DATA COLLECTION SURVEY ON POWER SECTOR IN THE KINGDOM OF THAILAND

FINAL REPORT

July 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

Shikoku Electric Power Co., Inc.

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Summary

1 Background and Objectives of the Study

1.1 Target Area of Study

The target area of the study is the whole of Thailand. An area study on the potential for renewable energy and energy conservation was undertaken.

1.2 Objectives of Study

- ✓ Grasp the current situation of the energy sector and position of energy conservation/renewable energy in the electric power field.
- ✓ Clarify government policy and institutions related to energy conservation/renewable energy in the power field, and identify trends of action plans of government, private companies, and households.
- ✓ Propose prior issues and areas and applicable resources for a long-term Japanese ODA framework, especially for renewable energy and energy conservation in the power sector.

1.3 Local Organization

Counterparts in this study are Energy Planning and Policy Office (EPPO) and Department of Alternative Energy Development and Efficiency (DEDE) under Ministry of Energy of Thailand, and electric power utilities such as Electricity Generating Authority of Thailand (EGAT), Provincial Electricity Authority (PEA), and Metropolitan Electricity Authority (MEA).

To accomplish the study, it is indispensable to share neutral opinions with staff of electric power utilities, private companies and universities specializing in the study of renewable energy and energy conservation.

2 Current Conditions in Energy Sector

2.1 Governmental Policy in the Energy Sector

The MOE in Thailand is therefore promoting renewable energy and energy conservation.

- ✓ To improve energy efficiency, the elasticity of energy to GDP is to be lowered to the same level as that of developed countries
- ✓ Target for share of alternative energy including renewable energy is to be 20% of the country's final energy demand in the year 2022

2.2 Current Conditions of Power Supply Sector

According to the Power Development Plan (PDP) 2010, although the demand will increase conspicuously, the demand prospect is planned lower than that of PDP 2007, after the energy conservation policy taken into account. And the development of nuclear power generation is planned.

The percentages of the fuel consumed for power generation in 2009 are 71% for natural gas, 21% for coal/lignite, and 5% for hydro power and alternative energy. The reserve margin has been around 26% for the recent five years and is expected to be around 15% in the future.

2.3 Current Conditions of Power Demand Sector: the Elasticity of Energy to GDP

Energy elasticity, which is the ratio of the growth rate of electricity consumption to the growth rate of GDP, is between 0.8 and 0.9 in developed countries. Thailand is promoting energy conservation to reduce energy elasticity, which turned out to be below “1.0” in 2007 and 2008 owing to the slowdown in the growth rate of electricity consumption and stagnant economy. The level of energy elasticity comparable to that of developed countries is aimed at in the future, with the long-term target of 0.99 set in PDP2010.

3 Current Conditions and Future Prospects for Renewable Energy

3.1 Governmental Policy and Current Conditions in Renewable Energy

○ Governmental Policy for Renewable Energy and Application Condition

The Thai government aims to adopt alternative energy including renewable energy for up to 20.3% of primary energy by 2022 as it promotes renewable energy based on the Alternative Energy Development Plan; AEDP (2008-2022), among which 2.4% is allocated to power generation. In general, introduction of renewable energy power generation of about 1,750 MW is set for January 2007, and it is necessary to increase that by 3,850 MW to about 5,600 MW of primary energy, or 2.4%. The existing biomass capacity of 1,600 MW accounts for more than 90% of the existing capacity. And the new biomass power development which accounts for more than 80% of the estimated potential and more than 60% of the target capacity in 2022, is required. Plus, the wind power capacity is planned to increase to 800 MW from 1 MW installed as of 2007 and the solar power is to 500 MW from 32 MW.

○ System for Promoting Utilization of Renewable Energy

Adder System

When electric power utilities (EGAT, MEA, and PEA) purchase power from SPPs: power producers under 90MW or VSPPs: power producers under 10MW, the "Adder" subsidy is added to the normal wholesale price. Adder differs in amount (0.3～8B/khW) and in period (seven to ten years) by the classification of the renewable energy and the scale of the contract to adjust promotion level in accordance with the business environment such as initial investment and administrative cost or the total amount of the applied capacity.

Investment Promotion Plan of BOI

BOI promotes all industries in Thailand, as well as renewable energy and energy conservation; however, the businesses related to renewable energy or energy conservation are prioritized and obtain the most generous benefits (tax incentives) as follows:

- ✓ Corporate income tax exemption for eight years (plus an extra five years with a 50% tax reduction)
- ✓ Import tax on equipment exemption

Others

As other effective promoting measures, Technical Assistance, Investment Grants, ENCON Fund (Revolving Fund, ESCO Fund) etc. are implemented.

○ Current Potential of Renewable Energy

Solar Power

Each domestic area has sufficient potential for development in the whole of Thailand. In particular, the central, eastern, and northeast areas are found to have good conditions, where many recent constructions of solar power generating facilities are being proceeded.

Small Hydro Power

The half of the development target is estimated to reach by using the irrigation dams for the generation. Although many water sources have the potential enough to produce electricity, it is regarded as difficult for the private sector to develop commercial-base power plants of around 1 to 15 MW because the permission to develop a forest area and successful negotiation with the inhabitants cannot be achieved easily.

Biomass

Farm product resources are constantly available in large supplies (rice husks and cassava rhizome (root and stem), sugar cane bagasse etc.), so abundant biomass resources are also produced. The total amount of biomass potential in Thailand is estimated to be 4,400 MW.

But at present, the agricultural biomass supply market is typified by high prices due to a lack of resources for the large-scale businesses and it is not such a promising resource for power generation. Then the recent development of new resources such as wood chips is expected more.

Wind Power

The areas which provide good wind conditions for the large-scale wind turbines are located in the mountains of the southern Malay Peninsula, the western area and the eastern area, and account for 7% of the country. However, it is very likely that these areas are far from trunk lines of the electric power system. On the other hand, if small-scale wind turbines for low wind speeds can be introduced, wind power generation can become power source in the areas where 64% of the population lives. Their development is underway in Thailand at present, aiming at their supply by domestic companies.

3.2 Future Prospects for Renewable Energy

For each of the various power generation businesses using renewable energy sources, the summary of those business conditions, the present support measures, the situation of the applications, the effectiveness of the promotion measures, etc. are described below.

Solar Power Generation Businesses

They are expected to achieve profitability under the current support measures including Adder, and the number of applications submitted, primarily for large-scale businesses, is already several times more than the promotion target. A further support to these businesses is considered unnecessary. On the other hand, small-scale solar power generation businesses have not spread due to their low current profitability, and their promotion is possible through financial and other supports. Since, however, the generating capacity per unit is small with small-scale solar power generation and since there is a limit to what one can expect of the financial capacity of general households, a support to these businesses is considered to be ineffective for promoting their introduction.

Wind Power Generation Businesses

There are some supports considered effective including assistance towards the costs for importing facilities and extending a power transmission line for large-scale businesses. The adder for wind power generating businesses, however, is one of the most preferential, second only to the adder for solar power generation, and the capacity of applications for wind power generation businesses is already several time more than the promotion target in spite of their lagged development relative to solar power generation. Therefore, a further support is considered unnecessary. On the other hand, with regard to small-scale businesses, a support is conceivable for technological development going on in Thailand for an increased promotion in the future, but its contribution to the achievement of the introduction target is considered to be low.

Biomass Generation Businesses

Biomass generation businesses have come to account for more than 90% of the current power generation from renewable energy sources by exploiting its rich potential in Thailand, but the future development of biomass generation is likely to slow down relative to others. The capacity of applications that have been approved at present barely reaches the introduction target. The reason for this is that there are fuel shortage and price hike, which constitute the operational problem for large-scale biomass generation. Unless this fundamental problem is solved, promotional measures through financial and other supports remain ineffective. On the other hand, small-scale businesses are expected to grow further given technological and financial supports which include providing new information, e.g., about generation method through self-supply of fuel and generation facilities designed to have greater durability than conventional ones.

Among these sources of energy, it is considered most effective for achieving the target for introducing power generation by renewal energy sources to provide financial and technological supports to small-scale biomass generation businesses.

4 Current Conditions and Future Prospects of Energy Conservation

4.1 Governmental Policy and Current Conditions of Energy Conservation

○ Related Governmental Policies to Energy Conservation and Introduction Situation of Energy Conservation

Thailand has created an energy conservation discipline as a national culture and encouraged energy conservation in all sectors—household, industrial, services & commerce, and transportation—through a campaign aiming to build energy conservation consciousness. Thailand is also continuing to promote the efficient use of energy by providing incentives to attract the private sector to opt for energy conservation appliances, and has established incentive measures to reduce electricity use during peak periods. Major energy conservation initiatives have been launched to be a main driver to promote EC (Revolving Fund for EC/RE, ESCO venture capital funds, Tax incentives for energy saving, DSM Bidding, and Energy management Promotion). Furthermore, Thailand researches, develops, and sets the energy-conserving performance standards for electrical

appliances and buildings; and, encourages development of mass public transportation and railway system to promote effective energy use, which will reduce the country's investment on energy procurement.

Energy conservation measures are categorized (e.g.; High Tech and Design & Concept, etc.) and arranging necessary measures in each category is being planned.

○ The existing Energy Conservation Dissemination Measures

Energy Conservation Promotion Act B.E. 2535 (ECP Act)

The Energy Conservation Promotion Act was established in 1992 to promote energy conservation measures and investments on factories and buildings. This act stipulates the definitions of the designated factory/building and the duties of their owners, etc.

Energy Conservation Promotion Fund（ENCON Fund）

This Fund was established under the ECP Act for financial support to promote energy conservation and disseminate renewable energy and is funded mainly from the Petroleum Fund. The ENCON Fund mainly comprises ESCO Fund and Revolving Fund.

Revolving Fund

This has been started in January 2003 to stimulate bank loans (less than 4% interests) in order to promote investments for renewable energy and energy conservation projects by large-scale buildings/factories. The loan amount of the first phase was THB 2,000 million (approx, USD 60 million), and this fund has continuously been supported through four phases with a total loan amounting to THB 5,342.5 million (approx, 250 projects).

ESCO Fund

This was established in October 2008 to help Small and Medium Enterprises (SMEs) to carry out renewable energy and energy conservation projects. The term is composed of 2 phases (the 1st phase is from October 2008 to September 2010 and the 2nd phase is from October 2010 to September 2012). Although its main scheme is based on equity investment, the ESCO Fund provides several services such as equipment leasing and technical assistance and so on. The ESCO Fund has approved 26 RE/EC projects, totaling 367 million THB (11.12 million USD).

DSM Bidding

The DSM Biddings, implemented in 2008 to provide financial support to encourage businesses to invest in high energy-efficient machinery/equipment, is monitored by EPPO. A subsidy is granted based on actual energy savings achieved in one year resulting from such investment.

Others

There are other effective measures such as investment promotion plan of BOI and new building code and so on to promote and disseminate energy conservation,

○ Outline of current energy conservation activities in electric power utilities, municipalities, private companies and households

Electric Power Utilities・Municipalities

As for efforts by electric power companies and municipalities, they have systematically implemented a variety of programs in accordance with Thailand's energy conservation policy and in close

cooperation with the Thai government, achieving steady results. Some municipalities, however, have just started planning energy conservation in order to extend energy conservation efforts from urban to rural areas. The future efforts are thus more important for them.

Private Companies

Facilities of private companies specified as designated commercial and factory buildings under the Energy Conservation Promotion Act have been engaged in Energy conservation activities for long years. While their activities are relatively substantial, there is still a room for greater efficiency, for instance, through the introduction of a “thermal storage air conditioning system” into daytime air-conditioning load. In addition, the management of companies that possess facilities not designated under the Energy Conservation Promotion Act still has low energy conservation consciousness. The energy conservation potential of these facilities is considered even greater compared with designated facilities.

Households

Energy conservation consciousness has been improved in households owing to the labeling program and publicity campaigns implemented by EGAT, and their efforts have been achieving better results. There is, however, no financial support such as subsidies for the purchase of high efficiency products that requires high initial investment, preventing the accelerated dissemination of high efficiency products. Since air conditioners in households are particularly expected to increase rapidly, just like in private companies, there is an urgent need for a response to the concomitant rise in power demand.

4.2 Future Prospects for Energy Conservation

Possibility of Introducing Energy Conservation into Electric Power Utilities

In electric power facilities, annual load factor, thermal efficiency, losses of transmission and distribution network are reflected in the index of energy conservation measures for electric power facilities, and they are comparable to the values of developed countries. Accordingly, the prospects for further energy conservation in electric power facilities are small, although there is some possibility of partial gains such as introducing capacitors into the transmission and distribution network to improve the power factor.

Possibility of Introducing Energy Conservation into Private Companies

The daily load curve shows extreme peak demand in daytime in Thailand according to economic growth. This trend is similar to Japan, so it could become greater as it tracks economic growth and decreasing the annual load factor in electric power facilities is apprehended. In this situation, the introduction of “thermal storage air conditioning systems” to commercial facilities, which are exhibiting a significant rise in demand, is considered to be the most effective measures for improving the annual load factor of electric power facilities.

Possibility of Introducing Energy Conservation into Households

As the above mentions, the daily load curve shows extreme peak demand in daytime in Thailand according to economic growth. This trend is similar to Japan, so it could become greater as it tracks economic growth. And the rate of energy consumption by air conditioners will also be high during

peak demand in daytime, because energy consumption of air conditioners accounts for approximately 45% of the energy consumption of electric appliances in households. In addition, the dissemination rate of air conditioners is still low in the Thai market and it can be considered that the dissemination rate of air conditioners will grow very rapidly in line with economic growth in Thailand. Accordingly, “Inverter air conditioners” has the highest potential for energy conservation by households in the future.

5 Proposal for Future ODA Scheme for Renewable Energy and Energy Conservation in the Power Sector

Confirming the idea of the request and the direction of the policy through several discussions with the counterparts in Thailand, the proposals of financial and technical support for such promotion measures and of the technologies concerning renewable energy and energy conservation from Japan that can be utilized in assistance to Thailand are made, the details of which are described below.

5.1 Promotion for Small-scale Biomass Generation

Regarding the biomass generation businesses, there is the possibility of developing the biomass in local communities, which have great potential. Also from the perspective of revitalizing local communities and narrowing gaps between regions, there are strong incentives to promote the small-scale biomass generation in the country, while the promotion of the large-scale biomass is stagnant.

However, some incentives are required for the initial cost to introduce the system because it is relatively high for the small-scale investors. In addition, a support by governmental agencies, local governments, or universities for technical support and information service is considered appropriate to promote the dissemination of the small-scale biomass generation.

① Subsidy
② Adder increase
③ Measures to lower risk
④ Establishment of biomass promotion center

5.2 Proposal of the Capacity Building for Renewable Energy Engineers

Human Resource Development on renewable energy generation is often required recently, due to the drastic increase of installed capacity of renewable energy as one of the climate change measures, and due to being utilized of for electrification, too. At present DEDE is considering the Human Resource Development on renewable energy technique, as a measure to disseminate and promote renewable energy.

The support from Japan for personnel training on renewable energy techniques mentioned above has been carried out many times up to now. There are many results of trainings carried out in the country and Japan. Therefore, utilizing this knowledge and results of the training know-how accumulated in Japan is considered one of methods to meet the request of Thailand.

5.3 Problems and Support Measures for introducing Thermal Air Conditioning System

It can be thought as problems for introducing thermal air conditioning system that very low recognition of it regardless of some introducing cases and long payback period due to small difference between electricity tariff in daytime and nighttime under TOU, etc. The following items are proposed as main effective support measures to solve these programs.

① Educational activities using case studies

The recognition will be improved by introducing case studies in Thailand and Japan.

② Review of TOU

The characteristic of this system is heat energy stored using electricity supplied under a cheaper nighttime tariff to operate an air-conditioning system in daytime. The initial cost of this system is paid back by the difference between daytime and nighttime in the electricity tariff. Therefore, the payback is improved by a review of TOU and establishing a larger difference between daytime and nighttime.

③ Construction of special electricity tariff for this system

If a special electricity tariff with a larger difference between daytime and nighttime rates than the existing one is proposed for a thermal storage air conditioning system is constructed, it would become a specific support measure for thermal storage air conditioning systems and contribute to their dissemination.

5.4 Problems and Support Measures for introducing Inverter Air Conditioners

It can be thought as problems for introducing inverter air conditioners that approximately 30% higher initial cost compared with non-INV and INV not effective due to use of only “Energy Efficiency Ratio”. The following items are proposed as main effective support measures to solve these programs.

① Introduction of subsidy system for inverter air conditioners

If a subsidy system for inverter air conditioners is introduced and the price difference between inverter air conditioner and non-inverter air conditioner can be reduced, a dissemination of energy conservation facilities will be promoted in residential sector, which is expected have increased energy demand.

② Adoption of “seasonal energy efficiency ratio (SEER)”

The existing labeling program for room air conditioners in Thailand adopts “Energy Efficiency Ratio (EER)”as a performance standard, which only evaluates energy consumption efficiency under rated load operation. This performance standard cannot evaluate the performance of an INV, which has greater energy conservation effectiveness at partial load operation. Therefore, the incentive to use an inverter air conditioner is not seen by the consumer. On the other hand, the “Seasonal Energy Efficiency Ratio (SEER)” is an index that evaluates energy consumption efficiency throughout one year, and the effects on energy conservation of a inverter air conditioner can be visualized. Introduction of SEER as a labeling performance standard would promote the spread of inverter air conditioners.

5.5 Financial Support

It is more reasonable to use the existing system than to establish a new system from scratch when implementing financial support. Since they are highly responsible for operations from cash injection to return, the Revolving Fund and the ESCO Fund under the ENCON Fund are reliable. It is therefore recommended to provide financial support to DEDE.

Taking into account the interest rate of 4% of the Revolving Fund and ESCO Fund, it is desirable to utilize the Climate Change Program Loan (CCPL), with which a low interest rate for financial support is possible.

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Abbreviations

AC	Air Conditioner
ADB	Asian Development Bank
APF	Annual Performance Factor
BAS	Building Automation System
BEMS	Building and Energy Management System
BMA	Bangkok Metropolitan Administration
BOI	Board of Investment
CDM	Clean Development Mechanism
CFL	Compact Fluorescent Lamp
COP	Coefficient of Performance
DEDE	Department of Alternative Energy Development and Efficiency
DNA	Designated National Authority
DSM	Demand Side Management
EC	Energy Conservation
ECFT	Energy Conservation Foundation of Thailand
ECP Act	Energy Conservation Promotion Act B.E.2535
EE	Energy Efficiency
EEI	Electrical and Electronics Institute
EER	Energy Efficiency Ratio
EFE	Energy for Environment Foundation
EGAT	Electricity Generating Authority of Thailand
EGCO	Electricity Generating Public Co., Ltd.
ENCON Fund	Energy Conservation Fund
EPC	Energy Policy Committee
EPPO	Energy Policy and Planning Office
ERC	Energy Regulatory Commission
FS	Feasibility Study
Ft	Fuel Adjustment Charge
GEF	Global Environment Facility
GHG	Green House Gas
HEPS	High Energy Performance Standard
INV	Inverter
IUCN	International Union for Conservation of Nature and Natural Resources
JETRO	Japan External Trade Organization
KMUTT	King Mongkut's University of Technology Thonburi
LED	Light Emitting Diode
LEP	Local Energy Planning
MEA	Metropolitan Electricity Authority

MEPS	Minimum Energy Performance Standard
MNRE	Ministry of Natural Resources and Environment
MSW	Municipal Solid Waste
MOE	Ministry of Energy
NED	Natural Energy Development
NEDO	New Energy and Industrial Technology Development Organization
NEPC	National Energy Policy Council
NGO	Nongovernmental Organization
NSTDA	National Science Technology Development Agency
ODA	Official Development Assistance
ONEP	Office of Natural Resources and Environmental Policy and Planning
PDD	Project Designed Document
PDP2010	Power Development Plan 2010
PEA	Provincial Electricity Authority
PPA	Power Purchase Agreement
PRE	Person Responsible Energy
RE	Renewable Energy
RPS	Renewable Portfolio Standard
PV	Photovoltaics
SEER	Seasonal Energy Efficiency Ratio
SHS	Solar Home System
SMEs	Small and Medium Enterprises
SPP	Small Power Producer
TGO	Thailand Greenhouse Gas Management Organization
TISI	Thai Industrial Standards Institute
TOD	Time of Day
TOU	Time of Use
UNDP	United Nations Development Program
VSD	Variable Speed Drive
VSPP	Very Small Power Producer

1 Basic Approach of the Study

1.1 Background and Objectives of the Study

Today, increasing demand for electricity in Thailand in response to economic growth is a growing problem. From the viewpoint of reducing greenhouse gas emissions too, The Royal Government of Thailand is now giving serious consideration to the efficient use of energy resources within the context of environmental sustainability.

The Ministry of Energy in Thailand created a road map to encourage the use of renewable energy; for example, to encourage measures for promoting electricity generation from renewable energy sources such as very small power plant producers (VSPP) and energy efficiency in all sectors.

On the other hand, public concerns about energy conservation are rising with the development of energy conservation promotion measures and research on improving energy efficiency. Energy conservation strategic planning is based on the Energy Conservation and Promotion Act under a national energy policy. Now that Thailand has recently adopted policies setting 20% of the country's final energy demand as the target for the share of alternative energy including renewable energy by the year 2022, it has brought forward the original target of renewable energy to 8% by 2011. Developing domestic energy resources to sufficiently meet demand encourages the use of renewable energy.

The nuclear energy is also an option with two 1,000 MW power plants included in the energy roadmap for introduction in 2020 and 2021.

Based on the background above, Japan agreed to the theme of a " Decade Toward a Green Mekong" and declared support for countries in the region in the fields of energy conservation and clean energy, in accordance with the "Prime Minister Hatoyama Initiative." In this study, from the viewpoint of the effective use of energy, we collected information and analyzed problems concerning the introduction of renewable energy and promoting energy conservation in the energy sector, particularly the electric power field in Thailand, and regarding the progress of implementation by the Thai government and surrounding organizations, and we clarified the directionality and prior issues for supporting them effectively in this field in the future.

The contents of this report are the unofficial opinion of JICA.

1.2 Target Area of Study

The target area of the study is the whole of Thailand. An area study on the potential for renewable energy and energy conservation was undertaken.

1.3 Objectives of Study

- ✓ Grasp the current situation of the energy sector and position of energy conservation/renewable energy in the electric power field.
- ✓ Clarify government policy and institutions related to energy conservation/renewable energy in the power field, and identify trends of action plans of government, private companies, and households.
- ✓ Propose prior issues and areas and applicable resources for a long-term Japanese ODA framework, especially for renewable energy and energy conservation in the power sector.

1.4 Local Organization

Counterparts in this study are Energy Planning and Policy Office (EPPO) and Department of Alternative Energy Development and Efficiency (DEDE) under Ministry of Energy of Thailand, and electric power utilities such as Electricity Generating Authority of Thailand (EGAT), Provincial Electricity Authority (PEA), and Metropolitan Electricity Authority (MEA).

To accomplish the study, it is indispensable to share neutral opinions with staff of electric power utilities and universities specializing in the study of renewable energy and energy conservation.
To conduct tasks effectively in the short period of the project term, the study team separated into two teams—renewable energy and energy conservation—and shared knowledge and opinions. For the introduction of Japanese technologies, information was shared with Japanese agencies such as JETRO and NEDO.

2 Update and Confirmation of Current Conditions in Energy Sector

2.1 Current Conditions and Government Policy in the Energy Sector (Electric Power Field)

(1) Government Policy and Targets for Energy Efficiency and Renewable Energy

Imports of fossil fuels are following an increasing trend to keep up with recent demand increases, and that is a significant problem for energy security in Thailand. Therefore, to improve the long-term energy self-sufficiency ratio, the initial target of energy policy is to secure energy supplies at reasonable cost and in an environmentally friendly way, and to promote the use of domestic resources.

However, concerns among the Thai people about the environment mean that construction of large power plants often takes a long time. Besides, due to the remarkable rise of crude oil prices, the Thai government is emphasizing the promotion of energy conservation and renewable energy, as well as developing power plants powered by fossil fuels. (*1)

In EPPO, the Ministry of Energy (MOE) considers introducing efficient technologies for using coal to reduce crude oil dependence and expanding the future use of coal is considered to be important.

The MOE in Thailand is therefore promoting renewable energy and energy conservation.

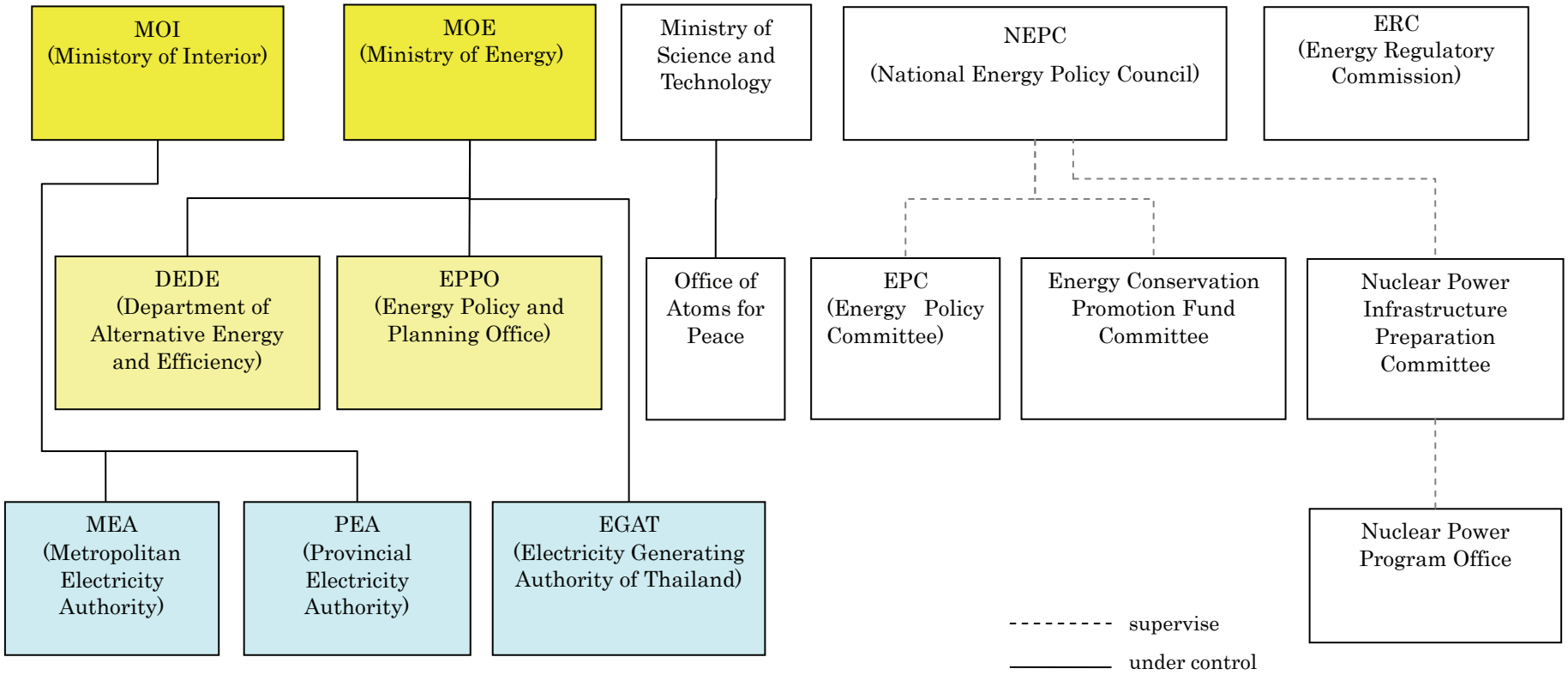
- To improve energy efficiency, the elasticity of energy to GDP is to be lowered to the same level as that of developed countries
- Target for share of alternative energy including renewable energy is to be 20% of the country's final energy demand in the year 2022

(*1) Construction of IPP power stations, which were due to start commercial operation in 2013, has been delayed.

E.g.) Siam Energy Bang Khla Power Station (1600 MW), National Power Supply Power Station (540 MW)

(2) Structure of Regulators in Electric Power Sector

There are several organizations related to the energy sector as outlined in Fig. 2.1.1.



(Remarks)

- ✓ National Energy Policy Council (NEPC) : High-ranking decision-making organization for national energy policy composed of Prime Minister and designated members
- ✓ Energy Policy Committee (EPC) : Subsidiary organization under NEPC. Practical business unit is composed of under-secretaries and directors of relevant organizations.
- ✓ ERC (Energy Regulatory Commission) : Commission composed of seven members (experts) in charge of regulation and approval concerning energy business. It also establishes electricity tariffs and implements measures for ensuring the reliability of electric power systems

Source: created by the study team

Fig. 2.1.1 Organizations Related to Energy Sectors

Ministry of Energy (MOE)

The organization supervises and regulates stable energy supplies in Thailand, as well as securing reasonable electricity prices, promoting fair competition within the private sector, and providing alternative energy sources to consumers.

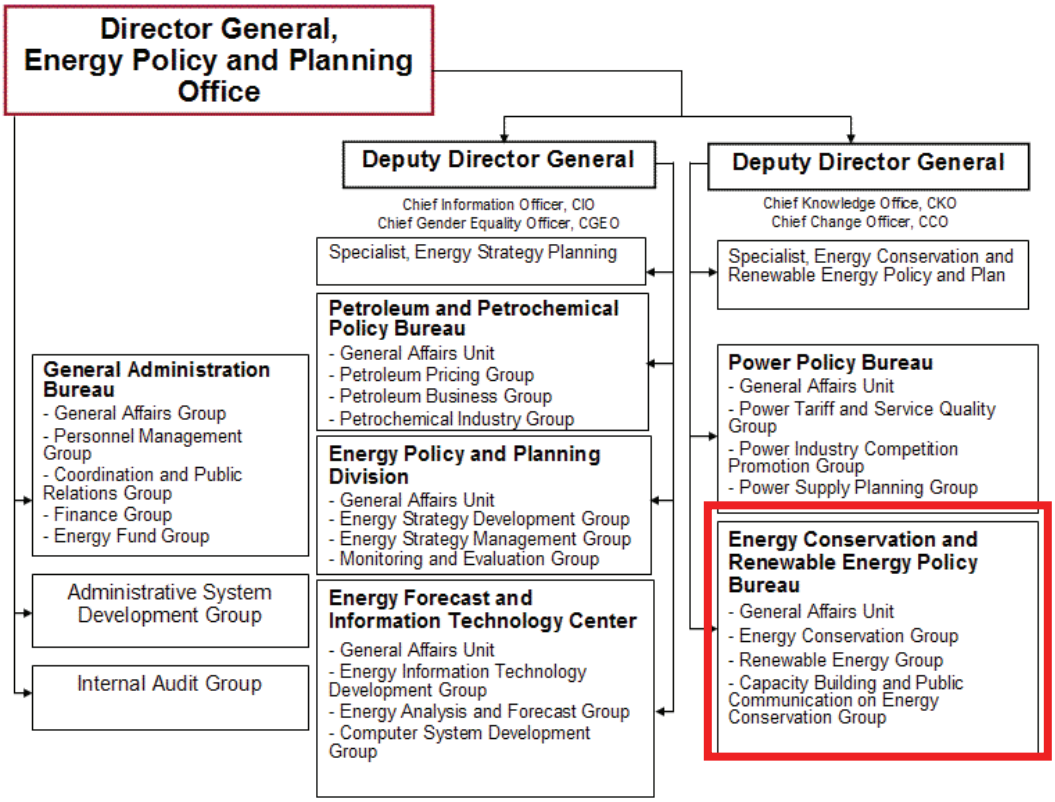
Energy Policy and Planning Office (EPPO)

EPPO is the governmental agency responsible for managing and administering national energy policies and planning, developing, and promoting energy conservation and energy efficiency.

It offers recommendations for energy policies and energy management and development plans; takes measures for energy conservation and alternative energy; and, determines the framework for allocating budgets for energy conservation and promoting alternative energy.

Its strategies include:

1. Providing support in terms of policy formulation as regards alternative and new energies
2. Accelerating promotion of the efficient use of energy and energy conservation, through the application of proactive measures, regulation and supervision, provision of incentives, and fostering a consciousness of energy conservation



Source: EPPO HP

Fig. 2.1.2 Organization of Energy Policy and Planning Office (EPPO)

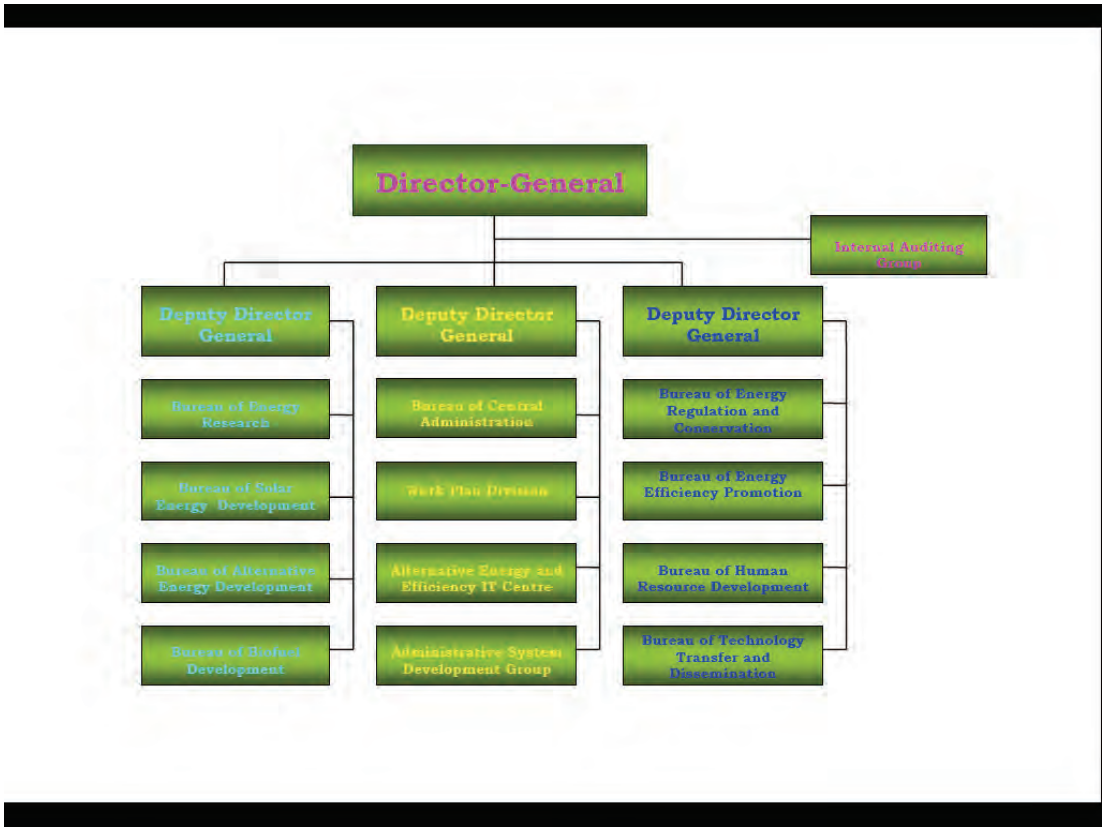
Department of Alternative Energy Development and Efficiency (DEDE)

DEDE was established as the National Energy Authority (NEA) under the Office of the Prime Minister by the National Energy Authority Act. Its purposes are to develop and promote energy

production, transmission and distribution, research and development on alternative energy sources, and regulation and promotion of energy conservation and energy efficiency.

It promotes energy efficiency, regulations on energy conservation, development of alternative energies, and dissemination and transfer of technologies to meet the requirements of the public at appropriate costs to the benefit of national development and quality of life. Detailed responsibilities are as follows:

1. To promote, support, and regulate energy conservation.
2. To research and develop alternative energies.
3. To establish rules and standards, and promote dissemination and transfer of technologies related to alternative energies
4. To monitor and evaluate alternative energy development and energy conservation.
5. To engage in activities assigned by the Ministry of Energy or the Cabinet.
6. To regulate and facilitate designated large factories/buildings, in order to effectively and efficiently implement energy conservation in accordance with the Energy Conservation Promotion Act.



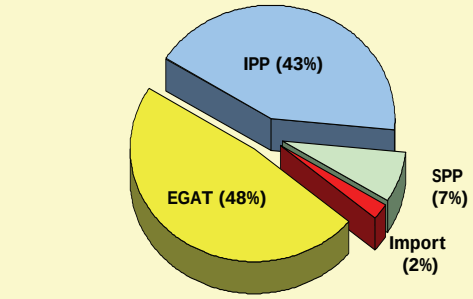
Source: DEDE HP

Fig. 2.1.3 Organization Chart of DEDE

(3) Structures of Electric Power Utilities

Electricity Generating Authority of Thailand (EGAT)

EGAT generates and wholesales electricity to MEA, PEA, and other large electric energy consumers in Thailand. EGAT also owns ultra high-voltage transmission and load-dispatching facilities, and operates the power system in Thailand.



Source: DEDE

Fig. 2.1.4 Structure of Power Generation

Metropolitan Electricity Authority (MEA)

MEA distributes electricity to the metropolitan area and two adjoining provinces: Nonthaburi and Samut Prakarn. MEA supplies power to 2.75 million customers amounting to 42,003 GWh, or 31.4% of total national power consumption.

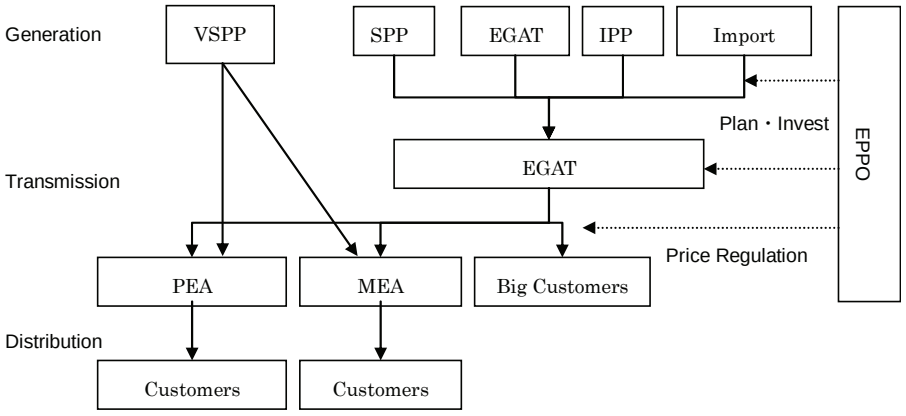
Provincial Electricity Authority (PEA)

PEA supplies electric energy to the other 73 provinces outside the MEA area.

(4) Power Supply System in Thailand

The electricity power industry in Thailand comprises the following utilities:

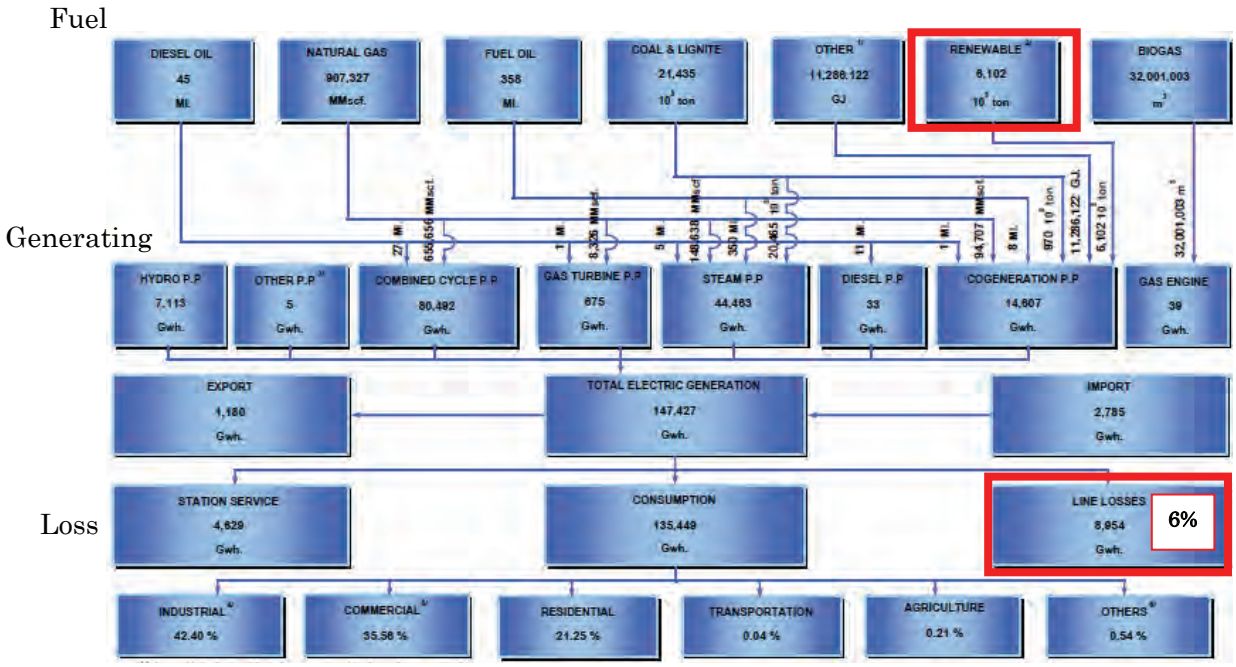
Generation facilities and trunk transmission system are owned and managed by EGAT. The distribution sector in Bangkok and the surrounding area is managed by MEA, and in other local areas are managed by PEA. In the power generation sector, independent power producers provide power to EGAT, MEA, PEA, or their customers directly.



Source: created by the study team

Fig. 2.1.5 Power Supply System in Thailand

In 2009, electricity consumption in Thailand totaled 135,420 Gwh. The total installed capacity was 30,279 MW, 52% of which was from state/public power utilities and 48% of which was from private power producers. During 2008, a new power plant was introduced at Chana Combined Cycle Power Plant unit 1 in Songkhla Province with a total capacity of 710 MW. Moreover, EGAT purchased electricity from Independent Power Producers (IPPs), namely Gulf Power Generation Co., Ltd. at Combined Cycle Power Plant unit 2 (734 MW) on March 1, 2008 and Ratchaburi Power Co., Ltd. at Combined Cycle Power Plant unit 1&2 (1,400 MW) on March 1, 2008 and June 1, 2008 under 25 year-contracts. Fig. 2.1.6 shows energy supply flow from power generation to distribution.



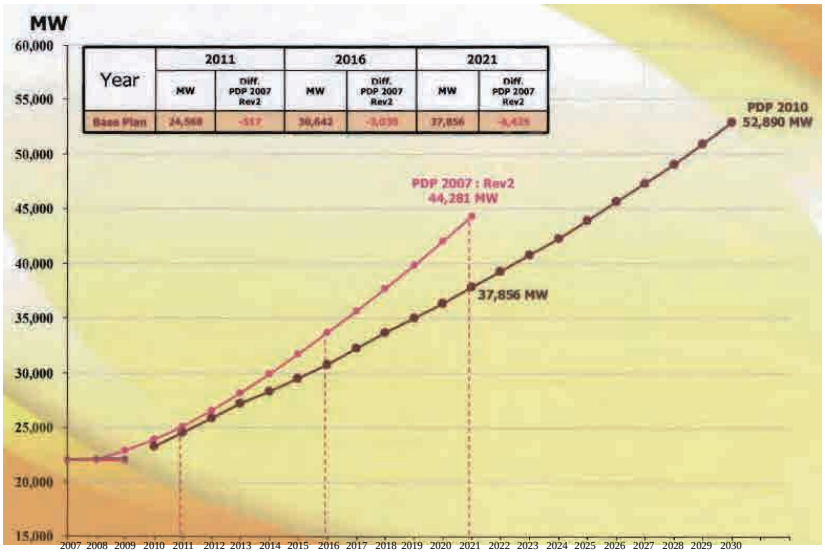
Source: DEDE

Fig. 2.1.6 Energy Supply flow in Thailand

2.2 Current Conditions of Power Supply Sector

(1) Power Development Plan 2010

According to the Power Development Plan (PDP) 2010, based on demand assumptions, demand will increase conspicuously to 347,947 GWh in 2030 from 146,182 GWh in 2009, and peak demand is planned to increase from 24,566 MW in 2011 to 37,856 MW for 2021. Such growing electricity demand raises concerns about climate change, which favors nuclear power. Every 1 kWh of electricity produced in Thailand emits 0.5 kilogram of CO2. Therefore, development of nuclear power will also assist in achieving future climate change goals.

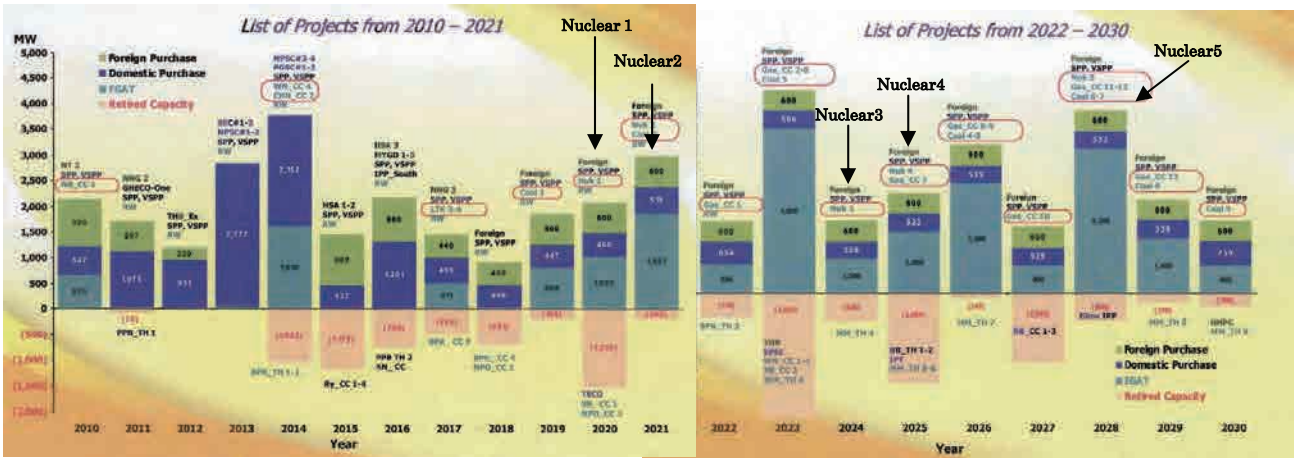


Source: EGAT

Fig. 2.2.1 Power Demand Forecast (PDP2010)

Fig. 2.2.2 shows a table of power plants operating over 20 years. The contracted capacities of main power plants are 21 combined cycle power plants (16,670 MW), five nuclear power plants (5,000 MW), and 11 = coal-fired power plants (8,400 MW).

Thailand's nuclear facilities and future development under PDP include two 1,000 MW nuclear power plants expected to start operation during the period 2020-2021. EGAT will be responsible as owner and operator of these nuclear power plants.



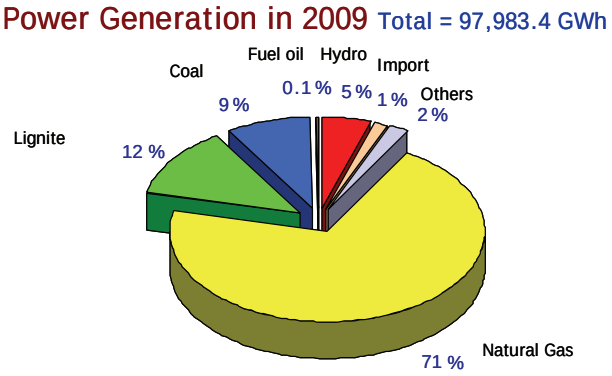
Source: EGAT

Fig. 2.2.2 PDP 2010

(2) Structure of Power Supply System

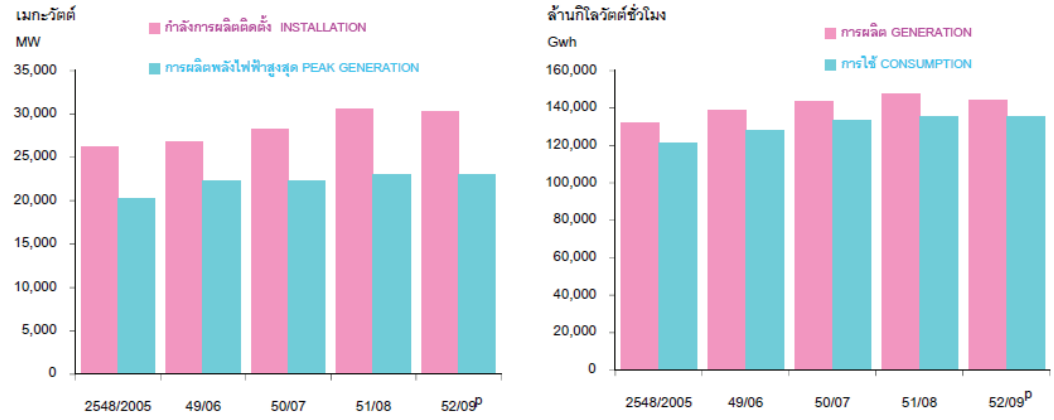
Fuel consumption for electric generation in 2009 is as follows: natural gas was mainly consumed for electric generation sharing 71% of total fuel consumed for electric generation, followed by

coal/lignite 21%, fuel oil & diesel 0.7%, and the remaining 5% was contributed by alternative energy & other energy (paddy husks, bagasse, agricultural waste, garbage, biogas, black liquor, and residual gas from production processes), hydro & others (geothermal, solar cells and wind power).



Source: DEDE

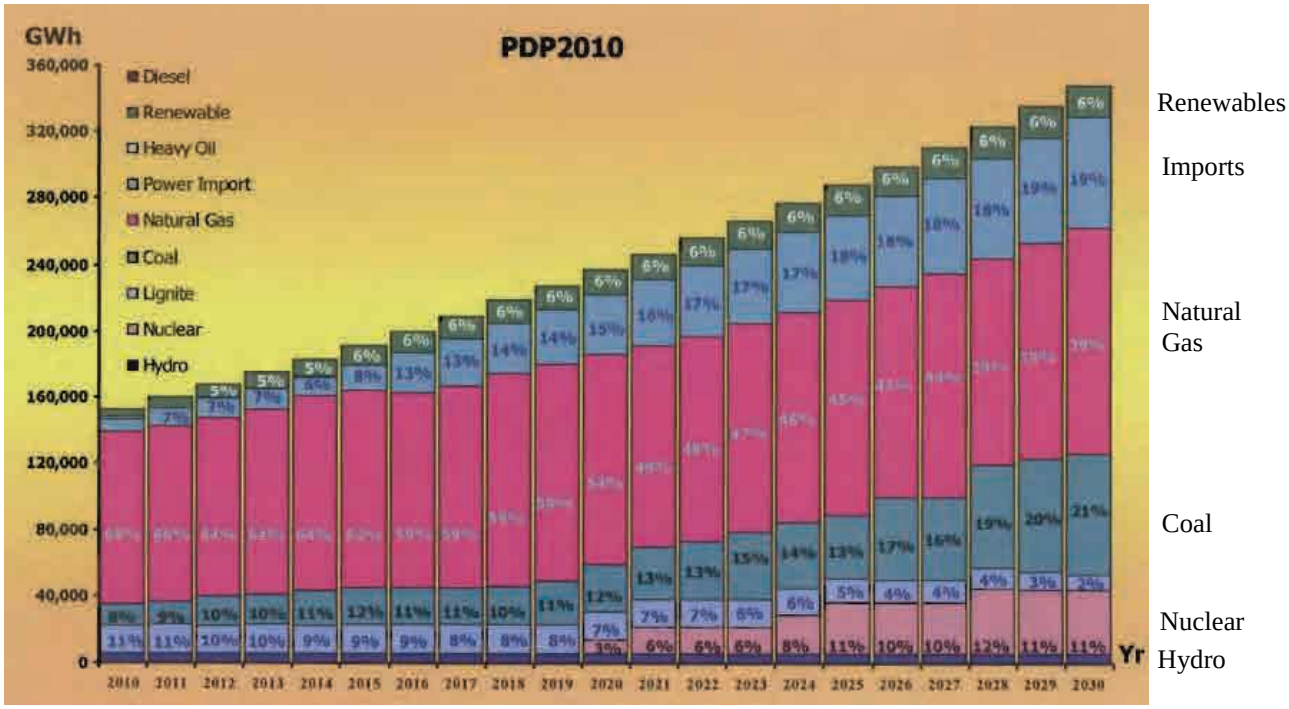
Fig. 2.2.3 Type of Power Generation



Source: DEDE

Fig. 2.2.4 Comparison of Installed Capacity and Peak Generation

Fig. 2.2.4 shows a comparison of installed capacity and peak generation. The percentages of reserve margin have been at a high level of around 26% for the last five years because of proper planning and management to secure stable power supplies. PDP expects the reserve margin to be around 15% for 30 years, and there are no problems related to energy security.



Source: EGAT

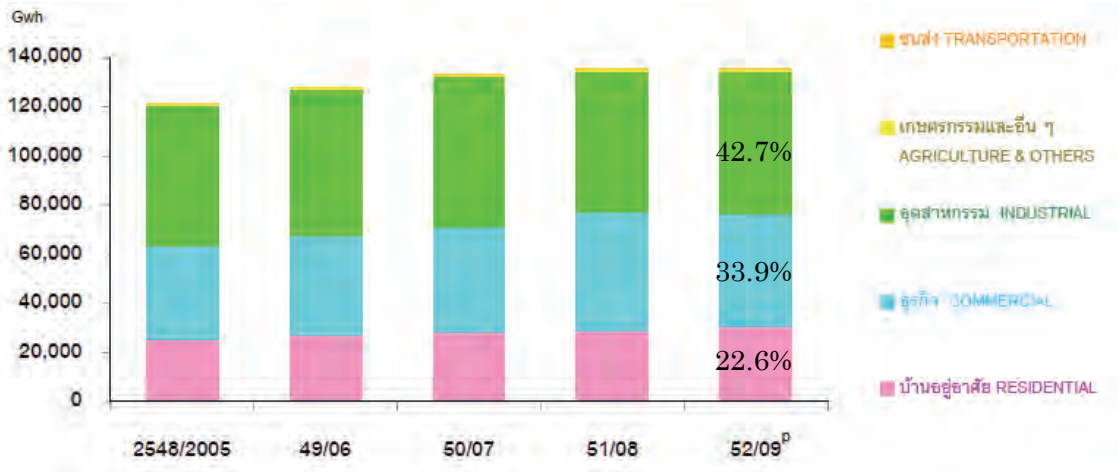
Fig. 2.2.5 Share of Generating Development by Fuel Type

PDP has estimated the development of power plants over 20 years. Fig. 2.2.5 shows a breakdown of generating plants by fuel type. Combined cycle, which is a major source of power, will decrease while nuclear power generation, coal power generation, and imports from a large hydro generator in Laos will increase their shares.

2.3 Current Conditions of Power Demand Sector

(1) Electricity Consumption by Economic Sector

Thailand's electricity consumption in 2009 was 135,420 GWh, which is almost the same as in the previous year. Consumption per capita is 2,125 kWh/capita and is increasing steadily. Industrial and commercial consumption occupied 76.6% of total consumption, and the remaining 22.6% was occupied by residential consumption. Details of the energy situation are shown in Fig. 2.3.1



Source: DEDE

Fig. 2.3.1 Thailand's Electric Consumption

(2) Strategic Target for Energy Elasticity Ratio

Energy elasticity(*3), which is the ratio of the growth rate of electricity consumption to the growth rate of GDP, is between 0.8 and 0.9 in developed countries. Thailand is promoting energy conservation to reduce energy elasticity, which turned out to be below "1.0" in 2007 and 2008 owing to the slowdown in the growth rate of electricity consumption and stagnant economy. The level of energy elasticity comparable to that of developed countries is aimed at in the future, with the long-term target of 0.99 set in PDP2010.

GDP AT 1988 PRICE (million Baht)	CONSUMPTION (Gwh)	ELASTICITY	% CHANGE OF GDP	% CHANGE OF CONSUMPTION	
3,008,401	87,932	1.7	4.8	8.0	2000
3,073,601	92,290	2.3	2.2	5.0	2001
3,237,042	100,173	1.6	5.3	8.5	2002
3,468,166	106,959	0.9	7.1	6.8	2003
3,688,189	115,044	1.2	6.3	7.6	2004
3,858,019	121,229	1.2	4.6	5.4	2005
4,056,550	127,811	1.1	5.1	5.4	2006
4,256,564	133,178	0.9	4.9	4.2	2007
4,361,396 p	135,449	0.7	2.5	1.7	2008

Source: DEDE

Fig. 2.3.2 Energy Elasticity

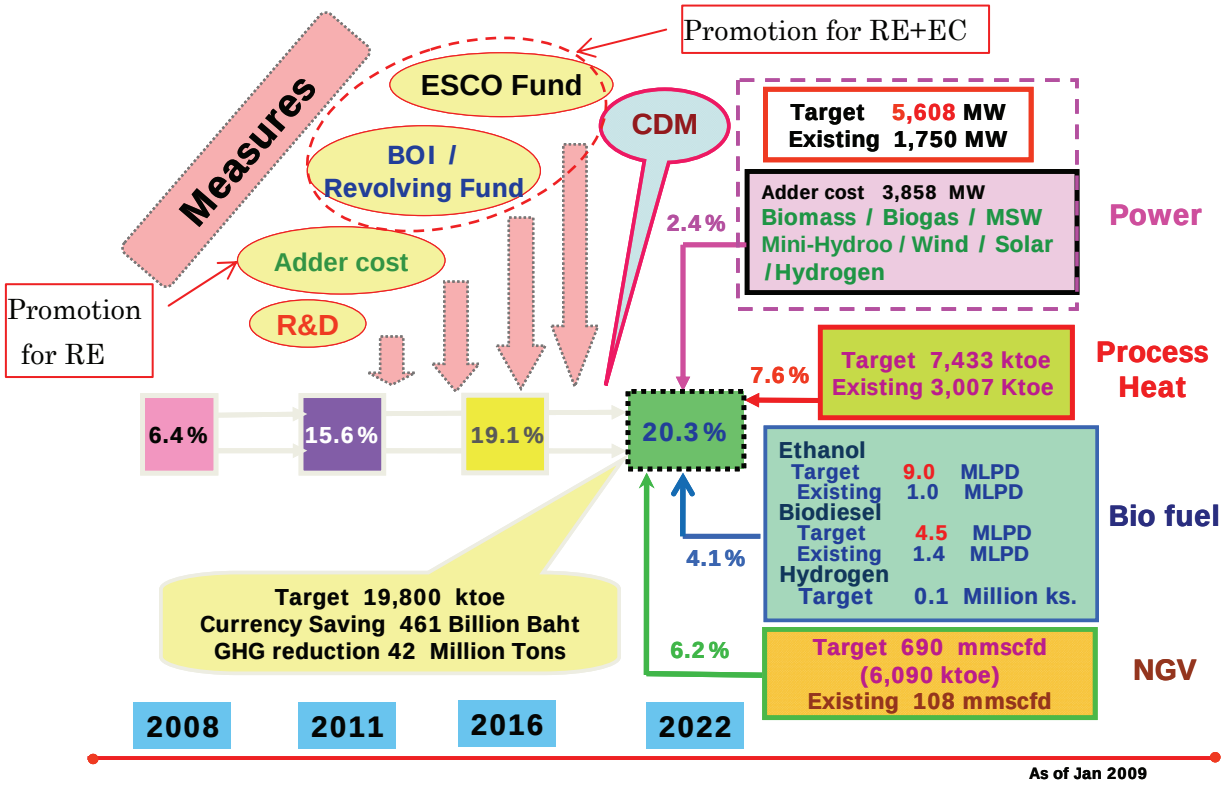
(*3) It is a ratio of the growth rate of electricity consumption to that of GDP and used to measure a change in energy use efficiency. The smaller this value is, the more advanced energy conservation is.

3 Confirmation of Current Conditions and Future Prospects for Renewable Energy

3.1 Government Policy and Current Conditions of Renewable Energy

a Government Policy for Renewable Energy and Application Conditions

The Thai government aims to adopt alternative energy including renewable energy for up to 20.3% of primary energy by 2022 as it promotes renewable energy based on the Alternative Energy Development Plan; AEDP (2008-2022). The breakdown is as follows: 2.4% from generation, 7.6% from heat utilization, 4.1% from bio-fuel, and 6.2% from NGV.



Source : DEDE/Alternative Energy Development Plan (2008 - 2022), Medium- and Long-term Investment Plan and Role of Private Sector

Fig. 3.1.1 Alternative Energy Development Plan, AEDP (2008 - 2022)

Table 3.1.1 Renewable Energy Potential and Targets (2008 - 2022)

Type of Energy	Potential	existing	2008 - 2011		2012 - 2016		2017 - 2022	
Electricity	**MW**	**MW**	**MW**	ktoe	**MW**	ktoe	**MW**	ktoe
Solar	50,000	**32**	**55**	6	**95**	11	**500**	56
Wind Energy	1,600	**1**	**115**	13	**375**	42	**800**	89
Hydro Power	700	**56**	**165**	43	**281**	73	**324**	85
Biomass	4,400	**1,610**	**2,800**	1,463	**3,220**	1,682	**3,700**	1,933
Biogas	190	**46**	**60**	27	**90**	40	**120**	54
Municipal Solid Waste	400	**5**	**78**	35	**130**	58	**160**	72
Hydrogen			**0**	0	**0**	0	**3.5**	1
Total		**1,750**	**3,273**	1,587	**4,191**	1,907	**5,608**	2,290
Thermal	**ktoe**	**ktoe**		**ktoe**		**ktoe**		**ktoe**
Solar Thermal	154	**1**		**5**		**17.5**		**38**
Bimass	7,400	**2,781**		**3,660**		**5,000**		**6,760**
Biogas	600	**224**		**470**		**540**		**600**
Municipal Solid Waste		**1**		**15**		**24**		**35**
Total		**3,007**		**4,150**		**5,582**		**7,433**
Biofuel	**m lt / d**	**m lt / d**	**m lt / d**	ktoe	**m lt / d**	ktoe	**m lt / d**	ktoe
Ethanol	3.00	**1.24**	**3.00**	805	**6.20**	1,686	**9.00**	2,447
Biodiesel	4.20	**1.56**	**3.00**	950	**3.64**	1,145	**4.50**	1,415
Hydrogen			**0**	0	**0**	0	01 mill kg	124
Total			**6.00**	1,755	**9.84**	2,831	**13.50**	3,986
Total Energy Consumption		66,248		70,300		81,500		97,300
Total Energy from R E (ktoe)		4,237		7,492		10,319		13,709
Renewable Energy Ratio		**6.4%**		**10.6%**		**12.7%**		**14.1%**
NGV (mmscfd - ktoe)		108.1	393.0	3,469	596	5,260	690	6,090
Total Energy from RE + NGV (ktoe)				10,961		15,579		19,799
Alternative Energy Ratio				**15.6%**		**19.1%**		**20.3%**

Source : DEDE/Alternative Energy Development Plan (2008 – 2022), Medium- and Long- term Investment Plan and the Role of the Private Sector

The Thai government divides it into the following three phases to be completed by 2022, and gives the overview below of the alternative energy development plan.

Short term (2008 – 2011)

Emphasize promotion of commercial alternative energy technologies and energy sources with high potential such as biofuels, and co-generation from biomass and biogas with full support provided.

Mid-term (2012 – 2016)

Focus on development of alternative energy technology industry, encourage new alternative energy R&D to achieve economic viability including new technologies for biofuels production, and introduce model development of Green Cities to communities for sustainable economic development.

Long term (2017 – 2022)
Enhance utilization of new available alternative energy technologies, i.e., hydrogen, bio hydrogenated (BHD), extend Green City model throughout Thai communities, and encourage biofuel hubs and alternative energy technology exports to the ASEAN region.

In general, introduction of renewable energy power generation of about 1,750 MW is set for 2007, and it is necessary to increase that by 3,850 MW to about 5,600 MW of primary energy, or 2.4%. This target is estimated from installed capacity. The capacity of the off-grid system is also accounted for in the table.

As of 2007, in the breakdown of installed capacity for renewable energy generation, biomass accounts for more than 90%, or more than 1,600 MW. In the breakdown of the increment to the target for 2022, it accounts for 60%, or 3,700 MW. This 3,700 MW, the targeted value for 2022, means developing more than 80% of the energy potential estimated now.

On the other hand, application of wind power etc., which has been negligible until now, is planned to be at least 800 MW, hydro power to be 324 MW, and solar power to be 500 MW each. The target for solar power is one-100th of the estimated 50,000 MW-potential, while that for hydro power is more than 45% of the 700 MW-energy potential, and that of wind power is 800 MW, or half the estimated 1600 MW-potential. As for wind power, there is little experience with only 1 MW installed as of 2007, but the aim is to increase this 800 times before 2022.

From interviews with DEDE and PEA, the reason for making more efforts to increase wind power and hydro power than solar power in Thailand is that the policy is to positively use domestic resources that can be developed by domestic enterprises. Although there are some domestic PV manufacturers in Thailand, capacity to make and install the solar generating facilities is limited because materials such as silicon for PV panels have to be imported.

The target is 7.6% for process heat, which accounts for the largest portion of the alternative energy promotion target of 20.3%, although it is not related to electric power application. It is planned to promote some kind of renewable energy such as biomass, which accounts for the largest share of process heat, and biogas, solar heat, etc.

b System for Promoting Utilization of Renewable Energy

As a countermeasure for adopting renewable energy shown in Fig. 3.1.1, the feed-in tariff system for buying up renewable energy power mentioned below (expanded purchases from SPP/VSPP) is mainly anticipated. In addition, as countermeasures for promoting renewable energy and energy conservation, soft loans (Revolving Fund, ESCO Fund) from the ENCON Fund (Energy Conservation Fund), an investment promotion plan of the Thailand Board of Investment (BOI) and the Clean Development Mechanism (CDM), by which Certificated CO2 Emission Reduction (CER)

is obtained by replacing existing CO2 discharging systems with alternative carbon-neutral energy, etc,, are planned. Renewable energy is to be promoted through these measures. Besides, the RPS system was introduced in 2003, but it has been decided to abandon it in 2011.

Each system is explained below.

System for Purchasing Surplus Power by Electric Power Utilities

Renewable energy is to be promoted by obliging electric power utilities (EGAT, MEA, and PEA) to purchase electricity from SPP and VSPP. The Adder subsidy from the government is paid to electric power utilities to compensate for the purchase price. SPP, VSPP and Adder system are summarized below.

＜Small Power Producer (SPP)＞

The SPP system established in 1992 supports the promotion of renewable energy generation and energy efficiency. SPPs can sell the power they generate to EGAT, if their installed capacity meets the condition of being equal to or less than 90 MW. SPPs mainly consists of cogeneration companies supplying heat and power and companies owning power stations for private use. Generating fuels include non-commercial energy such as sugar cane, rice husks, and charcoal, as well as commercial energy such as natural gas, coal, and heavy oil. The Adder system was implemented in 2007 for SPPs generating more than 10 MW or less than 90 MW to subsidize electricity generated by renewable energy, which is purchased by EGAT. As of December 2009, 24 (installed capacity : 604 MW, selling power : 374 MW) were operating, and 27 (installed capacity: 2,151 MW, selling power: 1,886 MW) have already applied and been registered. (See Table 3.2.2, described in 3.2.b)

＜Very Small Power Producer (VSPP)＞

The VSPP system was implemented in May 2002 to promote renewable energy generation on a smaller scale than that of SPP with power generated sold to MEA or PEA.

The system expands buyers (selling to MEA and PEA as well as EGAT) and the subsidy for the surplus power tariff from enterprises with renewable energy generation facilities (solar power, wind power, micro hydro power, biomass, and others) is initially for less than 1 MW. This subsidy is called the additional purchasing price of electricity (Adder), and varies according to renewable energy classification. It will be added to the tariff for seven years (or 10 years).

Regarding the VSPP system, the installed capacity registered was extended to 10 MW in 2006, and the system was also applied to cogeneration systems. As of December 2009, 159 VSPPs (792 MW of installed capacity, and 350 MW of power sold in total) were operating, and 986 VSPPs (5,942 MW of installed capacity, 5,077 MW of power sold) will be sold to MEA or PEA. (See Table 3.2.3, described in 3.2.b)

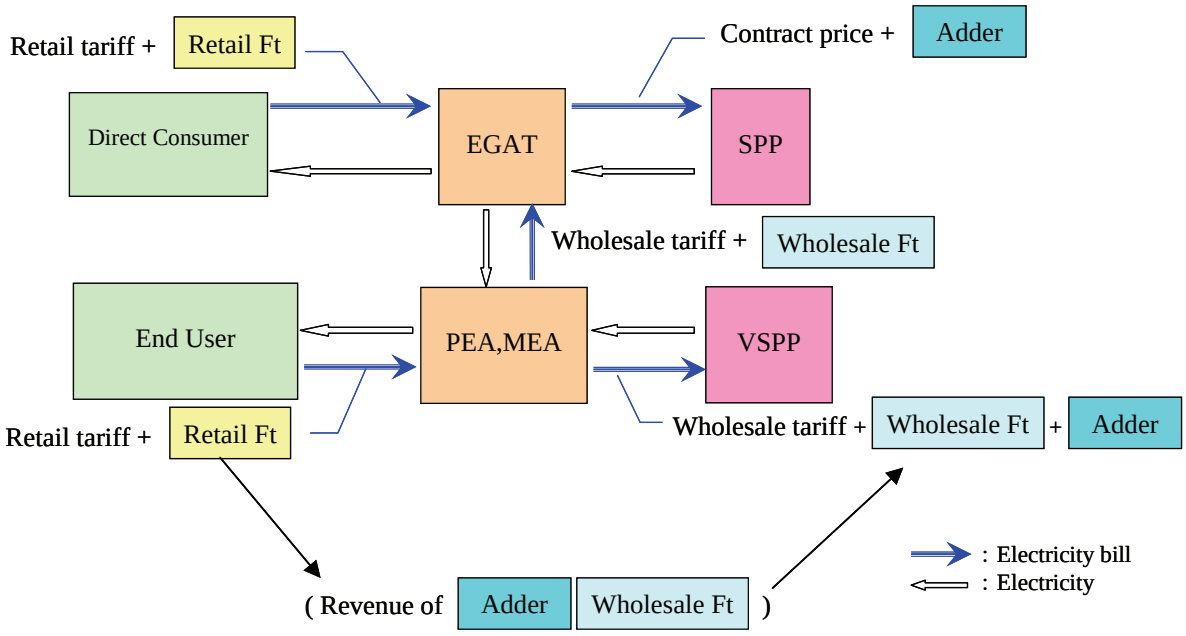
＜Adder System＞

The Adder system is a subsidy system introduced to promote renewable energy generation by SPPs and VSPPs in 2007. Electric power utilities (EGAT, MEA, and PEA) purchase at a wholesale

price with the "Adder" subsidy added to the normal selling price. Adder differs in amount and period by classification of renewable energy and scale of generation, i.e., for wind power and solar power, which have not been extensively introduced because of the high initial investment, and is differentiated by making the amount of Adder generous and by making the period of Adder 10 years. Adder for some small and medium-size generating operations was reviewed and increased in March 2009. (See Table 3.1.2) However, in March 2010, another review of Adder was announced. Extra Adder (1 Baht/kWh) is supported when RE is introduced as an alternative energy to diesel generation. Electricity is supplied by diesel generation, whose cost is high because of high import/transportation costs to the north and islands of Thailand far from the existing grid. In these areas, support will be more generous to reduce costs and fossil fuel use. For instance, at PEA, four applications are submitted for VSPPs converting to PV in Mae Hong Son province in northern Thailand. Extra Adder (1 Baht/kWh) is also supported when RE is introduced in the three Southern provinces of Thailand (Yala, Pattani, and Narathivath) to more generously support areas where investment risk is high because of poor public security. It aims at local activation such as industrial development/job creation by inviting the RE industry to the areas. For instance, at PEA, five applications were submitted by hoggeries for VSPPs of about 100kW.

Adder that electric power utilities pay to SPP and VSPP is financed by the following methods.

- Adder is financed by fuel adjustment tariff (Ft).
- Fuel adjustment tariff (Ft) is collected from all retail customers.
- Fuel adjustment tariff (Ft) is calculated on the basis of the costs of power generation from all sources including gas, oil, and other fossil fuels as well as renewable energy such as solar power.
- The utilities (EGAT, PEA, and MEA) report the record of Adder payment to the Ft committee (a subcommittee of ERC (Energy Regulatory Commission)), but the Ft committee does not collect Adder fund.
- Fuel adjustment tariff (Ft) is determined by the Ft committee every four months after its appropriate calculation. (See Fig. 3.1.2, Fig. 3.1.3)



Source: created by the study team

Fig. 3.1.2 Electricity Bill and Electricity Flow

Recent Trend of Adder Promotional Measures

On 23 March, 2010, the Thai government announced a review of the current Adder system, because the application capacity has increased sharply beyond the promotion target.

As of June 2010, the signing of new PPAs has been restricted. Power utilities have submitted information required for considering a revision of the Adder system to the committee under EPPO. The direction of the revision has not been announced. But, it is assumed the amount of support will decrease due to the recent tendency for projects applying to greatly exceed the promotion target.

Under the present regulations, it is easier to get approval for SPP projects than larger projects such as IPP projects, which require a bidding procedure. Some SPP investors who have sold their rights to authorized projects to European investors have found it difficult to collect repayments or have delayed investments in projects that have been applied due to the recent European economic crisis.

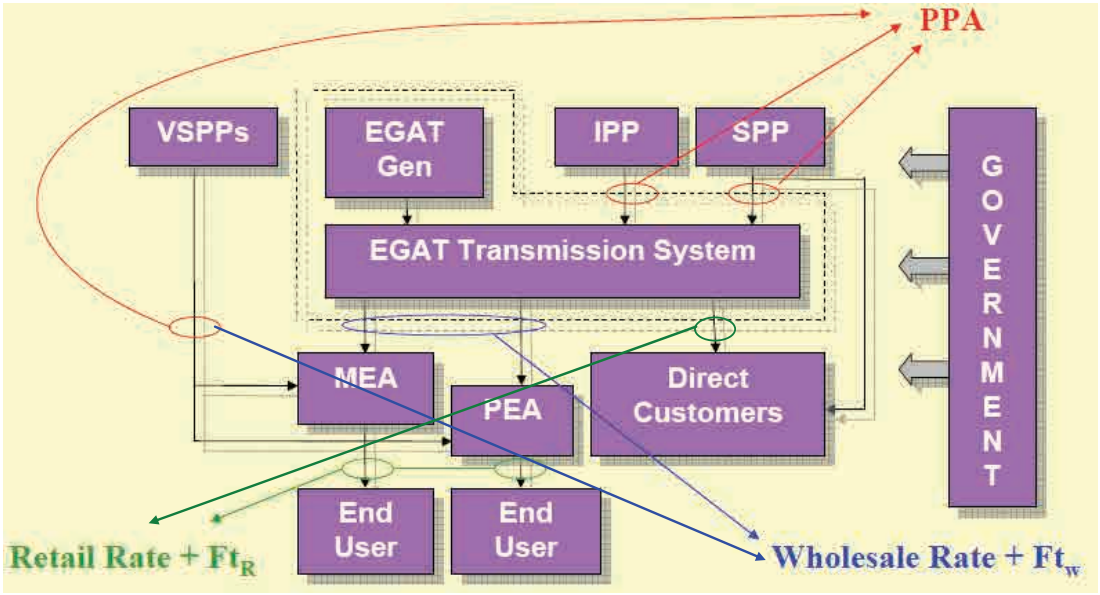
Table 3.1.2　Adder List（Revision in May 2009）

Fuel Types / Size	Adder (Baht/kwh)	Extra Adder[1] (Baht/kwh)	Extra Adder[2] (Baht/kwh)	Period (Years)
1. Biomass				
Capacity ≤ 1 MW	0.50	1.00	1.00	7
Capacity > 1 MW	0.30	1.00	1.00	7
2. Biogas				
Capacity ≤ 1 MW	0.50	1.00	1.00	7
Capacity > 1 MW	0.30	1.00	1.00	7
3. MSW				
AD / Land Fill Gas	2.50	1.00	1.00	7
Thermal Process	3.50	1.00	1.00	7
4. Wind Energy				
Capacity ≤ 50 kW	4.50	1.50	1.50	10
Capacity > 50 kW	3.50	1.50	1.50	10
5. Mini Hydro				
Capacity 50 kW - < 200 kW	0.80	1.00	1.00	7
Capacity < 50 kW	1.50	1.00	1.00	7
6. Solar PV	8.00	1.50	1.50	10

Notes 1 = Electricity from Renewable Energy for diesel oil replacing　　: Increase review in March ,2009
2 = For 3 Southern Provinces (i.e. Yala, Pattani and Narathivath)

Source : DEDE/Alternative Energy Development Plan (2008 - 2022), Medium- and Long-term Investment Plan and Role of the Private Sector

Power purchasing system for SPP and VSPP is described below.



Source : EGAT/Power Purchase Agreement-Principles and Payment Structure, by Mr. Chira, Sept. 2006

Fig. 3.1.3　Overview of Power Purchasing System

As shown in Fig. 3.1.3, a SPP signs a Power Purchase Agreement (hereinafter PPA) with EGAT. There are the following two types of PPA:

1． Firm Contract：Capacity Payment＋Energy Payment, five to 25-year contract

2． Non-firm Contract：Energy Payment, less than five years (typically one year contract)

In April 2007, EGAT raised the renewable energy of a SPP as shown in Table 3.1.3 and in October seven SPPs (Total selling capacity：335 MW) were approved.

Table 3.1.3　Application Conditions for SPP using Renewable Energy　（as of April 2007）

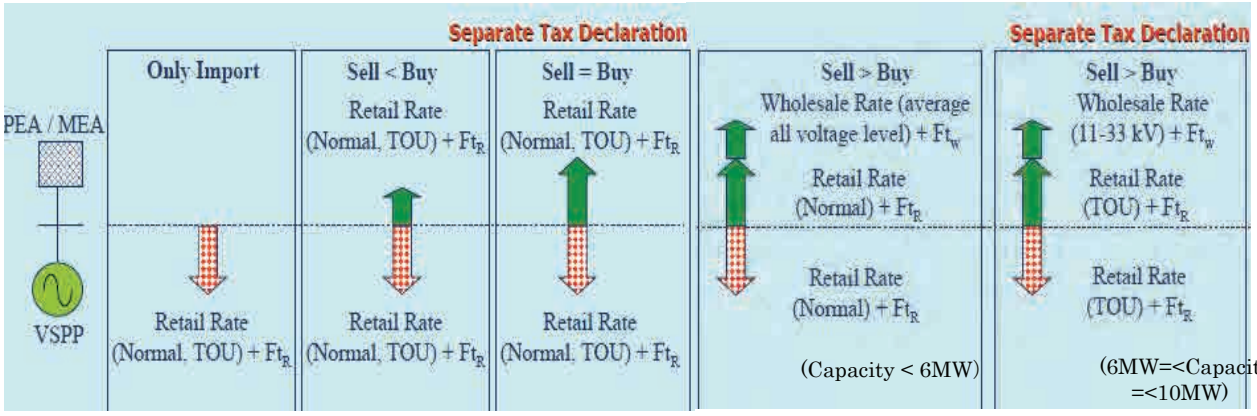
Purchase capacity	530 MW （Breakdown：MSW 100 MW，　Wind power 115 MW，Solar power 15 MW，Other RE type 300 MW）	
Participation conditions	・Selling power capacity is over 10 MW and less than/equal to 90 MW ・Selling electricity to the grid by 2012 ・The fossil fuel co-firing ratio is less than 25%	
Contract form	Firm contract	Non-firm contract
Contract period	20 to 25 years	One year（continuous renewal）
Power selling rate	Capacity payment ＋ Energy payment＋Ft＋Adder	Energy payment＋Ft＋Adder
Adder (Duration)	・MSW：2.5 Baht/kWh（7 years） ・Wind power：3.5 Baht/kWh（10 years） ・Solar power：8.0 Baht/kWh（10 years） ・Other RE type：Bidding [limit 0.3 Baht/kWh]（7 years）	

Notes：The underline part was revised in November 2007

Source：created by the study team based on EPPO, Renewable Energy Policy; Recent Policies on SPP/VSPP

On the other hand, VSPP signs a PPA for PEA or MEA to buy surplus electricity as described in Fig. 3.1.4. However, when it signs a PPA, a VSPP can select either surplus electricity purchase or gross electricity purchase at present.

In June 2007, PEA and MEA raised VSPP using renewable energy as shown in Table 3.1.4.



Source：EGAT/Power Purchase Agreement-Principles and Payment Structure, by Mr. Chira

Fig. 3.1.4　Overview of Surplus Power Purchases

Table 3.1.4　Application Conditions for VSPP using Renewable Energy (as of June 2007）

Purchase capacity	No ceiling setting
Participation conditions	・Selling power capacity is 10 MW or less ・Fossil fuel co-firing ratio is less than 25% ・Generating enterprise bears expenses such as distribution line needed for connection to the grid, and its inspection.
Contract period	One year（continuous renewal）
Power selling rate	Standard fee（Unit cost × kWh）＋Ft＋Adder
Unit cost of standard fee	(1) Selling power capacity：Less than 6 MW In case of Sell =< Buy ・Equivalent unit cost of retail rate In case of Sell > Buy ・Regular fee agreement : Average of wholesale rate from EGAT to PEA(MEA) ・TOU agreement : The wholesale rate of 11 - 33 kV from EGAT to PEA(MEA) (2) Selling power capacity：More than 6 MW, and less than/equal to 10MW ・Regular fee agreement : Average of wholesale rate from EGAT to PEA(MEA) ・TOU agreement : The wholesale rate of 11 - 33 kV from EGAT to PEA(MEA)
Adder (Duration)	・Biomass, Biogas：0.3 Baht/kWh（7 years） ・Mini-Hydro power<50～200 kW>：0.4 Baht/kWh（7 years） ・Micro-Hydro power<less than 50 kW>：0.8 Baht/kWh（7 years） ・MSW：2.5 Baht/kWh（7 years） ・Wind power：3.5 Baht/kWh（10 years） ・Solar power：8.0 Baht/kWh（10 years）

Notes：The underline part was revised in November 2007

Source：created by the study team based on EPPO, Regulations for Purchases From Very Small Power Producers, and Renewable Energy Policy; Recent Policies on SPP/VSPP

The power selling rate is shown in Table 3.1.5 with the example of solar power generation. Here, you may think of Bulk Supply tariff in Table 3.1.5 as being equivalent to Wholesale Rate in Fig. 3.1.4. Therefore, in the case of solar power generation, the selling rate of a VSPP (and a SPP) as of December, 2009 is shown below.

Selling rate＝Wholesale rate (11 kV-33 kV)＋Ft_w＋Adder

=1.81+0.92+8.0= approximately 10.7 [Baht/kWh]

Table 3.1.5　Example of Power Selling Rate（in case of solar power generation）

	VSPP
Utility	PEA
Tariff	Bulk Supply tariff (TOU) + Ft + Adder
Bulk Supply tariff (average as per Dec 09)	Onpeak: 2.92 baht/kWh Offpeak: 1.11 baht/kWh
Ft (as per Dec 09)	0.92 bath/kWh
Adder	8.0 bath/kWh for 10 years
Tariff (average as per Dec 09)	**10.7** baht/kwh

Note) On-peak：Mon.-Fri. 9:00-22:00
Off-peak：Mon.-Fri. except for On-peak hours,
Weekends and holidays

- ✓ VSPP：Very Small Power Producer
- ✓ Bulk Supply tariff：Price EGAT sells bulk electricity to PEA/MEA
- ✓ TOU：time of Use
- ✓ Ft：Fuel price volatility

Source: created by the study team based on the data of ENSOL

For reference, the trend of the electricity buying price (wholesale rate and retail rate) for a VSPP in 2002-2009 is shown in Table 3.1.6. Ft suddenly rose due to the influence of a sharp rise of crude oil prices in 2006 and 2009.

The flows of the application procedure of a SPP and VSPP until the beginning of operations is shown in Fig. 3.1.5. It takes four to six months from submitting an application to signing a PPA. Then, it takes around eight months at minimum until the Commissioning Operation Day (COD), even if the construction period is two months. An application to sell electricity and system connection (extract) includes technical and general information related to the generator and connection, and documents submitted other than information on the applicant and the generator parameters are described in Fig. 3.1.6. The procedure is not complex.

Table 3.1.6 Trend of Electricity Buying Prices for a VSPP, 2002-2009

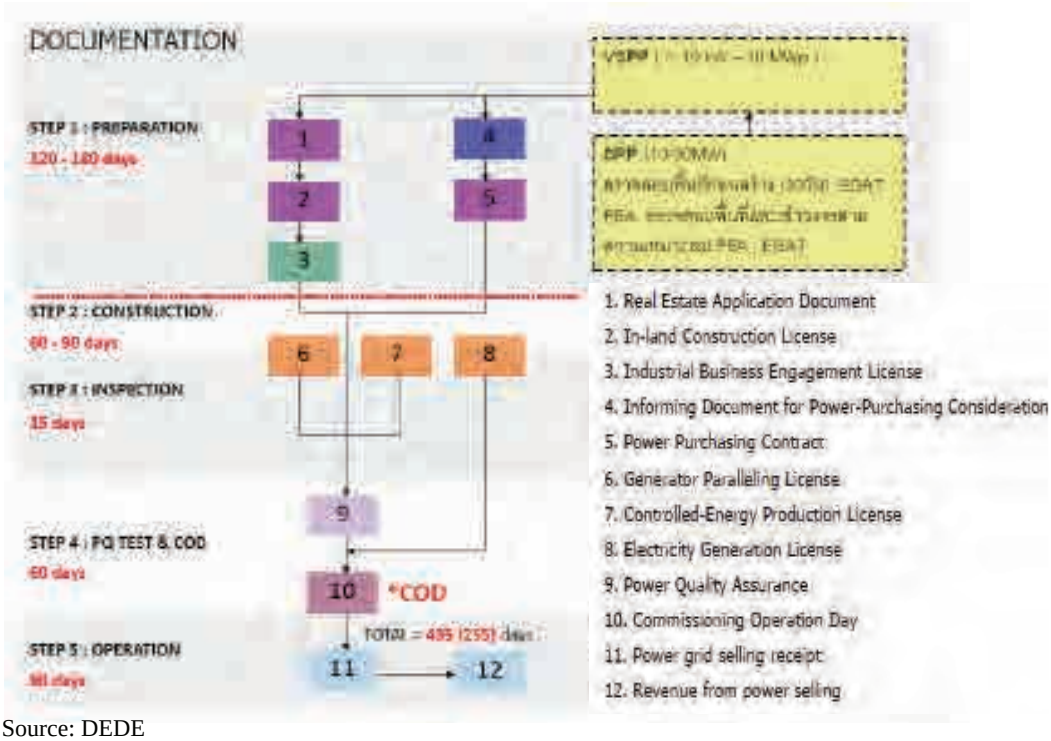
Unit: Baht/kWh

Year/Month	Wholesale Tariff			Average Wholesale Ft	Total Wholesale	Retail Tariff		Total Retail
	Peak	Off Peak	Average			Average Retail	Retail Ft	
2002								
Average	**-**	**-**	**1.7555**	**0.2370**	**1.9925**	**2.2462**	**0.2195**	**2.4657**
2003								
Average	**-**	**-**	**1.7472**	**0.2809**	**2.0280**	**2.2475**	**0.2577**	**2.5052**
2004								
Average	**-**	**-**	**1.7279**	**0.4063**	**2.1342**	**2.2426**	**0.3852**	**2.6278**
2005								
Average	**-**	**-**	**1.6985**	**0.4935**	**2.1920**	**2.2419**	**0.4785**	**2.7204**
2006								
Average	**2.4807**	**1.0997**	**1.6744**	**0.7808**	**2.4553**	**2.2449**	**0.7810**	**3.0259**
2007								
January	2.4841	1.0998	1.7012	0.7788	**2.4800**	2.2337	0.7842	**3.0179**
February	2.4806	1.0997	1.7100	0.7788	**2.4888**	2.2599	0.7342	**2.9941**
March	2.4821	1.0997	1.6914	0.7322	**2.4236**	2.2449	0.7342	**2.9791**
April	2.4791	1.0995	1.6377	0.7322	**2.3699**	2.2563	0.7342	**2.9905**
May	2.4851	1.0998	1.6679	0.7322	**2.4001**	2.2486	0.7342	**2.9828**
June	2.4781	1.0995	1.6829	0.7322	**2.4151**	2.2631	0.6842	**2.9473**
July	2.4825	1.0997	1.6721	0.6849	**2.3570**	2.2438	0.6842	**2.9280**
August	2.4797	1.0996	1.7136	0.6849	**2.3985**	2.2707	0.6842	**2.9549**
September	2.4740	1.0994	1.6565	0.6849	**2.3414**	2.2405	0.6842	**2.9247**
October	2.4730	1.0993	1.6922	0.6849	**2.3771**	2.2450	0.6611	**2.9061**
November	2.4714	1.0992	1.7095	0.6632	**2.3727**	2.2594	0.6611	**2.9205**
December	2.4689	1.0992	1.6021	0.6632	**2.2653**	2.2088	0.6611	**2.8699**
Average	**2.4782**	**1.0995**	**1.6781**	**0.7127**	**2.3908**	**2.2479**	**0.7034**	**2.9513**
2008								
January	2.4711	1.0992	1.6967	0.6632	**2.3599**	2.2517	0.6611	**2.9128**
February	2.4702	1.0991	1.6704	0.6895	**2.3599**	2.2477	0.6886	**2.9363**
March	2.4699	1.0992	1.6623	0.6895	**2.3518**	2.2310	0.6886	**2.9196**
April	2.4761	1.0996	1.6653	0.6895	**2.3548**	2.2826	0.6886	**2.9712**
May	2.4725	1.0993	1.6146	0.6895	**2.3041**	2.2213	0.6886	**2.9099**
June	2.4729	1.0992	1.6797	0.6749	**2.3546**	2.2513	0.6285	**2.8798**
July	2.4750	1.0993	1.6656	0.6749	**2.3405**	2.2383	0.6285	**2.8668**
August	2.4790	1.0994	1.6414	0.6748	**2.3162**	2.2283	0.6285	**2.8568**
September	2.4829	1.0995	1.7180	0.6749	**2.3929**	2.2771	0.6285	**2.9056**
October	2.4822	1.0995	1.6976	0.7730	**2.4706**	2.2615	0.7770	**3.0385**
November	2.4790	1.0994	1.6629	0.7730	**2.4359**	2.2509	0.7770	**3.0279**
December	2.4801	1.0995	1.6529	0.7730	**2.4259**	2.2770	0.7770	**3.0540**
Average	**2.4759**	**1.0994**	**1.6690**	**0.7033**	**2.3723**	**2.2516**	**0.6884**	**2.9399**
2009								
January	2.4814	1.0996	1.6856	0.9098	**2.5954**	2.2818	0.9255	**3.2073**
February	2.4787	1.0994	1.6736	0.9100	**2.5836**	2.2892	0.9255	**3.2147**
March	2.4788	1.0994	1.6965	0.9101	**2.6066**	2.2726	0.9255	**3.1981**
April	2.4796	1.0996	1.6166	0.9100	**2.5266**	2.2574	0.9255	**3.1829**
may	2.4734	1.0993	1.5833	0.9177	**2.5010**	2.2258	0.9255	**3.1513**
June	2.4711	1.0991	1.7025	0.9177	**2.6202**	2.2974	0.9255	**3.2229**
July	2.4710	1.0992	1.6583	0.9177	**2.5760**	2.2298	0.9255	**3.1553**
August	2.4749	1.0993	1.6387	0.9177	**2.5564**	2.2437	0.9255	**3.1692**
September	2.4704	1.0991	1.7065	0.9206	**2.6271**	2.2723	0.9255	**3.1978**
October	2.4715	1.0992	1.6649	0.9206	**2.5855**	2.2331	0.9255	**3.1586**
November								
December								
Average	**2.4751**	**1.0993**	**1.6627**	**0.9152**	**2.5778**	**2.2603**	**0.9255**	**3.1858**

Notes :

1) Wholesale tariff is the average value of PEA's and MEA's wholesale tariffs at all voltage levels.
2) Average wholesale Ft is the average value of PEA's and MEA's wholesale Ft at all voltage levels.
3) Average retail tariff is the average value of PEA's & MEA's retail tariff for their customers and EGAT's retail tariff for direct customers

Source: EPPO Home Page



Source: DEDE

Fig. 3.1.5 Flow of Application Procedure for SPP and VSPP

Application for Sale of Electricity and System Interconnection
(For Generators with Net Output under 10 MW)

The application for sale of electricity and system interconnection for power producers with a generating facility with net output under 10 MW to be interconnected with the Provincial Electricity Authority (PEA)/Metropolitan Electricity Authority (MEA) system.

***Remarks:** Power Producers with generators less than 30 kW are not required to fill in the shaded areas.*

Section 1: Applicant Information

Name: _____ Age: _____ Nationality: _____ Ethnic: _____

Mailing Address: _____

Province: _____ Post Code: _____ Telephone: _____

Submitting the application in the capacity as _____ Business: _____ or

Company: _____

Headquarters Location:

_____

Telephone: _____ Fax: _____

Facility Location:

_____

Telephone: _____ Fax: _____

Section 2: Generator Qualifications

Is Generator powered by renewable energy sources? ☐ Yes ☐ No

Type of renewable energy: ☐ Solar ☐ Wind ☐ Hydro ☐ Biogas ☐ Geothermal ☐ Waste ☐ Others: _____

Other energy source: ☐ Natural Gas ☐ Oil ☐ Coal ☐ Others: _____

Will there be excess power to be exported to PEA/MEA? ☐ Yes ☐ No

Total System Capacity: _____ kW Site Load: _____ kW (Typical)

Maximum Export: _____ kW

Source: EPPO Home Page

Fig. 3.1.6 Application for Sale of Electricity and System Interconnection (extract)

Other Renewable Energy Promotion Systems

＜Investment Promotion Plan of BOI＞

BOI is an organization that is responsible for enforcing the Investment Promotion Act in Thailand and establishes investment policies and authorizes important investments.

This investment promotion policy consists of granting benefits such as tax incentives and non-tax incentives for Activities Eligible for Promotion, and is aimed at dissemination of local industries, local industrial promotion, and narrowing income gaps. It divides Thailand into three zones and gives generous benefits to areas far from the Bangkok metropolitan area (Fig. 3.1.7). It also gives generous benefits for priority activities (*) among Activities Eligible for Promotion regardless of zone to promote specific industries and industrial clusters.

Tax incentives for the 3rd zone are the most generous.

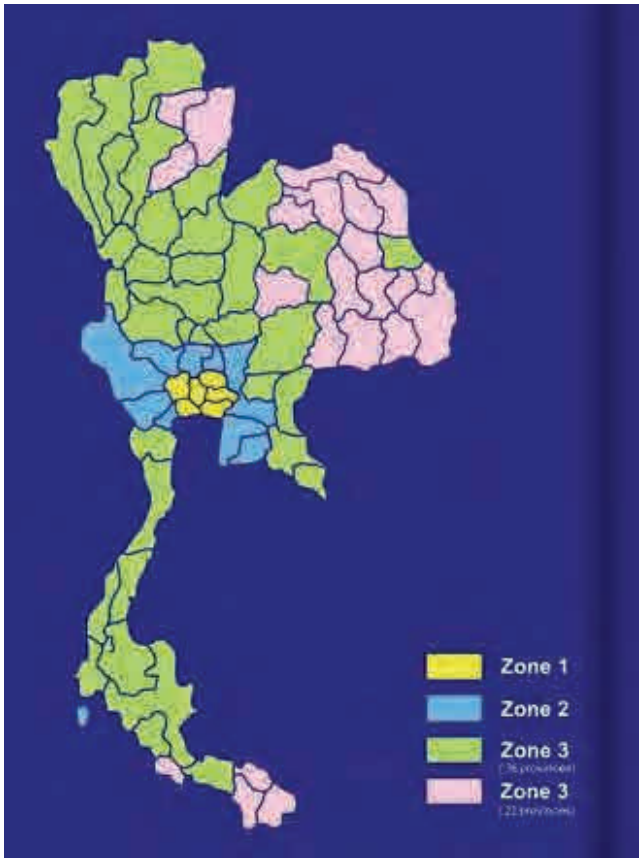
- Corporate income tax exemption for eight years (plus an extra five years with a 50% tax reduction)
- Import tax on equipment exemption

BOI promotes all industries in Thailand, as well as renewable energy and energy conservation; however, businesses related to renewable energy or energy conservation (as belonging to electricity or ESCO business among “Section 7: Service and Public Utilities”), which are subjects of this survey, are designated priority activities and attract most benefits (tax incentives), as well as the 3rd zone, regardless of location zone.

(*) Priority activities：

It determines Activities that are important to Thailand (Agriculture and marine products industry, public utilities, business related to environmental conservation/measures, etc.), and details are shown in the "List of Activities Eligible for Promotion."

As shown in Fig. 3.1.8, renewable energy allied businesses have been promoted remarkably in recent years thanks to incentives from BOI. They are essential for a development enterprise (an investor) in Thailand. From an interview survey, approximately 100% of the generation enterprises receive benefits from BOI.



Zone 1: 6 metropolis, provinces
Bangkok, Samutprakan, Samutsakhon, Nonthaburi, Nakhonpathom, Pathumthani

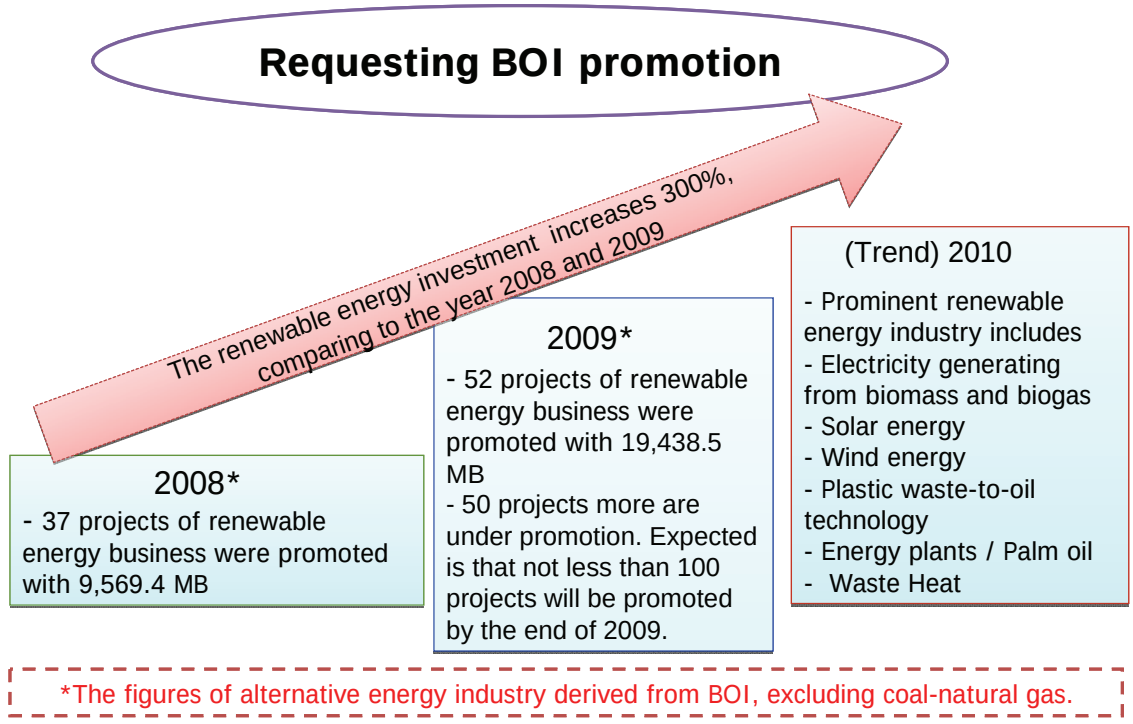
Zone 2: 12 Provinces
Samutsongkhram, Ratchaburi, Kanchanaburi, Suphanburi, Angthong, Ayutthaya, Saraburi, Nakhonnayok, Chachoengsao, Chonburi, Rayong, Phuket

Zone 3 (others): 36 Provinces
Zone 3 special area: 22 Provinces
} 58 Provinces

Sisaket, Nongbualamphu, Surin, Yasothon, Mahasarakham, Nakhonphanom, Roiet, Kalasin, Sakhonnakhon, Buriram, Amnatcharoen, Phrae, Phayao, Nan, Satun, Pattani, Yala, Narathiwat, Chaiyaphum, Udonthani, Nongkhai, Ubonratchathani

Source: BOI Home Page

Fig. 3.1.7 BOI investment promotion zone



Source : DEDE

Fig. 3.1.8 Support for Renewable Energy Businesses from BOI

＜Technical Assistance＞

Regarding five types of renewable energy (wind energy, solar energy, biomass, biogas, and mini-hydro) DEDE has studied, potential data and research reports are published on Web sites, and information is offered free of charge through a one-stop service. It plans to promote dissemination by arranging an environment in which an investor and anyone including a company interested in renewable energy can obtain information easily.

○ Information service on potential renewable energy:

- Map of potential renewable energy
- Research report on renewable energy

○ Setting up information service center for renewable energy and energy conservation:

- Information service that is free of charge through one-stop service

＜Investment Grants＞

MOE or EPPO gives a subsidy to a design/consultation/investment for small projects related to three types of renewable energy (biogas, municipal solid waste, and solar heat). Specifically, in 2009, the maximum grants were 30% of the project cost for biogas, 100% for municipal solid waste, and 30% for solar heat, but did not exceed 50 million baht for each project investment.

＜Revolving Fund，ESCO Fund etc.＞

○Revolving Fund:

- Soft loan for energy conservation activities and use of renewable energy
- Annual interest: less than 4%, Term: seven years
- Finance up to 50 million Baht per case
- Commercial banks borrow from ENCON Fund (*) and lend to enterprises（two-step loan）

○ESCO Fund：

- Co-investment fund with private investors, which manages 500 million Baht from ENCON Fund (*) for enterprises each year
- Energy Conversation Foundation of Thailand (ECFT) and Energy for Environment Foundation (EFE) are Fund Managers.
- Description of business: Equity Investment, Venture Capital, Equipment Leasing, CDM Trading, Technical Assistance, and Credit Guarantee Facility

（*）Energy Conservation Promotion Fund (ENCON Fund)：
The source of revenue is income of approximately 2-2.5 billion baht a year from taxes such as gasoline, diesel oil, oil, and kerosene taxes (0.05-0.25 Baht/Liter).

Revolving Fund and ESCO Fund are described in detail in Section 4.

＜RPS System＞

The Renewable Portfolio Standard (RPS) was introduced in 2003. When EGAT constructs a new power plant or when IPP constructs a power plant to be sold to EGAT, they are obliged to assign 5% of installed capacity to renewable energy generation. Regarding EGAT's power plants, EGAT planned to develop power generation facilities using renewable energy sources for the capacity of

140 MW (80 MW capacity to be developed by EGAT itself, and 60 MW capacity to be developed by SPPs and purchased by EGAT as credit) in constructing new fossil-fuel power plants with total capacity of 2,800 MW from 2008 to 2010. Under the RPS system, however, no obligation arises for increasing installed capacity for renewal energy without the construction of a new power source, to begin with, and the RPS does not motivate the introduction of renewable energy more than 5% of the installed capacity even upon the construction of a new power source. Furthermore, since a development of a large-scale power source takes several years and is not frequently planned, a trading contract for power from renewable energy sources is delayed accordingly. As power generation using renewable energy sources is not an operation with attractive profitability to begin with, a situation is unlikely where its voluntary development by power producers is facilitated.

In consideration of these circumstances, in promoting the introduction of renewable energy, a development target should be set that is commensurate with the potential of each resource, and the development of renewable energy should be motivated on its own. It is thus considered more effective to establish an incentive system for investors and have them initiate a development project voluntarily. Therefore, the current Adder system was introduced in 2007, and the RPS system was determined to be abolished in 2011.

＜CDM＞

Thai government specifies the fields of energy, environment, transportation, and industry as priority areas for Clean Development Mechanism (CDM). Renewable energy and energy conservation projects can be subject to CDM application. Power generation using renewable energy can be deemed to contain greenhouse gas emission in comparison with power generation using fossil fuel. Implementing energy conservation measures in existing business operations also can be deemed to reduce the amount of energy and to contain concomitant emission of greenhouse gas.

In the case of power development with renewable energy in Thailand, a project can get credits at around 0.5 tCO_2/MWh and can sell these credits in the market or under contracts. The unit price calculated by the World Bank in 2008 was 11.46 Euros (US$ 16.78), although the market fluctuates.

Companies can get some income by selling credits for 10 years or renewing each seven years (they can extend them to 21 years at maximum). But, they do not consider the amounts effective considering the huge construction costs. It is considered that it is worth getting credits to improve the images of their companies.

Present situation and procedure of CDM in Thailand are as follows.

- Procedure of CDM in Thailand

In Thailand a CDM is processed as follows:

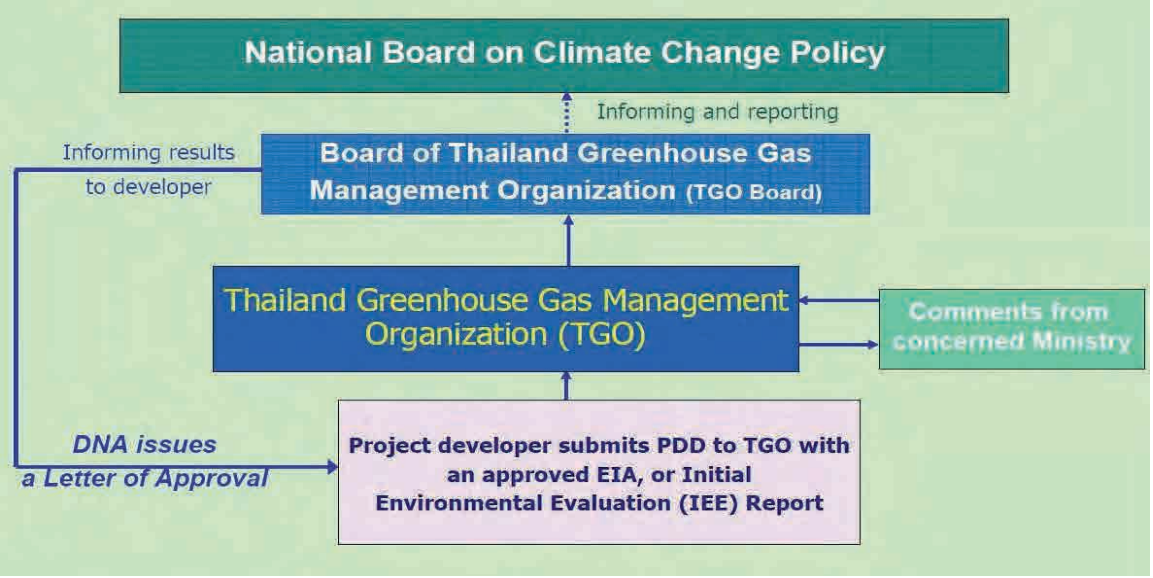
- December 1994 - Ratification of United Nations Framework Convention on Climate Change
- August 2002 - Ratification of Kyoto protocol
- January 2007 - Approved as host country of CDM project

In July 2003, the Ministry of Natural Resources and Environment (MNRE) was assigned as the Designated National Authority (DNA). The Office of Natural Resources and Environmental Policy and Planning (ONEP) was assigned as the National focal point of UNFCCC and the secretariat of the National Committee on CC. Then, in July 2007, the Thailand Greenhouse Gas Management Organization (TGO) was established as the DNA-CDM Office.

- Procedure for Approval in Thailand

Procedure for Approval of CDM in Thailand is as follows (Fig. 3.1.9):

1. Project developer submits Project Designed Document (PDD) to TGO
2. TGO sends the document to concerned Ministry
3. Concerned Ministry replies with comments to TGO
4. TGO board discusses project with comments
5. TGO informs the results to National Board on Climate Change Policy and developer
   TGO (as DNA) issues Letter of Approval (LoA)

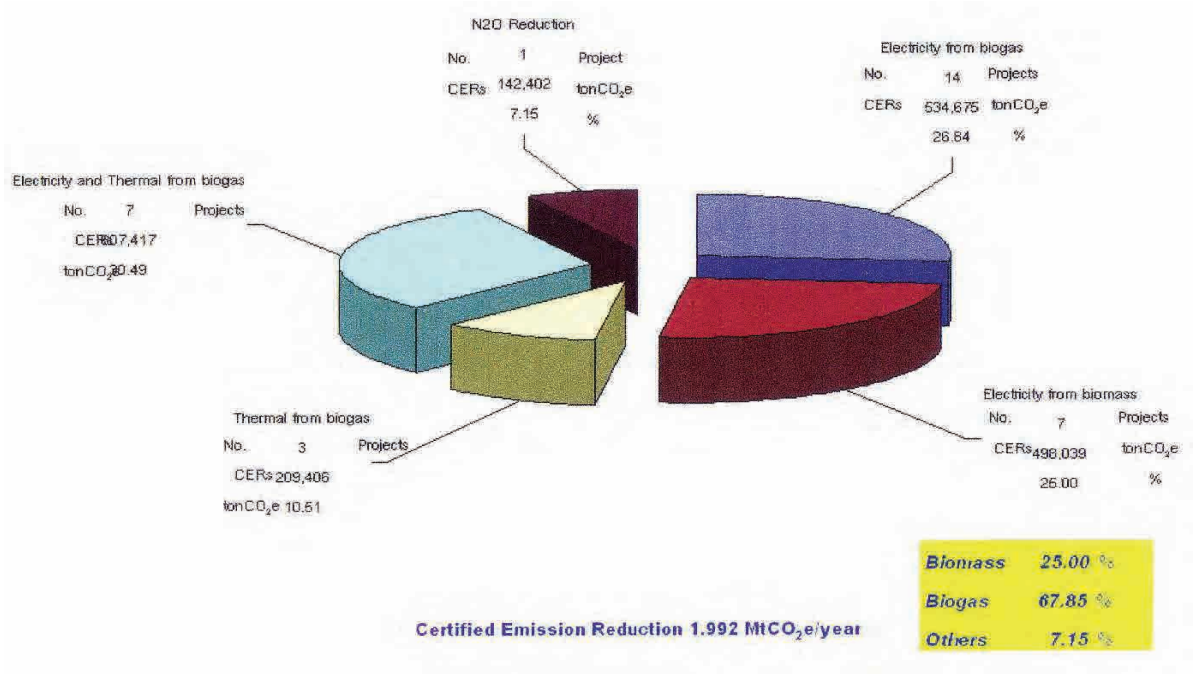


Source: Current and Future Policies, Measures, and Supporting Implementation for Thai CDM Projects, TGO

Fig. 3.1.9 Procedure for Approval

- Current situation of projects in Thailand registered at the UN CDM Executive Board (Fig. 3.1.10, Fig. 3.1.11)

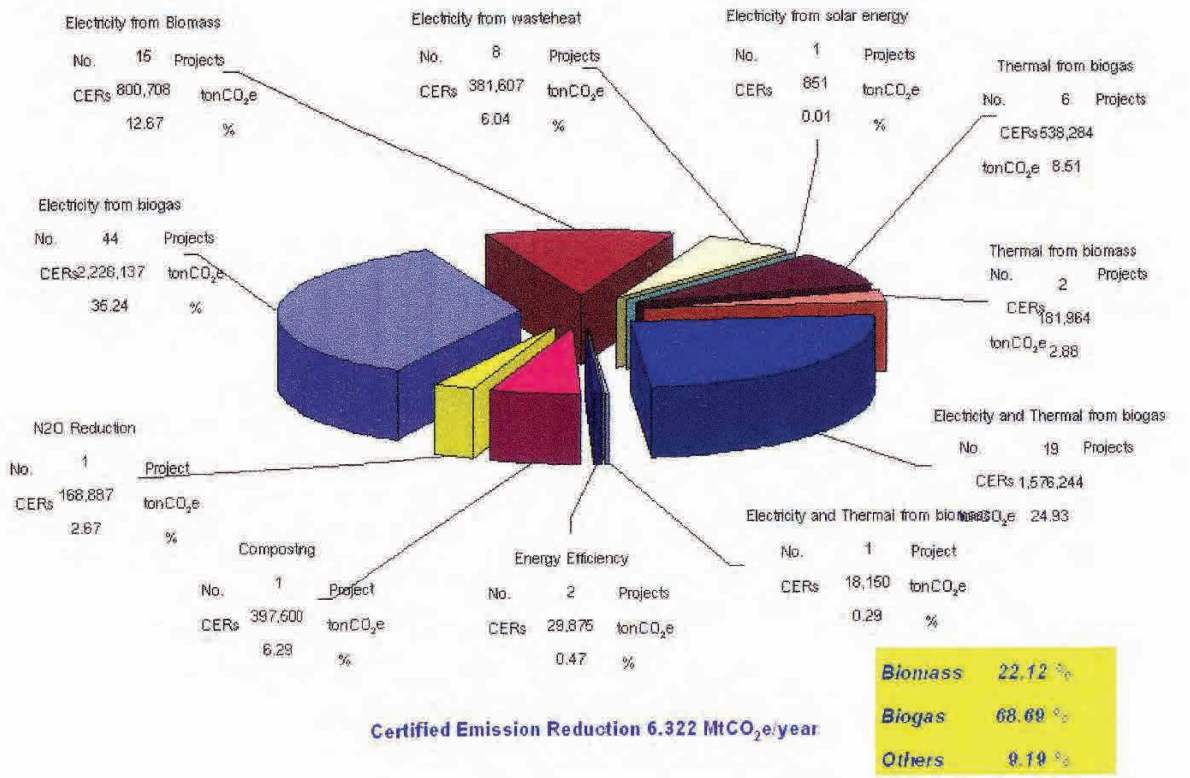
As of March 2010, the number of projects registered at the UN CDM Executive Board was 32. Of the projects, 14 biogas generation projects accounted for 27%, seven biomass generation projects accounted for 26%, and seven biogas cogeneration projects accounted for 30%. Power production projects with renewable energy account for the largest portion.



Source: Key Development of the Designated National Authority in Thailand and Work Programme in 2010, TGO

Fig. 3.1.10 Current Number of Projects in Thailand Registered as CDM (As of March 3, 2010)

100 projects are waiting for registration at the UN CDM Executive Board after being approved in Thailand. Among these projects, 44 biogas generation projects account for 35%, 15 biomass generation projects account for 13%, and 19 biogas cogeneration projects account for 25%. As above, power production projects with renewable energy account for the largest portion. Two energy efficiency projects were also approved.



Source: Key Development of the Designated National Authority in Thailand and Work Programme in 2010, TGO

Fig. 3.1.11 Current Number of Projects in Thailand Receiving LoA (As of March 3, 2010)

c Current Potential of Renewable Energy

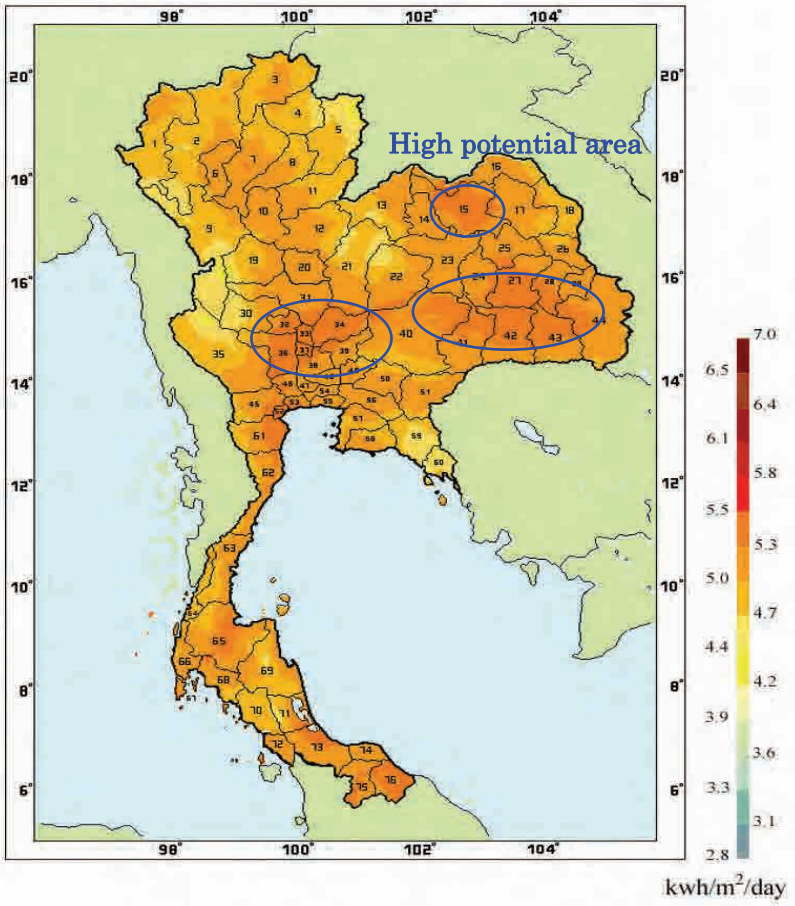
The renewable energy potential in Thailand is described in the "Alternative Energy Development Plan (2008-2022)" (Table 3.1.1) announced by DEDE in 2009.

The potential of each renewable energy planned to be utilized in the power sector is explained below.

c-1 Solar Power

In the insolation map of Thailand announced by DEDE (Fig. 3.1.12), the mean solar radiation of the whole of Thailand is 18.2 MJ/m^2, and there are few regional differences. Therefore, each domestic area has sufficient potential for development. The total potential in Thailand with an area of 510×10^9 m^2 is estimated to be 50,000 MW. As of 2007, 32 MW were installed (Table 3.1.1).

However, upon examining the insolation map, the central, eastern, and northeast areas of Thailand are found to have especially good conditions for solar irradiation. Most recent constructions of solar power generating facilities have been in the central area (Lop buri Province. etc.), which has advantages of more solar energy potential and convenience to Bangkok (described in Section 3.2.c-1).



Source: DEDE

Fig. 3.1.12 Insolation Map of Thailand

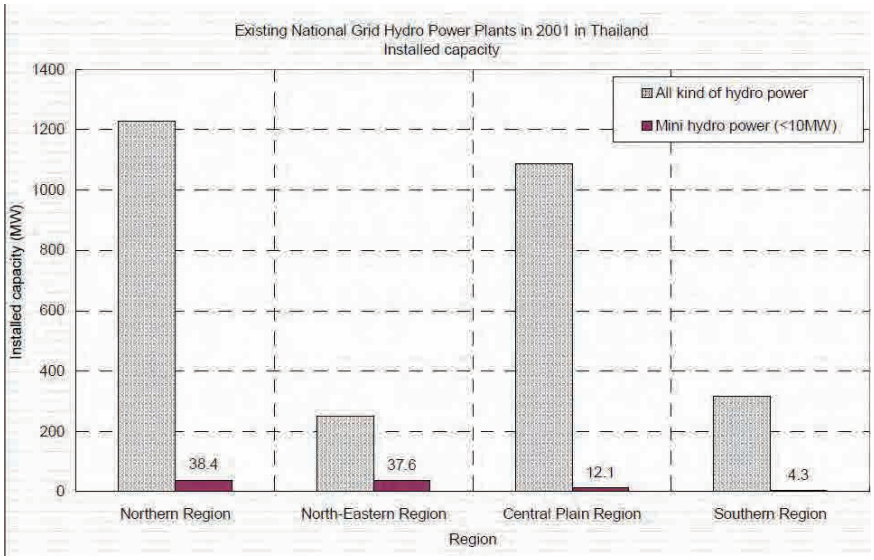
c-2 Micro Hydro Power

While large-scale hydro power development is difficult to achieve with strict usage limitations on forest area by the Ministry of Natural Resource and Environment, micro hydro power potential is estimated to be 700 MW by DEDE (Table 3.1.1). In particular, the northern and northeast areas are considered to have extensive water resources judging from existing capacity (Fig. 3.1.13, Fig. 3.1.14). Information on the main small hydro projects is shown in Table 3.1.7. In addition, for reference, the distribution of specific yields in Thailand is shown in Fig. 3.1.15. It was found that in the southeast area and in the southwest peninsular area there are extensive water resources.

However, in 2007, the installed capacity was still only 56 MW. The reason is that development by the private sector is difficult because permission to develop a forest area and negotiating with inhabitants cannot be achieved easily. Another difficulty is to secure a large enough water flow for continuous generation throughout the year.

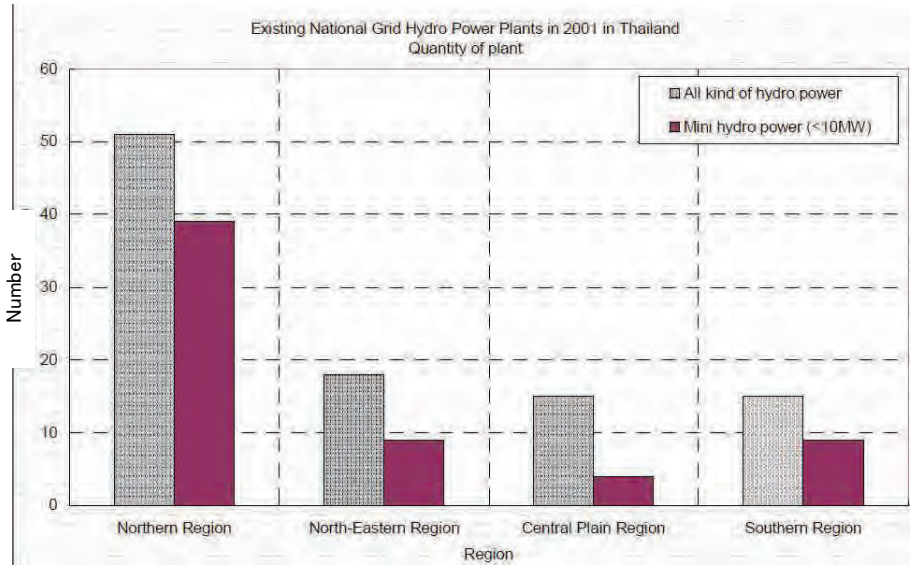
The 162 MW by 2011, targeted by DEDE in 2007, was estimated using 594 irrigation dams for generation. The idea was to use existing dams or weirs because plans to construct new hydro stations require a company to be established for building electric facilities and civil works, and because many engineers need to be employed and trained.

The evaluation of micro hydro power development by the faculty of engineering, King Mongkut's University of Technology Thonburi (KMUTT), found that many water sources have the potential to produce electricity in the country with positive benefits for the environment and communities. Considering costs and benefits, facilities of 1 to 15 MW capacity are more economical than those of less than 1 MW.



Source: NEDO, Feasibility study on introduction of alternative energy for oil in Thailand

Fig. 3.1.13 Installed Capacity of Existing National Grid Hydro Power Plants



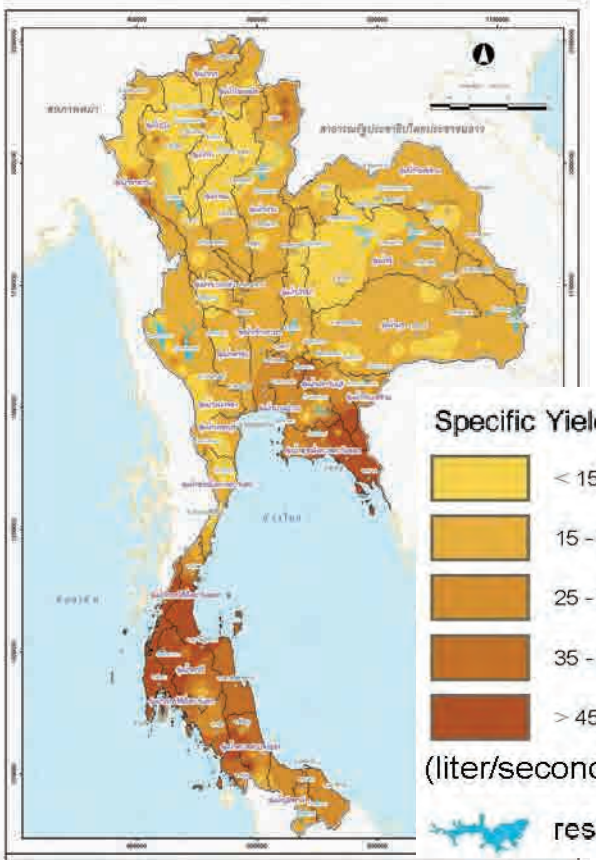
Source: NEDO, Feasibility study on introduction of alternative energy for oil in Thailand

Fig. 3.1.14 Number of Existing National Grid Hydro Power Plants

Table 3.1.7 Main Small Hydro Projects in Thailand

No	Project	Plant Site		Gen. Capacity	(kWh) Average of
		Amphoe	Province	(kW)	FY2004-2008
1	MaeHongSawn	Muang	MaeHongSawn	850	3,427,602.00
2	MaeGeumLaung	MaeEye	ChiengMai	3,200	11,663,420.00
3	Huai MaePhong	DonkKamTai	PhaYao	860	2,562,063.20
4	AiGaPoe	Sukirin	NaraThiwas	200	201,082.59
5	MaeSaRieng	MaeSaRieng	MaeHongSawn	1,250	2,525,866.80
6	Kireetaan	MaKhaam	Chuntaburi	12,200	28,052,642.80
7	MaeSaNga	Muang	MaeHongSawn	5,040	23,289,298.76
8	MaeSaab	SaMoeng	ChiengMai	1,360	2,242,572.20
9	BoeKaew	SaMoeng	ChiengMai	200	321,217.04
10	MaeMao	Fang	ChiengMai	4,330	8,114,458.60
11	HuaiMaeSawd	MaeSawd	Tak	660	1,820,540.54
12	KlongLumplork	YanTaKhao	Trang	1,182	4,262,026.96
13	NamKaMoen	NakornThai	Pitsanuloke	1,030	3,020,362.55
14	MaeHaad	WiengHaeng	ChiengMai	818	2,359,810.32
15	MaeTuen	OmKoi	ChiengMai	250	180,096.00
16	KlongDuson	KuanGaLonk	Satoon	680	2,310,085.72
17	HuaiPratown	GangKraw	Chaiyapoom	4,500	11,708,446.00
18	GiewLom	Muang	Lampang	350	622,941.60
19	HuaiLumsint	GongHlah	Patthaloong	958	468,152.56
20	LumPraploeng	PakThonhChai	NakornRatchasima	850	1,850,820.80
21	HuaiNamkhoon	MaeSaRouy	ChiengRai	1,700	7,967,399.80
22	HuaiYaMoe	OomPhang	Tak	850	1,823,773.00
Total				**43,318**	120,794,679.86

Source: DEDE Homepage



Basin	Specific Yield (liter/second/sq.km.)
Salawin	5.82 - 55.85
Khlong	6.01 - 33.4
Kok	9.02 - 52.4
Ping	2.6 - 57.12
Yom	5.33 - 25.73
Nan	7.82 - 60.05
Pasak	8.66 - 20.67
Prachinburi	9.44 - 44.59
Southern East side	35.98 - 35.98
Tapee	19.99 - 71.51
Pattani	20.56 - 25.36
Southern West Side	22.54 - 230.85
Total	2.6 - 230.85

Source: PEA

Fig. 3.1.15 Specific Yield Data in Thailand

c-3 Biomass and Biogas

Farm product resources are constantly available in large supplies (rice husks and cassava rhizome (root and stem), sugar cane bagasse etc.), so abundant biomass resources are also produced.

The total amount of biomass potential in Thailand is estimated to be 4,400 MW. 1610 MW was installed as of 2007 (Table 3.1.1).

Differentiating biogas and biomass: biogas is methane, which is extracted from waste fluid after a fermentation process by municipal liquid garbage as well as waste water of factory and animal waste; Biomass uses agricultural waste (rice husks, cassava rhizome, sugarcane bagasse, woodchips, etc.) for generation by direct combustion/mixed combustion or gasification.

Based on a survey by DEDE, domestic biomass potential from agricultural resources is shown in Table 3.1.8, and there are 117 million tons. Biomass from rice, sugar cane and rubber occupy high ranks.

Table 3.1.8 Biomass Potential from Agriculture

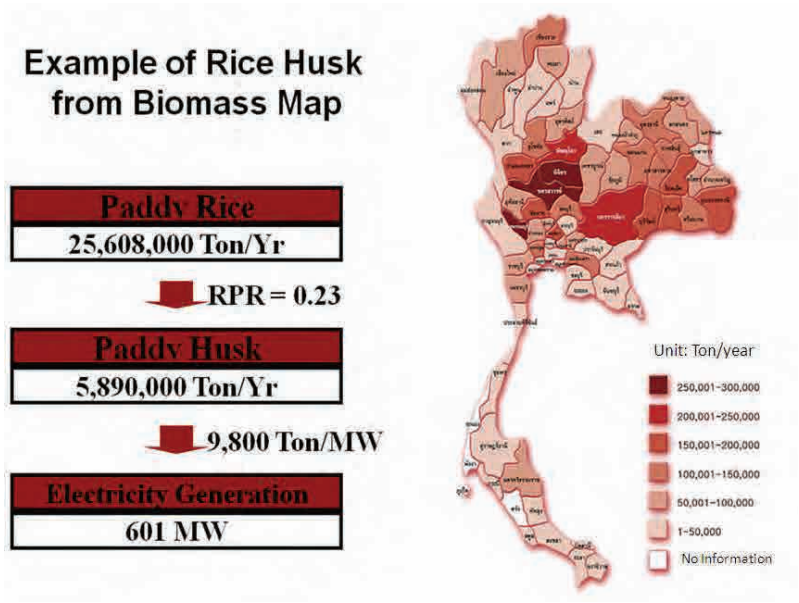
No.	Plant	Plant area (Rai) Rai =1,600 m2	Production (Ton)	Biomass	Conversion to Biomass	Biomass (Ton)
1	Sugar cane	7,000,000	70,000,000	Trash	0.30	21,000,000
				Top and Leaf	0.24	16,800,000
2	Oil palm	3,500,000	8,750,000	Palm Bunch	0.23	2,012,500
				Oil cake	0.15	1,312,500
				Palm shell	0.06	525,000
				Leaf/stalk	0.27	2,362,500
3	Paddy rice	57,000,000	28,607,931	Paddy husk	0.23	6,988,591
				Rice straw	1.19	34,043,438
4	Corn	6,300,000	4,396,779	Corncob	0.19	835,388
5	Cassava	6,500,000	17,550,000	Stalk	0.12	2,106,000
				Rhizome	0.10	1,755,000
6	Rubber	500,000	200,000,000	Sawdust	0.03	6,000,000
				Wood chip	0.10	20,000,000
7	Eucalyptus	1,360,000	6,800,000	Firewood	0.20	1,360,000
				Bark	0.10	680,000
Total			336,104,710			117,780,917

Source: Biomass Potential in Thailand. Energy and Efficiency Information Center, DEDE

The typical producing areas of the each kind of biomass are as follows (Fig. 3.1.16, Fig. 3.1.17):

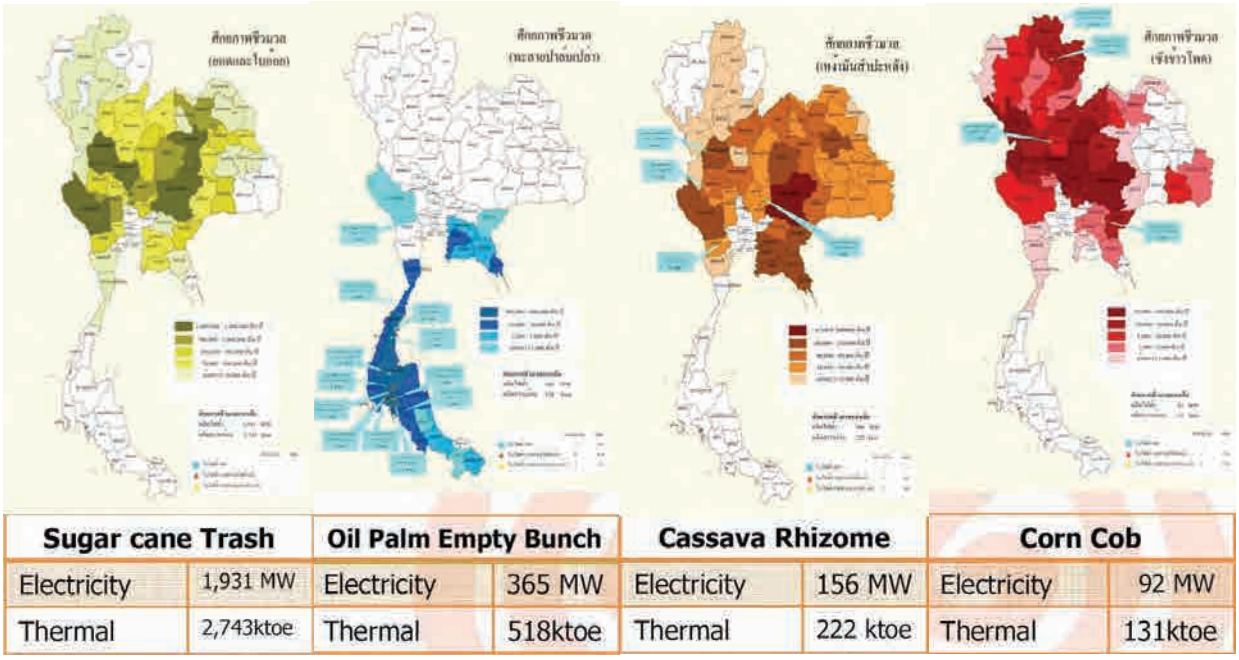
- Cassava is produced mostly in the northeast area, especially Nakhon Ratchasima Province.
- Rice husks are produced mostly in the northeast and central areas, especially Nakhon Sawan Province and Phichit Province.
- Sugar cane bagasse is produced mostly in central and northeast areas.
- Palm coconut oil is produced mostly in the southern area.

According to a DEDE examination, estimated resources for generation are 1,931 MWh/year of sugar cane, 365 MWh/year of oil palm, and 156 MWh/year of cassava etc. (Fig. 3.1.17).



Source: DEDE

Fig. 3.1.16 Biomass Potential Map of Rice Husks



Sugar cane Trash		Oil Palm Empty Bunch		Cassava Rhizome		Corn Cob	
Electricity	1,931 MW	Electricity	365 MW	Electricity	156 MW	Electricity	92 MW
Thermal	2,743ktoe	Thermal	518ktoe	Thermal	222 ktoe	Thermal	131ktoe

Source: Business Opportunities in Thailand's Renewable Energy, DEDE, 2010

Fig. 3.1.17 Biomass Potential Map of Sugar cane, Oil Palm, Cassava Rhizome, and Corn Cob

The agricultural biomass supply market is typified by high prices due to a lack of resources at present, and it is not such a promising resource for power generation. The potential of wood chips has been very promising recently, which is being examined by PEA and universities etc. The

production and supply and demand balance of wood chips are shown in Fig. 3.1.18.

Production was found to be high in the northern area. Under the current balance of supply and demand, supply is lacking in the central area around Bangkok and in the northeastern area. But, in north, many areas where the International Union for Conservation of Nature and Natural Resources (IUCN)[1] sets a usage limit from the viewpoint of conserving nature require attention in the event of development. Heat capacity provided from wood is shown in Table 3.1.9.

Table 3.1.9 Basic Parameters and Conversion Factors

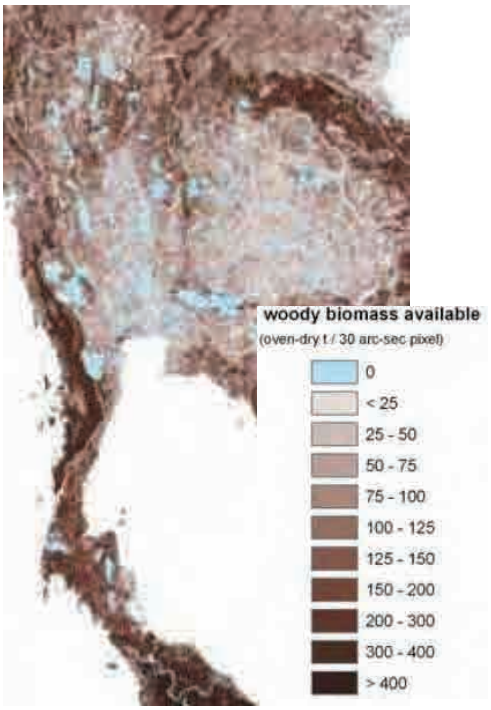
Wood – Net Calorific Value (30 percent moisture content, dry basis)	13.8 MJ/kg
Charcoal – Net Calorific Value (5 percent moisture content, dry basis)	30.8 MJ/kg
Charcoal/fuelwood	165 kg charcoal/m3
Wood density (air-dry)	725 kg/m3
Wood density (oven-dry)	593 kg/m3

Source: Wood-energy supply/demand scenarios in the context of poverty,

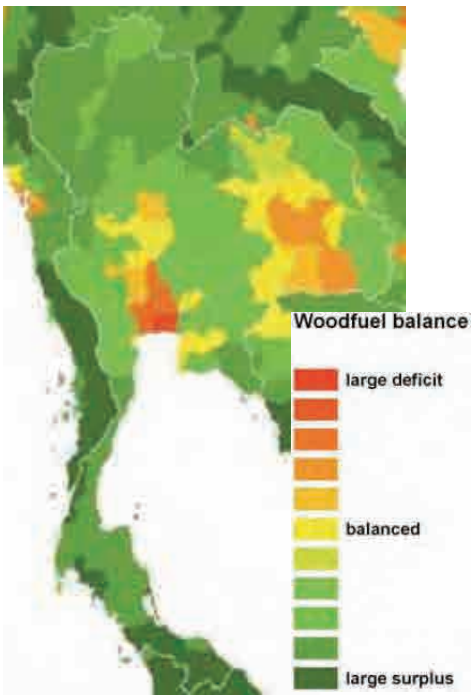
mapping Food and Agriculture Organization of the United Nations Rome, 2007

[1] IUCN (International Union for Conservation of Nature), established in 1948, is the largest organization in the world for conservation of nature composed of 84 countries, 111 governmental agencies, 874 non-government organizations, and 35 organizations as of April, 2008. IUCN has helped more than 75 countries to realize the sustainable society as well as to prepare and implement strategies at national level concerning nature conservation and biological diversity through assisting conferences for international conventions within the framework of global, regional, and national programs.

Distribution of potential annual increment of woody biomass in 2000



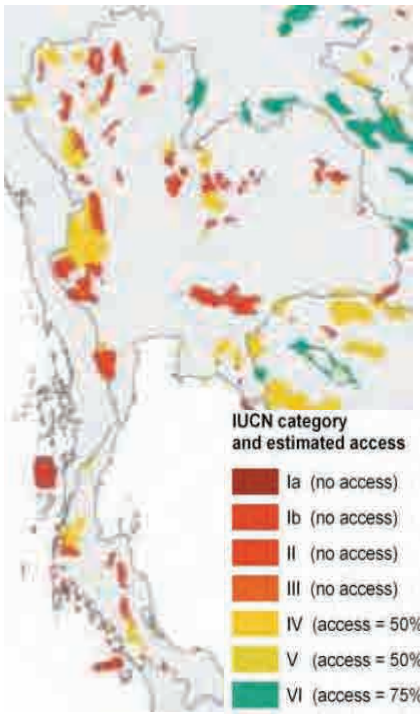
Supply/demand balance by sub-national administrative units. Year 2000



Protected areas by IUCN categories and tentative estimation of accessibility of woody biomass production

(Protected areas by IUCN categories)

IUCN: International Union for Conservation of Nature and Natural Resources



Category		Description
Ia	Strict Nature Reserve:	protected area managed mainly for science
		Definition: Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
Ib	Wilderness Area:	protected area managed mainly for wilderness protection
		Definition: Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
II	National Park:	protected area managed mainly for ecosystem protection and recreation
		Definition: Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
III	Natural Monument:	protected area managed mainly for conservation of specific natural features
		Definition: Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
IV	Habitat/Species Management Area:	protected area managed mainly for conservation through management intervention
		Definition: Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
V	Protected Landscape/Seascape:	protected area managed mainly for landscape/seascape conservation and recreation
		Definition: Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
VI	Managed Resource Protected Area:	protected area managed mainly for the sustainable use of natural ecosystems
		Definition: Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Source: Wood-energy supply/demand scenarios in the context of poverty,

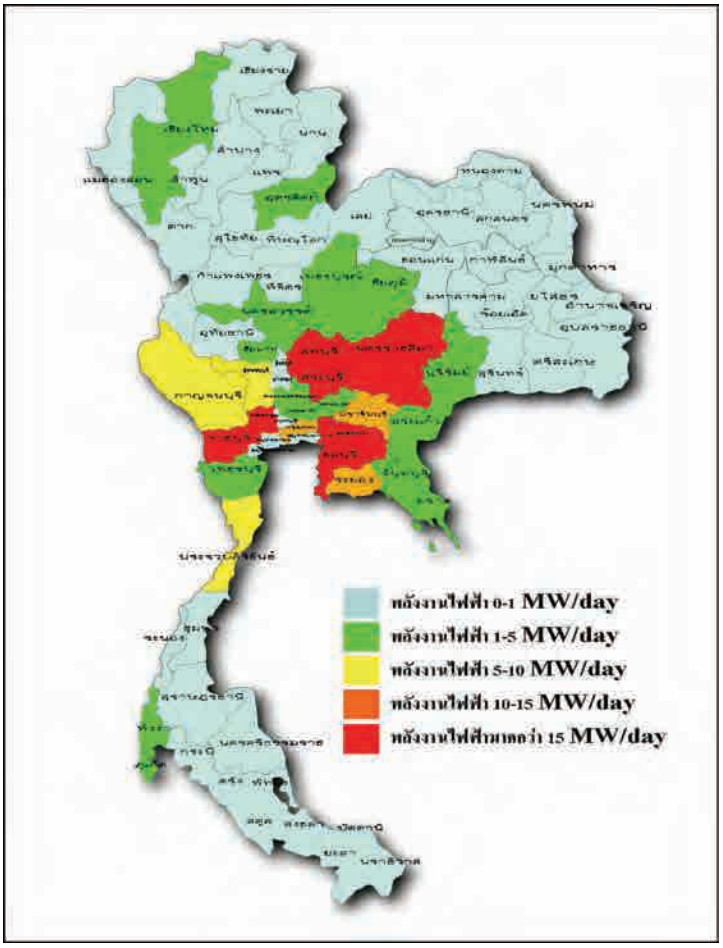
mapping Food and Agriculture Organization of the United Nations Rome, 2007

Fig. 3.1.18 Biomass Potential Map of Wood Chips in Thailand

Biogas can be used as a power source, too. The potential is estimated to be 190 MW inside the country and 46 MW was already installed as of 2007 (Table 3.1.1).

The potential of biogas from animal farm excrement is shown in Source: DEDE

Fig. 3.1.19. The potential of chicken farms is about double that of cattle farms or pig farms in Thailand. The provinces with high potential are mainly located at the center of Thailand around Bangkok. Provinces that could generate electricity of more than 15 MW a day are Nakorn Ratchasrima, Lobburi, Saraburi, Chonburi, Chachengsao, Nakornphatom, and Ratchaburi.



Pig Farm		Cattle Farm		Chicken Farm		Total	
Biogas (m^3/d)	MWh/d	Biogas (m^3/d)	MWh/d	Biogas (m^3/d)	MWh/d	Biogas (m^3/d)	MWh/d
84,597.9	101.5	72,253.9	86.7	154,117.1	184.9	310,968.9	373.2

Source: DEDE

Fig. 3.1.19 Biogas Energy Potential from Animal Farms

c-4 Wind Power

The total amount of wind power potential in Thailand is estimated to be 1,600 MW. 1 MW was installed in 2007 and 5.13 MW was installed in 2009.[2] (Table 3.1.1). A survey report[3] mentioned that an area where wind blows at more than 6 m/s at 65 m above the ground provides good conditions for large-scale wind turbines, and accounts for 7% of the country (Table 3.1.10). Specific areas with good wind conditions are the mountains of the southern Malay Peninsula at around 800-1,800 m above sea level, ridges of 1,400-1,600 m above sea level in the western area, and ridges of 900-1,100 m above sea level in the eastern area. However, it is very likely that these areas are far from trunk lines of the electric power system, to which they would generally need to be connected for power transmission. Other large expenses are necessary to build transmission lines of sufficient reliability and capacity (Fig. 3.1.20).

On the other hand, small-scale wind turbines are usually installed in the suburbs of residential areas. Whereas existing typical wind turbines require a wind speed of at least 4m/s to start power generation and an average wind speed of 5-6m/s for practical operation, only 9% of the population live in areas where a wind speed of 5-6 m/s is available.. The introduction of many wind turbines thus can not be expected under the present condition. If, however, small-scale wind turbines for low wind speeds can be introduced which can start power generation at a wind speed of 1-2m/s and can be practically operated at a wind speed of 4-5m/s, wind power generation can be expected to become possible in the areas where 64% of the population lives (Table 3.1.11). Although some manufacturers in Japan have already developed and started selling such small-scale wind turbines for low wind speeds, their development is underway in Thailand at present, aiming at their supply by domestic companies. (Ref. Section 3.2 c-4 Small-scale Wind Power Generation)

Table 3.1.10 Wind Energy Potential at 65 m

Wind velocity	m/s	< 6	6 - 7	7 - 8	8 - 9	9 <
		Poor	Fair	Good	Very good	Excellent
Area	km^2	477,157	37,337	748	13	0
		92.6%	7.2%	0.2%	0.0%	0.0%
Potential of wind power	MW	197,342	100,361	25,679	2,187	113

Source: WIND ENERGY RESOURCE ATLAS OF SOUTHEAST ASIA, TrueWind Solutions, 2001

Table 3.1.11 Proportion of Rural Population in Each Small Wind Turbine Resource Class at 30 m

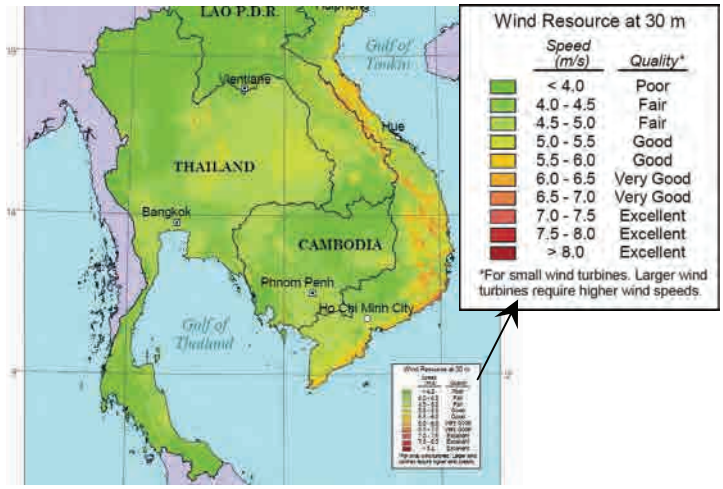
Wind velocity	m/s	< 4	4 - 5	5 - 6	6 - 7	7 <
		Poor	Fair	Good	Very good	Excellent
Proportion of population	km2	26%	64%	9%	0%	0%

Source: WIND ENERGY RESOURCE ATLAS OF SOUTHEAST ASIA, TrueWind Solutions, 2001

[2] Business Opportunities in Thailand's Renewable Energy, DEDE, 2010
[3] WIND ENERGY RESOURCE ATLAS OF SOUTHEAST ASIA, TrueWind Solutions, 2001

Annual average wind velocity

at 30 m above ground

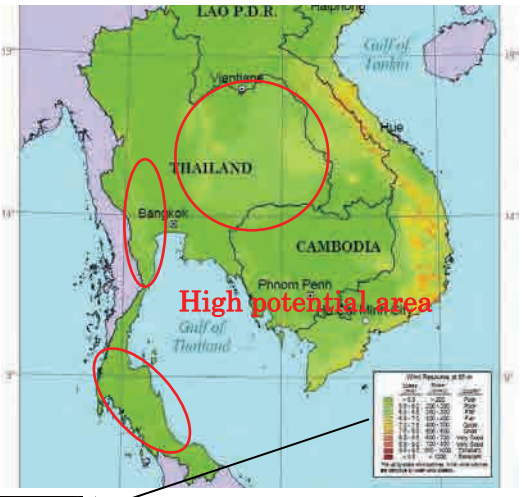


Wind Resource at 30 m

Speed (m/s)	Quality*
< 4.0	Poor
4.0 - 4.5	Fair
4.5 - 5.0	Fair
5.0 - 5.5	Good
5.5 - 6.0	Good
6.0 - 6.5	Very Good
6.5 - 7.0	Very Good
7.0 - 7.5	Excellent
7.5 - 8.0	Excellent
> 8.0	Excellent

*For small wind turbines. Larger wind turbines require higher wind speeds.

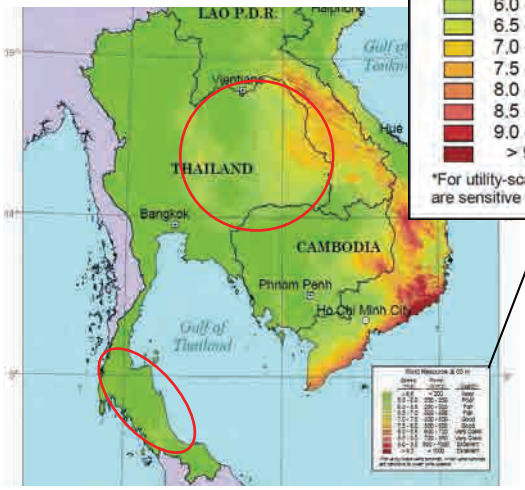
at 65 m above ground



Seasonal average wind velocity

at 65 m above ground

December – February



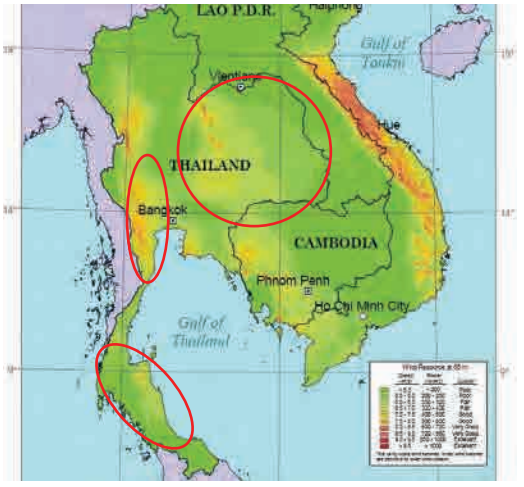
Wind Resource at 65 m

Speed (m/s)	Power (W/m2)	Quality*
< 5.5	< 200	Poor
5.5 - 6.0	200 - 250	Poor
6.0 - 6.5	250 - 320	Fair
6.5 - 7.0	320 - 400	Fair
7.0 - 7.5	400 - 500	Good
7.5 - 8.0	500 - 600	Good
8.0 - 8.5	600 - 720	Very Good
8.5 - 9.0	720 - 850	Very Good
9.0 - 9.5	850 - 1000	Excellent
> 9.5	> 1000	Excellent

*For utility-scale wind turbines. Small wind turbines are sensitive to lower wind speeds.

March - May

June - August

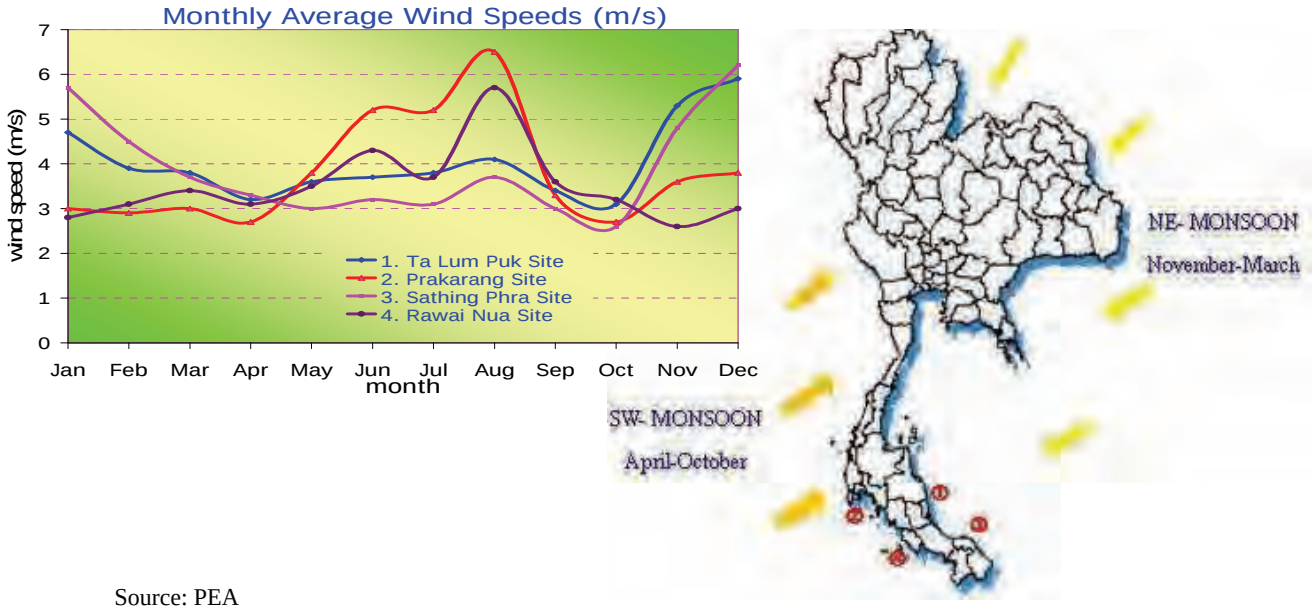


September - November

Source：True Wind Solutions WIND ENERGY RESOURCE ATLAS OF SOUTHEAST ASIA

Fig. 3.1.20　Potential Map of Wind Power (by height and season)

In Thailand, there are seasonal winds, so strong winds blow in different seasons in different areas, since northeasterly winds become stronger from November to March with stronger southwesterly winds from April to October . For instance, winds are stronger from November through March in the eastern coast and from April through October in the western coast (Fig. 3.1.21). For this reason, in choosing an area for wind power generation, it is necessary to give sufficient considerations to methods for using power generated, backup facilities, the annual profitability of power generation operations, etc.



Source: PEA

Fig. 3.1.21 Monthly Average Wind Velocity

c-5 Municipal Solid Waste (MSW)

The total amount of MSW potential in Thailand is estimated to be 400 MW by DEDE. 5 MW was installed as of 2007 (Table 3.1.1). Current potential distribution is shown in Fig. 3.1.22. Approximately 10,000 tons of the waste is produced every day (Table 3.1.12).

Generation methods using MSW include steam turbine and gas engine. But, there are still many landfill or open landfill-type processing facilities now. So, it is expected that large MSW resources will be developed using methane gasification-processing facilities etc. in the future. The development target by 2011 of 100 MW was set in 2007 (Fig. 3.1.23). But, power development with Municipal Solid Waste is to be conducted not only by private companies, but also through cooperation with local governments.

Table 3.1.12 Daily Municipal Solid Waste from Each Local Government

Quantity (t/day/ autonomous)	Number of autonomous	Total(t/day)
100 <	26	3,891
50 - 100	36	2,388
10 - 50	166	2,915
< 10	455	1,382
(Total)		(10,576)

(Source: Potential of Municipal Solid Waste. (2010), Alternative Energy and Efficiency Information Center, DEDE)

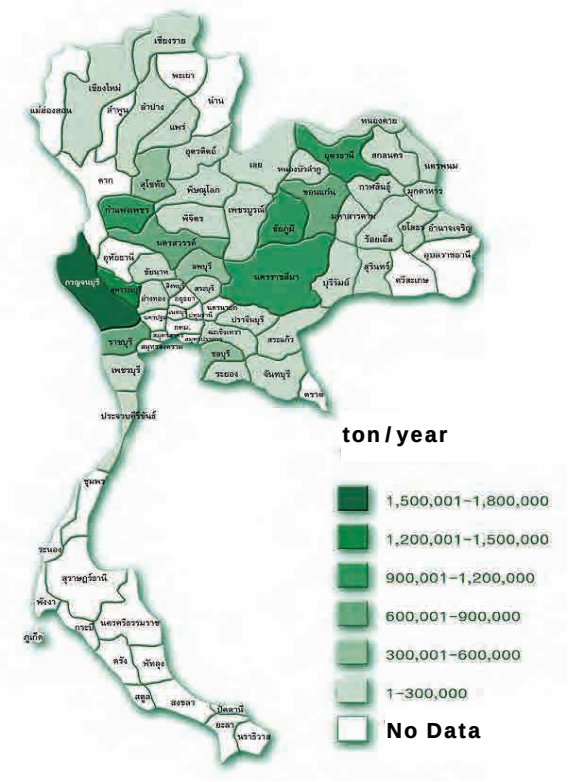
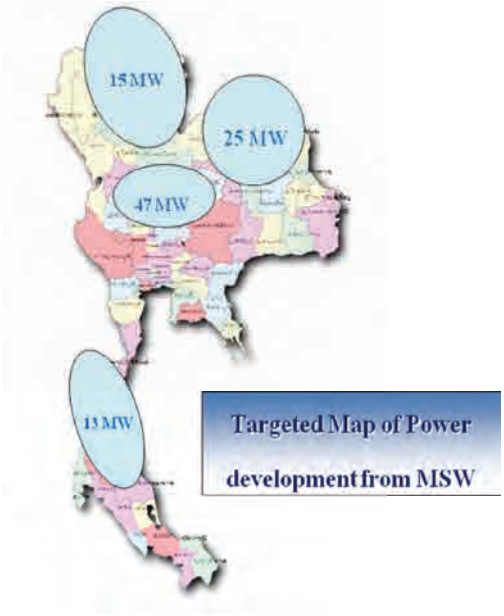


Fig. 3.1.22 Potential Map of Municipal Solid Waste



Source: Potential of Municipal Solid Waste. (2010), Alternative Energy and Efficiency Information Center, DEDE

Fig. 3.1.23 Development Target for Municipal Solid Waste by 2011

3.2 Future Prospects for Renewable Energy

a Future Plan for Introducing Renewable Energy in Electric Power Utilities

EGAT announced a renewable energy power development plan in EGAT up to 2022 in the Summary of Thailand Power Development Plan 2010-2030, published in April 2010 (Table 3.2.1). The breakdown consists of small hydro power, wind power, solar power, and municipal solid waste. EGAT plans to install 339.20 MW, which is equivalent to approximately 19% of the domestic introduction target with the exception of biomass and biogas.

In particular, small hydro power facilities installed by EGAT will account for 59.8% of domestic target capacity and wind power facilities will account for 16.06%.

These targets are estimated considering the following conditions:

- Developable energy potential for each resource.
- Lower generating cost than wholesale price with Adder from SPP and VSPP.
- Promotion of development according to CSR policy.

The order of generating cost in EGAT from the lowest is hydro power (including the use of irrigation dams), MSW, wind power, and solar power. This tendency generally corresponds to the allocation of development capacity in EGAT in Table 3.2.1.

Table 3.2.1 Renewable Energy Power Development Plan in EGAT

	Target of EGAT				Target of Thailand	Ratio
	Short Term (2008–2011)	Medium Term (2012–2016)	Long Term (2017–2022)	Total		
Small Hydro	48.7	86.0	59.0	193.7	324.0	59.8%
Wind Energy	20.5	19.0	89.0	128.5	800.0	16.1%
Solar Energy	1.0	0.5	0.5	2.0	500.0	0.4%
Municipal Solid Waste (MSW)	0.0	7.5	7.5	15.0	160.0	9.4%
Total	70.2	113.0	156.0	339.2	1,784.0	19.0%

Source: Drawn up by the study team from Summary of Thailand Power Development Plan 2010-2030, EGAT, April 2010

Other electric power utilities include power distributing utilities, MEA, and PEA. But, they do not have targets set to install renewable energy facilities because they are not generating utilities.

Adder is not applied to electricity generated from renewable energy sources at generation facilities installed by these power utilities themselves since such electricity is deemed to be retailed by electric power utilities.

On the other hand, if companies related to electric power utilities such as EGCO develop power plants and produce power, they can be treated as private companies — either as SPP (more than 10 to 90 MW) or VSPP (10 MW or less) —, and the Adder subsidy is added to the wholesale tariff according to the scale of their contracts.

The above-mentioned target for renewable energy development in Thailand up to 2022, published by DEDE, originally assumed development by private companies, and a private business promotion policy using Adder was therefore prepared. In contrast, the development and introduction of power generation facilities using renewable energy sources by power utilities including EGAT, PEA, and MEA, is said to have purposes of both leading technological development for power generation using renewable energy sources and enlightening private companies. PEA is particularly positive with technological development for renewable energy in general, including solar power, wind power, and biomass, and they conduct research on technology applicable to a wind power generation system and high efficiency photovoltaic power generation system.

On the other hand, the renewable energy-producing business by private companies in MEA's supply area is mostly limited to business with PV facilities, in particular, those installed on roofs. MEA is also conducting research on a photovoltaic power generation system in urban areas and technology for connection to an electric power system. Recently, however, a subsidy system to provide support for the initial investment cost of small-scale PV facilities was abolished. So, profitability has deteriorated. Introduction of renewable energy is not so active in MEA (refer to 3.2 c-1 Past measures for promoting small-scale solar power generation projects).

b Possibility of Introducing Renewable Energy into Private Companies and Households

b-1 Adoption result and development prediction

EGAT estimates the progress of developing by SPP and VSPP as shown in Table 3.2.2 and Table 3.2.3, while it has targets for installing its own facilities. The total capacities are—SPP: 2,260.3 MW and VSPP: 5427.544 MW including facilities under construction, consideration, and supplying the grid etc. MOE and the electric power utilities predict that the renewable energy introduction target of the country can be achieved (detailed information on 51 SPP projects for which applications have been made is introduced in Table 3.2.4). However, some might abandon the business due to future changes in the business environment, and not all businesses can reach contracts and start to sell power. This information on projects for which applications have been made is available on the homepage of EPPO.

Table 3.2.2 Progress of Renewable Energy Development by SPP (December 2009)

	Type of RE/Technology	Under Consideration			Received Notification of Acceptance (waiting for PPA)			Already Signed PPA (Under Construction)			Supplying to Grid		
		Projects	Installed Capacity (MW)	Sale to Grid (MW)	Projects	Installed Capacity (MW)	Sale to Grid (MW)	Projects	Installed Capacity (MW)	Sale to Grid (MW)	Projects	Installed Capacity (MW)	Sale to Grid (MW)
Renewable Energy													
1	**Solar Energy**	**4**	**302.570**	**300.000**	**1**	**60.000**	**55.000**	**0**	**-**	**-**	**0**	**-**	**-**
2	**Biogas**	**0**	**-**	**-**	**0**	**-**	**-**	**0**	**-**	**-**	**0**	**-**	**-**
3	**Biomass**	**0**	**-**	**-**	**2**	**230.000**	**112.000**	**1**	**4.800**	**4.000**	**23**	**571.500**	**349.300**
	Baggasse	0	-	-	1	65.000	22.000	0	-	-	8	180.400	84.000
	Rice Husk	0	-	-	0	-	-	0	-	-	5	57.300	46.800
	Rice Husk and Wood Chip	0	-	-	1	165.000	90.000	0	-	-	2	57.800	49.000
	Baggasse,Wood Chip, Rice Husk	0	-	-	0	-	-	0	-	-	2	104.900	56.000
	Palm Residual, Empty Fruit Bunch and Cassava Root	0	-	-	0	-	-	0	-	-	1	9.900	8.800
	Rice Husk,Baggasse,Eucaliptus	0	-	-	0	-	-	0	-	-	0	-	-
	Wood Chip, Wood Chip,Black Liquar	0	-	-	0	-	-	0	-	-	1	75.000	50.000
	Parawood chip, Other Wood Chip	0	-	-	0	-	-	1	4.800	4.000	1	23.000	20.200
	Baggasse, Rice Husk, Straw And Other Biomass	0	-	-	0	-	-	0	-	-	3	63.200	34.500
4	**MSW**	**4**	**285.000**	**285.000**	**0**	**-**	**-**	**0**	**-**	**-**	**0**	**-**	**-**
5	**Mini Hydro**	**0**	**-**	**-**	**0**	**-**	**-**	**0**	**-**	**-**	**0**	**-**	**-**
6	**Wind**	**10**	**928.000**	**790.000**	**5**	**341.100**	**340.000**	**0**	**-**	**-**	**0**	**-**	**-**
7	**Others**	**0**	**-**	**-**	**0**	**-**	**-**	**0**	**-**	**-**	**1**	**32.900**	**25.000**
	Black Liquar	0	-	-	0	-	-	0	-	-	1	32.900	25.000
Total		**18**	**1,515.570**	**1,375.000**	**8**	**631.100**	**507.000**	**1**	**4.800**	**4.000**	**24**	**604.400**	**374.300**

Source: EGAT report 29 March, 2010

Table 3.2.3 Progress of Renewable Energy Development by VSPP (December 2009)

	Type of RE/Technology	Under Consideration			Received Notification of Acceptance (waiting for PPA)			Already Signed PPA (Under Construction)			Supplying to Grid		
		Projects	Installed Capacity (MW)	Sale to Grid (MW)	Projects	Installed Capacity (MW)	Sale to Grid (MW)	Projects	Installed Capacity (MW)	Sale to Grid (MW)	Projects	Installed Capacity (MW)	Sale to Grid (MW)
Renewable Energy													
1	**Solar Energy**	**135**	**649.180**	**637.630**	**94**	**415.291**	**398.360**	**291**	**1,421.789**	**1,331.887**	**51**	**7.785**	**7.674**
	PV	52	138.680	129.630	67	275.771	266.715	25	98.089	93.327	51	7.785	7.674
	Thermal	83	510.500	508.000	27	139.520	131.645	266	1,323.700	1,238.560	0	-	-
	- Parabolic trough	11	64.500	62.000	7	51.100	45.000	46	286.900	272.260	0	-	-
	- Stirling engine	46	276.000	276.000	8	48.000	48.000	149	874.300	874.300	0	-	-
	- others (Solar thermal)	7	56.000	56.000	10	28.420	26.645	71	162.500	92.000	0	-	-
	- Not Specify	19	114.000	114.000	2	12.000	12.000	0	-	-	0	-	-
2	**Biogas**	**21**	**68.547**	**61.593**	**31**	**52.438**	**44.777**	**32**	**80.716**	**69.171**	**41**	**51.012**	**43.039**
	Dung	0	-	-	2	0.153	0.133	4	1.410	1.310	8	1.604	1.325
	Industrial waste water	20	66.643	60.593	19	46.295	39.097	25	76.106	64.711	29	47.566	40.054
	Straw	0	-	-	4	1.300	1.290	0	-	-	4	1.842	1.660
	Other	1	1.904	1.000	6	4.690	4.257	3	3.200	3.150	0	-	-
3	**Biomass**	**65**	**539.872**	**413.733**	**36**	**274.950**	**213.400**	**201**	**1,970.865**	**1,495.890**	**53**	**720.026**	**287.835**
	Palm Residual	0	-	-	2	2.800	2.000	1	9.500	8.000	1	12.000	8.500
	Jatropa Residual	0	-	-	1	9.500	8.000	1	9.500	8.000	0	-	-
	Baggasse	2	38.000	8.000	1	18.000	6.000	12	258.000	92.000	29	530.800	164.300
	Baggasse+Rice Husk	0	-	-	0	-	-	0	-	-	1	39.400	8.000
	Rice Husk	9	75.600	63.500	7	62.740	53.200	35	314.900	267.900	13	71.450	67.400
	Rice Husk+Wood Chip	10	92.100	73.500	3	29.300	24.000	93	916.800	742.500	2	27.100	14.500
	Rice Husk+Corncob	0	-	-	0	-	-	1	9.000	7.800	0	-	-
	Saw Dust	0	-	-	0	-	-	0	-	-	1	0.600	0.600
	Coconut Fibre	2	2.400	2.000	3	19.460	16.150	1	6.000	5.000	0	-	-
	Corncob/Core/shel	1	1.800	1.800	0	-	-	1	9.900	8.000	1	-	-
	Corncob+Rice Husk	1	9.900	8.000	0	-	-	1	6.000	5.400	0	-	-
	Empty Fruit Brunch	2	17.456	12.280	3	22.000	20.000	6	48.450	36.500	4	26.516	18.200
	Wood Bark	1	7.500	6.750	0	-	-	1	6.000	5.500	0	-	-
	Straw	0	-	-	1	0.150	0.150	0	-	-	0	-	-
	Cassava (Residual+Root)	0	-	-	0	-	-	4	21.900	17.600	0	-	-
	Wood	0	-	-	1	1.400	1.000	5	24.315	21.250	0	-	-
	Wood Chip	37	295.116	237.903	11	80.200	65.900	38	325.500	265.640	1	12.000	6.200
	Other Biomass	0	-	-	3	29.400	17.000	1	5.100	4.800	0	-	-
4	**MSW**	**20**	**140.360**	**120.550**	**13**	**74.600**	**59.450**	**14**	**108.585**	**96.360**	**8**	**12.540**	**10.820**
	Gas Engine	6	24.180	22.800	5	15.280	14.950	5	32.925	31.260	6	6.340	5.820
	Steam terbine	3	21.980	18.750	6	48.220	39.000	8	70.540	60.100	2	6.200	5.000
	Gasification	1	6.000	6.000	1	1.200	1.000	1	5.120	5.000	0	-	-
	Not Specify	10	88.200	73.000	1	9.900	4.500	0	-	-	0	-	-
5	**Mini Hydro**	**1**	**0.030**	**0.025**	**1**	**5.040**	**5.040**	**5**	**1.295**	**1.275**	**3**	**0.560**	**0.540**
	< 50 kW	1	0.030	0.025	0	-	-	1	0.040	0.030	2	0.080	0.060
	50 - 200 kW	0	-	-	0	-	-	2	0.185	0.175	0	-	-
	> 200 kW *	0	-	-	1	5.040	5.040	2	1.070	1.070	1	0.480	0.480
6	**Wind**	**13**	**94.125**	**85.250**	**7**	**18.100**	**17.800**	**5**	**26.424**	**25.040**	**3**	**0.380**	**0.380**
7	**Used Vegetable Oil***	**0**	**0.000**	**0.000**	**0**	-	-	**1**	**0.025**	**0.025**	**0**	-	-
	Total	**255**	**1,492.114**	**1,318.781**	**182**	**840.419**	**738.827**	**549**	**3,609.699**	**3,019.648**	**159**	**792.303**	**350.288**
	* Don't get Adder												

Source: EGAT report 29 March 2010

Table 3.2.4 Information on SPP Projects for which applications have been made (As of December 2009) (1/3)

No.	Name of Company	Plant location	Plant capacity (MW)	Electricity selling (MW)	Type of Company	Adder	Type of Fuel Supply	Type of Fuel classify by Adder	Volt at the grid connected point (kV)	Date (Approved the purchasing contract)	Date of Sign the contrct	Type of contract	Period of Contract	Selling electricity to the grid (COD)
1	บ. น้ำตาลมิตรภูเวียง จก.(Namthan Mitr Phu Weing)	Kon Kean	27.00	6.000	Sugar factory	Non Adder	Sugar cane	Biomass	22	30/4/2540	22/5/2540	Non - Firm	Non - Firm 5 year and continue	June, 2540
2	บ. น้ำตาลรีไฟน์ชัยมงคล จก. (Namthan Refine Chai Mongkol)	Supunburi	18.00	7.000	Sugar factory	Non Adder	Sugar cane	Biomass	22	7/9/2541	9/6/2551	Non - Firm	Non - Firm 5 year and continue	Feb, 2543
3	บ. พีอาร์จี พืชผล จำกัด (PRG Pheudpon)	Pathumthanee	9.00	5.900	Rice mill	Non Adder	Rice Husk	Biomass	22	15/1/2543	2/4/2544	Non - Firm	Non - Firm 5 year and continue	Dec, 2545
4	บ. ไทยรุ่งเรืองอุตสาหกรรม จก. (Thai Rung Rueang Industry)	Petchaboon	29.50	8.000	Sugar factory	Non Adder	Sugar cane	Biomass	22	12/10/2544	5/3/2552	Non - Firm	Non - Firm 5 year and continue	Jan, 2546
5	บ. น้ำตาลราชสีมา จก. (2) (Namthan Ratchasrima)	Nakorn Ratchasrimaa	34.00	30.000	Sugar factory	Non Adder	Sugar cane	Biomass	115	9/4/2546	6/6/2551	Non - Firm	Non - Firm 5 year and continue	Aug, 2546
6	บ. น้ำตาลสระบุรี จำกัด (Namthan Saraburi)	Saraburee	29.50	8.000	Sugar factory	Non Adder	Sugar cane	Biomass	22	12/12/2546	4/4/2552	Non - Firm	Non - Firm 5 year and continue	Jan, 2545
7	บ. น้ำตาลกุมภวาปี จก. (Namthan Kumpawapee)	Udonthanee	19.60	5.000	Thermal Power Plant	Non Adder	Sugar cane	Biomass	22	18/8/2548	24/7/2551	Non - Firm	Non - Firm 5 year and continue	April, 2547
8	บ.ไบโอ-แมส เพาเวอร์ จก. (Biomass Power)	Chai Nath	6.00	5.00	Thermal Power Plant	Non Adder	Rice Husk	Biomass	22	10/1/2538	22/6/2541	Firm	Firm 25 years	Sept, 2544
9	บ. บีพีเค เพาเวอร์ ซัพพลาย จก. (BPK Power Supply)	Chachengsao	10.40	8.00	Rice mill & Wood factory	Non Adder	Rice Husk & Woodchip	Biomass	N/A	16/2/2541	16/4/2542	Firm	Firm 21 years	May, 2542
10	บริษัท ร้อยเอ็ด กรีน จำกัด (Roi-Et Green)	Roi-Et	9.90	8.80	Thermal Power Plant	Non Adder	Rice Husk	Biomass	22	20/2/2543	22/10/2544	Firm	Firm 21 years	May, 2546
11	บ.แอ๊ดวานซ์ อะโกร จก. (มหาชน) (1) (Advance Agro)	Prachenburi	75.00	50.00	Thermal Power Plant Black Liquor	Non Adder	Wood chip and black liquor	Biomass	115	10/2/2546	22/9/2546	Firm	Firm 25 years	Nov, 2546
12	บ. ภูเขียว ไบโอ-เอ็นเนอร์ยี จก. (Phu Keaw Bio Energy)	Chaiyapoom	56.90	29.00	Thermal Power Plant	Non Adder	Sugar cane, wood chip, rice husk	Biomass	115	9/4/2546	13/5/2547	Firm	Firm 21 years	Sept, 2547
13	บ. เอ.ที. ไบโอ พาวเวอร์ จก. (A.T. Bio Power)	Pichit	22.50	20.00	Thermal Power Plant	Non Adder	Rice husk	Biomass	22	30/5/2546	29/3/2547	Firm	Firm 25 years	Dec, 2548
14	บ. น้ำตาลมิตรกาฬสินธุ์ จก. (Namthan Mitr Kalasin)	Kalasin	25.70	8.00	Thermal Power Plant	Non Adder	Sugar cane, rice husk, paddy husk,	Biomass	22	7/8/2546	6/8/2547	Firm	Firm 21 years	Sept, 2547
15	บ. ไทยเพาเวอร์ ซัพพลาย จก. (1) (Thai Power Supply)	Chachengsao	47.40	41.00	Rice mill & Wood factory	Non Adder	Rice husk, wood chip	Biomass	115	16/12/2547	16/4/2542	Firm	Firm 25 years	April, 2542

Source: SERT report (from EPPO's home page. Years in the table adopt the Buddhist calendar: western calendar plus 543 years

Table 3.2.4 Information on SPP Projects for which applications have been made (As of December 2009)(2/3)

No.	Name of Company	Plant location	Plant capacity (MW)	Electricity selling (MW)	Type of Company	Adder	Type of Fuel Supply	Type of Fuel classify by Adder	Volt at the grid connected point (kV)	Date (Approved the purchasing contract)	Date of Sign the contrct	Type of contract	Period of Contract	Selling electricity to the grid (COD)
16	บ. ด่านช้าง ไบโอ-เอ็นเนอร์ยี จก. (Darn Chang Bio Energy)	Supunburi	48.00	27.00	Thermal Power Plant	Non Adder	Sugar cane, wood chip, rice husk	Biomass	115	20/5/2548	19/12/2546	Firm	Firm 21 years	July, 2547
17	บ. สตึก ไบโอแมส จก. (Satuek Biomass)	Burirum	7.50	6.50	Thermal Power Plant	Non Adder	Rice husk, Sugar cane	Biomass	22	26/8/2548	14/12/2548	Firm	Firm 21 years	Jan, 2549
18	บ. กัลฟ์ ยะลา กรีน จก. (Gulf Yala Green)	Yala	23.00	20.20	Thermal Power Plant	Adder	Wood chip from Rubber tree	Biomass	115	26/9/2545	19/5/2546	Firm	Firm 25 years	Nov, 2546
19	บ. โรงไฟฟ้าน้ำตาลขอนแก่น จก. (Namthan Kon Khen Electricity)	Kon Kean	30.00	20.00	Thermal Power Plant	Non Adder	Sugar cane, rice husk, paddy husk,	Biomass	22	23/7/2547	21/2/2548	Firm	Firm 21 years	Dec, 2549
20	บ. มุ่งเจริญกรีน เพาเวอร์ จก. (Mung Chalearn Green Power)	Surin	9.90	8.00	Thermal Power Plant	Non Adder	Rice husk	Biomass	22	29/10/2547	20/5/2548	Firm	Firm 21 years	Jan, 2550
21	บ. สุราษฎร์ธานี กรีน เอ็นเนอร์ยี จก. (Surathanee Green Energy)	Surathanee	9.90	8.80	Thermal Power Plant	Non Adder	Palm, Cassava	Biomass	33	20/12/2547	18/5/2548	Firm	Firm 25 years	Sept, 2550
22	บ.อมตะ บี.กริม เพาเวอร์ 1 จก. (Amata B-Grim Power)	Chonburi	168.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	11/11/2537	23/2/2541	Firm	Firm 21 years	Sept, 2551
23	บ. โกลว์ เอสพีพี 1 จก. โครงการ 1 (Glow SPP)	Rayong	67.68	55.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	19/12/2538	25/12/2540	Firm	Firm 23 years	Feb, 2541
24	บ. โกลว์ พลังงาน จก. (มหาชน) โครงการ 1(Glow Energy)	Rayong	150.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	26/2/2539	7/1/2541	Firm	Firm 21 years	Apr, 2539
25	บ. โกลว์ พลังงาน จก. (มหาชน) โครงการ 2(Glow Energy)	Rayong	150.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	22/3/2539	7/1/2541	Firm	Firm 21 years	Oct, 2539
26	บ.สหโคเจน (ชลบุรี) จก. (มหาชน) (Saha Cogen (Chonburi))	Rayong	139.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	29/3/2539	19/12/2540	Firm	Firm 25 years	Apr, 2542
27	บ.โรจนะ เพาเวอร์ จก. (Rothjana Power)	Ayuthaya	131.50	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	29/3/2539	19/12/2540	Firm	Firm 25 years	May, 2542
28	บ.สมุทรปราการ โคเจนเนอเรชั่น จก. (Samutprakarn Cogeneration)	Samuthprakarn	128.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	29/3/2539	24/12/2540	Firm	Firm 21 years	Aug, 2542
29	บ.ไทยออยล์ เพาเวอร์ จก. (Thai Oil Power)	Chonburi	138.88	41.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	230	20/12/2539	17/12/1940	Firm	Firm 25years	Apr, 2541
30	บ. โกลว์ เอสพีพี 1 จก. โครงการ 2 (Glow SPP)	Rayong	66.35	55.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	20/12/2539	25/12/2540	Firm	Firm 23 years	Sept, 2541
31	บ. โกลว์ เอสพีพี 2 จก. โครงการ 1 (Glow SPP)	Rayong	70.00	60.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	230	20/12/2539	23/12/2540	Firm	Firm 25 years	March, 2542
32	บ. โกลว์ เอสพีพี 2 จก. โครงการ 2 (Glow SPP)	Rayong	70.00	60.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	230	20/12/2539	23/12/2540	Firm	Firm 25 years	Apr, 2542
33	บ. ไทย เนชั่นแนล เพาเวอร์ จก. (1) (Thai National Power)	Rayong	120.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	20/12/2539	5/1/2541	Firm	Firm 25 years	Oct, 2543

Source: SERT report (from EPPO's home page. Years in the table adopt the Buddhist calendar: western calendar plus 543 years

Table 3.2.4 Information on SPP Projects for which applications have been made (As of December 2009)(3/3)

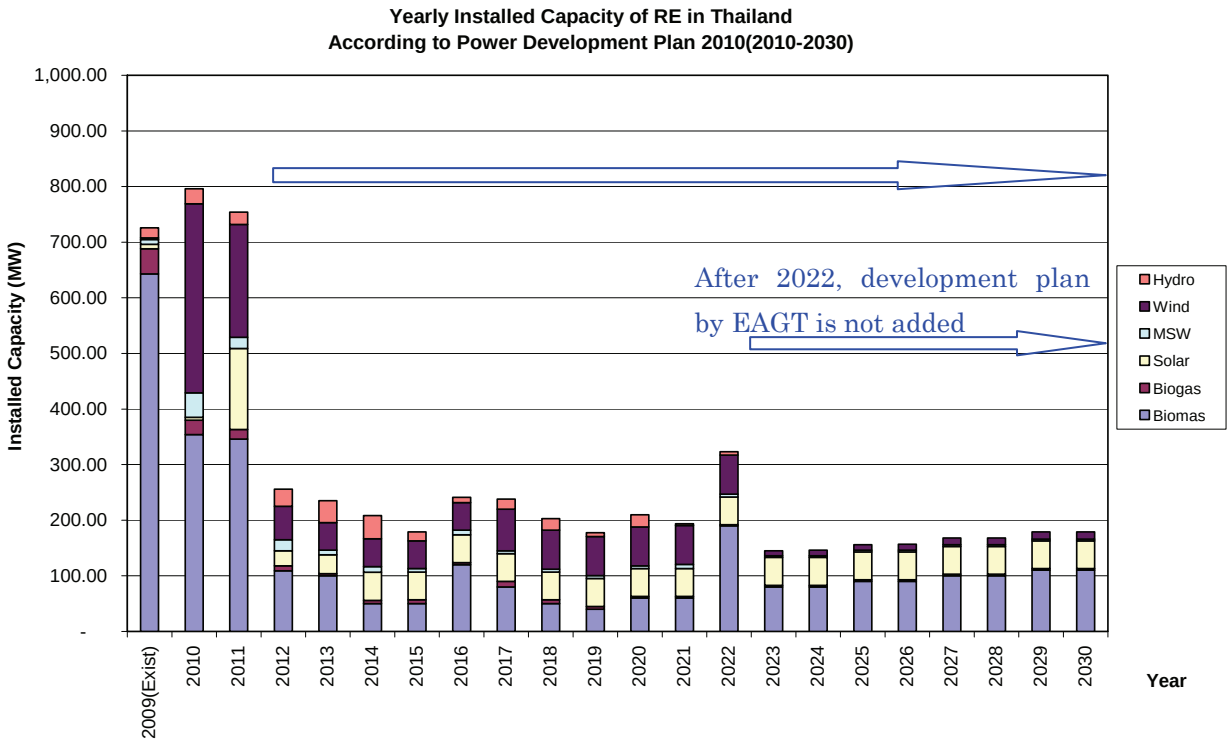
No.	Name of Company	Plant location	Plant capacity (MW)	Electricity selling (MW)	Type of Company	Adder	Type of Fuel Supply	Type of Fuel classify by Adder	Volt at the grid connected point (kV)	Date (Approved the purchasing contract)	Date of Sign the contrct	Type of contract	Period of Contract	Selling electricity to the grid (COD)
34	บ.หนองแค โคเจนเนอเรชั่น จก. (Nong Kare Cogeneration)	Saraburee	131.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	20/12/2539	24/12/.25 40	Firm	Firm 21 years	Oct, 2543
35	บ. แหลมฉบัง เพาเวอร์ จก. (Larm Cha Bang Power)	Chonburi	105.00	60.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	20/12/2539	5/1/2541	Firm	Firm 21 years	July, 2544
36	บ.อมตะ บี.กริม เพาเวอร์ 2 จก. (Amata B-Grim Power)	Chonburi	108.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	20/12/2539	9/1/2541	Firm	Firm 21 years	Sept, 2544
37	บ. เอ็กโก โคเจนเนอเรชั่น จก. (EGCO Cogeneration)	Rayong	120.00	60.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	20/12/2539	9/1/2541	Firm	Firm 21 years	Jan, 2546
38	บ.กัลฟ์โคเจนเนอเรชั่น จก. (gulf Cogeneration)	Saraburee	111.00	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	26/12/2539	6/1/2541	Firm	Firm 21 years	Sept, 2541
39	บ. ปตท. เคมิคอล จก. (มหาชน) (PTT Chemical)	Rayong	171.10	32.00	Cogeneration Power Plant	Non Adder	Off-Gasfrom Olefins factory and Natural	Natural Gas	115	31/3/2540	26/1/2541	Firm	Firm 21 years	Apr, 2540
40	บ.บางกอก โคเจนเนอเรชั่น จก. (Bangkok Cogeneration)	Rayong	115.30	90.00	Cogeneration Power Plant	Non Adder	Natural Gas	Natural Gas	115	25/7/2541	19/12/2540	Firm	Firm 21 years	Feb, 2542
41	บ. ผลิตไฟฟ้าและน้ำเย็น จก. (Electricity and Cold Water Generation Company)	Samuthprakarn	55.00	50.000	Gas Turbine Power Plant	Non Adder	Natural Gas	Natural Gas	115	21/12/2547	11/3/2552	Non - Firm	Non - Firm, year by year and continue	March, 2549
42	บ. ไออาร์พีซี จก.(มหาชน) (IRPC)	Rayong	108.00	45.000	Thermal Power Plant	Non Adder	Gas from Oil and Coal production	Hybrid	22	15/1/2541	28/7/2536	Non - Firm	Non - Firm, year by year and continue	May, 2537
43	บ. พีทีที ยูทิลิตี้ส์ จก. (PTT Utility)	Rayong	300.00	60.000	Thermal Power Plant	Non Adder	Natural Gas	Natural Gas	115	16/11/2549	25/5/2550	Non - Firm	Non - Firm 1 year	Jan, 2552
44	บ.ปัญจพล พัลพ์ อินดัสตรี้ จก. (มหาชน) (Panjapol Pulp Industry)	Ayuthaya	40.00	8.000	Paper Factory	Non Adder	Black Liquor Coal	Hybrid	115	18/1/2537	16/1/2552	Non - Firm	Non - Firm, year by year and continue	Nov, 2538
45	บ.ไทยอคริลิคไฟเบอร์ จก. (Thai Akilick Fiber)	Saraburee	17.20	6.000	Fiber Factory	Non Adder	Lignite	Coal	22	20/9/2537	4/11/2552	Non - Firm	Non - Firm 5 years	Aug, 2538
46	โกลว์ เอสพีพี 3 จก. โครงการ 1 (Glow SPP)	Rayong	160.00	90.00	Cogeneration Power Plant	Non Adder	Coal	Coal	230	29/3/2539	23/12/2540	Firm	Firm 25 years	Sept, 2542
47	บ. โกลว์ เอสพีพี 3 จก. โครงการ 2 (Glow SPP)	Rayong	160.00	90.00	Cogeneration Power Plant	Non Adder	Coal	Coal	230	20/12/2539	24/12/2540	Firm	Firm 25 years	March, 2543
48	บ.ทีพีที ยูทิลิตี้ส์ จก. (TPT Utility)	Rayong	55.00	9.50	Cogeneration Power Plant	Non Adder	Coal	Coal	230	18/11/2541	12/5/2541	Firm	Firm 25 years	Feb, 2540
49	กรมการพลังงานทหาร (Defence Energy Department)	Chiang Mai	10.40	4.50	Thrmal & Gas Power Plant	Non Adder	Coal	Diesel	22	21/3/2539	13/5/2541	Firm	Firm 25 years	June, 2541
50	บ. ภูเขียว ไบโอ-เอ็นเนอร์ยี จก. (โครงการ 2) (Phu-Keaw BioEnergy)	Chaiyapoom	11.40	10.000	Thermal Power Plant	Adder	Sugar cane	Biomass	115	23/6/2551	9/9/2552	Firm	Firm 25 years	May, 2552
51	บ. ด่านช้าง ไบโอ-เอ็นเนอร์ยี จก.(โครงการ 2) (Dan Chang Bio Energy)	Supunburi	11.40	10.000	Thermal Power Plant	Adder	Sugar cane	Biomass	115	16/6/2551	9/9/2552	Firm	Firm 25 years	May, 2553

Source: SERT report (from EPPO's home page. Years in the table adopt the Buddhist calendar: western calendar plus 543 years

EGAT predicts the developed capacity of power sources with renewable energy for EGAT, SPP, and VSPP by 2022 and 2030, as shown in Fig. 3.2.1 and Fig. 3.2.2.

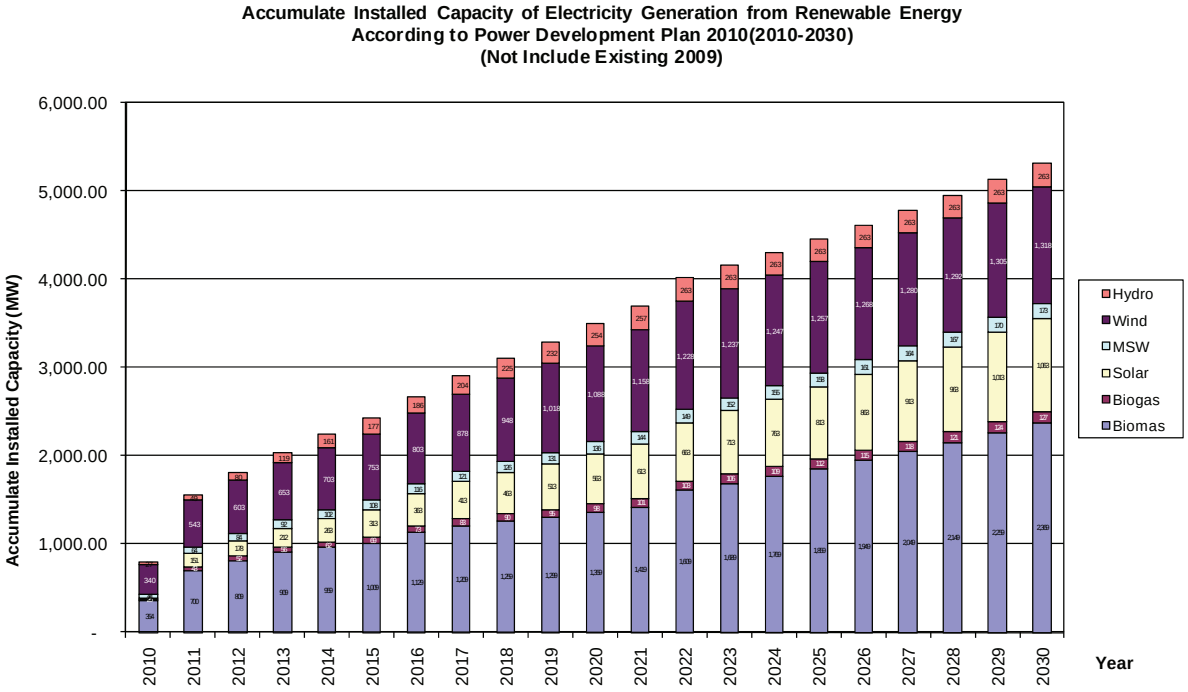
From the data, the calculated results of approved capacity and existing capacity, and progress toward the target by 2022 are shown in Table 3.2.4. As for solar power, the existing capacity is still small, but approved capacity is almost four times the target. On the other hand, for biomass, existing capacity has achieved 35% of the target, which is the greatest progress among resources, but approved capacity barely reaches the target. Regarding wind power, approved capacity is still low at 64%. But, there is a lot of capacity under consideration. The total capacity will meet the target capacity under consideration, but it is expected to be developed later than other resources.

For reference, in prospective data, contracted capacity with SPP is not counted because it is difficult to announce before conclusion of contracts, although there continue to be applications for new projects. There is a condition of starting operation within two years with compensation for damages in case completion is delayed. Consequently, information is limited to the capacity in the near future. There are differences between these data and the estimation of DEDE because the capacity of off-grid facilities and facilities belonging to DEDE such as hydro power stations are not counted.



Source: EGAT report 29 March, 2010

Fig. 3.2.1 Power Development Plan of Renewable Energy in the Future



Source: EGAT report 29 March 2010

Fig. 3.2.2 Accumulated Installed Capacity of Renewable Energy Facilities

Table 3.2.5 Power Development Plan for Renewable Energy in the Future (EGAT+SPP,VSPP)

Source	Company	(Under Consideration)	Approved / PPA /Planed	Existing (progress)		Total (progress)		Target by 2022
Solar Energy	SPP(10-90MW)	(303)	60		0		60	500
	VSPP(<10MW)	(649)	1,837		8		1,845	
	EGAT		1		1		2	
	Total	(952)	1,898	2%	9	381%	1,907	
Biogas	SPP(10-90MW)	(0)	0		0		0	120
	VSPP(<10MW)	(69)	133		51		184	
	EGAT		0		0		0	
	Total	(69)	133	43%	51	153%	184	
Biomass	SPP(10-90MW)	(0)	235		572		807	3,700
	VSPP(<10MW)	(540)	2,246		720		2,966	
	EGAT		0		0		0	
	Total	(540)	2,481	35%	1,292	102%	3,773	
MSW	SPP(10-90MW)	(285)	0		0		0	160
	VSPP(<10MW)	(140)	183		13		196	
	EGAT		15		0		15	
	Total	(425)	198	8%	13	132%	211	
Mini-Hydro	SPP(10-90MW)	(0)	0		0		0	324
	VSPP(<10MW)	(0)	6		0.6		7	
	EGAT		194		0		194	
	Total	(0)	200	0%	1	62%	201	
Wind	SPP(10-90MW)	(928)	341		0		341	800
	VSPP(<10MW)	(94)	45		0.4		45	
	EGAT		126		3		129	
	Total	(1,022)	512	0%	3	64%	514	
Total	SPP(10-90MW)	(1,516)	636		572		1,208	5,604
	VSPP(<10MW)	(1,492)	4,450		793		5,243	
	EGAT		336		4		339	
	Total	(3,008)	5,422	24%	1,369	121%	6,790	

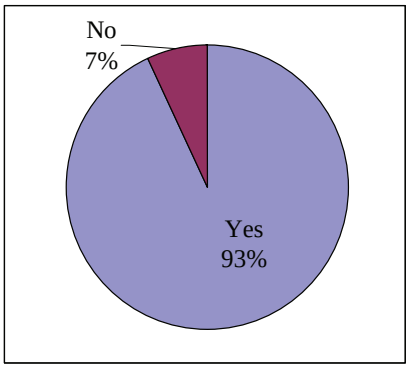
Source: drawn up by the survey team, from PDP 2010 and EGAT report on March 29, 2010

b-2 Consciousness and Recognition of Renewable Energy among Households

In this study, an investigation was conducted on the renewable energy consciousness of households. The evaluation results are shown as follows. (For an outline of targets, refer to Table 4.1.21)

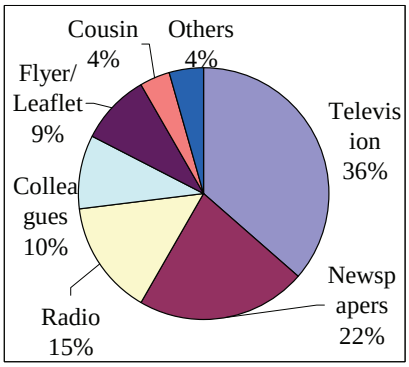
○Investigation Results

(1)Have you heard about renewable energy?



<Evaluation>
Because 93% of people have heard about it, name recognition is very high.

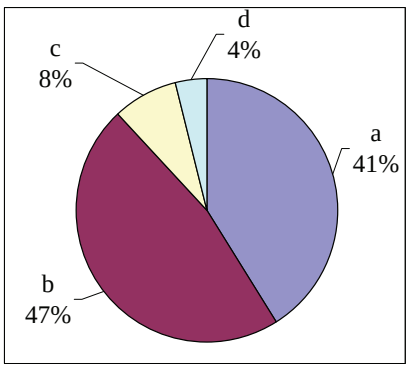
(2)If you answered yes to the above question, where did you hear about it?



<Evaluation>
Television, newspapers, and radio occupied high shares because they are sources of daily information.

(3)How important do you think renewable energy is?

a. You think about it actively.
b. You think about it as much as you can.
c. You do not like to think about it.
d. You do not need think about it.



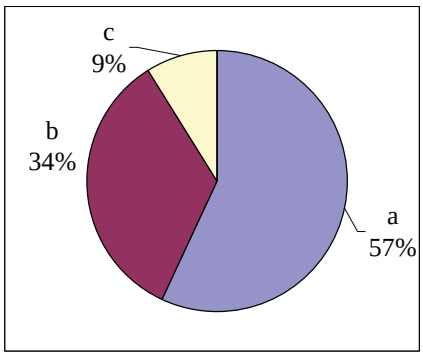
<Evaluation>
Because persons who answered (a) and (b) totaled 88%, the attitude was found of people trying to understand the importance of the renewable energy and contributing to it.

(4)What is the biggest advantage of renewable energy for households?

a. Contribution to the environment

b. Lower electricity costs

c. Usage quality standard for electric appliances



<Evaluation>

It seems that people who answer "contribution to environment," accounting for around 60%, understand the practical uses of renewable energy, but it is not certain if the other respondents understand its basic characteristics.

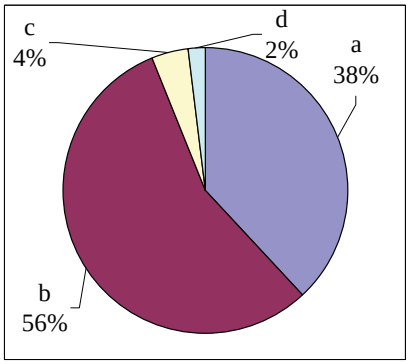
(5) Are you interested in introducing a power generator that uses renewable energy as a residential power generator?

a. It can contribute to solving environmental problems, so I want to introduce it actively.

b. If it can pay for itself, I want to introduce it.

c. I do not want to introduce it due to a lack of knowledge of maintenance.

d. I am not interested in it.



<Evaluation>

The people who think about contributing to the environment despite the expenditure account for near 40%, but more than half of respondents want to contribute provided expenditure does not increase.

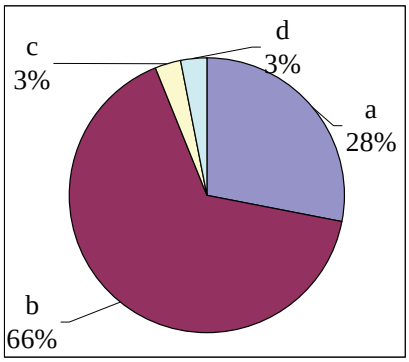
(6) Do you want to use the Surplus Power Purchase System for Renewable Energy for power generated by a generator installed in your home?

a. It can contribute to solving environmental problems, so I want to introduce it actively, even if it cannot pay for itself.

b. If it can pay for itself, I want to introduce it.

c. I do not want to introduce it due to a lack of knowledge of maintenance.

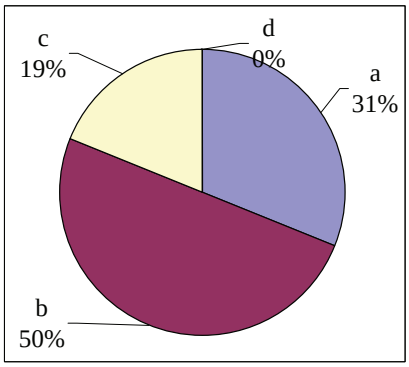
d. I am not interested in it.



<Evaluation>
The people who think about contributing to the environment despite the expenditure account for near 30%, which is the as same as for the item above. On the other hand, two thirds of people want to use it provided expenditure does not increase.

(7) Do you know that there is Surplus Power Purchase System for Private Companies in the area of renewable energy?

a. I know about it very well.
b. I have heard about it.
c. I have not heard about it.
d. I am not interested in it.



<Evaluation>
Because people who know about it account for 30%, and those who have heard about it account for half, most people seem to know that there is such a system.

○Overall Evaluation

From the evaluation above, it is found that word recognition of renewable energy is high and most people understand that its introduction is important to solve environmental problems. It is considered that recognition among general households is not high enough, and some people misunderstand the meaning. Mostly, they are interested in purchasing generating facilities and participating in the wholesale purchase system as their contribution to the environment. But, people who are willing to contribute by incurring expenditure personally are in the minority.

To promote renewable energy generation facilities in the general household sector in the future, it is effective to make efforts to:

- Establish a system to support the initial investment and operating expenses of installers.
- Educate on characteristics and significance of renewable energy generation and knowledge of facility operation.

c Study Contents on Introducing Renewable Energy

Future prospects toward promotion target, promotion policies, and problems considered for each of the various renewable energies are described in the following sections.

c-1 Solar Power

For the target to adopt 500 MW by 2022, the capacities of 2,376 MW for VSPP and 355 MW for SPP are already applied (Table 3.2.2, Table 3.2.3). But, not all of them promise to be accepted, constructed, and contracted.

Trend of the Large-scale Power-producing Business Using Solar Power

Recently, the solar cell industry has been pointing to the development and production of thin film cells, whose materials cost less that the material than for the crystal cells, and have a conversion efficiency that does not fall sharply at high temperatures. By adopting the thin film solar cells and large-scale construction with economies of scale, the construction cost of around 160 million B/MW two or three years ago, has been decreasing to less than 100 million B/MW recently. As for large-scale businesses, good profits are promised with the current Adder subsidized price, and many applications have been made by power production businesses.

But, many applications in rural areas have been made because for a large-scale power production business, large amounts of inexpensive land are necessary where solar power conditions are good. Sites are far from the trunk electric power system and even if there is an electric power system, the transmission line capacity is insufficient. Because construction of transmission lines is required at the enterprise side and profit from the business is decreased, a large number of applicants might abandon the business.

According to EGCO, they use the BOI system and other low-interest financing systems actively. 60-70% of the project cost is provided by financing over 20 years. They also use the CDM, but the amount is not high enough to cover expenses.

＜Examples of Large-scale Solar Power-generating Businesses＞

1. Enterprise: Natural Energy Development Co., LTD (NED) *1
   Site: Lop buri province (Central Thailand)
   Power output: 73 MW (55 MW will be provided wholesale to EGAT under a five-year contract)
   Commissioning year: 2012
   Investment: 7,960 million baht
   Authorized by BOI
   Financed by 62 million dollars (70 million dollars at maximum)
   by ADB (Asian Development Bank)
   Grant of 2 million dollars from The Clean Energy Financing Partnership Facility (CEFPF)
   Under discussion to receive preferential financing for emission reduction certification using the Carbon Market Initiative (CMI) system of the ADB

*1: Co-funded 33.3% each by three companies:
- Electricity Generating Public Co., Ltd. (EGCO) (EGAT-affiliated company),
- Diamond Generating Asia Ltd.
(Mitsubishi Corporation-affiliated company in the generation business in Southeast Asia),
- CLP Thailand Renewables Ltd. (Hong Kong)

2. Enterprise: Solar Power Holdings Company Ltd.
Site: Nakhonratchasima province
Power output: 6 MW
Commissioning year: 2012
PV manufacturer: Kyocera

3. Enterprise: EGAT
Site: Thap Sakae district (central southern area of Thailand)
Power output: 5 MW (4000 ray area)
Commissioning year: 2012
Manufacturer of PV has not decided yet. Thin film type is to be installed.

4. Enterprise: Bangkok Solar Co., Ltd.
They started to sell power from a solar farm on 5 October, 2007 (Site No.1 below was the first site).
At present, they are operating seven systems at six sites.
1. 1.644 MW: Chachoengsao province
2. 2.144 MW: Petchabri province
(The largest thin film PV system in the world at that time)
3. 1.563 MW: Udonthanee province
4. 0.285 MW: Udonthanee province
5. 1.136 MW: Angthong province
6. 0.500 MW: Nakhornsawan province
7. 2.2 MW: Lop buri province (Total: 9.472 MW)

Now, they are constructing the following, too.
8. 6.6 MW: Lop buri province
9. 4.4 MW: Lop buri province
10. 1.8 MW: Prachukkirikhan province
11. 1.5 MW: Karat province (Total: 14.3 MW, Grand total: 23.772 MW)

[Constitution of Bangkok Solar Group to which Bangkok Solar Company belongs]

Bangkok Solar Company:

- produces and sells PV modules with Si Amo Rufus thin film, whose efficiency deteriorates little in a high-temperature environment, as the anchor product.
- is recommending the product in two-level structure modules with a-Si and polycrystalline, which resulted in the most effective performance in a comparative experiment in Spain.

Bangkok Solar Power Company:

- arranges all facilities for PV system (PV modules, base, inverters (which are products made by LEONICS company based on their joint-venture business) etc.)
- delivers solar farms.
- builds solar farms itself to sell power.

Bangkok Cable Company:

- produces cables for PV system, joint boxes, and connectors.
  (The parts of the joint box are purchased from a Japanese maker.)

Trend of Small-Scale Solar Power Generation Businesses

At present, 51 projects are engaged in generating businesses with solar power as VSPPs (Table 3.2.3). 31 under contract to MEA and 20 are under contract to PEA. According to MEA, from estimated payback period of ten years as the support period of the current Adder system, a wholesale price of about 11 B/kwh produces poor profits from an investment of around 16 B/kWh. Starting the business is also difficult. Existing projects are still profitable because initial investment support was provided from the ENCON fund for pilot cases (refer to the following article). Small-scale projects without benefits of scale are unprofitable now since the investment support has ceased, and individual investors without large amounts of capital hesitate to start a project due to large installation costs. Therefore, this business is not so encouraging.

For promotion to households in the future, it is effective to establish systems that support installation and operating costs of the residential installer and to educate people on the characteristics and significance of renewable energy generation and knowledge of facility operation.

There is still a possibility of promoting it for small-scale projects. But, every ministry office and electric power utility considers the promotion target of solar power to be secured. Therefore, the need to inject additional promotion support is to be judged by Thai government.

＜Past measures for promoting small-scale Solar power generation projects＞

Two past measures for promoting small-scale solar power generation projects are introduced below.

1. Support from ENCON fund

   Entity: EGAT

   Funding: ENCON Fund

   Purpose: To promote PV systems to general households and evaluate the grid-connected PV

system for general households

Implementation period: 2002 - 2005

Implementation contents:

Projects were limited by 50 households.

45.7% of installation cost (Around 0.6 million baht a household) was provided from the ENCON fund and the household had to invest 54.3%

When the target (50 households) was met, support was stopped. After the Adder system was implemented, the support system was not restarted.

2. Support to promote SHS in un-electrified area by Ministry of Interior

Entity: PEA

Funding: Revenue of Ministry of Interior

Purpose: To electrify an area and provide a power supply as a basic service everybody can access equally.

Implementation period: 2004 - 2005

Implementation contents:

Providing gratis Solar Home System (SHS) to un-electrified area that is difficult to electrify by PEA extending a distribution line

Target: 290,716 households for two years.

Project cost: 7.912.433 million Baht

After installation by PEA, the assets of the facilities were transferred to the local government and the budget for replacement parts was distributed to the local government.

c-2 Small Hydro Power

Trend of Small-Scale Hydro Power Generation Businesses

According to DEDE's plan, the potential power is 700 MW, the target adopted by 2022 is 324 MW, and the installed target of EGAT is 193.7 MW (Table 3.2.1). To achieve the target, the present projects under consideration and construction are shown in Table 3.2.6. As planned in 2007, about 165 MW of capacity will be developed using irrigation dams and others will be developed mainly by constructing new dams.

Electric power utilities wish to adopt hydro power positively because of the policy to use domestic energy effectively when promoting renewable energy in the future.

However, due to land-use restrictions, large-scale hydro power development is impossible. Even for small-scale development, the actual potential is considered to be the same as the target adopted for 2022 at maximum.

Under the present circumstances, land-use restrictions for five levels of forest area are strictly controlled under Cabinet Resolution by the Ministry of Natural Resources and Environment. In some areas, all development is regulated. In other areas, it is also necessary to get approval to develop and negotiate with inhabitants who are strong opponents. Projects are seldom planned by

private companies because of such difficulties. Present development projects are mostly planned by EGAT and DEDE etc.

Table 3.2.6 EGAT'S Hydro Electric Power Station Construction Plan

	Project	Grid Connected	Capacity (MW)	Energy (kWh/Year)	Investment (MB)
Under consideration	**Small Hydro Power Plant (2009-2012)**		**48.7**	**241,570,000.00**	**3,265.28**
	Chowpraya Dam	2010	12.0	61,750,000	910.36
	Naresuan Dam	2011	8.0	43,030,000	726.66
	Maeklong Dam	2012	12.0	74,000,000	919.21
	Khundanprakarnchol	2012	10.0	27,990,000	362.73
	Pasakcholasit Dam	2012	6.7	34,800,000	346.32
Future project	**Small Hydro Power Plant (2013-2017)**		**86.0**	**443,782,000.00**	**8,470.23**
	kwaenoi Dam	2013	30.0	146,600,000	1,220.75
	Klong Tron Dam	2013	2.5	12,210,000	175.21
	Kew Kor Mar Dam	2013	5.5	32,040,000	464.49
	Chulabhorn Dam	2013	1.00	5,407,000	121.99
	Phraya Man Weir	2014	3.0	13,020,000	286.69
	Rasi Salai Weir	2014	12.0	79,670,000	1,464.92
	That Noi Weir	2015	4.0	15,000,000	311.49
	Hua Na Weir	2015	10.0	69,950,000	1,375.58
	Yasothorn-Phanomprai Weir	2016	5.0	14,650,000	271.05
	Lam Dom Yai Weir	2016	4.0	12,000,000	247.13
	Lower Khao Leam Dam	2017	9.0	43,235,000	2,530.92
	Small Hydro Power Plant (2018-2022)		**59.0**	**243,015,000.00**	**4,062.89**
	Chonabot Weir	2018	4.0	9,250,000	220.39
	Lower Khao Leam Dam (Unit2)	2018	9.0	43,235,000	505.05
	Mahasarakham Weir	2018	5.0	10,260,000	266.19
	Kamalasai Weir	2018	3.0	10,000,000	177.83
	Huai Raeng Dam	2019	2.5	5,860,000	146.27
	Huai Sator Dam	2019	1.5	6,930,000	116.83
	Nakhon Nayok Dam	2019	3.0	9,700,000	162.98
	Mae Sauy Dam	2020	2.0	5,000,000	96.05
	Pha Chuk Dam	2020	20.0	110,850,000	1,602.83
	Bang Pakong Dam	2021	2.0	7,010,000	133.28
	Nong Plalai Dam	2021	1.0	4,820,000	106.94
	Huai Nam Sai Dam	2022	2.0	9,590,000	266.90
	Wang Yang Weir	2022	4.0	10,510,000	261.34
	Mini Hydro (2552 - 2565)		**193.7**	**928,367,000**	**15,798.40**

Source: EGAT report 29 March, 2010

Financial Support from Adder

Therefore, to support small-scale hydro power that cannot be expected to be developed by private sector with promotional measures funding by Adder et al. is ineffective.

c-3 Biomass

As for SPP, 23 Biomass generation facilities of about 570 MW (installed capacity base) had already been connected to the grid as of 2009. And three projects for about 235 MW (installed capacity base) have been applied (see Table 3.2.2).

As for VSPP, small and medium-size biomass generation facilities of less than a few MW, which are most commonly introduced in Thailand, have already reached 3,000 MW (installed capacity base) including facilities for which applications have been made (see Table 3.2.3).

On the other hand, the introduction target of DEDE sets the goal of increasing biomass generation facilities to 3,700 MW by 2022.

Large-scale Biomass Power Generation

Under such circumstances, securing fuel for biomass power generation will become a problem in later years. For instance, a power plant over 10 MW fueled by rice husks has been operated by gathering fuel from more than ten factories because the supply of rice husks was not sufficient from rice mills designated at the time of the original plan. In another example, a power plant is forced to shut down due to shrinking rice harvests caused by droughts and increasing prices of rice husks. This is becoming a serious problem. Because, power producers implement feasibility

studies individually, possible fuel supplies overlap, and rice husks are also used as a raw material outside the power generation business, we think fuel shortages will occur.

It is thought a similar situation will occur with biomass power generation using other plant sources as fuel. At the moment, SPP will not consider large-scale biomass power generation over 10 MW, because they (or investor) are waiting to see how this situation develops. We cannot expect promotion unless the problem of a lack of fuel is solved, even if financial support such as Adders is provided.

Therefore, to promote large-scale biomass power generation, a scheme for securing fuel to operate sustainably and stably (for example, potential investigation and introduction of area classification system nationwide) and a subsidy system for developing biomass power generation technology assuming new plant fuels need to be considered comprehensively. However, the study team concludes that it is very difficult to have a large-scale generation facility of over 10 MW operate on a commercial basis in terms of time and cost, so it is more reasonable to develop a small-scale facility first.

Small-scale Biomass Power Generation

At present, there is steady growth of small-scale biomass power generation by VSPPs, however, like large-scale power generation, if affected by rising prices of fuel, so it might be impossible to operate sustainably. However, if there are measures to support stable, sustainable operation such as guidance on a specific method of supplying fuel and a subsidy for small-scale biomass power generation, it is thought that we can anticipate further dissemination to be promoted.

Concrete examples are:

- Recommendation of community-based, small-scale biomass generation model
- Development of new-generation technology and construction of administrative system for the above generation model
- Incremental subsidy system or soft loan for small-scale biomass

We think it would be effective to provide support from Japan for the above.

We think construction of a model that secures its own fuel by establishing a biomass fuel plantation that is sustainable in a community, can avoid the risk of fluctuating fuel prices, and be an effective measure for boosting employment and slowing depopulation in remote areas (district) .

Moreover, technical transfer and succession are important to continue operating a power plant stably. For instance, as a model case, capacity building of engineers and research and development on biomass power generation technology using a new technique of a Japanese company could be implemented in organizations studying biomass power generation such as universities. Then, to promote dissemination, support could be provided through technical assistance for installation/operation and maintenance of generation facilities and construction of a community administration system in local communities.

＜Example of Small-scale Biomass Power Generation＞

As for an example of a small-scale biomass generation project under development in Thailand, a 10-kW demonstration plant is being operated by a Japanese agricultural machine maker in collaboration with Suranari University of Technology to assess commercial viability. An investigation is also underway to solve a tar removal problem occurring in the gasification process. In addition, the project described below has received attention as a business model that secures its own fuel for power generation.

Business owner：A+POWER

This biomass gasification generation company was established to support the independence of AIDS patients. It installed a power station at a temple called Wat Prabat Nampoo in Lop Buri prefecture. It is going to allocate profits from selling electric power to cover hospital costs and expenses for medicine for AIDS patients. Besides, the temple manages nursing facilities using an AIDS patient relief fund (Dharmaraksa Foundation), and is famous for providing relief to AIDS patients

Site of construction ：Lop Buri prefecture

Output capacity：1.8 MW (Selling electric power 1.5 MW to PEA)

Year to be commissioned： 2010 (commissioning due to start in June)

Other：The business model uses a plantation tree (black locust species) whose growth is about two times the normal rate as the raw material for power generation

c-4 Wind Power

As of 2009, wind power generation facilities operating in Thailand generated only a few MW. (Table 3.2.7 shows the wind power generation development plan of EGAT.) This is because areas with good conditions for wind power generation in Thailand are limited to the southern coastal area and northern mountain area. In addition, when installed in a forest area, there are restrictions such as systems limiting forest use. Therefore, wind power generation has not been developed positively so far.

On the other hand, DEDE has set the goal of increasing wind power generation facilities to 800 MW by 2022. It is considered necessary to solve the problems below to promote wind power generation from the results of interviews carried out in this study with electric utilities and private generation enterprises on present conditions and targets.

Table 3.2.7　Wind Power Generation Development Plan of EGAT

Type	Project	Grid Connected	Capacity (MW)	Energy (kWh/Year)	Investment (MB)
Wind	**Wind Power Plant (2009-2012)**		**20.5**	**42,399,000**	**1,886.40**
	Wind Turbine ((Kou Yai Tiang-1)	2009	2.5	4,599,000	145.00
	Wind Turbine (Kou Yai Tiang-2)	2012	18	37,800,000	1,741.40
	Wind Power Plant (2013-2017)		**19.0**	**38,763,000**	**1,484.75**
Operating	Wind Turbine (Kou Yai Tiang-3)	2013	15	31,536,000	1,147.50
	Wind Turbind (Ra Wai Stadium)	2014	2.5	4,599,000	181.25
	Low wind-Wind Turbine (Southern part)	2017	0.5	876,000	52.00
	Low wind-Wind Turbine 1	2017	1	1,752,000	104.00
	Wind Power Plant (2018-2022)		**89.0**	**183,960,000**	**7,056.00**
	Low wind-Wind Turbine 2	2018	9	15,768,000	936.00
	Wind Turbine (North-East Part)	2022	50	105,120,000	3,825.00
	Wind Turbine (Central Part)	2022	30	63,072,000	2,295.00
	Wind Total (2009-2022)		**128.5**	**265,122,000**	**10,427.15**

Source：EGAT answer data of 29 March, 2010

Large-scale Wind Power Generation

According to an investigation of wind conditions etc., candidate sites for a large-scale wind power plant of a few MW/unit are often located at remote places such as mountains. When a power transmission line is not available, it is necessary for the generating enterprise to install a connecting route to an existing grid. In such a case, the increased initial investment becomes a barrier to promotion.

In an interview with a consultancy on a renewable energy project, there was some opinion that wind power businesses have the worst assistance conditions among relevant power generation businesses under the current Adder system. Currently, general construction costs are estimated to be around 120 Million B/MW. Therefore, if a candidate site with good wind conditions is found in an area far from an existing grid, it is considered effective for promoting wind power businesses to provide assistance towards the cost for extending a power transmission line. Since, however, the Japanese government cannot provide financial assistance to a particular private business, such means for support needs to be considered as two-step assistance involving the establishment of a power transmission line construction fund or a similar fund.

To execute a large-scale wind-power development in Thailand, it is necessary to install wind turbines that can generate power with low-velocity wind. If prompt development is needed, expensive products have to be imported because there is no fully developed domestic product available at present. As a result, profitability is poor under the present subsidy system. On the other hand, there is still a possibility that private enterprises will enter the business, expecting merits of CSR such as improving corporate image despite the high cost.

EGCO regards it to be more useful to allocate a budget for purchasing or developing a large-scale turbine for low-velocity wind than to study high wind velocity points high above the ground. Therefore, it is desirable for the wind power business to be better supported.

Operation and maintenance engineers are considered sufficient because human resources can be

built up under its own system. On the other hand, it thinks sufficient techniques are needed to examine and design a facility capable of being connected to the grid. So, it states that technical support would be helpful.

DEDE has the opinion that qualification systems need to be maintained to push forward with large-scale wind power development, which needs high-level techniques.

＜Examples of Large-scale Wind Power Generation by the Private Sector＞

Current examples of large-scale wind power-generation projects under development in Thailand by the private sector, except for projects undertaken by EGAT above, are shown below.

1. Enterprise: NED*2
   Site: Northeastern Thailand
   Power output: 13.5 MW
   Year to be commissioned: 2017
   (Planning to complete at the same time as reinforcing transmission line capacity)*3
   Other: Power Purchase Agreement with PEA in 2009 under VSPP system already contracted
   NED is conducting other feasibility studies for wind farms of several decades MW class.
   .*2: Described in Section 3.2.c-2 Examples of Large-scale Power Production Business

*3: usually installed by the developer, but in this case, construction is in an area where EGAT will reinforce the grid line, so the plan was changed to adjust completion of the wind farm to completion of reinforcement.

2. Enterprise: Co-funded by Japan Wind Development Co., Ltd. and Ratchaburi Electricity Generating Public Co., Ltd. *4
   Site: Highlands at 150 m elevation in eastern Thailand
   Power output: 180 MW
   Year to be commissioned: 2013 (Planned to be commenced in stages and to start construction in 2012)

*4: Ratchaburi Electricity Generating Public Co., Ltd.:
- affiliated company of EGCO.
- owns Ratchaburi Power station (Gas CC)
- is building another wind farm of 62 MW in Phetchaburi province with Wind Energy Holdings.
  It is planned to start construction within 2010 and commence operation at the end of 2011.

Small-scale Wind Power Generation

DEDE is examining development of a small-scale wind turbine for low-velocity winds of below 5 kW/unit as a measure mainly to promote the small-scale private sector in Thailand. It is still researching and developing generating facilities, and it considers that broad technological

development covering everything from investigation, designing, and construction to operation and maintenance is necessary next.

Interviews with DEDE suggest it regards wind power generation as an industry that can be developed domestically, and it is developing a wind turbine for low-velocity winds in collaboration with some universities. Therefore, it states it would be very effective to prepare a wind tunnel experiment facility now.

However, it does not regard small-scale wind power generation to be a measure for achieving the renewable energy promotion target by 2022. The small-scale wind turbine is assumed to be connected to the grid mainly to sell the power, not to improve the electrification ratio of an unelectrified area.

Considering dissemination and promotion of small-scale wind generation, as with the case of small-scale photovoltaic generation, the profitability of small-scale facilities is poor because there are few economies of scale. So, it is considered that the big initial investment will be a barrier against dissemination to individual investors.

It is necessary to examine the effectiveness of supporting small-scale wind power generation, considering subsequent technological development and direction of policy.

In Japan, there are also several companies developing and selling small wind turbines for private companies and households that start to rotate at wind speeds of 1 m/s, and which are relatively easy to install and maintain, such as vertical axis wind turbines. Therefore, if there is a request for technical support, it is available.

c-5 Municipal Solid Waste (MSW)

DEDE estimated the total potential to be 400 MW and utilization target in 2022 to be 160 MW including 15 MW for EGAT's installation target. 5 MW was installed as of 2007 (Table 3.2.1).

Although originally such potential for generating power had not been expected, even local governments of urban areas, which deal with municipal waste, have not started setting up businesses. However, according to the plan of DEDE in April 2010, installation of more than 500 MW is expected by 2020 (Table 3.2.8).

Summing up the total source potential in Thailand, it is possible to enlarge this power-generating business by incorporating it into environmental improvement measures designed by local governments. However, profitability is not considered to be so good because there are no economies of scale from small facilities. A large portion of the technical development is still outstanding. There, it is considered that financial support for power generation with MSW would be effective, although consideration is needed for the requirements of the Thai government and technological trends in this field. It is necessary to consider countermeasures to barriers by examining management methods and sources of funding in local governments, and discussing how to execute business between private companies and local governments.

Table 3.2.8 MSW Development Plan

Scale	Project	MW	COD
SPP(10-90MW)	5	285	2012-18
VSPP(<10MW)	30	269	2011-20
Total		554	

Source: Business Opportunities in Thailand's Renewable Energy, DEDE, 2010

c-6 Conclusion

For each of the various power generation businesses using renewable energy sources discussed above, Table 3.2.9 summarizes business conditions, present support measures, situation of applications, effectiveness of introduction promotion measures, etc. Its outline is described below.

Solar Power Generation Businesses

They are expected to achieve profitability under the current support measures including Adder, and the number of applications submitted, primarily for large-scale businesses, is already several times more than the promotion target. A further support to these businesses is considered unnecessary. On the other hand, small-scale solar power generation businesses have not spread due to their low current profitability, and their promotion is possible through financial and other supports. Since, however, the generating capacity per unit is small with small-scale solar power generation and since there is a limit to what one can expect of the financial capacity of general households, a support to these businesses is considered to be ineffective for promoting their introduction.

Wind Power Generation Businesses

There are some supports considered effective including assistance towards the costs for importing facilities and extending a power transmission line for large-scale businesses. The adder for wind power generating businesses, however, is one of the most preferential, second only to the adder for solar power generation, and the capacity of applications for wind power generation businesses is already several time more than the promotion target in spite of their lagged development relative to solar power generation. Therefore, a further support is considered unnecessary. On the other hand, with regard to small-scale businesses, a support is conceivable for technological development going on in Thailand for an increased promotion in the future, but its contribution to the achievement of the introduction target is considered to be low.

Biomass Generation Businesses

Biomass generation businesses have come to account for more than 90% of the current power generation from renewable energy sources by exploiting its rich potential in Thailand, but the future development of biomass generation is likely to slow down relative to others. The capacity of applications that have been approved at present barely reaches the introduction target. The reason

for this is that there are fuel shortage and price hike, which constitute the operational problem for large-scale biomass generation. Unless this fundamental problem is solved, promotional measures through financial and other supports remain ineffective. On the other hand, small-scale businesses are expected to grow further given technological and financial supports which include providing new information, e.g., about generation method through self-supply of fuel and generation facilities designed to have greater durability than conventional ones.

Among these sources of energy, it is considered most effective for achieving the target for introducing power generation by renewal energy sources to provide financial and technological supports to small-scale biomass generation businesses.
In terms of support system, financial supports for initial investment and operating expenses as well as technical supports should be given through financial assistance to ENCON fund or the establishment of another fund to finance such supports. It is considered difficult by many to add some financial support to the fuel adjustment tariff revenues, the current financial source for Adder, to enhance the Adder system because it makes Adder financing complicated. The establishment of another fund or any other appropriate measure is conceivable if Adder support is to be implemented.

<Technological Development Currently Considered Necessary by DEDE and Power Utilities>

DEDE is of the view that it is required to establish quality standard control and quality testing systems for wind power generation facilities in order to promote large-scale wind power development that requires a high level of technology. In Thailand, such systems have been established for solar energy and solar heat facilities by National Science Technology Development Agency (NSTDA) under the Ministry of Science and Technology, but there are no such systems for wind power generation facilities. It is also considered effective to provide technological support to this project.
According to the interview with EGAT, the largest problem in introducing renewable energy is technology for establishing a stable operating method for solar and wind power generation. EGAT says that technologies are required for overcoming the problems of methods to control voltage and frequency of an electric power system, methods to utilize back-up systems, etc. For instance, given know-how for calculating constant dependable capacity (base load capacity), it is possible to make a plan for the future introduction of facilities and effective operation. PEA is similarly developing technology for introducing multiple wind power facilities into its power system using information and other technologies.
As a part of the program for eliminating non-electrified villages, a project is being carried out for installing Solar Home System (SHS) in non-electrified villages. PEA is currently developing highly efficient photovoltaic such as concentrator photovoltaic, which are considered necessary in islands where the space for facilities is limited.

<Problems in Introducing Power Generation Facilities Using Renewable Energy Sources>

It is well known that output instability resulting from the connection of solar and wind power facilities to an electric power system constitutes a problem in introducing a large number of power generation facilities using renewable energy source, as mentioned above. Besides, following problems have occurred in developed countries, particularly in regard to wind power generation facilities. Countermeasures against these problems should also be considered in their active introduction in Thailand.

Problems in Introducing Wind Power Generation Facilities

[Noise pollution and health damage] There is a problem of noise from a wind turbine, aerodynamic noise from the rotor blades, etc. Low frequency noise which is inaudible to human ears but makes objects such as wind vibrate has been reported to cause headache, vertigo, and insomnia. Suits have been filed by neighboring residents, and there have been movements against the construction of wind turbines.

[Landscape] The construction of wind power generation facilities is sometimes opposed in scenic sites and similar places due to the problem of their impact on natural landscape.

[Strong wind] Strong wind may cause motor burnout and blade damage by making a wind turbine run at a speed greatly exceeding the rated velocity.

[Lightning strike] Lightning strikes may physically destroy the wind power generation facilities. The larger the facility is, the more likely it is to be damaged due to its greater height.

Table 3.2.9 Summary of Findings of Power Generation Businesses using Renewable Energy Sources

Resource	Scale & Type of Business	Current condition of business	Current supports	Current Situation of Project Applications (Approved vs. target capacity /applied vs. target capacity)	Effectiveness of Promotional Measures for Introduction (○: effective, △: not so effective, ×: ineffective)	Effectiveness of financial support		Effectiveness of technical support	
						Initial investment	Operating expense	Business development	Sustain-ability
Solar power	Large scale (around 1 MW or more)	High energy potential in whole of Thailand, especially the central and eastern areas	Adder(8B/kWh×10yrs) BOI, Encon Fund	3.8／5.7	×Some prospect for achieving the target. Good profitability through Adder support.	–	–	–	–
	Small scale, Roof top (Several to 100 kW)	High energy potential Small unit capacity Lack of capital, Little profitable	Adder(8B/kWh×10yrs) (BOI, Encon Fund)	0.02／0.05	△Some prospect for achieving the target with large-scale businesses. Low contribution due to small unit capacity.	Subsidy	Adder reinforcement	–	–
Wind power	Large scale (around 1 MW or more)	Far promising site Lack of domestic technique Lack of quailification system	Adder(3.5B/kWh× 10yrs) BOI, Encon Fund	0.6／1.9	△Technological support and assistance towards power transmission line construction and facilities import are effective. Some prospect for achieving the target.	Subsidy	Adder reinforcement	Grid connected Technique Quailification system	–
	Small scale (several to 50 kW)	Lack of technique for small scale, low wind speed Small unit capacity Lack of capital, Little profitable	Adder(4.5B/kWh× 10yrs) (BOI, Encon Fund)	In a small number	△Domestic technology development is effective. Some prospect for achieving the target with large-scale businesses. Low contribution due to small unit capacity.	Subsidy	Adder reinforcement	Technique for small scale, low wind speed	Enlighten ment to household
Biomass	Large scale (Several 10 MW or more)	Lack of fuel High price fuel Difficulty of sustainable operating	Adder(0.3B/kWh×7yrs) BOI, Encon Fund	1／1.2	×Establishment of regulations on fuel purchasing methods required. Financial and technological supports under the present situation are ineffective.	–	–	–	–
	Small scale (around 0.1 to 1 MW)	Promising development of resource Little profitable	Adder(0.5B/kWh×7yrs) BOI, Encon Fund	0.003／0.004	○Technological and financial supports are effective for the promotion of small-scale operations because of the presence of fuel purchasing methods and new generation technologies.	Subsidy	Adder reinforcement	New technique and system	New management know-how
Biogas	Small/Large scale (0.1～ about 1MW /1MW or greater)	Potential is not so large compared with other resources	Adder (0.3or0.5B/kWh×7yrs) BOI, Encon Fund, Investment Subsidy System	1.5／2.1	×Some prospect for achieving the target. Low contribution due to small total capacity.	–	–	–	–
Hydro power	Small hydro (around 1 to 10 MW)	Restricted developed capacity negotiating with inhabitants application of irrigation dams	BOI, Encon Fund (No Adder)	0.6／0.6	×Financial supports are ineffective since hydropower development is not led by private companies.	–	–	–	–
	Mini hydro, Micro hydro (up to 200 kW)	Restricted developed capacity negotiating with inhabitants Little profitable	Adder (0.8or1.5B/kWh×7yrs) BOI, EnconFund	In a small number	×Low contribution due to small total capacity with hydropower development not being led by private companies.	–	–	–	–
Municipal Solid Waste (MSW)	around 1 to 10 MW	Little profitable Necessity of arrangement with the local government	Adder (2.5or3.5B/kWh×7yrs) BOI, EnconFund, Investment Subsidy System	1.3／4	△Financial supports are effective. Some prospect for achieving the target. Low contribution due to small total capacity.	Subsidy	Adder reinforcement	–	–

Source: Created by the study team

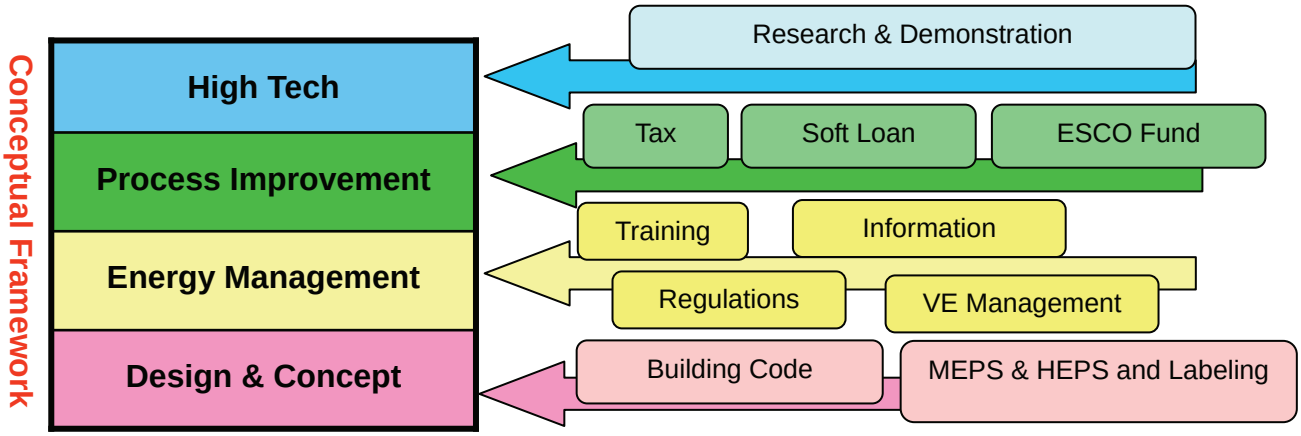
4 Confirmation of Current Conditions and Future Prospects of Energy Conservation

4.1 Governmental Policy and Current Conditions of Energy Conservation

a Energy Conservation Policy

Thailand has created an energy conservation discipline as a national culture and encouraged energy conservation in all sectors—household, industrial, services & commerce, and transportation—through a campaign aiming to build energy conservation consciousness. Thailand is also continuing to promote the efficient use of energy by providing incentives to attract the private sector to opt for energy conservation appliances, and has established incentive measures to reduce electricity use during peak periods. Major energy conservation initiatives have been launched to be a main driver to promote EC (Revolving Fund for EC/RE, ESCO venture capital funds, Tax incentives for energy saving, DSM Bidding, and Energy management Promotion). Furthermore, Thailand researches, develops, and sets the energy-conserving performance standards for electrical appliances and buildings; and, encourages development of mass public transportation and railway system to promote effective energy use, which will reduce the country's investment on energy procurement.

Energy conservation measures are categorized (e.g.; High Tech and Design & Concept, etc.) as shown in Fig. 4.1.1 and arranging necessary measures in each category is being planned.



Source：DEDE

Fig. 4.1.1 Energy Conservation Measures Concept

b Institutional Plan for Promoting Energy Conservation and Problems in Energy Power Sector

Concerning energy conservation, JICA has so far given proposals on energy conservation policy through "The study on energy conservation project" (1982−1984) and "The study after-care on the energy conservation project" (1993−1994). In "The Project on the Practical Energy Management Training Center" (2002−2005), JICA provided supports in equipments and curricula for energy managers training based on the Energy Conservation Promotion Act and gave a proposal on a qualification system for energy managers.

In addition, JICA installed inverter air conditioners and BAS in the Practical Energy Management Training Center in “The Project on the Practical Energy Management Training Center (Follow-up)” (2008−2010).

In this way, JICA supported energy conservation in Thailand in terms of the establishment of the Energy Conservation Promotion Act, the promotion of systems relevant to this law, and human resource development.

b-1 Energy Conservation Promotion Act B.E.2535 (ECP Act)

The Energy Conservation Promotion Act was drafted in 1992 to promote energy conservation measures and investments on factories and buildings. An outline of the Energy Conservation Promotion Act is shown in Table 4.1.1.

Table 4.1.1 Outline of Energy Conservation Promotion Act

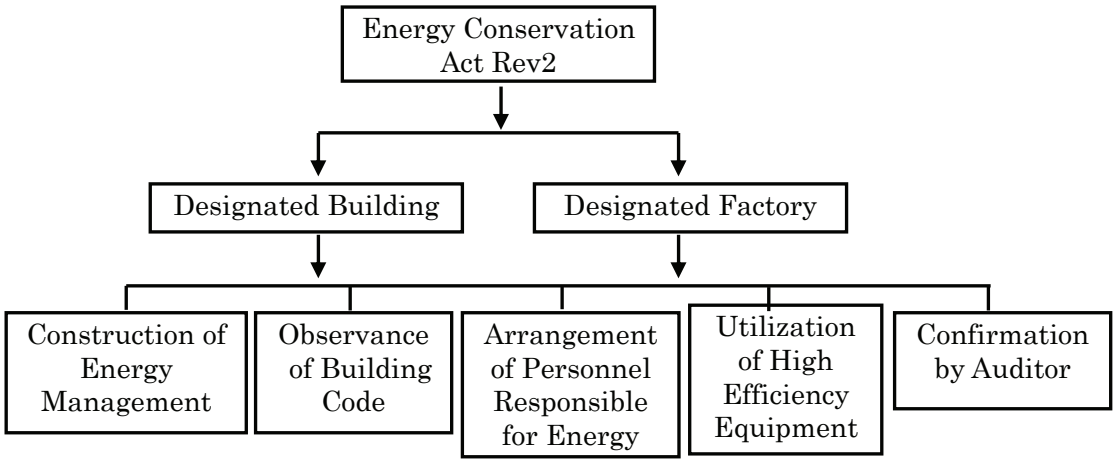
Division	Outline of Contents
Division 1 Energy Conservation in Factories	In the case of exceeding any one standard (Contract Demand・Transformer Capacity・Energy Consumption), the factory is designated a Designated Factory and shall comply with the obligations prescribed in the ECP Act.
Division 2 Energy Conservation in Buildings	In the case of exceeding any one standard (Contract Demand・Transformer Capacity・Energy Consumption), its building is designated a Designated Building and shall comply with the obligations prescribed in the ECP Act.
Division 3 Energy Conservation in Machinery and Equipment, and Promotion of Energy-efficient Materials	The Cabinet shall have the power to designate machinery or equipment as having high efficiency in order to promote the introduction of machinery or equipment that contributes to energy conservation. The Cabinet shall have the power to determine which materials are used in order to promote the use of high-efficiency materials for energy conservation.
Division 4 Fund for Promoting Energy Conservation（ENCON Fund）	Established to promote energy conservation through Grants or Subsidy. The fund shall be used to provide working capital, grants, or subsidies for investment in and operations of energy conservation program, or to cover administrative cost of promotion and educational activities.
Division 5 Measures for Promotion and Assistance	Designated factory・building and producer or distributor of machinery or equipment shall have the right to request exemption from paying surcharges and grants or subsidies from the ENCON fund as measures for promoting and assisting energy conservation. Factories and buildings that are not designated as Designated Factories or Buildings also have the same right related to energy-conservation activities.
Division 6 Surcharges	Designated Factories or Buildings shall pay surcharges for using electricity in the case of failing to comply with targets in Ministerial Regulations.
Division 7 Competent Officers	Competent Officers shall have the power to ask designated factories or Buildings to submit information on Operating Condition and Replacement, etc. of their own equipment in writing and to inspect their actual condition.
Division 8 Appeals	Owners who do not consent to designation as designated factories or buildings or to surcharges mentioned in Division 6 may appeal to the Minister within thirty days of the date of having been informed.
Division 9 Punishments	In case designated factories or buildings submit false information or do not arrange PRE or fail to comply with the targets in Ministerial Regulations, etc., the owners shall be punished with imprisonment or fine, etc.

Source：Created by the study team on the basis of SERT’s response

The main purpose of this Energy Conservation Promotion Act is to promote energy conservation in designated factories or buildings. The detailed regulations in this Act are as follows.
The aforementioned designated factories or buildings fall under the following items and the owners have the duties shown in Fig. 4.1.2.

Designated Factory・Building

① Building or Factory of over 1,000 kW in contract demand
② Building or Factory of over 1,175 kVA in total capacity of installed transformers
③ Building or Factory of over 20 million MJ in annual consumption



Source: King Mongkut's Institute of Technology Thonburi (KMUTT)

Fig. 4.1.2 Outline of Energy Conservation Promotion Act

Table 4.1.2 Obligations Under Energy Conservation Promotion Act

Category	Content
Construction of Energy Management Organization	Construction of Organization for Managing Energy Consumption in Designated Building・Factory. This organization shall have the duty to keep records on energy consumption, introduction and replacement of equipment, to set targets and plans for energy-conservation activities, and to submit them to DEDE (every three years), etc.
Observance of Building Code	New Buildings and Existing Buildings have the duty to comply with the Building Code at the design stage of introducing equipment. The New Building Code focuses only on New Buildings.
Arrangement of Personnel Responsible for Energy (PRE)	Designated Building and Designated Factory have the duty to arrange PRE with official qualification and to carry out energy-conservation activities promptly.
Utilization of High Efficiency Equipment	Designated Building and Designated Factory have the duty to use energy-efficient machinery and equipment.
Confirmation by Auditor	Designated Building and Designated Factory have the duty to set targets and plans for energy-conservation activities and to submit them to DEDE, as well as to have them certified by an Auditor before submitting them to DEDE.

Source: King Mongkut's Institute of Technology Thonburi (KMUTT)

In the case of failing to comply with the obligations in Table 4.1.2, the following punishments are imposed.

Punishment

① Any owner of designated factory or building who submits false information shall be imprisoned for a period not exceeding three months or shall be fined an amount not exceeding THB 150,000, or both.

② Any owner of designated factory or building who fails to comply with the targets of Ministerial Regulations shall be fined an amount not exceeding THB 50,000.

③ Any owner of designated factory or building who does not arrange PRE shall be fined an amount not exceeding THB 200,000

In the past, one PRE was required to be appointed as designated buildings and factories according to the Energy Conservation Promotion Act. At present, Advanced PRE is also required to be appointed

depending on the amount of energy consumed under the Energy Conservation Promotion Act Rev2 (ECP Rev2), which was enforced in January 2008 as shown in Table 4.1.3.

Certification of Advanced PRE can be obtained by passing a test administered by DEDE or by attending lectures.

Table 4.1.3 Appointment Rules for PRE

	Classification	
	Past	Present
Transformer Capacity	1,175 kVA～3,530 kVA	Over 3,530 kVA
Contract Demand	1,000 kW～3,000 kW	Over 3,000 kW
Annual Energy Consumption	2o million MJ～60 million MJ	Over 60 million MJ
Conditions for PRE	More than 1 PRE	More than 2 PRE including Advanced PRE

Source：King Mongkut's Institute of Technology Thonburi

b-2 Institutional Plan for Promoting Energy Conservation

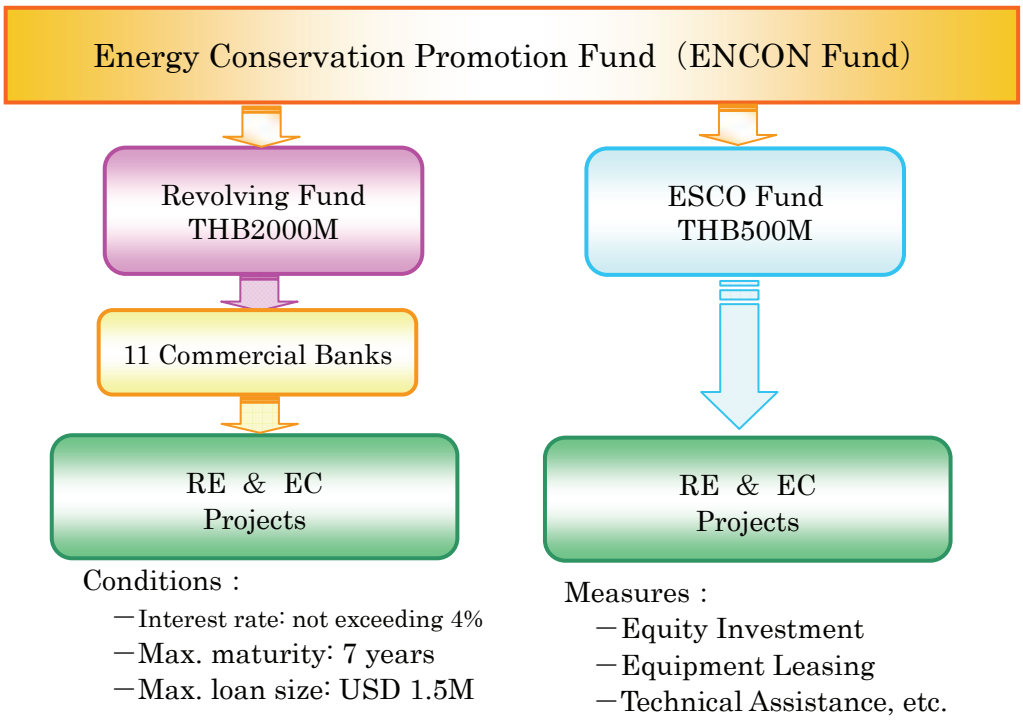
To promote and encourage the provisions of the Energy Conservation Promotion Act, the Government of Thailand is planning to promote energy conservation through the following ministerial ordinances, etc.

(1) Energy Conservation Promotion Fund (ENCON Fund)

The ENCON Fund described below is funded mainly from the Petroleum Fund, and was established for promoting energy conservation and disseminating renewable energy.

- Funds are transferred from the Petroleum Fund in the amount determined by the Prime Minister.
- Remittances are made from petroleum producers and importers at rates prescribed by the National Energy Policy Council.
- Surcharges for using electricity (collected from designated factories/buildings that violate or fail to comply with Ministerial Regulations).
- Subsidies from the Government at times considered appropriate.
- Funds or property received from the private sector, both local and foreign, including interest and other benefits received by this Fund.

The ENCON Fund mainly comprises ESCO Fund and Revolving Fund. The features of ESCO Fund and Revolving Fund are as follows.



Source：PEER REVIEW ON ENERGY EFFICIENCY IN THAILAND Final Report 18 March, 2010

Fig. 4.1.3　Scheme Concept of Revolving Fund & ESCO Fund

Table 4.1.4　Features of Revolving Fund and ESCO Fund

	Advantages	Disadvantages
Revolving Fund	・11 banks available ・Low interest rate possible	・Relatively small loan amount ・Strong credibility needed
ESCO Fund	・No financial expenses such as interest payments at the initial stage ・Other services available, such as technical assistance or so	・Only two implementers ・Various equity holding limits

Source: created by the study team

(2) Revolving Fund

This is provided to stimulate and expedite energy efficiency investments on large-scale factories and buildings. The characteristics of this fund, which is administered by DEDE, are as follows.

◆ The first phase of the fund was launched in January 2003 with a loan amount of THB 2,000 million (approx, USD 60 million) allocated from the ENCON Fund, and has continuously been supported through 2nd to 4th phase with a total loan amounting to THB 5,342.5 million as shown below.

Table 4.1.5 Track Record of Revolving Fund

Phase	Period	Budget (million THB)	# of Project	Approved Amount (million THB)
EC Phase 1	Jan 2003 - Jan 2006	2,000	78	1,902
EC Phase 2	Mar 2006 - Mar 2009	2,000	85	1,805
EC Phase 3	Aug 2007 - Aug 2010	1,942.5	104	2,861
RE Phase 1		1,000		
EC Phase 4	Sep 2009 - Sep 2012	400	9	300
Total		7,342.5	276	6,868

- DEDE provides low-interest loans and seven years final maturity to local commercial banks as an incentive to encourage the banks to lend to RE/EC projects, including ESCO companies at a maximum interest rate of 4%.
- The maximum loan size is THB 50 million (USD 1.5 million).
- The bank manages all aspects of loans and reports project status to DEDE.
- DEDE ensures projects are genuine energy conservation projects, not simply equipment replacements.
- DEDE monitors the performance of banks to ensure they meet their targets in terms of the projects, lending, and repayment.
- DEDE evaluates the program to measure energy conservation.

Because the direct lender is a commercial bank, the evaluation criteria are the same as a normal commercial loan, such as presentation of financial plan or collateral. However, the energy conservation technology proposed by the developer is evaluated by an educational agency hired by DEDE. Although it varies from project to project, the evaluation period needed from submission of application to approval is three months for an energy conservation project and six months for renewable energy on average.

Currently, 11 commercial banks are participating in the Revolving Fund. Approximately 280 projects have been approved so far and almost all funding has been borrowed. On the other hand, it was decided that the loan amount for the Revolving Fund will be 500 million THB from the next phase.

(3) ESCO Fund

The ESCO Fund was established in October 2008 to help Small and Medium Enterprises (SMEs) to carry out renewable energy and energy conservation projects, and is administered by DEDE. There are two fund managers: EFE and ECFT. So far, the ESCO Fund has passed the 1st phase of the term which is October 2008 to September 2010 and the 2nd phase of the term from October 2010 to September 2012 is uncertain. Although its main scheme is based on equity investment, the ESCO Fund provides several services such as equipment leasing and technical assistance and so on.

Although it varies from project to project, the duration from submission of application to approval is three months for an energy conservation project and six months for a renewable energy on average. The evaluation criteria are: 1) neighbors' consent, 2) profitability, 3) technology, 4) management skills and experience, and 5) fuel supply in case of biomass or biogas project. Especially for the ESCO Fund, 4) management skills and experience are prioritized. The result of the evaluation is submitted to the Investment Committee, where the project is finally approved for support from the ESCO Fund.

The ESCO Fund has approved 26 RE/EC projects, totaling 367 million THB or 11.12 million USD. The breakdown of the approved projects is shown in Table 4.1.6.

Table 4.1.6 Track Record of ESCO Fund

Area	Type	Fund Manager		Total
		E for E	ECFT	
Renewable Energy	Equity Investment (Carbon Credit)	9 (Biomass, Solar Farm)	5 (Biomass, Biogas)	14
Energy Conservation	Equity Investment	-	2 (Fuel Conversion, ESCO)	2
	Equipment Leasing	6 (Chiller, Solar Water Heating)	4 (Variable Speed Motor, Voltage Regulator etc)	10
Total		15	11	26

Source: Created by the study team

＜EFE＞

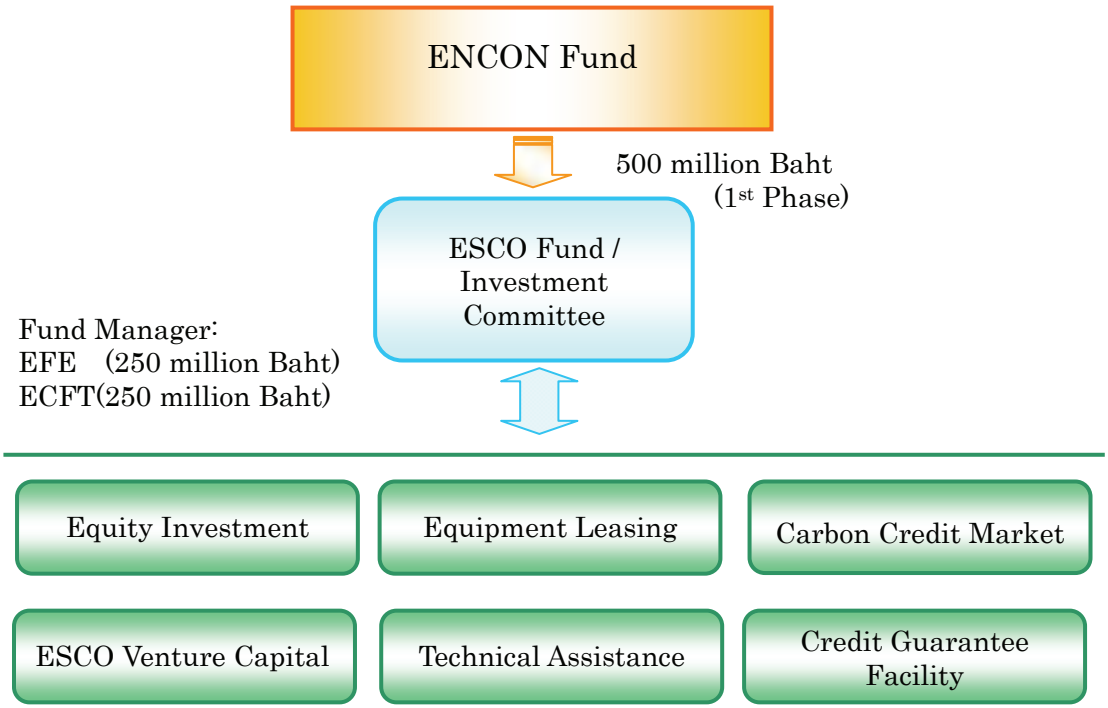
EFE is a non-profit organization founded on June 15, 2000. Its activities are to promote and develop renewable energy projects, which are beneficial to the environment, and also to disseminate the latest innovations in renewable energy and energy efficiency. Since its establishment, EFE has been involved in renewable energy, not only commercial but also community projects, especially in remote areas, and has conducted electrification projects in remote areas with renewable energy to improve the quality of life. EFE has been consulted by government organizations in the energy sector, providing suggestions and recommendations, to build private-sector confidence for more investment in renewable energy. Concerning the ESCO Fund, EFE was appointed as one of the fund managers of the ESCO Fund by DEDE.

＜ECFT＞

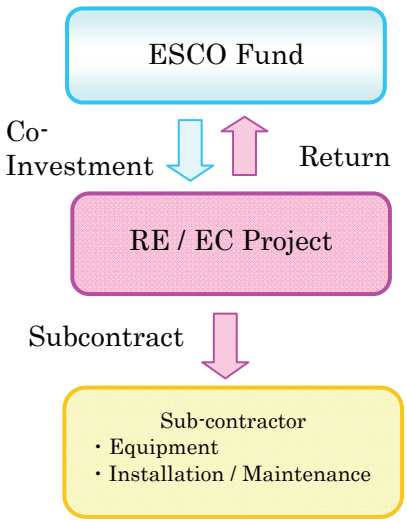
ECFT is a non-profit organization founded to invest the ESCO Fund. Like EFE, its activities are to promote and develop renewable energy projects, which are beneficial to the environment, and also to disseminate the latest innovations in renewable energy and energy efficiency. But, priority is given to, but not limited to, Energy Service Companies (ESCO). ECFT supports

projects in biomass, biogas, carbon neutral fuels, energy efficiency, and other renewable energy technologies, and also assists small enterprises with carbon credit trading. ECFT was also appointed as one of the fund managers for the ESCO Fund by DEDE.

＜ESCO Fund＞

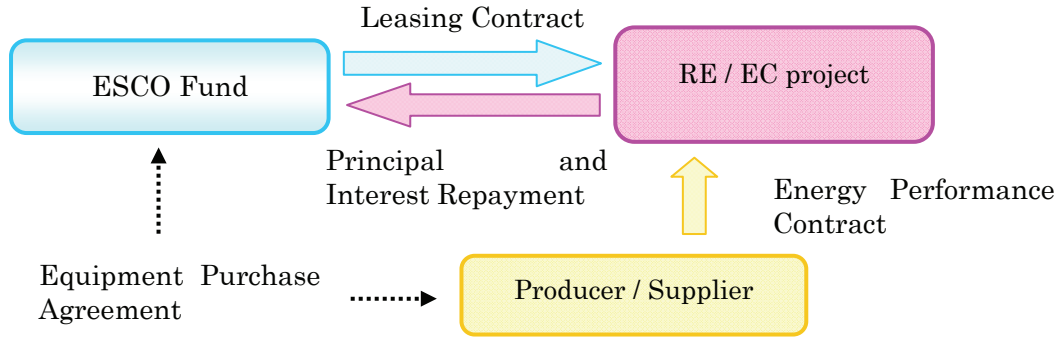


＜Equity Investment＞



- 10-50% of investment cost, but limited to 50 million THB
- Investment period of 5-7 years or until owner is ready to buy back the shares, find a new strategic partner, or list on SET/Mai, but is limited to 7 years
- Exit price is market price

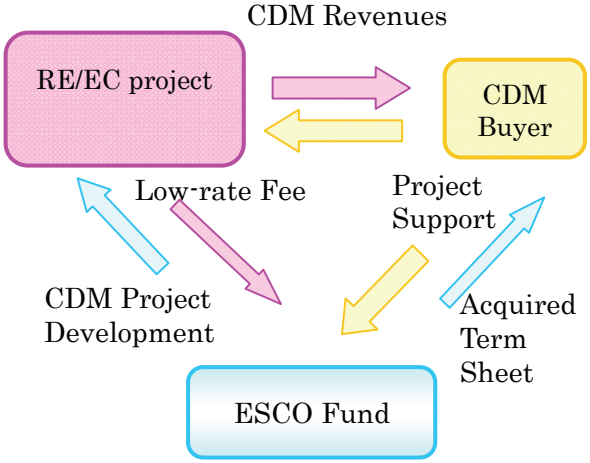
＜Equipment Leasing＞



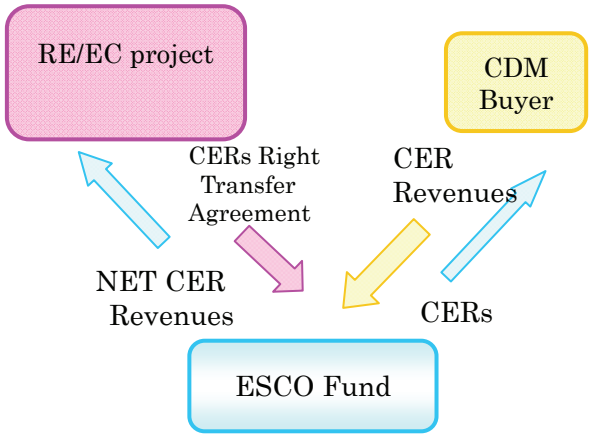
- 100% of equipment cost but limited to 10 million THB
- Repayment within 5 years
- Interest rate at 4% pa

＜Carbon Credit Market＞

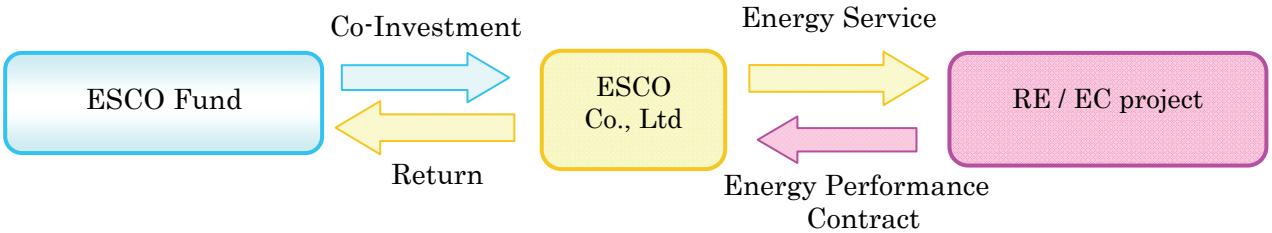
For a large project, the fund manager will facilitate project owners to develop CDM and access CER buyer at lower service rate



For a small project, the fund manager will act as coordinating and managing entity (CME) developing programmatic CDM

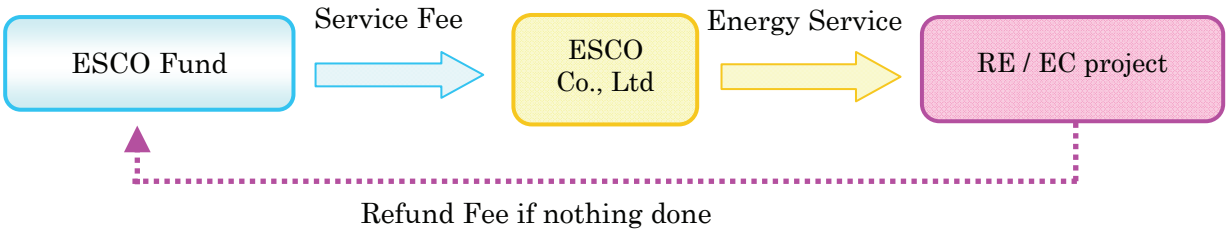


＜ESCO Venture Capita＞



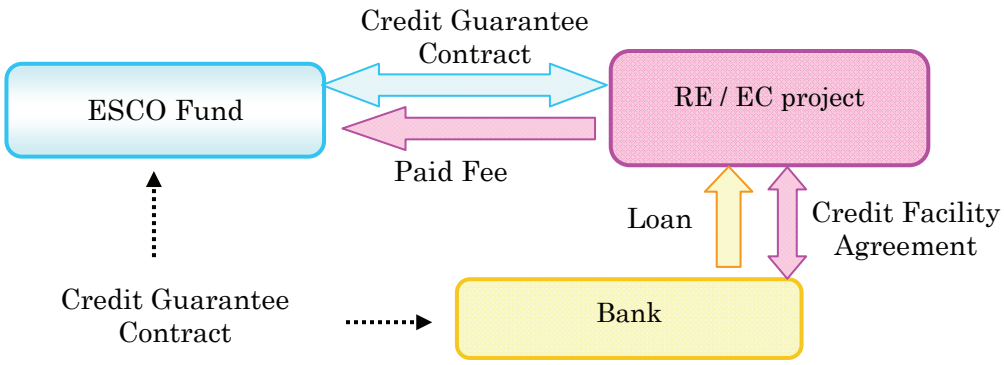
- Venture with energy service companies (ESCO) 10-30% of registered capital, but limited to 50 million THB
- Investment period of 5-7 years or until owner is ready to buy back shares or find a new strategic partner, but is limited to 5 years
- Exit price is market price

＜**Technical Assistance**＞



- ESCO Fund provides technical assistance to encourage energy-efficient projects by paying energy audit fee, but total is limited to 100,000 THB per project
- The fee must be reimbursed to ESCO Fund if the recommended energy conservation measures are not implemented

＜**Credit Guarantee Facility**＞



- ESCO Fund guarantees loans by commercial bank to project owner, but this is limited to 10 million THB
- Project owner pays fee to guarantor at 1.75% pa. of guarantee amount
- Loan guarantee amount is not more than 5 years

(4) Promoting Investment for Energy Conservation Activities

Based on the Investment Promotion Act, BOI selects the categories of business for investment promotion and encourages investors by giving tax benefits and other advantages. The ESCO Business was designated a special, significant business on 20th December, 2004. The ESCO Business can receive benefits including tax exemption for imports of energy conservation machinery and corporation tax for eight years, regardless of the construction zone. The installer of high efficient machinery or equipment of renewable energy will get the same benefit as the ESCO business.

(5) DSM Biddings (DSM by Bidding Mechanism)

The DSM Biddings, implemented in 2008 to provide financial support to encourage businesses to invest in high energy-efficient machinery/equipment, is monitored by EPPO. A subsidy is granted based on actual energy savings achieved in one year resulting from such investment (subsidy = annual energy saving x subsidy rate) (cf. Table 4.1.7). The maximum subsidy is set for each energy type as shown in Table 4.1.7. With a bidding mechanism, proposals with a lower weighted subsidy are subsidized first. The subsidy is provided in three steps: 1) 10% - when proposal is approved, 2) 40% - when construction or modification is completed, and 3) 50% - when proposed performance is confirmed. A university team nominated by EPPO verifies all three steps. The source of the subsidy is the ENCON Fund.

There have been six DSM biddings. As DSM biddings are conducted, recognition increases and the number of proposals and approvals also increases. According to "EPPO opens new DSM biddings with 600 m Baht injected into Rounds 7-8" (cf. Table 4.1.8) published by EPPO, only the 7th and 8th DSM biddings are opening. The proposal submission dates of the 7th and 8th DSM biddings are on 15 February, 2010, and 18 May, 2010, respectively. With a budget of 600 million THB, DSM biddings cover state enterprises and universities as well as private companies, unlike past biddings.

Table 4.1.7 Subsidies and DSM Biddings

Energy Type	Maximum Subsidy
Electricity	THB 1 /kWh
Heat from liquid and gas fuels e.g.: fuel oil, LPG, natural gas, etc	THB 75 /MM Btu
Heat from solid fuels e.g. : coal, wood, rice husks, sawdust, bagasses and other agriculture waste	THB 15 /MM Btu

Source：Peer Review on Energy Efficiency in Thailand, Final Report 18 March, 2010

Table 4.1.8 Results of DSM Biddings

Round No.	Proposal Submission Date	No. of Proposal Submission	No. of Approved Proposals	No. of Withdrawn Proposals	No. of Proposals with Contract Signed	Investment Capital (Baht)	Expected Energy Saving		Maximum Subsidy (Baht)
							Heat (MMBTU/yr)	Electricity (kWh/yr)	
1	20-Dec-07	8	8	-	8	179,585,403.00	662,750.53	5,379,969.00	25,139,102.50
2	10-Apr-08	10	8	-	8	352,207,380.00	174,453.84	26,870,431.80	33,760,534.60
3	21-Jul-08	60	51	16	35	479,061,451.50	197,242.30	70,320,388.63	71,911,298.03
4	29-Apr-09	31	30	3	27	123,272,864.15	128,910.94	20,094,802.02	27,029,271.49
5	24-Jun-09	17	16	4	12	479,585,327.52	422,564.13	22,429,663.86	28,641,932.18
6	26-Aug-09	80	77	15	62	1,074,486,737.00	836,429.64	79,553,551.20	122,524,119.07
Total		206	**190**	**38**	**152**	**2,685,622,642.17**	**2,422,351.38**	**224,648,806.50**	**309,006,257.88**

Source：EPPO opens new DSM biddings with 600 m Baht injected into Rounds 7-8

(6) New Building Code

Based on the Energy Conservation Promotion Act, the existing Building Code regulates building facilities performance criteria for new and existing buildings. However, this New Building Code is applicable only to newly developed buildings and its contents are more stringent than the previous one. Target appliances are building envelopes, lighting systems, and air conditioners. The building facilities performance criteria of each target in this new building code are set for three categories: (a) offices and educational buildings, (b) department stores, retail stores, shopping centers, and hypermarkets, (c) hotels, hospitals/convalescent homes. A new building to be constructed with the total floor area of 10,000m^2 or more must satisfy the building facilities performance criteria in this new building code at its design stage. Table 4.1.9 shows the building facilities performance criteria for lighting systems as an example.

Table 4.1.9 Allowable Rated Power for Lighting.

Category of building	**Allowable rated power (W/m^2. of utilized area)**
(a) Offices and educational buildings	14
(b) Department stores, retail stores, shopping centers and hypermarkets	18
(c) Hotels, hospitals/convalescent homes	12

Source：Created by the study team on the basis of SERT's response

The building facilities performance criteria in this new building code for lighting systems are specified for each of the following three categories: (a) offices and educational buildings, (b) hotels, hospitals/convalescent homes, and (c) department stores, retail stores, shopping centers,

and hypermarkets. For instance, in (a) offices and educational buildings, the rated capacity of lighting facilities per 1 m^2 of used floor area is permitted up to 14W.

b-3 Barriers

As mentioned, various policies and systems have been created in Thailand to disseminate and promote energy conservation in the electric power sector. However, based on the results of this study, the barriers shown in Table 4.1.10 were confirmed. Here, they are classified and evaluated by electric power utilities, private companies, and households.

Table 4.1.10 Assumed Barriers to Energy Conservation Dissemination and Promotion in Electric Power Sector

Category	Contents	Electric Power Utilities	Private Companies	Households
Policy barriers	・ Lack of national policy aims to disseminate energy conservation	Low	Low	Low
	・ Gap between subsidy system and actual market conditions	Low	High	High
Finance barriers	・ Lack of incentives for investment	Low	High	High
	・ Difficulty investing due to high risk	Low	High	High
Information barriers	・ Low consciousness of energy conservation by policy makers and consumers	Low	High	High
	・ Lack of accurate information on energy conservation	Low	High	High
	・ Lack of latest information	Low	High	High
Technical barriers	・ Limited access to latest technology	Low	High	High
	・ Lack of experience of engineers	Low	High	High
Institutional barriers	・ Insufficient reliability of new products and technologies	Low	High	High
	・ Conservative customs and activities	Low	High	High

Source: Created by the study team

Electric Power Utilities

The current activities for energy conservation in Electric Power Utilities were established by the DSM team at an early stage and promote the policy of the Thai government. Accordingly, they conduct the DSM program systematically and there are no barriers in all items.

Private Companies

There are no barriers in the national policy for private companies because the national policy had already been arranged in terms of finance and technology. However, there is a barrier in 「Gap

between subsidy system and actual market conditions」, because the financial measures seem to have the gap with actual conditions such as short-term loan and high interest rates. The initial cost of energy conservation facilities is generally high. Accordingly, investment is not attractive and funding becomes difficult. In addition, the understanding of owners of small and medium-size companies of energy conservation is judged to be low because of a lack of accurate information on energy conservation and a lack of experience of engineers.

Households

In its national policy for households, the Thai government focuses on the labeling system, which was implemented at an early stage, and raising awareness of energy conservation. EGAT handles the labeling system as the main administrator and has already drafted the next plan for a DSM project. The plan intended to enhance the existing labeling system and establish a new labeling system that evaluates standby power. Awareness of energy conservation has been promoted through scheduled visits by neutral agencies such as Bangkok Metropolitan Administration (BMA) and ECFT. Accordingly, the national policy has already been established. Regarding items other than national policy, there have not been positive activities to collect information on energy conservation from households due to the high initial costs of efficient appliances in general and a lack of incentives for households. Therefore, an environment does not exist in which to verify the reliability of a new product or technology. In addition, conservative customs and activities have not been improved.

c Current Energy Conservation Activities in the Power Sector for Electric Power Utilities, Local Governments, Private Companies, and Households

c-1 Electric Power Utilities

(1) EGAT

Electric Power Facilities

EGAT is in charge of energy conservation measures in its electric power facilities (power-generating facilities) as measured by annual load factor and thermal efficiency. The annual load factor is the rate of annual average demand power against annual maximum demand for power. As load factor increases, the efficient utilization of power-generating facilities increases, and the efficient utilization of energy is promoted. Accordingly, as load factor increases, energy conservation is promoted in the operation of power-generating facilities. Table 4.1.11 shows the annual load factor of power-generating facilities of EGAT. The average was approximately 75% in 2007-2008, which is higher than the 60% annual load factor in Japan. In addition, the average trend is 76% to 2030 according to PDP 2010 and it is comparable to the highest European values (E.g., 65% for France and 68% for the UK). Accordingly, energy conservation in EGAT power-generating facilities has been promoted strongly, and energy conservation measures for the power generation facilities are sufficient if the annual load factor is as planned. However, when

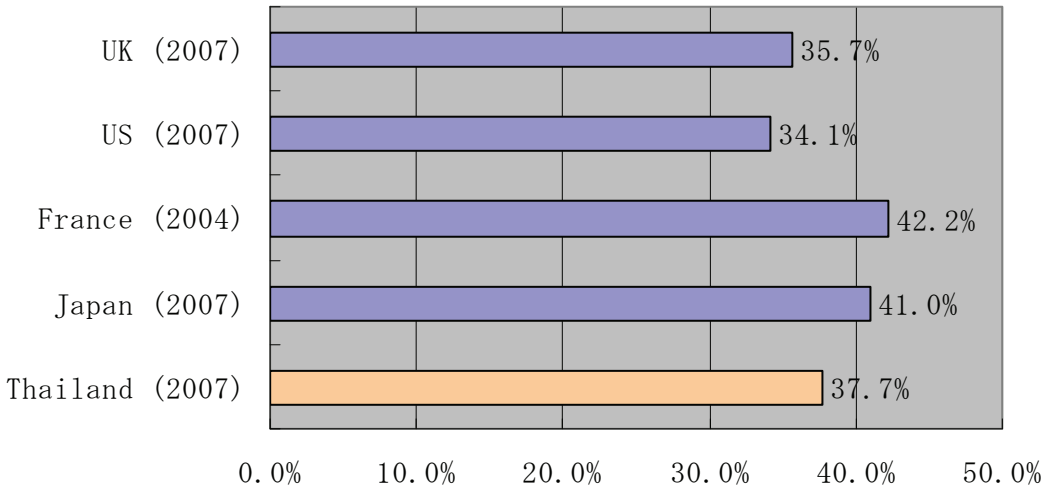
comparing the record in Japan, careful monitoring is required, because economic development can result in significant daytime peaks.

Table 4.1.11 Load Forecasting in EGAT Power Development Plan 2010

Year	Peak			Energy			Load Factor %
	MW	Increase		GWh	Increase		
		MW	%		GWh	%	
Actual : NET Generation							
2007	22,009.20	N/A	N/A	143,740.98	4,940.40	3.56	74.55
2008	22,018.00	8.80	0.04	145,227.50	1,486.52	1.03	75.09
2009	22,044.90	26.90	0.12	145,233.00	5.50	0.00	75.21
Average (2007-2008)	-	-	0.08	-	-	1.53	74.95
Forecast : NET Generation							
2010	22,690	645	2.93	150,454	5,221	3.59	75.69
2011	23,788	1,098	4.84	156,656	6,202	4.12	75.18
2012	24,995	1,207	5.07	163,914	7,258	4.63	74.86
2013	26,111	1,116	4.46	170,712	6,798	4.15	74.63
2014	27,101	990	3.79	177,944	7,232	4.24	74.95
2015	28,081	980	3.62	185,215	7,271	4.09	75.29
2016	29,176	1,095	3.90	193,157	7,942	4.29	75.58
2017	30,453	1,277	4.38	201,761	8,604	4.45	75.63
2018	31,766	1,313	4.31	210,748	8,987	4.45	75.74
2019	32,915	1,149	3.62	219,040	8,292	3.93	75.97
2020	34,102	1,187	3.61	227,853	8,813	4.02	76.27
2021	35,507	1,405	4.12	237,162	9,309	4.09	76.25
2022	36,709	1,202	3.39	245,700	8,538	3.60	76.41
2023	38,058	1,349	3.67	255,143	9,443	3.84	76.53
2024	39,387	1,329	3.49	264,893	9,750	3.82	76.77
2025	40,974	1,587	4.03	275,021	10,128	3.82	76.62
2026	42,498	1,524	3.72	285,586	10,565	3.84	76.71
2027	44,077	1,579	3.72	296,552	10,966	3.84	76.80
2028	45,625	1,548	3.51	307,932	11,380	3.84	77.05
2029	47,393	1,768	3.88	319,734	11,802	3.83	77.01
2030	49,172	1,779	3.75	332,068	12,334	3.86	77.09
Average (2010-2030)	-	-	3.90	-	-	4.02	76.05

Source : EGAT

Thermal efficiency in a thermal power plant is a measure of the efficiency of converting the calorific value of a fuel into electric power. It is an index of the efficiency of a thermal power plant. Fig. 4.1.4 shows thermal efficiencies in Thailand and developed countries. The value of 37.7% for Thailand is comparable with other countries. Accordingly, energy conservation measures in power-generating facilities have already been promoted well. The reason for high thermal efficiency in Thailand is that combined cycle accounts for more than 50% of supplies.



Source：Thailand「Electric Power in Thailand 2008」, Others「Hand Book of Electric Power Industry 2009」

Fig. 4.1.4　Thermal Efficiency by Country

Energy Conservation

＜Philosophy＞

Current energy conservation activities of EGAT began with the DSM project started in 1993, financed by the Thai government (about ¥35 billion), a grant from Global Environment Facility (GEF) by the World Bank (about ¥17 billion), which included a grant from the Australian government, and international yen loan from Japan (about ¥14 billion). Its primary objective was to enhance the supply capacity of the Thai energy sector and relevant private corporations for energy conservation products and services by assisting the energy demand control in Thailand, thereby contributing to the promotion of energy conservation, a reduction in greenhouse gas and air pollution, a deceleration in power generation facilities augmentation, and economic welfare. EGAT evaluates that this DSM project can reduce GHG emissions from power generation and costs more than the DSM program. Therefore, EGAT is promoting the DSM project aggressively. The EGAT philosophy for DSM comprises the following four items.

- Same or better customer's benefit on electricity use but less consumption
- Efficiency increases with affordable prices
- Voluntary cooperation of manufacturers & importers (Labeling Program)
- Win-Win solution (Manufacturers/Customers/Nation)

＜Contents＞

EGAT has conducted several projects: Thin Tube Program to transform the market, Labeling Program for households, Green Learning Rooms for students to promote educational activities for energy conservation, etc. DSM projects EGAT has conducted are shown in Table 4.1.12.

Table 4.1.12 Outline of DSM Projects of EGAT

Category	Content	Current Situation
●Market Transformation		
①Thin Tube Program	Stop producing T12 and switch to T8	Completed in 1995
②Appliance Efficiency Labeling Program	Introduction of labeling program targeting electric appliances	Ongoing
●Public-Private Sector Partnership		
①Energy Audit	Implementation of energy conservation audit・consultancy service・financial services targeting commercial buildings・factories	Completed governmental energy conservation measures
●Attitude Creation		
①Green Learning Rooms	Implementation of education for energy conservation targeting 420 elementary and junior high schools in 76 Provinces	Ongoing
②Use of Mass Media	Educational activities for energy conservation through mass media (TV・newspapers, etc.)	Ongoing
●Municipal Street Lighting	Introduction of more than 270,000 street lamps	Completed
●Incandescent Phase-out scheme-CFL (2007-2010)	Giving away 800,000 CFLs using ENCON fund and EGAT budget, and selling low-priced CFLs with one-year warranty through more than 4,000 convenience stores	Ongoing
●Promoting Use of New Thinner Tube (T5) (2009-2014) Target of 83 million lamps within 5 years	Replacing T8 with T5 targeting commercial & industrial sectors using ENCON fund and public funds	Ongoing

Source: EGAT

＜**Evaluation**＞

To formulate the EGAT Demand Side Management Master Plan (2010-2014), EGAT evaluated the accumulated energy conservation effectiveness of the DSM program from 1993 to December 2009, showing a reduction of peak demand of approximately 1,800 MW and a reduction of electric energy of approximately 10,000 GWh. EGAT concluded that the DSM project has had a big impact. EGAT picked up the following qualitative evaluations of DSM program outcomes.

- Achieved GHG reduction during the period from 1993-2000 exceeding conservation targets.
- EGAT DSM programs are widely recognized worldwide for their innovations such as voluntary labeling programs and Green Learning Room.
- EGAT DSM programs clearly demonstrate that substantial electricity conservation can be achieved.
- Performance standards of electric appliances can be promoted in the market.

＜**Key Points**＞

EGAT announced the following four key points learned from the DSM program.

- DSM program should be designed to suit local cultural realities to ensure high acceptance and participation.
- Supportive government policies and financing mechanism are necessary for the success and the sustainability of DSM program.
- Labeling program is a voluntary system and the first step to educate consumers on energy performance of appliances.
- In many cases, distribution utilities such as MEA and PEA may be more appropriate agencies for the DSM program.

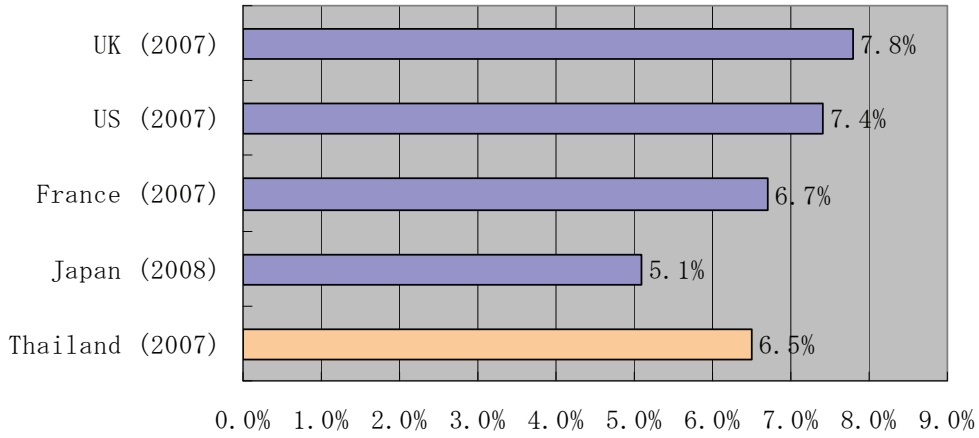
(2) MEA & PEA

MEA and PEA are in charge of distribution facilities in the electric power sector in Thailand, and their territories are divided by area supplied.

Distribution Facilities

Energy conservation measures in electric power facilities (distribution facilities) in MEA and PEA can be understood by referring to the loss rate of the transmission and distribution network. Losses in the transmission and distribution network mean the electricity lost in the transmission and distribution network. The rate of loss is the quantity of electricity lost between the point of generation and the customer. As losses in the transmission and distribution network decrease, the efficient utilization of power generation facilities increases. Fig. 4.1.5 shows losses in the transmission and distribution network in Thailand of 6.5% in 2007, which are higher than in Japan; however, they are comparable to other developed countries. Accordingly, energy conservation measures in distribution facilities in Thailand have already been promoted. In addition, based on an interview survey with MEA, the loss rate of distribution facilities in the center of Bangkok is approximately 3.5%

because conversion to a high-voltage system from 12 kV to 24 kV has been conducted systematically since the 1990s and low-loss transformers have been introduced since 2002. Therefore, energy conservation measures have been promoted strongly in MEA distribution facilities.



Source：Japan「Hand Book of Electric Power Industry 2009」Others「Overseas Electric Power Industry Statistics 2009」

Fig. 4.1.5 Loss Rates of Transmission and Distribution Networks by Country

Energy Conservation

＜MEA＞

MEA also created its own DSM plan (2009-2011) and is now implementing following eight projects. MEA is making positive efforts for energy conservation since mitigating a rapid increase in electricity demand in its service areas enables MEA to effectively utilize facilities it possesses.

- Air conditioner cleaning

(Outline) It is implemented from the viewpoint of CSR and its targets are households in MEA territory. Although it costs approximately 500 Baht when executed by private companies, MEA provides this service for approximately 300 Baht.

(Target) 15,000 air conditioners in households in the MEA territory.

(Progress) Approximately 50%（As of June 2010）

- Campaign for energy conservation and safe electricity use for customers in housing development

(Outline) It is implemented from the viewpoint of CSR and its targets are households in MEA territory. One campaign is executed in each village. The contents of the campaign are the follows.

  - ✓ Turn off lights that are not needed.
  - ✓ Do not use electricity near water, etc.

(Target) 54 villages/year

(Progress) Approximately 20%（As of June 2010）

- Pilot project for energy conservation in MEA's head office using BEMS technology

(Outline) This project introduces a BEMS system, which can manage all air-conditioning and lighting facilities, etc. in MEA's head office.

(Target) MEA's head office

(Progress) Approximately 80% of facilities have already been introduced and introduction will be completed by the end of July. After introduction, the effects of BEMS will be verified during the remaining period.

- Energy conservation for designed building (commercial and factory buildings)

(Outline) The targets of this project are two facilities (MEA designated building and customer's designated factory). An energy conservation audit is conducted on the MEA building by MEA staff, who propose plans to improve equipment operation and to replace equipment, etc. continuously. In the customer's factory, MEA staff also conduct energy conservation audits free of charge and also propose plans to improve equipment operation and replace equipment, etc. If the customer adopts the proposals of MEA, MEA will move on to the next project.

(Target) MEA designated buildings and customer's designated factory in MEA territory.

- Building energy performance standard

(Outline) The purpose of this standard is to set a performance standard for total energy consumption in a target building for a certain period. Optimum energy consumption is classified by scale and use of target building, etc.
(New Building Code is applied as the mandatory standard when designing.)

(Target) Commercial buildings in MEA territory including MEA own buildings (mainly, office buildings, hospitals, and department stores).

(Progress) Although negotiations on the specific number have not yet been completed, progress is approximately 80% and this activity is being conducted aiming at completion by the end of this year.

- Study for the appropriate load factor of commercial and factory buildings

(Outline) The study investigates and analyzes energy consumption and usage conditions, etc. in target facilities for the abovementioned building energy performance standard.

- Customer relations for DSM projects

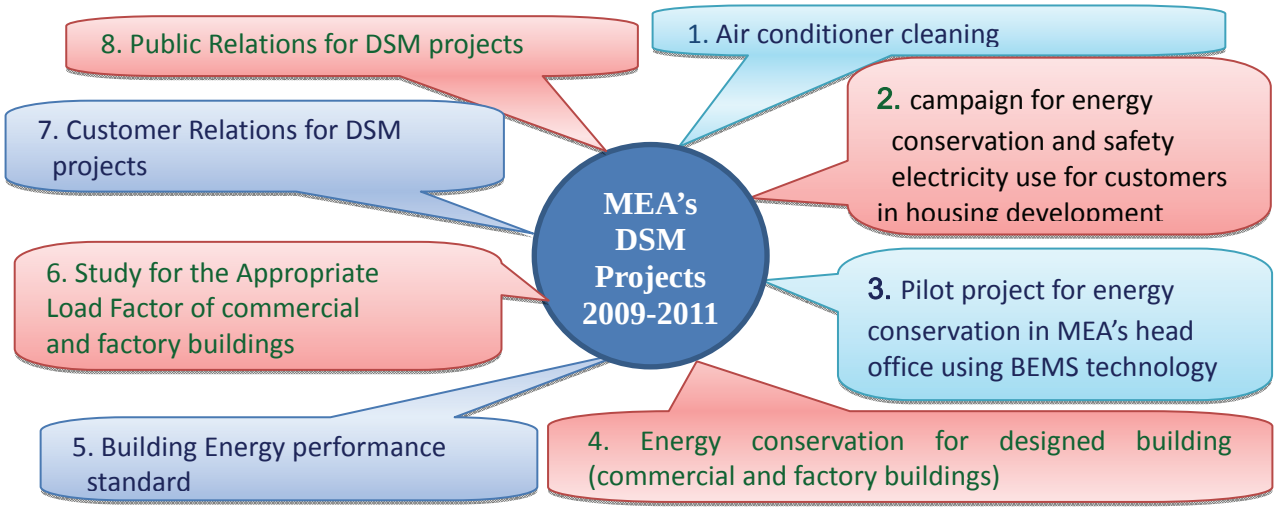
(Outline) Educational activities for customers through seminars on energy conservation.

(Budget) 0.2 million Baht/year

- Public relations for DSM projects

(Outline) Educational activities for customers through the mass media (television, newspapers, and outdoor advertising, etc.).

(Budget) 8 million Baht/year



Source：MEA

Fig. 4.1.6　MEA's DSM Projects 2009-2011

＜PEA＞

PEA also made its own DSM plan (2009-2013) and is implementing the following six projects. Just like MEA, PEA is making positive efforts for energy conservation since mitigating a rapid increase in electricity demand in its service areas enables PEA to effectively utilize facilities it possesses.

I. Public and street lighting

Target：At least 300 GWh reduction (2009-2013)

- Introduction of Energy Conservation Devices for High Mast and High Intensity Discharge (HID) Project

  Quantity　　：500,000 lamps
  Investment cost　：THB 2,360 million
  Project duration　：3 years (2009-2011)

High mast in tourist area

Lighting system along main road

- Introduction of High Efficient Fluorescent Lamps, Reflectors, and Ballasts

  Quantity　　：500,000 lamps
  Investment cost　：THB 525 million
  Project duration　：4 years (2010-2013)

Street Light

Reflector

II. PEA office buildings

Target：At least 15 GWh reduction (2009-2013)

- Increase the Efficiency of Air Conditioner System Project

  Target facility ：PEA Head Office, 12PEA administration areas

  Quantity ：10,000 sets

  Investment cost ：THB 120 million

  Project duration ：4 years (2010-2013)

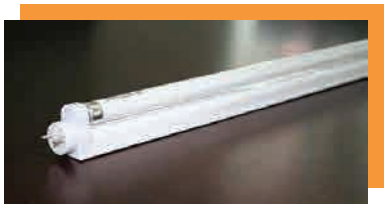
- Increase the Efficiency of Lighting System Project (T8→T5）

  Target facility ：PEA Head Office, 12PEA administration areas

  Quantity ：200,000 lamps

  Investment cost ：THB 75 million

  Project duration ：3 years (2009-2011)



High-efficiency Fluorescent Lamps（T5）

III. PEA Customer

Target：At least 300 facilities (2009-2013)

- Provision of consultancy services in energy management to customers in business and industrial sector projects

  Target Quantity ：200 facilities

  Investment cost ：THB 20 million

  Project duration ：5 years (2009-2013)

Consultancy Services for Business Facility

- Provision of consultancy services in energy management to government sectors and local administrative organizations
  Target Quantity ：100 facilities
  Investment cost ：THB 10 million
  Project duration ：5 years (2009-2013)

・Project supported by ADB

The project supported by ADB differs from PEA's own DSM projects

The contents supported by ADB provide technical assistance for energy-conservation activities in municipalities in the PEA territory. ADB supports two activities: ((i) Retrofitting municipal buildings, (ii) Upgrading public street lighting) by providing consultants in cooperation with PEA. The reasons why ABD and PEA decided to support these activities are as follows. Concerning (i), the municipality had been asking PEA to conduct energy conservation measures to reduce energy consumption in municipal buildings for a long time. Concerning (ii), PEA can reduce the cost of Energy Saving Technologies for Public and Street Lighting System which PEA is conducting.

Specifically, two international consultants and six to eight domestic consultants were provided by ADB as key persons for this project. They selected six municipalities for the project based on the criteria, and evaluated the cooperative structure of the municipality and the effects of this project, etc. After selection, a walk-through investigation in each targeted municipality was conducted as a pre-audit and target facilities were decided. Concretely, municipal buildings, schools, and hospitals, etc. were the specific targets. However, these vary by municipality.

＜Outline of Project＞

・Cost：Total Cost USD 1,450,000
USD 1,000,000 provided from Multi-Donor Clean Energy Fund under Clean Energy Financing Partnership Facility as Grant and remaining USD 450,000 provided by Thailand Government as a loan.

・Period：March 2009 ～ February 2011（2 years）
March 2009 ～February 2010 Selection of target municipality & facility, selection & design of pilot project
March 2010 ～ September 2010 Implementation of pilot project, evaluation of data collected
October 2010 ～ February 2011 Holding Workshops

Electricity Tariff

MEA and PEA introduced the following electricity tariffs to promote reduced electricity consumption by customers.

- Time of Use (TOU) and Time of Day (TOD)

  Electricity tariffs in Thailand are classified by user/use (households, small･medium-size･large customer, government･NPO, Irrigation). TOU covers all classes, and TOD is designed for large consumers.

  TOU promotes peak shifting from daytime to nighttime with less electric power demand by making the energy charge for nighttime (22:00～9:00) less expensive than the daytime energy charge (9:00～22:00). Peak mitigation is thus implemented by using the electricity tariff.

  How electricity charge is calculated under TOU is shown below.

Table 4.1.13 Electricity Tariff in Thailand
(TOU Large General Service)

Demand charge[Baht/kW]		132.93
Service charge[Baht/Month]		228.17
Energy charge[Baht/kWh]	Daytime	2.6950
	Nighttime	1.1914

Source: Created by the Study Team

Let
a: Demand charge [Baht/kW]
b: Service charge [Baht/Month]
c: Daytime energy charge [Baht/kWh]
d: Nighttime energy charge [Baht/kWh]
e: Maximum demand [kW]
f: Daytime electricity consumption [kWh]
g: Nighttime electricity consumption [kWh].
Electricity charge per month is calculated as follows.
Electricity charge = $a \times e + c \times f + d \times g + b$

On the other hand, TOD can be selected by a large consumer and changes demand charge according to time zone, while TOU changes energy charge by time of day. The demand charge in the evening (18:30～21:30), when electric power consumption in households increases, is set higher, and the daytime demand charge (8:00～18:30) is set lower. There is no demand charge during nighttime (21:30～8:00). Demand charge is calculated on the basis of maximum demand during the evening hours, and the daytime demand charge reflects the difference in maximum demand between daytime and evening hours. Since

demand charge is more expensive during the evening and less expensive during daytime, consumers can curb electricity charges by suppressing electricity demand during the evening hours. This makes it possible to shift power demand during the evening period to other periods. Most large consumers, however, now select TOU, and there are few who select TOD.

How electricity charge is calculated under TOD is shown below.

Table 4.1.14 Electricity Tariff in Thailand
(TOD Large General Service)

Demand Charge [Baht/kW]	Evening hours	285.05
	Daytime hours	58.88
	Nighttime hours	0
Energy Charge [Baht/kWh]		1.7034

Source: Created by the Study Team

Let
a: Evening demand charge [Baht/kW]
b: Daytime demand charge [Baht/Month]
c: Nighttime demand charge [Baht/kWh]
d: Energy charge [Baht/kWh]
e: Maximum demand during evening hours [kW]
f: Maximum demand during daytime hours [kWh]
g: Maximum demand during nightime hours [kWh]
h: Electricity consumption [kWh]

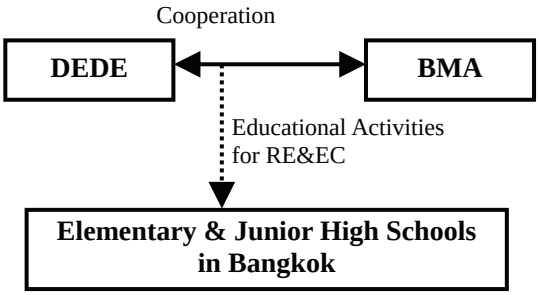
Electricity charge per month is calculated as follows.
Electricity charge = $a \times e + b \times (f - e) + d \times h$

c-2 Local Governments, etc.

(1) BMA

BMA conducts energy-conservation activities in cooperation with central government and electric power utilities. The main activities are as follows.

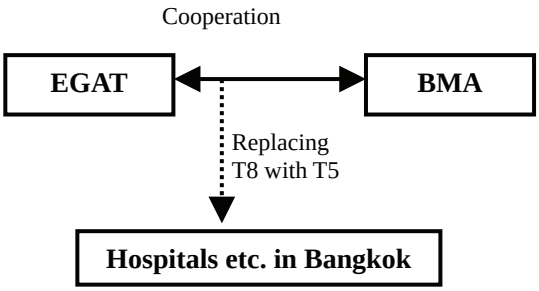
○ Educational activities for renewable energy and energy conservation have been conducted in elementary schools and junior high schools in cooperation with DEDE (800 million Bath).



Source：Created by the study team

Fig. 4.1.7　Outline of Joint Structure between DEDE and BMA

○ Replaced lighting—from T8 to T5 in hospitals, etc.—in Bangkok in cooperation with EGAT.



Source：Created by the study team

Fig. 4.1.8　Outline of Joint Structure Between EGAT and BMA

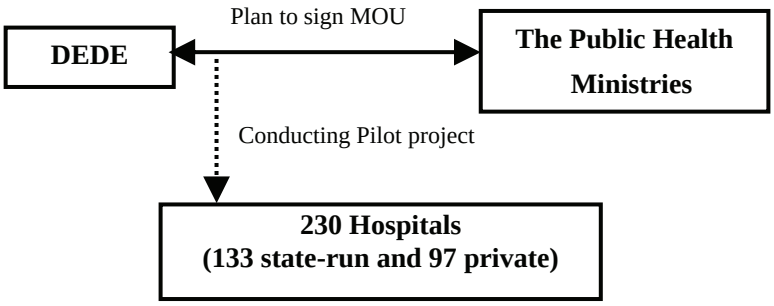
○ The main joint energy-conservation projects with private companies are educational activities such as publication of books and educational activities in schools. BMA is in constant communication with 36 agencies and associations including NGOs, and is supported by some of them according to project content.

(2) Hospitals

DEDE plans to launch a pilot project at 230 hospitals related to energy conservation and sign a MOU for the project with Public Health Ministries. The targets are 230 hospitals (133 state-run and 97 private) among 1,300 hospitals in Thailand.

Overhauling buildings and introducing equipment that contribute to energy conservation in the target hospitals would cost approximately 500 million Baht. However, once the equipment is upgraded, there are expected to be savings of approximately 326 million Baht in combined energy bills (electricity and gas) and 54,000 tones in carbon dioxide emissions a year.

DEDE will provide hospitals that require financial and/or technical support with soft loans and/or technical assistance.



Source：Created by the study team

Fig. 4.1.9　Outline of Joint Structure of Pilot Project for Energy Conservation in Hospitals

c-3 Private Companies

A walk-through investigation was conducted of private companies to consider the current energy-conservation activities and the potential for improving energy efficiency in the private sector. The potential for improving energy efficiency is based on the results of the walk-through investigation.

The targets of the walk-through investigation are lighting systems, air conditioning systems, and water heating systems, which were chosen because they have strong effects on energy conservation and they are likely to be disseminated among private companies. Target facilities are hotels, office buildings, hotels, hospitals, and factories that cooperated with this study. Table 4.1.15 shows the results of the walk-through investigation by facility.

Table 4.1.15　Results of Walk-Through Investigation

Hotel（277 rooms）				
	Lighting Systems	Air-conditioning Systems	Hot water supplying Systems	Other equipment and remarks
Current situation	・High-efficiency fluorescent lamp (T8[40 W/36 W]　CFL) is used. ・Magnetic ballast is used.	・Packaged air conditioner (constant speed system) is used in each room.	・Electric instantaneous water heater is used in each room.	・There is an energy conservation committee in-house, and it works positively on energy conservation.
Improvement plan	・Introduction of energy-conserving fluorescent lamp (T5[40 W/28 W]) and electronic ballast. ・Introduction of LED lamp. ・Introduction of motion sensor.	・Introduction of inverter air conditioner.	・Introduction of heat pump water heater.	
Office building（40,000 m2）				
	Lighting Systems	Air-conditioning Systems	Hot water supplying Systems	Other equipment and remarks
Current situation	・High-efficiency fluorescent lamp (T5[40 W/28 W] CFL) is used. ・The electronic ballast is used. ・Effective use of natural light is implemented.	・Central air-conditioner system with a centrifugal chiller (constant speed system) is used. ・Operation is controlled according to load. ・Heat transportation equipment (pump and fan) has variable speed control using an inverter according to load.	—	・Air conditioner optimizing control uses BAS (Building Automation System) ・Photovoltaic generation is introduced. ・Excellent energy conserving buildings win energy conservation prize.
Improvement plan	・Introduction of LED lamp. ・Introduction of he motion sensor.	・Introduction of inverter chiller. ・Introduction of thermal storage air conditioner system.	—	
Hospital（53,000 m2）				
	Lighting Systems	Air-conditioning Systems	Hot water supplying Systems	Other equipment and remarks
Current situation	・High-efficiency fluorescent lamp (T8[40 W/36 W] CFL) used. ・Magnetic ballast used.	・Central air-conditioner system with centrifugal chiller (constant speed system) used. ・Heat transportation equipment (pump and fan) is adjusted by opening and shutting valve and damper.	・Heat pump water heater used. ・Thermal storage at night is uses nighttime power with cheap tariff.	・Operation management of air conditioner facilities introduce through BAS.
Improvement plan	・Introduction of energy-conserving fluorescent lamp (T5[40 W/28 W]) and electronic ballast. ・Introduction of LED lamp. ・Introduction of motion sensor.	・Introduction of inverter chiller. ・Introduction of inverter to heat transportation equipment.		・Introduction of BEMS.
Factory（87,000 m2）				
	Lighting Systems	Air-conditioning Systems	Hot water supplying Systems	Other equipment and remarks
Current situation	・High-efficiency fluorescent lamp (T8[40 W/36 W] CFL) used. ・Magnetic ballast used. ・Power turned off at lunchtime.	・Packaged air conditioner (constant speed system) used.	—	・High-efficiency brine chiller with ammonia refrigerative (constant speed system) used for freezer. ・Compressor equipment (constant speed system) used.
Improvement plan	・Introduction of energy-conserving fluorescent lamp (T5[40 W/28 W]) and electronic ballast. ・Introduction of LED lamp. ・Introduction of motion sensor.	・Introduction of inverter air conditioner.	—	・Introduction of inverter equipment and controller.

Source：Created by the study team

Lighting System

Every facility of the lighting system has a highly efficient Compact Fluorescent Lamp (CFL) instead of an incandescent lamp as a down-light. In addition, the fluorescent lamp has a highly efficient fluorescent lamp and reflector. Accordingly, energy conserving equipments have already been disseminated.

Air Conditioning System

Only one of four target facilities has introduced an air-conditioning system with an inverter for heat transportation equipment (E.g.; pump and fan, etc.). No facility has introduced an inverter for the chiller. The reason for not introducing the inverter is that the inverter emphasizes initial cost more than life-cycle cost when investing in equipment. When an interview survey was conducted with persons in charge of maintaining equipment, they responded that they did not have any plans to introduce inverters due to the high initial cost, although they could understand their effectiveness for conserving energy.

In private companies, especially commercial facilities, energy consumption of air-conditioning systems accounted for the large share of the total energy consumption. Accordingly, potential energy-conserving effects in a commercial facility can be expected from introducing an inverter to an air-conditioning system. An inverter is introduced when replacing existing equipment with equipment of an equivalent capacity. Therefore, examination is simple, which could also be a positive point for disseminating inverters.

In addition, the thermal storage air-conditioning system can reduce peak demand (peak cutting and peak shifting of the peak demand in daytime) significantly and also the capacity of the chiller.

Hot Water Supplying System

The hot water supplying system usually uses an electric water heater, but a lot of facilities use a large boiler. Accordingly, the potential for introducing a heat pump water heater is large.

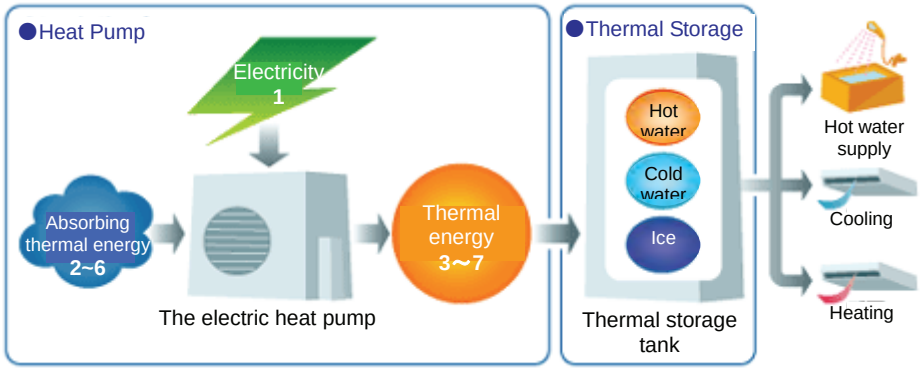
However, the initial cost of a heat pump water heater is high and the payback period is generally long because the capacity of the heat pump water heater is small, and a large capacity is needed when the total heating load is only met by the heat pump water heater. To reduce the payback period, it is effective to use the existing boiler and heat pump water heater together. However, it is necessary to select the capacity of heat pump water heater and heated water storage tank carefully accordingly to heating load.

Among the four target facilities of this walk-through investigation, hotels, office buildings, and hospitals already have energy conservation committees in-house and conduct energy conservation activities actively. One reason is that most come under designated buildings in the ECP Act and have a high consciousness of energy conservation. On the other hand, small and medium-size companies do not have designated buildings, so they have more potential for energy conservation than designated buildings.

－Heat Pump

A heat pump is a technology that transfers thermal energy in the air using electricity. It can extract a large quantity of thermal energy using less electricity than other means. Typically, heat-pump technology is used in an air conditioner for cooling or heating and for supplying hot water. It is very effective for conserving energy. An electric heat pump also greatly reduces CO2 emissions because no combustion is required.

As shown in Fig. 4.1.10, a heat pump can extract "3" - "7" of thermal energy by absorbing "2" - "6" of thermal energy in the air using "1" of electricity. Moreover, further advantages can be expected by combining a heat pump and a thermal storage system. (Refer to Section.5)



Source：Heat Pump & Thermal Storage Technology Center of Japan

Fig. 4.1.10　Heat Pump and Thermal Storage System

Summary

All target facilities of this walk-through investigation are observed to be making positive efforts for energy conservation, although the extent of their efforts varies. Energy conserving equipments have been widespread particularly for lighting systems, partly owing to the effect of the labeling program implemented by EGAT. On the other hand, there is much to be improved in air conditioning and hot water supplying systems although some facilities are observed which have implemented energy conservation measures.

On the basis of the above, the potential for energy conservation in private companies is shown in Table 4.1.16.

Table 4.1.16 Potential for Energy Conservation in Private Companies

Equipment	Evaluation	Comment
Lighting Systems	×	・ Agencies in Thailand have already conducted dissemination activities actively.
Air Conditioning Systems	○	・ Energy efficiency is improved by substituting heat source machine and heat transportation equipment with inverter type. (The initial examination is simple because the existing machine is replaced with one having an equivalent capacity, so it is easy to introduce to facilities.) ・ Reducing peak demand and heat source equipment capacity are possible by introducing a thermal storage air-conditioning system. (It is suitable for office building, department store, etc. that do not require an air conditioner load at night.)
Hot Water Supplying Systems	△	・ Energy conservation is possible by introducing a heat pump water heater. (It is necessary to select the capacity of the heat pump water heater and the heated water storage tank carefully according to heating load.)

Source: created by the study team Evaluation ○：High potential △：Middle potential ×：Low potential

c-4 Households

Regarding energy conservation measures for households, EGAT has conducted a labeling program for households since the 1990s as the main measure. United Nations Development Program (UNDP) is also planning to implement a labeling program in Southeast Asia. EGAT is cooperating with UNDP to implement such a plan and the labeling program of EGAT is a pilot scheme.

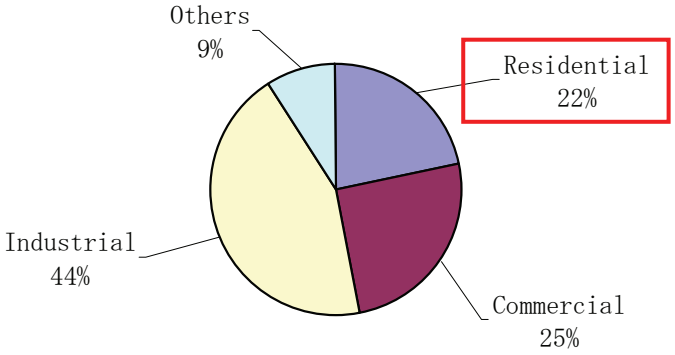
The contents of EGAT's labeling program are explained in detail below.

Labeling Program

As Fig. 4.1.11 shows, electricity consumption of households accounts for 22% of total electricity consumption in Thailand. Based on the premise that targets its reduction, this labeling program was launched from September 1994 with the following objectives.

－Objectives

- To promote the greater use of energy-efficient appliances
- To establish a local market for high-standard products
- To create energy conservation awareness among the people of Thailand

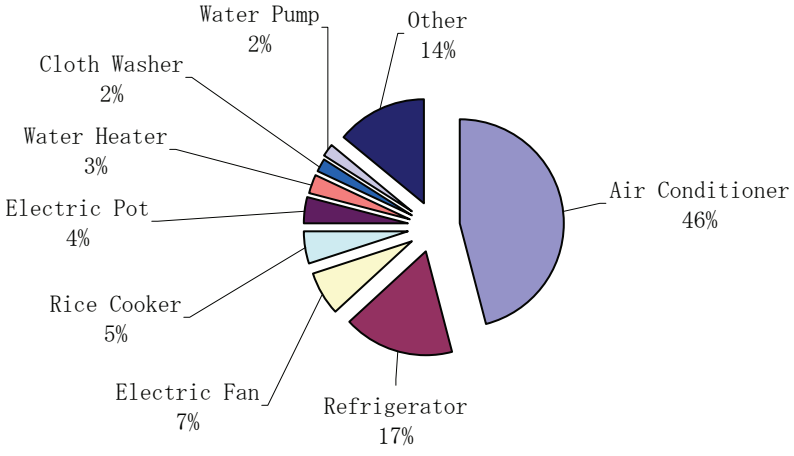


Source：Appliances and Energy Efficiency Label in Thailand

Fig. 4.1.11　Electricity Consumption as of May 2004

－Targets

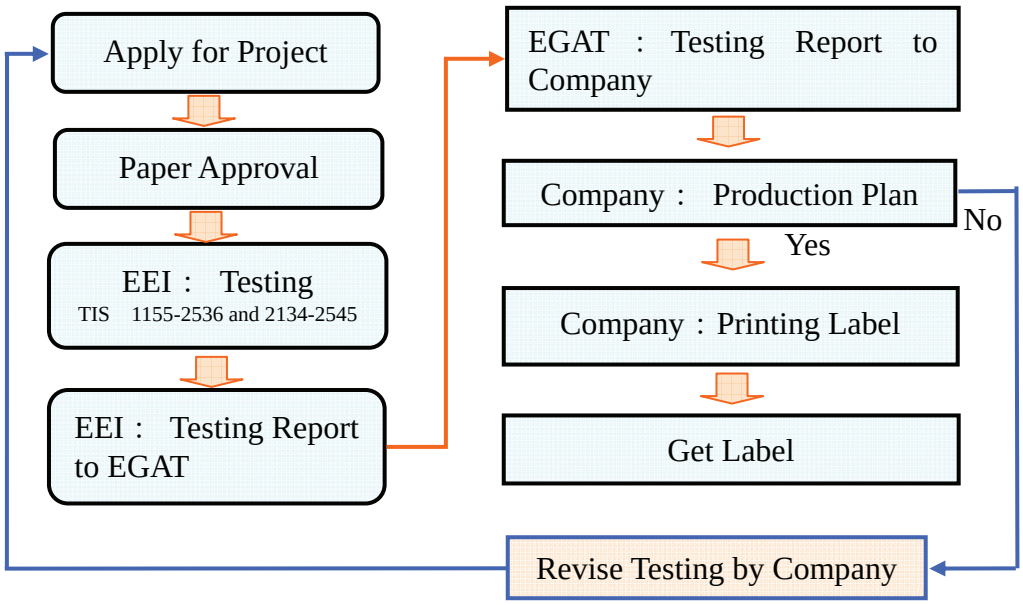
1994：　Refrigerator
1995：　Air Conditioner
1996：　Compact Fluorescent Lamp (CFL)
1998：　Electromagnetic Ballast
2001：　Electric Fan
2003：　Automatic Rice Cooker, Luminaries
2009：　Fluorescent Lamp T5, Electric Ballast for T5, Rotating Fan



Source：Appliances and Energy Efficiency Label in Thailand

Fig. 4.1.12　Electricity Consumption in Residential Section

－Label Acquisition Process



Source：Appliances and Energy Efficiency Label in Thailand

Fig. 4.1.13 Procedure of Labeling Program

－Label

Annual average energy consumption (kWh/year) and electricity expenses (baht/year), etc. are shown on the label. Ranking of energy consumption of a target appliance can be judged from the label index.

Source：Appliances and Energy Efficiency Label in Thailand

Fig. 4.1.14 Label Type

－Label Index

An example of the performance standard of an air conditioner is shown in Table 4.1.17. The label index is classified into five Ranks (Rank 3 is the average of tested products and Rank 5 is the top rank.). The performance standard of each rank is rated by its Energy Efficiency Ratio (EER), which is the efficiency ratio at a fixed temperature.

Table 4.1.17　Air Conditioner Ranks in EGAT Labeling Program

Grade	EER[BTU/h/w](COP[W/W])
No.5 (Excellent)	11.0 (3.22) ≦
No.4 (Good)	10.6 (3.11) ≦
No.3 (Average)	9.6 (2.82) ≦
No.2 (Fair)	8.6 (2.53) ≦
No.1 (Poor)	＜ 8.6 (2.53)

EER(BTU/h/W)：Cooling capacity is divided by power consumption (BTU/h)
COP(W/W)：Cooling capacity is divided by power consumption (W)
Difference between EER and COP：Different representations of cooling capacity

Source：Appliances and Energy Efficiency Label in Thailand

In Japan, the COP was adopted as the performance standard until the 「Energy Conservation Law」 was revised in September 2006. However, the Annual Performance Factor (APF) has been adopted since the revision because in the case of operating an air conditioner, its cooling capacity and power consumption, which depend heavily on temperature conditions cannot be controlled at the same level as the COP at all times. When the APF is adopted, the characteristics of the inverter air conditioner, which achieves high energy efficiency by controlling rotational speed throughout the year, can be evaluated properly.

APF（Annual Performance Factor）:

Necessary cooling capacity over a year／Power consumption of air conditioner over a year
（Seasonal Power Consumption）

Table 4.1.18 shows the performance standard of the labeling program in Japan. The target performance of an air conditioner that is shipped in the domestic market is not less than the APF for cooling and heating shown in Table 4.1.18. When comparing the label index in Thailand（Table 4.1.17）and the label index in Japan（Table 4.1.18), it can be judged that the minimum value of “3.10” of the label index in Japan corresponds to rank No. 4 of the label index in Thailand, although they cannot be compared directly due to differences in the performance standard. Accordingly, the performance of the label index in Thailand can be thought be comparable to the label index in Japan, which is considered to be relatively high in global terms.

Table 4.1.18　Performance Standard for Air Conditioner in Japan（Example）

Type of Unit	Cooling and Heating Capacity	Performance Standard (APF)
Wall-hanging Type	～2.5 kW	5.27
	2.5～3.2 kW	4.90
	3.2～4.0 kW	3.65
	4.0～7.1 kW	3.17
	7.1 kW～	3.10

Source：Ministry of Economy, Trade and Industry

－Evaluation of Past Labeling Program

- **One-door Refrigerator**

The energy conservation effectiveness of the labeling program for a one-door refrigerator is shown in Fig. 4.1.15. Based on the calculation of EGAT, approximately a 41% reduction of annual power consumption from 1994 (2538 in Thailand) to 2008 (2551 in Thailand) has been achieved.

Source：Appliances and Energy Efficiency Label in Thailand

Fig. 4.1.15　Resulting Energy Efficiency Improvement of Refrigerator (one door)

- **Room Air Conditioner (12,000 BTU/Hr)**

The energy conservation effectiveness of the labeling program for a room air conditioner (12,000 BTU/Hr) is shown in Fig. 4.1.16. Based on the calculation of EGAT, a reduction of approximately 21% of annual power consumption between 1995 (2539 in Thailand) and 2009 (2,552 in Thailand) has been achieved.

Source：Appliances and Energy Efficiency Label in Thailand

Fig. 4.1.16　Resulting Energy Efficiency Improvement of Air Conditioners (12,000 BTU/Hr)

－Next Plan 2010-2014 (EGAT's Demand Side Management Master Plan 2010-2014)

EGAT has continuously developed the country's electric power system to serve requirements nationwide with a quality electricity service and reasonable prices, while giving due care to the environment and society. EGAT recognizes the DSM project to be significant for promoting the efficient use of electricity. The DSM project conducted by EGAT has successfully resulted in cumulative savings of peak demand and energy, and the country has achieved investment savings on building new power plants, while reducing carbon dioxide emissions to alleviate the impacts of climate change.

For the next DSM project, EGAT set up the DSM Master Plan Committee 2010-2014 and evaluated DSM measures to determine the optimal mix of supply-and-demand-side resources based on the energy policy of the Thai government, technological maturity, manufacturer acceptance, laboratory testing availability, and results of feasibility study. In this master plan, EGAT plans to focus on energy conservation measures such as the labeling program and rescaling the performance standard, rather than load management as in the previous DSM project.

Table **4.1.19** outlines the high-efficiency labeling program in EGAT's Demand Side Management Master Plan 2010-2014.

Table 4.1.19 Outline of EGAT's Demand Side Management Master Plan 2010-2014

Item	Appliance/Equipment	Year					Measures
		2010	2011	2012	2013	2014	
1	T5 Luminarie	○					Labeling
2	Electric Water Boiler	○					Labeling
3	Standby Power - Television - Computer Monitor - Air Conditioner	○	○	○			Standby power labeling
4	Electric Water Heater		○				Labeling
5	Television		○				Labeling
6	Electric Fans		○				Rescaling the efficiency standard to be 7% higher than current standard
7	Air Conditioner		○				Rescaling the efficiency standard to be 5% higher than current standard
8	Refrigerator		○	○			Rescaling the efficiency standard to be 7.5% higher than current standard, in 2011 for 1 door and in 2012 for 2 door
9	Freezer			○			Labeling
10	Washing Machine			○			Labeling
11	Electric Motor				○		Labeling
12	Transformer				○		Labeling
13	LED				○		Replacing the existing lamps such as Halogen lamp used in 'EXIT' sign
14	Load Control (Load Management Program)				○		Stimulate and support the use of standby generators
15	Chiller					○	Labeling
16	Microwave Oven					○	Labeling
17	Pump					○	Labeling
18	Air Conditioner (Inverter, Hybrid technology)					○	Rescaling the efficiency standard to be consistent with advanced technology

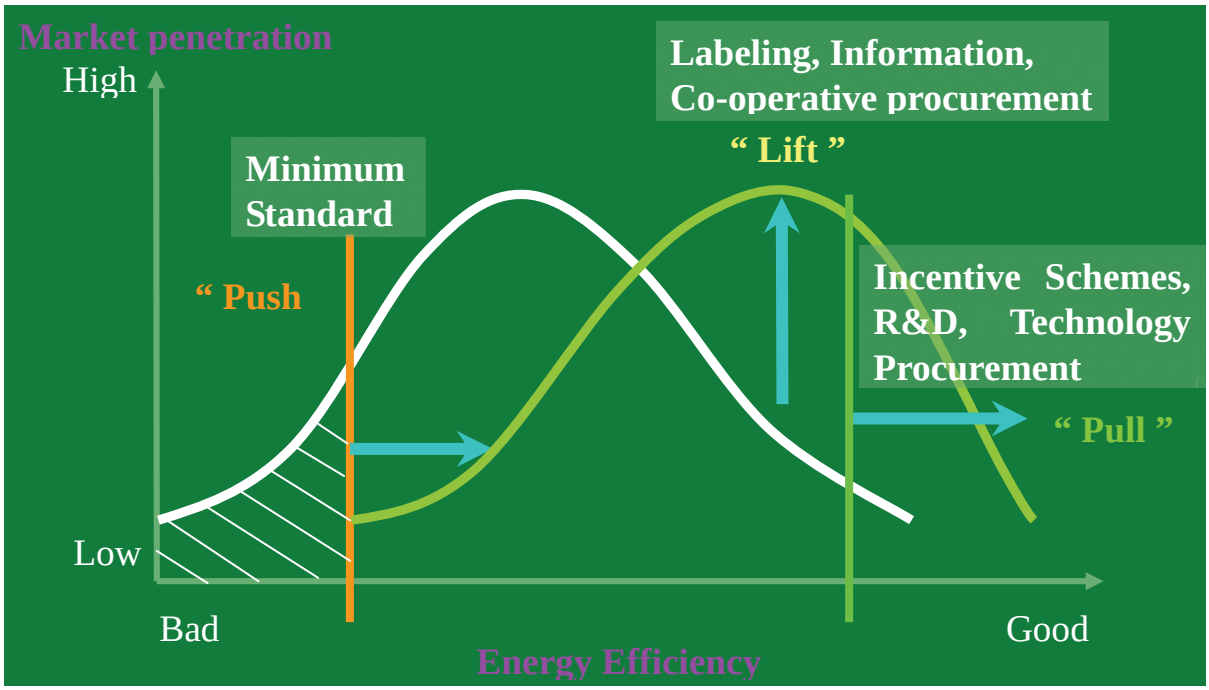
Source：EGAT's Demand Side Management Master Plan: 2010-2014

In this table, products subject to this next plan are listed in the "Appliance/Equipment" column. The "year" in which measures planned in the next plan are to be implemented is indicated by "○," and the "description" of such measures is given in the "Measures" column. The plan rescales performance standards for electric appliances which are covered by the existing labeling system (6/7/8/18) and establishes performance standards based on energy efficiency, similar to those for other electric appliances, for those for which no performance standards are presently specified (1/2/4/5/9~12/15~17). Of the remaining items, concerning 3, a new labeling program is planned to be launched for evaluating standby electric energy consumption, and concerning 13/14, replacing and constructing support measures are planned instead of a labeling program. However, there are

some possibilities of changes in the future because a feasibility study is planned to be conducted on some items from 2010-2014.

－MEPS & HEPS

Minimum Energy Performance Standard (MEPS) and High Energy Performance Standard (HEPS) have been introduced to improve the energy efficiency of electric appliances on the market. MEPS is a mandatory standard and promotes raising the minimum energy efficiency on the market by excluding electric appliances that fail to meet the MEPS, as indicated in Fig. 4.1.17. In Thailand, this system was begun when DEDE and Thai Industrial Standards Institute (TISI) concluded a MOU and started considering introduction of MEPS and HEPS in 2007. Under this plan, they target at least 35 electric appliances under MEPS up to 2011. The plan has been revised, and the new plan targets 50 electric appliances under MEPS and 54 electric appliances under HEPS between 2007 and 2011, and the target electric appliances have been decided gradually.



Source：DEDE

Fig. 4.1.17　MEPS & HEPS Concept

－Relationship between MEPS and Labeling System

As discussed in the previous section, the purpose of introducing MEPS is to promote raising the minimum energy efficiency in the market by excluding electric appliances that fail to meet MEPS. Table 4.1.20 shows the performance standard for room air conditioners as one example of MEPS. Room air conditioners belonging to categories that do not meet the performance standard (No.1～3 in cooling capacity under 8,000 W, No.1～2 in cooling capacity over 8,001 under 12,000) are prohibited from being sold in Thailand.

Table 4.1.20　Performance Standard of Room Air Conditioner According to MEPS

	Cooling Capacity	
	≦8,000 W	8,001 W≦、<12,000 W
EER（W/W）	Under 2.82 Prohibited from Selling （Corresponding to No. 3 in Labeling Index in Thailand）	Under 2.53 Prohibited from Selling （Corresponding to No. 2 in Labeling Index in Thailand）

Source：DEDE

○DEDE

The Labeling Program conducted by EGAT targets household electric appliances. On the other hand, the Labeling Program started from 2009 and conducted by DEDE targets non-electric appliances, and has been applied to only two appliances (Gas Stove and VSD: Variable Speed Drive).

The Label is shown in Fig. 4.1.18 and its appearance is similar to the EGAT Label. One of characteristics of this Label is that it only has a label index of Rank 5.

Source：DEDE

Fig. 4.1.18　Label in DEDE Labeling Program

－Energy Conservation Consciousness Investigation for Households

In this study, an energy conservation consciousness investigation on households was conducted to evaluate the consciousness of energy conservation among households. The results are shown as follows.

Outline of Investigation

The targets in this study were 100 ordinary citizens. This study was conducted with the cooperation of SERT in Bangkok and Phitsanulok, where buildings of Naresuan University are located. The breakdown of targets is shown in Table 4.1.21 and the results may be helpful for comprehensively understanding the consciousness of energy conservation among households, because the targets show moderate large variations of age, current occupation, and highest educational background, etc.

Table 4.1.21 Outline of Targets

Contents		Respondents
Gender	Male	61
	Female	39
Age	Less than 20 years	16
	During 21-30 years	32
	During 31-40 years	31
	During 41-50 years	10
	During 51-60 years	8
	More than 60 years	3
Current Occupation	Government Officer	20
	State Enterprise Staff	4
	Private Staff	45
	Others	31
Highest Education Background	Lower than High school	15
	High scholl	18
	Bachelor degree	52
	Master degree	15
Residential Area	Urban(Bangkok)	50
	Rural (Phitsanulok)	50

Source：Created by the study team

Contents of Investigation

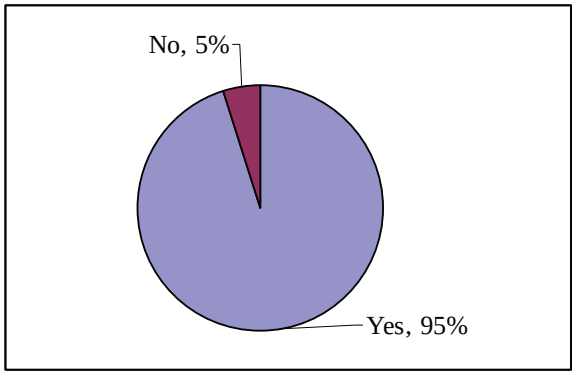
The investigation is wide-ranging from basic contents and specific barriers concerning energy conservation such as: “Have you ever heard about Energy Conservation?” “Do you know about the Labeling System?” “Which is the biggest barrier to promote Energy-conservation Activities? Here, noteworthy results are picked up and evaluated. The findings of this investigation are evaluated as a whole based on the results.

Noteworthy Investigation Results

①Have you ever heard about energy conservation?

a. Yes

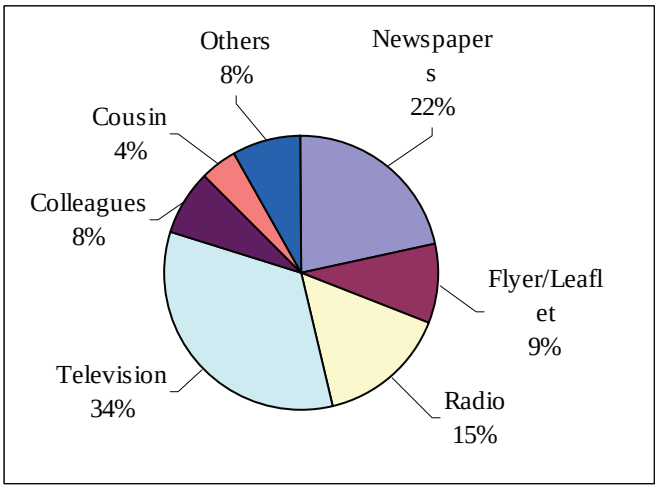
b. No



<Evaluation>

Recognition of the term is very high because over 95% of the targets answered: “Yes.”

②If you answered yes to the above question, where did you hear about it? (Multiple answers allowed)



<Evaluation>

Television and Newspapers were ranked No. 1 and No. 2. Television has more impact because it is closest to people’s lives. Accordingly, Television is an effective media for energy conservation PR.

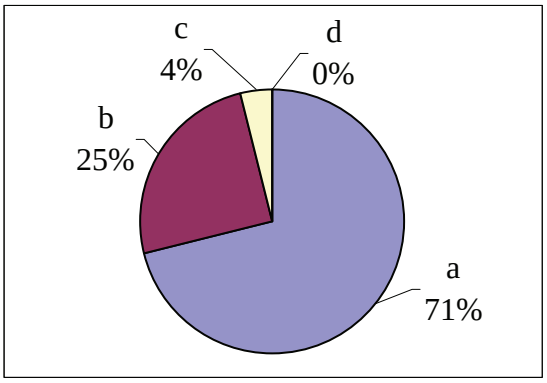
③Do you think that increasing energy consumption of households influences global warming?

a. It influences global warming. I already try to decrease household energy consumption.

b. It influences global warming, but I do not know how to decrease household energy consumption.

c. It does not influence global warming.

d. I am not interested.



<Evaluation>

The fact that increasing energy conservation by households influences global warming is understood because over 90% of the targets answered “a” and “b.” There is a general understanding of the importance of energy conservation and trying to decrease household energy consumption because over 70% of the targets answered “a.”

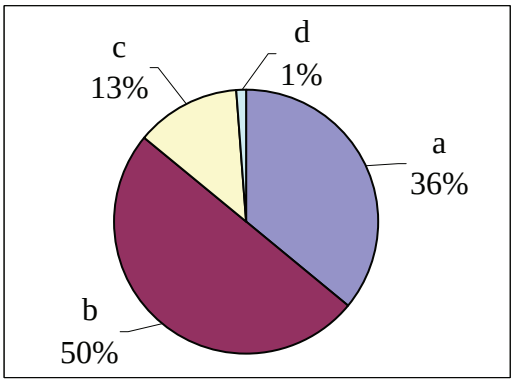
④Do you engage in any activities to raise consciousness of energy conservation?

a. I try to engage in some activities related to energy conservation.

b. I recognize necessity of energy conservation, but I do not engage in any specific activities.

c. I have not thought about energy conservation .

d. I am not interested in it.



<Evaluation>

As with the answer to the previous question, the importance of energy conservation is understood by most people who also try to decrease energy consumption in households, because over 85% of the targets answered “a” and “b.” However, specific activities for energy conservation are not understood clearly, because only half of the targets answered “b.”

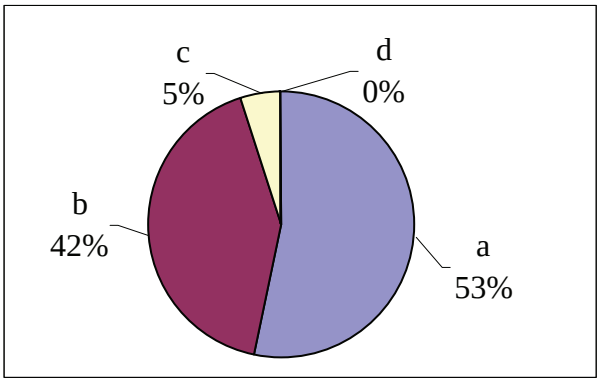
⑤Do you know about the labeling program applied to electric appliances for energy conservation?

a. I know about it very well.

b. I have heard about it.

c. I have not heard about it.

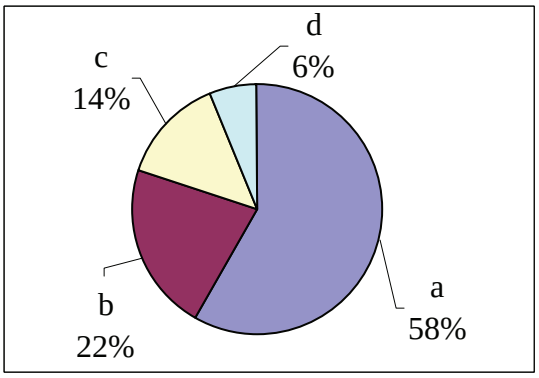
d. I am not interested in it.



<Evaluation>
The recognition of the term is very high because 95% of the targets answered “ a ” and “ b .” The outline of the labeling program is also understood by over 50% of the targets.

⑥Do you want to buy electric appliances that are evaluated in the highest rank in the labeling program?

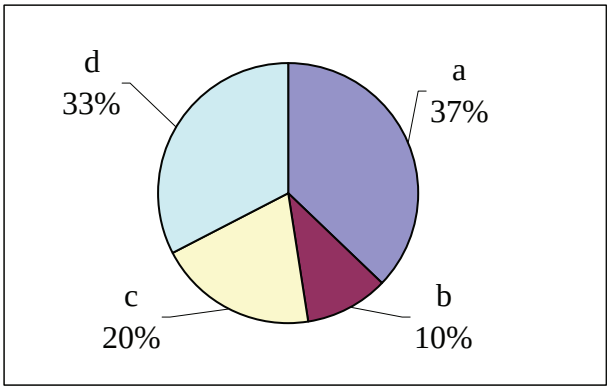
a. I want to buy them because it can contribute Energy Conservation.
b. I want to buy them if the price is average.
c. I want to buy them if the price is less than average.
d. I want to buy the cheapest one regardless of the labeling program.



<Evaluation>
The willingness to buy appliances evaluated in the highest rank in the labeling program does not depend heavily on price because over 50% of the targets answered “ a .” This finding shows that the public has high confidence in the labeling program.

⑦What information is necessary for energy conservation by households? (Multiple answers allowed)

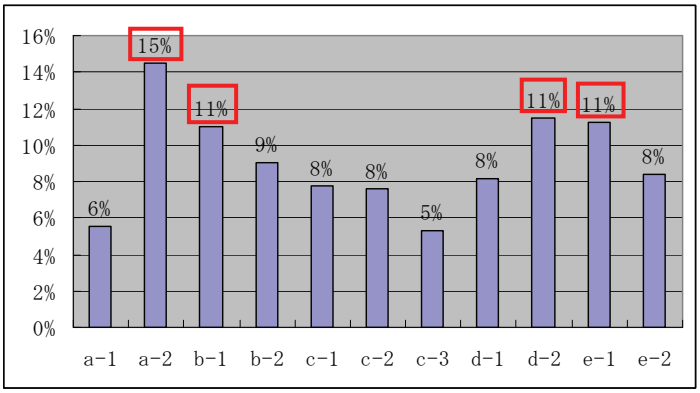
a. Comparing information on energy conservation performance of electric appliances
b. Advice center
c. Lectures, events
d. Survey of energy usage conditions in households



<Evaluation>
"a" and "d" account for a large share of responses. From "a," it can be understood that the public feels a need to compare information on the energy conservation performance of electric appliances, and has a high consciousness about energy conservation. And, from "d," it can be understood that the Public feels the need for a survey on energy usage conditions in households; therefore, the public do not clearly grasp energy usage of households.

⑧Which is the biggest barrier to promoting energy conservation activities? (Multiple answers allowed)

Policy barriers	a-1	Lack of national policy to disseminate energy conservation
	a-2	**Gap between subsidy system and actual market conditions**
Financial barriers	**b-1**	**Lack of incentives for investment**
	b-2	Difficulty investing due to high risk
Information barriers	c-1	Low consciousness of energy conservation among policy makers and consumers
	c-2	Lack of accurate information on energy conservation (Costs and Benefits, etc)
	c-3	Lack of latest information
Technical barriers	d-1	Limited access to latest information
	d-2	**Lack of experience of engineers**
Institutional barriers	**e-1**	**Lack of reliability of new products and new technologies**
	e-2	Conservative customs and activities



<Evaluation>
Over 10% of the targets answered "a-2," "b-1", "d-2," and "e-1," and they can be thought to be barriers to promote energy conservation. "a-2" and "b-1" are connected to investment and the fact that the public feels a lack of incentives for costly, high-efficiency efficient appliances can be understood. And, from "e-1," it can be understood that it is difficult for the public to have confidence in the reliability of new products and new technologies.

Overall Evaluation

From the results, recognition of energy conservation is very high and its necessity is also widely understood. However, specific activities for energy conservation cannot be understood clearly. Recognition of the labeling program and confidence in it are very high. People's willingness to buy appliances evaluated in the highest rank in the labeling program does not depend heavily on price. The facts that the public feels there is a lack of incentives to buy costly high-efficiency appliances and they believe new products and new technologies might not be reliable are considered to be barriers to promote energy conservation.

Based on these results, the following three measures would be effective for promoting energy conservation among households.

①Reinforcing education on specific energy conservation activities

②Establishing subsidy for costly high-efficiency appliances

③Reinforcing labeling program supporting new products and new technologies

d Study on Potential for Energy Conservation

Based on the results of the survey, the measures shown in Table 4.1.22 can be picked up as available energy conservation measures for electric power utilities, private companies, and households. In this study, by taking into account of the circumstances of the energy business in Thailand, the potential for energy conservation was analyzed. The results are shown in Table 4.1.22.

Table 4.1.22 Table of Potential Energy Conservation Measures Available in Each Category

Category		Measures	Current	Potential
Electric Power Utilities	Power Plant	・Rehabilitation of old power stations	○	×
		・Construction of high-efficiency power station	○	×
		・Conversion of generating fuel	○	×
	Transmission Line & Substation	・Conversion to high-voltage system	○	×
		・Strengthening multiple circuits	○	×
		・Power Storage System	×	△
	Distribution Line	・Installation of capacitors and improving power factors	○	△
		・Improving imbalance of distribution line	○	×
		・Introduction of low-loss transformers	○	×
		・Strengthening conductors	○	×
		・Conversion to high-voltage system	○	×
Private Companies (including Central and Local Govt.)		・Introduction of energy-conserving lighting facilities	○	△
		・Introduction of inverters to air conditioners	△	○
		・Introduction of thermal storage air conditioning system	△	○
		・Introduction of heat pump water heater	△	△
Households		**・Introduction of high-efficiency air conditioning system**	△	○
		・Introduction of energy conserving lighting facilities	○	△
		・Labeling system for electric appliances	△	○

Current：○Already done, △Some introducing cases, ×not yet Potential：○Large, △Medium, ×Small

Source: created by the study team

In Table 4.1.22, concerning the items which show current:△ and potential:○, some cases of introduction can be recognized and their effectiveness has already been understood in Thailand; however, recognition is still low (excluding the labeling program). Accordingly, these items can be judged to have relatively large future potential. The next section focuses on these items.

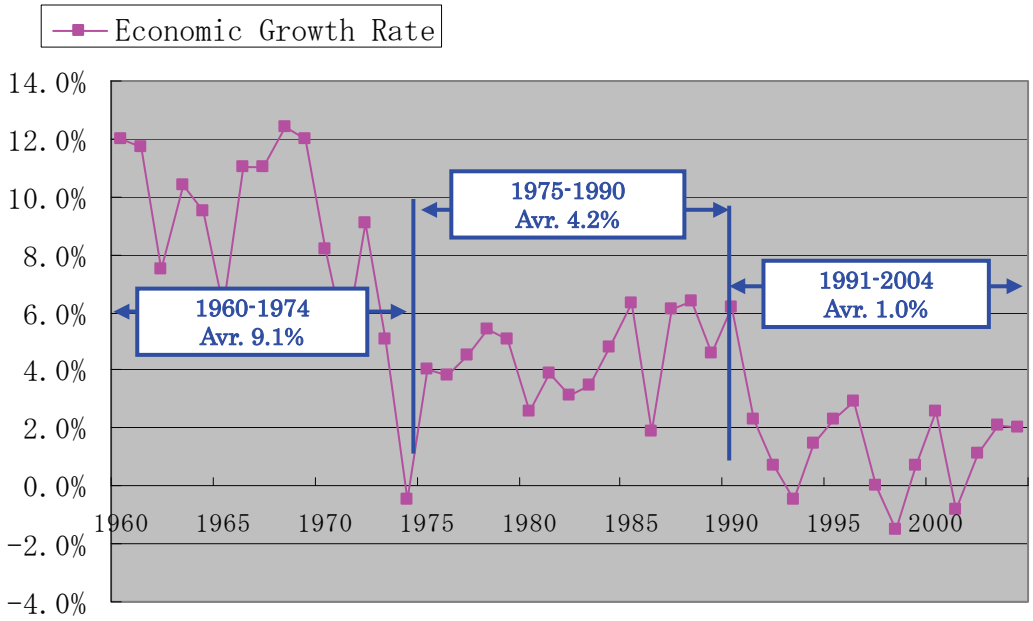
4.2 Future Prospects for Energy Conservation

a Possibility of Introducing Energy Conservation into Electric Power Utilities

In electric power facilities, annual load factor, thermal efficiency, losses of transmission and distribution network are reflected in the index of energy conservation measures for electric power facilities, and they are comparable to the values of developed countries. Accordingly, the prospects for further energy conservation in electric power facilities are small, although there is some possibility of partial gains such as introducing capacitors into the transmission and distribution network to improve the power factor.

b Possibility of Introducing Energy Conservation into Private Companies

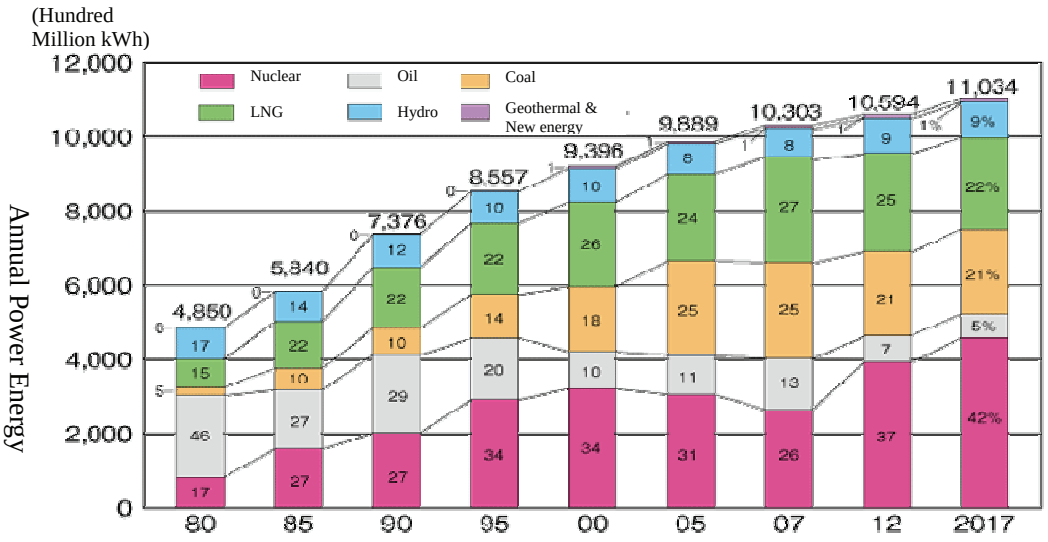
Considering the future prospects of Thailand and economic growth rate in Japan, electric power demand and annual load factor of electric power facilities are explained first. Fig. 4.2.1 shows the general trend of the economic growth rate in Japan during three periods: the high-growth period, 1960-1974 (Average Economic Growth Rate: approx 9.1%); period approximately 15 years after the high-growth period, 1975-1990 (Average Economic Growth Rate: approx 4.2%); and, period bridging 20th and 21st centuries, 1991-2004 (Average Economic Growth Rate: approx 1.0%). Economic growth has continued synthetically, although average economic growth rates in the three periods show big differences and there have been slumps on a single-year basis.



Source：Agency for Natural Resources and Energy

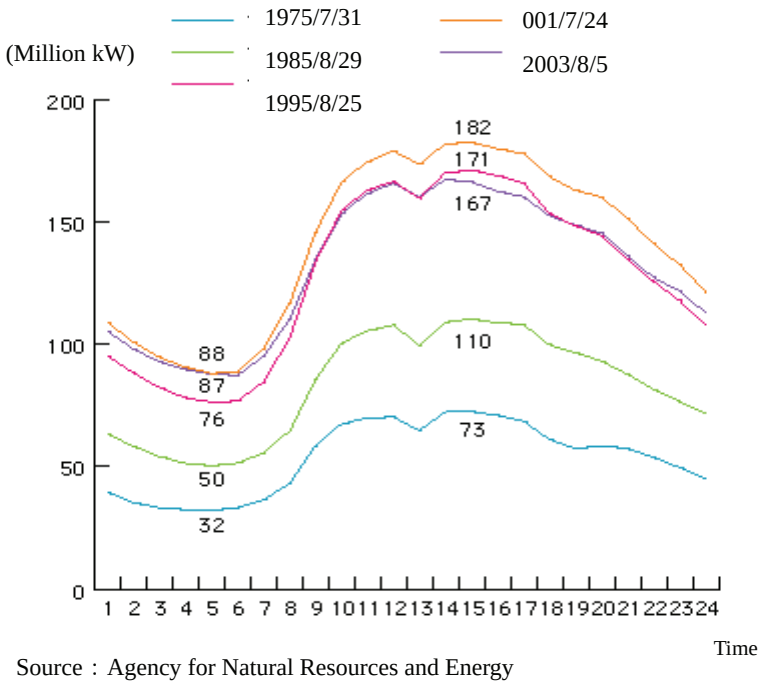
Fig. 4.2.1 Economic Growth Rates in Japan

Electric power demand increased in line with economic growth as Fig. 4.2.2 shows. And, while the daily load curve increased constantly as shown in Fig. 4.2.3, the growth of electricity demand in daytime was marked. This demand trend featured by peak demand in daytime is typical of developed countries in general, and the main cause is an increasing load for air conditioners, which increases with economic growth.



Source：Agency for Natural Resources and Energy

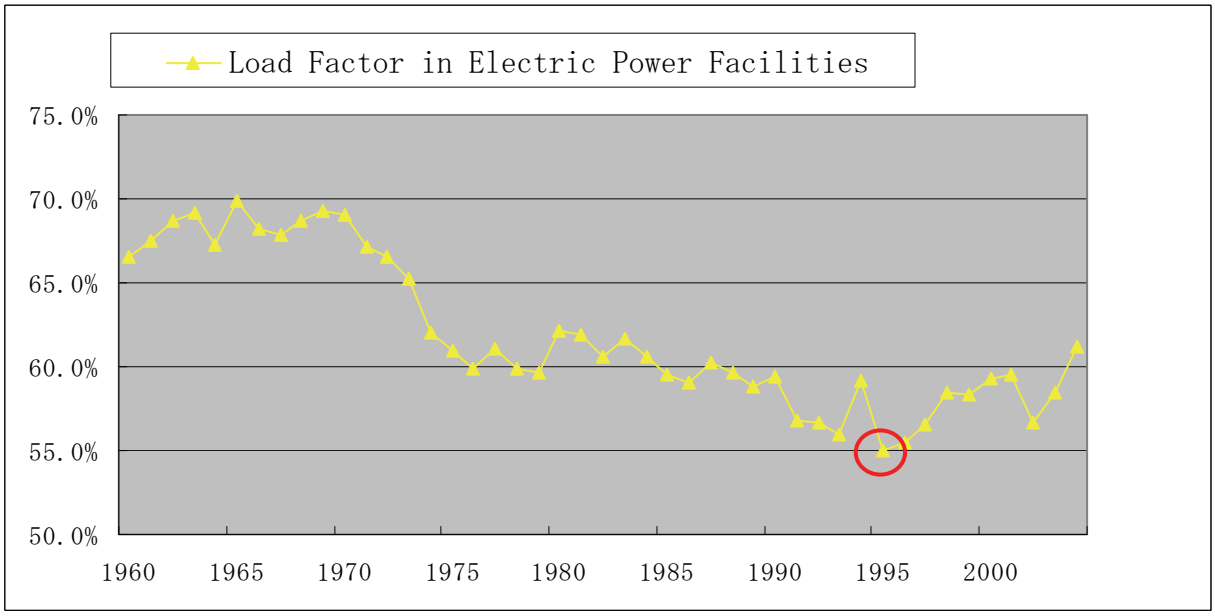
Fig. 4.2.2　Actual Output and Forecast of Annual Power Energy in Japan



Source：Agency for Natural Resources and Energy

Fig. 4.2.3　Trend of Daily Load Curve in Summer in Japan

In addition, the annual load factor of electric power facilities has decreased every year because of increasing electricity demand in line with economic growth. The lowest value (approx 55%) was recorded in 1995, as indicated in Fig. 4.2.4, when there was the biggest difference between peak (daytime) and off-peak (nighttime) use.



Source：Agency for Natural Resources and Energy

Fig. 4.2.4　Annual Load Factor of Electric Power Facilities in Japan

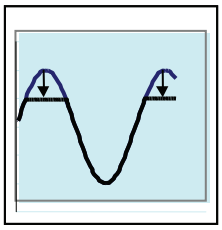
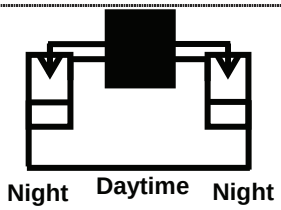
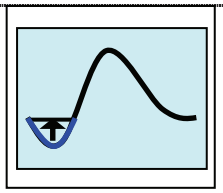
The Government of Japan emphasizes activities that promote improving the annual load factor of electric power facilities from the viewpoints of contributing to the stable operation of nuclear power and reducing the costs of electric power facilities and CO2 emissions. Against this background, the measures shown in Table 4.2.1 have been taken. In recent years, the annual load factor of electric power facilities has improved to approximate 60% based on the results of these measures, as indicated in Fig. 4.2.4.

Table 4.2.1　Outline of Improvement Measures for Annual Load Factor in Japan

	Measures
1 Peak Cutting	・High-efficiency Air Conditioner ・Energy-conserving Appliances ・Changes to Electricity Tariff
2 Peak Shifting	・**Thermal Storage Air Conditioning System** ・Battery ・ Changes to Electricity Tariff
3 Bottom Up	・Night Water Heating Appliances ・ Changes to Electricity Tariff

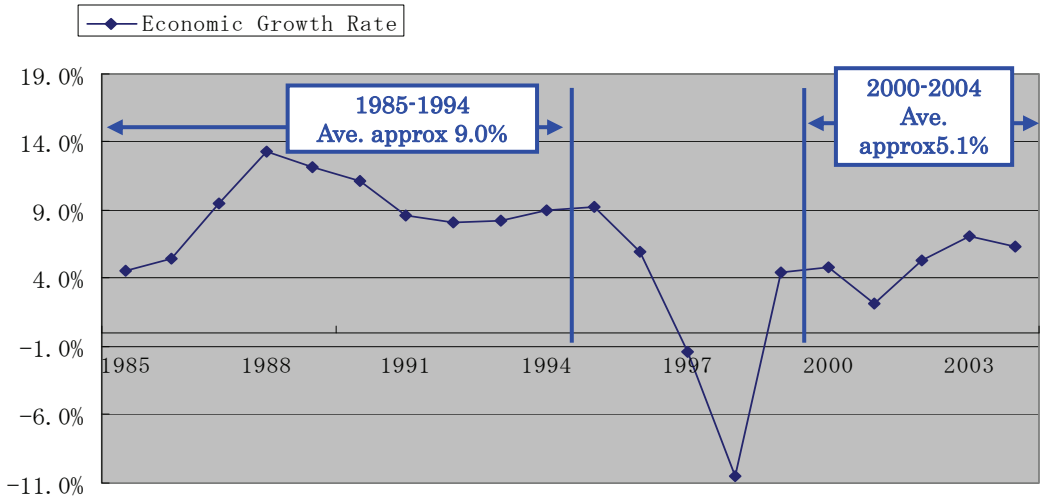
Source：Agency for Natural Resources and Energy

Table 4.2.2 Outline of Load Management Type DSM

	Type	Method	Image
1	Peak Cutting	Measures for reducing peak load using low power-consuming technologies	
2	Peak Shifting	Measures for shifting peak power consumption time frame by adopting time-based electricity tariffs and seasonal tariffs	
3	Bottom Up	Measures for using electric power at nighttime	

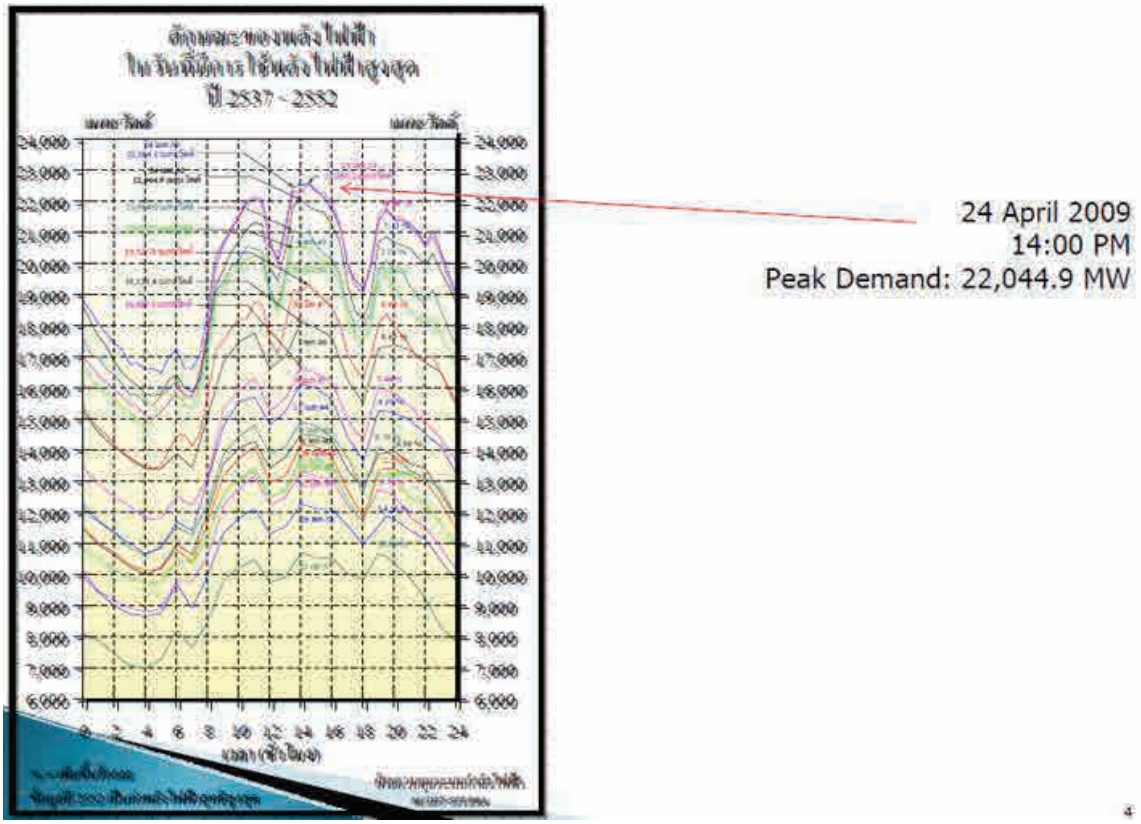
Source：Federation of Electric Power Companies of Japan

On the other hand, the economy of Thailand has grown constantly at approximately 5.1% on average, although it was adversely affected by the Asian Currency Crisis in 1998, as shown in Fig. 4.2.5. The peak demand spike in daytime is being created in the same way as in Japan with constantly increasing electric demand corresponding to economic growth as shown in Fig. 4.2.6. In addition, power consumption in Thailand (Fig. 4.2.7), shows peak demand in daytime in the business sector. In other words, the same trend as in Japan can be forecasted for the annual load factor of electric power facilities.



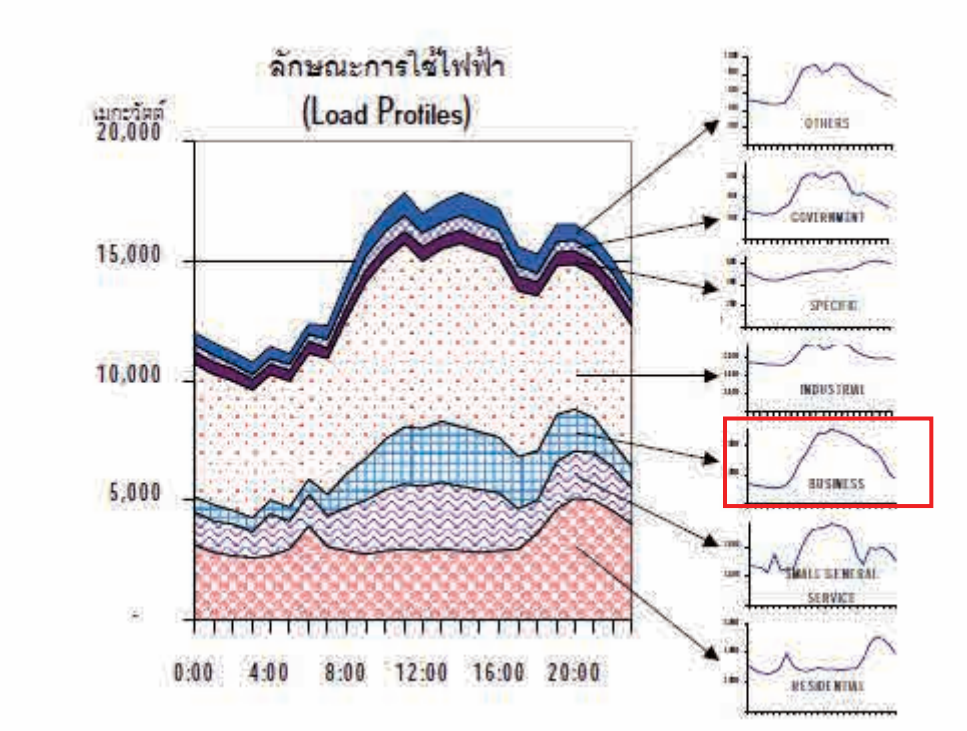
Source：Japan Electric Power Information Center, Inc.　Electric Power Situation in Foreign counties in 2008

Fig. 4.2.5　Economic Growth Rate in Thailand



Source：EGAT

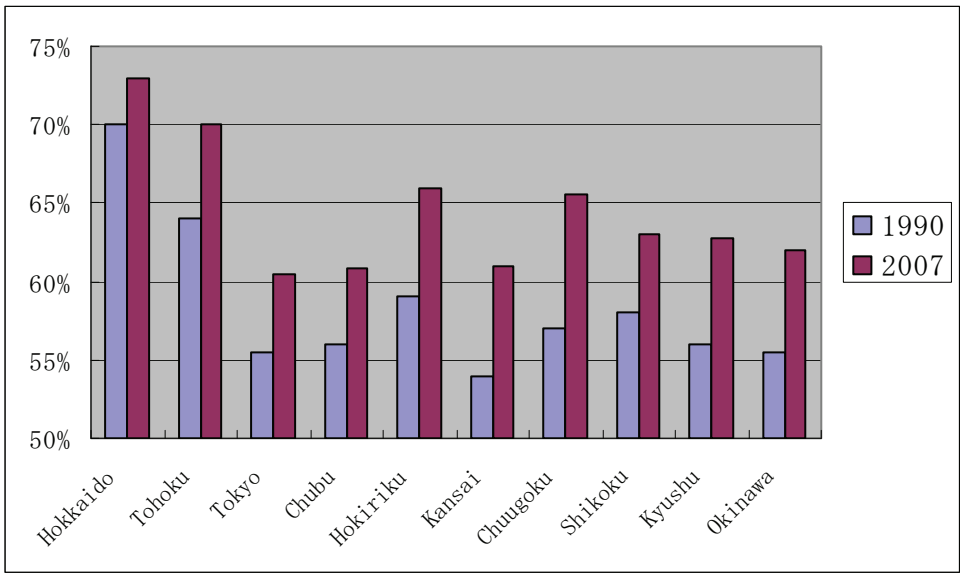
Fig. 4.2.6　Daily Load Curve Transition in Thailand



Source：EGAT

Fig. 4.2.7　Breakdown of Daily Load Curve in Thailand（April 2006）

As Fig. 4.2.8 shows, the annual load factor of electric power facilities is high in areas that have characteristics such as lower peaks in summer and higher loads in winter than other areas (E.g.; Hokkaido, Tohoku, Hokuriku, etc.). On the other hand, Thailand has mild weather throughout the year with weather characteristics similar to Okinawa in Japan. Accordingly, the load factor of electric power facilities in Thailand will become more marked than in Japan.



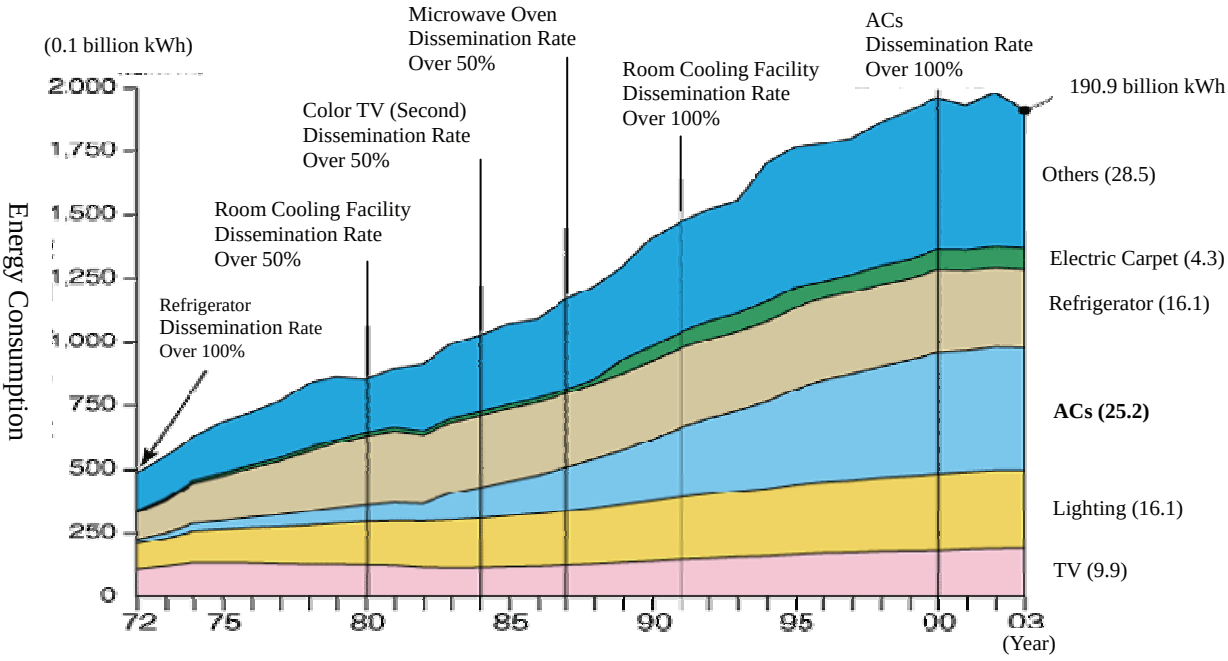
Source：Federation of Electric Power Companies of Japan

Fig. 4.2.8　Annual Load Factor by Electric Power Company in Japan

On the basis of the above, concerning the future prospects for energy conservation in private companies, measures that focus on improving the annual load factor of electric power facilities have the greatest potential. The introduction of “thermal storage air conditioning systems” to commercial facilities, which are exhibiting a significant rise in demand, is considered to be the most effective measures for improving the annual load factor of electric power facilities.

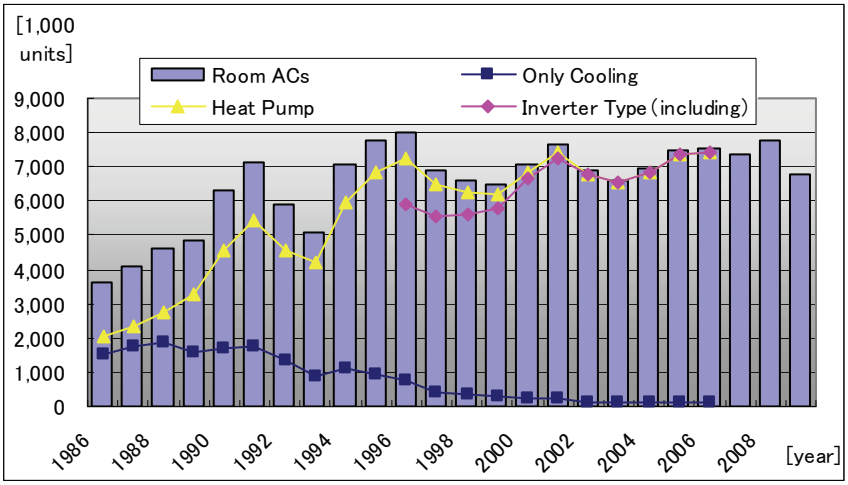
c Possibility of Introducing Energy Conservation into Households

The energy consumption of households in Japan is shown in Fig. 4.2.9. It has increased in line with increases of power energy as shown in Fig. 4.2.2. The electric appliance that consumed most energy in households in 2000 was the air conditioner, accounting for 25% of total energy. The growth rate to 25% increased very rapidly from the 1980s. The reason for this rapid growth is said to be the dissemination of electric appliances among middle-income earners in line with economic growth, especially the dissemination of air conditioners, which provided comfort by controlling temperature. Accordingly, Japan has promoted the dissemination of inverter air conditioners since the 1990s to reduce energy consumption by air conditioners. As Fig. 4.2.10 shows, the dissemination rate is approximately 100% of households at present.



Source：Federation of Electric Power Companies of Japan

Fig. 4.2.9 Energy Consumption of Households in Japan



Source： The Japan Refrigeration and Air Conditioning Industry Association

Fig. 4.2.10 Number of Units of Room Air Conditioner Shipped in Japan

On the other hand, the daily load curve shows extreme peak demand in daytime in Thailand as shown in Fig. 4.2.6. This trend is similar to Japan and could become greater as it tracks economic growth. The rate of energy consumption by air conditioners will also be high during peak demand in daytime, because energy consumption of air conditioners accounts for approximately 45% of the energy consumption of electric appliances in households, as shown in Fig. 4.1.12. In addition, based on the results of an interview survey with Mitsubishi Electric Consumer Products (Thailand) Co., Ltd., the dissemination rate of air conditioners is approximately 18% (a few percent for inverter air conditioners) in the Thai market. As mentioned above, it can be considered that the dissemination rate of air conditioners will grow very rapidly in line with economic growth in Thailand compared to the case of Japan. Accordingly, “Inverter air conditioners” has the highest potential for energy conservation by households in the future.

On the basis of understanding of the current situation of energy conservation in Thailand and examination of its future prospects in accordance with the above, the following conclusion can be drawn.

As for efforts by electric power companies and municipalities, they have systematically implemented a variety of programs in accordance with Thailand’s energy conservation policy and in close cooperation with the Thai government, achieving steady results. Some municipalities, however, have just started planning energy conservation in order to extend energy conservation efforts from urban to rural areas. The future efforts are thus more important for them.

Facilities of private companies specified as designated commercial and factory buildings under the Energy Conservation Promotion Act, as indicated above, have been engaged in Energy conservation activities for long years. While their activities are relatively substantial, there is still a room for greater efficiency, for instance, through the introduction of a “thermal storage air conditioning system” into daytime air-conditioning load. In addition, the management of companies that possess facilities not designated under the Energy Conservation Promotion Act still has low energy

conservation consciousness. The energy conservation potential of these facilities is considered even greater compared with designated facilities.

Energy conservation consciousness has been improved in households owing to the labeling program and publicity campaigns implemented by EGAT, and their efforts have been achieving better results. There is, however, no financial support such as subsidies for the purchase of high efficiency products that requires high initial investment, preventing the accelerated dissemination of high efficiency products. Since air conditioners in households are particularly expected to increase rapidly, just like in private companies, there is an urgent need for a response to the concomitant rise in power demand.

5 Proposal for Future ODA Scheme for Renewable Energy and Energy Conservation in the Power Sector

5.1 Possibility of Applying Japanese Technology in Thailand

This section deals with such promotion measures and technologies concerning renewable energy and energy conservation in Japan that can be utilized in assistance to Thailand.

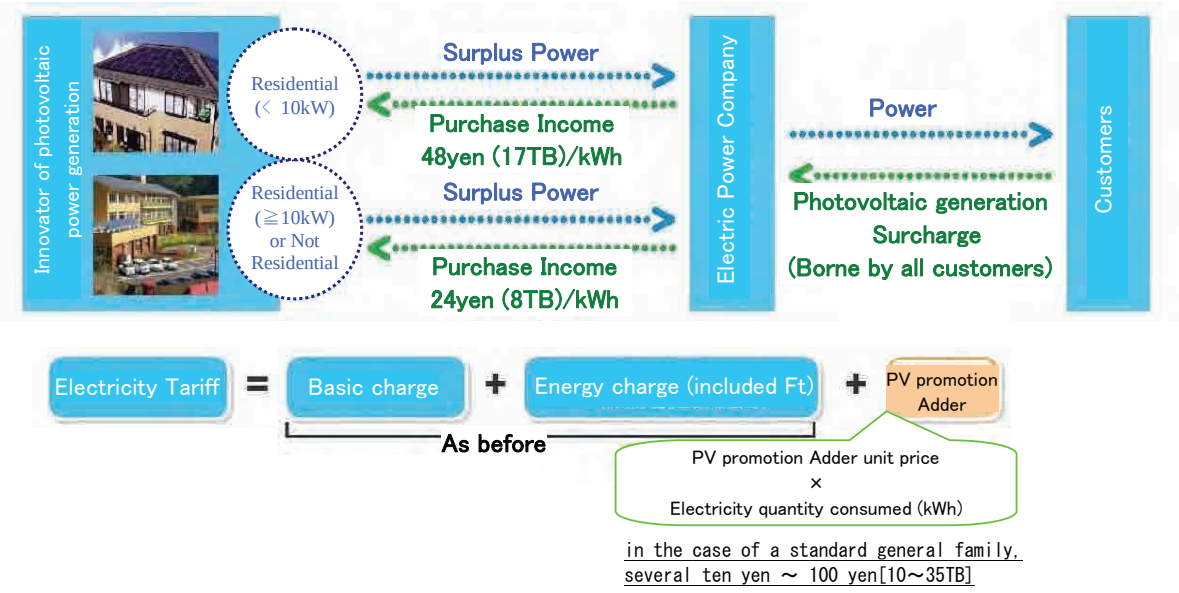
a Solar Power System

Promotion Measures for Photovoltaic Power Generation in Japan

The Japanese Government has introduced an electricity wholesale purchase system (Feed-in tariff) and subsidy system for photovoltaic power generation in Japan. (Exchange Rate: 1 TB = 2.8 yen)

【Feed-in Tariff】

- Purchase covers only surplus electricity
- Purchase period is 10 years, and purchase price is fixed (48 yen [17 TB]/ kWh: twice the normal retail price)
- Universal Cost System (All electricity consumers bear expenses for purchase cost through solar power surcharge: in the case of a standard family, less than 100 yen [10～35 TB] /month)



(Source：METI HP, http://www.enecho.meti.go.jp/kaitori/)

Fig. 5.1.1 Overview of Feed-in Tariff in Japan

【Subsidy system】

(ⅰ) Subsidy from national government

- ✓ Residential solar power generation installation supporting subsidy : 70,000 yen[25,000 TB]/kW, the target is a maximum output of less than10 kW.
- ✓ Housing loan taxes reduction : For Example: 190,000 yen[68,000 TB] / 3.5 kW PV, Only applies to new residential housing
- ✓ Tax reduction for energy-conserving repair work : 230,000 yen[82,000 TB] 3.5 kW PV, installation in existing residential housing is the target.

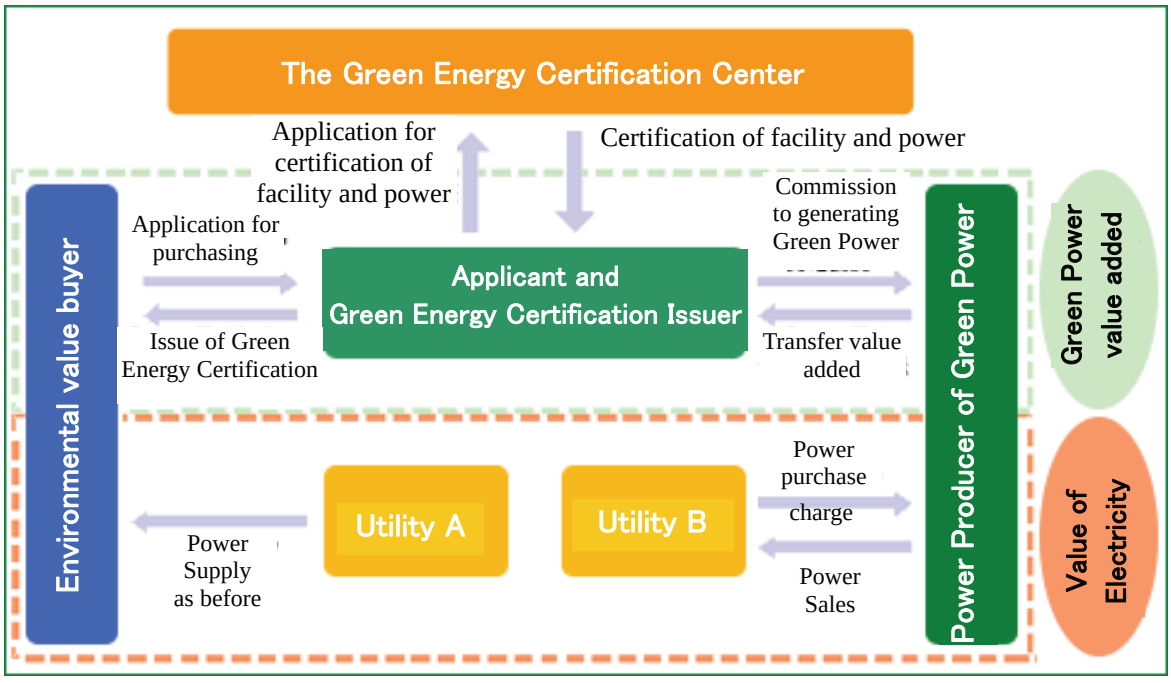
(ⅱ) Subsidy from local community

- ✓ Solar power generation system installation subsidy : 40,000～100,000 yen[14,000～35,000 TB]/kW up to 120,000～400,000 yen[42,000～142,000 TB], residential solar power generation is the target.

(ⅲ) Other

- ✓ The Green Power Certification System (*): captive consumption of electricity can be sold as a Certificate of Green Power.

(*)「The Green Power Certification System」is a scheme by which an enterprise publishes environment added-value electricity generated from natural energy with certification of the green power certification mechanism (Institute of Energy Economics, Japan/the Green Energy Certification Center, Japan) in a form called "Certificate of Green Power." (See Fig. 5.1.2)

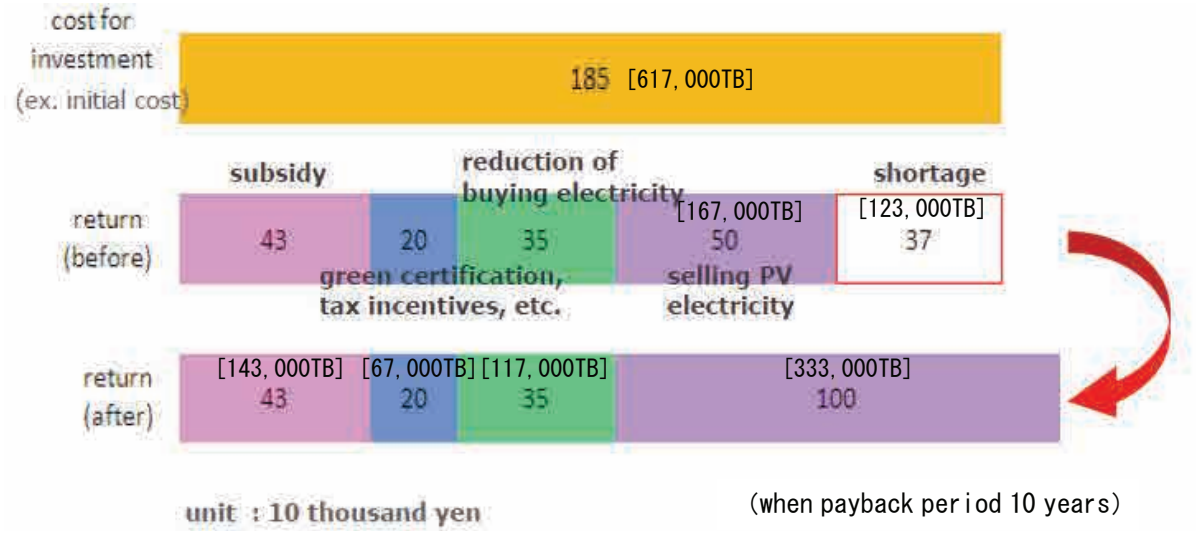


(Source : the Institute of Energy Economics, Japan HP, http://eneken.ieej.or.jp/greenpower/)

Fig. 5.1.2 Outline of Green Power Certification System

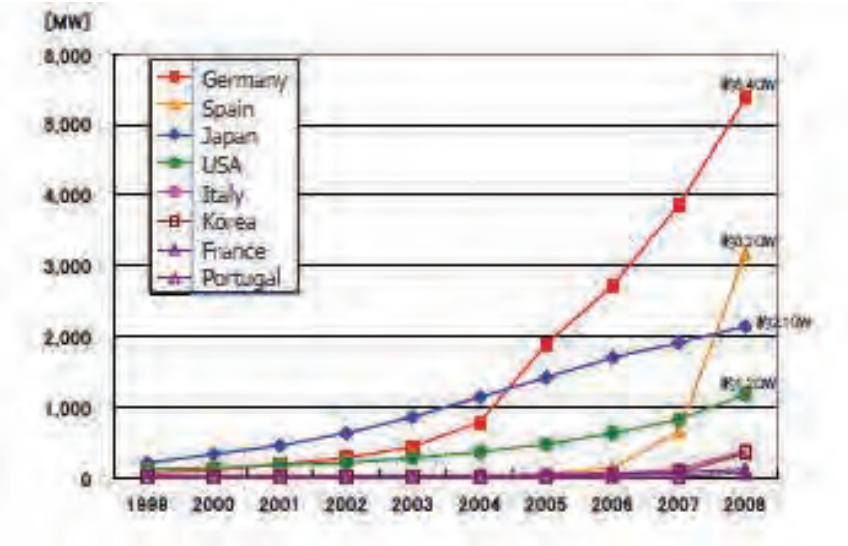
The payback period of the PV system is calculated to be approximately ten years using these support systems. (See Fig. 5.1.3)

For reference, the cumulative number of photovoltaic power generation facilities installed in major countries is shown in Fig. 5.1.4. The figure shows a remarkable spread during the past several years in Germany (introduced in 1991) and Spain (introduced in 1994), which introduced the Feed-in-tariff system ahead of Japan.



(Source: NEDO, Government policies for solar energy in Japan)

Fig. 5.1.3 Example of Payback for Rooftop Photovoltaic Power Generation Facilities



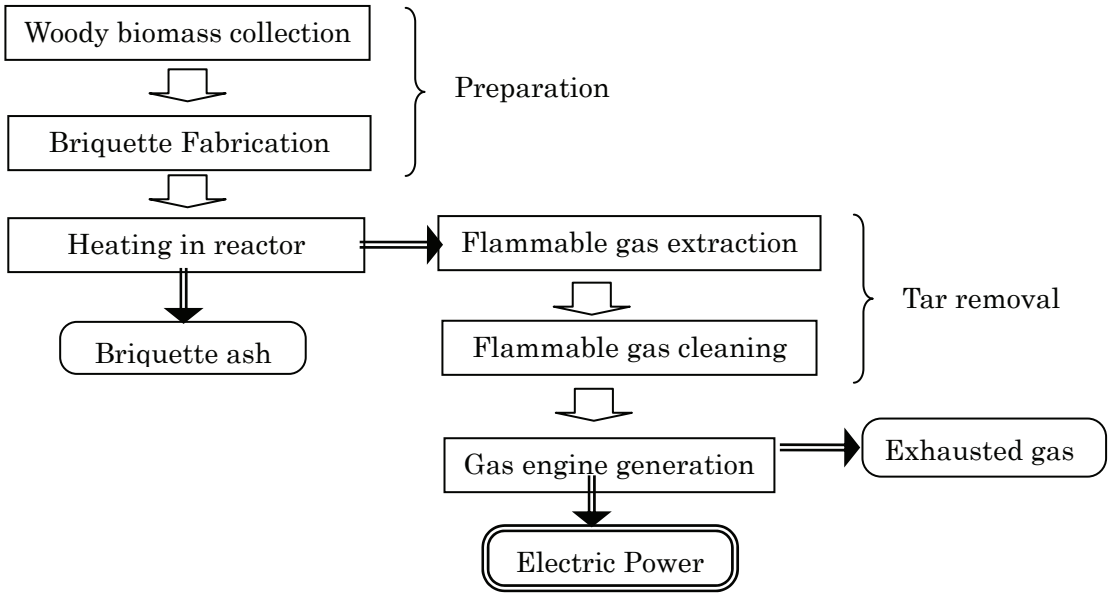
(Source: NEDO, Government policies for solar energy in Japan)

Fig. 5.1.4 Cumulative Number of Photovoltaic Power Generation Facilities Introduced in Major Countries

b Small Scale Biomass Generating System

Outline

Biomass generation uses fuel woody biomass, which is a by-product of agricultural activities. The work-flow of biomass generation is shown in Fig. 5.1.5.



Source: created by the study team

Fig. 5.1.5 Work-flow of Biomass Generation

As Fig. 5.1.5 shows, woody biomass is not inputted directly into a reactor, but is first fabricated into briquettes, which reduces the amount of tar in the flammable gas. The large amount of tar in the flammable gas would increase the frequency of replacing gas cleaning facilities, such as filter elements, and maintenance of the gas engine generator. It is, therefore, more profitable to fabricate briquettes than to input woody biomass directly into a reactor.

In general, there are two types of woody biomass generation: direct combustion and gasification. In the direct combustion type, biomass is burned to generate high-temperature, high-pressure steam to rotate the steam turbine for power generation, which can generally be seen in a thermal power station. The direct combustion type needs complicated machinery for high-temperature, high-pressure steam turbine operation, and also requires strict water quality control of feed water facilities and boiler, and maintenance and safety control of high-temperature, high-pressure facilities. Therefore, the direct combustion type is suitable for medium- or large-scale generation, and is not profitable at capacities of less than 10 MW. On the other hand, the gasification type is also appropriate for small-scale generation due to its simple structure and ease of maintenance. (See Fig. 5.1.6)

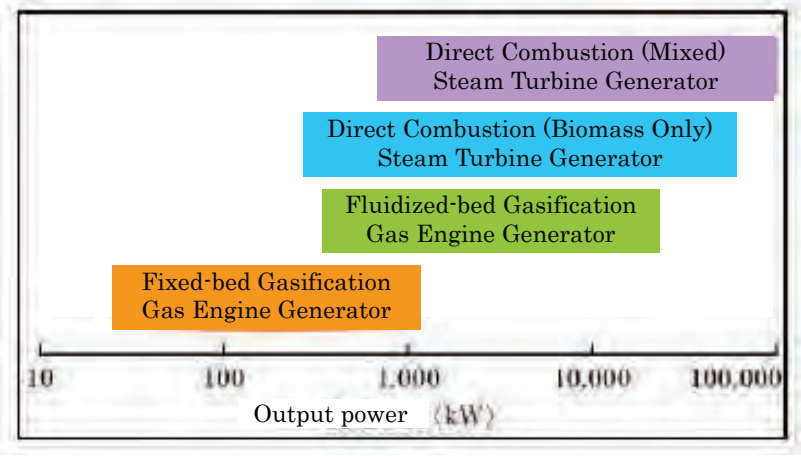


Fig. 5.1.6 Comparison of Generators

Features

In general, people tend to regard biomass generation skeptically, especially from the viewpoint of fuel procurement, because production of biomass is influenced by seasonality and the market price of biomass fuel is not stable. However, small-scale biomass generation is free from such concerns because woody biomass can be collected locally by users who are aware of the influences of seasonality and market prices of biomass.

In addition to reducing purchases of power from PEA and sales of power to the PEA with Adder, introducing small-scale biomass generation can bring the following benefits:

- Reduced distribution losses
  This system, which is located at the end of a power supply line, reduces distribution losses.

- Waste utilization
  How to dispose of woody biomass by-products is a big operational problem in farms and agricultural product-processing plants. Introduction of small-scale biomass generation could turn woody biomass waste into an asset for generating fuel.

- Heat recovery from exhaust gas
  The temperature of exhaust gas from a gas engine is relatively high and such heat can be recovered, for example, for drying or heating processes in agricultural product-processing plants.

- Briquette ash utilization
  Briquette ashes extracted from the reactor contain calories and are still flammable. Moreover, the shape itself is the same as a pre-heated briquette (cylinder shape: φ50 mm x 100 mm). Therefore, briquette ashes can be used or sold as fuel for the grills in homes.

– CDM credit

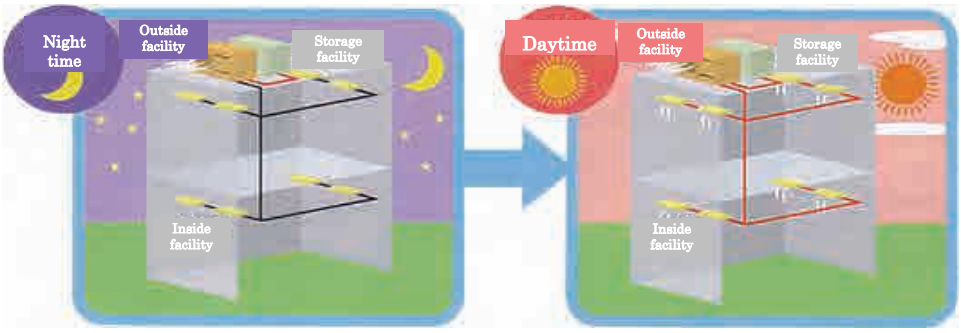
Woody biomass is carbon neutral, so it is considered that, through small-scale biomass generation, you can reduce consumption of fossil fuel that otherwise would be used for power generation; therefore, Certificated Emission Reduction (CER) can be obtained under the CDM scheme.

c Thermal Storage Air Conditioner System

As described in Section 4, confirmation of current conditions and future prospects of Energy Conservation 4.2 Future prospects for energy conservation b. Possibility of Introducing Energy Conservation into Private Companies, measures can be considered that focus on improving the annual load factor of electric power facilities as shown in Table 4.2.1. Here, a「Thermal Storage Air Conditioner System」is proposed because this system can apply existing measures such as TOU and TOD in Thailand, and is most effective for the commercial sector where electricity demand in increasing significantly. However, it is most suitable for commercial buildings such as office buildings and department stores that have small loads or do not operate at night, because TOU can be used effectively to reduce high initial costs. The characteristics of the system are described below.

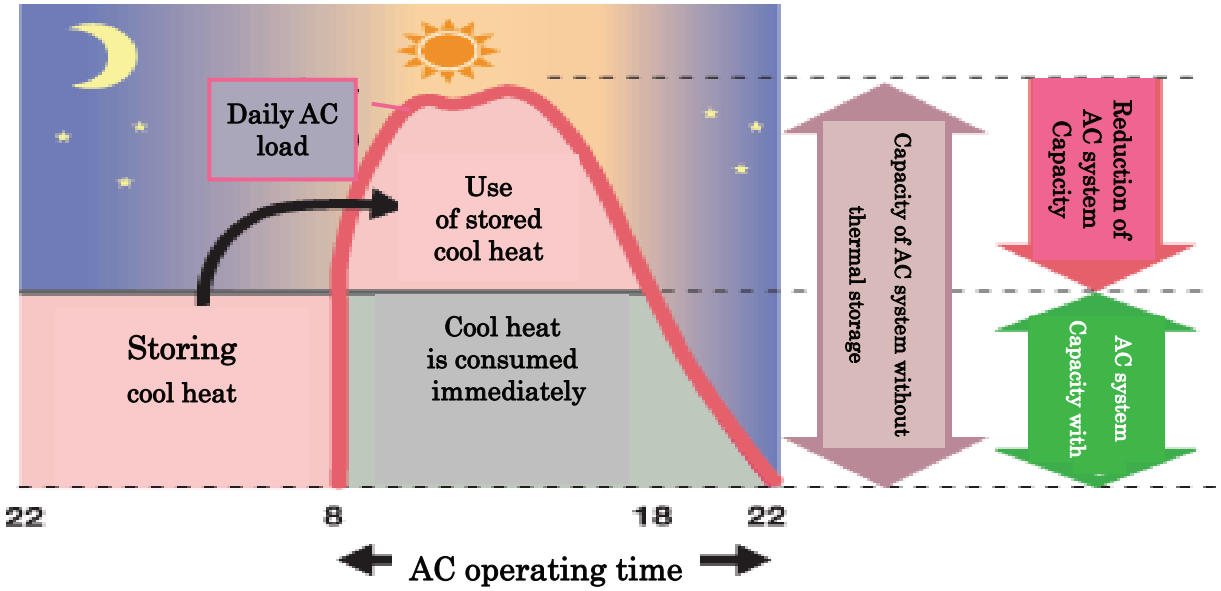
Thermal Storage Air Conditioner System

This is a highly efficient, clean energy system because this utilizes a heat energy (making ice, etc.) stored at night to operate air conditioners in daytime.



Source： Shikoku Electric Power Company HP

Energy required to operate air conditioners in daytime can be reduced because the system uses heat energy stored at night to operate air conditioners in daytime. So, the capacity required of an air conditioner system can be reduced.



Source： Shikoku Electric Power Company HP

The merits of the system are as follows.

① Cost Reduction

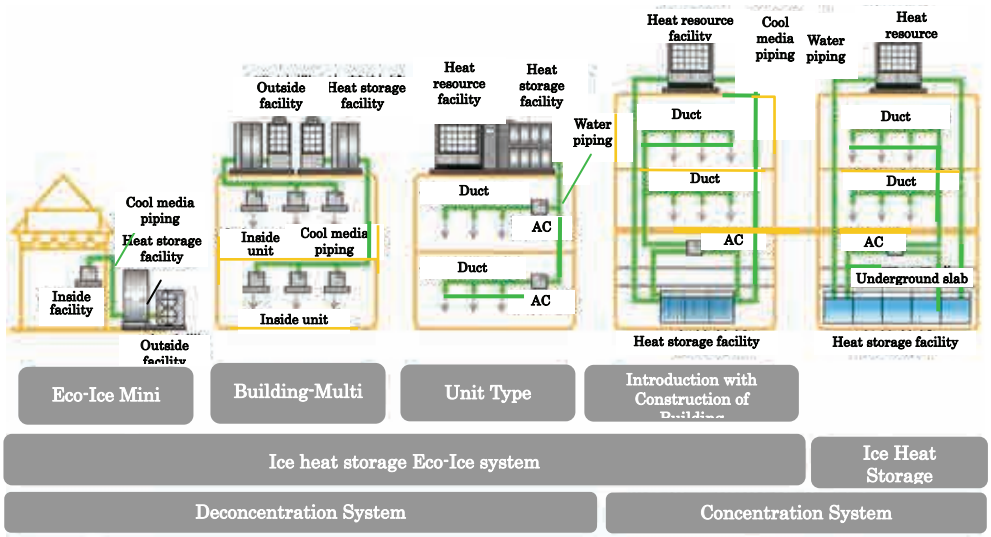
The thermal storage air-conditioning system can reduce the demand charge in an electricity tariff, because a smaller capacity air conditioner system is needed. In addition, this system can reduce operating costs because some of the electric power needed by an air-conditioning system in daytime can be supplied at a cheaper electricity tariff at night.

② Capacity Reduction

The capacity of an air-conditioning system can be reduced because the energy needed to meet the maximum electric demand of an air conditioner system in daytime can be reduced using energy stored at night.

③ Various Types Are Available

Types and sizes of thermal storage air conditioner system for a target facility can be freely selected from the wide range available. “Eco-Ice mini” and “Building Multi Type” are small and can be introduced easily for new builds and retrofitting.



Source： Shikoku Electric Power Company HP

④ Contribution to Energy Conservation

This system contributes to energy conservation because it can store heat energy generated by efficient rated operation at night.

⑤ Environmentally Friendly

This system contributes to reduce CO_2 emissions because it can improve the load factor of power generation facilities through efficient rated operation at night.

Unit Price of Electricity Tariff and Subsidy System for Thermal Storage Air Conditioner System in Japan

① Electricity Tariffs in Japan

There are various electricity tariffs in Japan and Thailand, and it is possible to select one according to a customer's usage pattern. Among the electricity tariffs in Japan, Time-of-Use is offered in two categories —season and time zone—and is structured to improve usage of electric power facilities by shifting loads to nighttime when electricity demand is low.

For reference, the Electricity tariff in Japan is shown in Table 5.1.1 and the electricity tariff in Thailand is shown in Table 5.1.2.

Table 5.1.1　Electricity Tariffs in Japan　(TOU for Season and Time Zone)

Demand Charge [Yen/kW] （Baht/kWh）※		1,476.00（527.14）
Energy Charge[Yen/kWh] （Baht/kWh）※	Peak time	20.48（7.31）
	Summer daytime	18.62（6.65）
	Daytime in other season	17.60（6.29）
	Nighttime	8.49（3.03）

(For medium-scale business facilities)

※　Exchange rate: 1 Baht=2.8 Yen.

Source: created by the study team

Table 5.1.2　Electricity Tariffs in Thailand　(TOU)

Demand Charge	Demand Charge [Baht/kW]	132.93
	Service Charge [Baht/Month]	228.17
Energy Charge [Baht/kWh]	On peak	2.6950
	Off peak	1.1914

(Medium-scale general service)

Source: created by the study team

In Japan's electricity tariff, the energy charge at nighttime is approximately nine Japanese yen less than the energy charge in daytime of seasons other than summer and approximately 12 Japanese yen less than the energy charge at daytime in summer. Meanwhile, in Thailand's electricity tariff, the difference between the daytime energy charge (On peak) and nighttime (Off peak) is approximately four Japanese yen, and the difference is smaller than under the tariff in Japan. Accordingly, when shifting the load to nighttime when electricity demand is low, the electricity tariff in Japan can reduce the cost of electricity more than the electricity tariff in Thailand, thus the Japanese tariff seems to be more attractive.

The demand charge in Japan is also set higher than in Thailand, and this can be reduced by decreasing the capacity of an air conditioning system through the introduction of a thermal storage air conditioning system. Accordingly, the cost reduction achieved by introducing a thermal storage air conditioning system under the Japanese electricity tariff is greater than under the Thai electricity tariff, thus the Japanese demand charge also seems to be more attractive.

② Thermal Storage Adjustment Contract

In addition to the above electricity tariff, there is a thermal storage adjustment contract in Japan, which is a discount electricity tariff that promotes shifting electricity usage from daytime to nighttime by introducing a thermal storage air conditioning system. When applying this contract to time of use for a season and time zone for business, the unit price in the electricity tariff in Japan is approximately two Japanese yen less than the energy charge in daytime of seasons other than summer and in the summer under Time-of-Use for season and time zone for business. Accordingly, the advantages of introducing a thermal storage air conditioner system increase under this contract.

③ Subsidy System for Supporting Businesses Introducing High-efficiency Air-conditioning System

The subsidy system for supporting businesses introducing a high-efficiency air-conditioning system was constructed in Japan as a measure to support the introduction of such systems. The main purpose of this subsidy system is to promote comprehensive energy-conservation measures by supporting the introduction of high-efficiency air conditioning systems into buildings covered by Japanese policy. The detailed contents are as follows.

Applicable equipment:

Outdoor facility or heat source facility for air conditioning system that meets regulations (e.g.; performance, COP, etc.) and uses vapor compression-type heat pump technology for air conditioning

Contents: （In the case of new construction）

One third of difference between purchase cost of high-efficiency air conditioner and purchase cost of conventional air conditioner

（In the case of replacing existing facility）

One third of a purchase cost of facility

d Inverter Air Conditioner

Operation is stopped when the temperature reaches point “a” after the preset temperature is exceeded and operation is restarted when the temperature reaches point “b” after the preset temperature is exceeded (see Fig. 5.1.7). Thus, a non-inverter air conditioner is very inefficient because it cools excessively.

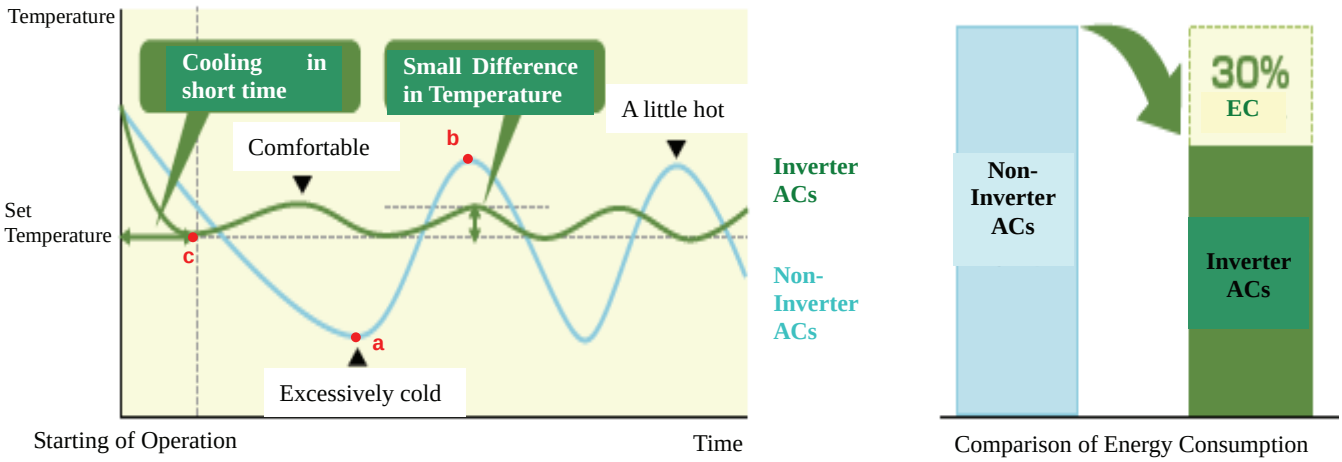
On the other hand, an inverter air conditioner can operate in high-speed mode and can reach a preset temperature (point “c”) quickly, and can switch to low-speed mode operation as the preset temperature is approached. The inverter air conditioner can reduce electric power losses caused by excessive cooling by changing the cooling capacity according to temperature. Accordingly, an inverter air conditioner can reduce energy consumption by approximately 30% compared to a non-inverter air conditioner (it can reduce energy consumption by approximately 80% compared to a non-inverter air conditioner used 15 years ago).

This energy conservation gained by inverter technology is achieved by finely controlling the

rotational speed of the motor driving the compressor and fan, which have important roles in cooling air.

Whereas the dissemination rate of home inverter air conditioners is still a little less than 10% worldwide, Japanese manufacturers have been actively engaged in technological development for them, resulting in their dissemination rate of almost 100% in Japanese households.

Since the demand for air conditioners is expected to increase with the future economic development in Thailand, where the dissemination rate of air conditioners in households is about 18% at present, the promotion of inverter air conditioners is considered to be quite important.



Source : Daikin Industries, Ltd.

Fig. 5.1.7 Comparison of Inverter Air Conditioner and Non-inverter Air Conditioner

5.2 Prior Issues, Prior Regions, and Available Resources for Future ODA Scheme

As a result of the first site study in Thailand, the JICA Team conducted a study on future ODA schemes for renewable energy and energy conservation in the Thailand power sector. The proposal is described this section as mentioned before under “Future Prospects” in Sections 3.2 and 4.2. There is great potential for renewable energy and energy conservation in the power sector with small-scale renewable energy, capacity building, and high-efficiency air-conditioning systems. The support method is described below.

In addition, for financial support, it is more reasonable for the Thai Government to use the existing the ENCON Fund, which has already been established and has a track record.

a Possibilities of ODA Support for Renewable Energy in Thailand

(1) Promotion for Small-scale Renewable Energy Generation

Today, renewable energy is expected to be widely used as the prices of facilities decline and incentives are provided such as the feed-in tariff “Adder.” In particular, big projects with economies of scale are booming with many candidate developers having sufficient

financial resources and technical capabilities to build well-designed facilities. But, small-scale facilities have no economies of scale and there are no incentives for developers to invest because of a lack of finance to pay initial expenses for facilities that nevertheless are expensive. Even if they can start operating the system, there are big barriers to long-term operation due to a lack of operating and maintenance expertise.
A lack of awareness of grid interconnection opportunities is one of the most significant barriers. Because of a lack of information about renewable energy resources, local people do not think about using agricultural waste to produce electricity, and generally lack the background needed to evaluate an investment in renewable energy equipment.

Under this situation, the Ministry of Energy created “Local Energy Planning (LEP)” to promote community-based development featuring self-sufficiency and sustainability. It gave priority to introducing community-scale energy with systems that would be self-sufficient in the future and understood that it is very important for local development to have good management of energy, environment, and local budget.
This section focuses on small-scale renewable energy, especially biomass energy generation and roof-top solar power, and explains the importance of introducing these systems to local communities in Thailand.

According to the “PDP2010” 20-year plan for renewable energy development, the biggest share of new development is for biomass generation and solar power. Large-scale generating facilities will be developed over the first few years. This is a kind of last-minute development under the principle of first-come-first-served. But, PDP2010 also assumes continuous development of renewable energy after this initial stage of high activity. Most development projects are relatively small scale compared to the initial ones and there is no choice but to accept those that do not offer economies of scale.

Table 5.2.1 summarizes the number and the average capacity of approved and planned solar and biomass projects by VSPP on the basis of data published by EPPO at the seminar “Solar Business in Bangkok” held in March 2010. According to this table, the capacity of most of these projects exceeds 1-MW, and there is little incentive to invest in those whose capacity is under 1-MW. As there was a support from ENCON Fund for household solar energy facilities before, the number of roof top solar projects is greater for existing solar energy facilities (grid connection).

Table 5.2.1 Project Scale of VSPP Solar and Biomass

Stage	VSPP_Solar		VSPP_Biomass	
Under planning	Roof Top Solar Average [600 kW]	34	<1 MW Average [777 kW]	9
	>1 MW Average [5 MW]	159	>1 MW Average [6.7 MW]	93
Approved PPA	Roof Top Solar Average [500 kW]	6	<1MW Average [666 kW]	3
	>1 MW Average [4.8 MW]	332	>1MW Average [7.5 MW]	189
Grid Connection	Roof Top Solar Average [42 kW]	48	<1MW Average [666 kW]	6
	>1MW Average [1.2 MW]	5	>1MW Average [6 MW]	47

(Source: created by the study team based on EPPO document)

Regarding small-scale solar power, economies of scale are not expected and the initial cost is high. The introduction target of 2022 for solar power has already been exceeded, taking the current situation of promoting large-scale solar power into consideration. Therefore, incentives for promoting small-scale solar power are low for investors.

Regarding small-scale biomass, the introduction target of 2022 is almost achievable, although promotion of large-scale biomass is slow. There is also the possibility of developing biomass in local communities, which has great potential. In addition, there are strong incentives to promote small-scale biomass generation in the country from the perspective of revitalizing local communities and narrowing gaps between regions.

Therefore, the study team gives a detailed explanation of the dissemination of small-scale biomass generation below.

Excellent Characteristics of Small-scale Biomass in Local Communities

The rate of electrification is almost 90% and PEA has installed distribution facilities throughout Thailand.

The small-scale biomass generating facilities which generally adopt gasification furnaces, have the advantage of easy adjustment of the output power in comparison with the direct combustion stoker furnace. Therefore, due to the limitation of the fuel, it is easily possible to stop the generation at night, for the purpose to generate to sell or use in daytime when the retail tariff and wholesale tariff are high.

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Usually, small-scale biomass generators are located in rural areas that are downstream in

the power flow. They have specific features to operate and generate electricity during peak load times and can sell power to the grid.

The power input from the feeders can reduce the peak power load of a substation and reduce the current of power feeders. This contributes to reducing distribution line losses and peak cutting. Electricity peak demand is following an upward trend, therefore, developing power-generating facilities is an urgent issue in the electric power sector in Thailand. Taking a long view, it is very useful to defer construction of power facilities and there are important economic benefits for electric power utilities.

Grid-connected small-scale renewable energy is particularly appropriate for Thailand.

Small-scale Biomass Generators

Thailand is the world's leading exporter of rice, and is a major producer of cassava, sugarcane, palm, and coconut. Forestation by plantations using large areas of land is also a major potential biomass energy source.

The main barrier is a shortage of high-quality, affordable equipment suitable for deploying grid-connected renewable energy systems except that economies of scale are not expected. Major problems include integrated protection relays for interconnection of rotating generation and internal combustion engines suitable for long-term use. Expertise in the design and installation of all types of small-scale renewable energy systems including biomass generator is also in short supply.

To resolve some of the barriers, many measures are very effective for promoting small-scale biomass generator introduction to local communities.

1. Promoting training and exchanges of experience in renewable energy; for instance, regional training and information-sharing workshops that bring together experts in the field of biomass.
2. Strengthening and establishing appropriate regional networks or centers for exchanging information on renewable energy.
3. Developing a college-level curriculum to enhance understanding and skills in the field of clean-energy technologies
4. Incentives for building local manufacturing capabilities and diffusing renewable energy technologies and developing high-efficiency renewable energy systems
5. Program to provide financial assistance to promote development of appropriate technologies using local resources.
6. Management of various conditions concerning adoption in each local area (transportation and logistic management for material, proper grid-connecting point, and environmental problems)

These activities and programs at local levels will help Thailand meet its goal for

promoting renewable energy. Furthermore, rural renewable energy projects create jobs and can slow urban centralization.

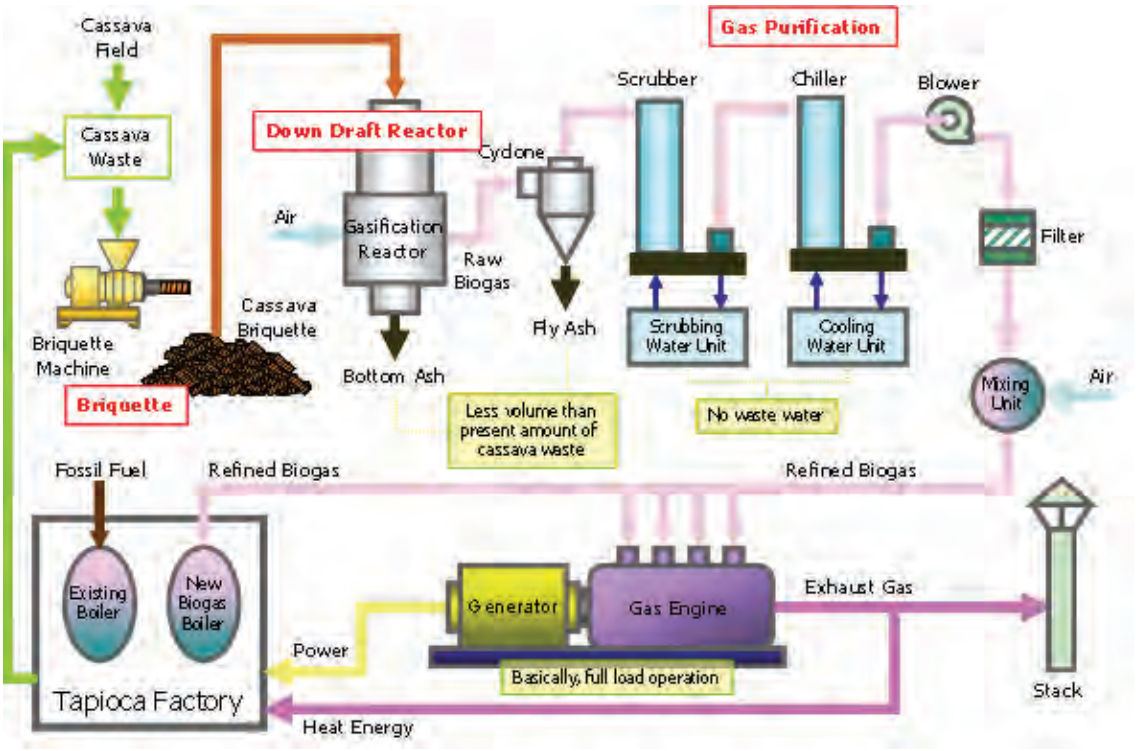
Other social development benefits expected are listed below,

- •Reduce migration to cities by creating jobs in rural areas
- •Stable farm income from selling agricultural products
- •Enhance quality of life of people and equity

Proposal for small-scale Biomass Gasification System

The need for small-scale biomass generation is high in Thailand. Many laboratories have recently conducted experimental studies, and a large number of 100 kW-class biomass generation plants are being introduced on a commercial basis. On the other hand, some plants have stopped operation because of contamination of fuel gas generated during the gasification process. Small-scale biomass generation is regarded to be problematic in terms of fuel procurement and operation and maintenance, in addition to its small economic scale, and its sustainability is in doubt due to such issues.

Japan has developed a design to strictly control the combustion temperature in a gasification reactor and has introduced a preparation process to convert biomass fuel into briquettes, so that it can reduce the amount of tar in the flammable gas, which results in a long period of operation.



Source: created by the study team

Fig. 5.2.1 Basic Plant Specifications

Because the initial cost of introducing the system is relatively high, some incentives are required for small-scale investors to purchase it. In addition, a support by governmental agencies, local

governments, or universities is required at present, and it is considered appropriate to promote the dissemination of small-scale biomass generation by private corporations.
As a governmental support is thus essential for their widespread dissemination, the implementation of following measures is recommended.

① Subsidy

To make small-size biomass generation popular, financial support from the government, such as through subsidies, is required initially. When a certain quantity of small-scale biomass generation facilities are traded in the market, the production line for the facilities will become established and enjoy economies of scale, which will make such systems more popular. Some laboratories already have pilot plants for small-scale biomass generation, so it can be concluded that the basic design of facilities has been established. In fact, the Suranaree University of Technology has overcome such problems as tar removal, and small-scale biomass generation plants are being operated commercially in neighboring communities.

(Source: Suranari University)

Fig. 5.2.2 Pilot Plant at Suranaree University

② Adder increase

Under the current Adder system, biomass and the biogas generation receives a lower Adder than any other form of renewable energy generation. While woody biomass generation has relatively high initial costs as discussed above, such a cost is not widely perceived. Because economies of scale are not expected in the case of small-scale facilities, the Adder is not sufficient.
Because the current Adder system does not provide enough incentives for business managers, Adder for biomass and biogas generation should be increased after such initial costs and preparatory expenses for woody biomass fuel are taken into consideration.
As the economies of scale of biomass generation have more impact on profitability than any other renewable energy, a still higher Adder is required, although a supplementary Adder was introduced for small-scale biomass generation of less than 1 MW in May 2009. In addition, even though a supplementary Adder from 1 to 1.5 THB/kWh is available for remote areas to shift from diesel generation, expansion of such areas or a further Adder is also recommended for promotion.

③ Measures to lower risk

Because it is administered by local communities, and does not have the fuel supply issues of large-scale biomass generation, there is little risk of fuel price fluctuations with small-scale biomass generation.

Completely removing the risk of fuel price fluctuations would attract more business managers. Thus, financial tools to avoid risk, such as insurance and options, and zoning management are required to be developed.

④ Establishment of biomass promotion center

Because woody biomass fuels are widely available throughout Thailand, the most suitable areas in terms of the fuel procurement should be selected for the promotion campaign. Generally, the most suitable areas are located in northeast Thailand where power is generated by diesel generators of PEA and where electricity is as expensive as 12 THB/kWh. In such areas, small-scale biomass generation is competitive, and is expected to replace diesel generation.

More importantly, information and knowledge are not fully provided in such areas, so a biomass promotion center should be established and information sharing and technology transfers should be implemented.

Universities in such areas are candidates for the biomass promotion center, and it is expected that such universities will play major roles in promoting small-scale biomass generation.

Fig. 5.2.3 Community Biomass Promotion Center

(2) Proposal for Capacity Building Renewable Energy Engineers

Human resource development for renewable energy generation is frequently required due to the sharp increase of the installed capacity of renewable energy as a climate change measure and for electrification. At present, DEDE is considering human resource development related to renewable energy techniques as a measure to disseminate and promote renewable energy.

Support from Japan for personnel training on renewable energy techniques has been provided many times with training carried out in Thailand and Japan. Therefore, this knowledge and the results of training accumulated in Japan are being considered to meet needs in Thailand.

① Demand for Human Resource Development in Thailand

Demand for technical assistance and training was found in interview surveys of electric power utilities and private companies.

PEA has the target of undertaking its own research and development for renewable energy, and intends to promote the introduction of facilities by the private sector. It has the idea of strengthening personnel training on principles, design, construction, management, etc. for all kinds of renewable energy. In particular, it is considering research and development of techniques to connect a number of small-scale wind turbines to the grid and high-efficiency solar cells as urgent subjects. PEA has also been providing training for its employees and private companies.

As EGCO develops large-scale solar farms and wind farms, there is demand for more appropriate examination techniques for connecting large-scale renewable energy generation facilities to the grid. Its existing training system for O&M engineers is substantial, and is effective for the renewable energy business, too.

In addition, there is a lack of O&M engineers in enterprises administering small biomass gasification generation facilities, and personnel training are required.

Furthermore, O&M engineers and advisors are needed to push forward with the installation of renewable energy generation facilities such as SHS to villages not supplied with electricity.

② Method of providing training

The following methods of providing training are considered.

1. Methods of supporting technical training projects of electric power utilities and private companies in Thailand

Methods of providing training to workers in electric power utilities and private companies are as follows.

- Electric power utilities and private companies arrange training for employees using in-house personnel training resources
- Electric power utilities and private companies arrange training for employees using an outside training curriculum
- Electric power utilities and private companies arrange training for outside students using an in-house or outside training curriculum and inviting experts as lecturers

Methods of supporting training are as follows, although it is necessary to discuss them with the Thai government.

- Japan gives financial support to expand the coverage of the ESCO fund, which already can be used for technical support
- Japan gives financial support to establish a technical support fund, and support its use

In addition, electric power utilities are proceeding with research and development to apply renewable energy for the dissemination of renewable energy businesses. They would also like training on newly developed techniques and to invite Japanese experts. Therefore, the fund can also be used effectively for these purposes.

2. Method of providing training from Japan

Other than the above, it is also considered that Japanese organizations can plan, hold, and manage training. A method to arrange funding for training within the framework of the ESCO fund or establish another fund, as same as the case mentioned above, is considered. Training will be arranged for employees of government offices and electric power utilities. Subsequently, participants will plan and arrange various forms of training in Thailand to disseminate knowledge widely to domestic engineers and raise their technical levels.

Methods being considered to provide training from Japan are as follows.

[Example of training provided from Japan]

① Implementing method

There are many proper universities with experiment facilities for renewable energy in Thailand that can be bases for training Thai engineers. While training will basically be arranged in local universities, it is effective to combine training in Japan with experiments and site studies applying high-level techniques. Lecturers will be invited from among experts in Japan and Thailand according to the subject.

Thailand and surrounding countries have close links. If training in Thailand includes participants from those countries, it can be used to develop techniques throughout Southeast Asia. Training resources can also be used effectively.

② Example of training structure

Training curriculum are arranged appropriately according to the participants' business, technical level, and target. Generally, knowledge and practice needs to be provided in various fields, such as basic principles, design techniques, O&M methods, grid connections, and systems. Training is provided step-by-step in the order from basic contents to high level.

How the technical levels of participants are enhanced is shown in Fig. 5.2.4.

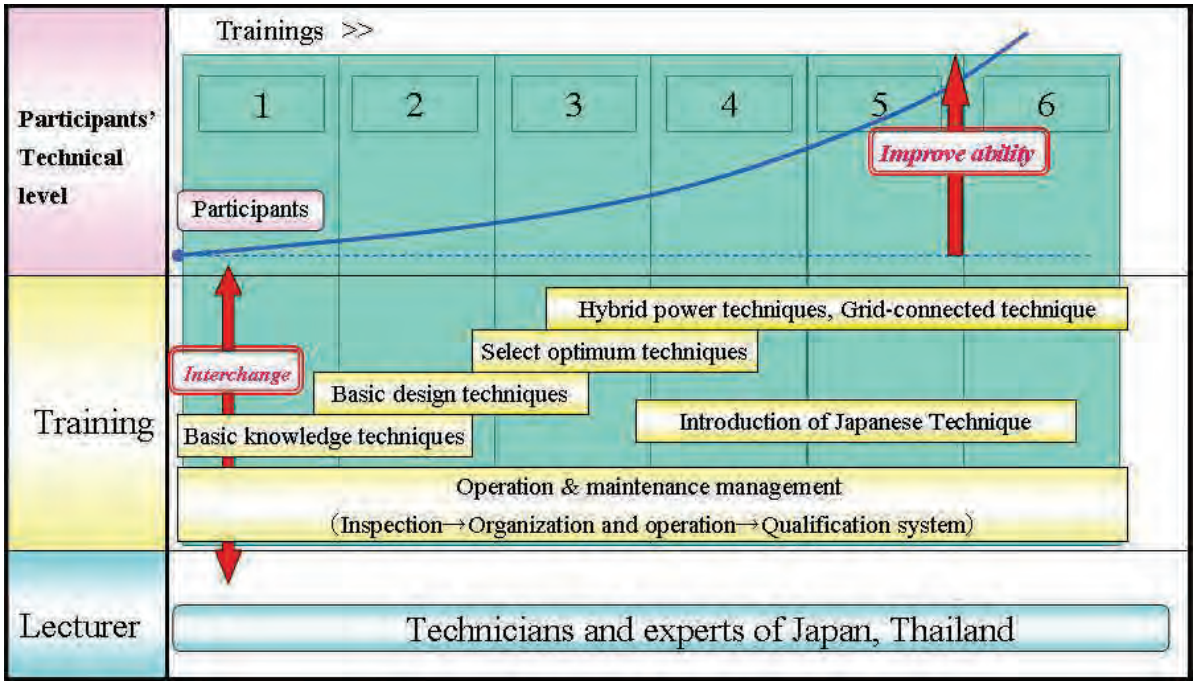


Fig. 5.2.4 Human Resource Development on Renewable Energy to Enhance Technical Level

③ Example of curriculum

A concrete example of subjects offered to enhance the technical levels of engineers is explained below by step. The principal subjects are included in each step. In practice, subjects would be chosen by type of renewable energy and required field in a country and at sites (such as O&M on small-scale biomass).

○ Training on basic knowledge, Basic design techniques, selection of optimum electrification method

- PV generation (basic/design), small hydro power generation (basic/design), Wind power generation (basic/design) etc.: To obtain basic knowledge, facility composition, operating principles, characteristics and design knowledge, etc. for renewable energy generation facilities such as solar power, small hydro power, wind power, and biomass.
- Selection of optimum electrification method: To obtain skills needed to select the optimum electrification method for areas without an electricity supply.

○ Training on inspection techniques

- Installation and maintenance of PV system, Hydro power generation (maintenance), biomass generation (maintenance), etc.: To learn methods to quantifiably judge operating condition, inspection method and period, troubleshooting measures etc. for renewable energy generation facilities such as solar power, small hydro power, wind power, and biomass.

○ Training (experiments) to learn practical techniques for inspection, O&M, and management

- Outline of facilities and points for inspection, hands-on training for maintaining PV generation facility, troubleshooting, etc.: To understand the practical structures of facilities and inspection methods through a study tour of generation systems with hands-on training on inspections etc.

○ Training on hybrid generation techniques

- Outline of PV hybrid system, example of PV hybrid system project etc.: To study design, facility composition, operating principles, characteristics, and evaluation methods, etc. for hybrid systems using renewable energy generation facilities such as solar power, small hydro power, wind power, and biomass.

○ Training on grid connection techniques

- Grid connection techniques, issues considered for connecting large-scale PV, etc.: To understand issues related to connecting renewable energy generation facilities to the grid while introducing Japanese technology.

○ Training on certification system and qualification system

Certification system, qualification system, etc.: Training on quality improvement and managing and examining methods for grid connection, to understand certification system of facility performance and qualification system for engineers, referring to Japanese examples.

○ Training　managing organizations

- Sustainable community electrification development, O&M system etc.: Understand methods of managing community electrification and operation systems and methods for evaluating economic profit.

○ Introduction of Japanese techniques on renewable energy generation

- Study tour of mega-solar facilities, study tour of wind farms etc.: To understand the present situation of high-level and large-scale electricity supply technologies and grid-connecting techniques through study tours of renewable energy generation facilities in Japan and seminars.

Based on the example above, a sample curriculum of two-week training three times a year is shown in Table 5.2.2. It can be extended to a course of two training sessions a year for three years etc.

Table 5.2.2 Human Resource Development on Renewable Energy, Example of Curriculum (three times a year)

Training	Place	Main Purpose	Week		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1st	Japan Shikoku Island	Facility Tour	First Week	am	Opening Ceremony/Orientation RE Trend in Japan	Skill for Selecting the optimum electrification method	Area Heat Supply Center (Facility Tour)	Misaki Wind Power (Facility Tour)	PV Matsuyama Power Plant (Facility Tour)	
				pm	RE Activities in Shikoku Electric Power Company		PV Facility near Head Office (Facility Tour)			
			Second Week	am	Wind Power (Basic)	Small Hydro Power (Basic)	Biomass (Basic)	Characteristic Measurement of PV System (Hands-on)	Institutional Frameworks for PV	
				pm	Wind Power (Design)	Small Hydro Power (Design)	Biomass (Design)		Closing Ceremony	
2nd	Thailand (Univ.)	Training (Hands-on・Economic Efficiency)	First Week	am	Opening Ceremony/Orientation	PV (Basic)	PV (Hands-on)	PV (Hands-on)	Small-scale PV (Facility Tour)	
				pm	General Measures for O&M	PV (Design)				
			Second Week	am	Trouble Case Introduction in RE Project	Technology Economics for RE Project	Same as on the left	CDM	PV Micro Grid (Lecture)	
				pm					PV Micro Grid (Facility Tour) Closing Ceremony	
3rd	Thailand (Univ.)	Training (Grid Connection Technology・Hybrid)	First Week	am	Opening Ceremony/Orientation	PV SHS (System Design)	Grid Connected PV (System Design)	Design for PV Hybrid (Demand Estimates～System Design) (Lecture)	Same as on the left (Hands-on)	
				pm						
			Second Week	am	Guideline for Grid Connected PV (Lecture)	Same as on the left (Hands-on)	Considered Issues for Connection of Large-scale PV (Lecture)	Same as on the left (Hands-on)	Certification System	
				pm					Qualification System Closing Ceremony	

Source: Created by the study team

b Possibilities of ODA Support for Energy Conservation in Thailand

(1) Problems and Support Measures for Introducing Thermal Storage Air Conditioning Systems

Problems

A thermal storage air conditioning system enables curbing of demand charge and a reduction in air conditioner capacity as well as makes available inexpensive electricity charge during nighttime by shifting daytime air conditioning load to nighttime. In introducing this system, however, it is possible that its introduction results in maximum demand during nighttime with a facility with large power load throughout the day. It should be noted that this precludes curbing of demand charge. For this reason, it is more effective to introduce thermal storage air conditioning systems into commercial buildings (e.g., office buildings and department stores, etc.) that have a small or no load at night. The problems shown in Table 5.2.3, however, should be addressed when introducing this system to these buildings.

Table 5.2.3 Problems Introducing and Disseminating Thermal Storage Air Conditioner Systems in Thailand

Recognition	・There are few cases of introduction and recognition is very low
Economic Efficiency	・Difference between electricity tariff in daytime and nighttime under TOU is small and payback period is long ・Initial cost is high

Source：Created by the study team

Support Measures

The following items are proposed as effective support measures to solve these programs.

Table 5.2.4 Support Measures for Introducing and Disseminating Thermal Storage Air Conditioner Systems in Thailand

Recognition	①Educational activities using case studies（EGAT Building・MEA Building, etc.）
Economic Efficiency	②Review of TOU ③Construction of special electricity tariff for this system ④Introduction of subsidy system for initial cost

Source： Created by the study team

① **Educational Activities Using Case Studies**

As shown in Section 4-4.2-b, this system is very effective measure for decreasing the load factors of electric power facilities in line with economic growth in Thailand. However, recognition of this system is very low based on the results of our interview survey. Accordingly, its recognition will be improved by introducing case studies in Thailand and Japan.

② **Review of TOU**

As shown in Section 5-5.1-5.1.3, a characteristic of this system is heat energy stored using electricity supplied under a cheaper nighttime tariff to operate an air-conditioning system in daytime. The initial cost of this system is paid back by reducing the basic rate of electricity tariff according to the decreased capacity of an air-conditioning system and the difference between daytime and nighttime in the electricity tariff. Meanwhile, in TOU in Thailand, the difference between daytime and nighttime electricity tariff is approximately 1.4 baht (approximately 4 Japanese yen). This is much smaller than the difference in the Japanese electric tariff (approximately 9~12 yen) and is not offer a large enough incentive to overcome the high initial cost of this system. Therefore, the payback period is longer. Here, in order to improve this condition, a review of TOU and establishing a larger difference between daytime and nighttime are proposed.

③ **Construction of Special Electricity Tariff for Thermal Storage Air-conditioning Systems**

Based on the results of our interview survey, a review of the existing electricity tariff in Thailand requires negotiations with a large number of people and the procedure would be troublesome. Therefore, reviewing the existing electricity tariff in Thailand might be impractical. It would be easier to construct a special electricity tariff for the thermal storage air conditioning system if its significance can be made clear. Accordingly, a special electricity tariff with a larger difference between daytime and nighttime rates than the existing one is proposed for a thermal storage air conditioning system. If this special electricity tariff is constructed, it would become a specific supporting measure for thermal storage air conditioning systems and contribute to their dissemination.

④ **Introduction of Subsidy System for Initial Costs**

The high initial cost of this system is a possible barrier to its dissemination, even if the TOU is reviewed or a special electricity tariff is constructed, because of the greater importance placed in Thailand on initial cost than life-cycle cost. Accordingly, introduction of a subsidy system for the initial cost would contribute to the dissemination of thermal storage air conditioning systems.

It has been found through discussion with EGAT that they have expectation on the peak shift effect by the spread of thermal storage air conditioning systems since the inhibition of peak sharpening in power demand and an improvement in annual load factor lead to the curbing of capital investment in power generation facilities. They also recognize the necessity of TOU revision and the establishment of a special electricity tariff for thermal storage air conditioning systems, and they agreed with us that these countermeasures constitute measures for improving annual load factor.

(2) Problems and Support Measures for Introducing Inverter Air conditioners

For the dissemination of inverter air conditioners in Thailand, the problems shown in Table 5.2.5 can be considered. Accordingly, effective support measures are desirable to solve these problems.

Table 5.2.5 Problems Introducing and Disseminating Inverter Air Conditioners in Thailand

Economic Efficiency	・Approximately 30% higher initial cost compared to non-INV
Performance Standard in Labeling Program	・INV not effective due to use of only 「Energy Efficiency Ratio」

Source: created by the study team

Support Measures

To solve the problems shown in Table 5.2.5, the support measures shown in Table 5.2.6 are proposed.

Table 5.2.6 Support Measures for Introducing and Disseminating Inverter Air Conditioners in Thailand

Economic Efficiency	① Introduction of subsidy system for inverter air conditioners
Performance Standard in Labeling Program	② Adoption of「seasonal energy efficiency ratio (SEER)」

Source: created by the study team

① Introduction of Subsidy System for Inverter Air Conditioners

An inverter air conditioner can reduce electric consumption by 30% compared to a non-inverter air conditioner, however, the initial cost of an inverter air conditioner is 30～50% higher than a non-inverter air conditioner and this high initial cost is a barrier to their dissemination. Dissemination of energy conservation facilities will be promoted in residential sector, which is expected have increased energy demand, if a subsidy system for inverter air conditioners is introduced and the price difference between inverter air conditioner and non-inverter air conditioner can be reduced.

② Adoption of "Seasonal Energy Efficiency Ratio (SEER)"

The existing labeling program for room air conditioners in Thailand adopts "Energy Efficiency Ratio (EER)"as a performance standard, which only evaluates energy consumption efficiency under rated load operation. This performance standard cannot evaluate the performance of an INV, which has greater energy conservation effectiveness at partial load operation. Therefore, the incentive to use an inverter air conditioner is not seen by the consumer.

On the other hand, the "Seasonal Energy Efficiency Ratio (SEER)" is an index that evaluates energy consumption efficiency throughout one year, and the effects on energy conservation of a inverter air conditioner can be visualized. Introduction of SEER as a labeling performance standard would promote the spread of inverter air conditioners.

While EER has only one point at rated load operation to measure energy consumption efficiency, SEER, which can reflect the energy conservation effects of an inverter air conditioner, needs two or more points to measure energy consumption efficiency at partial load (Low-speed operation) in addition to that at the rated load.

There are two testing laboratory for air conditioners in Thailand at the Electrical and Electronics Institute: Governmental Testing Laboratory (EEI), and a new product requires two or three months for testing. If SEER is adopted to disseminate inverter air conditioners, it is expected to take a long time to test inverter air conditioners because of the increased measuring points.

For reference, regarding the labeling system, an examination of standardization among ASEAN nations including Thailand is now being conducted by the Ministry of Economy, Trade and Industry in Japan under consignment—"Energy conservation standards and labeling system construction support activities in developing countries."

In the case of disseminating inverter air conditioners in the future, there is a possibility of an

increasing need to evaluate the performance of each inverter air conditioner in the existing labeling program, in order to promote the most efficient air conditioner among several options. Based on the results of our consideration, including this possibility, adoption of「SEER」is proposed as the best solution. However, there are few manufacturers in Thailand that can produce inverter air conditioners themselves and there is a possibility of them being excluded from Thai market if 「SEER」is adopted into the existing labeling program. To avoid this risk and to disseminate inverter air conditioners, one proposal is to put a mark on an inverter air conditioner that informs customers.

c Financial Support

(1) Problems with current system

RE/EC developers need initial capital to install facilities. To meet this need, Revolving Fund and ESCO Fund under ENCON Fund are very attractive schemes to developers.

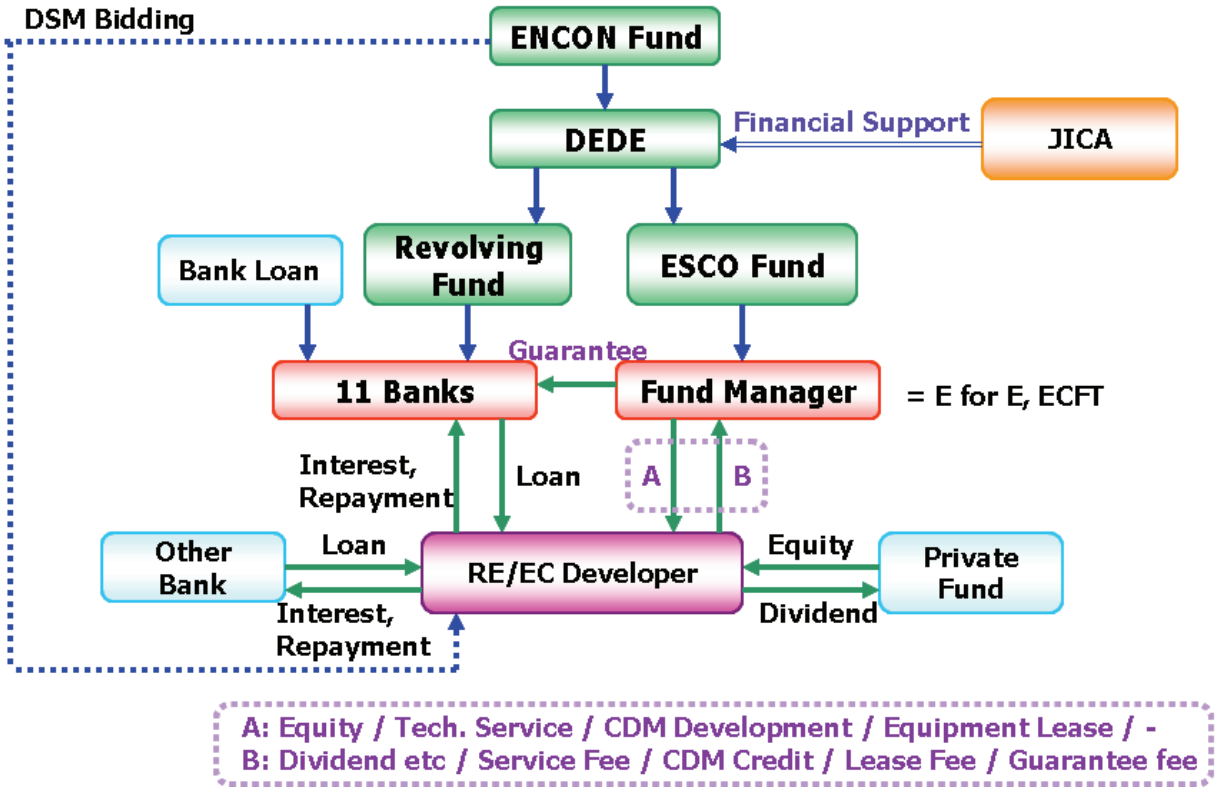
Because the initial purpose of establishing the ENCON Fund was to promote energy conservation, the budget is going to be decreased due to the fact that many developers have applied for the Revolving Fund and ESCO Fund and DEDE tends to conclude that its initial purpose has already been achieved. therefore, the amount of the Revolving Fund will decrease from 2,000 to 500 million THB from the next phase and it is uncertain that the ESCO Fund will be applied in the next phase.

Even though public recognition of energy conservation is high compared to the initial stage, many developers still needs the ENCON Fund. Therefore, the scale of the ENCON Fund should be maintained or even increased.

(2) Support Measures

As stated in Section 4, the direct lenders are 11 commercial banks for the Revolving Fund and two fund managers appointed by DEDE for the ESCO Fund. Commercial banks and fund managers are, as they should be, responsible for operations from cash injection to return. Although the ESCO Fund does not have a long history, the Revolving Fund has a good track record and has demonstrated its soundness.

Therefore, the study team concludes that the ENCON Fund is reliable In addition, it is more reasonable to use the existing system than to establish a new system from scratch when implementing financial support. In conclusion, the study team proposes to provide financial support to DEDE, as shown in Fig. 5.2.5. Taking into account the interest rate of 4% of the Revolving Fund and ESCO Fund, the study team recommends using the Climate Change Program Loan (CCPL), with which a low interest rate for financial support is possible.



Source: created by the study team

Fig. 5.2.5 Framework of Financial Support

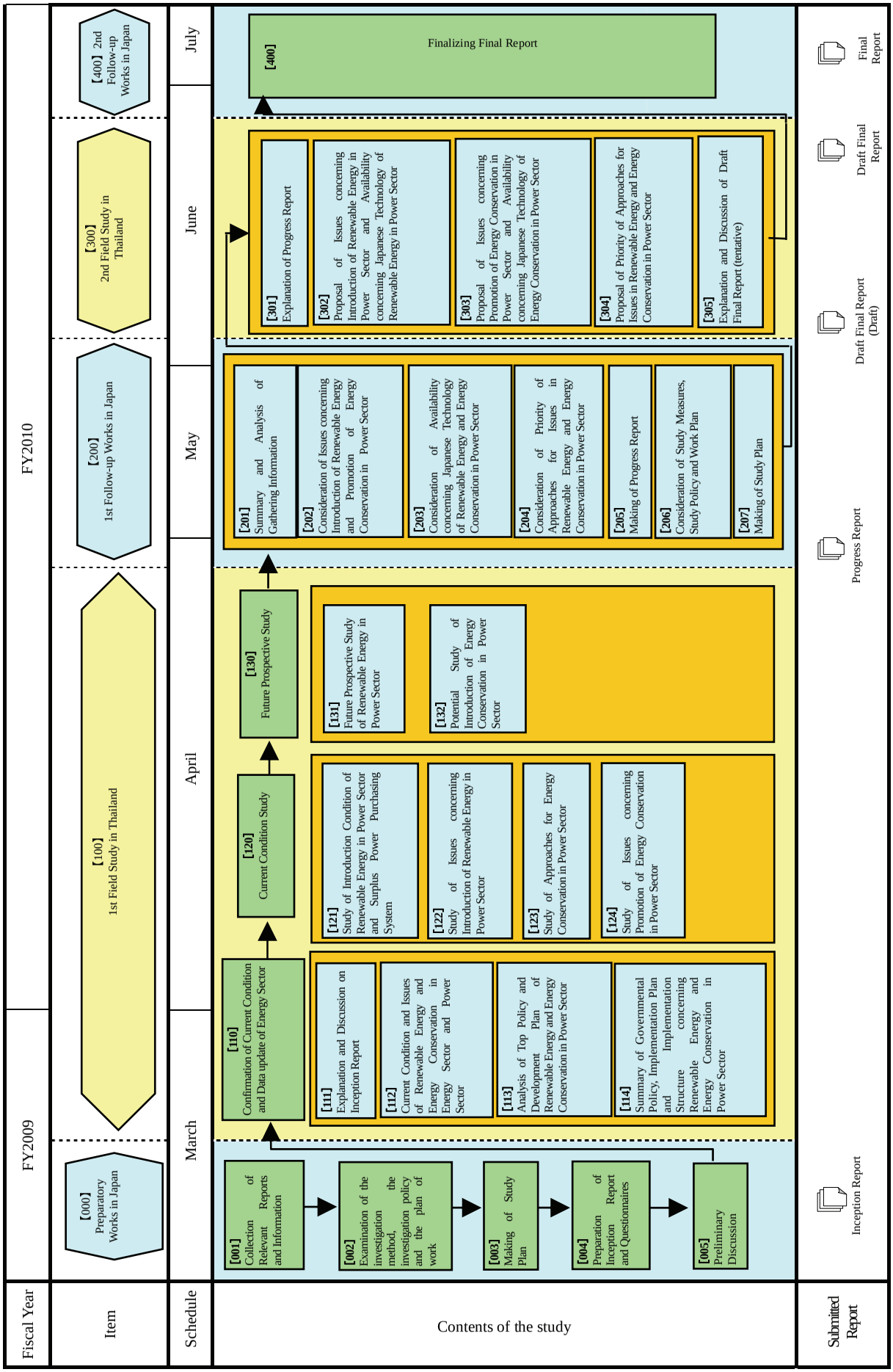
Appendix

Appendix 1　Member List of the Study Team

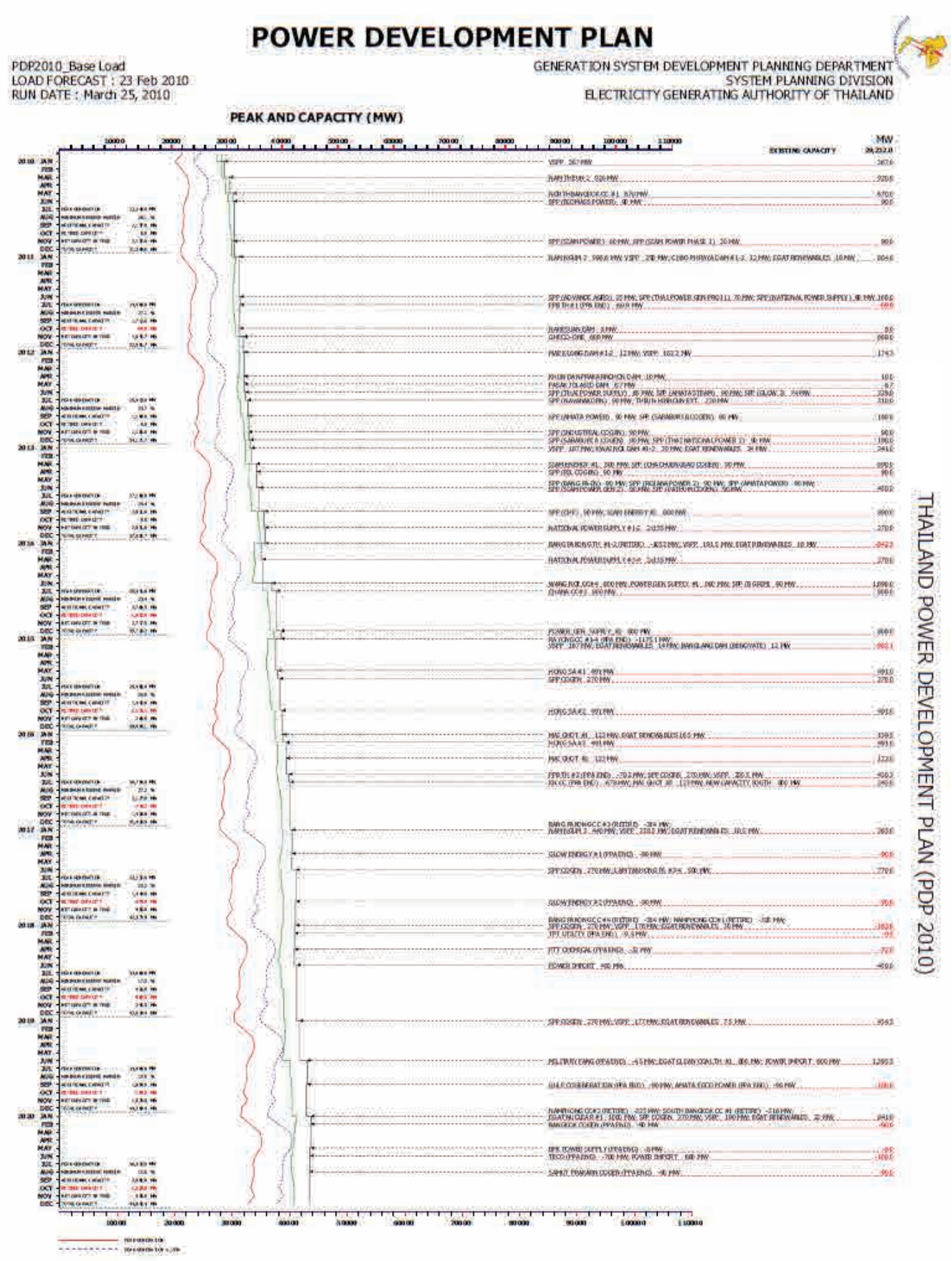
Member List of the Study Team

Name	Position	Organization
Mr. Kenichi KUWAHARA	Study Team Leader	Shikoku Electric Power Co., Inc.
Mr. Hiroshi SUGIHARA	Renewable Energy Expert(A)	Shikoku Electric Power Co., Inc.
Mr. Masahiro IZUMIKAWA	Renewable Energy Expert(B)	Shikoku Electric Power Co., Inc.
Mr. Yoshitetsu FUJISAWA	Energy Conservation Expert(A)	Shikoku Electric Power Co., Inc.
Mr. Naoki YOKOTA	Energy Conservation Assistant(A)	Shikoku Electric Power Co., Inc.
Mr. Hisatoshi AKIYAMA	Energy Conservation Assistant(B)	Shikoku Electric Power Co., Inc.

Appendix 2 Study Schedule



Appendix 3 EGAT POWER DEVELOPMENT PLAN 2010-2030 (Extract)

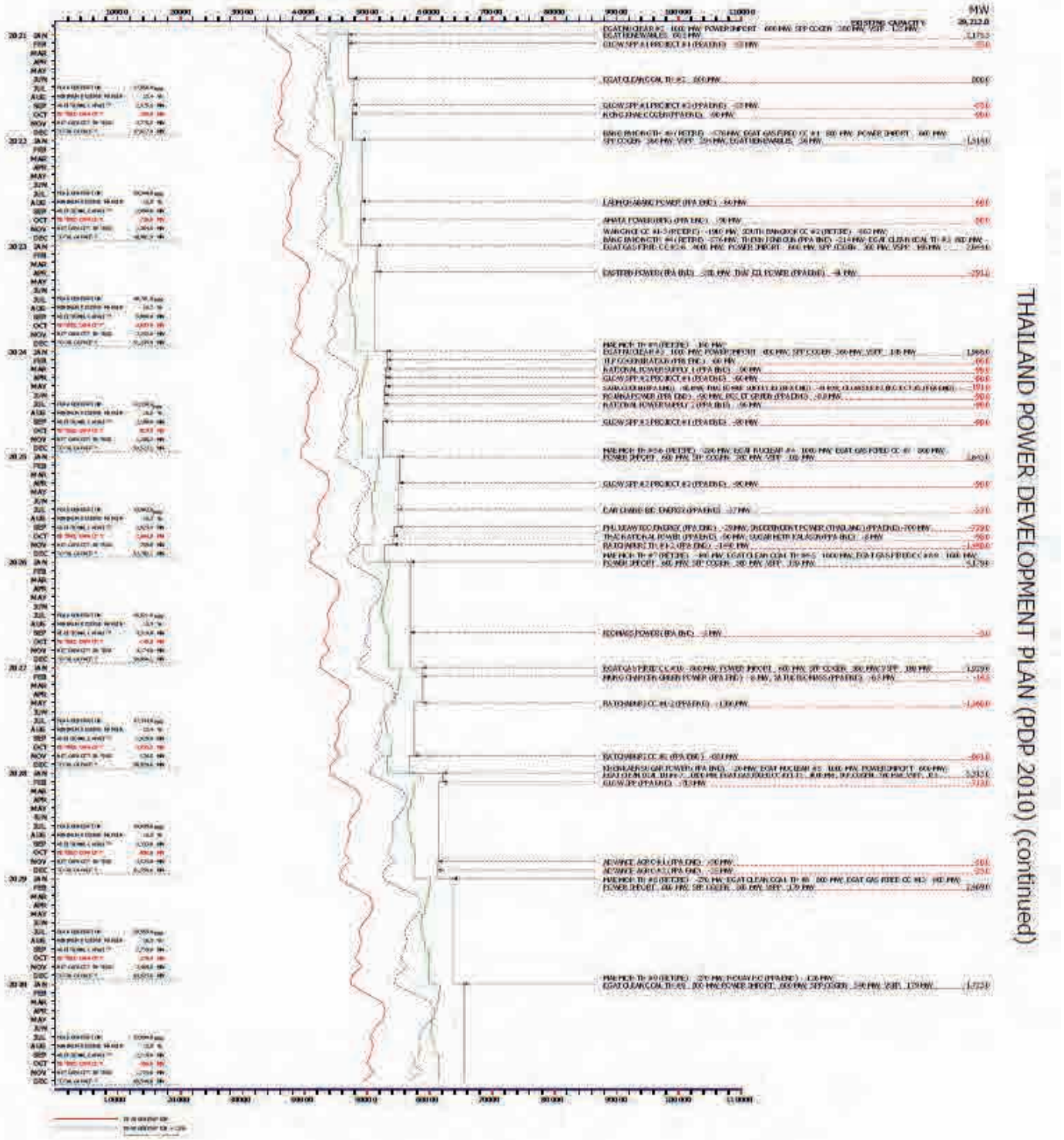


POWER DEVELOPMENT PLAN

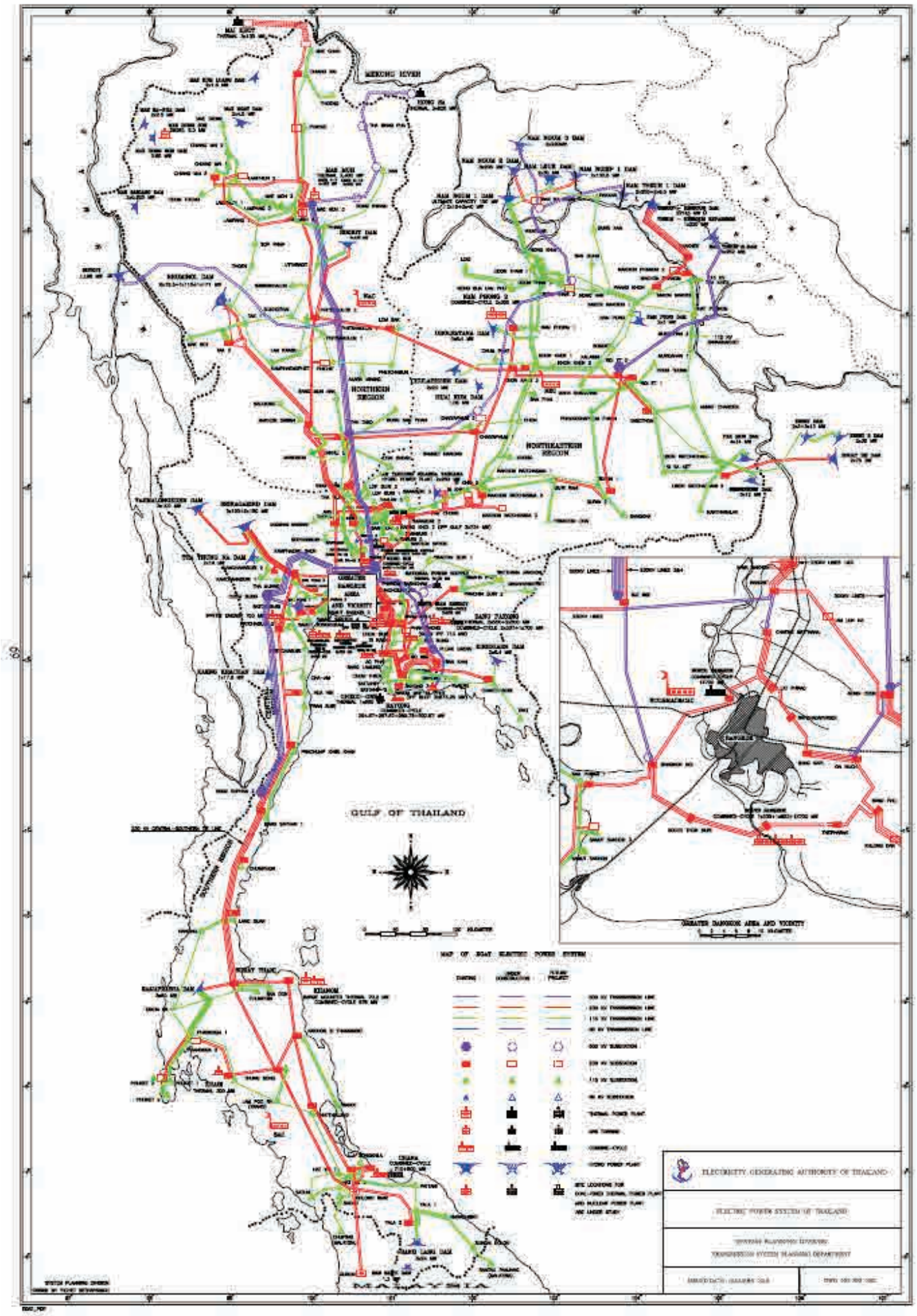
PDP2010_Base Load
LOAD FORECAST : 23 Feb 2010
RUN DATE : March 25, 2010

GENERATION SYSTEM DEVELOPMENT PLANNING DEPARTMENT
SYSTEM PLANNING DIVISION
ELECTRICITY GENERATING AUTHORITY OF THAILAND

PEAK AND CAPACITY (MW)



THAILAND POWER DEVELOPMENT PLAN (PDP 2010) (continued)


MEKONG RIVER
NORTHERN REGION
NORTHEASTERN REGION
GULF OF THAILAND
GREATER BANGKOK AREA AND VICINITY
ELECTRICITY GENERATING AUTHORITY OF THAILAND
ELECTRIC POWER SYSTEM OF THAILAND
TRANSMISSION SYSTEM PLANNING DEPARTMENT

CAPACITY OF THAILAND POWER SYSTEM

(as of December 2009)

Plant Type		Fuel Type	Capacity (MW)	
Hydroelectric Power Plant				
Bhumibol		-	779.2	
Sirikit		-	500.0	
Ubolratana		-	25.2	
Srinakharin		-	36.0	
Chulabhorn		-	40.0	
Nam Pung		-	6.0	
Srinagarind		-	720.0	
Vajiralongkorn		-	300.0	
Tha Thung Na		-	20.0	
Kang Krachan		-	19.0	
Bang Lang		-	72.0	
Ban Santi		-	1.275	
Mae Ngat		-	9.0	
Huai Kum		-	1.05	
Hajprabhi		-	240.0	
Pak Mun		-	136.0	
Lam Takhong PS		-	500.0	
Small Hydro Power Plants		-	4.448	
Subtotal			3,424.180	11.72%
Power Plant				
South Bangkok	Block 1	Gas	316.0	
	Block 2	Gas	562.0	
	Block 3	Gas	710.0	
	Subtotal		1,588.0	
Bang Pakong	Unit 1	Gas/Heavy oil	525.5	
	Unit 2	Gas/Heavy oil	526.5	
	Unit 3	Gas/Heavy oil	576.0	
	Unit 4	Gas/Heavy oil	576.0	
Bang Painong	Block 3	Gas	314.0	
	Block 4	Gas	314.0	
	Block 5	Gas	710.0	
	Subtotal		3,542.0	
Mae Moh	Unit 4-7	Lignite	560.0	
	Unit 8-13	Lignite	1,620.0	
	Subtotal		2,180.0	
Krabi	Unit 1	Heavy oil	315.0	
	Subtotal		315.0	
Nam Pung	Block 1	Gas	325.0	
	Block 2	Gas	325.0	
	Subtotal		650.0	
Wang Noi	Block 1	Gas	612.0	
	Block 2	Gas	612.0	
	Block 3	Gas	686.0	
	Subtotal		1,910.0	
Chana	Block 1	Gas	710.0	
	Subtotal		710.0	
Subtotal			10,895.0	37.30%
Diesel Power Plant				
Mae Hong Son		Diesel	4.4	
Subtotal			4.4	0.02%
Renewable Energy Source				
	Subtotal		4.546	0.02%
Total Capacity of EGAT			14,328.1	49.05%

CAPACITY OF THAILAND POWER SYSTEM (con.)

(as of December 2009)

Plant Type		Fuel Type	Capacity (MW)	
Purchased Power				
Hydroelectric Power Plant				
Theun Hinboun		-	214.0	
Houay Ho		-	126.0	
Subtotal			340.0	1.16%
Power Plant				
Khanom PPB	Unit 1	Gas/Heavy oil	69.9	
	Unit 2	Gas/Heavy oil	70.2	
	Block 1	Gas	678.0	
		Subtotal	818.1	
Ratchaburi	Unit 1	Gas/Heavy oil	720.0	
	Unit 2	Gas/Heavy oil	720.0	
	Block 1	Gas	685.0	
	Block 2	Gas	685.0	
	Block 3	Gas	685.0	
		Subtotal	3,485.0	
BLCP Power Co.,Ltd (BLCP)	Unit 1	Bituminous Coal	673.3	
	Unit 2	Bituminous Coal	673.3	
		Subtotal	1,346.5	
Rayong	Block 1	Gas	294.7	
	Block 2	Gas	285.3	
	Block 3	Gas	289.8	
	Block 4	Gas	302.9	
		Subtotal	1,175.0	
Tri Energy Co.,Ltd (TECO)	Block 1	Gas	700.0	
		Subtotal	700.0	
Independent Power Producer (Thailand) Co.,Ltd (IPT)	Block 1	Gas	700.0	
		Subtotal	700.0	
Glow IPP Co.,Ltd	Block 1	Gas	356.5	
	Block 2	Gas	356.5	
		Subtotal	713.0	
Eastern Power & Electric Co.,Ltd (EPEC)	Block 1	Gas	350.0	
		Subtotal	350.0	
Gulf Power Generation Co.,Ltd	Block 1	Gas	734.0	
	Block 2	Gas	734.0	
		Subtotal	1,468.0	
Ratchaburi Power Co.,Ltd	Block 1	Gas	700.0	
	Block 2	Gas	700.0	
		Subtotal	1,400.0	
SPP		Coal	369.5	
		Heavy oil	4.5	
		Gas	1,293.0	
		Subtotal	1,667.0	
Subtotal			13,818.6	47.30%
Renewable Energy Source				
SPP		Biomass	305.3	1.05%
Gas Turbine Power Plant				
SPP		Gas	120.0	0.41%
Others				
EGAT-TNB		-	300.0	1.03%
Total Capacity of the Purchased			14,883.9	50.95%
Grand Total Capacity			29,212.0	100.00%

Source : System Control and Operation Division and Power Purchase Agreement Division , EGAT

The DEDE Four-Year Action Plan (2008-2011)

Vision

Be a Clean Energy Leader of Asian Region by 2011.

Missions

To develop, promote and support the clean energy production and consumption pertinent to each area situation with worthy and sustainability. Develop the commercial clean energy technology for domestic consumption and export. Create the co-operation network that will lead Thailand to the energy knowledge base society for our economic security and social sustainable happiness.

Policy	Servicing Target	Strategy/Implementation as required in the National Bureaucratic Admin. Plan
1st Policy: Restoring the Country Reliance Policy Issue (detail) 1.15: Implement the measure on reducing the energy pricing impacts		
• Policy Target • Reduce the energy cost and reduce using an energy. • Indicator: Expanding rate of using the NGV, biodiesel and gasohol	• Ministerial Servicing Target: Sustainable increasing of an alternative energy development. • Indicator: Push up an increasing use of biodiesel from 1.4 ml/d to 3 ml/day.	• Strategy: Promote using of alternative energy and disseminate the energy saving and energy efficiency measures
	• Organisation Servicing Target: Promote using of alternative energy • Indicator: Biofuel production of 52.000 l/day	• Strategy: Develop an alternative energy at the three southern border provinces.
Policy Issue (detail) 1.19: Accelerate the projects and measures for mitigating the global warming impacts		
• Policy Target • The problem of global warming crisis is substantially and continuously resolved by such the measures / projects. • Indicator: the GHG reduction rate	• Ministerial Servicing Target: Prevent and control the environment impacts causing from energy industry for the better life quality and sustainable development. • Indicator: Certified Emission Reduction (CER), from the Energy CDM Project, at not less than 1 mt of CO_2 equivalent per year.	• Strategy: Campaign for proposing energy projects to the CDM project.

Policy	Servicing Target	Strategy/Implementation as required in the National Bureaucratic Admin. Plan
3st Policy: Economics policy Policy Issue (detail) 3.7: Energy Policy	• Organisation Servicing Target: Propose the energy project for CDM certification • Indicator: 17 projects proposed for CDM certification.	• Strategy: Promote R&D for all alternative energy resources.
• Policy Target 1.Promote using the alternative energy. • Indicator: Increasing of sustainable alternative energy development.	• Ministerial Servicing Target: Sustainable increasing of an alternative energy development. • Indicator: Increasing of alternative energy share from 6.14 percent to 9.75 percent by 2011.	• Strategy: Promote R&D for all alternative energy resources
	• Organisation Servicing Target: To use the alternative energy resources. • Indicator: Consume alternative energy at 85.585 ktoe	• Strategy: Provide, push up and promote using the alternative energy.
2. Increase an efficient use of energy in Thailand • Indicator: Expansion rate of energy consumption reduced.	• Ministerial Servicing Target: Using energy of the country at higher efficiency • Indicator: Energy intensity of industrial sector reduced by 20 percent	• Strategy: Increase the country energy efficiency.
	• Organisation Servicing Target: To use energy efficiently. Indicator: Reduce an energy consumption of 7,577.1 ktoe	• Strategy: Promote, support and regulate the energy conservation.

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Output: Bioenergy Production Activity of Producing Biofuel						
1) Research and Testing Project on Using Biodiesel Blended over 20 percent in the Fishing Boats	20				20	BBFD
2) Project to Study and Build the Machine Model for Community Biodiesel Produced from Crude Palm Oil and Palm Seeds.	1				1	BBFD
3) Project to Develop, Access and Recommend the Management of Energy Self Reliance Project by Local/ Community Biodiesel	20				20	BBFD
4) Feasibility Study of Biodiesel Produc from Seaweed /Algae and Candlenut Tree		5			5	BBFD
5) Promotion on MSW Energy Production (RDF of Municipal/Local Admin Organisations)	191				191	BER
6) Demon Project on Wind Energy Development for Power Generation in Pattani	25.5				25.5	BED
7) Demon Project on Power Generation from Large Wind Turbine in Pattani	125				125	BED
8) Project on Establishment of Solar Hot Water System for Health Station in the Three Southern Border Provinces	6	7.2			13.2	BETD
9) Feasibility Study Project: Environmental Impacts and Detail Designing for Klong AiBuTae Hydropower Project in Narathiwat	18				18	BED
10) Community Biodiesel in the Three Southern Border Provinces	14				14	BBFD
11) Crude Palm Oil Extraction for Integrated Biodiesel Production Project for Medium Community in Yala	17				17	BBFD
12) Project to Establish a Production System of Biodiesel derived from Palm at BaJoh Co-operatives, Amphoe Bajoh in Narathiwat	40				40	BBFD
13) Biogas Production Project Using Wastewater from Palm Oil Extraction Plant	20				20	BBFD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Output: CO_2 Reduction **Activity of Studying the CDM Projects**						
1) Hiring Cost to Study the Development Methods of Small Energy Project for CDM Project Implementation	3.072				3.072	BER
2) Study the Technology and Potential of Reducing GHG Released from Energy Production	6				6	BER
Output: Alternative Energy Produced **Activity: Study and Develop the Alternative Energy**						
1) Facilitating and Administrative Cost	25.3	33.647	31.74	31.74	122.427	
2) Hiring Cost to Study the Feasibility and Environmental Impacts of the Mini Hydropower Project: MaeNgao Project at Amphoe OmGoi in ChiengMai	9				9	BED
3) Hiring Cost to Study the Feasibility and Environmental Impacts on Mini Hydropower Project : HuaiMaePahPai Project at Amphoe Hawd in ChiengMai	9				9	BED
4) Hiring Cost to Design the Mini Hydropower Project Detail of HuaiOngPoe Project at ThongPahPoom, Kanchanaburi	9.025				9.025	BED
5) Design the Mini Hydropower Project Detail of HuaiClitee Project at Amphoe ThongPahPoom, Kanchanaburi	9.025				9.025	BED
6) Hiring Cost to Study the Prelim Environmental Impacts of Mini Hydropower Project: HuaiDanMeeh Project at Amphoe PaLein, Trang	4.798				4.798	BED
7) Hiring Cost to Study the Prelim Environmental Impacts of Mini Hydropower Project: KlongAeh Project at Amphoe Kirirathnikom, Suratthani	4.798				4.798	BED
8) Study the Feasibility and Environmental Impacts of Mini Hydropower Project: HuaiSlakPra Hydropower Project in Kanchanaburi		9.850	10.5	11	31.35	BED

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
9) Feasibility Study to Construct Mini Hydropower Plant at Floodgate Rear in the ChaoPraya Project		9.5			9.5	BED
10) Design Mini Hydropower Plant (1 plant)		9.45	10	10.5	29.95	BED
11) Design the Mini Hydropower Project Detail at Irrigation Dam Ridge (4 plants)		18.5	19	09.5	57	BED
12) Study the Feasibility and Environmental Impacts of Hydropower Project: Maekong Stepladder Weir, a PagKom Weir.		30	50		80	BED
13) Design the Hydropower Project Detail for Maekong Stepladder Weir, a PagKom Weir				120	120	BED
14) Study the Feasibility and Prelim. Environmental Impacts of MaeOab Mini Hydropower Project	9.5				9.5	BED
15) Study and Establish the Master Plan of Hydropower Project Development (Village Level)	15				15	BED
16) Development and Promotion Project on Using Micro Hydropower (Household Level)	4				4	BED
17) Design the Mini Hydropower Project Detail: HuaiPahPu Project	9				9	BED
Ethanol						
18) Develop and Test Using Desohol in Passenger Car				10	10	BBFD
19) Develop and Demonstrate on Building up Value Added from Ethanol Production			10		10	BBFD
20) Feasibility Study on Producing Ethanol from Cellulose		8			8	BBFD
21) Develop and Demonstrate Machine Model for Ethanol Produced from Cellulose			20	30	50	BBFD
22) Research and Test Using Gasohol as Flex Fuel for Car (FFV,*Flexible Fuel Vehicle*)			30		30	BBFD
23) Research and Test Producing Yeast by Extracting from Ethanol Plant Waste		10			10	BBFD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Biodiesel						
24) A Testing Cost of Using Jatropha Oil in the Low Rotation Speed (rpm) Engine	5				5	BBFD
25) Hiring Cost to Analyse and Recommend the Biofuel Development		3	3	3	9	BBFD
26) Hiring Cost of Biofuel Public Relations	4.750	4	4	4	16.750	BBFD
27) Research and Test Producing Community Biodiesel with no Water Use by Replace Using Methanol by Ethanol		3			3	BBFD
28) Establish and Demonstrate the Mini Crude Palm Oil Extractor		15			15	BBFD
29) Demonstrate Biodiesel Production in the Educational Centre		2	2	2	6	BBFD
Solar Energy						
30) Hiring Cost to Develop Solar Drying System-Greenhouse Type in Large Industry		7.5	10	10	27.5	BSED
31) Hiring Cost to Study the Potentials of Solar Cooling System Production and Consumption	7		15	25	47	BSED
32) Hiring Cost to Develop the Solar Radiator Database			10		10	BSED
33) Hiring Cost to Study and Develop the Power Generation System by Solar Thermal Energy			40	10	50	BSED
34) Hiring Cost to Study and Develop the Prototype of Solar Cell Water Pump Set by Deploying Domestic Assembling Parts	3				3	BSED
35) Project on Standard Testing Centre for Appliances of Solar Hot Water System	12	15	11		38	BSED
36) Thailand Solar Cells Development to the Best Project	40	40	40	40	160	BSED

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
37) The 3rd Year Project on Solar Cells System Testing and Standard Development Centre	30				30	BSED
38) Promotion Project on Solar Hot Water Generation by Hybrid System	37.5	48.75	67.5	101.25	255	BSED
Biomass						
39) Hiring Cost to Study, Design and Promote Biomass Thermal Generation for Small Industry		3	10	15	28	BER
40) Hiring Cost to Develop and Promote Using the Brick Making Furnace and Biomass Furnace in Community Industry			3	9	12	BER
41) Study and Develop Biomass Gas System for Agro-Water Pumping		3.5	8	8	19.5	BER
42) Hiring Cost to Demonstrate Power Generation System by Biomass Gas	6				6	BER
43) Study and Establish the Plan of Planting the Fast Growth Tree for Energy Production and Study the Promotion on Using and Producing the Biomass to Charcoal Processing		4	3	3	10	BER
44) Public Relations and Support the Clean Coal and Biomass Energy Network		4	4	4	12	BER
45) Project on R&D, Promotion and Support the Biomass Energy Production System of Three Stage Gasifier	67	56	185	350	658	BER
46) Promote Using the High Efficient Biomass Stove and Cooking Stove		30	50	100	180	BER
47) Study, Research and Establish the Prototype and Promote the Bio-Oil Production from Biomass		20	50	70	140	BER

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
MSW/RDF						
48) Hiring Cost to Follow-up and Increase Efficiency in Using the Energy Production System from MSW	4	3.5	5	5	17.5	BER
49) Campaign to Educate the People on Energy Production from MSW/RDF			5	5	10	BER
50) Study the Development and Promotion on RDF-5 Production		5			5	BER
51) Promote Using the Biogas Fermented Tank in the BMA Schools	5				5	BER
52) Study the Prototype/Model of Biogas Production System from the BMA Market Waste/Garbage	10				10	BER
Coal						
53) Develop and Demonstrate the Clean Coal Technology in Industry		20	14	18	52	BER
54) Study the Promotion on CHP System from Coal Fuel		5			5	BER
55) Campaign to Educate the People on Clean Coal Technology	3	3	16	16	38	BER
56) Royal Decree on Coal as Regulated Energy and Draft Ministerial Regulation for Using Coal Efficiently and Environmental Friendly		5			5	BER
57) Hiring Cost to Develop the Hot Spring Sources for the Low Potential Group by Using the Efficiency Increasing Technology to Build up the Drying Chamber for Agricultural Crops	4				4	BER
58) Hiring Cost for Public Relations on Geothermal Energy Utilisations			1	1	2	BER

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Biogas						
59) Hiring Cost to Study the Use of Biogas as Energy in the Compressed Granular Organic Fertiliser Making Machine	1.5				1.5	BER
60) Hiring Cost to Study the Biogas Production System Control by Simulation System and Consultancy of Expert System		11.5	8		19.5	BER
61) Establish the Draft Ministerial Regulation Re: Safety Requirements on Biogas Consumption and Production System		2			2	BER
62) Hiring Cost to Study on Performance Assessment and Efficiency Improvement for Biogas Production System		7.2	8	8	23.2	BER
63) Knowledge Dissemination on Adding Value by Wastewater from Biogas Production System and Compressed Granular Organic Fertiliser Making Machine		2	2	2	6	BER
64) Study on Adding Value to the Water processed from Treatment from Biogas Production System of Swine Farm to follow the Sufficiency Economy		3.5			3.5	BER
65) Promotion Project on Biogas Production System from Finished or Semi-finished Manures		25	25	25	75	BER
66) Support, Demonstrate and Promote Biogas Production System from Cassava Residues		15	15	15	45	BER
67) Study and Demonstrate Technology of Biogas Production System by Wastewater from Concentrated Latex Factory		22	25	25	72	BER
68) Study, RD&D and Promote Biogas Production from Biomass Residues		5	10	15	30	BER
69) Monitor and Assess the Biogas Production System from Finished or Semi-finished Manures		3	3.5	4	10.5	BER

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Wind Energy						
70) Hiring Cost to Monitor and Assess the Implementation on Wind Energy Development and Promotion	2.5				2.5	BER
71) Hiring Cost to Study the Design, Potential and Assessment of Using the Bailer (traditional water turbine) by Wind Energy		3			3	BER
72) Hiring Cost to Investigate and Maintain the Wind Potential Measurement Station			1.8		1.8	BER
73) Hiring cost to Develop Network of the Wind Potential Measurement Station		31			31	BER
74) Hiring Cost to Establish a Wind Energy Potential Map of Thailand		18			18	BER
75) Hiring Cost to Study and Research for Efficiency Increasing of Wind Turbine Assembly			3.5		3.5	BER
76) Demonstrate and Promote Using Bailer (traditional water turbine) by Wind Energy			3	6	9	BER
77) Project on Supportive the Wind Turbine Power Generation for the Royal Initiative Projects			15	15	30	BER
78) Demonstrate and Promote Power Generation by Small, Low Speed Wind Turbine at Community level			30	30	60	BER
79) Demonstrate and Promote Power Generation by Large Wind Turbine in the Wind Zone at particular sources			125	250	375	BER
80) Demonstrate the Hybrid Power Generation by Wind Turbine and Other Power Generation System			30		30	BER
Hydrogen and Fuel Cells						
81) Hiring Cost to Develop Using Hydrogen in Natural Gas (NGV) Car as for Prototype	5				5	BER
82) Preparing the Infrastructure Readiness to Respond Using Hydrogen and Fuel Cells in Transport & Communication Sector	2				2	BER

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
83) Producing the Methanol from Biomass for Using as Fuel in Fuel Cells		6			6	BER
84) Study the Line and Plan for Using, Supporting and Promotion on Fuel Cells and Hydrogen Energy Industry			5		5	BER
85) Development on the Prototype of the Commercial Fuel Cells Tricycle (Tuk-Tuk)			8		8	BER
86) Hiring Cost to Develop the Safety Requirements on Production, Consumption, Storing and Transport the Fuel Cells and Hydrogen In Sectors of Transport and Power Generation			4		4	BER
87) Development and Demonstration on Hydrogen Production from Chemical Thermal Process: the 2nd Phase	6				6	BER
88) Establishment of the Appliance Standard for Using Hydrogen Technology	8				8	BER
89) Development on Hydrogen Production System at Community Level for Decentralisation			5	5	10	BER
90) Develop and Demonstrate the Fuel Cells for Power Generation Coupling with Other Alternative Energy Resources				4	4	BER
91) Hiring Cost to Study and Prepare the Knowledge Base to response with Development on Using Nuclear for CDM Energy Aspects			2	2	4	BER
92) Promotion Project on Implementing the CDM Energy Project		3	4	4	11	BER

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Activity of Alternative Energy Production and Maintenance						
1) Facilitating and Administrative Cost	130.659	164.376	154.787	154.787	604.609	
2) Produce and Maintain the Hydropower Project	125.740	156.339	54.370	55.886	392.335	BED
3) Hiring Cost to Install the Dam Behaviour Measuring Instrument (5 Projects)		12.5			12.5	BED
4) Procurement Cost to Purchase Water Turbine plus the Installation and Testing Costs for Huai YaMoeh Hydropower Project (binding budget 2008-2009)	12	48			60	BED
5) Maintain the Solar Cells Power Generation System	7.624	8.130	10.192	10.210	36.156	BSED
6) Improve the Standby Energy Source of the Solar Cells Power Generation System for 61 Plants in Operation not less than 5 Years		27.021	27	27	81.021	BSED
7) Hiring Cost to Improve the Solar Water Pumping System for Annually 100 Plants			10	10	20	BSED
8) Hiring Cost to Provide and Install the Wind Turbine for Power Generation by Small Wind Turbine in the Area of ChiengMai (2 Plants)		15.488	45.150	46.150	106.788	BED
9) Hiring Cost to Proceed the Wind Power Generation and Maintenance	0.4	1	1	2	4.4	BED
10) Hiring Cost to Establish the Solar Energy System Supporting the Utilisations in the Area of the Royal Initiative Project for 28 Sites	20.373	5.975	19.9	19.9	66.512	BSED
11) Hiring Cost to install the Solar Cells Power Generation System for the 140 Community Learning Centres	16.210	16.877	25.5	59.5	188.087	BSED

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
12) Hiring Cost to install the Solar Cells Power Generation System for the 80 Rural Schools	21.477	20.8	46	92	180.277	BSED
13) Hiring Cost to install the Solar Cells Power Generation System for the National Reserved Forest and National Park for 110 Sites	14.485	15.689	48	96	174.174	BSED
14) Hiring Cost to install the Solar Cells Power Generation System in Rural School for Generating Capacity Expansion in 65 Schools	14.485	14.33	32	40	100.815	BSED
15) Hiring Cost to install the Solar Cells Power Generation System for Border Patrol Police and Military Bases for 60 Sites	4.338				4.338	BSED
16) Hiring Cost to install the Solar Cells Power Generation System for the 23 Health Stations	19.423				19.423	BSED
17) Hiring Cost to install the Solar Cells Power Generation System for the 143 Community Learning Centres			34	87.55	121.55	BSED
18) Hiring Cost to install the Solar Cells Power Generation System for the 117 Rural Schools			69	200.1	269.1	BSED
19) Hiring Cost to install the Solar Cells Power Generation System for the National Reserved Forest and National Park for 240 Sites			96	288	384	BSED
20) Promotion Project for Solar Cells Power Generation for Border Patrol Police and Military Bases for 223 Sites	15.744				15.744	BSED
21) Hiring Cost to Establish the Laboratory for Quality Testing and to Install the Wastewater Treatment System in the Biodiesel Production Plant (binding budget 2008-2009)	1.573				1.573	BBFD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Activity of Alternative Energy Promotion, Dissemination and Transfer						
1) Facilitating and Administrative Cost	20.523	31.531	27.068	27.068	106.19	
2) Cost for Alternative Energy Dissemination and Transfer to Support the Royal Initiative Project following the Sufficiency Economy	15	9.4	15	15	54.4	BETTD
3) Cost of Project on Result Expansion for Establishing the Community Energy Plan to Respond the Royal Initiative in Sufficiency Economy	24	48.6	24	24	120.6	BETTD
4) Cost to Disseminate and Demonstrate the Incinerator for Local Government Agency		5.1	5.1	6.8	17	BETTD
5) Cost to Establish the Energy Security Home Project	12	15	15	15	57	BETTD
6) Cost of Dissemination and Demonstration on Producing and Using the Economic Stove for Community	1.8				1.8	BETTD
7) Cost to Establish the Energy Village Project in Upcountry	18	18	36	36	108	BETTD
8) Cost to Promote the Furnace for Steam Pasteurisation the Sawdust Substrate Bag to Culture the Mushroom Spawn for the Community in Upcountry	6.4				6.4	BETTD
9) Project on Monitoring and Assessing the Project Implementation of Building up the Consciousness for Juveniles in Educational Institution	5.582				5.582	BETTD
10) Project: Building up the Consciousness in Energy Use for Juveniles in Educational Institution administrated by the Bangkok Metropolitan	17.4				17.4	BETTD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
11) Monitor and Assess the Energy Security Housing Project	3.75				3.75	BETTD
12) Promote the Energy Production from the MSW	191	213.5	330.5	271.5	1.006.5	BETTD
13) the Solar Cells System Testing and Standard Development Centre Project: the 3rd Year	30				30	BETTD
14) the Promotion Project on MSW Management for Community Energy		16	16	16	48	BETTD
15) School/ Learning Centre of the Samples of Alternative Energy Use and Production following the Sufficiency Economy		15	15		30	BETTD
16) Project on Transfer the Production and Consumption of High Efficiency Cooking Stove and Charcoal Making Furnace for the Skill Development Human Resource			15		15	BETTD
Activity: Alternative Energy Facilitation						
1. Facilitating and Administrative Cost	32.023	34.599	90.715	90.715	248.052	
2. Project on Campaign and Contest of Alternative Energy and Energy Conservation	55	110	240	150	555	BCA
3.Project on Analysing the Situation and Forwarding Public Relations		10	10	10	30	BCA
4. Project on Media Development of Knowledge in Alternative Energy and Energy Conservation		15	30	10	55	BCA
Hydropower Dam Construction Project at Knlong ThoongPleng						
1. Activity of Constructing the Hydropower Dam Project at Klong ThoongPleng	71.544	31.773			103.317	BED
Hydropower Dam Construction Project at Upper Nan River Basin						
1. Activity of Constructing the Hydropower Dam Project at Upper Nan River Basin	340.860	547.114	191.83	302.95	1382.754	BED

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Hydropower Dam Construction Project at Mae Kanai						
1. Activity of Constructing the Hydropower Dam Project at Mae Kanai	23.226	72.07	19.49		114.786	BED
Hydropower Dam Construction Project at Huai Clitee						
1. Activity of Constructing the Hydropower Dam Project at Huai Clitee		95	180	200	475	BED
Mini Hydropower Capacity Expansion Project						
1.Activity of Additional Construction of Hydropower Project	69	158.89	54.85		282.74	BED
Hydropower Dam Construction Project at Kwae Noi						
1. Activity of Constructing the Hydropower Dam Project at Kwae Noi	64.78	104.24	185.64	95.71	450.37	BED
Hydropower Dam Construction Project at Mae U-Su						
1. Activity of Constructing the Hydropower Dam Project at Mae U-Su			36.89	102.69	139.58	BED
Hydropower Dam Construction Project at Huai OngPawh						
1. Activity of Constructing the Hydropower Dam Project at Huai Ong Pawh				25.99	25.99	BED
Hydropower Dam Construction Project for Village Level						
1. Activity of Constructing the Hydropower Dam Project for Village Level (2nd Phase)	24.503	19.61	14.76	20.37	79.243	BED
Community Hydropower Development Project	67	67	67		201	BED
On-Grid Hydropower Project for Village Level	56.5	48	45.5		150	BED
Hydropower Project for Village Level	15.25				15.25	BED

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
Output: Energy Conservation Activity: Regulate, Promote and Support Energy Conservation						
1) Facilitating and Administrative Cost	56.462	68.309	71.206	73.927	269.904	BEEP, BERC
2) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Food and Textile Sub-sectors	11.4				11.4	BERC
3) Hiring Cost to Monitor and Promote the Collaborative Energy Conservation	1.52	2	2	2	7.52	BEEP
4) Hiring Cost to Implement the Collaborative Energy Conservation by the Small and Medium Commercial Buildings and Factories in the Central Region	11.883	11.883	11.883	11.883	47.532	BEEP
5) Hiring Cost to Implement the Collaborative Energy Conservation by the Small and Medium Commercial Buildings and Factories in the Eastern Region	11.883	11.883	11.883	11.883	47.532	BEEP
6) Hiring Cost to Implement the Collaborative Energy Conservation by the Small and Medium Commercial Buildings and Factories in the North Eastern Region	11.883	11.883	11.883	11.883	47.532	BEEP
7) Hiring Cost to Implement the Collaborative Energy Conservation by the Small and Medium Commercial Buildings and Factories in the Northern Region	11.883	11.883	11.883	11.883	47.532	BEEP
8) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Food Sub-sector		15.642	78.209	78.209	172.06	BERC
9) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Textile Sub-sector		15.642	39.104	39.104	93.85	BERC
10) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Paper Sub-sector		15.642	19.552		35.194	BERC

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
11) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Chemical Sub-sector		15.642	78.209	78.209	172.06	BERC
12) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Non-metallic Sub-sector		15.642	19.552	19.552	54.746	BERC
13) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Basic Metal Sub-sector		15.642	19.552	19.552	54.746	BERC
14) Hiring Cost for Consultant to Conduct Energy Conservation in Production Process of the Designated Factory in Equipment and Machinery Metallic Product Sub-sector		15.642	78.209	97.761	191.612	BERC
15) Hiring Cost to Conduct the Efficiency Analysis and Implement the Measure in the Air Compressing System for Designated Factory		10	10	10	30	BERC
16) Hiring Cost to Conserver Energy in the Central Air-conditioning System in Designated Building		10.096	10.096	10.096	30.288	BERC
17) Tax Privilege Project for Energy Conservation, the 2nd Phase (Supportive Money for Tax Refund)		100	100	100	300	BERC
18) Tax Privilege Project for Energy Conservation, the 3rd and 4th Phase		50	100	50	200	BERC
19) Revolving Fund Project for Energy Conservation by Financial Institutions in the 3rd Phase (Additional)	2000	2000	2000	2000	8000	BERC
20) Supporting the Implementation to Pursue the ECP Act 1992 (B.E.2535)	95.976	150	120	110	475.976	BERC
21) Project on Promoting Investment in Energy Conservation and Alternative Energy (ESCO Fund)	525	1050	1050	1050	3675	BERC
22) Assessment on the Designated Building/Factory Implementation in Compliance with ECP Act 1992	27	27	27	27	108	BERC

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
23) the Collaborative Energy Conservation Project by the Small and Medium Commercial Buildings and Factories	100	100	100	100	400	BERC
24) the Collaborative Energy Conservation Project by Designated Commercial Buildings and Factories	58				58	BERC
25) Study and Build up Understanding in the Revised Act and Laws of Energy Conservation	15	10	10	10	45	BERC
26) Servicing Project of One Stop Service Unit	4	5	5	5	19	BERC
27) Energy Savings Consultancy Centre	6	9	9	9	33	BERC
28) Regulation, Monitoring to Administrate the Revolving Fund Project for Energy Conservation	6	6	6	6	24	BERC
29) Demonstration Project on Energy Conservation Detailed Technologies		100	100	100	300	BERC
30) ESCO Promotion Project and Establishing the Network for ESCO, Entrepreneurs/ Industry and Financial Institutions	8	8	10	10	36	BERC
31) Building Energy Conservation Promotion Project by Energy Labeling	12	12	12	12	48	BEEP
32) Project on Hiring the Consultant to Promote High Efficiency Machinery/Equipment and Material/Appliances for Energy Conservation (Energy Labeling Products)	13	30	40	50	133	BEEP
33) Energy Efficiency Laboratory Centre Network Project for Testing the Machines, Equipment, Appliances and Materials to Conserve Energy	4.5	4	1	1	10.5	BEEP
34) Energy Conservation Demonstration and Promotion Project for Agricultural Sector		11	12	15	38	BEEP

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
35) Project on Establishing the Method to Manage the Transport System for Easily Rotten Damage Agro-Products for Energy Conservation	9	10	10	10	39	BEEP
36) Industrial Boiler Quality Development Project	20		25	25	70	BEEP
37) Project to Develop the Energy Conservation Network and Knowledge Centre		5	5	5	15	BERC
38) Project to Disseminate the Energy Conservation Technology Documents		10	10	10	30	BERC
39) Project to Study the SEC (Specific Energy Consumption) in Industry and Commercial Buildings		20	20	20	60	BERC
40) Project to Monitor and Assess the Energy Auditing		5		5	10	BERC,BEEP
41) Hiring the Consultant to Administrate the Collaborative Energy Conservation Project (SMEs)	3.5	3.5	3.5	3.5	14	BEEP
42) Hiring Cost to Study and Develop the Secondary Law Enacted by the ECP Act and Laws	5				5	BERC
43) Hiring Cost to Study and Analyse the Method to Implement the ECP Act	5				5	BERC
44) Project to Study on Establishment of Ministerial Regulations for the 54 Products (incl. cars) and Establish the Draft on Minimum Energy Efficiency Performance Standards for 50 Products	20.545	42.23	47.23	47.23	157.235	BEEP
45) Project to Establish the Promotion Measures on Recovery the Building Wastewater to Re-use in Sanitary System for Energy Conservation Purpose		6	10	10	26	BEEP
46) Hiring the Consultant to Promote and Regulate the Designated Building of the Public Sector		110	110		220	BERC

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
47) Hiring the Consultant to Promote and Regulate the Energy Conservation in Building to be Constructed or Modified		20	10	10	40	BERC
48) Project to Hire the Consultant to Study the Method of Implementing the DEDE Mission to Fulfill an Achievement	3.2		4		7.2	WPD
49) Vocational and Technician Team Project for Energy Savings	30	30	30	30	120	BEEP
50) Project to Produce the Documentary for Energy Conservation and Alternative Energy for Dissemination and Public Relations through Television Media	30				30	BCA
51) Project to Contest for Distinguished Energy Conserving House	12	12	12	12	48	BEEP
52) Project to Study and Promote the House Plan for Comfortable living and Energy Saving that Compatible with the Country Climate and Geography.		15	10	10	35	BEEP
Activity : Training, Dissemination and Transfer of Energy Conservation Technologies						
1. Facilitating and Administrative Cost	25.512	31.237	31.91	31.91	120.569	BHRD, BETTD
2. Hiring Cost to Develop the Human Resources for Practical Work in Energy Conservation Technology of Air-conditioning System for 400 Personnel.	3.5	3.5	3.5	3.5	14	BHRD
3. Hiring Cost to Develop the Human Resources for Practical Work in Energy Conservation Technology of Lighting System for 400 Personnel.	3.5	3.5	3.5	3.5	14	BHRD
4. Hiring Cost to Develop the Human Resources for Practical Work in Energy Conservation Technology of the Steam Boiler and Air Compressing System for 400 Personnel	3.5	3.5	3.5	3.5	14	BHRD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
5. Project to Sustainable Promote and Develop the Quality of PRE (Personnel Responsible for Energy) for Energy Conservation	23.25	23.25	23.25	23.25	93	BHRD
6. Project to Develop Energy Conservation Personnel by Industrial Sub-sectors (Food, Textile, Chemical, Metal, Paper, etc.)	20	20	20	20	80	BHRD
7. Result Expanding Project of the Vocational Energy Management Course	16				16	BHRD
8. Project to Promote and Disseminate the Energy Conservation Technology of the Display Centre and the Energy Savings Home	15	15	15	15	60	BHRD
9. Human Resources Development Project for Energy Conservation Technology in the General and Common Machine /Equipment Used in Factory and Commercial Building.	16	16	16	16	64	BHRD
10. Human Resources Development Project for Factory Energy Auditing	5	5	5	5	20	BHRD
11. Human Resources Development Project for the Efficient Machinery Operating and Maintenance			4	4	8	BHRD
12. PRE Seminar Project (overall 3,500 persons throughout the country)	7			7	14	BHRD
13. Human Resources Development Project for Energy Conservation from the Case Study of Achieved Industry	10	10	10	10	40	BHRD
14. Promotion and Dissemination Project for Energy Conservation Knowledge	5	5	5	5	20	BHRD
15. Project to Develop the Energy Management Auditor		4	4	4	12	BHRD
16. Human Resources Development Project for Energy Conservation Auditor in Government Building	24				24	BHRD
17. Human Resources Development Project for Energy Conservation Auditor in Commercial Building	5	5	5	5	20	BHRD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
18. Hiring Cost to Develop the Energy Learning for the 5,000 Juveniles		9.5			9.5	BHRD
19. Hiring Cost to Develop the 450 Energy Management Personnel	4.75	5	5	5	19.75	BHRD
20. Project to Build up the Energy Consciousness for Juveniles in Educational Institutions	16	24	24	24	88	BETTD
21. Cost to Promote Using Alternative Energy and Energy Conservation to Army Force in Military Base	10	20	20	20	70	BETTD
22. Hiring Cost for Personnel Development and to Develop the Knowledge Management System	4.75	5	5	5	19.75	BHRD
23. Project to Produce the Spot Ads for Projects/Activities on Energy Conservation and Alternative Energy to Disseminate and Public Relations via Radio Media	5				5	BCA
24. Project to Produce Articles for Projects/Activities on Energy Conservation and Alternative Energy to Disseminate and Public Relations via Newspaper and Journal Media	30				30	BCA
25. Project to Disseminate and Public Relations on Energy Conservation and Alternative Energy via Publication Media	15	25	25	25	90	BCA
26. Project to Establish the Achievements of Projects/Activities and Progressive News of the Energy Conservation and Alternative Energy Project via Posters and Cut-Out Media	10				10	BCA
27. Project to Strengthen the DEDE Image through PR Advertisement						
- Produce and Disseminate the Ads Film by Television Spot to Build up a DEDE Good Image			95	50	145	BCA
- Produce and Disseminate the Radio Spot to Build up a DEDE Good Image			3	3	6	BCA
- Produce and Disseminate the News and Information through Newspapers and Magazines			5	5	10	BCA

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
- Produce and Disseminate the Information through the Media in the Public Mass Transit Stations and in the Exposed Media			8	4	12	BCA
28. Project to Hire the Consultant for PR Administration and Management (as for the DEDE PR Strategy)	8	25	25	30	88	BCA
29. Energy Conservation Project for Temples /Monasteries.	16	16	16	16	64	BETTD
Activity: Issuing the Permit for Generation and Generation Extension of Regulated Energy						
1. Facilitating and Administrative Cost	2.207	3.299	3.42	3.42	12.346	BERC
2. Hiring Cost to Inspect the Generation System of Regulated Energy and Making the Report to Issue the Permit	2.1	3	3	3.5	11.6	BERC
Activity: Energy Conservation Facilitation						
1. Facilitating and Administrative Cost	29.984	28.75	26.823	16.823	112.38	BCA, WPD
2. Alternative Energy and Energy Conservation Co-operation Project between Thailand and Neighbouring Countries	94.616	1.334	42.5	0.3	138.75	WPD
3. Cost to Hire the Consultant to Coordinate the International and Regional Co-operation for Alternative Energy and Energy Conservation.	2.841	3.29	3.45	3.8	13.381	WPD
4.Hiring Cost to Develop and Improve the Information Dissemination System (a DEDE Website)		2		2	4	IT Centre
5. Hiring Cost to Study the Energy Consumption Structure in Agricultural Sector	8				8	WPD
6. Cost to Hire the Consultant to Develop the Competency Measuring System, Reporting, Monitoring and Assessment for Administration aimed at Effective Achievement		6.5		6.5	13	WPD

DEDE Projects –Activities by 2008 - 2011 Budget

Unit: million baht

Project-Activity	2008	2009	2010	2011	Total	Responsible Person
7. Hiring Cost to Monitor an Assessment and Promotion on Administrative Efficiency for Energy Conservation and Alternative Energy	4.75		5		9.75	WPD
8. Hiring Cost to Develop the IT Personnel		1	1	1	3	WPD
9. Hiring cost to Develop the DEDE Personnel Potentials on Communication and Public Relations		0.825			0.825	BCA
10. Hiring Cost to Administrate the Information and News Tasks for Public Relations (on Line News Clipping)	2	2	2	2	8	BCA
11. Hiring Cost to Public Relation for Alternative Energy and Energy conservation to Reduce the Global Warming in Compliance with the National Energy Strategy		5.5	5.5	5.5	16.5	BCA

Acronyms & Abbreviations

BCA	Bureau of Central Administration
BED	Bureau of Energy Development
BEEP	Bureau of Energy Efficiency Promotion
BER	Bureau of Energy Research
BERC	Bureau of Energy Regulation and Conservation
BETTD	Bureau of Energy Technology Transfer and Dissemination
BBFD	Bureau of Biofuel Development
BHRD	Bureau of Human Resource Development
BSED	Bureau of Solar Energy Development
DEDE	Department of Alternative energy and Efficiency
IT CentreAlternative Energy and Efficiency IT Centre	
WPD	Work Plan Division
BMA	Bangkok Metropolitan Administration
CDM	Clean Development Mechanism
ECP	Energy Conservation Promotion (ECP Act)
ESCO	Energy Service Company
GHG	Green House Gas
IT	Information Technology
ktoe	Thousand ton of oil equivalent
NGV	Natural Gas Vehecle
MSW	Municipal Solid Waste
PR	Public Relations
R&D	Research and Development
RDF	Refuse Derived Fuel
SMEs	Small and Medium Enterprises

Appendix 5 Energy Conservation and Renewable Energy Consciousness Investigation for Households

Consciousness and Recognition Survey for Energy Conservation and Renewable Energy in Thailand

This questionnaire aims to explore attitudes and awareness of general public in Phitsanulok and Bangkok toward energy conservation and renewable energy in Thailand. 100 respondents in Phitsanulok and Bangkok were asked by walk-through survey.

An analysis of the questionnaire from 100 respondents is divided into three parts as follows;

Part 1: General information of respondents

1.1 Gender

	Respondents
Male	61
Female	39

1.2 Age

	Respondents
Less than 20 years	16
During 21-30 years	32
During 31-40 years	31
During 41-50 years	10
During 51-60 years	8
More than 60 years	3

1.3 Current Occupation

	Respondents
Government Officer	20
State Enterprise staff	4
Private Staff	45
Others: student, housekeepers, etc	31

1.4 Highest Education background

	Respondents
Lower than High school	15
High school	18
Bachelor degree	52
Master degree	15

1.5 Type of accommodation

	Respondents
Single house (one floor)	29
Single house (two floor)	23
Townhouse	23
Apartment/ Mansion/ Dorm	20
Other	5

1.6 How many people in your house

	Respondents
One	11
2 persons	14
3 persons	35
4 persons	21
5 persons	12
More than 6 persons	7

1.7 Residential Area

	Respondents
Urban (Bangkok)	50
Rural (Phitsanulok)	50

Part 2: Consciousness and Recognition of Energy Conservation

2.1 Have you ever heard about Energy Conservation?

	Respondents
Yes	95
No	5

2.2 If yes in above question, where did you hear about it?

	Respondents	Percentage
Newspapers	56	22
Flyer/ leaflet	24	9
Radio	39	15
Television	87	34
Colleagues	20	8
Cousin	11	4
Others (Internet)	21	8
	258	100

2.3 What kind of Image about Energy Conservation do you have?

	Respondents
Know and understand	44
Know and less understand	50
Don't know and less understand	6

2.4 What is the best advantage of Energy Conservation in Households?

	Respondents
Contribution to the Environment	44
Less Electricity Payment	43
Usage quality standard electricity appliances	13

2.5 Do you think that Increasing of Energy Consumption in Households influences Global Warming?

	Respondents
It influences on Global Warming, I already try to decrease Energy Consumption in Households	71
It influences on Global Warming, but I do not know How to decrease Energy Conservation in Households	25
It does not influence on Global Warming	4
I am not interested	0

2.6 What kind of Tendency does your Energy Consumption in your Household have? (last year)

	Respondents
Increasing	33
Decreasing	35
Not Changing	28
I do not know	4

2.7 Do you have any Activities with Consciousness of Energy Conservation?

	Respondents
I try to have some Activities related Energy Conservation	36
I recognize Necessity of Energy Conservation, but I do not have any specific Activities	50
I have not thought of Energy Conservation yet	13
I am not interested in it	1

2.8 Do you know that Government of Thailand formulated Law and Ministerial Ordinances, etc. in order to disseminate Energy Conservation in Households.

	Respondents
I know it very well	24
I have heard it	45
I have not heard it	29
I am not interested in it	2

2.9 Do you know that Labeling System is applied for Electric Appliances with Energy Conservation?

	Respondents
I know it very well	53
I have heard it	42
I have not heard it	5
I am not interested in it	0

2.10 Do you want to buy Electric Appliances which are evaluated as Highest Rank in Labeling System?

	Respondents
I want to buy it, although it can contribute Energy Conservation	58
I want to buy it, if its price is average	22
I want to buy it, if its price is lower than average	14
I want to buy cheapest one regardless Labeling System	6

2.11 What's Main Electric Appliance which consumes energy in your Household?

	Respondents	Percentage
Air Conditioner	36	18.00
Lighting	45	22.50
Television	45	22.50
Refrigerator	40	20.00
Washing Machine	13	6.50
Personal Computer	11	5.50
Microwave Oven	9	4.50
Water Heater	1	0.50
	200	100

2.12 What information is necessary for working on Energy Conservation in Households? (You can choose answers as much as you like)

	Respondents	Percentage
Comparing Information on Energy Conservation Performances of Electric Appliances	65	37
Advice Place	18	10
Lectures, Events	35	20
Survey of Energy Usage Condition in Households	57	33
	175	100

2.13 Which is the most barrier not to promote Activities of Energy Conservation?

		Respondents	Percentage
Policy barriers	□Lack of national policy aims to disseminate energy conservation	27	6
	□Gap between subsidy system and actual market condition	71	15
Finance barriers	□Lack of incentive for investment	54	11
	□Difficulty of investment due to high risk	44	9
Information barriers	□Low consciousness for energy conservation by policy makers and customers	38	8
	□Lack of accurate information concerning energy conservation(Cost and Benefit, etc)	37	8
	□Lack of latest information	26	5
Technical barriers	□Limited access to latest information	40	8
	□Lack of experience of engineers	56	11
Institutional barriers	□Lack of reliability of new product and new technology	55	11
	□Conservative custom and activity	41	8
		489	100

Part 3: Consciousness and Recognition of Renewable Energy

3.1 Have you heard Renewable Energy?

	Respondents
Yes	93
No	7

3.2 If yes in above question, where did you hear about it?

	Respondents	Percentage
Newspapers	50	22
Flyer/ leaflet	21	9
Radio	34	15
Television	84	37
Colleagues	22	10
Cousin	9	3
Others (Internet)	10	4
	230	100

3.3 What kinds of Image about Renewable Energy do you have?

	Respondents
You work on it actively	41
You work on it as long as you can	47
You do not like to work on it	8
You do not need to work on it	ภ

3.4 What is the best advantage of Renewable Energy in Households?

	Respondents
Less Electricity Payment	34
Contribution to the Environment	57
Usage quality standard electricity appliances	9

3.5 Are you interested in Introducing Power Generator which utilizes Renewable Energy as Residential Power Generator?

	Respondents
It can contribute Environmental Problem, so I want to introduce it actively, if it cannot be paid back	38
If it can be paid back, I want to introduce it	56
I do not want to introduce it due to lack of knowledge of maintenance	4
I am not interested in it	2

3.6 Do you know that there is Surplus Power Purchase System for Private Company in Renewable Energy Field?

	Respondents
I know it very well	31
I have heard it	50
I have not heard it	19
I am not interested in it	

3.7 Do you want to utilize the System, if Surplus Power Purchase System for Renewable Energy is applied in Households?

	Respondents
It can contribute Environmental Problem, so I want to utilize it actively, if it cannot be paid back	28
If it can be paid back, I want to introduce it	66
I do not want to introduce it due to lack of knowledge of maintenance	3
I am not interested in it	3