Asia-Pacific
Economic Cooperation

Peer Review on Low Carbon Energy Policies in Thailand

Final Report

9 November 2012

Endorsed by the APEC Energy Working Group

CONTENTS

Preface

The APEC Peer Review on Low Carbon Energy Policies (PRLCE) was endorsed by the APEC Energy Ministers at the 2010 Energy Ministers Meeting. The review is an extension APEC's Peer Review on Energy Efficiency and follows its guidelines. The PRLCE seeks to achieve the following objectives:

- Share information on low carbon energy performance as well as on policies and measures for improving and promoting low carbon energy in respective economies
- Provide opportunities for learning from the experiences of other economies and for broadening the network among low carbon policy experts
- Explore how low carbon goals on an overall and /or sectoral basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstance of each economy
- Monitor progress on attaining low carbon energy goals on an overall and/or sectoral basis and implementing action plans, if such goal and action plans have been already formulated at the time of the review
- Provide recommendations for voluntary implementation on how implementation of action plans could be improved with a view to achieving low carbon energy goals

Thailand volunteered to undertake the first ever low carbon energy peer review. This report presents the results of a peer review of low carbon energy policies conducted in Bangkok, Thailand.
The primary accountability for each peer review is shared by the economy being reviewed and the Review Team. The peer review in Thailand was conducted by a team of ten experts (see Appendix A) who visited Thailand from 21 -25 May 2012.

During the visit, the Review Team had comprehensive discussion on low carbon energy policies with representatives and experts from government ministries and agencies, private and state companies (see Appendix B). The Review Team wishes to thank all the presenters and others that spent time with the team for discussions, especially the representatives of the Department of Alternative Energy Development and Efficiency-Ministry of Energy who organised the event.

EXECUTIVE SUMMARY

Thailand is engaged in highly commendable efforts in promoting low carbon energy throughout the economy. It has in place comprehensive low carbon energy policies and programmes coordinated through various government agencies such as the Department of Alternative Energy Development and Efficiency (DEDE, Energy Policy and Planning Office (EPPO), both in the Ministry of Energy, Energy Regulating Commission of Thailand, Thailand Provincial Electricity Authority (PEA) and the Thailand Green House Gas Management Organisation (TGO), amongst others.

From an institutional context point of view, the Thailand Ministry of Energy has a clear framework set up and a clear power plan in place. The review team however recommends that frequent revision of this plan in terms of assessing its achievement of set goals and targets and amending accordingly should be considered with a revision period clearly stipulated in law.

A critical step in the promotion of low-carbon energies at the economy level is the development of an alternative energy master plan with aggressive and clear targets. The Ministry of Energy does this through the development of the Alternative Energy Development Plan (AEDP). However it is recommended that in addition to this the Thai Government should consider supporting the development of a renewable energy business association. Renewable energy business associations have proven to be an essential element in engaging small and medium enterprises in the new business of renewable energy development globally.

Thailand has been successful in establishing a regulatory agency - the Thailand Energy Regulatory Commission (ERC), established in 2008 as the dedicated regulatory authority, separated from EPPO), the policy making authority. It is recommended that Thailand maintains the functions of this regulatory commission and continue existing efforts in supporting measures. Not only is there government sponsored support for the financial industry in supporting the alternative energy industry but also a sound industrial basis for skilled workers is provided in Thailand. Strengthening of the grid system, however, especially in less densely populated areas such as the north east region of Thailand is required.

Thailand is a pioneer among APEC economies in establishing policies to promote biofuel (biodiesel and bioethanol) production and usage. However it is recommended that through research and development activities bioenergy standards should be developed and the promotion and development of domestic bioenergy industries enhanced.

Due to increasing wind capacity and investor satisfaction it can be concluded that Thailand's wind energy industry is growing. However as the industry continues to grow there are likely to be challenges in the future, particularly when 1200MW wind capacity becomes a reality. It is vital that Thailand continues to develop technical capabilities both in government, academia and industry to handle challenges that may occur in the future.

Thailand has already set a very ambitious target for the promotion of renewable energy, especially for the photovoltaic (PV) system. However, there are still some challenges for the further implementation of solar energy application in Thailand, such as local industry chain, grid connection, professional skills, management, etc. These hurdles can be overcome through various actions including setting up an accreditation system and making sure that there are a sufficient number of professional engineers and skilled workers to set up and monitor PV systems and the like.

Under the AEDP there is a detailed plan for the development of hydro power, and many successful projects have been completed, which encourages future utilisation. It is important however that as hydropower utilisation increases that there is stricter monitoring of hydro power plants', including small hydro plants' compliance with environmental regulation.

Thailand's proposed feed in tariff system (FiT) is likely to prove successful when introduced, in promoting the development of renewable energy technology and supply in the economy. However it is recommended that this system be evaluated on a periodic basis. A possible revision to the proposed scheme could possibly include adding a bonus to the scheme. Thailand has demonstrated a keen interest in the utilisation of smart grids throughout the economy. One way the development and promotion of this technology within the economy can be expedited is through the involvement in **APEC related activities on smart grid** such as Energy Smart Communities Initiative, APEC Smart Grid Initiative, EGNRET, etc. The robust growth in electricity demand has underlined the need for a significant expansion in future power generation and transmission capacity in Thailand. This is creating considerable private sector participation through the creation of investment opportunities. It is therefore important that the Government encourages the use of local content including encouraging the use of local service providers.

In terms of electricity generation the clear green house gas mitigation target set out in the 2010 Power Development Plan is highly commendable. It is however recommended that in order to achieve such targets that there are consistencies among policies, especially with regards to encouraging clean development mechanism projects, which will assist in mitigation actions.

RECOMMENDATIONS

Institutional Context

Recommendation 1

It is desirable to stipulate the frequency of revision or updating of Power Development Plan in the law (e.g. in principle, once every 3 to 5 years). Similar process for mandated review of the adders (annually) will also be beneficial.

Recommendation 2

There is a National Energy Committee, but on a day to day basis, there needs to be better coordination of plans across the Metropolitan Energy Authority, Provincial Energy Authority, Electricity Generating Authority and Energy Policy and Planning Office. This would be beneficial at the implementation stage as well, especially for smart grids.

Recommendation 3

Incentive scheme should be developed according to the situation in the future.

Recommendation 4

Expedite "feed-in tariffs" process to accelerate the utilisation of renewable energy.

Recommendation 5

Focus on education not only for professional workers but also technical training for vocational workers.

Alternative Energy Goals, Targets and Strategy

Recommendation 6

Consider the development of a renewable energy law to provide certainty to developers. Renewable energy laws are difficult to develop since they require careful thought of legal, economic, and policy issues. However, they can provide increased certainty to developers.

Recommendation 7

Consider the development of a Renewable Energy Portfolio Standard (RPS) that would work in combination with the FiT which would combine Renewable Energy/Energy Efficiency targets.

Recommendation 8

Consider the full range of economy specific benefits associated with biomass as a renewable energy fuel. Biomass can be an important contributor to the ADEP, but to fully realize its potential, careful attention needs to be given to account for the full range of economy specific benefits.

Recommendation 9

Support the development of a renewable energy business association.

Recommendation 10

Consider extending financial support for small-scale renewable energy development. The development of small-scale renewable energy systems can require special financial support mechanisms. Since small- scale renewable energy

projects have the potential to benefit a broad range of Thai society, the government should consider the development of more attractive incentives that were available in the original revolving fund.

Regulation and Infrastructure

Recommendation 11

Continue existing efforts in supporting measures in the area of regulation, especially as the renewable energy industry expands.

Recommendation 12

Co-ordination amongst relevant government agencies of monitoring outcomes and ensuring feedback to assist with regulation.

Recommendation 13

For smart grid technology introduction, it is important to harmonise standards and codes internationally.

Recommendation 14

Strengthening of the grid system, especially in less densely populated areas such as the north east region of Thailand is required.

Recommendation 15

The "Energy Soft Loan" Fund should be brought back and utilized for other high priority national strategies.

Recommendation 16

Although 100 per cent electrification is said to be achieved, efforts to strengthen the electricity grid will be needed.

Recommendation 17

It is important to expedite the Smart Grid and Low Carbon City activities, it is recommended to coordinate with APEC projects.

Recommendation 18

Highly recommend maintaining dialogue with investors and continue improving investment climate.

Bioenergy including Biofuels

Recommendation 19

Supply, quality, and cost are three pillars for the success of utilizing bioenergy. It is highly recommended that these factors are promoted throughout the industry.

Recommendation 20

Introducing densified refuse derived (RDF) technology, a distributed treatment & centralized power generation concept may assist with coping with collection and transportation and subsequent utilization of biomass resources.

Recommendation 21

Establishing a complete waste recycling system, and large scale incineration systems to replace landfill is recommended to increase the capacity of waste-to-energy (WTE) rapidly.

Recommendation 22

Co-firing with biomass (< 5%) in existing coal-fired power plants is encouraged, without modification of existing boilers.

Recommendation 23

Second generation biofuel technology (e.g., BTL) should be more encouraged.

Recommendation 24

Work on removing barriers to the industry such as technical, policy, public support and economic. This can be done through clear information dissemination to all related parties.

Wind Energy

Recommendation 25

Accelerate transmission capacity enhancement as a medium to long term challenge to coordinate with the development of renewables.

Recommendation 26

Continue to develop technical capabilities both in government, academia and industry.

Recommendation 27

Encourage international cooperation for further study and R&D, especially on low wind speed.

Solar Energy

Recommendation 28

Increased small power input into the grid system will influence the quality of power supply. In order to eliminate any associated problems and speed up the promotion of the roof-top PV system, we recommend that the integration and deployment of smart grid systems and power management systems should be made a high priority.

Recommendation 29

In order to maintain the long-term performance of PV systems, the training mechanism for the professional engineer/technician should also be considered.

Recommendation 30

The monitoring mechanism for the PV system (especially for the small capacity roof-top system) needs to be enhanced for long-term tracing of actual performance.

Hydro Power

Recommendation 31

Stricter monitoring of hydro power plants', including small hydro plants' compliance with environmental regulation.

Recommendation 32

Hydro power station coupled with local grid technology should be promoted.

Recommendation 33

For further promotion of very small hydropower in the remote district, the initial cost should be decreased in the future.

Power Supply System- FiT, Smart Grid and Private Participation

Recommendation 34

It is proposed to add some bonuses to the rate: (CP + EP + FS + REP) + (Adder) + ***(Bonuses)****.*

Recommendation 35

Annual power availability should be stated in the application form to declare their energy yield as an agreement to their contribution to the national grid.

Recommendation 36

Feasibility study for grid connection should be done before the FiT submission.

Recommendation 37

Monitoring and communication is one of the substantial issues; Smart Grid is a solution (2 way communication), therefore adoption and implementation of this system as soon as possible is highly recommended.

Recommendation 38

Full collaboration and coordination between the beneficiaries are important for smoother materialization.

Recommendation 39

To be more involved in APEC related activities on smart grid such as Energy Smart Communities Initiative, APEC Smart Grid Initiative, EGNRET, etc.

Recommendation 40

Encourage the use of local content including the encouragement of the use of local service providers.

Recommendation 41

The establishment of a formal technology development plan, a strong legislative framework and a clearly defined public-private partnership strategy are critical policy elements to effectively promote Thailand's Low-Carbon Energy Programme.

Green House Gas Management

Recommendation 42

Consistencies among policies encouraging CDM projects and simplification of approval process of CDM projects are highly recommended.

Recommendation 43

The Thailand Government should consider taking into account CER revenue in the price structure of feed-in tariffs for renewable energy projects.

Recommendation 44

Commercial banks should join with developers to support them in terms of proving additionality of CDM projects.

Recommendation 45

The government should support and encourage the private sector to develop Program of Activities (PoAs) in sectors such as wind, solar, biomass and biogas power since Thailand has many VSPPs with renewable energy projects.

APEC PEER REVIEW ON LOW-CARBON ENERGIES (PRLCE)

PART 1 : Background Information

This part of the report was contributed by Thailand and includes basic information on renewable energy and the main institution associated with energy in the economy. The main purpose of this part is to provide the reader with the context within which the review team based its recommendations.
The report shows the aspect of renewable energy including the current policy and objectives as well as renewable energy activities.

Introduction

1.1 Energy Situation

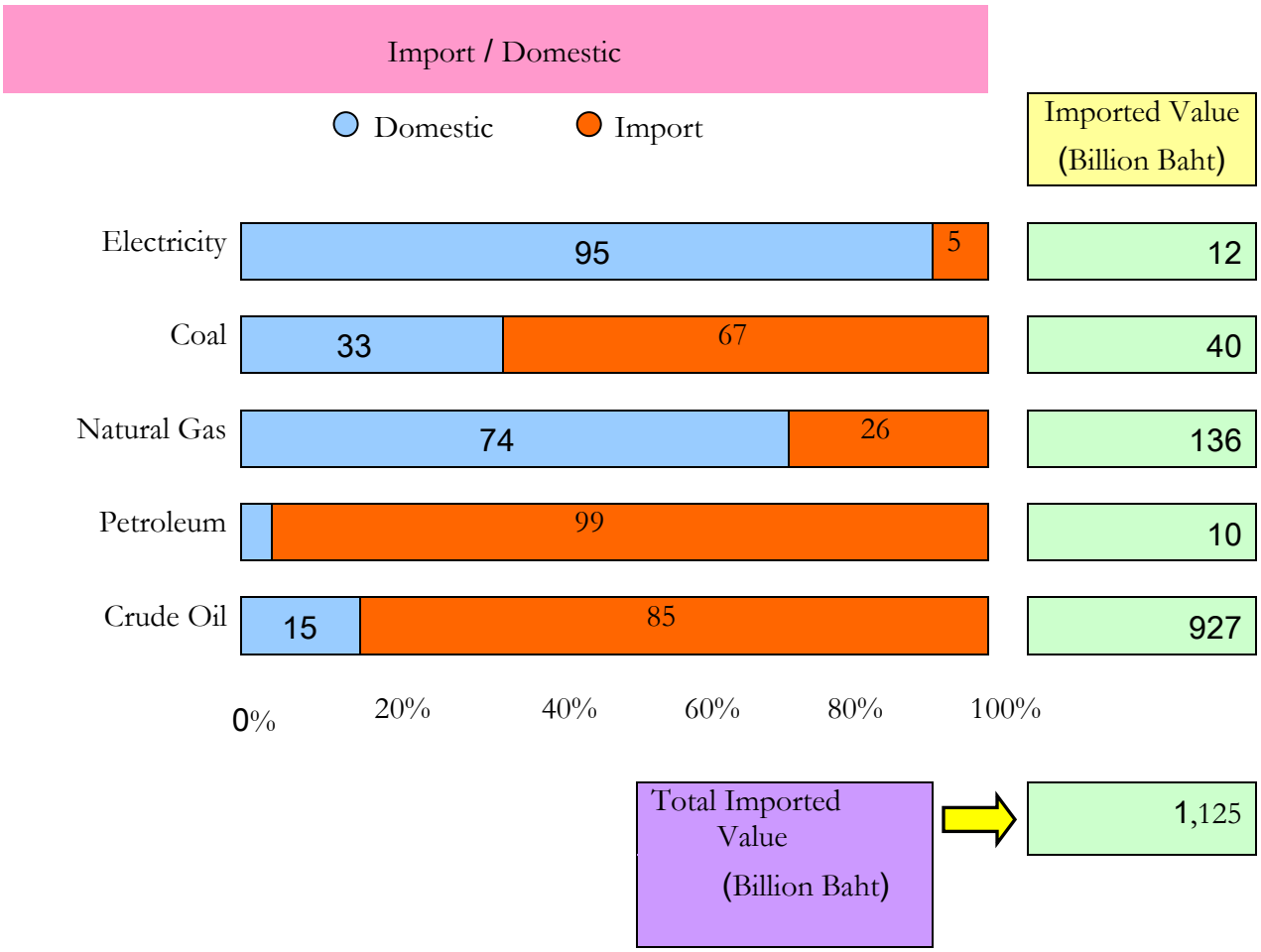


Figure 1: Energy situation in Thailand

Thailand is heavily dependent on fossil fuels (petroleum products making up over 45% of total energy supply), and has limited own energy resources, but with a rapidly growing demand (6% average growth of overall energy consumption and 9% per year of electricity consumption, over the past 25 years) in the country. In 2011, the total electricity production in the country was 153,252 GWh – depending mostly on natural gas (65.4%) of which the majority comes from Thailand's own reserves and a small percentage is imported. The remaining power generation is predominantly from coal (8.3%), lignite (13.3%), hydropower (2.1%), fuel oil and diesel (1.4%), other sources – including renewable sources (6.7%), and imports (from Malaysia and Laos) (2.8%). Currently, the renewable resources being used are growing rapidly. In the first of quarter of 2011, renewable electricity generation (not counting

large hydro sources) accounted for around 2% of the overall electricity generated onto the grid, and increased to 3.4% (3,925 Gwh) by the end of the year 2011. The majority of RE comes from biomass, including agricultural waste (bagasse, rice husks, wood chips, biogas). However, there is also huge potential in wind and solar energy development which can be tapped into if the market constraints are addressed effectively.

Installed capacity since 2007 has been augmented by Independent Power Producers (IPPs) and Small Power Producers (SPPs), and through power purchase agreements with neighboring countries. The current distribution of installed electricity generating capacity between EGAT, IPP and SPP can be seen in Figure 2. VSPPs power contributions are negligible to the overall capacity.

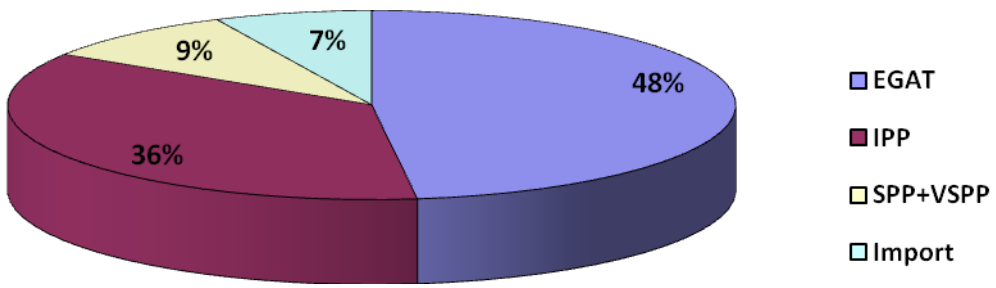


Figure 2: Installed generating capacity by power producers (EPPO 2011)

The Power Producers

In the process of power production, transmission, distribution and delivery, there are stakeholders and activities to be involved as follows:

- Producers: EGAT, Small Power Producers - SPPs (10-90MW), Independent Power Producers - IPPs (>90MW), and Very Small Power Producers - VSPP (<10 MW).
- Transmission: The SPPs and the IPPs under Power Purchase Agreements (PPAs) are required to sell electricity to EGAT who will subsequently transmits to the distributors.
- Distribution and retailing of electricity are the responsibility of the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA). EGAT generates and supplies electricity to the MEA and PEA for further distribution (REEEP 2010). Electricity produced by Very Small Power Producers (VSPPs) (<10MW) is purchased directly the MEA and PEA.

In 2010, MEA consumers used 45,060 GWh and PEA consumers used 102,488 GWh whilst direct customers only used 1,771 GWh.

It is due to the fact that as economy grows, energy is much more needed which has critically affected the global environment and energy security. Therefore, it cannot be relied only on fossil fuels as has previously been but has to breakthrough new alternative energy sources for the green transformation. To illustrates the situation of energy in Thailand, Table 1 below reflects the current energy situation and the indication of the country's reliance on imported fossil fuels which makes us turn more attention towards renewable energy sources to drive the green economy.

Table 1: Thailand's Energy Sector at a Glance

Total energy consumption in 2011	3,030,078 TJ (841,779 GWh)
Total electricity consumption in 2011	535,424 TJ (148,745 GWh) – 17.7% of all energy
Total electricity production in 2011	153,252 GWh
Thailand's total final energy consumption from fossil fuels in 2011	2,449,011 TJ – 80.8%
Consumption of petroleum products in 2011	41,528 Million Litres (1,407,189 TJ)
Consumption of coal and lignite in 2011	36,847,580 tonnes (650,400 TJ)
Percentage of coal (and lignite) energy used which was imported in 2010 (note that all coal is imported)	45.09%
Consumption of natural gas in 2011	47.17 billion m^3 (1,701,710 TJ)
Percentage of natural gas imported in 2011	21.70%
Natural gas reserves	10.24 billion m^3
Lifetime of reserves	~20 years
Annual growth in overall energy consumption over the last 25 years	6.2%
Annual growth in electricity consumption	9.1%
over the last 25 years Growth in per capita electricity consumption in the period 2005-2011	26.53%
Per capita electricity consumption in 2011	2.31 MWh
Energy expenses in 2011	>US $58 billion
Percentage of electricity which was imported in 2011 (from Malaysia and Laos)	>US $58 billion 6.88%

The predominance of fuel use such as, petroleum, natural gas and coal, and the distribution of energy use by real sector are indicative to Thailand's ranking as a middle-income country where the challenges faced are more in line with that of OECD countries. It is also worth noting that, unlike many developing countries, the agricultural sector only consumes 5% of the country's total final energy consumption.

2. Energy Sector: Structures and Stakeholders

2.1 Ministry of Energy

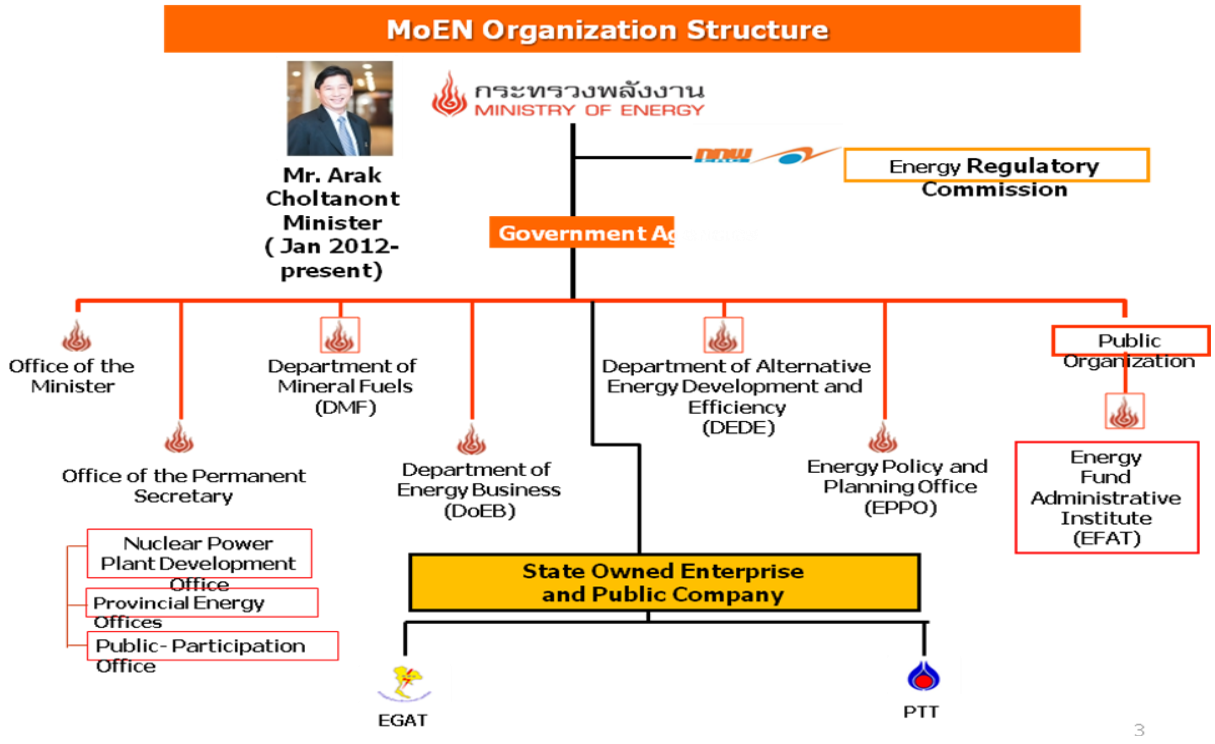


Figure 3 MoEN Organization Structure

Under Thailand's government reforms in 2002, there emerged the new Energy Ministry (MoEN) which has entire responsibility for energy development in Thailand (http://www.energy.go.th/. MOEN is divided into the following offices and departments:

1. **The Energy Policy and Planning Office (EPPO)** (http://www.eppo.go.th/) is the principle authority responsible for determining regulatory policy with respect to the power sector. All key energy policy and plans including price structures of petroleum products, energy exploration commissions and policies on IPPs, SPPs and VSPPs must go through the EPPO. The funding for energy efficiency programmes must also go through the EPPO and be approved by the Energy Conservation Promotion Fund Committee, the NEPC (The National Energy Policy Committee) and finally the Cabinet.
2. **The Office of the Permanent Secretary to the Minister of Energy (OffEN)** is a government institution operating under MoEN which supports the Permanent Secretary to the MoEN, and is concerned with the administration, coordination, control, monitoring and supervision of the operation and implementation of the ministerial policies.
3. **The Department of Mineral Fuels (DMF)** (http://www.dmf.go.th/) is a government

agency, which was established under the Department of Mineral Resources, Ministry of Industry, on 17 January 1972 with the aim of developing energy resources in Thailand in order to reduce dependency on energy imports. Currently the DMF oversees the development, exploration, production and management of petroleum ensuring national energy security to be maintained efficiently and sustainably.

4. **The Department of Energy Business (DoEB)** (http://www.doeb.go.th/) is a government agency which addresses energy laws and monitoring energy imports, sales and production. It aims to provide sustainable, safe and quality energy services and carry out a number of activities related to fuel quality and testing.

5. **The Department of Alternative Energy Development and Energy Efficiency (DEDE)** (http://www.dede.go.th/dede/)

The Department is responsible for promoting energy efficiency, regulating energy conservation, supplying energy resources, developing integrated alternative energy and disseminating energy technology systematically and continuously as stated by the Government energy policy. There are 9 bureaus, 2 divisions and 1 Center under the management structure of DEDE as shown in the organization chart below.

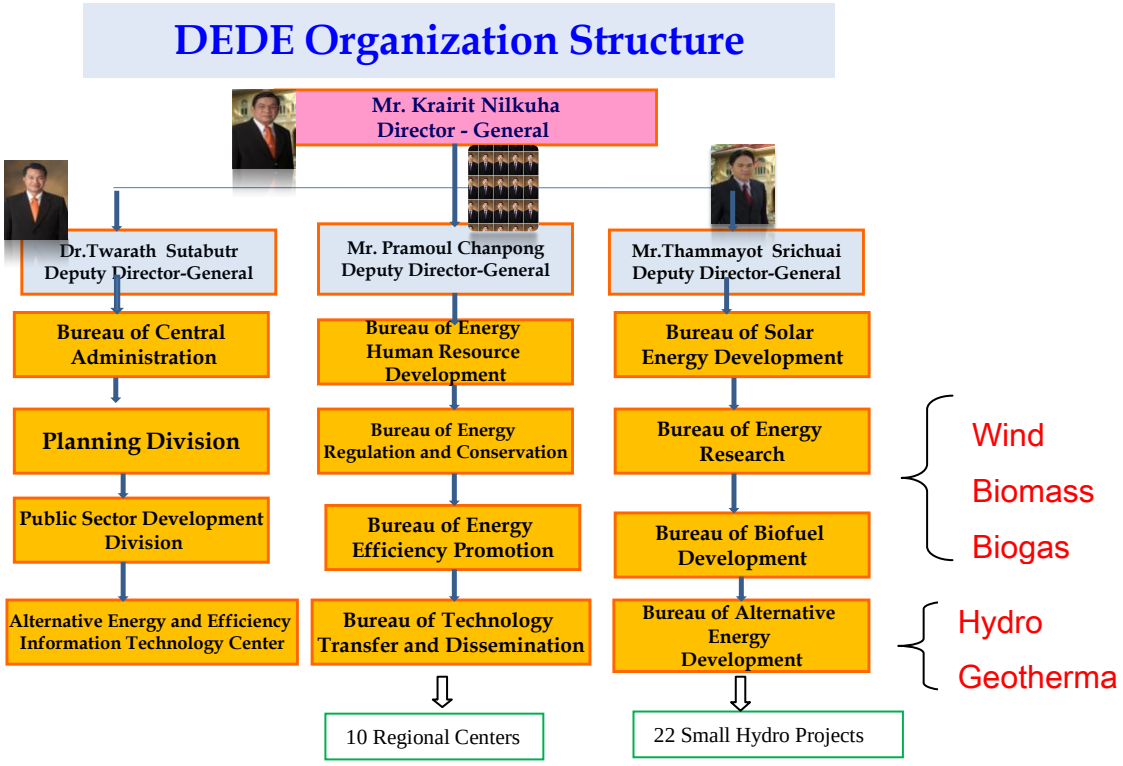


Figure 4 DEDE Organization Structure

6. **The Energy Fund Administration Institute (EFAI)** (http://www.efai.or.th/) is a public organization, an independent agency work in which operates as an independent agency under the MoEN, the responsibility of which is to ensure the stability of domestic oil prices through the procurement of funds as well as other tasks in accordance with the government policies relevant to the Energy Fund Administration.
7. **The Energy Regulatory Commission (ERC)** (http://www.erc.or.th/ERCWeb/default.aspx) was established under the Energy Industry Act in 2007, aiming to: regulate the energy industry operation in compliance with the objectives of the Act and the policy framework of the government; establish a license issuance process and regulations that are transparent and standardized for the benefits of energy consumers, communities and the country, in both short and long terms; promote efficient energy industry operation and energy utilization as well as fair competition in the energy industry; prevent abusive use of monopoly power; establish a secure, reliable and safe energy structure; and encourage the participation of local communities, general public, energy consumers and energy industry operators in the energy system development in Thailand.

2.2 State Enterprises under the Ministry of Energy

1. **The Electricity Generating Authority of Thailand (EGAT)** (http://www.egat.co.th) is a state enterprise responsible for nearly 48% of the power generation. It is also the buyer of independent and small power producers (IPP, SPP) and it is responsible for transmission and supply of electricity nationwide through the Provincial Electricity Authority (PEA) and the Metropolitan Electricity Authority (MEA). Further to this, EGAT is also in charge of the **Demand Side Management (DSM) Office**. The DSM develops national standards for the promotion of energy efficiency.
2. **PTT Public Co. Ltd (PTT)** (http://www.pttplc.com/) is the national integrated oil and gas company. Its main responsibilities the oil and gas Market, the operator of Natural Gas pipeline, the Petrochemical and International trading. PTT has established the research institute named as *PTT Research and Technology Institute (PTT RTI)* to do related researches on new technologies, development of petrochemical products, alternative energy solutions as well as the environmental impacts on business development.

2.3 Other Related Organizations

1. **The Metropolitan Electricity Authority (MEA)** (http://www.mea.or.th) was

established on 1 August 1958 as a state enterprise under the Ministry of Interior which is responsible for the distribution of electricity within Bangkok metropolitan areas.

2. **The Provincial Electricity Authority (PEA)** (http://www.pea.co.th/th/eng/) is a state enterprise which was established on 20 September 1960. It is now under the supervision of the Ministry of Interior. The PEA main responsibilities are to produce, distribute and sale electricity to households, business and industrial sectors as well as to the general public in the provincial areas of Thailand.

Both PEA and MEA are designated buyers of Very-Small Power Producers (VSPP) programs. Currently the electricity generation can cover all provinces of Thailand making up 99.4% of the country's total area.

3. Renewable energy development in Thailand: Alternative Energy Development Plan (AEDP 2012~2021)

As an agricultural country, Thailand is rich in agricultural wastes and products that can be yielded for energy purposes such as biomass, biogas, biodiesel, ethanol, and the by-products from processed food industry. Geographically situated in the equator, Thailand also has great potential in solar with average radiation of 18.2 $MJ/m^2/day$; and in some areas with wind speed potential. Such abundant alternative energy sources certainly make Thailand the best potential on alternative energy development and create opportunity to strengthen energy security in the future.

3.1 National Energy Policy

With the new Cabinet led by Prime Minister, Ms. Yingluck Shinawatra, the Government of Thailand stated in the Parliament the energy policy, to be highlighted here are:

(1) Promote and encourage the energy industry for increasing national income, invest more in energy infrastructure and develop as regional business hub

(2) Strengthen energy security by seeking and developing energy resources and power systems, allocate various energy types for diversification and sustainability

(3) Regulate reasonable energy prices, adjust the role of the Oil Fund to maintain price stability, promote more use of natural gas in transportation sector, and promote uses of gasohol and biodiesel in household

(4) Promote the production and use of renewable and alternative energy, including research and development aiming to replace fossil fuels at least 25% within 10 years

(5) Fully Promote energy conservation by reducing energy intensity by 25% within 20 years, promote high efficient equipments and buildings, promote clean energy mechanism to reduce GHG and global warming, Create awareness of consumers to use energy efficiently in production, transport and household sectors

With the severe impact of fossil fuel consumption on environmental problems such as green house gas emission, climate change, and insecurity that may be arisen in energy supply in the future together with abundant renewable energy resources in the country and strong commitment to the government energy policy statement, the Ministry of Energy now has announced the 10-Year Alternative Energy Development Plan (AEDP) aiming to create the framework and direction for increasing alternative energy consumption by 25% in 2021. This

plan will replace the previous 15-Year Renewable Energy Development Plan (REDP) 2008-2022 where the renewable energy consumption target was 20.3% in 2022.

3.2 Development Framework of AEDP

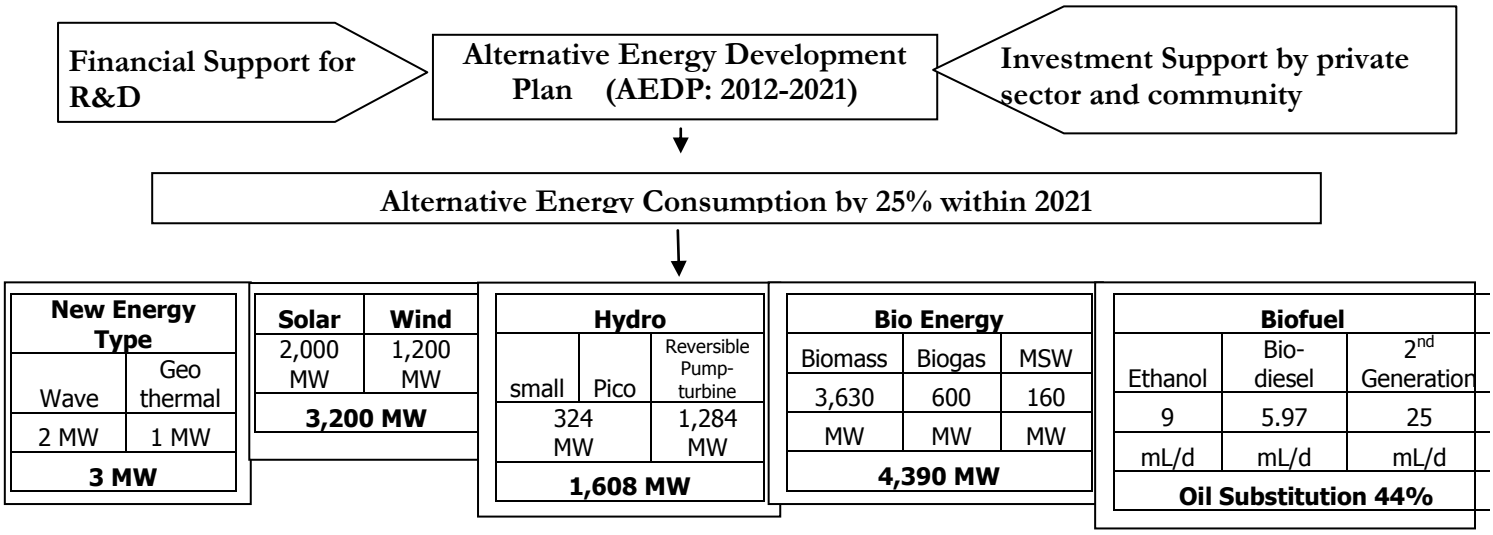


Figure 5: Thailand's newly approved AEDP

Objectives:

(1) To sustainably develop alternative energy as one of the main energy for fossil fuels substitution and oil import replacement (AEDP excludes CNG from the monitoring table in transport sector)

(2) To strengthen the national energy security

(3) To create the community-based alternative energy facility in the form of "zero-waste integrated complex"

(4) To support the alternative energy technology production in the country

(5) To research, develop, and promote alternative energy technologies for the country's competitiveness

6-Strategies

(1) Promotion of community participation across the country in alternative energy development and consumption

(2) Fine-tuning of the incentive measures for private investment

(3) Amendment of the laws and regulations unfavorable to alternative energy development

(4) Improvement of the infrastructure such as transmission and distribution system as well as smart grid,

(5) Public relations, information dissemination and knowledge enhancement

(6) Utilization of research and development activities as a tool to develop the alternative energy industries

3.3 Targeted Renewable Energy Technologies:

(1) Solar:

The AEDP target of solar development is 2,000 MW, while the current existing generating capacity is only 75.48 MW. Focused activities are to promote, develop, and create awareness campaign as follows:

a) Community participation across the country in the alternative energy development and consumption of PV rooftops for power generation of 1,000 MW.

b) Adder System review for being transformed to the Feed In Tariff (FiT) System

c) Laws and regulations amendment such as Factory Act B.E. 2535 (1992)

d) Infrastructural Improvement such as transmission and distribution system and smart grid by requesting EGAT, PEA and MEA to extend transmission system to serve the increasing supply of alternative energy, and smart grid development respectively.

e) The promotion of knowledge understanding on using different types of solar PV system among people or related sectors

f) The promotion of upstream solar cell production industry such as Silicon Wafer

Recently, the price of solar panels has decreased tremendously from what was in the past or about 80-100 million Baht to 40-50 million Baht per 1 MW which is likely to be at the same level of the power generation from fossil. Therefore, the improvement of electricity generation from solar is crucial to alternative energy development in Thailand.

(2) Wind:

The wind target under AEDP is 1,200 MW, while the current generating capacity is only 7.28 MW. Activities to be taken up are as follows;

a) The promotion of wind turbine generation in mountain areas and inaccessible-electricity islands, and for agricultural purpose especially water pumping as well as small wind turbines that are locally produced

b) Private sector facilitation to explore remote areas to install wind turbine

c) Urge for laws/regulations improvement such as; the procedures of the Ministry of Natural Resources and Environment with regard to land exploitation for wind farm, a permission for the private sectors to develop energy project by allowing them to utilize some sensitive areas which have no more forestry condition or faces difficulty to be rehabilitated, including the amendment of Factory Act B.E. 2535 (1992)

d) The improvement of transmission system and storage, i.e. pumped storage, in such high wind potential area as the Northeastern part of Thailand

There are, as studied, 6 potential wind areas in Thailand: (i) Aow-noi district, Amphur Muang, Prachuabkhirikhan; (ii)Lam-phak-bea district. Amphur Ban-lam, Phetchaburi; (iii)Thai-sa-mak-kee district, Amphur Wang-nam-keaw, Nakhon Ratchasima; (iv)4. Khao-ko district, Petchabun; (v)Ta-ma-fai-wan district, Amphur Kaeng Khro, Chaiyaphum; (vi)Kao-ya-dee district, Amphur Kaeng Khro, Chaiyaphum.

e) The creation of wind user/producer network

f) The production stimulation of industry relating to the component parts of electricity storage and hybrid wind generation and the development of wind turbine suitably applied for wind velocity in the country

(3) Hydropower

The hydropower target under AEDP is 1,608 MW, while the existing generating capacity is 86.39 MW. (excluding the 500 MW of existing EGAT Pumped Storage Power Plant at Lam Takong 1-2). The activities for hydropower development under AEDP strategies are:

a) The promotion of hydro power plant in the communities where local administration agencies or community owners can, by themselves, be partly participated in or owned, operated and maintained in the future

b) Solving problems/obstacles arisen from small hydropower project development in the sensitive areas such as watershed areas, national parks, or wildlife conservation areas etc.

c) Assignment to; DEDE and EGAT on the project development of the small hydro power at the existing irrigation dams and the small hydropower generator system with the generating capacity from 200 – 6,000 kW; and EGAT on the development of the new Pumped Storage System Projects in 2 areas in the North East, Lam Takong Pumped Storage Projects (3-4) with the installed capacity of 500 MW and

Chulabhorn Pumped Storage Power Plant Project with the installed capacity of 684 MW

d) Disseminating useful information on hydro power projects

e) Research and development of a micro hydro turbine generator and micro hydro turbine with minimum head

(4) Waste-to-Energy

The AEDP planned to achieve the 160 MW of waste-to-energy target, meanwhile the existing generating capacity is 13.45 MW. With the amount of the target, major activities under the AEDP strategies are set as follows:

a) The promotion of Waste-to-Energy in the Small and Medium Local Administrations and small communities such as schools, temples, communities, other agencies etc.

b) The amendment of Private Participation in State Undertaking Act B.E. 2535 (1992) to allow private sectors to jointly invest with Local Administrations in implementing all types of waste-to-energy, especially plastic waste-to-fuel (pyrolysis-oil) and the RDF that is to be managed for co-generation use in industries

c) The creation of participation in installing waste-to-energy production system, and knowledge campaign to educate waste management to the youth at the community level

d) The entire promotion and development of alternative energy industry with regard to the RDF management, the incinerator and small scale RDF production system of not more than 50 tons/day, and the standards and equipment relating to plastic waste-to-fuel production

(5) Biomass:

The target of biomass under AEDP in 2021 is 3,630 MW while the existing generating capacity is 1,751.86 MW. The development to reach the target includes the followings:

a) The promotion to install Distributed-Green-Generation-DDG (DGG ≤ 1 MW) under the entire ownership and management of community energy enterprise group , and fast-growing plantation in the empty/non-used lands to be processed and distributed to DDG for power generation extension

b) Consideration for new/modified approaches of financial supporting measures such as ADDER or FIT, special Renewable Energy Incentives for community based DGG projects only, and other financial support measures for increasing efficiency

in the biomass power plant with the modification/replacement of low pressure boiler to a higher one, especially in sugar industries

c) An assignment to PEA and EGAT to expand the transmission system and distribution to sufficiently serve the biomass power plant development, especially in such high potential areas as in the South of the country

d) The creation of biomass network and participation in the targeted areas where biomass production system can be installed; and knowledge campaign to educate the youth for biomass management with in-depth details of energy and environment at the community level

e) The development of biomass pallet production, consumption and standards, Gasifier, Gas Engine technology, downstream industries for a domestic production capability, and biomass-to-liquid technology

(6) Biogas:

The AEDP target is 600 MW, while the existing generating capacity is 138 MW. Major activities towards the success are:

a) The support of biogas production for household uses in the rural community, and the network development of surplus biogas to be connectedly supplied in the system for use by communities under their self-management

b) The promotion of CBG (Compressed Biogas) production for transport sector through appropriate pricing mechanism that reflects the actual cost of production

CBG is produced by fermenting biodegradable materials followed by quality improvement processes in order to be used as vehicle fuel and replaced natural gas in electricity generation. CBG is suitable for small-scale power plants yielding the power output of not more than 1 MW.

The result of the study conducted by the Ministry of Energy found that, about 30 locations in Thailand are potential sources of materials for the CBG production. Most of them are situated in the North, North-eastern and Southern parts of the country where pig farms, starch plants and palm oil industries have been located. In addition, a research reported that elephant grass or Bana grass can be used as raw material in the fermentation for CBG use in vehicles and power generation. A ton of Bana grass produces 160-190 m2 of biogas, which is interesting in term of alternative energy development.

c) The study and development of laws and regulations relating to Biogas System Safety Standards

d) Public relations enhancement to provide knowledge and information dissemination through media, and Biogas Safety Campaign to gain the image of biogas production and uses

e) Research and development on co-digestion for biogas production particularly on using industrial waste-water and cornstalk to be fermented with animal waste, and CBG use to increase efficiency in transport sector

(7) New Alternative Energy for Power Generation

The Ministry of Energy and DEDE used to study new alternative sources of energy viable for power generation and have been expected to potentially develop further for future commercial purposes. These sources are also included in the AEDP as follows:

(7.1) Geo-thermal:

The 1 MW of geothermal is set under AEDP with the current capacity of 350 kW.

Even though, geothermal is set as one of the renewable technology in the AEDP plan to be achieved, it, somehow, has some Impediments to be tackled such as the insufficiency of heat from geothermal, the community understanding process on using geothermal as an energy production source, and the reliance on imported technology.

To problem-solve, DEDE has primarily set guidelines and directions towards geothermal development starting with: geothermal potential map; an assessment on feasible geothermal development with appropriate types of technologies, economic value, community, environment and health impact, to support geothermal production; a test bed on suitable technologies for low heat geothermal; and the follow up of technologies that can support the country potentially and geographically. Noted that, there is no "Adder" for geothermal –power plant as yet.

(7.2) Tidal and Current Energy:

The target set at the AEDP year end is 2 MW, while the present generating capacity is none.

Major impediments towards the energy development from the tidal wave is lack of the information and assessment of tidal energy use. Therefore, DEDE firstly set the guidelines and directions of tidal and current energy by, studying the tidal energy sources and technology models in Thailand which is expected to be potentially located at Sarasin bridge in Phuket, Samui-Pa Ngan Island vicinity, and also seeking for potential to be assessed and prepared for a possible pilot project.

(7.3) Hydrogen and Energy Storage System

Hydrogen and Energy Storage System have also been faced with impediments to be developed such as lack of recognition of essential research and development planning and

implementation in the country, reliance of imported technology, and continuous financial support and incentive measures to develop and utilize hydrogen in the power sector and the energy storage system.

(8) Alternative Energy in Transport Sector (petroleum replacement)

(8.1) Ethanol

The ethanol target under AEDP is 9 mL/day while the existing generating capacity accounts for 1.3 mL/day. To succeed the target two areas are focused:

a) Supply side

- The acceleration of cassava and sugar cane production at the average amount of 5 and 15 tons/rai/year respectively within 2021 as indicated in table 2 below;

Table 2: Thailand Ethanol Feed stocks

Raw Materials	Land (MRAI)*	Productivity/ton/rai	Output (mton/yr.)
cassava	7	5	35
sugar cane	7	15	105

* 1 Rai = 0.39 Acres
= 0.16 Hectares

- The promotion of other alternative energy crops for commercial purposes such as sweet sorghum, pineapple etc.

Nowadays, Thailand possess10 ethanol plants and there will be 5 more within 2012. With the continuous and strong support by the Thai Government, Thailand would developed towards the Ethanol Hub in ASEAN.

b) Demand side

- The mandate towards the cancellation of gasoline 91 (ULG91) within October 2012
- Pricing management for E20 and gasohol 95 by making the former 3 Baht/litre cheaper and more marketing-margin than the latter but not less than 50 Satang/litre to bring more attractive incentives for the expansion of E20 stations
- Financial support provided for research and testing implementation, and the incentive measures to accelerate the ethanol use by providing the conversion guidelines/kid for old vehicles and motorcycle modification into E85 use or ED95 use of diesel engine buses

- Continuous public relations and campaign to create the better understanding on gasohol E10, E20, E85
- The support of E-85 and ECO vehicle manufacturers by reducing excise tax at the rate of 50,000 and 30,000 Baht/vehicle respectively
- Urge for government agencies to consider E85 car purchasing
- The modification of rules, regulations and laws to support a free ethanol market in the future i.e. the cancellation of the Liqueur Act enforcement on the prohibition of ethanol production for fuels, and the improvement of the Excise Act to help ethanol export and prepare for the new technology such as Multi Dispenser etc.

(8.2) Biodiesel

The target of biodiesel under AEDP is 5.97 ML/day, while the existing combined capacity is 1.62 ML/day. The key activities will be developed as follows:

a) Supply side

Taking into account the impact on food crops plantation, the promotion of palm plantation in suitable areas will be developed by; promoting the 5.5 Million Rais of palm plantation land with the combined yield of 5.3 Million Rais within 2021 and the raw palm oil capacity of not less than 3.05 Mton/rai/year. Meanwhile, the yielded target will be reached not less than 3.2 tons/rai/year and 18% of oil content.

b) Demand side

Key strategies have been outlined on the demand side through; the management of biodiesel mixed portion to be in line with palm oil production volume in the country, the pilot project of B10 and B20 utilization in truck fleets or fishery boats, and the development of the standard of FAME model to be able to contain 7% biodiesel mixed portion (B7).

c) Fine-tuning management has been designed for the management concept to promoted biodiesel such as; plantation, extraction, edible oil production, biodiesel production and run-on industries, import, export and R&D with the aim to reduce cost and create value-added for the country's maximum profit

(8.3) 2nd Generation Biofuels for future diesel substitution:

The target under AEDP is 25.0 ML/day.

a) At present, ethanol has been planned for use in the country as efficient gasoline substitution. However, this seems not to be the same as in the case of the

replacement of diesel with biodiesel due to some impediments, especially in the insufficiency of raw materials for its production. Therefore, the research and development on 2nd Gen biofuels, to replace biodiesel are crucial, leading to the set up of 7 new directions which comprise; the development of two energy crops (Jatropha and Algae), three types of blended ethanol to substitute biodiesel (FAEE, ED95 and Diesohol), and two types of petroleum processing technologies (BHD and BTL). These have been an action plan (2013-2016) with the integrated cooperation between the Ministry of Energy and the Ministry of Science and Technology. The details are as follows;

- Jatropha: The development of jatropha plantation, species, life-cycle equipment and a test-bed on long term engine operation
- Algae (fresh and salt-water): The improvement of species and the development for commercial scale
- FAEE: The experiment on use of FAEE in vehicles, and looking-up for the standard of quality testing
- ED95: The development of additives and old engine technology modification
- Diesohol: An ethanol proportion to be experimented for suitable blended diesel which already had 3-5% of biodiesel combination, and the engine testing with diesohol
- BHD: The engine testing with BHD and quality testing standards
- BTL: The pilot scale production and work testing

b) The result to be extended for commercial purposes (long term for 2017-2021) will be prepared for the next action plan when the research results are acceptable and will be extended to all refineries in Thailand.

Development Plan	Indicator	Phase 1	Phase 2
1. Research			
1.1 ED95	- The research result on the future new fuels has been envisaged enough for the policy decision and is ready for the pilot project and commercial development respectively.	ED95 Diesohol **2014**	
1.2 Diesohol			
1.3 FAEE		FAEE BHD **2015**	
1.4 BHD			
1.5 River and Sea Algae		River and Sea Algae BTL, Jatropha **2016**	
1.6 Jatropha			
1.7 BTL			
2. Pilot Project and Fleet Test	- The emergence of the Pilot Project at the Fleet Test Level - The decision to select the most suitable new fuels	2014-2016 -Piloting ED95 or Diesohol or FAEE 2015-2017 -Piloting Algae, Jatropha+BHD 2015-2017 -Piloting the BioJet(BHD)	
3. The Commercial Development	- The emergence of commercial-based factories with the generating capacity of 2 ml/day in 2018 - The increasing capacity to 25 ml/day in 2021.	Capacity for commercial purpose 18 19 20 21	

Table 3: New Fuels Development Plan for Future Diesel Replacement

(8.4) Renewable Heat

Renewable heat incentive measures on biomass, waste, biogas and solar, for the replacement of heat from fossil fuels in the industrial sectors such as cooking gas, fuel oils, LPG and coal etc will also be developed as follows:

a) Solar

A 100 ktoe of solar heating capacity is set under AEDP while the existing combined generating capacity is 1.98 ktoe. To achieve the target, key activities are planned to; promote the installation of solar heating/cooling, probably to be firstly started as the pilot project in the government building; develop the low cost solar heating system at the residential level and solar drying system in SME and community enterprises (OTOP), as well as improve mandatory mechanism, such as building energy code for large building, to install the solar heating/cooling system

b) Biogas

The AEDP target for biogas in 2021 is 1,000 ktoe while the existing combined generating capacity is 379 ktoe. The development includes, among other, the implementation of the compressed biogas projects, aiming to accelerate the use of natural gas in the transport sector up to 5% target

c) Biomass

The AEDP target for biomass is 8,200 ktoe while the existing combined generating capacity is 3,286 ktoe. This will be promoted through biomass pellet production and the comprehensive use of heat co-generation (electricity and heat) or biomass co-generation.

3.4 AEDP Targets for 25% in 2021

The following tables 4 and 5 indicate the target value comparison of installed generating capacity expected from the former 15-Year REDP and the new 10-Year AEDP.

Table 4: Targets under AEDP

Type	Unit	Original Targets		New targets		
Electricity		KTOE	MW	KTOE	Million units	MW
1. Wind		89	800	134	1,283	1,200
2. Solar		56	500	224	2,484	2,000
3. Hydro		85	324	756	5,604	1,608
4. Biomass		1,933	3,700	1,896	14,008	3,630
5. Biogas		54	120	270	1,050	600
6. MSW		72	160	72	518	160
7. New Energy		1 (Hydrogen)	3.5	0.86	10	3
Total		**2,290**	**5607.5**	**3,352.86**	**24,956**	**9,201**
Power substitution portion	**%**	**6%**		**10.1%**		
Heat						
1. Solar	KTOE	38		100		
2. Biomass	KTOE	6,760		8,200		
3. Biogas	KTOE	600		1,000		
3.1 Biogas				797		
3.2 CBG (5% of NGV)				203		
4. MSW	KTOE	35		35		
Total	**KTOE**	**7,433**		**9,335**		
Biofuels						
1. Ethanol	mL/day	9.0		9.0		
2. Biodiesel	mL/day	4.5		5.97		
3. New Fuels for diesel substitution	mL/day	-		25.0		
Total	**mL/day**	**13.5**		**39.97**		
Fuels substitution portion		**14%**		**44%**		
Alternative energy consumption per final energy consumption of the country		**12% (not include NGV)**		**25%**		

Table 5: Targets of electricity produced from Alterative Energy

Type	**The consumption target in 2021**	**The installed capacity in 2021**
	GW-hr	MW
1. Wind	1,283	1,200
2. Solar	2,484	2,000
3. Hydro	5,604	• EGAT Pump storage 1,284MW • Small-Hydro 324 MW 1,608
4. Biomass	14,008	3,630
5. Biogas	1,050	600
6. MSW	518	160
7. New Energy	10	• Geothermal 1 MW • Tidal or Current 2 MW 3
Total	**24,956**	**9,201**

3.5 AEDP Advantages

In conclusion, the AEDP will lead to many advantages in multiple sectors such as:

Energy sector: If we reach the alternative energy production target, 25% of total energy consumption, it means we are getting 9,201 MW of electricity, 9,335 ktoe of heat and 39.97 million liters per day of biofuel.

Economic sector: The plan trends to reduce oil imports for 574,000 million baht and to promote private sector investment about 442,000 million baht.

Environmental sector: The CO2 emission will be decreased for 76 million tons/year within 2021, moreover, there will be possibility of income from trading carbon credit approximately 23,000 million baht.

4. Current development of alternative energy source

4.1.SOLAR ENERGY

1. Thailand's solar Energy potential

The data of solar radiation of Thailand has been developed by the Department of Alternative Energy Development and Efficiency (DEDE) and Silpakorn University. The latest version has been updated in 2010 using solar radiation measured data of 38 DEDE's Network Stations for Solar Radiation Intensity Measurement for Thailand and 4 stations of Silpakorn University around the country. The daily global solar radiation collected from 1990 till 2010 are used as input data for modelisation. The results from the model are averaged monthly as shown in Figure 6.

The solar radiation in all over Thailand is similar. The average sunlight of the whole country is 18 MJ/m2-day. The variation of solar radiation depends on location and time of the year. The areas which receive the highest radiation (20~22 MJ/m2-day) are mainly in the Northeast and partly in the Centre. The solar radiation is the highest during the year from March to April and is gradually lower during the monsoon, from May to September; yet still higher comparing to the value of solar radiation during winter from October to January. The yearly average of solar radiation map in Thailand is shown in Figure 7.

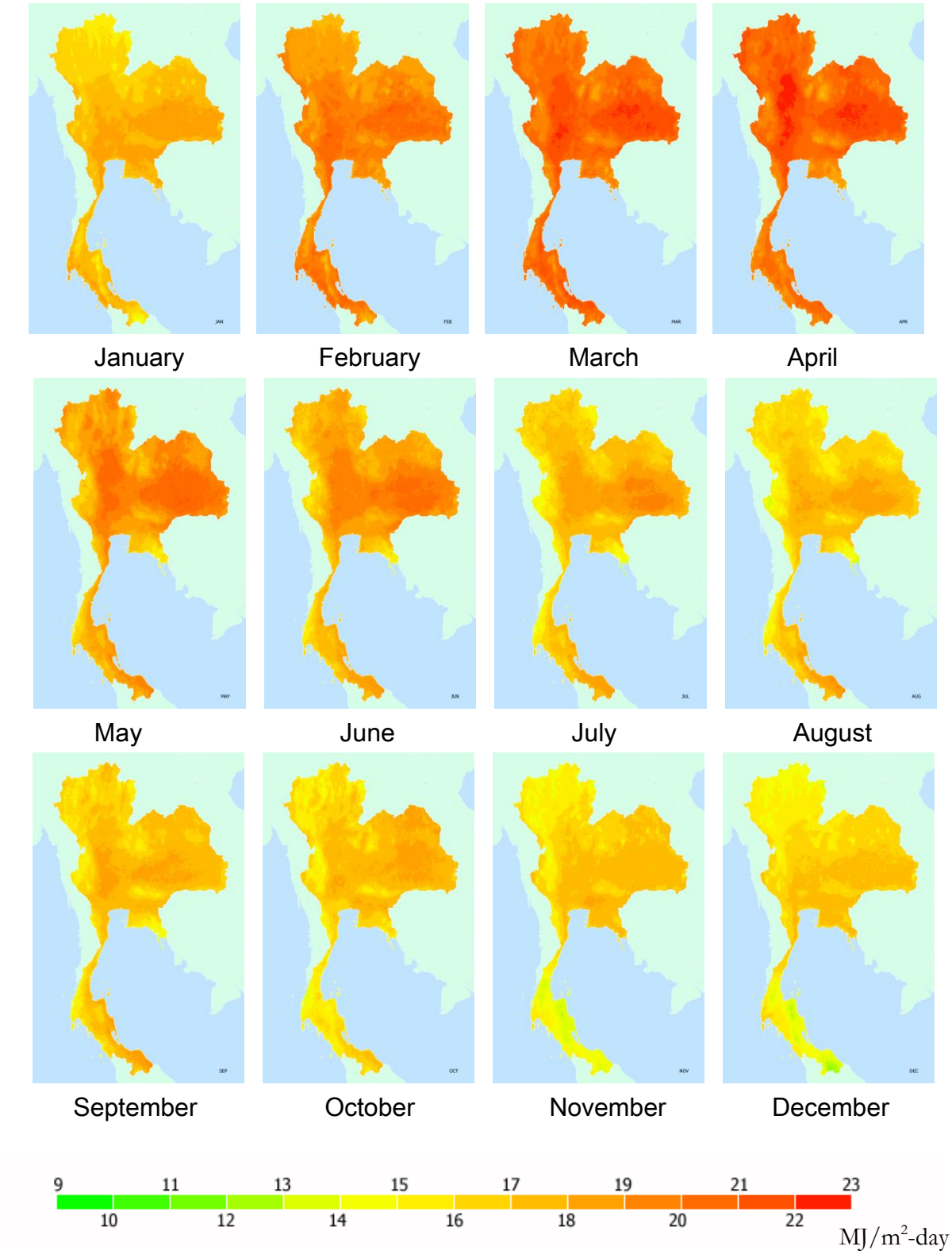


Figure 6 Monthly Average Global Solar Radiation Maps

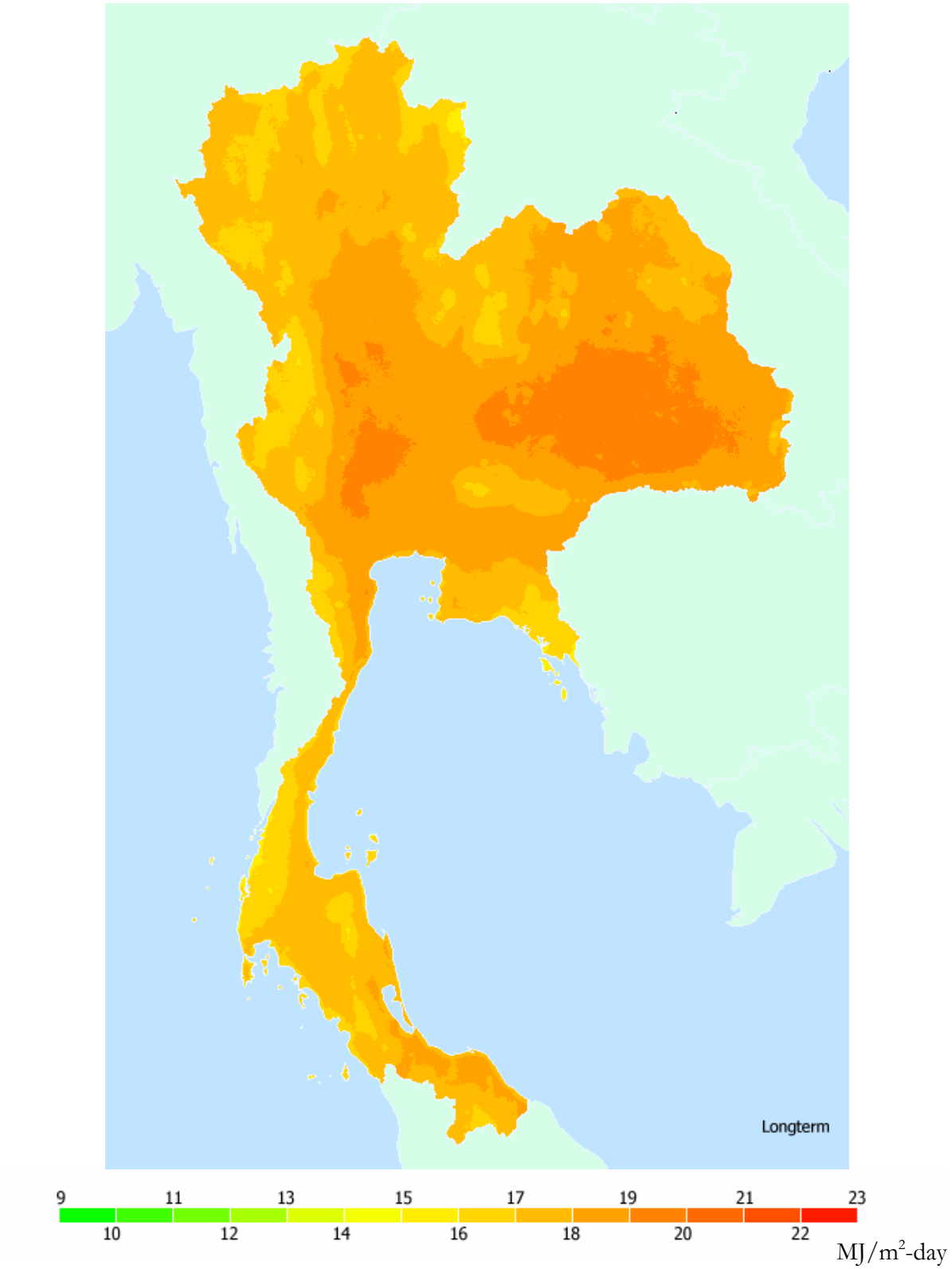


Figure 7: Yearly Average Solar Radiation Map in Thailand

4.2 Thailand's Solar Power Situation

a. Off-grid

The PV system to generate electricity for the health care service unit is the first PV application ever introduced in Thailand in 1976. Most of the off-grid systems were installed in rural and un-electrified remote areas to improve the quality of rural inhabitants' lives. Its major applications are for lighting and telecommunications, water pumping, generating electricity for schools/learning centers and healthcare clinics. Other examples include the use of PV in the military and police bases along the border areas and in the Royal agricultural projects. These developments were financed by the government budget and implemented effectively by the Ministry of Energy. The boom of the off-grid electrification has been emerged during 2004-2005 when the "Solar Home Program" was introduced. During that period, 203,000 units of the solar home systems (SHS) were installed by PEA throughout the country. The cumulative installation capacity (updated September 2011) of the off-grid PV systems is about 29.65 MW

b. On-grid

During 1997-1998 and 2002-2004, EGAT introduced solar rooftop demonstration projects for 10 and 50 systems for the feasibility study of PV rooftop in Thailand. In 2004, without any financial incentive scheme, EGAT installed the first large grid supported PV power plant of 500 kW in Mae Hong Son Province, in the North of Thailand. In the same year, the large PV rooftop of 460 kW was first introduced at the Tesco Lotus Department Store located in downtown Bangkok. The rapid growth of on-grid installation has been predominant since 2007, after the adoption of adder or Feed-in-Premium**.** The cumulative installed capacity already commissioned (updated September 2011) of the on-grid PV systems, is about 70.74 MW in which 67.34 MW is the result of adder scheme.

Table 6: Solar VSPP and SPP status (updated September 2011)

	VSPP		SPP		Total	
	MW	Project	MW	Project	MW	Project
Already commissioned	67.34	85	-	-	67.34	85
PPA signed (Waiting for COD)	1,963.336	436	90.41	2	2,053.75	438
Approved (Waiting for PPA signed)	188.411	63	181.44	2	369.85	65
Under Consideration process	890.257	171	175.72	3	1,065.98	174
Total	3,221.119	755	447.57	7	3,668.69	762

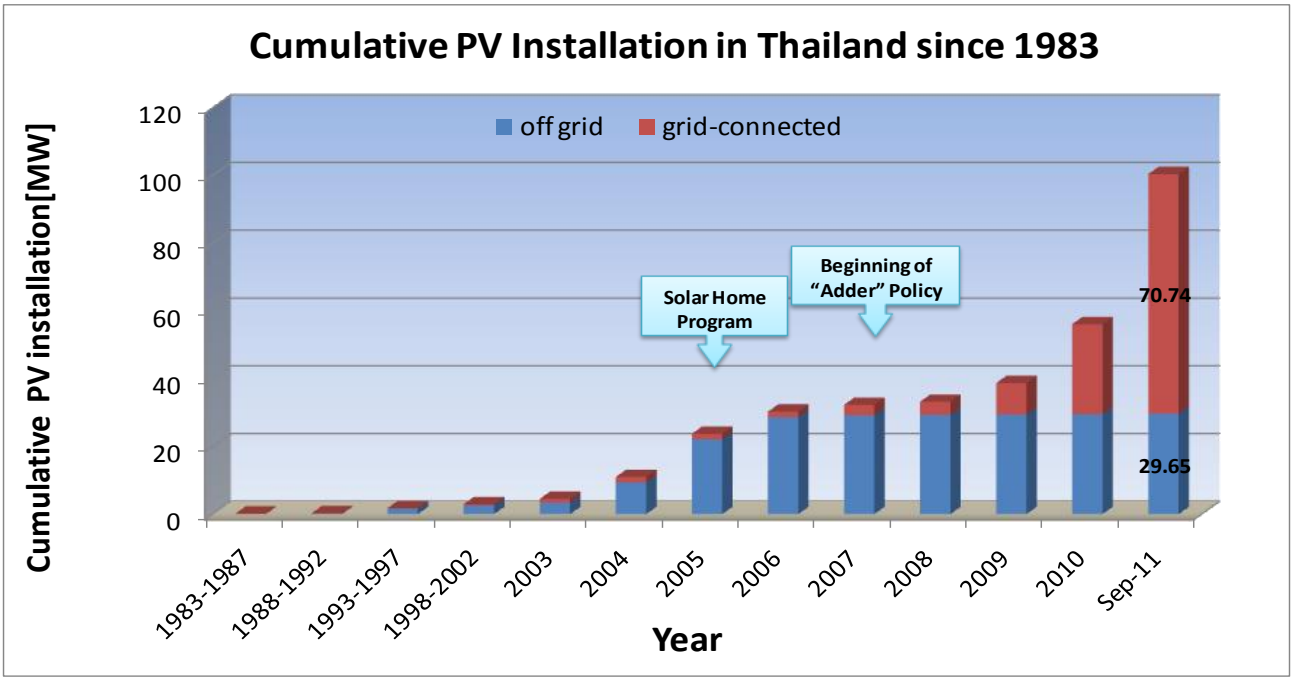


Figure 8: PV growth in Thailand

4.3 Policy and incentive

a. PV Capacity Target

In December 2011, the Thai Cabinet approved the 10 Year AEDP in which solar energy is set modestly to be achieved with the electricity generating capacity at 2,000 MW. (in order not to affect the retail price of electricity, from the adder measure).

b. Incentives for Solar Power Promotion

To support solar power development, DEDE has provided investors with Incentives which are the same as other renewable technologies including 6 main incentives for supporting RE use and production. Five of them are from the Ministry of Energy and one from the Thailand's Board of Investment (BOI). The five measures from the Ministry of Energy are the information dissemination and services for investors and the public, the financial grant for initial investment, the Revolving Fund soft loan, the ESCO Capital Fund support and the adder measures. The BOI provides an income tax privilege and other cost deductions. Another indirect measure to support solar is the Clean Development Mechanism (CDM). The summary of these incentives is shown in Figure 9.

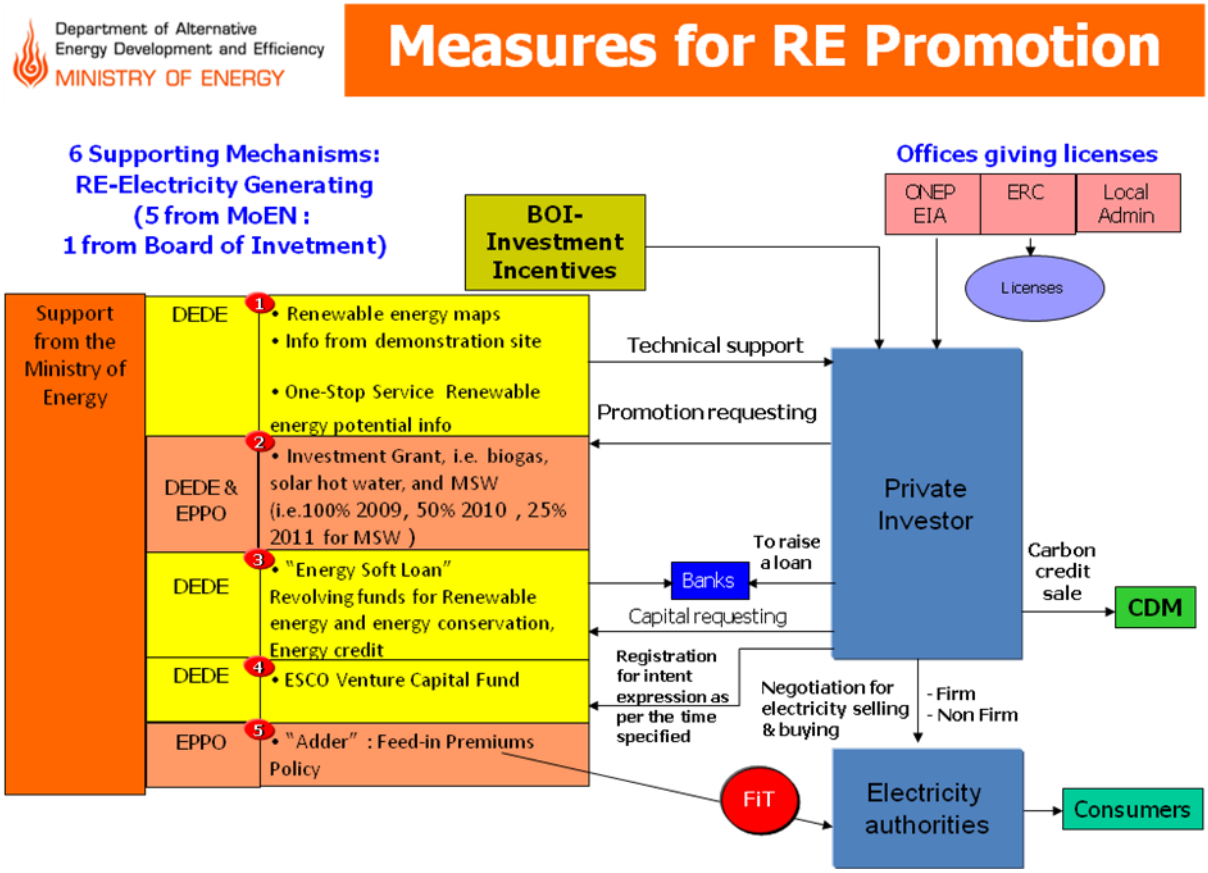


Figure 9: Measures for renewable energy promotion

1) **Information Provider** The solar radiation maps are available for the public. For more information please enter the website: www.dede.go.th
2) **Investment Grant** These grants are available for the solar hot water system, biogas, etc. The grant from Energy conservation Promotion Fund (ENCON Fund) supports 10-30% of installation investment.
3) **Revolving Fund** This fund comes partly from the Ministry of Energy (about 7,000 million THB) and another part, the same amount, from commercial banks who agreed to take part in the project. The total fund will be channeled through 13 banks to finance all viable renewable energy projects. The loan has fixed interest rate at ≤4% for 7 years of the loan period with one year grace period.
4) **ESCO Venture Capital Fund** The Energy Conservation Promotion Fund (ENCON Fund) provides fund to 2 fund managers; one for the Energy for Environment foundation (E for E) and the other for the Foundation of Thailand Energy Conservation Center. These two fund managers will support the private sectors and investors in various schemes, each not more than 50 million THB per project. The support provided ranges from a loan

to ESCO at 4% interest rate, venture capital with the ESCO and the SME investment, an equipment leasing, technical support, CDM support, etc. The size of the ESCO capital fund is 1,000 million Baht or 33 million USD.

c. Adder Measures

1) Thailand is one among ASEAN countries that promote the power generation from renewable energy through the provision of adder incentive measure. Adder is an additional energy purchasing price on top of the normal prices that power producers will receive upon selling electricity to the Power Utilities. The policy directive regarding the adder scheme was initiated in 2006, and the actual implementation commenced in early 2007, after the National Energy Policy Council (NEPC), chaired by the Prime Minister, had approved adder rates.
2) The adder scheme has been reviewed from time to time to best suit each renewable energy technology for encouraging more private investment. The latest revision, made in 2010 by EPPO and MoEN has reflected the changing trends of project costs, technologies and the economic conditions. The amendments were also made to the criteria and terms of power purchase. It is to ensure that the promotion of the power generation from renewable energy be complied with the stipulated policy, which can be briefed as follows.

d. Reduction of Adder for Solar-PV Projects

During 2007-2008, the growth rate of the proposed sale of electricity generated by solar photovoltaic cell to the national grid system was rather insignificant. This is due to the fact that the solar-PV system cost was still expensive. Hence the designated adder of 8 THB/kWh (about 0.23 USD/kWh) at that time was not attractive enough to induce investments. However, in the third quarter of 2008, the costs of the solar-PV systems and system components in the world market began to drop drastically. In addition, under the initial adder scheme, the deadline for submission of the capacity sale proposals was set to be the end of 2008. A number of investors rushed to submit their proposals to meet with the deadline in the fourth quarter of 2008. This has resulted in a noticeable increase in the proposed sale capacity from the solar-PV projects. The increasing sale capacity, if operated by all approved projects, would have a great impact on power system stability and tariffs, since the capacity is over the grid system capacity. An analysis was done by EPPO on the Return of Invested Capital (ROIC) of all solar-PV projects and the impact of the adder provision on the power tariff to end-consumers. The findings have led to a resolution made by the National Energy Policy Committee (NEPC) to reduce the adder rate for the solar-PV projects from 8.00 THB/kWh to 6.50 THB/kWh on 28 June 2010. However, the support duration remains unchanged, i.e. 10 years from the commercial operation date (COD).

In addition, NEPC required that a recommendation be made on an alternative approach to support solar-PV projects in the future, i.e. the introduction of Feed-in-Tariff (FiT).

4.4. Standards, Codes and Testing Services

a. Standards and Codes

Most standards for the PV systems (the IEC standards) were adopted into the TIS family of standards. Examples include the TIS 1843:2542 (IEC 1215-1993), TIS 1844:2542 (IEC 1277-1995) and TIS 2210:2548 (IEC 1646-1996). The Thai version of IEC 61215-2005 or TIS 1843-2553 has been announced in the Government Gazette in March 2011 which will be effective in January 2012 (After 270 days of the Announcement in the Government Gazette).

For grid connection, inverters must be certified in compliance with the utility codes and one combination of the IEC 61727:2004 and IEC 62116:2008 or IEEE 1547 and UL 1741 or any others accepted by the utility. For the project with the installed capacity less than 10 MW (VSPP), the utilities in charge of the connection are PEA for the provincial area and MEA for the metropolitan area. For those investors who invest more than 10 MW (or SPP) will be under EGAT's responsibility.

For off-grid systems, the standard is specified by the project owners. In general, the agencies specify their own technical specifications and the IEC standards of the PV modules. Most of them request that the main equipment be tested by the government testing bodies. With regard to the group of households located in remote and restricted areas, another set of standards for the solar home system (SHS) is used. The SHS was prepared by a cooperation of the Department of Local Administration, under the Ministry of Interior and the Engineering Institute of Thailand (EIT) under H.M. the King's Patronage.

As we are approaching towards the single market of ASEAN Economic Community in 2015 (AEC 2015), all stakeholders in Thailand are preparing themselves to meet with the ASEAN Electrical and Electronic Mutual Recognition Arrangement (ASEAN EE MRA). The essential requirements would be aligned to IEC standards.

b. Testing Services

The testing facilities are located in universities and government agencies (e.g. PTEC (Electrical and Electronic Product Testing Center) at NSTDA (National Science and Technology Development Agency) and EEI (Electrical and Electronics Institute under Ministry of Industry). These facilities provide testing services for the specifications stipulated in the procurement's terms of reference.

1) The CES Solar Cells Testing Center (CSSC) of the King Mongkut's University of

Technology Thonburi (KMUTT) was established in 2005 under the financial support from DEDE, Ministry of Energy, and the Energy Conservation Fund. The CSSC facility can provide services for PV modules up to a 2 m x 2 m size, according to the IEC 61215:2005 and IEC 61646:2008, inverters up to 30 kW according to the IEC 61727:2004 and IEC 62116:2008 and batteries up to 3000 Ah at 100 hours rate according to the IEC 61427:1999 and IEC 60896-11:2002. For more information, please visit: http://www.ces.kmutt.ac.th/ces2008/index.html

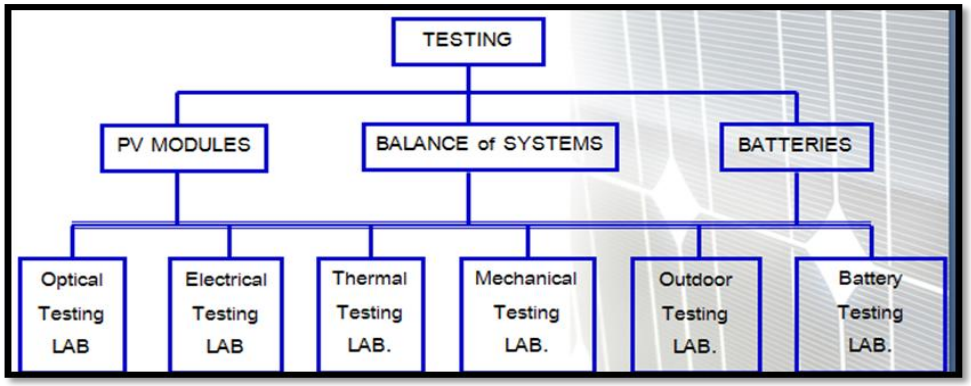


Figure 10: CSSC Testing Facility

Figure 10 (cont.): CSSC Testing Facility

2) PTEC was founded in 1998, under the co-operation between NSTDA and King Mongkut's Institute of Technology Lardkrabang (KMITL). PTEC provides services in electrical and electronic products testing, calibration and consultancies for local manufacturing, especially exporters to upgrade their products to meet with the international market. PTEC also provides the PV standard testing (IEC 61646 and IEC 61245) and PV on site testing in addition to the maintenance services. For more information, please visit: http://www.ptec.or.th/english/.

Solar Power industry

Recently, policy, regulations and incentives in order to facilitate the development of PV solar industry in Thailand have been restructures in many ways. The output that we see today includes the roof top installation's FiT, the adder for VSPP and SPP, and the future plan for the PV industry among other renewable energy sources. Yet, there are challenges that Thailand is facing such as the financial issue, the regulations for buildings, the power plants operation guidelines and infrastructure.

a. Production of Ingots and Wafers

There was no wafer production in Thailand in 2010. However, Thailand has a rich cluster of silica mining industry, the SiO2 content is 99-99.25%, and mostly avail in Kanchanaburi and Ratchaburi provinces. This indicates that Thailand could rely on its own upstream feed of raw and qualitative material for a local wafer production. An arc furnace smelting plant of Mg-Si has been built with a capacity of 45,000 TPA for the export markets. Next is the development of a suitable SoG refining technology. The advanced and high investment technology like CVD (Chemical Vapor Disposition) is over the range for local applications.

The current status of the value chain of the crystalline silicon type PV industry in Thailand is shown in Figure 11. At present, the wafers used for the solar cells and modules fabrication are all imported.

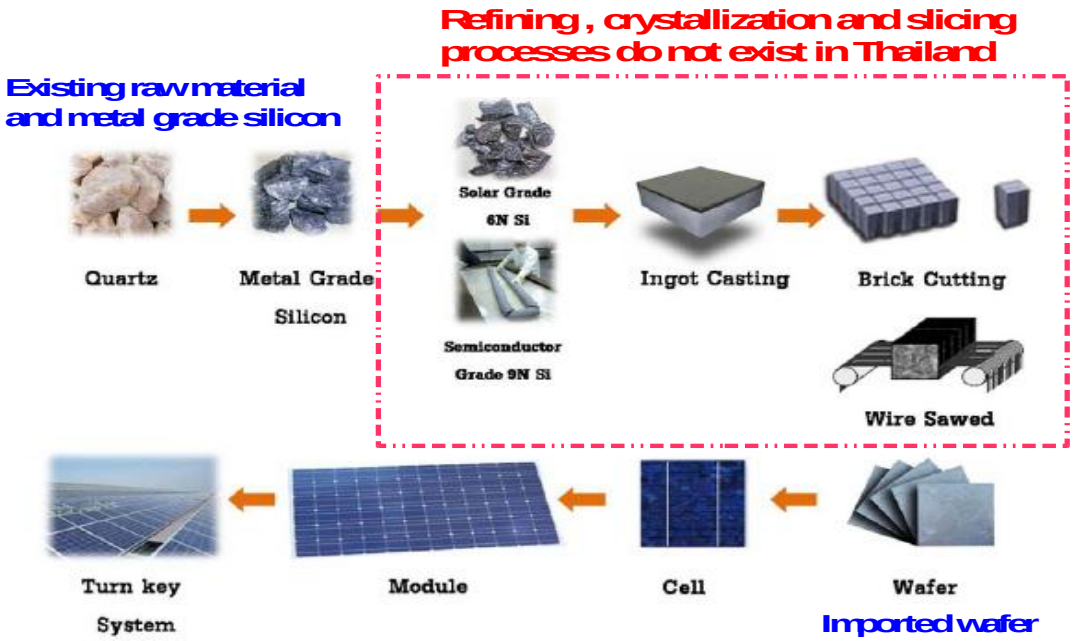


Figure 11 : PV industry in Thailand

b. Production of PV Cells and Modules

Currently, there are three companies producing solar cells from imported TCO glasses, encapsulant sheets and wafers, while some others make PV modules from imported solar cells which are shown in Table 7.

Table 7: Local Manufacturers of PV Modules and Related Materials

Type	Component	Local Manufacturer
PV module	Solar cell and module	Bangkok Solar (65 MW Thin film Si) Ekkarat (24 MW mono and multi c-Si) Solartron (mono and multi c-Si)
	Module (imported cells)	Spot Solar, Sharp, and Solartron
Related materials	Silicon wafer	None
	TCO glass	None
	Encapsulant sheet	None
	Terminal box	Bangkok Solar

c. Manufacturers and Suppliers of BOS and Components

There is only one Thai manufacturer that produces the power conditioning unit (PCU) for solar electrification for both off-grid and on-grid PV systems. These components contain inverter, charge controller and the monitoring system. The capacity of its PCU ranges from 150

W to 5 kW for the off-grid solar home system, up to 1,200 kW for the standalone hybrid off-grid system, and 2.5 kW to 1,250 kW for the grid-connected type. In addition, there exists a Thai company who provides the tele-monitoring and O&M service for both types of the PV installations. Tables 8 and 9 show a list of local manufacturers of BOS and PV service companies in Thailand.

Table 8: Local Manufacturers of Balance of System (BOS) and Components

BOS	Local Manufacturer
Inverter	Leonics (on-grid up to 1,250 kW and standalone hybrid type up to 1,200 kW)
Solar charging controller	Leonics (MPPT type with high voltage and current, 480 V, 200 Amp)
Cable	Bangkok Cable (PV cable, XLPE cable) Jaroong Thai (CV cable, XLPE cable)
Structure	Kemrek, Leonics Esco and other local suppliers
Combiner box	Leonics (Surge protector and String power monitoring) EIC (Diode)
MV Transformer	Ekarat Engineering, Charoeanchai TF and Tusco Trafo

Table 9: PV Service Companies

Service	Local Company
Contractor	ItalyThai, Toyothai, Ritta-TGE, Leonics ESCO, Thai Solar Future, and Demco
Engineering & Procurement and Construction (EPC)	Ekarat Solar, Bangkok Solar Power, Leonics ESCO, and Thai Solar Future.
System Monitoring	Leonics-MoC
Operation and Maintenance (O&M)	Bangkok Solar Power, Leonics ESCO, and Thai Solar Future

Problem and resolution

a. Capacity Building

The big obstacle to develop and expand the use of Solar power is the lack of right understanding on the technology, its limitation and etc. among the stakeholders. Solar energy has many advantages but its instability due to the weather and availability only daytime create the restriction of use for this energy. In order to use solar energy effectively, it is not to replace all conventional energy sources with solar energy but use it when it is available. The policy makers should keep this aspect in mind and transfer this clearly to stakeholders. To make system last

longer, PV installation should be done by qualified system designers and installers. For this, certified systems should be structured. For users, knowledge transfer via medias or through conventional education systems should be used.

b. Grid connection bottleneck

For grid-tied system, the system will connect and sell electricity to the grid. Up until 2011, the trend of PV system in Thailand is concentrated mainly on large scale solar power plant. Due to the land price, most of the systems are installed in suburb areas where, in some case, there is no electricity demand. This can be solved by the preliminary study on the available feeder matching with electricity demand by the government side before giving PPA.

c. Local industry

The Thai government has laid the energy policy with an intention to attract investment from both local and foreign investors. However, this is quite difficult for the local industry to take part in a market due to its small economy of scale. Besides, stipulating a policy with the special incentive for increasing the local content may be very sensitive to offend WTO law (Agreement on Subsidies and Countervailing Measures, TRIMs, GATT 1994, etc.)

d. Solar PV Rooftop

The Ministerial Regulation no. 17 B.E. 2549 (2006) issued under the Factory Act, B.E. 2535 (1992) seems to be the main obstacle for the development of solar PV Rooftop, as it defines places with installed engines of power equivalent of 5 horsepower (3.75 kWp for PV system) as a factory which is prohibited to install in near public places such as school, temple, hospital and natural park etc., hence cannot be applied to those public places and households. This regulation is, now, in consideration of the Council of State.

4.5. WIND ENERGY

1. Potential and Development

In 1974, DEDE undertook its first study to gather information on the potential of wind energy in the country. Accordingly, a series of wind resource maps were developed on the basis of the data collected by the Department of Meteorology and DEDE. In 2010, DEDE developed a new version of the wind resource map of Thailand where the Karlsruhe Atmospheric Mesoscale Model (KAMM) was used for calculating wind speeds. A 15-year period of atmospheric basic state data, elevation and roughness data were used as main inputs of the model. This model was employed to calculate hourly wind speeds for the period of 15-years(1995-2009). The annual mean wind speed at the elevation of 10,40,70,90 and 110 m obtained from the model were used to generate the wind resource maps of Thailand. The

monthly maps revealed that wind speed and direction in the country are mainly influenced by the northeast and the southwest monsoons and local geography. Wind speed increases with the increase of the elevation. For instance, at the elevation of 10 meters, the wind speed is in the range of 3-4 m/s, while at the elevation of 40 meters, the wind speed increased to 4-5 m/s for most parts of the country. In the case of geometer elevation, the relatively high wind speed of 6 m/s is found in mountain ranges, mainly in the South, the Northeast and the Western part of the Central region as shown in Figure 12.

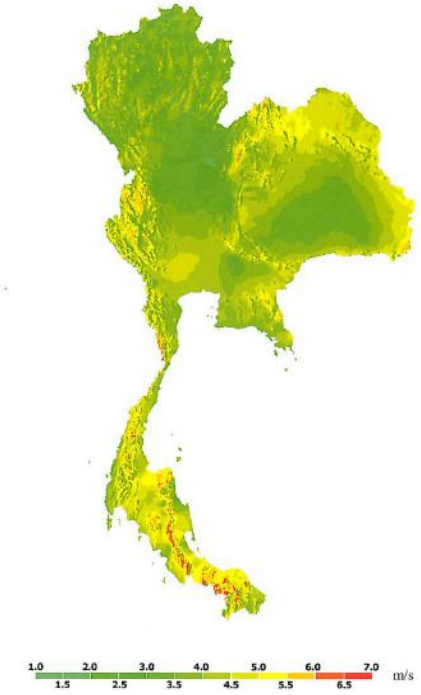


Figure 12: The average wind power classes and percentage in Thailand

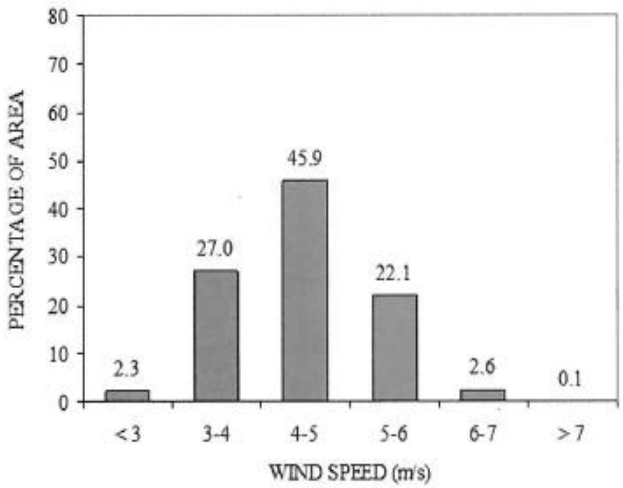


Figure 13: Potential map of yearly average wind speed at 90 meter above the ground level (DEDE, 2010)

The average wind power classes and percentage of land in Thailand as shown in Figure 11 indicated that the average wind speed ranges from 4-5 m/s, 45.9 percentage of land in Thailand and 5-6 m/s, 22.1 percentage of land in Thailand.

The first demonstration project using 150 kW at Lhaem Prom Tep at Phuket in 1996 by EGAT and using 250 kW, was set up in 2007 by DEDE at Ban Ta Lay Pang, Hua Sai District in Nakhon Srithammarat province. The project was connected to the grid on December 15, 2008. Ban Ta Lay Pang saw the commissioning of another 1.5 project in 2009. In addition, there are two more demonstration projects in Pattani province with the capacity of 250 kW and 1.5 MW, due for completion by the end of the year 2012.

2. The Installed Capacity and Energy Potential by Region

The whole installed capacity and energy potential of wind energy in Thailand in September 2011 was around 7.3 MW. The installed capacity and potential of wind energy by regions and provinces in 2011 are summarized as shown in Table 10.

Table 10: Installed capacity and potential of wind energy by regions and provinces in 2011

Region	**Province(capacity, kW)**	**Total installed capacity (kW)**
North	Chaing Mai(53), Lampang (0.4)	53.4
South	Chumphon(2.0), Nakhon Si Thammarat(1,855), Narathiwat(5.0), Pattani(10.0), Phuket(182.8), Ranong(0.40), Satun(10.0), Songkhla(1,500), Surat Thani(258.7),Yala(2.4)	3,826
Central	Bangkok(18.15), Nakhon Pathom(19.8), Nonthaburi(7.6), Phra Nakhon Si Ayutthaya, Pathum Thani(43.35), Lop Buri(0.2), Samut Prakan(36.60), Samut Songkhram(1.75), Samut Sakhon(80.2), Saraburi(1.0), Nakhon Sawan(0.2), Phetchabun(10.0) Phetchaburi(75.45), Prachuap Khiri Khan(2), Kanchanaburi(2.5), Ratchaburi(3.0), Chanthaburi(25.4), Chachoengsao(15.0), Chon Buri(365.8) ,Rayong(12.50)	830.6
Northeast	Nakhon Ratchasima(2,580), Khon Kaen (1.55), Loei(2.5),Sakon Nakhon(5.0), Ubon Ratchathani(1.0)	2,590
Total		**7,300**

3. Projects and new capacity planned in future

Table 11: The project planned for future development

Wind farm	Stage or province	Status	Year online	Total install capacity	unit
Huay Bong II	Nakhon Ratchasima	Planned	2012	90.00	MW
Huay Bong III	Nakhon Ratchasima	Planned	2012	90.00	MW
Kao Koh	Petchaboon	Planned	2012	60.00	MW
Mueng Pattani	Pattani	Planned	2012	2.025	MW
Thaprarak	Nakhon Ratchasima	Planned	2016	90.00	MW
Tropical	Nakhon Ratchasima and Chaiyaphum	Planned	2016	90.00	MW
KRS	Nakhon Ratchasima and Chaiyaphum	Planned	2016	90.00	MW
Thepsathit	Chaiyaphum	Planned	-	90.00	MW
Theppana	Chaiyaphum	Planned	-	15.00	MW
SGC Wind Energy	Nakhon Si Thammarat	Planned	2013	8.965	MW
Wind energy development	Nakhon Ratchasima	Planned	2015	8.00	MW
Wind energy development	Nakhon Ratchasima	Planned	2015	2.00	MW

4. The New Target of Wind

The wind energy target under the new 15-Year AEDP is to be installed up to 1,200 MW by 2021, in order to reach the whole target of AEDP in increasing the share of alternative energy utilization to 25% of the country's final energy consumption in the year 2021.

5. Incentives and developments toward future investment growth of wind in Thailand

1) Feed-in Premium (Adder) on top of regular tariff (will soon shift to Feed-in Tariff)
2) BOI tax incentives scheme
3) Government soft loans
4) Government co-investing scheme, so called "ESCO Fund"
5) Technical assistances, such as wind maps, technical catalog and 1-stop service
6) Encouraging CDM (Clean Development Mechanism) Project. The entrepreneur in CDM program can take a carbon credit and sell to any country required to reduce GHG release. This will be a part of revenue which can encourage the company to invest in renewable energy with reasonable financial returns
7) The "sensitive" areas where the process for land-permission is complicated.; the Area of Agricultural Land Reform Office, Economical Forest area and Watershed area 1-A, 1-B.

MoEN already cooperated with relevant government sectors to get the land-permission for the development of electricity from wind energy project at the area of Agricultural Land Reform Office , Economical Forest area.

4.6. BIOMASS ENERGY

1. Potential of Biomass

Thailand is one of the major food producing and supplying country of the world. Agricultural products and their residues are, therefore, left abundant and available for biomass exploitation. Recently, utilization of biomass sources has been continuously used in both households and generation.

The potential of solid biomass in Thailand has been accessed by gathering and estimating from the quantity of agricultural waste such as industrial sugarcane, rice, maize, cassava, oil palm, coconut, groundnuts, cotton, soybeans, sorghum, para rubber, pineapple and black liquor which is accounted for 33,004.54 ktoe. The average annual amount of agricultural waste is approximately 61 million tons. However, about 41 million tons of residues that can produce 426 PJ of energy are still unused (Sawangphol and Pharino, 2011)

2. Biomass Power Status and Target

The most significant energy sources of biomass in Thailand are forestry and agricultural residue. Rice husk, bagasse, oil palm residue, forest industry, and residential are the major sources with high availability that contribute to high feasibility of heat-power co-generation. The technology used for biomass which is direct and thermo-chemical combustion is the most applicable methods used in commercial heat and power generation.

The Ministry of Energy has set the target of biomass for electricity generation under the AEDP in 2021 by 1,896 MW. In 2011, the use of biomass for electricity generation was reported about 1,790 MW (DEDE, 2011) increasing 11.8% from the capacity in 2010.

The Power Development Plan 2010 (PDP2010) of EGAT has set the purchase capacity of SPPs and VSPPs using biomass during 2010 to 2015. The purchase capacity from SPPs is divided into 3 phases and will be accounted for 315 MW of total purchase capacity for Firm contract and 29 MW of total purchase capacity for Non-Firm contract.

AEDP has set incentives to promote commercial sectors to attend SPP and VSPP programs. The present status of SPP and VSPP from MEA and PEA using biomass was summarized by EPPO (as of September 2011). There are about 33 projects that are under consideration of EGAT for SPP contracts with the total contract capacity of 655.70 MW after successful commission. The total contract capacity of VSPP under consideration of PEA is

2,284.29 MW, totally 357 projects after successful commission. It can be noted that VSPP power plants using biomass are the major sectors currently selling and waiting for supplying electricity to PEA. However, no new VSPP project using biomass has been signed and expected to supply electricity to the PEA grid after 2013 (PEA, 2010).

3. Obstacles

The biomass development has encountered many obstacles, such as poor raw material management from the severe competition and a risk to procure materials at reasonable prices has affected project viability considerably. Lack of knowledge on gas emission including environmental issues among local people is another drawback which has led to public resistance. Complicated and time consuming rules, regulations in obtaining permission, inadequate transmission line capacity, power, purchasing terms and price, mode and duration, and insufficient data on raw material availability have also been drawbacks and affected high costs of investment. As such, the establishment of biomass development is not an easy task.

4.7. BIOGAS ENERGY

1. Potential and Status of Biogas

In Thailand, waste water and waste from industries, farms and communities have to be treated with waste water and waste treatment standard and measure before being discharged. Treatment by using Anaerobic Digestion will yield biogas that consists of 60-70% by volume of Methane Gas (CH_4), 30-50% of Carbon dioxide Gas (CO_2) and a small portion of Ammonia (NH_3), Hydrogen sulfide (H_2S) and water vapor. Biogas can be used to replace conventional fuels like heavy oil or firewood. Moreover, biogas production from anaerobic digester presents the additional advantage of treating organic waste and reduces the environmental impact caused by these wastes. It contributes to a better image of the agro-industries and farming community while reducing odor, pathogens and weeds from the manure and producing an enhanced fertilizer that can be easily assimilated by plants.

At present, biogas energy is normally used for producing heat and generating electricity for supplying to manufacturing process and also selling to the grid. The current capacity of biogas power plants is approximately 159.17 MW and the target to be reached in 2021 is 600 MW. For producing heat, the current capacity is approximately 421.34 ktoe and the target to be reached in 2021 is 1,000 ktoe. The potential of biogas sources for thermal use and electricity generation are shown in Table 12.

Table 12: Potential of Biogas Sources for Thermal Use

Type of Industries	Potential (ktoe)	Existing capacity (ktoe)	Target of 2012 (ktoe)
Tapioca	287.37	275.47	40.00
Food	79.70	18.02	4.00
Paper	14.14	0.00	
Rubber	41.75	0.77	1.00
Ethanol	108.54	106.58	20.00
Distillery and Brewery	92.52	NA	
Oil Palm	NA	9.07	10.00
Others	95.52	7.73	1.00
Livestock Farm	(ktoe)	(ktoe)	(ktoe)
- Large	15.19	3.36	11.35
- Small	34.61	0.34	0.24
Total	754.42	421.34	508.93

Currently, the power generation from tapioca, food, oil palm, ethanol industries and livestock farms was accounted for 191.58 MW. Biogas energy consumption in commercial electricity generation was 89.0 MW for On-Grid and 70.17 MW for Off-Grid. Therefore, the total utilization reached at 159.17 MW and the target of 2012 and 2021 are set at 194.57 and 600 MW respectively. Details of potential biogas sources for electricity generation are illustrated in Table 13.

2. Barriers of Biogas Development and Promotion

Major barriers of biogas utilization in Thailand can be summarized as follows:

- Technical barriers: lack of standards, local manufacturing, components and systems promoting, for household and industry, such as gas engine, gas blower, valve, etc. and flare management.
- Public support barriers: lack of awareness and confidence in new technologies and applications that led to misperception of biogas production and safety system.
- Policy barriers: lack of respective laws enforcement and measuring on environment to actualize water treatment together with biogas production. The policy to support renewable energy through the bidding process unable to persuade private sectors for investment.
- Economic barriers: there is a risk of high investment because the financial institutions and investors lack knowledge to strengthen of biogas power plants.

Table 13: Potential of Biogas Sources for Electricity Generation

Type of Industries	Potential (MW)	Existing capacity (MW)			Target of 2012 (MW)
		On-Grid	Off-Grid	Total	
Tapioca	46	31.16	29.51	60.67	10
Oil Palm	96	48.19	12.87	61.06	20
Ethanol	24	7.16	1.42	8.58	2
Food	NA	0	3.24	3.24	2
Others	NA	0.28	1.64	1.92	NA
Livestock Farm	(MW)	(MW)	(MW)	(MW)	(MW)
- Large	17.10	2.21	14.89	17.10	-
- Medium	8.48	-	6.60	6.60	1.40
Total	191.58	89.0	70.17	159.17	194.57

5. CLEAN DEVELOPMENT MECHANISM

Thailand is the member of Kyoto Protocol under Non-Annex I country in 2002, therefore can be eligible to participate in the Clean Development Mechanism (CDM) in order to encourage clean and environmental friendly technologies for greenhouse gas reduction in the country, as well as to promote the country's capability by developing sustainable business practices.

Thailand Greenhouse Gas Management Organization (Public Organization), or TGO, is the autonomous governmental organization with a specific purpose as an implementing agency on greenhouse gas emission reduction in Thailand. TGO performs its role as the Designated National Authority for CDM (DNA-CDM) office in Thailand.

5.1. CDM Policy in Priority

As the increasing reliance country on imported fossil fuels, coupled with a high energy demand, it is very necessary for Thailand to seek for the use of renewable energy sources in order to reduce environmental problems and climate change. CDM will, therefore, encourage the private sector in utilizing renewable energy sources for their activities. Thailand's CDM policy priority is currently based on 'Energy Sector', which includes renewable energy production and energy efficiency improvement projects.

5.2. Status of CDM Projects in Thailand

As of January 2012, TGO issued the Letter of Approval (LoA) to 155 Projects with expected annual average of 9,470,260 tCO2e. Of the total approved projects, 82 percent are

classified as renewable energy projects and more than 70 percent of these are biogas which are shown in Table 14.

Table 14: CDM developed projects in Thailand with the letter of approval

Project types	Number of projects	Expected annual CERs (tCO_2e)
Renewable energy projects		
Biogas	96	5,626,989
Biomass	29	1,783,673
Hydro	6	192,234
Solar	5	112,098
Wind	1	55,834
Others		
Electricity from Waste Heat	9	532,009
Electricity and Thermal from Natural gas	2	452,872
Composting	1	397,500
Nitrous Oxide Reduction	1	168,887
Methane Capturing	1	52,548
Transportation	1	34,711
Fugitive Emission Reduction	1	31,030
Energy Efficiency	2	29,875
Total	**155**	**9,470,260**

Up until now, the amount of CERs issued is 1.006 MtCO2e. The list of 9 CDM projects that received CERs is shown in Table 15.

Table 15: List of Thailand received CERs projects

Project title	Project detail	CERs issued (tCO_2e)
1. A.T. Biopower Rice Husk Power Project	Generate electricity from rice husk	100,678
2. Korat Waste to Energy	Generate heat and electricity from tapioca mill waste water	714,546
3. Univanich Lamthap POME Biogas Project	Generate electricity from palm oil mill waste water	4,346
4. Decha Bio Green Rice Husk Power Generation 7.5 MW	Generate electricity from rice husk	10,377
5. Bionersis Project Thailand 1	Generate electricity from land filled gas	21,594
6. Srijaroen Palm Oil Wastewater Treatment Project in Krabi Province, Thailand	Generate electricity from palm oil mill waste water	13,528
7. Catalytic N_2O Abatement Project in the tail gas of the Caprolactam production plant in Thailand	Reduce N_2O emission	37,422
8. Eiamburapa Company Ltd.	Generate heat and electricity from tapioca	16,050

Project title	Project detail	CERs issued (tCO_2e)
Tapioca starch wastewater biogas extraction and utilization project, Sakaeo Province, Kingdom of Thailand	mill waste water	
9. Bangkok Kamphaeng Saen West: Landfill Gas to Electricity Project	Generate electricity from land-filled Gas	87,868

6. References:

- Thailand Greenhouse Gas Management Organization (TGO), (http://www.tgo.or.th/)
- NSTDA and the solar Club, "Thailand PV Status Report 2011 (Draft version)", 2011,
- Electricity Generating Authority of Thailand (EGAT), "Summary of Thailand Power Development Plan 2010-2030 (PDP 2010)",
- Report No. 912000-5305 Electricity Generating Authority of Thailand, Bangkok, 2010

PART 2: REVIEW TEAM REPORT

This part of the report presents the PRLCE Team's conclusions and recommendation about low carbon energy policies and programs in Thailand.

1. INSTITUTIONAL CONTEXT

1.1. Critique

Thailand has well-established government related institutions in order to introduce renewable energy. Ideally functions of policy-making and regulation are separated and made up of a number of players, each described below.

The Energy Policy and Planning Office (EPPO) are responsible for determining regulatory policy with respect to power. All key policy and plans, including policies on Independent Power Producers (IPPs), Small Power Producers (SPPs) and Very Small Power producers (VSPPs) must go through EPPO.

The Office of Energy Regulatory Commission (OERC), which was established in 2007, has been playing the role of regulator on renewable energy. The OERC establishes a license issuance process and regulations that are transparent and standardized for the benefits of consumers, communities and the country.

Thailand has a dedicated agency for renewable energy promotion, the Department of Alternative Energy Development and Efficiency (DEDE). DEDE is responsible for promoting energy efficiency, regulating energy conservation, supplying energy developing integrated alternative energy and disseminating energy technology systematically and continuously.

The Electricity Generating Authority of Thailand (EGAT) is a 100% state-owned company and its Governors are selected by the Government Commission. The Thai Government assigns EGAT to make contracts with small power producers. The EGAT is a transmission system operator and a wholesaler of power to the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA). The EGAT is now preparing for revision of its 2010 Power Development Plan (PDP).

The Thai Government has established financial support for promoting renewable energy, such as "Adder"-a subsidy, "Investment grant", "Energy Conservation Fund" and so forth. "Feed-in tariff" is to be introduced.

The Thailand Greenhouse Gas Management Organization (TGO), which was established under the Ministry of Natural Resources and Environment in 2007, is Thailand's National Focal Point of the United Nations Framework Convention on Climate Change & Kyoto Protocol and Designated National Authority for clean development mechanism (CDM) implementation. TGO also works as a "One- stop service for information on renewable energy's potentials" for all interested parties.

The Thai Government will focus on funding Research & Development (R&D). The National Science and Technology Development Agency (NSTDA) have been playing an

important role in R&D, in promoting renewable energy. The Thai Government will welcome private-led investment in carrying out actual renewable energy related projects.

In December 2011, the Alternative Energy development Plan (AEDP) was announced in replacement of the Renewable Energy Development Plan (REDP) which was set in 2008.

1.2 Recommendations

Recommendation 1

It is desirable to stipulate the frequency of revision or updating of Power Development Plan in the law (e.g. in principle, once every 3 to 5 years). Similar process for mandated review of the adders (annually) will also be beneficial.

Frequency of revision or updating Power Development Plan is not clearly stipulated in the law. This can lead to uncertainty for investment activities in power sector and limited monitoring of implemented measures and follow-up through revision of plans will render such plans invalid.

Recommendation 2

There is a National Energy Committee, but on a day to day basis, there needs to be better coordination of plans across MEA, PEA, EGAT and EPPO. This would be beneficial at the implementation stage as well, especially for smart grids.

Thailand has several government institutions related to renewable energy. It is important to stipulate capacity (roles) of these institutions, clearly stating their responsibilities and fostering coordination amongst all these institutions to avoid duplication of work and streamlining of functions at the planning and implementation stages.

Recommendation 3

Incentive scheme should be developed according to the situation in the future

While there are a lot of foreign investment on renewable energy in Thailand now, to promote and foster domestic renewable energy related industries is of vital importance in order to achieve the Thailand's alternative energy goals. Thailand needs solid domestic renewable energy industry.

Recommendation 4

Expedite "feed-in tariffs" process.

In order to prevent uncertainty amongst private sector players and investors it is important that processes for relevant policies be expedited, for instance the feed-in-tariff scheme that is currently in talks. This increases the Government's credibility and attracts other potential investors and interested parties as well.

Recommendation 5

Focus on education not only for professional workers but also technical training for vocational workers.

It is important that education investment not be limited to professional workers but also enforced at the vocational level. Technical capabilities need to be developed for vocational workers to avoid failure at the implementation stage, for example if vocational workers are unable to correctly install photo voltaic panels on roofs then the whole scheme will be rendered invalid.

2. ALTERNATIVE ENERGY GOALS, TARGETS AND STRATEGY

2.1. Critique

Clear alternative energy targets have been established: A critical step in the promotion of low-carbon energies at the economy level is the development of an alternative energy master plan with aggressive and clear targets. The PRLCE team received a comprehensive review of Thailand's renewable energy goals, targets and strategy during the team visit to Bangkok. The team learned that in 2011 Thailand established new clear and aggressive renewable energy targets under the Alternative Energy Development Plan (AEDP). The AEDP goal is to create a framework and direction for increasing alternative energy consumption to 25% by 2021. This plan replaces the 2008-2022 Renewable Energy Development Plan (REDP) which had a 20.3% renewable energy target for year 2022. Thus the new AEDP both increased the alternative energy target by 23% and reduced the time allocated to achieve the target by one year. The targets specified in the AEDP are shown below in Figure 13.

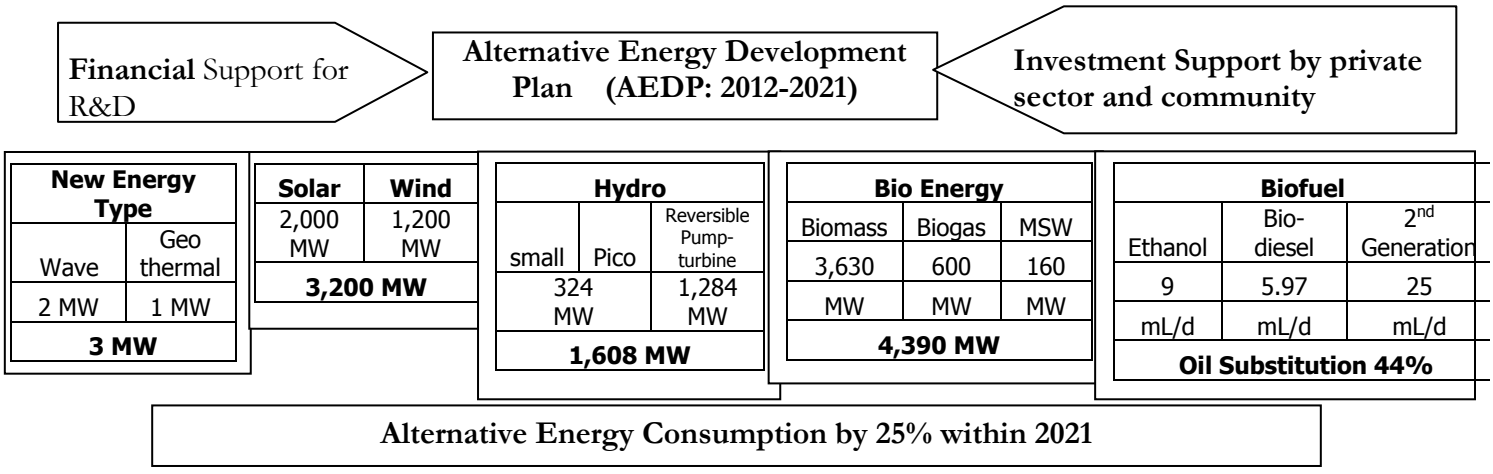


Figure 13: The Thailand Alternative Energy Development Plan Targets

Banks and the private sector have been engaged: A critical element of developing a low-carbon economy is engaging banks and the private sector in alternative energy development. The PRLCE team received a detailed review of successful PV and wind power case studies where private banks and the private sector have worked together in implementing projects associated with Thailand's Alternative Energy Development Plan. Presentations provided by Kasikorn Bank (Kbank), Natural Energy Development Co., Ltd. (NED), SPCG plc, and the Federation of Thai Industries (FTI) provided detailed case studies associated with the successful implementation of MW sized PV installations across Thailand that could serve as examples for other APEC economies. Key drivers for the successful investment were seen as strong government support, sponsor vision and strength, sound project structure and widespread public acceptance. Project sizes ranged from the 74 MW LopBuri Solar Project to the series of 34 solar farm 6 MW projects being developed by SPCG. The PRLCE team learned how Kbank moved from being a skeptic of investing in renewable energy projects to becoming a strong supporter of renewable energy projects, and thus developing an investment team specialising in the financing of large scale renewable energy projects. An important part of this transformation was the development of a clear understanding of both the benefits and the risks associated with renewable energy project development. Since private banks will be a critical partner in the development of low-carbon energies across the APEC region, the PRLCE team felt it was important the lessons learned in Thailand be widely shared across the APEC region.

Renewable energy capacity building in Thailand: Having a sufficiently skilled and trained workforce is often a constraint to the successful implementation of alternative energy development projects in developing APEC economies. The PRLCE team learned from the private sector project developers that the necessary and critical human capacity development for renewable energy was occurring in Thailand. The capacity building was occurring as a result of the long-term and on-going university-level training supported by the Thai Government. The programs associated with the School of Renewable Energy Technology (SERT) at Naresuan University were particularly highlighted as being beneficial to the overall development of Thailand's Alternative Energy Development Plan. A useful activity of the APEC PRLCE activity could be to share the development of university level renewable energy curriculum across the APEC region.

Low-carbon scientific research in Thailand: The promotion of low-carbon scientific research is often not supported in developing APEC member economies. However such research is critical to understanding how to best link the technical attributes of alternative energy

technologies with the inherent location specific resource potential and performance characteristics of those technologies. The PRLCE team learned that low-carbon research is being supported on a continuing basis at the National Science and Technology Development Agency (NSTDA), Thailand Science Park. NSTDA supports research at five centres:

BIOTEC:	National Centre for Genetic Engineering and Biotechnology
MTEC:	National Centre for Genetic Engineering and Biotechnology
NECTEC:	National Electronics and Computer Technology Centre
NANOTEC:	National Nonotechnology Centre
TME:	Technology Management Centre

In addition, there are cross-cutting clusters, such as the one on energy and environment which brings researchers together from across the basic centres to work on issues associated with the development of low-carbon energies. During a review of the low-carbon and alternative energy development activities at the NSTDA centres, the PRLCE team was informed that their research centers are linked to the Thailand Alternative Development Plan through a formal Memorandum of Understanding (MOU) between the Ministry of Energy and the Ministry of Science and Technology (MoST). The centres, which are funded by MoST at a level of approximately US$100 million/year, provide a good example for other APEC developing member economies on benefits of supporting the development of scientific research and national science research laboratories as part of an overall low-carbon energies strategy.

Thailand has shown significant progress in the development of large scale renewable energy projects. However, an important challenge for Thailand is to extend that success to small-scale renewable energy development. Small scale renewable energy development will require new forms of financial support but has the potential to provide significant benefits especially to rural areas across Thailand.

2.2. Recommendations

Recommendation 6

Consider the development of a renewable energy law to provide certainty to developers. Renewable energy laws are more difficult to develop since they require careful thought of legal, economic, and policy issues. However, they can provide increased certainty to developers.

The Thai Ministry of Energy developed new alternative targets as part of the Alternative Energy Development Plan in 2011 that replaced targets in the 15- year Renewable Energy Development Plan (REDP) for 2008-2022. Since the implementation of an overall low-carbon energy strategy

is a function of working across a broad combination of legal, technology, and policy areas, experience has shown that economy specific targets that are specified in renewable energy laws as opposed to ministry plans have a greater chance of succeeding over time. Thus a challenge for Thailand is to make sure that the current aggressive targets embodied in the ADEP are not changed in the near future and that businesses receive the certainty they need to develop long-term alternative energy projects.

Recommendation 7

Consider the development of a Renewable Energy Portfolio Standard (RPS) that would work in combination with the FiT which would combine Renewable Energy/Energy Efficiency targets.

The experience from developed economies around the world is that a combination of the RPS and FiT mechanisms can work together to fully develop economy wide low-carbon goals. RPS can most simply be thought of as a renewable energy policy instrument where government policy makers set the quantity of renewable energy desired leaving the price up to market mechanisms while FiT are focused on specifying the proper price that will drive renewable energy deployment. A combination of the two policies occurs in renewable energy tendering systems. In a tendering system, typically a government-administered completive bidding process is developed through which renewable energy developers compete for power purchase agreements. Such tendering process can also involve access to government-administered funds to support the winning bid. Electric utilities can also be obliged to purchase the electricity at the winning bids. Examples of economies that have used such systems include the U.S., China, United Kingdom, Ireland, Brazil, and France.

Thailand's major renewable support policy mechanism that is currently in discussion is the use of feed-in tariffs (FiT). With the continual advancement of alternative energy technologies where costs are continuing to decrease and performance is increasing, it becomes increasingly difficult to get the price right. A challenge for Thailand with the use of the FiT mechanism is to make sure that it develops economically sustainable support policies. There are important lessons that can be learned from the experiences of both APEC and non-APEC economies that have developed financial problems with their FiT programmes in the past. An important conclusion that many economies are coming to is that there is a role for FiT and renewable energy portfolio standards (RPS) to work together in the overall development of a low-carbon strategy.

Recommendation 8

Consider the full range of economy specific benefits associated with biomass as a renewable energy fuel. Biomass can be an important contributor to the ADEP, but to fully realise its potential, careful attention needs to be given to account for the full range of economy specific benefits.

Thailand has abundant biomass resources which can support its AEDP goals. However, the challenge with biomass development as an energy resource is that as a commodity, biomass development and use intersects with multiple economy goals related to issues such as food security, agricultural production, and raw commodity or finished product import/export issues. Thus in the development of its biomass energy resources, it is important that Thailand carefully considers the full range of benefits that can occur with biomass such as employment, energy security, and the economic impacts of reduced fossil energy imports. To this extent, the Thai Ministry of Energy should carefully consider the body of information that has been developed through the projects of the APEC Biofuels Task Force.

Recommendation 9

Support the development of a renewable energy business association.

Economies around the world have realized that small- and medium-sized enterprises (SMEs) are critical to overall economic development. Renewable energy business associations have proven to be an essential element in engaging SMEs in the new business of renewable energy development. Thailand has shown significant success in the engagement of large businesses in its AEDP activities. A challenge for Thailand is to make sure that the broad range of all sizes of businesses that could both participate and benefit in the development of its alternate energy resources are involved in the AEDP. Experience has shown that a strong renewable energy business association can provide the opportunity for businesses to share experiences related to both successes and failures of renewable energy development which leads to greater overall business participation and associated economy-wide economic benefits.

Recommendation 10

Consider extending financial support for small-scale renewable energy development. The development of small-scale renewable energy systems can require special financial support mechanisms. Since small- scale renewable energy projects have the potential to benefit a broad range of Thai society, the government should consider the development of more attractive incentives that were available in the original revolving fund.

Thailand has shown significant progress in the development of large scale renewable energy projects. However, an important challenge for Thailand is to extend that success to small-scale renewable energy development. Small scale renewable energy development will require new forms of financial support but has the potential to provide significant benefits especially to rural areas across Thailand.

3. REGULATION AND INFRASTRUCTURE

3.1. Critique

Regulation

The passage of the Energy Industry Act of 2007, which states the establishment of the Office of the Energy Regulatory Commission (OERC), is one of the most important achievements in recent energy regulation in Thailand. OERC was established in 2008 as the dedicated regulatory authority and was separated from the Energy Policy and Planning Office (EPPO) in the Ministry of Energy Thailand, the policy making authority. OERC's main objectives consist of monitoring energy market conditions by tariff review, licensing, approval of power purchase, dispute settlement and fulfilling its mandate, in order to counterbalance each other and to ensure maximum interests of the people and the country. OERC plays the central role in executing the "Adder" system which is the most essential scheme to increase renewable energy deployment in Thailand.

Infrastructure

The Thai Government has provided "Energy Soft Loans" to promote renewable energy projects in Thailand. One of the original purposes to start this loan was to show the finance institutions that renewable energy projects are profitable and therefore viable commercial loan options. The "Energy Soft Loan" scheme is no longer in place as the original concept and implementation has been successfully completed.

Not only government sponsored support for the financial industry but also a sound industrial basis for skilled workers is provided in Thailand. A low unemployment rate is evidence of utilisation of work force in Thailand; the unemployment rate in Thailand was reported at 0.7 percent in February 2012. For the renewable energy industry, Thailand has been successful in establishing flourishing research and educational centers for renewable energy including National Science and Technology Development Agency (NSTDA) and The Joint Graduate School of Energy and Environment (JGSEE).

The electricity grid network has been successful enough to achieve a 99.9 percent electrification ratio in Thailand. Data published by Electricity Generating Authority of Thailand (EGAT) shows that their transmission systems have 211 substations, transformers with 84,630MVA and circuits 30,840 kilometers in length. The current transmission system in Thailand can be seen below.

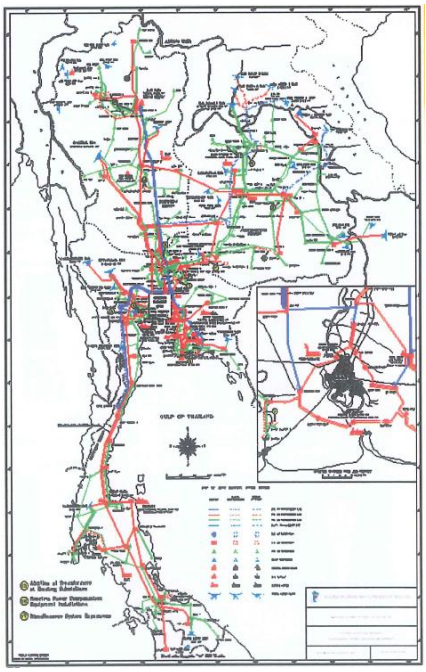


Figure 14: Transmission System in Thailand
(Source) EGA

3.2. Recommendations

Regulation

Recommendation 11

Continue existing efforts in supporting measures in the area of regulation, especially as the renewable energy industry expands.

As renewable energy supply and use expands it is imperative that regulation measures develop in parallel; to account for these changes and ensure that regulation continues to be a priority.

Recommendation 12

Co-ordination amongst relevant government agencies of monitoring outcomes and ensuring feedback to assist OERC with regulation.

It is important that there is clear communication and very good coordination amongst the OERC and policy and planning agencies and other relevant ministries as it is important to understand the policies in place clearly in order to be able to regulate effectively.

Recommendation 13

For smart grid technology introduction, it is important to harmonise standards and codes internationally.

Much work is being done globally on smart grid technology, in the early stages itself Thailand should look at working with other economies and international organisations to harmonise codes and standards internationally.

Infrastructure

Recommendation 14

Strengthening of the grid system, especially in less densely populated areas such as the north-east region of Thailand is required.

A large 73MW PV project of NED has already been deployed in Lopburi, central area in Thailand. Developments of large PV projects are currently being considered in the northeast region in the future, as this region has large solar energy potential. However, the current grid system in the northeast region is not strong enough because of decreased demand in this area; therefore a strengthening of the grid system is required.

Recommendation 15

The "Energy Soft Loan" Fund should be brought back and utilised for other high priority national strategies.

Strategies could include:

- ✓ Strengthening the transmission system in the north east region
- ✓ Solving the bottleneck for utilising renewable energy potential. Solving the bottleneck of the transmission line for utilizing abundant renewable energy potential, such as solar potential in northeast area of Thailand
- ✓ Utilising pumped hydro potential as energy storage is required

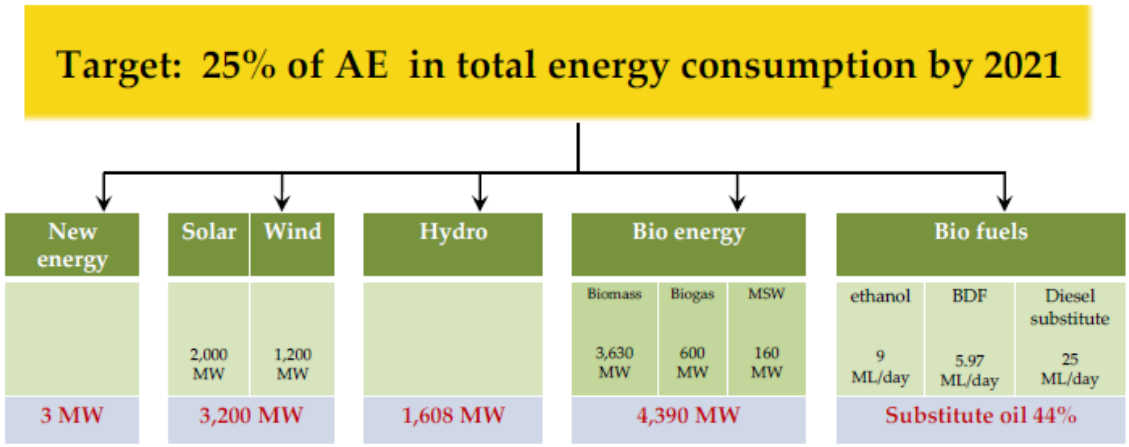
  Because the electricity output from PV fluctuates, strengthening the energy storage system including pumped hydro will be needed. For the large scale deployment of such intermittent renewable energy, emerging smart grid technology has attracted the world's attention. However, smart grid development in Thailand is comparably at an early stage.

Recommendation 16

Although 100 per cent electrification is said to be achieved, efforts to strengthen the electricity grid will be needed.

This is required because there are plans under the AEDP for large amounts of renewable energy power to be deployed.

As shown below:



(Source)NSTDA DEDE

Figure 15: Alternative Energy DEVELOPMENT Plan in Thailand

Recommendation 17

As it is important to expedite the Smart Grid and Low Carbon City activities, it is recommended to coordinate with APEC projects.

Participating in smart grid and low carbon city activities will assist in developing the infrastructure required to enhance Thailand's electricity generation infrastructure. APEC currently has a Low Carbon Model Town project in place as well as smart grid activities; it is highly recommended that Thailand participate in such activities to share knowledge and collaborate with their neighbours in the Asia-Pacific Region.

Recommendation 18

Highly recommend maintaining dialogue with investors and continue improving investment climate.

A key step in developing infrastructure is securing the necessary funds to develop reliable and efficient systems. Since it is sometimes difficult for the government to provide all funds, it is important that the Thai Government works with investors and seeks to improve the investment climate where possible with incentives to boost funding in this area.

4. BIOENERGY INCLUDING BIOFUELS

4.1. Critique

In general, Bioenergy can be divided into two main categories: biopower and biofuels. In Thailand, biopower generation from biomass, biogas, and municipal solid waste (MSW) is the largest renewable energy in Thailand. Compared to other APEC economies, Thailand is abundant in biomass resources. The potential of agricultural waste, such as those from sugarcane, rice, maize, cassava, oil palm, coconut, groundnuts, cotton, soybeans, sorghum, para rubber,

pineapple and black liquor accounted for 33,004.54 ktoe. The average amount of agricultural waste is around 61 mt/yr, but 2/3 of residues are still unused.

Currently biopower sources were reported as about 1751.86 MW from biomass, 138 MW from biogas, and 13.45 MW from MSW, respectively. The most significant biomass resources used for biopower generation are rice husk, bagasse, oil palm residue, and forest industrial residue. Biogas contained 60-70% methane (CH_4) form anaerobic digestion of waste water and waste, i.e., tapioca, food, oil palm, ethanol industries, livestock farms, etc. The major biopower technology is direct and thermochemical combustion for commercial heat and power generation.

AEDP targets by 2021 for biopower are 3,630 MW from biomass, 600 MW from biogas, and 160 MW from MSW, respectively. Also, for biomass heat utilisation, the existing combined generating capacity is 3,286 ktoe, and the AEDP target in 2021 is 8,200 ktoe. For biogas heat utilisation, the AEDP target in 2021 is 1,000 ktoe while the existing combined generating capacity is 379 ktoe.

Thailand is also a pioneer among APEC economies in establishing policies to promote biofuel (biodiesel and bioethanol) production and usage. In the transport sector for petroleum replacement using biofuels, currently biofuel production is 1.2 ML/d of bioethanol and 1.8 ML/d of biodiesel, respectively. The major feedstock used for producing biodiesel is palm oil, the major feedstock in the production of biofuel is sugar cane molasses (~90%) and cassava (~10%).

For diesel vehicles, B2 (a blend of 2% biodiesel with 98% fossil diesel) was first introduced to the market at the end of 2004. A mandate of B2 was introduced on 1 February, 2008. Recently, the mandatory biodiesel blends increased from 4% to 5% starting 21 October, 2011. On the other hand, E10 gasohol (10% of ethanol blended with 90% of gasoline) was the first ethanol utilisation in Thailand in 2003, E20 was introduced to the market on 1 January, 2008. Later, during the third Quarter of 2008, E85 for flexible fuel vehicles (FFV) was also introduced to the market. Currently the major promotion policies for using bioethanol include E10 gasohol for motorcycles, E20 for gasoline vehicles, and E85 for FFV.

AEDP targets in 2021 for biofuels are 9 ML/d of ethanol, 5.97 ML/d of biodiesel, and 25 ML/d of 2nd generation biofuels, i.e., BTL (biodiesel), respectively to replace 44% of transportation fuels in Thailand.

Thailand has made great achievements in developing biomass and biogas CDM (Clean Development Mechanism) projects. By 22 May, 2012, Letters of Approval (LoA) have been issued for 80% of bioenergy projects (in total 176 projects), and 89.71% of bioenergy projects have been registered (in total 69 projects). Also, 16 bioenergy projects have received issuance of

Certified Emission Reduction (CERs). The above bioenergy CDM projects mainly included biogas from landfills, tapioca plants, palm oil plants, pig farms, and ethanol plants, and biomass power plants utilizing bagasse, rice husk, and chip woods.

Even though Thailand has achieved much within its bioenergy industry, challenges still remain. As mentioned above, although Thailand is abundant in biomass resources, the utilization rate is low. The average amount of agricultural waste is around 61 mt/yr, but 2/3 of residues which can produce 426 PJ of energy are still unused.

4.2. Recommendations

Recommendation 19

Supply, quality, and cost are three pillars for the success of utilising bioenergy. It is highly recommended that these factors are promoted throughout the industry.

Establishing models through data collection and analysis can accelerate promotion of bioenergy.

Recommendation 20

Introducing densified refuse derived (RDF) technology, a distributed treatment & centralised power generation concept may assist with coping with collection and transportation and subsequent utilisation of biomass resources.

It can be seen that except the cost, the major challenge for utilisation of bioenergy in Thailand is feedstock management logistics including collection and transportation. RDF technology should assist with these particularly challenging aspects. Currently practices of production and use of RDF have been successfully applied in Japan, Chinese Taipei, and most member states of the European Union.

Recommendation 21

Establishing a complete waste recycling system, and large scale incineration systems to replace landfill is recommended to increase the capacity of waste-to-energy (WTE) rapidly.

The municipal solid waste (MSW) containing 55-60% of organic waste in Thailand is around 14 mt/yr (~40,000 t/d) with an annual growth rate of 3~5 %. Around 36% of waste was mostly sanitarily disposed by landfill, but 64% of waste was inappropriately disposed. The use of the recommended systems as an alternative to landfill will increase the effectiveness and efficiency of the bioenergy industry.

Recommendation 22

Co-firing with biomass (< 5%) in existing coal-fired power plants is encouraged, without modification of existing boilers.

Currently, few SPPs in Thailand have experiences in co-firing of waste gas, black liquor, and eucalyptus bark with coal. This will be a good starting point for future promotion of such technology.

Recommendation 23

Second generation biofuel technology (e.g., BTL) should be more encouraged.

Biofuel production should not compete with food for human consumption, and not compete for cropland needed to produce this food. The National Metal and Materials Technology Centre (MTEC) in Thailand should expand its related research and collaborate with international research organisations, especially within APEC economies, to accelerate the progress of the utilisation of 2nd generation biofuels. In addition to this the domestic standard of BTL should be developed in conjunction with international standards, speedily for future applications.

Recommendation 24

Work on removing barriers to the industry such as technical, policy, public support and economic. This can be done through clear information dissemination to all related parties.

In terms of technical barriers, standards and local manufacturing systems are inadequate. Through R&D activities establishing standards and developing domestic bioenergy industries may be accelerated.

Lack of knowledge, awareness and confidence in new technologies and applications may be a major reason for the public support barrier. In terms of policy barriers, complicated and time consuming rules, regulations in obtaining permission, lack of respective law enforcement, etc. may be the reason for being unable to attract investment from the private sector. Clear and streamlined policy measures are needed to overcome this barrier.

Due to insufficient data on feedstock availability the bio energy industry may be perceived as a high risk industry and therefore less attractive to financial institutions. This lack of knowledge and information will cause economic barriers which need to be overcome. Again information dissemination and clear and streamlined policies will address such issues.

5. WIND ENERGY

5.1. Critique

Wind energy is regarded as one of the most commercially available renewable energy technologies. The technology itself has become mature and available everywhere in the global market. Further, the cost of wind power generation has been decreased dramatically in recent years. At the same time, the success of wind power heavily relies on wind conditions, and power output fluctuates in accordance with the change of wind speed. Careful survey of wind

potentials and planning, particularly in view of transmission capacity, are necessary for wind energy promotion.

Thailand has a long history of wind potential surveys as DEDE started its first study on wind energy potential in 1974. Since then, a series of wind resource maps were developed based on the potential study. First demonstration project was launched by EGAT in 1996. First grid connection was made in December 2008. As of September 2011, 7.3 MW of wind capacity has been installed in Thailand. In addition further wind projects are still on-going and it is expected that more PPA will be concluded between EGAT and IPPs, SPPs and VPPs.

In 2008, wind target was set as 800MW by 2022 under the 15-year Renewable Energy Development Plan. This target was further expanded to 1200MW by 2021 in the 10-year Alternative Energy Development Plan (AEDP), in December 2011. This 50% increase of target capacity is evidence of Thailand's ambition to expand the renewable portfolio. Compared to other renewable sources like Biomass/Biogas and Solar, the wind target is set rather low. This should be, however, evaluated as realistic given the fact that there are rather moderate wind conditions in Thailand, with average wind speed around 4-6m/s.

Along with other renewable sources, wind energy is eligible for an investment support scheme such as Adder. The adder rate is set at 3.5 Baht/kWh for wind capacity more than 50kW and 4.5 Baht/kWh for smaller than 50kW. This scheme still functions with wind energies as no improvement has been requested currently.

Increasing wind capacity and investor satisfaction can deem Thailand's wind energy development as successfully growing. On the other hand, there are likely to be challenges in the future, particularly when 1200MW wind capacity becomes a reality.

5.2. Recommendations

Recommendation 25

Accelerate transmission capacity enhancement as a medium to long term challenge to coordinate with the development of renewables.

According to EGAT, Thailand has sufficient transmission capacity to receive fluctuating power output from renewable sources. Considering rapidly growing power demand in Thailand and global experience in mass introduction of intermittent energy sources, Thailand has to consider the expansion of transmission capacity as a medium or long term challenge. Such measures should be considered in long term planning of transmission systems and should be earmarked in the budget (investment) for transmission systems.

Recommendation 26

Continue to develop technical capabilities both in government, academia and industry.

Beside resources potential, wind forecast, measurement, maintenance, and others, technical capability needs to be developed in promoting wind energy. Thailand has well developed national research institutions that can be used as a national centre to implement such technical development for wind energy. Further efforts should be made for enhancing technology development among government, academia and industry. Given wind speeds in Thailand, research and development on low wind speed is the most urgent subject for development.

Recommendation 27

Encourage international cooperation for further study and R&D, especially on low wind speed.

International cooperation can be an efficient tool to enhance such technical development. Thailand should enhance its participation in multilateral fora like APEC/EWG and ASEAN. In addition, Thailand should consider further collaborations to other multilateral fora such as the International Energy Agency (IEA) and International Renewable Energy Agency (IRENA).

6. SOLAR ENERGY

6.1. Critique

Thailand has already set a very ambitious target for the promotion of renewable energy, especially for the photovoltaic (PV) system. The AEDP target for employment of PV is 2,000 MW by 2021, which is up from the current existing generating capacity of only 75.48 MW. In order to establish the capability to reach this goal, Thailand have done a lot of preparation to set up a very good foundation for further promotion of PV and other type of solar energy. The Department of Alternative Energy Development and Efficiency (DEDE) have carried out a very detailed study on the potential of solar energy, wind power and PV systems across the economy. The information gained from these studies was provided to investors to make their investment decision through the assessment of the study findings including the evaluation of the benefits from the installation of PV system The PV installation for the off-grid system and "Solar Home Program" has accumulated around 30MW of power generation capacity for the rural and un-electrified remote areas, improving the quality of rural inhabitants' lives. The cumulative installed capacity already commissioned (updated September 2011) for the on-grid PV systems, is about 70.74 MW of which 67.34 MW is the result of the adder scheme.

To support solar power development, DEDE has provided investors with incentives which are the same as other renewable technologies. There are six main incentives for supporting RE use and production. Five of them are from the Ministry of Energy and one from Thailand's Board of Investment (BOI). "Adder" is one of the incentives provided by the government to support the installation of PV systems. The adder scheme was initiated in 2006, with actual

implementation commencing in early 2007. The new Feed-in-Tariff (FiT) mechanism was proposed to replace the adder mechanism in December 2011.

Most of the standards for the PV system were adopted from the International Electrotechnical Commission (IEC) standards and are now applied as part of the Thailand Industry Standard (TIS) family as announced by the government. The standard harmonization was done through the APEC and ASEAN mechanisms. The testing facilities located in universities and government agencies for PV system are in a position to provide the testing service and make up the infrastructure for further PV industry development.

There is a very good cooperative environment for investors, financial institutions and power companies which encourage investment in the installation of PV systems. Government incentives also provide sufficient support. One of the world's largest PV thin film power plants by Natural Energy Development Co., Ltd. (NED) is a good example of the participation of the private sector.

Figure 16: One of the world's largest PV thin film Power Plants with 73MW capacity

However, there are still some challenges for the further implementation of solar energy application in Thailand, such as local industry chain, grid connection, professional skills, management, etc. The promotion of PV systems is an opportunity for Thailand to expand its green industry. The decision and methodology for the development of the PV industry chain locally or through cooperation with foreign companies based on local resources maybe a challenge in the future. It may be difficult to achieve a balance between developing the PV industry domestically whilst keeping development economically feasible and profitable.

As more small-scale PV systems connect to the grid it is highly likely that there will be a challenge in terms of the stability/quality of the existing grid system. How to implement the small power system into the grid system with new energy information communication technology (EICT) will increase the challenges faced by the power generation, power transmission and power distribution companies, especially in relation to their power management system and capability.

The promotion of roof-top PV systems as a next step will create a different operation/maintenance (O/M) mechanism within the solar farm, especially the requirement for professional engineers with regards to the installation, operation and maintenance of those small-scale PV systems. How to set up an accreditation system and make sure that there is a sufficient number of professional engineers is a challenge for both the government and private sector.

The long-term performance of the small-scale roof-top PV system is a major issue for the contribution by renewable energy to the reduction of CO_2 emissions. However, the roof-top PV system is a distributed power generation system and lacks a full time operator or technician to take care of it. This makes designing a mechanism for monitoring and tracing in order to maintain long-term performance difficult.

6.2. Recommendations

Recommendation 28

Increased small power input into the grid system will influence the quality of power supply. In order to eliminate any associated problems and speed up the promotion of the roof-top PV system, we recommend that the integration and deployment of smart grid systems and power management systems should be made a high priority.

This is to set up good infrastructure for the promotion of PV systems.

Recommendation 29

In order to maintain the long-term performance of PV systems, the training mechanism for professional engineers/technicians should be considered.

Cooperation with academics to train professional engineers/technicians should be considered. Another approach is to create a training program with standard training material and cooperate with professional engineer/business associations to carry out an on- the-job training mechanism. An accreditation mechanism for professional engineers/technicians should also be considered. This will require the engineers and technicians in this field to get the appropriate qualifications to perform the relevant work regarding the installation and O/M of roof-top PV systems, guaranteeing proper installation and monitoring of these systems.

Recommendation 30

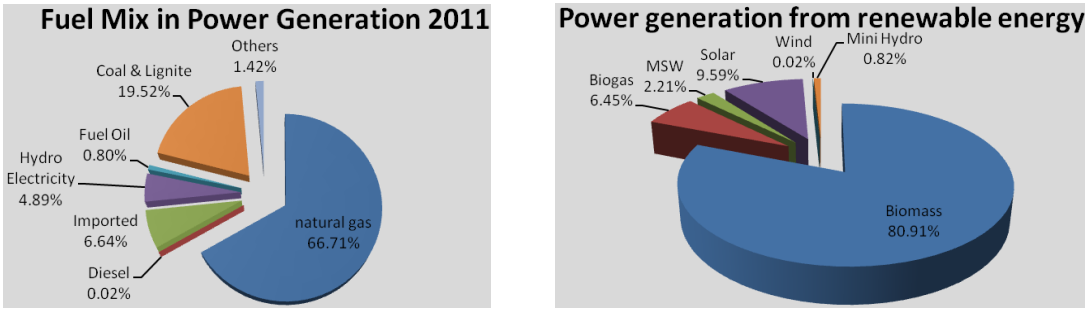
The monitoring mechanism for the PV system (especially for the small capacity roof-top system) needs to be enhanced for long-term tracing of actual performance.

Even though the FiT will create an incentive for the promotion of PV systems (especially for the roof-top PV system), long-term performance is the only way for renewable energy to make a contribution to the reduction of CO_2 emissions. Enhancing the real time monitoring and tracing mechanism for the roof-top PV system needs to be urgently considered, so that owners know what operation condition their roof-top PV system is in i.e. normal or abnormal. This monitoring system can be achieved by embedding the micro-inverter into the PV panel (technology development/integration is required) or by setting up some easy check list for the owner with intact technical support network.

7. HYDRO POWER

7.1. Critique

Fossil fuel (including petroleum products) consumption accounted for more than 45% of the total energy supply in Thailand. Fig 1 shows the fuel mix in power generation in 2011, from which we can see the portion of renewable power generation (not counting large hydro sources) is less than 2% of the total power generation, and the percentage of mini hydrogeneration is less than 1% in the total power generation from renewable energy.



Source: Energy Policy and Planning Office, Ministry of Energy

Fig 17: Power Generation in 2011

AEDP has made a detailed plan for the development of hydro power, and many successful projects have been finished in Thailand, which encourages future utilization. The technique of the hydropower generator system is also mature in the existing projects. AEDP has also made a series of strategies for hydropower, which will promote the small hydropower development in remote districts.

Comparing AEDP to REDP, there is much difference between the two targets in the mini hydropower, which is 1608 MW and 324 MW respectively, while the existing generating capacity is only 86.39 MW. Much feasibility analysis should be done to analyse whether the target can be reached.

Government should pay more attention to the stability of the small hydropower projects which will connect to the grid and also should conduct further research.

The Government has set a new feed-in tariff for hydropower (mini/micro Hydro) in accordance with the installed capacity; this policy will promote hydropower development, especially the mini/micro hydro.

7.2. Recommendations

Recommendation 31

Stricter monitoring of hydro power plants, including small hydro plants' compliance with environmental regulations.

It is vital that there is a strict regulatory process in place for the development of all types of hydro plants so that plants are constructed in an environmentally sustainable way and so that the construction of such plants doesn't defeat the purpose of providing environmentally friendly energy in the first place.

Recommendation 32

Hydro power station coupled with local grid technology should be promoted.

In order to decrease the cost of the power distribution system as well as to stabilise the power supply in remote districts, the hydro power station coupled with local grid technology should be promoted.

Recommendation 33

For further promotion of very small hydropower in the remote district, the initial cost should be decreased in the future.

This would encourage the development of very small hydro power plants and provide a feasible and environmentally friendly source of power for remote districts.

8. POWER SUPPLY SYSTEM-SMART GRID, FIT, PRIVATE PARTICIPATION

8.1. Critique

The system of power supply to instrumentation and control devices ensures operation of monitoring, recording and control devices, blocking devices, warning devices, and emergency and preventive protections of main process equipment for all modes of unit operation. The power supply to instrumentation and control devices is designed in a way to provide power to all

steady, transient and emergency modes of unit operation ensuring normal operation, limits and conditions of safe operation, equipment availability and optimisation of working parameters.

FiT

There are many kinds of support mechanisms promoting electricity supply from renewable sources, with various names, all over the world. Whilst the use of a feed-in-tariff scheme is currently being discussed in Thailand, it has yet to be introduced. In 2006, the Thai government enacted an adder scheme which is a sum of money paid on top of utility avoided costs, differentiated by technology type and generator size, and guaranteed for 7–10 years. Solar receives the highest; 8 baht/kWh and large biomass projects receive the lowest at 0.3 baht/kWh. Additional per-kWh subsidies are provided for projects that offset diesel use in remote areas.

Generally, FiT's oblige energy utilities to buy renewable energy from producers, at a mandated price. By guaranteeing access to the grid and setting a favorable price per unit of power, FiTs ensure that renewable energy projects are possible projects for a sound long-term investment, for companies, for industry, and for individuals, thereby creating a strong economic incentive for investing in renewable energy. That is why the Review Team highly recommends the expedited introduction of the FiT scheme as discussed in Part 2, 2.2.

The existing price structure implemented under the adder comprises of a base rate which includes the Capacity Payment (CP), Energy Payment (EP), Fuel Saving (FS) and RE Promotion (REP) plus the "Adder".

Smart Grid System

A smart grid uses digital technology to improve the reliability, security, and efficiency of the electricity system. EPPO has done a comprehensive study and was able to design a good action plan.

Private Participation

The robust growth in electricity demand has underlined the need for a significant expansion in future power generation and transmission capacity in Thailand. This is creating considerable private sector participation through the creation of investment opportunities.

The strategy of Participation, Integration, and Learning (PIL) was implemented in Thailand and at all management levels, it is a core strategy for the achievement of the RE program.

By applying the strategy of PIL the aim was to involve all stakeholders (including students, teachers, parents, local communities and NGOs) in the integrated learning process,

inducing a changed perception of energy consumption, resulting in more environmental friendly behavior.

Along with the aforementioned progress, significant challenges to enhance the power supply system via realising smart grid capabilities persist. Foremost among these are the challenges tied to the value proposition and the capital required to purchase the new technologies envisioned for communicating information between end-users, energy providers, and distribution and transmission providers.

8.2. Recommendations

FiT

In general in the APEC region, a Feed-in Tariff has proven to be the best available mechanism for accelerating the uptake of renewable energy in grid-connected areas. Furthermore, a good FiT system is a truly democratic policy because it is cost-effective for the public to generate their own clean electricity.

Recommendation 34

It is proposed to add some bonuses to the adder rate: (CP + EP + FS + REP) + (Adder) + (Bonuses).

This is to encourage the RE developer to choose the right and reliable technology for the sustainable system performance.

Securing this particular business activity to create added value in Thailand, will support the sector and preserve jobs also indirectly to promote innovative technologies and local economic development. To accomplish specific policy goals, bonus payments may be offered on top of base feed-in tariff or adder rates for certain categories. Bonus payments can have an influence on power producer behaviour and promote efficiencies, increase grid security and policy priorities such as using locally sourced materials or close to load projects.

Proven technologies: Promising the energy performance and sustaining the energy generation can be one of the key criteria in securing the energy supply. A right technology selection may give a value add in solving the country problems e.g. using indigenous sources like municipal solid waste (MSW) as a fuel; not only generating electricity but a solution to dispose the waste. In the case of solar project, by using the system as part of their building structure or materials may encourage the specific small developer (homeowners) to participate in contributing a MW power and it not just rely on the big system such as solar farm which inquire a huge land area and a huge cost of investment.

Local content: This is to encourage the local expert e.g. scientists, industry players, financiers and relevant beneficiaries to take part in contributing their knowledge and grasp the opportunities to make a dynamic local economy growth. More job creation means reducing unemployment and government liability of social issues. A stimulate programmes under universities on R&D might help their invented or innovated technologies for commercialization.

System/technology integration: Bear in mind that some of the solution might create a new problem. If the project owner consider all aspects of situation by thinking of Life Cycle Analysis (LCA) methodology and put as their accountability, they will put their effort parallel with an investment to make the project most reliable to the total solution. In this manner government should support and give some sort of incentive even not via bonus on top of adder, but perhaps through others government privilege.

Little fund allocation for bonuses on top of adder seems like a burden to the government and may add additional complexities in program administration, but in long term there is a positive projection and could bring more benefits to the government. Some others country like Italy, they have this kind of mechanism to promote and secure their internal market within Europe by using local products and technologies.

Recommendation 35

Annual power availability should be stated in the application form to declare their energy yield as a commitment to their contribution to the national grid.

A penalty may occur to the RE developer if the system fails to perform more than 70% (Applied for SPP firm renewables contract). This is to secure the stability of power generation from RE sources.

Recommendation 36

Feasibility study for grid connection should be done before the FiT submission.

The power system study is a pre-requisite for an application for feed in approval and should thus be performed prior to the signing of a renewable energy power purchase agreement with a distribution licensee. At this stage an eligible producer should not yet have committed to the physical construction of the renewable energy installation. The findings of the power system study will then assist the eligible producer to make a judgement on the feasibility of the project in terms of cost and assist the distribution licensee to prepare the technical requirements needed for interconnection. Only a genuine project that has made their commitment should get the approval; and access to grid after this is guaranteed.

Smart Grid System

Recommendation 37

Monitoring and communication is one of the substantial issues; Smart Grid is a solution (2 way communication), therefore adoption and implementation of this system as soon as possible is highly recommended.

A part of the vision of a smart grid is its ability to enable informed participation by customers, making them an integral part of the electric power system. With bi-directional flows of energy and coordination through communication mechanisms, a smart grid should help balance supply

and demand and enhance reliability by modifying the manner in which customers use and purchase electricity.

These modifications can be the result of consumer choices that motivate shifting patterns of behavior and consumption. These choices involve new technologies, new information regarding electricity use, and new pricing and incentive programs. This approach of good governance and robust customer/community involvement helps bring projects to successful fruition.

Recommendation 38

Full collaboration and coordination between the beneficiaries are important for smoother materialisation.

Given the complexities surround smart grid implementation it is vital that there is very good coordination amongst all involved parties, this allows for efficient implementation and monitoring.

The following criteria arguably represent a reasonable partitioning of the electricity system that covers the scope of smart grid concerns. To describe the progress being made in moving toward a smart grid, one must also consider the interfaces between elements within each criterion and the systemic issues that transcend jurisdiction. The areas of the electricity system that cover the scope of a smart grid include the following:

a. Enabling informed participation by customers
b. Accommodating all generation & storage options
c. Enabling new products, services, & markets
d. Providing power quality for the range of needs
e. Optimising asset utilisation & operating efficiency
f. Operating resiliently; disturbances, attacks, & natural disasters.

Given the complexities and components involved in smart grid implementation, it is vital that there is very good coordination amongst all involved parties, this allows for efficient implementation and monitoring.

Recommendation 39

To be more involved in APEC related activities on smart grid such as Energy Smart Communities Initiative, APEC Smart Grid Initiative, EGNRET, etc.

It is important that there is capacity building in the area of smart grids. Currently there are a number of projects on Smart Grid technology in the APEC region. It will be beneficial to Thailand in the planning and implementation stages to coordinate with its neighbours in the APEC region and learn from similar examples within the APEC region to work together to bring the most effective and efficient results for their economy.

<u>Private Participation</u>

Recommendation 40

Encourage the use of local content including the encouragement of the use of local service providers and local investment.

Surging demand, and a strong need to reduce dependence on expensive conventional fossil energy, will further motivate the development of the renewable energy sector. In order to successfully seek financing and achieve a balance between local investors and service providers, and foreign investors, is to set an appropriate maximum percentage in the project equity to foreign investors. In addition to this, further incentives for local investors could encourage the local investors to participate due to the perceived financial benefits and advantages from the project.

Recommendation 41

The establishment of a formal technology development plan, a strong legislative framework and a clearly defined public-private partnership strategy, are critical policy elements to effectively promote Thailand's Low-Carbon Energy Programme.

Local conditions and strong up-front assessment of costs and matching subsidies that would be required are;

a. Develop human capacity-building for long-term operation and maintenance,
b. Minimise risks for private sector investment, and
c. Appropriate allocation of government resources.

A strong legislative framework is considered necessary to remove barriers. Establishing fair and stable regulations with appropriate incentives to meet electricity demand will stimulate investment. The deployment of an environmental policy for clean energy sources and providing special incentives and financing for new technologies will be instrumental in developing low carbon technologies. These mechanisms will foster economic and social development and mitigate financial risk for investors.

9. GREEN HOUSE GAS MANAGEMENT

9.1. Critique

In terms of institutions, the Thailand Government established the Thailand Greenhouse Gas Management Organization (TGO) in 2007 an organization that works as the Designated National Authority (DNA) for clean development mechanism (CDM) (DNA-CDM) office in Thailand. TGO is also responsible for developing the strategy, policy, and planning of green house gas management as well as promoting the carbon market in Thailand.

Regarding CDM under Kyoto Protocol, Letter of Approval (LoA) from DNA has been issued for 176 projects with expected carbon credits (CERs) of around 10.41 MtCO2e/yr. There are 68 projects registered with CDM Executive Board with total expected CERs of 3.55 MtCO2e/yr, among them 64 projects are involving renewable energy with the share of CERs nearly 93%. Seventeen projects received CERs with total issued CERs now up to 1.35 MtCO2e. The emission factor has been issued annually by TGO to support developers in preparing Project Design Document (PDD) as well as calculating amount of CERs.

In the field of electricity production, the target of mitigation of greenhouse gases is set up clearly which is presented in the PDP 2010. It is reduced from 0.482 kg CO2/kWh in 2010 to 0.387 kg CO2/kWh in 2020. This target is established mainly based on increasing the target of alternative energy in total energy consumption up to 25% by 2021. The alternative capacity of electricity will increase from around 2,100 MW in 2012 up to 9,200 MW in 2021. Fixed adder rates or feed-in tariffs which the government subsidizes for renewable energy sources including biomass, biogas, waste to energy, wind, mini hydro, solar, are concrete policies for achieving objectives of renewable energy development. They are also important and targeted policies of the government for gaining the goal of reducing greenhouse gases in electricity generation.

The Thailand Government also has an action plan for climate change mitigation in which developing the voluntary carbon market is one of the key policies to improve CDM projects as well as greenhouse gas reduction. The structure of Thailand's voluntary carbon market is based on three types of carbon credits. The carbon credits are international voluntary emission reduction standards (VER), Thailand Voluntary Emission Reduction Scheme (T-VER), and Thailand Voluntary Emission Trading Scheme (T-VETS). The goal of developing Thailand voluntary carbon market is divided into three phases. Infrastructure foundation with MRV system and registry system is developed in the period of 2010-2012. T-VER system will be carried out in October, 2013 while T-VETS will be implemented in October, 2014. Crown Standard and Gold Standard for Thai CDM projects are one of the key policies which are used to improve the voluntary carbon market. The national registry system for domestic CDM projects is also developed for fulfilling the institution of this market.

9.2. Recommendations

Recommendation 42

Consistencies among policies encouraging CDM projects and simplification of approval process of CDM projects are highly recommended.

It seems to be that there are inconsistencies among policies to encourage CDM projects in Thailand. Many programs/measures have been developed to encourage CDM projects such as Low Carbon City, Footprint, Carbon Reduction Label, CoolMode, Crown Standard etc, even the goal of setting up a voluntary carbon trading market has been clearly established, while the procedure of CDM approval is too strict and complicated. It has also taken a long time for developers to get LoA from DNA. For instance, for the project to be considered as a CDM project and receive a LoA from Thailand DNA, the project must have a positive score in each group of criteria and the total score must be positive. This regulation is even stricter than Executive Board's requirements for CDM projects. For a single CDM project, the time to gain LoA is up to 180 days previously and now it has been reduced to 70 days while it takes 130 days and 73 days for PoA and bundle, respectively. This may be one of the reasons why Thailand has a high potential of renewable energy as well as CDM projects but the number of projects having LoA is limited. It is recommended that the approval procedures of DNA for CDM projects should be simplified parallel with reducing approved time so that benefits from CDM projects could actually be attractive to developers. Furthermore, increasing the number of CDM projects may assist Thailand in reaching its green house gas reduction target.

Recommendation 43

The Thailand Government should consider taking into account CER revenue in the price structure of feed-in tariffs for renewable energy projects.

The price structure of existing fixed adder rates or feed-in tariffs which have been subsidized for renewable energy projects did not take into account the revenue from CERs. The uncertainty of CDM projects may be one of the reasons to neglect CER revenue. In case of CER revenue not being considered in the structure of feed-in tariffs it is difficult for developers to prove the additionality requirement of CDM projects. This does not help to encourage developers to register CDM projects.

Recommendation 44

Commercial banks should join with developers to support them in terms of proving additionality of CDM projects.

Besides developers, other stakeholders such as commercial banks, communities, local authorities etc, play an important role in terms of developing successful CDM projects. It seems that the commercial banks did not pay attention to CER revenue of CDM projects so it is difficult for developers to prove the additionality requirement of CDM projects.

Recommendation 45

The government should support and encourage the private sector to develop Program of Activities (PoAs) in sectors such as wind, solar, biomass and biogas power since Thailand has many VSPPs with renewable energy projects.

CDM projects on a VSPP scale have to pay more money if they are registered alone while all the charges for registration including PDD preparation, verification, monitoring etc. will be reduced if they are done by PoAs.

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