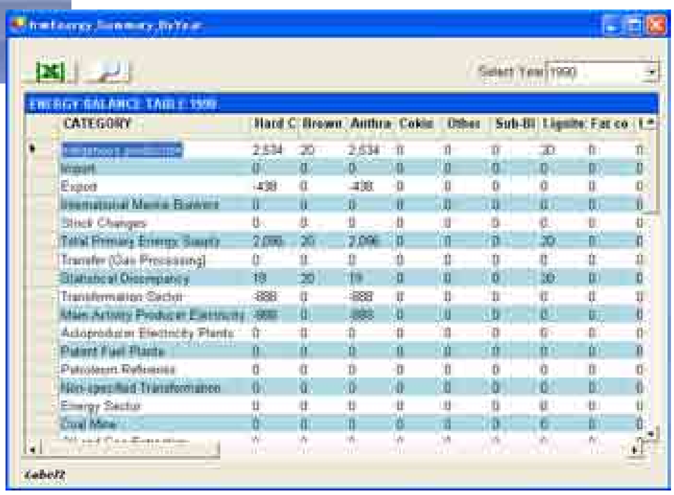
The database program is developed for data handling. The functions and the operations of the database program are as follows.

11.2.1 Macro economy data

Click Summary and select Macro Economy Table.

Then, time-series macro economy data will be displayed.

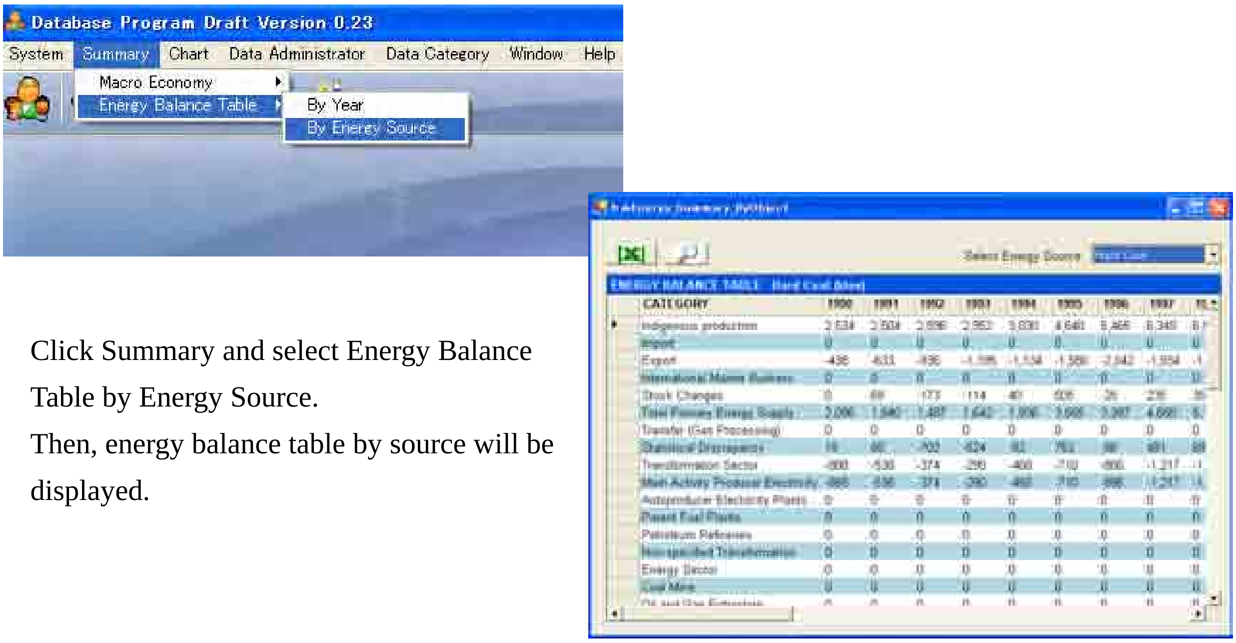
11.2.2 Energy balance table by year



Click Summary and select Energy Balance Table by Year.

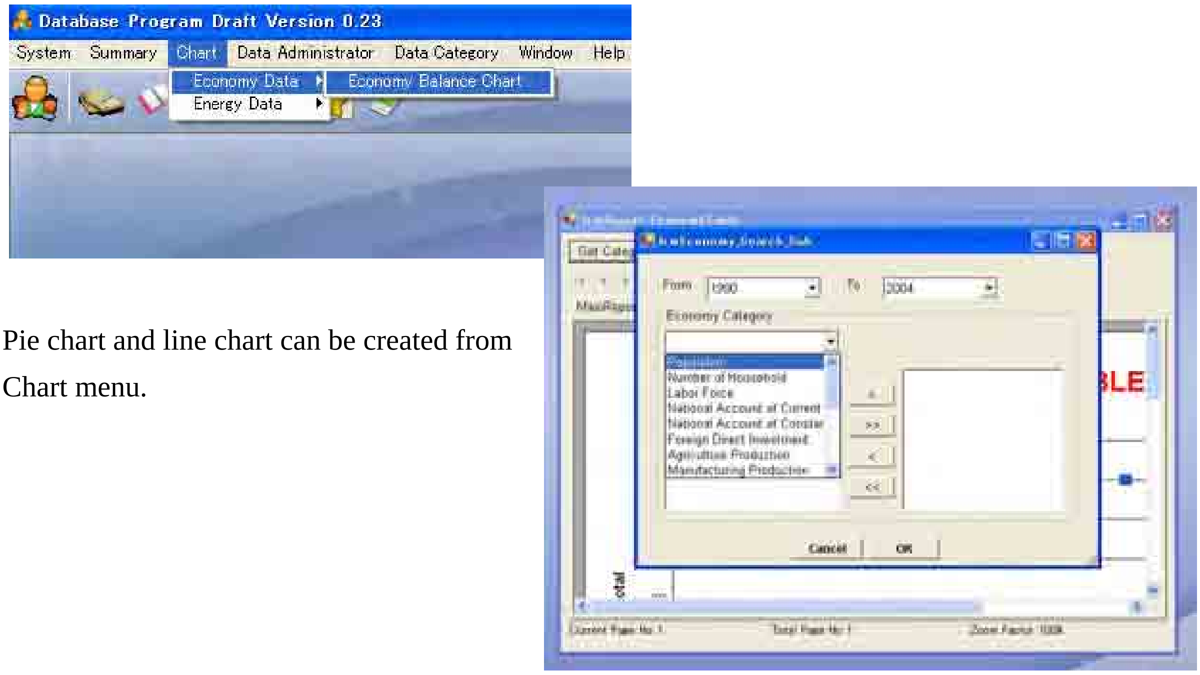
Then, energy balance table by year will be displayed.

11.2.3 Energy balance table by source



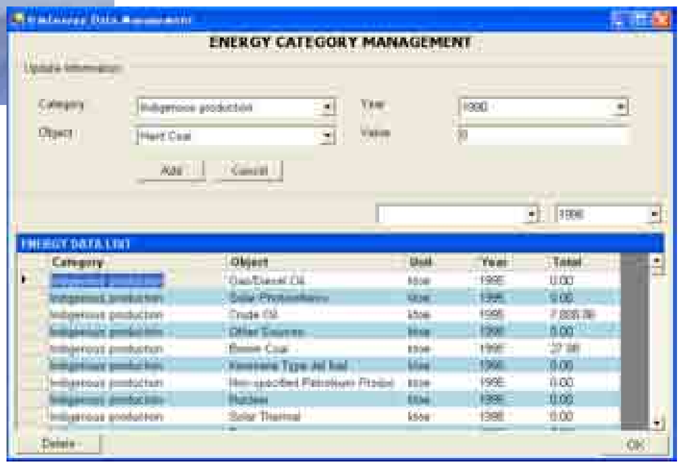
Click Summary and select Energy Balance Table by Energy Source.
Then, energy balance table by source will be displayed.

11.2.4 Graph generation



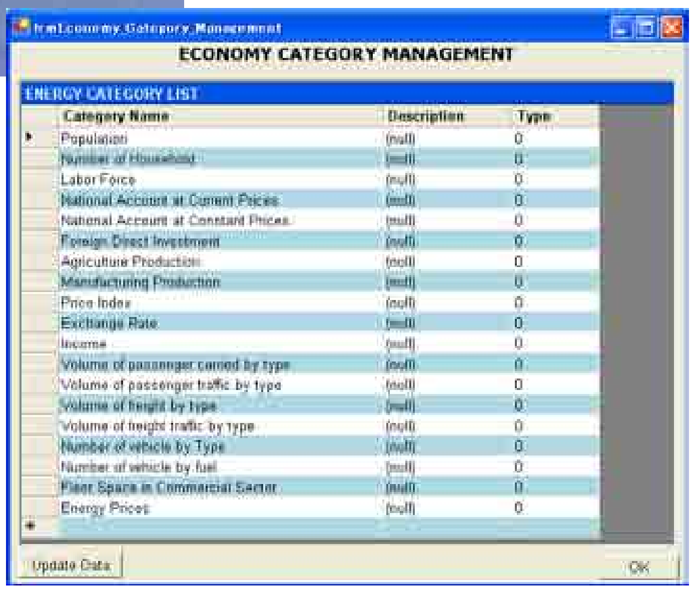
Pie chart and line chart can be created from Chart menu.

11.2.5 Data update



Click Data Administrator and select
Data Management.
You can update data.

11.2.6 Adding data item



Click Data Category and select Category,
Item, Field, or Source.
You can add new item.

Chapter 12 Energy Demand Forecasting Model

12.1 Simulation Models for Building National Energy Master Plan

Today, various econometric models are developed by academies and research institutions as a tool to project future energy outlook, to analyze issues in the energy field, to evaluate effects of energy policies and responses, to construct energy plans and so on. Energy outlook models used by International Energy Agency (IEA) and The Institute of Energy Economics, Japan (IEEJ) are generally composed of threes engines, namely, 1) the macro-economy model, 2) the energy demand forecasting model, and 3) the energy demand/supply optimization model as shown in Figure 12.1-1.

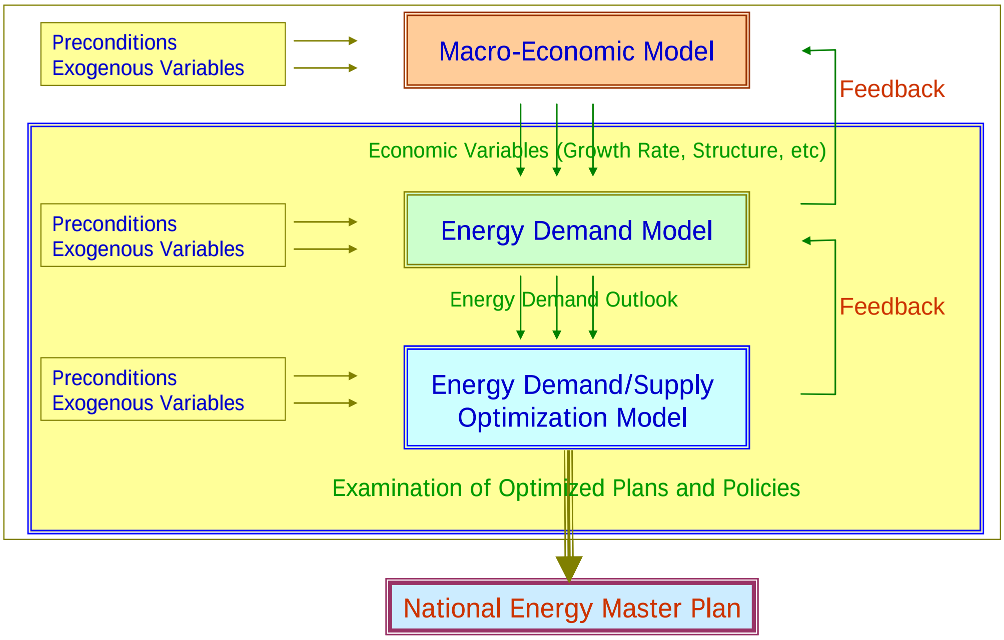


Figure 12.1-1 General Model for Energy Outlook Analysis

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

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

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

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

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

12.2 Energy Demand Forecasting Model

12.2.1 Structure of the Energy Demand Forecasting Model

The energy demand forecasting model is composed of the two blocks as shown in Figure12.2-1: the macro economic block and the energy demand block.

As explained in the previous section, economic indicators are in principle given to the model referring to those announced by the government and/or projected by relevant offices as external variables. Thus, the model reflects various economic and industrial policies stipulated under the Socio-economic Development Plan and other plans. However, it is not possible in this manner to obtain all the input data required at the demand forecasting block. Therefore, we calculate in the macro-economic block those future values of other indicators as internal variables, which are not available from government plans and projections. They are, for example, sectoral GDPs and energy consumption coefficients.

Then, in the Energy Demand Block, the final energy demand is divided into the transportation fuel such as gasoline and diesel gas oil and other general energy. The latter will be estimated by sector such as agriculture, industry, commercial, households and others. Then, they will be divided into two categories of power demand and fossil energy demand applying sectoral power ratios. The fossil fuel demand will be further divided into energy resources such as coal, oil, natural gas and renewable energies. In the electric power sector, fuel consumption at thermal power stations will be calculated applying the power flow system in generation and transmission processes using PDPAT II. The calculated results will be entered into the Supply/Demand optimization model. Energy balance tables are compiled in the optimization model.

Figure 12.2-1 Outline of the Energy Demand Forecasting Model

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

12.2.2 Supplemental Calculation in Macro economic block

In the process of compiling the National Energy Master Plan, major economic indicators are set forth first referring to the Socio-economic Development Plan and other major programs. Then, other economic variables that are not available but necessary for the demand forecasting block will be estimated in the macro economic block. For example, in EDF2050, GDP by production component are estimated referring to international movement, investment trend, etc, though the Gross Domestic Expenditure (GDE) is not shown by demand sector. As GDE items are used as explanatory variables in this model, it is necessary to estimate them in line with the economic development scenario.

Generally in forecasting economic outlook, main economic indicators such as investment, labor productivity and foreign trade balance are decided in the early step, and then other GDP items will be estimated as above. That is, in the forecast of national accounts, the calculation progresses in the order of “Survey on Economic activities”, “Forecast of GDE” and “Forecast GDP” as shown in Figure 12.2-2.

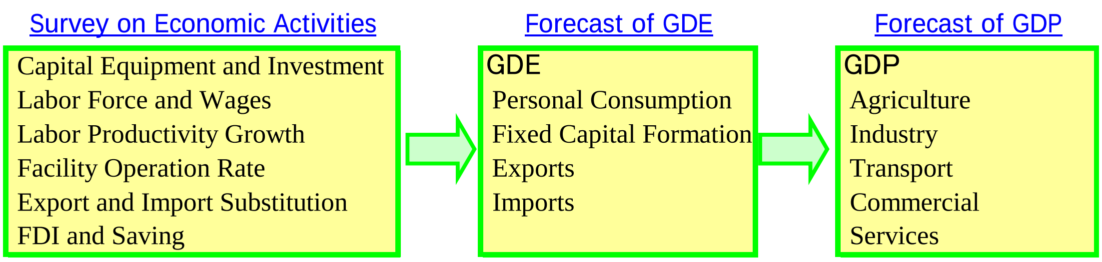


Figure 12.2-2 The Procedures on forecasting National Account

Here, the following equation system is considered for example to apply to the estimation of the GDE items.

Equations for estimation of Gross National Expenditure

Final Consumption Final Consumption$_{(t-1)}$x(1+ α x Growth Rate of Labor Productivity)

Gross Fixed Capital Formation Savings + FDI + Foreign trade balance

Exports of Goods and Services Oil & Coal Export + Other Export

Import of Goods and Services	Import of Petroleum Products and Coal + Other Import
Statistical Discrepancy	β x Statistical Discrepancy (β <1)
Gross National Expenditure	Aggregate of the above (Import is deducted)

Equations for estimation of Foreign Trade

Export of Oil	Crude Oil Price x (Production + Import - Domestic Use)
Export of Coal	Coal Price x (Production - Domestic Use)
Other Export	GDP - (GDP without Other Export)
Import of Petroleum Products	Petroleum Product Price x (Demand - Domestic Production)
Import of Coal	Coal Price x Coal Import
Other Import	α x Other Import (t-1) + β x (Incremental GDP)

For details of the model structure and equations, please refer to the model itself.

12.2.3 Economic Outlook by region and sector

Although we do not conduct regional energy study this time, when we do so, it is necessary to calculate regional economic variables. Then, it is necessary to consider and reflect differences in trends of economic growth by region (for example, for northern, central and southern regions) and by sector (for example for agriculture, industry/construction and services).

12.3 Structure and Function of the Energy Demand Forecasting Model

12.3.1 Functions of Energy Demand Forecasting Model

In the demand forecasting model developed in this study, the forecasting period is set for 2006 through 2025and the following functions are considered.

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

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

2) Demand forecast considering energy conservation policies.

   The Vietnamese Government is promoting policies of enhancing energy conservation institutions and systems aiming to reduce the total energy consumption by 3-5% (equivalent to 5 million toe) during 2006-2010 and 5-8%(equivalent to 13 million toe) during 2011-2015. The model should incorporate these activities with quantified inputs of their effectiveness.

3) Demand forecast incorporating energy price effects

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

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

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

5) Energy consumption in the power sector

Fuel consumption of the power sector should consider import of electricity.

12.3.2 Test and Evaluation of the Model Equations

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

1) Evaluation of energy demand forecasting equations
   - Determination coefficient (more than 0.85)
   - T-value test of parameters (more than 2.0)
   - Durbin Watson ratio test（1＜DW<3）
   - Sign test of the regression coefficient (logical according to economic theory)
2) Evaluation of macro economic forecast
   - Real GDP growth rate
   - GDP per capita（US$ base with international comparison）
   - Labor productivity growth rate
3) Evaluation of energy demand forecast
   - Energy demand growth rate
   - Energy consumption per GDP（GDP elasticity with international comparison）
   - Energy consumption per capita

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

1) Representativeness and Hetero-schedasity of the data used

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

2) Divergence of the model

   Although multi co-linearity test is conducted on the coefficients of the forecasting equations with Durbin-Watson Ratio, we often encounter parameters to cause divergence of the forecasting values. For avoiding the phenomenon, the forecasting equations have to be checked in the manner such as to evaluate stableness of parameters applying different regression period, to evaluate prediction ability of the equation extrapolating it for the past record, and to evaluate movement of the solution operating the model as the total test. The magnitude of parameters could also be known to some extent from empirical knowledge[39] and by technical analysis.

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

3) Adjustment of error

We often encounter discrepancy of an estimated value and the latest actual data, even though the forecasting equation has double-nine determination coefficient (0.99+). In such a case, if the equation[40] is applied without adjustment, it would produce odd and discontinuous forecast values. Therefore, such equation needs to be adjusted considering the tendency of the error. It is possible to install a measure to equation adjustment in advance, however, since the reasons of errors are different but not simple such as abnormal weather, accidents and so on, it is recommended that adjustment should be made one by one at the time of defining the equations.

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

12.3.3 Theory of Forecasting Equations

In the model, energy demand is forecasted by sector, namely, agriculture, manufacturing, transportation, commercial & services, and residential and others. The forecasting procedure of each sector, excluding transportation fuel, is same and as described below;

Total energy demand of a sector(TD) ＝*f*（Sectoral GDP and Investment）

Power demand before E-saving（BE） ＝TD x Power Ratio

Power demand after E-saving（AE） ＝BE x Power Saving Indicator

Fossil fuel demand before E-saving（BP） ＝TD - BE

Fossil fuel demand after E-saving（AP） ＝BP x Fossil saving indicator

Here, power ratios are set referring to ones of Malaysia, Thailand, Indonesia, Philippines, and Japan. Energy saving indicators are estimated considering energy price trend and energy conservation targets. In the model, the total energy demand (electricity + fossil fuels) excluding the transportation fuel of each sector is at first estimated using the sectoral GDP and Investment. GDP refers to the energy consumption in accompany with production activity, and the investment refers to construction and upgrading of facilities in the sector. In general, rapid increase of energy demand is observed in the sector where investment is growing fast. It is known that, even in the developed countries, the relationship between increases of energy consumption and investment is in proportion to a certain

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

extent. According to the above observations, it is considered in this model that sectoral GDP and investment are important explanation variables for energy demand forecasting.

12.3.4 Equations for Energy Demand Forecasting

In the energy demand forecasting model, the sectoral total energy demand excluding transportation fuel, that is, TD＝*f*（Sectoral GDP and Investment）, is defined by the following expressions, where TD_t is the sectoral total energy demand in year *t*, P_t is the sectoral GDP in year *t*、and I_t is the sectoral investment in year *t*.

Hypothesis 1: The sectoral total energy demand is expressed by the sectoral GDP and the sectoral investment as follows; "a" and "b" are energy intensities to GDP and Investment.

$$TD_t = aP_t + bI_t + c$$

Hypothesis 2: The growth rate of the sectoral investment (It) is proportional to that of the national investment (V_t); that is, $I_t = I_{t-1} \times V_t/V_{t-1}$. Then,

$$TD_t = aP_t + bI_{t-1} \times V_t/V_{t-1} + c$$

Hypothesis 3: Increase of the sectoral production(ΔP_t) is proportional to investment in the previous year (I_{t-1}), that is, $\Delta P_t = r\, I_{t-1}$ and $\Delta V_t = V_t/V_{t-1}$. Then,

$$TD_t = aP_t + b\Delta Pt / r\,\Delta V_t + c = Pt\,\Delta V_t\,(a / \Delta V_t + b/r\Delta P_t/P_t) + c$$

Hypothesis 4: The growth rate of the sectoral production ($g = \Delta Pt/Pt$) is proportional to growth rate of the sectoral investment (I_t/I_{t-1}) and the growth rate of sectoral investment is in turn proportional to the growth rate of national investment (V_t/V_{t-1}). Then,

$$TD\ t = P_t \times \Delta V_t \times (a/\Delta V_t + b/r\,\Delta V_t) = P_t \times (a + b/r \times \Delta V_t^{\ 2})$$

Hypothesis 5: When b/r is small, $a + b/r \times \Delta V_t^{\ 2}$ can be estimated by $f(\Delta V_t)$.

$$TD\ t = Pt \times f(\Delta V_t) = f(P_t \times \Delta V_t)$$

As explained above, the model forecasts the sectoral energy demand using GDP and investment by sector. As it is possible that the energy intensities are subject to change in the long run in accordance with energy conservation policies and technical innovation, it is difficult to express movement of these elements in the linear models like this. Therefore, model users are required to watch these movements and tendencies, and from time to time try to improve and update it.

12.3.5 Theory of Consumption Function and Demand Forecasting Equations

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

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

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

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

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

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

Secondly, in the above equation, $1/(1-a)$ is defined as the demand adjustment speed, $b/(1-a)$ is the log term income effect and $-c/(1-a)$ is the long term price effect. For example, when a=0.7, demand adjustment speed is 1/(1 - 0.7)=3.3, which means the adjustment against changes in income and price takes 3 years to complete in case of annual data. [41] However, since use of a lagged subjective variable

[41] *By using the methodologies, IEA calculates the elasticity as follows. Oil demand elasticity on income is 0.09, and on prices is*

would sometimes incur divergence of the model, such functions are used to a minimal extent in the model.

12.4 Model Building and Simulation Procedures

Building the demand forecasting model, Simple−E, software developed by IEEJ and delivered to developing countries on grant base, is used as model development engine. The model is developed in accordance with the following procedure and has functions for simulation, analysis and output data transfer to the demand/supply optimization model to follow up the analysis.

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

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

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

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

12.4.1 Functions and Roles of the Sheets in Simple-E

The model is created by Simple-E and one book consists of seven work sheets, namely, power sheet, data sheet, model sheet, simulation sheet, growth rate sheet, share sheet and summary sheet. The data sheet, the model sheet and the simulation sheet are created by Simple-E, however, the power sheet is a pre-procedure sheet for the model and the growth rate sheet, the share sheet and the summary sheet are the post-procedure sheets. Their functions and roles are summarized in the following table.

–0.15 for short term and –0.44 for long term. Power demand elasticity on income is 0.4 to 12 and on price is -0.04 to -0.14. However they are greatly different according to the economic development stages. (IEA World Energy Outlook 2006 Chapter 11)

Table 12.4-1 Functions of the Sheets

	Functions and Roles
Power Sheet	Input the future power development plan Calculate shares of power generation by thermal power plants Show power generation capacity by unit Calculate operation load by unit
Data Sheet	Input actual values on economy, energy, prices and efficiencies Input policy variables and exogenous variables Aggregate economic and energy values Describe variable names and comments
Model Sheet	Calculate the data used in the model Build the structure equations (Definition and Regression) Evaluate regression equations
Simulation Sheet	Show the actual data used in the model Show the forecast values and expressions
Growth Rate Sheet	Calculate growth rates Calculate elasticities
Share Sheet	Calculate shares of GDE and GDP items Calculate shares of energy demand by sector Calculate shares of power generation fuel Calculate shares of primary energy demand
Summary Sheet	Summarize power demand by sector Summarize final energy demand by sector Summarize primary energy demand by source

12.4.2 Sectors and Energies forecasted in the Model

Sectors and Energies prepared in the Model are as follows;

Classification of Sector

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

1) Agriculture sector

Forecast energy demand in the agriculture and forestry sectors.

2) Light industry sector

Forecast energy demand in the manufacturing and construction sectors

3) Heavy industry sector

Forecast energy demand in heavy industries such as Iron & Steel, Chemical, Cement and Paper.

4) Transportation sector

Forecast energy demand of the transportation sector by automobile (truck, bus, passenger car and motorbike), railway, marine and aviation.

5) Commercials & Services sector

Forecast energy demand of the communication, services and government sectors.

6) Residential

Forecast energy demand for residential use

7) Other sector

Forecast energy demand of the non-classified sector

8) Power sector

Forecast energy demand by the power generation applying generation, transmission and delivery systems of the power sector.

Energy Demand Forecasted in the Model

The energy demand by type to be forecasted by the model, which are the final energies in the above sectors plus fuel consumption in power sector, are as follows;

Table 12.4-2 Energies forecasted in the Model

Energy	Final Demand	Power Generation
Coal	Yes	Yes
LPG	Yes	
Gasoline	Yes	
Jet Fuel	Yes	
Kerosene	Yes	
Diesel Gas Oil	Yes	Yes
Fuel Oil	Yes	Yes
Natural Gas	Yes	Yes
Non-commercial Energy	Yes	

Chapter 13 Energy Demand and Supply Optimization Model

13.1 Objective

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

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

13. 2 Outline of the energy demand and supply optimization model

13.2.1 Basic policy of modeling

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

1) Whole country model or regional model?

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

a. The objective of this model is to assist and give a suggestion for formulation of an energy master plan projecting for 20 years, but not to make detail analysis for short term energy administration.
b. In order to make the optimization model, huge amount of data over 30 kinds are required. They all relate to various conditions on future supply conditions, prices and etc., estimating which is not easy even for a whole nation model. In view of the current status of statistical data in Vietnam, substantial difficulties may be encountered should a regional model be constructed.
c. In case the optimization model should be a three region model, the scale of the model becomes greater than three times, since transportation among regions should be added in the model. Thus, confining the projection only to one year, it would not be possible to handle the model by the student version of GAMS; the tool of making the optimization model will be described later. As the Counter part does not have experiences of making an optimization model using GAMS, technical transfer is another objective of this project. To promote this objective too, it would be appropriate to limit the model within a size that could be handled by the student version of

GAMS.

2) How to handle the investment issue?

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

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

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

13.2.2 Objectives of optimization model

1) Objective energies

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

- Crude oil: Domestic crude oil (Bach-ho, Su Tu Den)
  Import crude oil (Dubai, Sumatra light, Arabian light, Arabian heavy)
- Coal: Domestic (raw coal, high quality coal, medium quality coal, low quality coal)
  Import (import coal)
- Gas: domestic (raw gas) and import (PNG, LNG)
- Petroleum products: LPG, gasoline, kerosene, jet fuel, diesel gas oil, fuel oil
- Electricity
- Others (intermediate product or by product at refinery)

2) Objective facilities (plants)

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

- Oil refinery

  An oil refinery composes of topper (atmospheric pressure distillation unit), vacuum distillation unit, reformer, cracking unit, hydro-desulfurization unit, and etc. They make up an oil refinery as a package. This model contains the first refinery currently under construction, the second refinery under designing, the third refinery under study, plus hypothetical No4, 5, 6 oil refineries.

- Power Plants

  Power plants are classified into eight kinds based on the energy source as follows.

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

- Coal Preparation Plant (coal processing)

  At a preparation plant, raw coal will be separated into high-, medium- and low-quality coals. 10% of the raw coal will be void as waste.

- Gas Processing Plant

  At the gas processing plant, raw natural gas sent from offshore is processed. At first, condensate (C5+) is extracted and then the rest of the gas will be separated into LPG (C3, C4) and natural gas (C1, C2).

3) Objective period

The objective period is 21 years from 2005 through 2025 to be covered by the Master Plan.

4) Decision items

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

5) Objective function

In the standard cases such as the Reference Case, the objective function is defined as the net present value at 2005 of the total cost incurred during the projection period. This objective function can be defined applying other criterion subject to the purpose of analysis.

13.2.3 Energy flow

(1) Energy Flow Chart

Energy flow is the basic information in compiling an optimization model and is supposed to explain the current and future energy flow of Vietnam. Of course, consideration is made on simplification and easiness to understand. Primary energy is produced from mines or oil/gas fields and transformed to secondary energies before delivered to the users via several routes and finally consumed. The energy flow chart illustrates such flow of energy. As it is difficult to show all of them in one figure, they are shown in several figures stage by stage hierarchically in Figure13.1-1～Figure13.1-4.

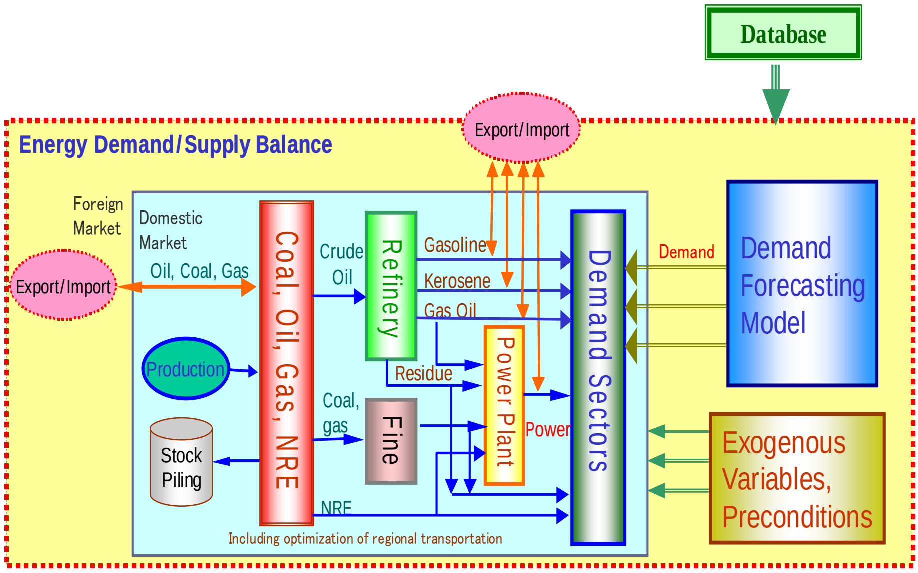

Figure 13.1-1 Energy demand and supply optimization model total flow

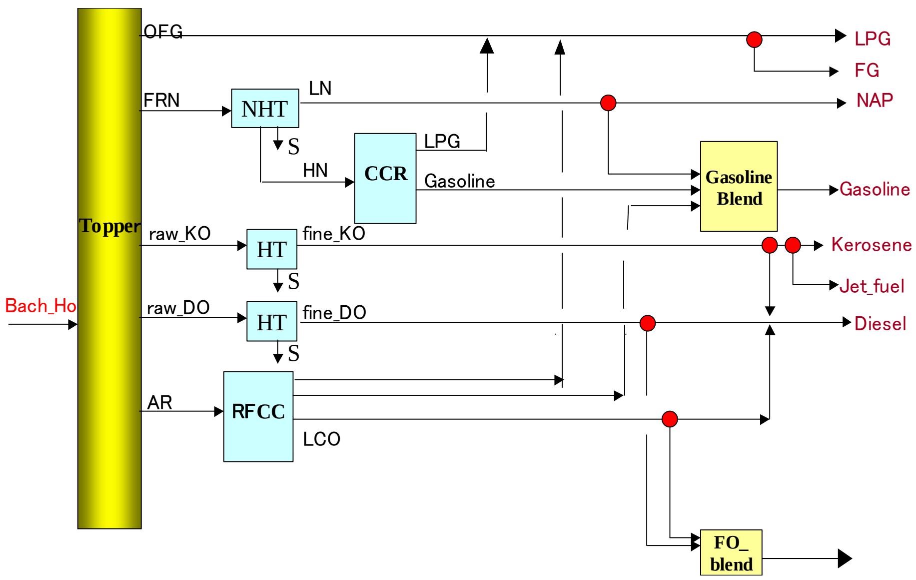

Figure 13.1-2 No1 oil refinery

Figure13.1-1 shows the total flow incorporated in this optimization model. This figure shows that demand data is given as input from the result separately forecasted by the demand forecasting model. The refinery part is composed of six plants from No1 to No6. Figure13.1-2 represents the process flow of the first refinery currently under construction at Dung Quat. Figure13.1-3 shows the hypothetical flow of No.3 through No.6 refineries incorporated in the model assuming processing of import crude oils.

Figure13.1-4 is the flow chart including flows of coal, natural gas and power plants. As shown here, produced domestic coal will be segregated by quality, and high quality PCI coal will be directed for export (for mainly Japan) while medium and low quality coal will be directed to domestic use at power plants and general users. The raw natural gas is separated at gas processing plant into condensate, LPG and natural gas. Among them, the flow chart shows that natural gas will be consumed at power plants and end users.

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

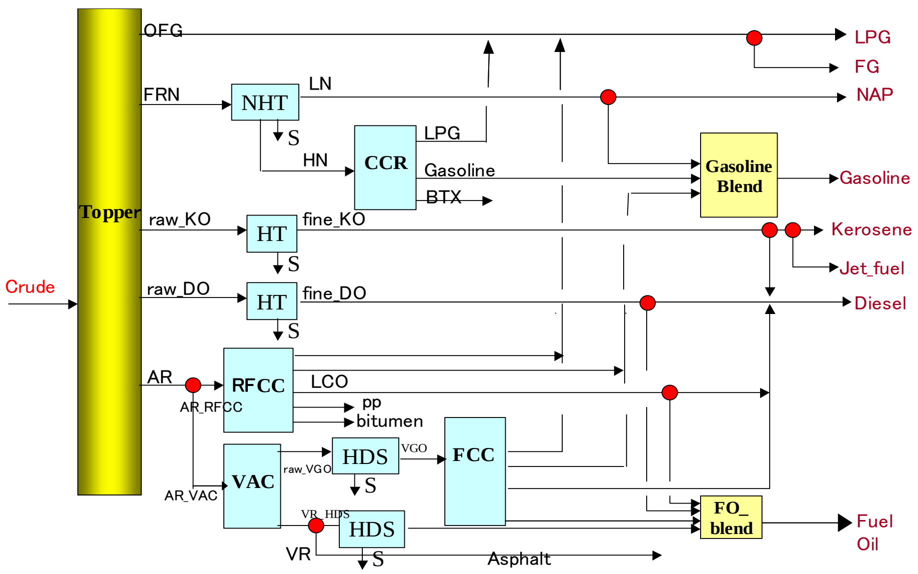

Figure 13.1-3 No3～No4 virtual refinery plan

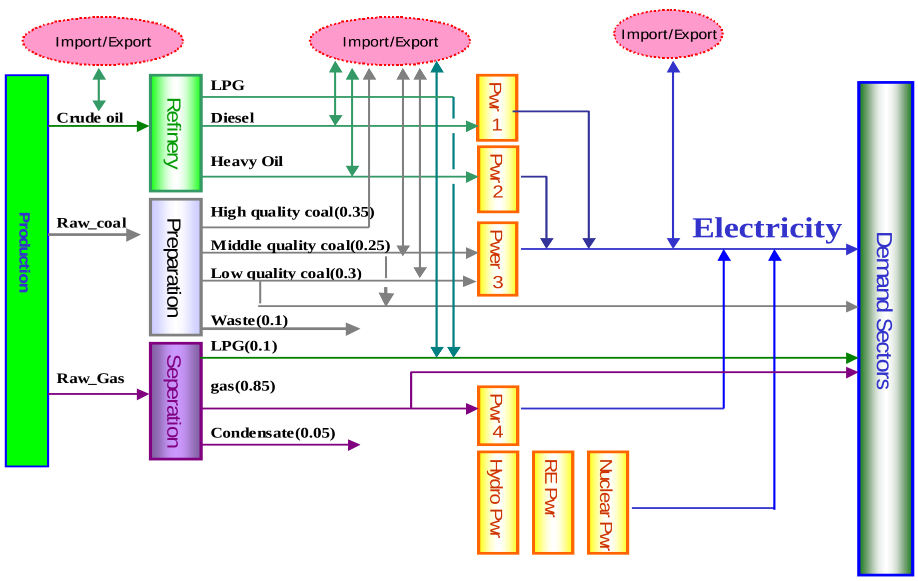

Figure 13.1-4 Coal, Gas, Electricity energy flow

(2) Special treatment

In this model, special treatments for simplification purpose are made in expression of flows of several energies as follows.

1) As there is no firm plan to utilize propylene produced from RFCC, they are delivered in the model to gasoline and diesel gas oil by 50/50 percents.
2) Whole quantity of BTX produced in the refining process is converted into gasoline.
3) Whole quantity of condensate produced at the gas processing plant is converted into gasoline.
4) Though bitumen is produced processing atoms residue at Vacuum Distillation Unit, the model is written as if bitumen is produced directly from RFCC with an adjustment of yields corresponding to the actual complex process.

13.2.4 Basic constraints

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

a. Production from topper = yield x crude oil feed
b. Crude oil feed into topper <= topper capacity
c. Domestic crude feed to No1 topper >=total crude feed x (1- import oil ratio)
d. Domestic crude feed to No2 topper = import crude feed
e. Fuel consumption=power generation x 860 / (heat value of fuel x heat efficiency)
f. Basic balance: production + import = consumption + export
g. Oil stockpiling: stockpiling = consumption of crude oil per day x stockpiling day
h. Total emission of CO2 <= maximum emission permitted

13.2.5 Input data

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

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

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

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

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

13.2.6 Output table

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

a. Energy balance table
b. Comparison tables of case study
c. Results of refinery products
d. Results of electricity
e. Results of import/export
f. Bound (min and max) of each variable

In addition, four summary sheets on Common Information, Oil & Gas, Electricity, Coal and Renewables are output for an easy comparison study. Please refer to sample of them attached as Appendix. However, as most of the tables covering 21 years are not suitable for print out, please refer to them on computers.

13.2.7 Model size and execution time

The size of a LP model can be measured by the number of variables and constraints incorporated. Now there are about 3,100 variables and 2600 constraints covering 21 years. Should the energy flow change, new plants be installed or new energy item be added, the model size would greatly increase. At this moment, the execution time of this 21 year model is less than 1 second. This execution time would also increase if constraints overlapping years are levied or strong constrain are added. At any rate, however, the execution time would not become a serious problem.

13.2.8 Modeling tool

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

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

Input file is written in EXCEL. One sheet contains one data item. These sheets are housed in one book and there are 36 sheets. As GAMS cannot directly handle a book form of EXCEL, we need to convert them from an EXCEL sheet to a CSV (Comma Separated Value) file one by one. To make this easier, a macro program is added in this input EXCEL book with a function to automatically convert one sheet to one CSV file by one click.

Regarding the output file, over 10 output tables are generated in the CSV file form so that it is easy to read the output tables by EXCEL. The configuration of these tools is shown in Figure13.1-5.

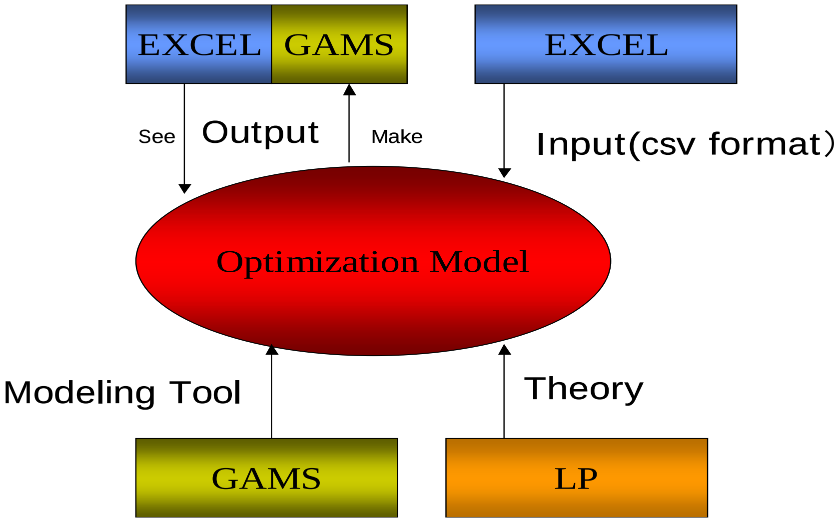

Figure 13.1-5 Modeling tool

13.2.9 System block flow

Figure 13.1-6 shows the system block flow from receiving the demand forecast results to obtaining the final solutions.

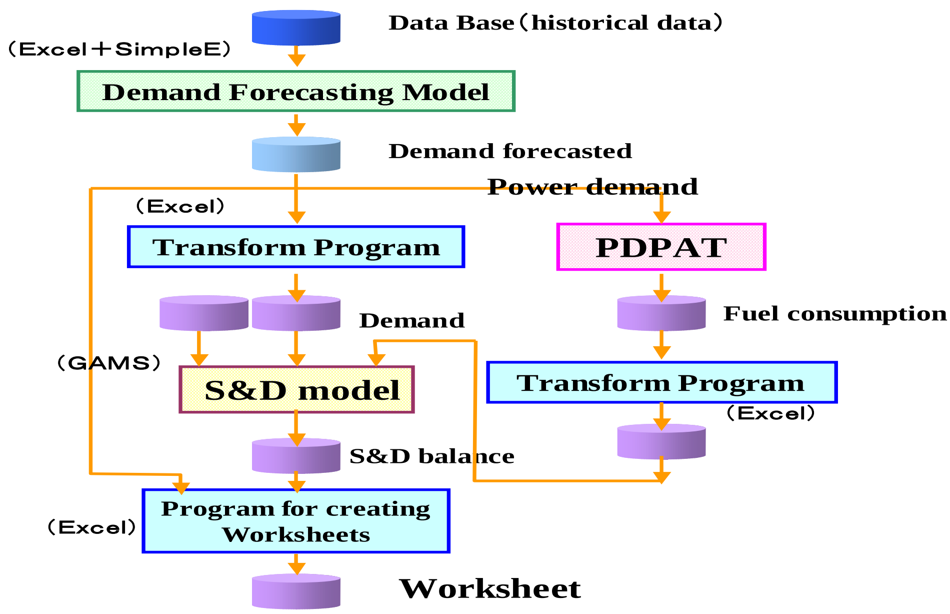

Figure 13.1-6 System flow

13.3 Functions and operations of the optimization model

This energy supply optimization model has following functions.

(1) Information created (main function)

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

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

b. To calculate the minimum total cost as the net present value at 2005

(2) Service functions for convenience of users

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

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

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

(3) Functions of GAMS itself

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

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

g. To show grammatical error message

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

i. To show the number of infeasibility if infeasible

j. To show name of the output table created

k. etc

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

Postscript

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 have completed the model that we had aimed at the very outset. Then, as discussed in Part 3, we identified important issues to be considered and illustrated possible direction of energy policies. We believe that we have successfully achieved the original objective, yet there are many points to be improved. We hope that the system shall be repeatedly tested and upgraded by the hands of Vietnamese colleagues. Toward this end, we would like to memorize several hinting as follows.

Method of Approach

At the workshop held on January 23, 2008 when we reported the draft final report of this study, we obtained various questions and comments and 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.

Subjects classified under Catergory-1 are those most important ones for the purpose of this study to "formulate a comprehensive energy plan to be positioned above various sector plans". We have tried to amplify our analyses on them as much as possible in this final report. On the other hand, because of time constraints, it was not possible to incorporate those changes and/or analyses in the study that occurred after October 2007 when we finalized the preconditions for this study, such as changes in the global economy and energy in particular abrupt rise of crude oil price and financial instability that followed. In addition, we think that subjects under Categories 2 and 3 should also be considered in the next step study. We expect that further studies will be conducted on the Vietnamese side, while we are pleased to provide every support.

Analytical Tools

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

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

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

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

Thirdly, the energy supply/demand optimization model comprises two blocks, namely, PDPAT to treat the electric power supply and the general block to optimize all other sectors. However, in consideration of equalizing the level of analysis, conducting comprehensive analysis and improving operationality, it is desirable to simplify the electric power sector, incorporating it into the general model, and make the latter as a self-complete one. Then, PDPAT should be used as a sub-model to check and verify if the simplified electricity block of the general model produces rational answer. With regard to coal, oil and gas and renewable energies, it is necessary to establish a system to check and verify the answers of the general model using sub-models and/or supplemental analyses since it is difficult to conduct in-depth analysis by the general model. Especially as the current model tends to be too much elaborating on the oil-refining sector, if we could simplify that part by way of sub-model, operationality of the general model will be substantially improved.

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

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

Fourthly, we have conducted in this study Strategic Environment Assessment (SEA) by way of environmental and social impacts (ESI) analysis applying the outcome of the case studies run on the energy supply/demand outlook. We have applied an integrated marking system to consider effects of various factors on environment and society, evaluating their effects in each energy sector by scoring them, then integrating them into a comprehensive index of ESI, and compared environmental impacts of various development scenarios. This was the first trial to build such an assessment method to be applied on an overall energy plan. While we try to accommodate substantial volume of factors in the evaluation, it is necessary to examine whether analyses and evaluations applied in individual sectors are fair and proper or whether the outcome is useful as an effective and comprehensive index.

To formulate and implement comprehensive energy policy reviewing issues and concerns as above, we think that it is essential to create an office or body responsible for energy and environment policy with sufficient power. To implement the mission, first of all, data collection is important. Thus, it is necessary to create a mechanism and responsible organization for data collection as soon as possible. Then, specific knowledge and expertise are necessary for conduct of energy analysis, operation of analytical models and improvement of them. Thus, it is desirable to create a research body equipped with specific expertise. Then, the responsible office should take initiative to integrate and coordinate among relevant sectors and offices for implementation of comprehensive energy policy.

Study on Energy Policy

In part 3, we have presented examples of contents to be incorporated in the National Energy Master Plan. Starting from various analyses developed in Part 2, we tried to identify issues and challenges anticipated in the energy field referring to experiences and discussions in Japan and the world and illustrated examples of basic policy, roadmap and action plan. We regret, however, that time was too short to thoroughly exchange views and opinions with our Vietnamese counterpart and relevant people either on the overall framework or individual subjects. It is the future task to elaborate on how to assemble the outcome of the model analysis into meaningful and practicable policies.

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

Secondly, it is the role of roadmaps and action plans to show the process how to create practicable policies toward the final goal and to implement them. In principle, such plans should be based upon reality and practicability, and be adjusted in due course from time to time reviewing changes in circumstances. For example, when we consider the characteristics of energy as a strategic commodity, long lead time and huge amount of fund required to construct energy system, effect of economics of scale, consistency of energy policy among the overall social policy and so on, it is not necessarily right to go forward straightly toward creation and liberalization of the energy market. We should learn from the historical lessons that American and European economies have experienced serious energy market failures. Though construction of energy efficient economy is an ideal, Vietnam as a developing country still constructing its economy needs feed of fundamental materials such as steel and cements to build factories, offices and social infrastructure such as roads, schools and hospitals. Definitely, energy will be needed for production, transportation and/or construction. Individual policy should not prejudice the overall goal of the society. To avoid such situation, it is important to establish the country's long-term goal and proceed with economic construction considering the consistent balance of various sectors.

Thirdly, suspicions and anxieties were raised on the outcome of the study that Vietnam would become a net energy importing country around 2015. It is of course a controversial issue that Vietnam, a net energy exporting country at present, would become a net energy importing country. Then, it is a quite reasonable response to try to enhance development of domestic energy resources. At the same time, however, it is necessary to prepare against the situation that import dependence would progress. Since the share of Vietnam's energy consumption is only about 1% among East Asian countries even in 2020, and compared with the fact that Japan and China are importing huge amount of energy, it is not necessary for the country to worry too much about international procurement. Despite this fact, there are three major principles to obey for the stable procurement, that is, 1) to procure them at international prices, 2) to prepare import facilities compatible with international standard, and 3) to establish contact channels with energy exporting countries and enterprises. From the energy security viewpoint, there may be an option to start energy import a little bit ahead of time while maintaining some reserves on development of domestic energy resources.

Fourthly, in the contemporary world, global warming is the issue that could not be decoupled from energy policy. As global concern and discussion on the Post-Kyoto Protocol mechanism are rising, it is necessary for Vietnam to discuss how to cope with the matter and set out its firm stance against the global warming issue, although the country's energy consumption is relatively small in the world.

From now on as our Vietnamese colleagues will start operating the model by your own hands and discussing the outcome for evaluation of policy options among yourselves, you will realize that there are far more approaches to evaluate and structure various energy policies than considered in this report. This report is just a starting point of such trials. We look forward to the day when 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.

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