
THAILAND

Energy and Natural Resources

Prepared for the National Identity Office by Energy Policy and Planning Office

With the advent of economic recovery after the 1997 economic crisis, Thailand's energy consumption has remarkably increased. The GDP growth rate has continuously increased, reflected by the increasing growth rate of the industrial output index. The industrial sectors which have a high growth rate include the construction material sector and the automobile and transportation equipment sector. Particularly, automobile and motorcycle manufacturing for commercial purpose has continuously increased since early 2002.

Thailand's commercial energy demand in 2002 totaled 1,283 thousand barrels per day of crude oil equivalent, an increase of 6.6% from the demand in 2001. The demand increased for all energy types, especially for natural gas and coal/lignite. The shares of commercial energy demand were the following: petroleum products, 46%; natural gas, 37%; coal/lignite, 14%; and electricity/import electricity, 3%.

The production of all types of commercial energy also increased by 6.2% to a level of 631 thousand barrels per day of crude oil equivalent. Crude oil production increased at a high rate of 22.1% since three new producing oil fields commenced operation, i.e. Maliwan of Chevron, Sangkajai of PTTEP and Yala which is one of the Big Oil Project of Unocal (comprising Plamuk, Kaphong, Surat and Yala fields). Natural gas production also increased at a rate of 4.5%.

Thailand's net energy import increased by 5.5%, accounting for 795 thousand barrels per day of crude oil equivalent. One major factor was the import of natural gas from Myanmar, which increased by 24.5%. Crude oil import slightly decreased by 0.3%; the net import of condensate, petroleum products and electricity also decreased. However, the ratio of dependency on commercial energy import to the total domestic energy demand still remained at the level of 62%. There was still export of petroleum products since the refining capacity was in excess of the domestic demand.

In 2002, the final commercial energy demand increased by 11.9%, compared with the previous year. Lignite consumption increased by 8.7%, mainly by cement manufacturing which increased considerably resulting from the government measures stimulating immovable property, particularly housing, and hence continual expansion of construction business. Utilization of natural gas, imported coal, petroleum products and electricity increased by 11.9%, 13.2%, 5.8% and 6.7% respectively.

Natural Energy Resources

Natural Gas and Condensate

In Thailand, the potential of natural gas production is quite substantial. Most of the gas reserves are off-shore in the Gulf of Thailand. As of December 2001, the total volume of natural gas reserves was estimated at 22,433 billion cubic feet. Proven reserves were estimated at 13,341 billion cubic feet. In 2002, the total natural gas production was 950 billion cubic feet. Bong-kot, the largest production field in the Gulf of Thailand, yielded 28% of the total domestic production. Imported natural gas was from Myanmar (Yadana and Yetakun fields) at the level of 152 and 72 billion cubic feet respectively. Normally, the natural gas produced is sent to gas separation plants. The portion containing methane is used as fuel in power generation, in the manufacturing sector, and by vehicles; another portion containing ethane and propane is used as feedstock for the petro-chemical industry; and the other portion containing propane and butane is used as cooking gas and as fuel in industrial factories and by vehicles. At present, natural gas is still the most important fuel in power generation and the consumption of natural gas in this sector was 71% in 2002.

Condensate is an associated product in gas-bearing basins; therefore, the amount produced has increased in proportion to the increase of natural gas production. In 2001, the total volume of condensate reserves was estimated at 481.33 million barrels, with proven reserves of 258.42 million barrels. The production of condensate was 53.1 million barrels, which was mainly utilized by domestic refineries. Condensate production is expected to increase to 63.4 million barrels in 2006.

Crude Oil

Crude oil reserves have been estimated at 476.1 million barrels, of which 324.9 million barrels are proven reserves. Most crude oil reserves are located at the Sirikit Oil Field in Kamphaeng Phet Province. In 2002, the total crude oil production was 75.6 thousand barrels per day, of which 35.1 and 20.6 thousand barrels per day (crude oil equivalent) came from the Benjamas and Sirikit Oil Fields, accounting for 74% of the total crude oil production. Besides, there was additional production from three new oil fields, i.e. Maliwan, Sangkajai, and Yala, which commenced operation in 2002.

Compared with the domestic demand, the production of crude oil from indigenous resources was very low; therefore, there was a need to import crude oil at a high rate of 90%. In 2002 the total imported crude oil was 677 thousand barrels per day. The total domestic refining capacity in 2001 was 994.5 thousand barrels per day, increasing from 844.5 thousand barrels per day in 2000, due to the increase of TPI's refining capacity from 65 thousand barrels per day in 2000 to 215 thousand barrels per day in 2001.

With regard to oil consumption by all economic sectors, the transportation sector is the largest consumer. This sector alone accounts for more than 60% of the total domestic oil consumption. Next to it are the industrial sector and the power sector, for power generation. The consumption by the residential and commercial, the agricultural and the mining sectors is rather small when compared with the consumption by other sectors.

Lignite and Imported Coal

Domestically produced coal is mostly lignite and sub-bituminous and has played an important role as a major energy source for decades. In 2001 the total reserve was 2,155 million tons. Of this, 1,124 million tons, or 52.16% was from the Mae Moh basin operated by the Electricity Generating Authority of Thailand (EGAT). The Krabi basin has a measured reserve of 112 million tons. In southern Thailand are the Saba Yoi basin in Songkhla Province, with a measured reserve of 350 million tons, and the Sin Pun basin, with a measured reserve of 91 million tons. In the north, there are the following basins: Wiang Haeng, Ngao and Mae Tha, with a measured reserve of 93, 48 and 25 million tons respectively.

In 2002, lignite production was 19.6 million tons, 76% of which came from the Mae Moh Mine of EGAT and was used in power generation. The remaining 24% was produced by private mines and used by the industrial sector, including cement, pulp & paper, food processing and tobacco-curing industries. Coal consumption by the industrial sector increased at an average rate of 22.2%. More than 70% was used as fuel in cement manufacturing.

Renewable/Alternative Energy Resources

Since it is projected that energy demand will keep increasing, efforts have been made to explore and develop other potential energy sources to accommodate the increasing demand. Renewable energy, energy which is inexhaustible, and alternative energy are considered potential options, which will help reduce not only the country's dependency on imported energy but also risks of volatility of imported fuel prices. Several public agencies have carried out, without cease, researches into various renewable energy and alternative energy sources.

Renewable energy is mostly derived from natural resources and hence considered clean and environmentally friendly. However, there exist some hindrances to the development of renewable energy and the costs of harnessing renewable energy resources are still high compared with the costs of using commercial energy, particularly, the development of solar and wind energy which require the use of high cost technology. Renewable energy that has high potential to be used in place of fossil energy includes, for example, hydropower, biogas and biomass energy, solar energy and geothermal energy. Studies and development on these energy sources have continuously been undertaken by several agencies, both at the local level initiated by local intellect and at the government level. At present, the development of renewable/alternative energy has become a focus of interest and wider utilization has been promoted to replace conventional energy consumption in parallel with the efforts to stimulate people to use energy efficiently and economically.

Hydro Electricity

Hydropower has been developed for power generation since 1964. The potential of hydropower in Thailand is estimated at 15,155 megawatts (MW). As of December 2002, EGAT produced 7,366.9 GWh of hydropower, which accounted for 6.6% of the total EGAT power generation by fuel type. However, hydropower resources are difficult to exploit due to the environmental impact on the resource areas a

power project would entail. Therefore, future development of hydropower resources will be limited to a few small-scale projects which are considered most economical and environmentally friendly.

As part of the rural electrification program, having already brought electricity to 99% of villages in Thailand, small hydropower sites have been identified as economically suitable for more accurate cost estimates and detailed engineering work. It should be noted, however, that a thorough feasibility study of a small hydropower project tends to indicate that the cost of electricity generated from a suitable hydropower site can be more economical than electricity generated from a set of photovoltaic plants.

Biogas and Biomass

In Thailand, there has been development of the biogas technology using biogas generated from animal manure, especially that of pigs and cows, as fuel in power generation and in cooking. Development has also been undertaken on power generation from landfill biogas. The major financial resource is the Energy Conservation Promotion Fund (ENCON Fund) of the government. Several biogas projects have been supported by the ENCON Fund, such as the biogas from animal manure for power generation in livestock farms, R&D on the feasibility of biogas generation from wastewater treatment systems in factories, and the development of a biogas map providing information on pig farms and dairy farms nationwide in order to facilitate the planning of biogas utilization in the future.

As for biomass, or biomass energy, it is a kind of fuel derived from organic substances, such as agricultural residues like woodchips, bagasse and paddy husks, or animal manure from livestock farms, including wastes from agricultural product processing and wastewater from factories. Biomass can be an important energy resource, and the resources of biomass are distributed across the country. Available data on biomass resources include firewood, bagasse and paddy husks. Other resources include agricultural and industrial residues, which have been used as fuel, but the data compilation is yet to be made; these include palm outer-covering fiber and shells, and empty bunches of palm, for example.

Thailand is an agricultural country with a huge agricultural output, such as rice, sugarcane, rubber sheets, palm oil and cassava. Part of the harvest is exported each year, generating billions of baht revenues for the country. However, in processing these agricultural products, a large amount of residues is also generated. Part of these residues has been used as fuel in the industries. For instance, paddy husks are burned to produce steam for turbine operation in rice mills; bagasse and palm residues are used to produce steam and electricity for on-site manufacturing process; and rubber wood chips are burned to produce hot air for rubber wood seasoning. Moreover, the remaining biomass can be used for power generation, with the following potential:

Paddy husks, biomass from rice mills: each ton of paddy requires 30-60 kWh of energy for all stages of processing, yielding about 650-700 kilograms of rice and residue, that is, about 220 kilograms of paddy husks which can be used to generate 90-125 kWh of energy.

Bagasse, biomass from sugar mills: each ton of sugarcane requires 25-30 kWh of energy and 0.4 ton of steam for all stages of processing, yielding about 100-121 kilograms of sugar and residue, that is, about 290 kilograms of bagasse which can be used to generate about 100 kWh of energy.

Palm outer-covering fiber, shells and empty bunches, biomass from palm oil extracting plants: each ton of palm requires 20-25 kWh of energy and 0.73 ton of steam for all stages of processing, yielding about 140-200 kilograms of palm oil and residues, that is, about 190 kilograms of palm outer-covering fiber and shells and 230 kilograms of emptied palm bunches which can be used to generate about 120 kWh of energy. In addition, there will be about 20 cubic meters of wastewater from the processing which can be used for biogas generation.

Woodchips, biomass from sawmills: one cubic meter of wood requires 34-45 kWh of energy for all stages of processing, yielding about 0.5 cubic meter of processed wood and residue, that is, about 0.5 cubic meter of woodchips which can be used to generate about 80 kWh of energy.

Apart from the use of biomass residues and wastewater containing organic matters for energy production, in recent years several efforts have been made to explore the potential to use biomass to produce **bio-liquid fuels** for engines and vehicles, which can be alternatives to use of gasoline and diesel oil and thus help reduce dependency on oil import.

Ethanol - The use of agricultural products, such as cassava and molasses, for ethanol production has been given particular attention since ethanol, which is 99.5% pure alcohol by volume, can replace the use of Methyl Tertiary Butyl Ether (MTBE), a fuel additive, which takes a long time to degrade. Each year Thailand spends more than 2 billion baht on MTBE import. Therefore, the use of domestically produced ethanol can contribute to foreign currency saving as well as mitigation of pollution problems resulting from fossil fuel combustion. Efforts to use ethanol as alternative fuel actually commenced in 1977, but the cost of ethanol production then was much higher than oil prices. Commercial production was, therefore, not materialized. However, at present, given the continually increasing oil prices, ethanol is considered a viable alternative fuel for the transportation sector.

The annual production of cassava in Thailand is estimated at 18 million tons while only about 4 million tons are used for domestic consumption and the rest will be exported. To increase added value of cassava, about 2 million tons per year can be used for ethanol production of up to 1 million litres per day.

To date, eight private ventures have expressed interest in ethanol production, with a combined production capacity of 1.5 million litres per day. Raw materials to be used in the production are cassava roots and molasses. It is expected that commercial production of ethanol could commence by mid-2003.

Gasohol - Gasohol is an alternative fuel for vehicles. It is a mixture of ethanol and regular gasoline at the ratio 1:9. The properties of derived gasohol are the same as Octane 95 gasoline. However, the use of gasohol will not only reduce oil consumption and air pollution from vehicle exhaust but also help farmers through the purchase of agricultural products, i.e. sugarcane and cassava.

In order to support and promote the production and use of ethanol and gasohol, the government has approved in principle the exemption of excise tax imposed on the ex-plant ethanol and on the ethanol mixed with gasoline, the deduction of contribution rates to the Oil Fund and to the ENCON Fund for gasohol; and the pricing of gasohol to be cheaper than that of Octane 95 gasoline within a range of not exceeding one baht per litre.

Moreover, the government has approved several supportive measures. For example, a policy will be established for government agencies and state enterprises to give priority to gasohol for their vehicle fleets. Promotion and support will be made to enhance preparedness of the automobile and oil refining industries to accommodate the production and use of fuel ethanol, by provision of tax privileges, for instance. Besides, potential SME practitioners and farmer organizations or entities will be encouraged to establish ethanol producing plants so that production of ethanol from agricultural products could be distributed across the country. Such measures as provision of financial assistance, in the form of concessional loan or soft loan, and provision of technical assistance from the government agencies will also be introduced for this purpose.

Biodiesel or Ester - Biodiesel, or ester, another alternative fuel for vehicles, can be produced from oil plants such as coconut, soy bean, palm and sunflower via a chemical process (Transesterification or Alcoholysis), using alkaline as a catalyst to transform fatty acid into ester or biodiesel, which has similar properties to those of diesel oil. In Thailand, biodiesel standards are yet to be established. The current mixtures vary, for example, between diesel and ester extracted from palm oil, diesel and ester extracted from coconut oil, or diesel and ester extracted from used cooking oil.

There are several factors encouraging research on biodiesel and its development in Thailand. These include: 1) problems of oil price hikes that Thailand, being an oil importing country, has been facing; 2) continuous price drops of agricultural products causing troubles for farmers; 3) increasing transportation costs of agricultural products due to increasing prices of diesel; and 4) the environmental impact resulting from diesel combustion. In 2001, His Majesty the King Bhumiphol of Thailand graciously took out a patent for the use of pure palm oil as fuel for diesel engines, with PTT carrying out the research and development.

Currently, several institutes have undertaken studies and development of the quality of biodiesel and "blended oil" (a mixture of diesel and crude plant oil or that of diesel and refined plant oil without any chemical process) compared with the specified diesel standards. It has been reported that blended oil has advantages over diesel in that it contains lower sulfur content and helps with lubrication; however, the quality of different bulks of blended oil varies although it is sold at the same distribution station. Research is being carried out on biodiesel production from crude coconut oil ("cocodiesel") and on the impact of cocodiesel utilization on the environment.

Similar to the promotion and support to ethanol and gasohol, ester can be mixed with diesel, at a ratio no greater than 1:9, and the excise tax and the contribution to the Oil Fund are exempted for the portion of ester produced from plant oil and mixed with diesel. As a long-term measure, through use of the ENCON Fund, the government will continue supporting R&D to improve biodiesel efficiency as well as research on other oil plants to diversify sources of production; the standards for engine adjustment to enable them to run on biodiesel will be established.

Solar Energy

The use of solar energy for power generation, using solar cells or photovoltaic (PV) cells, has been promoted by the government. So far, about 5 megawatts of PV power generation systems have been installed in Thailand; most of them are in remote areas beyond the grid systems, and solar cells have to be imported. Government support has also been given to demonstration projects on solar energy utilization and integrated systems of PV/hydropower and PV/wind energy.

Several government agencies under the Ministry of Energy have been undertaking studies and development of the PV technology. For example, the Department of Alternative Energy Development and Efficiency (DEDP) has studied and explored the potential of solar energy utilization. Solar cell battery-charging stations have been established in various rural villages that do not have access to the national grid system and for Border Patrol Police Schools that are located outside the grid system. Several demonstration projects have been carried out, for example, demonstration of renewable energy utilization in the areas of six major Royal Initiative Projects such as the installation of PV power generation systems and the installation of PV-pumping systems for rural village water supply.

The Electricity Generating Authority of Thailand (EGAT) has developed several projects demonstrating power generation using the PV technology, PV power generation without use of batteries, and rooftop PV grid-connected systems. Development has also been undertaken on the integrated use of solar/wind energy for power generation at Phromthep Cape in Phuket Province, and the integrated use of solar/hydro energy at Klong Chong Klum in Sakaew Province.

The Energy Policy and Planning Office (EPPO) is the government agency monitoring the ENCON Fund allocation for renewable energy projects. Grants have been given to encourage R&D on solar energy. Examples of funded projects are: the development of solar radiation measuring station network for Thailand; the demonstration project of electricity generation and distribution system using solar cells in Mae Hong Sorn Province in northern Thailand where most areas are mountainous with scattered population; and the establishment of "Solar Energy Park" to serve as the center for demonstration and information dissemination on solar energy.

Besides, the Thailand Research Fund (TRF), an independent organization under the Office of the Prime Minister, is another institute undertaking R&D and facilitating information on solar cells. In 2001, TRF approved a research project on the production of silicon from paddy husks, which can be eventually used for solar cell production and thus promoting development of solar cells using indigenous resources.

Wind Energy

The average wind speed in Thailand is moderate to rather low, usually lower than 4 meters per second; therefore, wind energy is currently used almost exclusively for propelling rooftop ventilators and water-pumping turbines. High wind speed along the coastline, however, may have the potential for power generation.

In Thailand, studies have been undertaken on wind energy development, particularly for power generation. A wind resource assessment of Thailand has been developed, showing details of wind resource distribution, prevailing wind, wind speed and directions, and other characteristics pertaining to potentialities of wind energy in various regions nationwide. Currently, a further detailed study is being carried out in areas where the wind potential is high, mainly along the southern coastlines from Nakhon Si Thammarat Province downwards, to obtain more data with a view to determining the feasibility to develop projects using wind energy for power generation.

Fuel Cells

Study has been undertaken in Thailand on the feasibility and potential to use the fuel cell technology for power generation, using a process that transform chemical energy of fuel into electrical energy via electrochemical mechanism. Generally, in a normal energy transformation process, the chemical energy (fuel) will be transformed into thermal energy, then to mechanical energy and finally to electrical energy; hence the energy potential will be less than the fuel cell technology due to energy loss in various stages of the process.

One major factor that makes the fuel cell technology a subject of interest is its environmental advantage. The fuel source for fuel cells is hydrogen and the output from the chemical reaction in the production process is water, which has no impact on the environment. Moreover, since no transformation into thermal energy occurs in the fuel cell process, there is no combustion and hence no generation of CO₂ and other greenhouse gases from the use of this technology. However, one major hindrance of the development of this technology is the high production cost and the technology is still under ongoing development.

In Thailand, the information on fuel cells has been compiled from both domestic and foreign sources. Cooperation has also been made with various laboratories so as to establish a fuel cell technology center. R&D and demonstration projects on molten carbonate fuel cell (MCFC) and phosphoric acid fuel cell (PAFC) have been undertaken, aiming to improve efficiency and to reduce the production costs to be affordable by the general public.

Geothermal Energy

Geothermal energy is natural energy from the internal heat of the earth; the temperature varies with respect to the distance from the earth surface (geothermal gradient) - the deeper from the earth surface, the higher temperature. At the depth of about 25-30 kilometers, the average temperature will be around 250-1,000°C.

There are approximately 64 geothermal resources in Thailand, but major ones are in the north of the country, especially the geyser field at Fang District in Chiangmai Province. Survey on the potential of geothermal energy development at Fang District commenced in 1978, with technical assistance and experts from France later in 1981. Currently, EGAT is operating a 300-kW binary cycle geothermal power plant at Fang District, generating electricity at about 1.2 million kWh per year, which helps reduce oil and coal consumption for power generation.

In addition, other benefits can be derived from the waste heat of hot water used in the power plant. The temperature of hot water, after being used in the power plant, will decrease from 130°C to 77°C, which can be used for drying agricultural products and feeding the cooling system for EGAT's site-office space. Some other non-energy uses of hot water from geothermal sources are for physical therapy and tourism.

Energy Conservation Program

Energy Conservation Promotion Act & Energy Conservation Promotion Fund

The Energy Conservation Promotion Act has been in force since 3 April 1992 with a view to promoting energy conservation discipline and promoting energy conservation investment in factories and buildings. This Act is an innovative policy instrument as it blends incentives with mandatory regulations to facilitate the implementation of mandated energy efficiency measures. The Energy Conservation Promotion Fund (ENCON Fund) was established, under the Act, to provide financial support to government agencies, state enterprises, non-government organizations, individuals, and businesses that wish to implement measures to increase efficiency in energy utilization. At the same time, a punishment clause is stipulated in the Act for owners of any designated factory or building who fails to comply with the standards, criteria and procedures as provided by related ministerial regulations issued under the Act. The role of the public sector is to establish and utilize government mechanisms to encourage and promote energy conservation implementation by consumers, including development and utilization of renewable energy which is environmentally friendly.

Financial assistance from the ENCON Fund to materialize the above-mentioned objectives is monitored under the framework of the Energy Conservation Program, divided into three main areas:

- Compulsory Program
- Voluntary Program
- Complementary Program

Compulsory Program

The Department of Alternative Energy Development and Efficiency (DEDP) of the Ministry of Energy is responsible for the program implementation. This program relates to mandatory energy conservation implementation as specified by laws and regulations enforced under the Act, involving "designated" factories and buildings, using energy at a level of 1,000 kW or 1,175 kilovolt-amperes (kVA) and greater, or using non-renewable energy or steam in a previous year at an amount equivalent to, or greater than, 20 million megajoules of electric power. The program also supports energy conservation in government buildings, of which electrical capacity demand is 100 kW and greater, that wish to implement energy conservation measures as in the case of designated factories and buildings.

The Compulsory Program currently comprises three main projects, i.e.

1. Government Building Project;
2. Project on Existing Designated Factories and Buildings; and
3. Public Awareness Campaign Project, under the DEDP's Responsibility.

Government Building Project aims to promote energy conservation in government buildings that are not designated by laws so as to spearhead energy conservation and to reduce the government expenditure on energy cost.

Project on Existing Designated Factories and Buildings aims to support owners of existing designated factories and buildings for both the development of a comprehensive energy efficiency

improvement plan and the investment to improve energy efficiency according to the plan as presented to and approved by the DEDP.

Public Awareness Campaign Project, under the DEDP's Responsibility is to disseminate information to persons directly involved in the ENCON Program, comprising owners and persons responsible for energy of designated factories and buildings, and manufacturers of equipment, machinery and materials contributing to energy conservation. The campaigns will focus on the information about the ENCON Program and the provision of government financial assistance for the implementation of energy conservation measures under the Compulsory Program.

Voluntary Program

This program is monitored by the Energy Policy and Planning Office (EPPO) of the Ministry of Energy to ensure continuous implementation of the program so as to achieve the objectives of the ENCON Fund allocation. Support and cooperation are provided to the government agencies, academic institutions or non-government organizations, aiming at the following:

- Promoting efficient use of energy in the agricultural sector, small industries, existing non-designated factories and buildings, the transportation sector as well as in the reuse and recycling of waste materials;
- Widening the market for products and services contributing to energy conservation in factories/buildings, in the transportation sector, and in the reuse and recycling of waste materials; and
- Encouraging studies, research and development on energy technology and energy conservation, and the application of the study/R&D outcomes to the actual operation of factories, buildings as well as households.

A funded entity is called "Project Owner" responsible for the project management. The project may have several "Project Participants" who will undertake energy conservation-related activities under the project. These "Project Participants" will receive both financial and technical assistance from the "Project Owner." The ENCON Fund assistance will be provided to "Project Participants" through the "Project Owner."

The Voluntary Program consists of five major projects as follows:

1. Promotion of Renewable Energy Utilization Project;
2. Industrial Liaison Project;
3. Research and Development Project;
4. Energy Conservation in Non-Designated Factories and Buildings Project; and
5. Promotion of Small Power Producers Using Renewable Energy Project.

Promotion of Renewable Energy Utilization Project focuses on opportunities to develop fuel substitution and on the introduction and dissemination of renewable energy technology, i.e. technology using renewable energy sources more efficiently, by providing full operational cost for project owners and granting financial support in the form of interest subsidies for project participants.

Some examples of funded projects which have proven to be successful in efficient use of renewable energy are as follows. Biogas projects utilizing manure of livestock (pigs in particular) have proved to be a great success. As of September 2002, a total of 56,000 cubic meters (m³) of the biogas system was installed in medium and large-sized farms, and 75,760 m³ in small farms nationwide. The yield of biogas is used as energy source for on-site electricity generation and/or cooking in households instead of traditional fuel and LPG. Since the results of biogas projects have been satisfactory, the ENCON Fund will further support the installation of 130,000 m³ of the biogas system in large farms and 150,000 m³ in medium-sized farms in seven years starting June 2002 and 300,000 m³ in small farms during 2003-2009.

Another interesting project is the industrial plant rooftop PV grid connected pilot project to demonstrate power generation from solar or photovoltaic (PV) cells installed on the rooftops of 10 industrial plants, with a 4.2-kWp system each. The excess PV-generated electricity can be sold back to the distribution utilities' grid systems. This project will stimulate the industrial sector to participate in self-generated electricity for on-site use and to use electricity efficiently.

Industrial Liaison Project enhances the capacity of the industrial sector to produce energy efficient equipment. The project also supports small-scale and full-scale demonstration projects, including information dissemination, of proven technology. Some interesting funded projects are the energy efficiency standards regime study, the establishment of household refrigerator testing laboratory, and the Demand Side Management (DSM) Program.

In 1999, EPPO commissioned a study on energy efficiency with a view to establishing the mandatory Minimum Efficiency Performance Standards (MEPS) of six electrical products, i.e. refrigerators, air-conditioners, motors, ballasts, compact fluorescents, and fluorescent tubes. The proposed efficiency levels are currently under review by the Thai Industrial Standards Institute (TISI) to be enacted in legislation. MEPS defines an energy efficiency performance threshold that energy-consuming equipment should meet. Hence, inefficient products will gradually be removed from the market. The implementation of this project is expected to reduce total energy consumption by 3,500 GWh within seven years' implementation and reduce capacity demand by 700 MW in the corresponding period. On the consumers' side, there will be substantial savings on their electricity bills due to the use of high-efficiency appliances. On the environmental side, it is expected that CO₂ emission will be reduced by about 2 million tons.

The project on household refrigerator testing laboratory aims to upgrade the capacity of the Electrical and Electronics Institute (EEI), Ministry of Industry, which provides quality and standards testing of electrical and electronics products, especially refrigerators. The existing laboratory can carry out the testing at a maximum of two units at a time and cannot provide testing of large-sized refrigerators. Owing to the campaigns on high-efficiency refrigerators (No. 5-energy efficiency labeling), there have been greater market demand for high efficiency products. With the ENCON Fund support, the new laboratory will be able to provide testing services for large-sized or the two-door type refrigerators and can test 4 - 6 units at a time, depending on the sizes of the refrigerators being tested. The new testing laboratory has been in service since January 2003.

The Demand Side Management (DSM) Program was initiated by EGAT in 1993 to promote energy conservation, targeting three major sectors, i.e. residential, commercial and industrial sectors. Market transformation strategy has been introduced, i.e. local manufacturers and importers are stimulated to produce and import energy-saving and efficient appliances whereas consumers are provided with education and energy conservation awareness through various media. Several campaigns have been launched with emphasis placed on utilization of high-efficiency electric appliances, such as lighting equipment, refrigerators, air-conditioners and motors. Manufacturers are encouraged to apply energy efficiency labelling to their products to stimulate and facilitate consumers to select high-efficiency equipment and appliances. The DSM Program stresses not on enforcement but on voluntary collaboration aimed at improving consumers' behavior in electricity utilization but with less consumption and/or a lower power bill. It is reported that the cumulative energy saving as at the end of 2002 was 735.70 MW of peak demand and 4,163.80 GWh energy.

Research and Development Project aims at developing new or improving existing technology, with support to small-scale demonstration projects as well as information dissemination. As of September 2002, the ENCON Fund has supported more than 104 R&D projects concerning energy-related technology development and energy conservation undertaken by various government agencies and academic institutions. An example of funded projects is the performance test of LPG-fired cookers in Thailand, in terms of both thermal efficiency and poisonous gas emission amount. The study outcome can be used to further improve LPG-fired cooker efficiency, which will help reduce LPG consumption, especially in the commercial and residential sectors which, according to the 2001 records, accounting for 71% of the total domestic LPG consumption. Another interesting project is the study on the potentiality of fly ash utilization as a cement replacement material. Fly ash, or pulverized fuel ash, is a by-product of coal combustion for thermal utilization. Currently, only a small portion of fly ash has been utilized to generate economic value; therefore, the amount of fly ash has been increasing substantially and hence may create environmental problems in the nearby areas. To use fly ash in concrete production by mixing it with cement is an option to create economic value of fly ash. This will reduce not only the amount of fly ash but also energy consumption in cement production. The project outcome will contribute to greater utilization of fly ash in place of cement, i.e. 30% of the total fly ash production volume. Hence, energy consumption in cement production can be reduced, accounting for a value of 100 million baht per year. Carbon dioxide emission resulting from the cement manufacturing process can also be reduced.

Energy Conservation in Non-Designated Factories and Buildings Project has the objective is to solve problems related to energy utilization in small and medium-sized enterprises (SMEs), including improvement of human resources and management. The project implementation can help reduce a substantial amount of energy consumption in SMEs. In addition, the production costs and exploitation of several resources in the production process can be reduced. An approach used in most facilities is energy auditing and energy saving development, using "Value Engineering (VE)" technique together with the Demand Side Management by Humanware Approach Technique (DSM by HAT). Energy experts and the factory personnel will jointly develop the implementation plan to reduce energy consumption in their individual facilities. Another approach is the replacement of inefficient equipment by energy efficient equipment/technology ("Standard Measures"). Energy audit will be made before and after the installation of energy efficient equipment in order to verify energy saving achieved.

Promotion of Small Power Producers Using Renewable Energy Project is to promote greater use of renewable energy for power generation. The government has approved an allocation of 3,060 million baht (about US\$ 70 million) from the ENCON Fund to provide incentives in the form of a pricing

subsidy for the capacity generated by renewable energy on top of the power purchasing rate from SPPs stipulated by EGAT. A target of 300 MW of electricity generated by renewable energy is expected during a five-year pilot phase starting in 2002. At present, 31 SPPs using mainly biomass, with a total proposed capacity sale of 511 MW, have been initially selected, pending a hearing process organization among the local communities of each individual project. Of the 21 operators of these 31 SPP projects, except for EGAT, all others are private companies.

By the year 2006, the Voluntary Program envisages the implementation of the following: 3.54-MW rooftop PV systems; 13.15-MW PV systems in remote areas; 9.25-MW PV grid support; installation of 54,200 m² of solar collector surface area for 10,000 households, 200 hotels and 142 hospitals; 400,000 m³ of biogas system utilizing pig manure; energy saving projects; and electricity generating from methane gas (landfill). It is also expected that SPPs using renewable energy and supported by the ENCON Fund can commence supplying power to the grid system by 2006.

Complementary Program

This program is also monitored by the Energy Policy and Planning Office (EPPO) to ensure effectiveness of the Energy Conservation Program implementation. The Complementary Program consists of three main projects:

1. Human Resources Development Project;
2. Public Awareness Campaign Project, under EPPO's Responsibility; and
3. Management & Monitoring Project.

Human Resources Development Project aims to increase and develop human resources competence to be able to effectively handle the implementation of the Energy Conservation Program. At present, the number of personnel with energy-related expertise is limited, whereas the demand is increasing due to, among others, the requirements of relevant ministerial regulations which require designated facilities to appoint energy managers to monitor energy saving measures in the facilities. Human resources mobilization and development are, therefore, major tasks under the Complementary Program.

Focus will be on the creation of knowledge on energy conservation and renewable energy utilization. Integration of such knowledge will be made into the curriculum of primary and secondary school levels. At the university level, financial support will be provided for the teaching and establishment of laboratories to enhance energy conservation and renewable energy learning process. In addition, university graduates will be encouraged to attend additional training on energy conservation and renewable energy.

Public Awareness Campaign Project, under EPPO's Responsibility aims at creating the general public's consciousness in energy conservation and encouraging their participation in the Energy Conservation Program. Campaigns have been undertaken on a continual basis, via such media as TV, radio and printed matters, with emphasis on the importance of energy saving and adverse impact of inefficient use of energy on the economics, society and environment. Simple energy saving methods that can be practised in daily activities, with low or even no costs, have been disseminated as they can bring about substantial reduction of expenditures on oil and electricity. The achievement and return on investment in energy conservation and renewable energy utilization will be publicized so as to persuade those who have not commenced saving energy or using renewable energy to seriously consider and practically take actions.

Management & Monitoring Project provides financial support to the executing agencies of the government for the launching and monitoring of the Energy Conservation Program to enhance effective monitoring of implementation of various projects and of total savings achieved under the Energy Conservation Program over time, including efficiency and effectiveness of utilization of the ENCON Fund.

Conclusion

Although Thailand relies heavily on imported energy, the energy security of the country has been maintained through a diversity of types and sources of energy. Fossil energy still plays a major role, especially petroleum products and natural gas. Renewable/alternative energy will be the main energy resource next to fossil energy. Biomass, which has been mostly used as fuel in rural households and industries, will have a greater role as fuel in power generation and as an energy source for bio-liquid fuel production for vehicles. Most of the renewable energy types have proved to be environmentally friendly. Therefore, promotion of renewable energy technology research and development is considered to be of great importance and will continue to be supported by the government.

Close cooperation among various agencies/institutions dealing with energy plays a critical role in achieving the targets of the Energy Conservation Program in Thailand. More importantly, consumers

need to be educated on the importance and necessity to conserve energy as they are energy end-users. Their awareness and participation is, therefore, crucial for achieving the success of the existing energy efficiency and conservation programs and will provide a strong foundation for future projects.

Activities on the public relations program under the umbrella of the "÷ 2" campaign will continue so as to stimulate people to be more conscious of energy saving, which can significantly help reduce the country's dependency on imported energy, and hence save foreign currency while the security of energy supply is still maintained. Besides, the severity of environmental problems, a matter of the global concern, will be reduced.

Last but not least, now that the Ministry of Energy has been established, following the bureaucratic reform of the Thai government in October 2002, various energy-related agencies that used to be scattered under the auspices of different ministries have been transferred to be under the Ministry of Energy. With more streamlined administrative structure, it is expected that national energy policy and planning, and the management and development of energy-related programs and activities in Thailand will be more efficient and effective than ever.
