ANNEX 2

Brief Report on Existing Policies Affecting Smart Grid Development and Analysis of Barriers in Thailand

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Smart/Intelligent Grid Development and Deployment in Thailand (Smart Thai)

BRIEF REPORT ON EXISTING POLICIES AFFECTING SMART GRID DEVELOPMENT AND ANALYSIS OF BARRIERS IN THAILAND

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I. BACKGROUND

Before any work could be done to strengthen the policies and regulatory frameworks for the adoption of Smart/Intelligent Grid systems in Thailand, it is essential to review and study the existing policies in order to identify the areas where policies could be enhanced. These include a review of policies on transmission and distribution of electricity by the Provincial Electricity Authority (PEA) and the Metropolitan Electricity Authority (MEA), as well as the generation component by the Electricity Generating Authority of Thailand (EGAT) and independent producers within the Independent Power Producers (IPP), Small Power Producers (SPP), and Very Small Power Producers (VSPP) schemes. Moreover, this report include a review of policies on Smart Grid relevant government agencies consisting of Energy Regulatory Commission of Thailand (ERC), Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, and Energy Policy and Planning Office (EPPO), Ministry of Energy, as well as other energy related policies. Potential improvements or additions to the current policies have been suggested. Furthermore, analysis of barriers for the development and deployment of SmartGrid systems and measures to remove the barriers are included in the report.

II. ENERGY RELATED ORGANISATIONS

2.1 Transmission and Distribution Utilities

Provincial Electricity Authority (PEA)

The Provincial Electricity Authority (PEA) is a government enterprise under the Ministry of Interior. The authority's responsibility is primarily concerned with the generation, distribution, sales and provision of electric energy services to the business and industrial sectors as well as to the general public in provincial areas, with the exception of Bangkok, Nonthaburi and Samut Prakran provinces. The PEA has expanded electricity supply to all areas covering 73 provinces, approximately 510,000 km^2, accounting for 99% of the country's total area.

PEA Strategic Objectives

- Performance & Utilisation

Increasing of organisation performance by continuous development of organisation, human resources and intellect resources as well as innovation development and operation process improvement with standard and efficiency. Placing importance on resources management and maximising utilisation through application of new and appropriate technology such as Energy Loss Management or Smart Grid project in order for better investment efficiency.

- Customer – Centric Organisation

Aiming to be Customer-Centric Organisation that will establish long-term advantage and competence by focusing on serving customer need and developing analysis ability and understanding customer's behavior, need and expectation. To be as an organisation that can bring most value to customer with a concept of Value Innovation. To create Customer Loyalty by building and keeping good relationship between customer and organisation as well as continuously promote good image of organisation.

- Growth & Ecosystem

Being an organisation that seeks for opportunities of investment and creating income from other businesses related to core business, both domestic and abroad. In order to develop ability of overall income creation and efficient utilisation of resources, emphasising on benefit of Synergy related business together in order to enhance business opportunities and competence ability in overall and approach strategy of PEA to participate in identifying national direction and energy development to be able to handle new challenges and changes in the future. Moreover, PEA will be able to determine a business plan that is in line and gain advantage from the changes.

PEA Policy

PEA policy consists of 6 main topics as follows:

1) Focusing on organisation's value added, securing financial status and sustainable growth by continuous improvement of management process. Best utilisation of available resources as well as seeking for investment and business development opportunities both national and international levels, through business partnership channel and investment expansion among affiliated companies
2) Aiming to be Customer-Centric Organisation by establishing and developing good customer relation to meet customer need and satisfaction as well as good performance in providing creativity, innovation and application of high-technology
3) Continuous development of electricity infrastructure in order to enhance quality of life and competence according to national government policy. Development of potential Smart Grid, which can serve adequate electricity power and efficient investment as well as security and universal reliability.
4) Promotion of alternative energy, renewable energy and efficient energy consumption to counter global warming crisis and being a government mechanism to drive and support for restructuring of national economy to Green Economy in the future.
5) Aiming to be Live Organisation which focuses on development of human resources and intellect resources, promotion of learning and knowledge management, prioritising on staffs' quality of life as well potential development to eventually improve the efficiency of work and meet ultimate goal of organisation.
6) Application of Good Governance principle as key driving force of organisation, along with Corporate Social Responsibility (CSR) for stable and sustainable growth.

Aspects of Smart Grid

According to PEA Strategic Objectives, Smart Grid project is clearly stated as part of new and appropriate technology in order to increase the organisation’s performance and utilisation. Along with PEA policy that the development of Smart Grid is stated as a tool for electricity infrastructure development in order to enhance quality of life and competence according to national government policy, Mr. Narongsak Kammales, PEA Governor officially announced PEA Smart Grid Policy on 10th March 2011.

PEA Smart Grid will integrate the delivery of renewable energy, such as solar and wind power, for the benefit of consumers in Thailand, in keeping with Thailand’s commitment to the protection of the environment. It will also lay the groundwork for supporting plug-in hybrid vehicles throughout the country. The Smart Grid would enhance energy supply efficiency and even promote battery-driven vehicles, solar and wind power.

The plan is for Thailand's Smart Grid to overlay the conventional electrical grid with an information- and net-metering system that includes smart meters. PEA Smart Grid includes an intelligent monitoring system that keeps track of all the electricity flowing through the system but in greater detail. It can also integrate renewable forms of energy such as solar and wind power but more effectively than before. Monitoring the times of day when power is the least expensive, a user can have the Smart Grid turn on selected home appliances such as washing machines or start factory

processes that can run at arbitrary hours. At peak times, it can turn off appliances to reduce demand. As well, the cost of solar cells and wind turbines will eventually decline significantly, becoming more affordable for homeowners to install them. Households can then sell the excess power produced to the state utility.

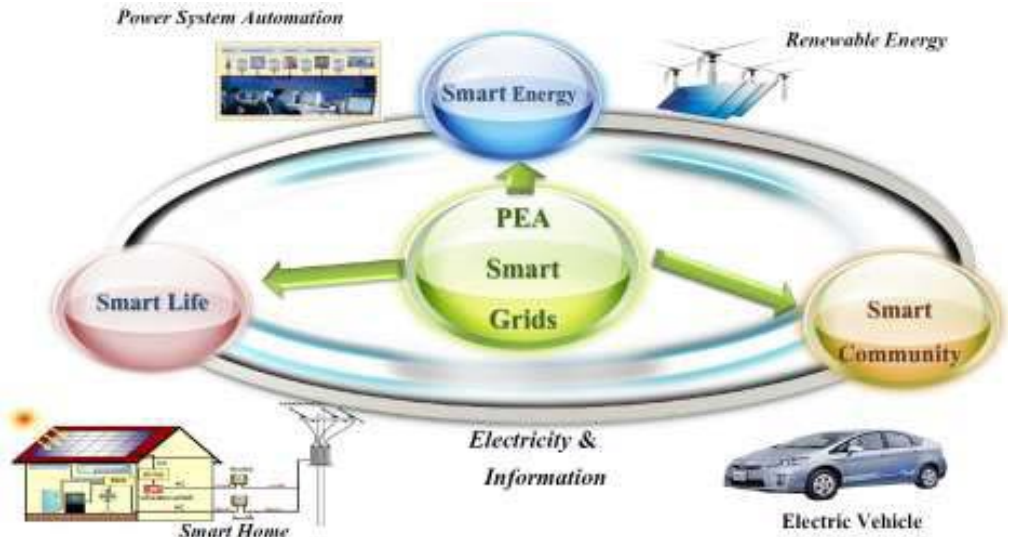
PEA is proud to be a part of society to motivate Thailand's economy for households, businesses and industries. New technology of electric power supplement and distribution system will be deployed in order to serve customers ' satisfaction with better efficiency, reliability and quality of service, especially to improve people's living quality and develop country infrastructure, within the 15 year time frame of the roadmap of PEA Smart Grid Development B.E. 2554-2569 (year 2012 - 2026).

Roadmap of PEA Smart Grid Development

PEA's Smart Grid focus is on Smart Energy, Smart Life and Smart Community to improve quality of life while maintaining environmental friendly.

The figure shown below depicts PEA Smart Grid Concept through three main areas namely: Smart Energy, Smart Life, and Smart Community.

Figure 1. PEA's Smart Grid Concept



1) Smart Energy

According to PEA, the Smart Energy refers to the Smart Electrical Energy Supply/Source, Smart Electrical Power System/Delivery and provides the needs for the 21st century including Renewable Energy, Power sources over a distributed area (Distributed Generation), Energy Storage, Electric Vehicle, (EV), and Virtual Power Plant (VPP). The main features of the Smart Energy concept are the following:

- The systems will work automatically (fully automated) in normal and emergency operating conditions.
- Provide better sensing and monitoring the real-time status of the system especially in respect of VSPP (Very Small Power Producers).
- Manage power consumption effectively.
- Reduce the peak load.
- Add to electrical energy storage to support NRE.
- Interactively communicate (data integration, interoperability, two-way communication/interactive) with individual electrical appliances and applications

- Facilitate the sale and purchase of electricity to the parties: This may be both power and small power producers.
- Support the use of electric vehicles (EVs)
- Support residential houses and office building automation

2) Smart Life

Smart Life means the ability, through an intelligent power network, to support daily lifestyle in the home and at work. Power users can participate in the management of electricity supply. Power users have the option to manage energy use to match their lifestyle. PEA has set policy for the Smart and Green Office to service customers and make employees satisfied with the quality of work life and to impress customers with the quality of service.
PEA will foster the intelligent use of energy resources (with the consent of the customers) and provide the tools to be efficient inside homes or office buildings. Overall electricity consumption nationwide is increasing in slower rate, and is likely to slow down the required new investment in power plants. Smart Grid will allow Thailand to reduce greenhouse gas emissions, thus reducing global warming.

3) Smart Community

Smart Community means intelligent and green community or society with respect to energy usage and environmental friendliness. Private homes, condominiums and the workplace will all benefit from the establishment of various systems and control equipment designed to limit pollution, reduce the use of oil and gas, reduce greenhouse gas emissions and thus reduce global warming. In addition, PEA will support a system of power generation to serve electric vehicles. Private members of the community can produce electricity from solar energy, wind power, biomass to bio-power plants (Grouped as Virtual Power Plant, VPP), within the five year time frame of the roadmap (B.E. 2554-2559 or year 2011 - 2016).

PEA Smart Grid Way Forward

With Smart Grid, PEA has adopted the vision to move toward becoming a utility with smarter supplies that provides power – through a smarter system – to a smarter community of customers to achieve better lives for everyone. Such smart supplies and smart communities are backbone of the smart utilities of the 21st century. To achieve this goal, the three main parts of a utility system: generation, transmission and distribution (T&D), plus customer participation all need to be changed.

The modification of generating resources would take the following steps:

- Development of renewable resources of energy as the backbone for distributed generation. Such distributed generation would bring power resources closer to the customers, which would shorten T&D lines and improve their operation. Such system would give way to two-way power flow, a goal pursued by PEA since the vision of VSPP.
- Distributed resources can also make the virtual power plans possible. VPP is used as a virtual tool with planning software to evaluate the effect of new generating stations within a utility‘s territory.
- Use of energy storage along with distributed resources to optimise generation, using renewable resources when available and using stored energy when needed. Electric vehicles can also be used toward this goal.
- Modernising the monitoring and control systems in generating stations and power plants.
- Use of consumption and other data from the advanced metering infrastructure (AMI) to forecast the load in short and long term future by data trend analysis, and plan to improve the generation facilities accordingly

The modification of the transmission and distribution system would take the following steps:

- Use automated operation as much as possible, especially under emergency conditions.

- Monitor real-time status and control the system, especially for the purpose of relay protection – using solid state relays.
- Monitor demand and perform trend analysis on demand fluctuation as a function of factors including customer participation in demand response programs, participation of distributed generation during peak hours and the effect of Time-of-Use (ToU) or Time-of-Day (ToD) programs in customer behaviours. Data from customers' electric meters (AMI project) can be leveraged to meet this goal.
- Use interactive two-way communication with various elements of the T&D system to make the monitoring and control of this system most effective.
- Data integration between various monitoring and control systems (such as SCADA, DDC, etc.)
- Adopt proactive monitoring methods to watch important elements of key equipment (for example: temperature on transformers) and act based on the information when needed. Interactive alarm panels can be leveraged for this purpose.
- Adopt management practices to calibrate equipment, especially meters, relays, and sensors, as often as recommended by the manufacturer and standards. Replace them at the end of their useful lifetimes.
- Support the use and improvement of electric vehicles (EV).

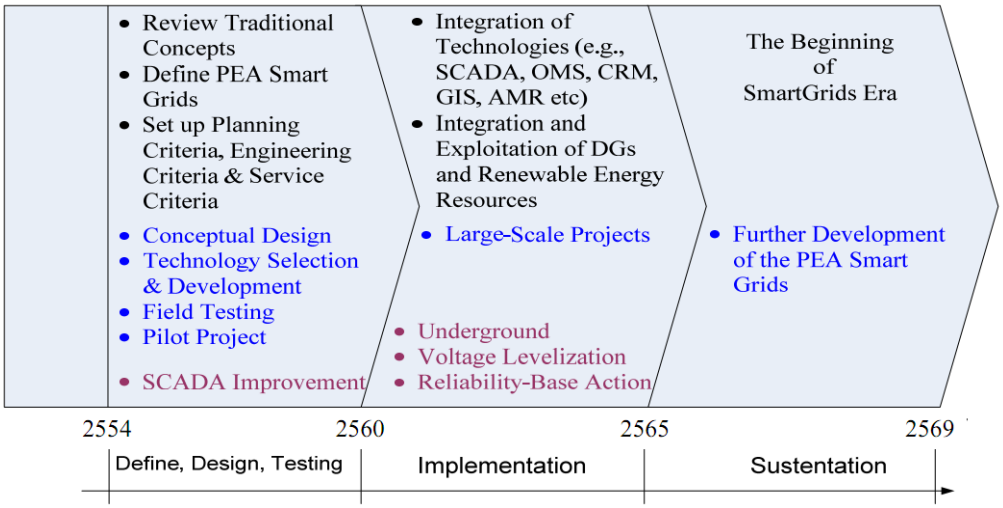
The modification of the customer-related applications would take the following steps:

- Realise the idea of smart life, meaning the ability to leverage an intelligent network to improve the citizens' lifestyles in their day-to-day life at home and work.
- Provide more authority to the customers to take charge and participate in planning and management of the electricity. Power users have the option to manage use of energy according to their lifestyle. They can participate in demand response and TOU programs and monitor their metering data on the web-portal or in-home devices.
- Provide smart and green offices for the employees with environment-friendly practices and systems that are as efficient as possible. Monitor and control office buildings by methods such as supervisory control and data acquisition (SCADA) and direct digital control (DDC).
- Foster the intelligent use of energy resources (with the consent of the consumer) and provide the tools to be efficient in the homes or office. This supports the goals of helping Thailand reduce greenhouse gas emissions to help the environment and reduce the effects of global warming.

Overall Timetable for Roadmap Implementation

An implementation plan comprises three major activities i.e. Implement Recommended RD&D Projects, Smart Grid Implementation, and Smart Grid Pathway. The timeline of PEA Smart Grids Development is shown in figure below.

Figure 2. Timeline of PEA Smart Grids Development



Source: Principle and Concept of Smart Grid Development in Thailand

PEA pilot project on Smart Grid and Advance Metering Infrastructure (AMI)

PEA has a plan to develop a pilot project on Smart Grid and Advance Metering Infrastructure (AMI), which will be implemented in Pattaya City, Chonburi province. The AMI pilot project is scheduled to operate during year 2012 – 2013 and the Smart Grid pilot project is scheduled to operate during year 2012 – 2014. Furthermore, PEA has been preparing for the development of Smart Grid as well as invested for infrastructure of electricity and information and communication technology for more than 6 years. Eventually, the application of these advanced technologies will optimise the operation of power system and become smart community with smart life and energy.

Throughout the 15 years of Smart Grid Development, the estimated yearly investment cost is expected to be even less than 10 percent of normal yearly electricity grid investment cost. The expected investment costs for each period are shown in Table 1 below. However, the appropriate investment budget is under study.

Table 1. Expected investment costs of smart grid for each period

Year	Investment cost (Billion Thai Baht)
2012 – 2016	168,551
2017 – 2021	175,197
2021 – 2026	178,008
Total Investment cost of 15 years	521,746

Metropolitan Electricity Authority (MEA)

The Metropolitan Electricity Authority is a government enterprise under the Ministry of Interior. Established in 1958, this organisation was responsible for generating and selling electrical power in the metropolitan area until 1961, when the generating aspect was transferred to EGAT. MEA provides high-class service while laying emphasis on sustainable growth of related business as well as responsibility for the society and the environment. MEA's missions are:

- to develop towards a high performance organisation with an efficient management systems based on participation of all stakeholders while adhering to a strong commitment to the Principles of Good Corporate Governance, promoting the organisation's positive image and taking responsibility for the society and the environment;
- to conduct electricity business in pursuit of sustainable growth with qualified , reliable and safe power distribution system as well as high class service; and

- to promote sustainable growth of related business that is promising and has the potential for growth.

MEA also performs its development in conformity with the Statement of Direction (SOD), which is the goal of the public sector and development directions of the country as follows:

1. Ensure the efficiency of operating cost management compliance with industry standards.
2. Develop and expand the power distribution system to meet high quality and cope with the increasing power demand with purpose to enhance competitive advantages of the country.
3. Oversee community security and enhance a nice landscape.
4. Focus on increasing value added to the organisation by means of maximising the utilisation of assets for utmost benefits and expanding related business for strengthening performance and financial status in preparedness for future competition including generating sustainable revenue for the Government.
5. Support resource conservation together with economic and efficient use of energy.
6. Initiate measures to enhance customer satisfaction.

Therefore, MEA's corporate strategies have been reviewed and improved to ensure linkages and compliances with the SOD. The significant plans/projects can be summarised as follows:

- The Eleventh Power Distribution System Improvement and Expansion Plan for the year 2012 – 2016:

The plan's objectives are to serve the increasing power demand and reinforce the power system reliability. Programs have been formulated under the Eleventh Power Plan covering Transmission and Distribution Substation System Program, Subtransmission Line System Program, Distribution System Program, Uprating of 12kV to 24 kV Primary Lines Program, and Power Supply Efficiency Improvement Program.

- Replacement of Overhead Line by Underground Cable System Plan for the year 2012 – 2019:

The plan's objectives are to reinforce the reliability of the existing power system in various main streets, enhance a nice landscape, and promote more security with approximate length of 25.4 kilometres for the construction of two projects including Ratchadaphisek-Asoke Project and Ratchadaphisek-Rama 9 Project.

- Customer Relationship Management (CRM) and Customer Experience Management (CEM) Plan for the year 2012 – 2016:

The plan's objectives are to enhance quality of service, increase customer satisfaction, and develop marketing and customer relations system to meet high quality and international standard. Significant plans/ projects include the MEA Ambassador Team Project and Project for Development of Customer Service Employee Quality and MEA Call Center, etc.

- Related Business Plan for the year 2012 – 2016:

The plan's objectives are to optimise the value added benefits of existing resources and exploiting opportunities in potential related business including Electrical System Service (ESS), MEA Better Care Service & Power Quality, Geographic Information Service, etc. as well as to develop new potential business such as Distributed Generation (DG) development and electricity production from alternative energy, etc.

- Master Plan on the Corporate Social Responsibility (CSR) for the year 212 – 2016:

The CSR Master Plan has been developed to use as organisation operation and development approach towards social responsibility for contributing to sustainable development. The plan is designed to raise awareness and inspire CSR responsibility by initiating social involvement projects

under the concept of "Green Spirit" in four key areas including MEA CSR & Green Spirit, Young Green Spirit, Green Environment Spirit, and Community and Society Green Spirit.

Grid Code

MEA and PEA have grid code with objectives to assign criteria, duty and responsibility related to the operation of grid connection as well as to define regulations and technical specifications of the grid. These are to prevent any impacts on power security, safety and quality of electricity system. Their grid code year 2008 is generally to identify on interconnection of distributed generation in terms of voltage control, frequency control, power factor control, harmonics and voltage fluctuation. MEA has grid code covering VSPP and SPP, while PEA has grid code that not only covers VSPP, SPP, but also consumers with power generator, and other energy industry.

Aspects of Smart Grid

In summary, MEA has only policies and projects that are related to efficiency of operating cost management, development and expansion of power distribution system, community security, organisation value added, resource conservation and customer satisfaction. Currently, MEA policy is still not supporting directly the development of Smart Grid. Neither on the grid code which is to ensure and control the quality of supply at the interconnection of distributed generation including SPP and VSPP. However, having said that, the existing grid codes are still not much related to, nor do they support Smart Grid development, but it can be said that the distributed generators as well as the grid codes will be inevitably significant for development of Smart Grid infrastructure.

2.2 Generation Utility (State-owned)

Electricity Generating Authority of Thailand (EGAT)

The Electricity Generating Authority of Thailand was established on May 1, 1969. It presently is the state enterprise under the Ministry of Energy. EGAT presently builds, owns and operates several types and sizes of power plants across the country with a combined installed capacity of 13,617.10 MW, accounting for about 47.8 percent of the country's 28,479.00 MW generating capacity. EGAT also purchases electric power from private power companies and neighboring countries.

A national long-term power development plan (PDP) has been revised regularly to best suit the country's economic and social situations. Based on the policy framework of the Ministry of Energy, the latest plan or PDP 2010 (2010 – 2030) was designated as a Green PDP placing particular emphasis on energy security, CO_2 emissions cuts, energy efficiency improvement, and promotion of efficient energy utilisation. The PDP 2010 was approved by the National Energy Policy Council (NEPC) and the Cabinet in March 2010.

In all, the entire PDP 2010 consisted of power projects to be implemented by EGAT and private power producers, power import capacity from neighboring countries, as well as transmission system development projects to timely accommodate the power expansion programs. Major projects in the short run under the new PDP 2010 include the following.

EGAT's Power Projects

During the short-term period of 2010 - 2015, new power projects totaling 3,234.70 MW will be developed by EGAT comprising 4 natural gas-fired combined cycle power projects totaling 3,070 MW, and 18 renewable energy projects totaling 164.70 MW.

Power Purchase

Independent Power Producer (IPP) Projects
Following the Energy Ministry's 2007 solicitation of proposals from independent power producers (IPPs) for selling electrical power to EGAT, a total of four IPP developers were selected to provide totally 4,400 MW of power (from Gheco-One Unit 1, Power Generation Supply Blocks 1 – 2, Siam Energy Blocks 1 – 2, and National Power Supply Units 1 – 4)

Small Power Producer (SPP) Projects
The PDP 2010 also includes power capacity purchase from small power producers (SPPs) using co-generation systems or renewable energy technologies. Under the government's 2007 Regulation for the Purchase of Power from SPPs, the purchase capacity from SPPs during 2010 - 2014 is 1,919 MW consisting of 1,604 MW from firm energy contract SPPs using co-generation systems and 315 MW from SPPs using renewable technologies. For the 2015 - 2021 period, the purchase capacity from SPPs (under the 2010 Regulation) will increase to 3,500 MW in response to the government's policy to promote power generation using cogeneration systems.

Power Import from Neighboring Countries
During 2010, a power purchase agreement (PPA) was reached for the purchase of power from Hong Sa lignite-fired power project in Laos. This added the total capacity to be imported from Laos's power projects currently under construction to a total of 3,209.50 MW.

Transmission System Development Projects
EGAT has planned and developed new transmission system projects to increase the capability of transmission lines and ensure the continuity and reliability of the power supply system. A number of transmission system interconnection projects have also been developed to receive electric power from domestic IPP projects as well as IPP projects in neighboring countries. These transmission projects will further strengthen system reliability and reduce system outages, and thus, minimising the country's economic loss.

EGAT's Renewable Energy Projects
The Electricity Generating Authority of Thailand (EGAT) has developed renewable energy for power generation since 1978. At the beginning, the projects were majorly relevant to Research and Development (R&D) of generation system prototypes for all entities involved. Thereafter, they were extended to the public development practices. To date, EGAT has several generating units of renewable energy such as Wind Turbine Power Plant at Lam Takhong, Wind Turbine Power Plant at Promthep Alternative Energy Station, Solar Power Plant at Pha Bong, and Solar Power Plant at Sirindhorn dam. Furthermore, EGAT has been developing a number of small hydropower projects at existing dams of the Royal Irrigation Department (RID) since 2004. The main purpose of the projects is to maximise the utilisation of water resource with hydropower generation.

To pursue EGAT's renewable energy development and to response to the policy of the Ministry of Energy, EGAT prepared its Renewable Energy Development Plan for Power Generation (Preliminary Plan) considering four renewable resources suitable for EGAT, i.e. wind energy, solar energy, small hydropower at existing RID dams and biomass.

Grid Code

EGAT has a grid code with the objectives to assign criteria, duty and responsibility related to the operation of grid connection as well as to define regulations and technical specifications of the grid. These are to prevent any impacts on power security, safety and quality of electricity system. For SPP, EGAT has a grid code which requires some background information prior to interconnection of distributed generation including generator specification and other information for dynamic simulation, turbine governor and excitation system information, unit transformer ratings/ features, type of primary fuel and back up fuel, interconnection system information, and other generality. The grid code of

EGAT also defines items such as interconnection voltage, frequency, voltage and current distortion, and flicker.

Aspects of Smart Grid

From the perspective of a generating utility, there may not be many activities that EGAT does that are relevant to Smart Grid; however, EGAT has several projects that can be considered as support for Smart Grid development in Thailand. Some of those projects include power purchase from IPPs and SPPs as a promotion of distributed generators, transmission system development projects as well as EGAT's renewable energy projects. Moreover, EGAT's grid code ensures and controls the quality of supply at the interconnection of distributed generation including SPP and VSPP. However, from the point of view of Smart Grid, the grid code of EGAT does not directly support Smart Grid development, but rather supports the development of Smart Grid infrastructure.

2.3 Generation Utility (Private sector)

Independent Power Producer (IPP)

With the attempt to promote competition in this industry, the government has promoted private sector participation in the generation business in the form of Small Power Producers (SPPs) and Independent Power Producers (IPPs) since 1992. Under the power purchase agreements, both SPPs and IPPs are required to sell electricity to EGAT that subsequently transmits to the distributors.
In December 1994, EGAT announced for the first time to purchase electricity from IPP sectors, for a total of 5,800 Megawatts. During the year 1996 - 2003, 7 IPP projects signed contracts with EGAT for selling a total of 5,944 Megawatts of electricity to EGAT.

The power purchase agreement conditions of IPPs consisted of the following:

1) The private sector needs to prioritise on clean fuel, stable price, ascertain supply, and agree with the policy on promotion of fuel diversity;
2) The private sector can propose the project location but needs to follow the zoning criteria in line with the National Economic and Social Development Plan (NESDP), which is to expand the development to regional and customer location, future electricity need and distance from EGAT transmission line system;
3) Since EGAT is the one who demands production of power plant as well as power delivery to the system, hence, the tariff structure is set up as two part tariff, consisting of Availability Payment (to be paid no matter whether the power plant is operated or not) and Energy Payment (to be paid when the power plant is operated, which will be tied to fuel price);
4) The private power plant needs to follow environmental standards assigned by the government, and Environmental Impact Assessment (EIA) report is required for approval from the Office of Natural Resources and Environmental Policy and Planning prior to project startup.

Small Power Producer (SPP)

In 1992, the same year as the IPP program, Thailand also began the Small Power Producer (SPP) Program. SPP generators connect to PEA or MEA lines and sell electricity under power purchase agreements (PPAs) to EGAT. SPP generators are divided into two categories: firm and non-firm, depending on their ability to guarantee availability. Firm fossil fuel-fired SPPs must generate for at least 7,008 hours per year and must generate during the months March, April, May, June, September and October. SPPs could sell up to 90 MW of capacity and employ Combined Heat and Power (CHP) or Cogeneration systems burning conventional fuels (i.e. natural gas and coal) or renewable technologies using non-conventional resources (i.e. waste, agricultural residues, biomass and solar energy) to generate electricity.

Small Power Producer Using Renewable Sources

The Cabinet endorsed the initial Regulations for the Purchase of Power from SPPs on 17 March 1992. Later, on 27 October 1993, the National Energy Policy Council (NEPC) had a resolution to raise the maximum contract capacity of each SPP to 90 MW. On 28 November 1995, the Cabinet agreed to expand the total purchased capacity from SPPs to 1,444 MW and 3,200 MW in 1995 and 1996, respectively. Thereafter, on 9 July 1996, the Cabinet approved the unlimited purchase capacity and duration from SPPs that generate power from non-conventional resources such as biomass or residues. In addition, the "Adder" incentive scheme has been commenced in 2007 to encourage power generation harnessing renewable resources.

According to PDP 2010, the total purchase capacity from SPPs using renewable technologies during 2010–2015 is 1,045 MW comprising 315 MW of Firm Contracts and 730 MW of Non-Firm Contracts.

As of January 2010, the contract capacity of 35 potential SPPs using renewable energy was 902.923 MW consisting of 395.3 MW Firm Contracts (18 projects) and 507.623 MW Non-Firm Contracts (17 projects). However, there were only 26 commissioned projects with a total capacity of 384.923 MW including 17 Firm Contracts (305.3 MW) and 9 Non-Firm Contracts (79.623 MW). The other nine upcoming projects were composed of one Firm Contract (90 MW) and eight Non-Firm Contracts (428.0 MW).

Small Power Producer Using Cogeneration System

On 16 January 2007, the Cabinet endorsed the NEPC's resolution on 26 December 2006, which extended the capacity of all SPPs from 3,200 MW to 4,000 MW. EGAT then announced to purchase 500 MW of electricity from cogeneration SPPs under Firm Contract. There were 28 tenders with 2,191 MW, which was much above the announced capacity. As a result, on 31 August 2007, NEPC had EGAT pause receiving the proposal from such SPP projects. On 16 November 2007, NEPC eventually agreed to let the purchased power from cogeneration SPPs exceed 500 MW, but cumulatively not more than 4,000 MW.

On 24 August 2009, NEPC had a resolution to promote power generation by cogeneration system. This program was later approved by the Cabinet on 8 September 2009. Its goal is to receive power from Cogeneration SPPs under Firm Contract up to 2,000 MW in 2015 – 2021 and more in the future year. As of January 2010, the contract capacity of 50 potential SPPs using cogeneration system was 3,600 MW comprising 3,391 MW Firm Contracts (43 projects) and 209 MW Non-Firm Contracts (7 projects). Among these, only 31 projects with a total capacity of 1,956 MW were commissioned including 25 Firm Contracts (1,788 MW) and 6 Non-Firm Contracts (169 MW). The other 19 upcoming projects consisted of 18 Firm Contracts (1,604 MW) and 1 Non-Firm Contract (40 MW).
Both IPPs and SPPs have long-term power purchase agreements with EGAT as the single buyer. The Power Purchase Agreements allocate market risk to EGAT (and its captive ratepayers) leaving SPPs and IPPs to manage the operating and fuel price risks. SPP contracts are between 5 and 25 years with terms and specifications set by EGAT, the national power monopoly. EGAT has defined two types of purchasing rates for buying SPP power, non-firm and firm power. The value of non-firm power is determined by EGAT's shortrun avoided energy cost. Firm power means the SPP can guarantee availability of electricity supply during the system peak months. Payment to firm SPPs is determined by EGAT's long-run avoided capacity and energy costs.

Very Small Power Producer (VSPP)

Very Small Power Producers Using Renewable Energy

Very Small Power Producers (VSPPs) are private power producers selling electricity to the Metropolitan Electricity Authority (MEA) or the Provincial Electricity Authority (PEA) with generating capacity of less than 10 MW. They can be Combined Heat and Power (CHP) or Cogeneration systems or renewable technologies using non-conventional resources (i.e. waste, agricultural residues, biomass, and solar energy). In 2002, the Government of Thailand introduced policies to promote power generation from non-conventional resources and renewable energy with a very small capacity of not greater than 1 MW selling electricity to power distribution utilities. Considering the advancements and high potential of renewable technologies, it was found that VSPPs using renewable energy are also feasible for the generating capacity greater than 1 MW. As a result, NEPC agreed to enlarge the VSPP's contract capacity from 1 MW to 10 MW on 4 September 2006. As well as SPPs using renewable technologies, all VSPPs are eligible for the "Adder" scheme. It was anticipated that power generation from renewable energy would increase dramatically and be strategically important to the sustainable development of the country

Very Small Power Producer Using Cogeneration System
On 6 November 2006, NEPC had a resolution on "National Power Development Policy and Plan" which was subsequently endorsed by the Cabinet on 21 November 2006. Its main objective is to support energy conservation and efficiency through a suitable purchase from cogeneration SPPs, regarding the Regulations for the Purchase of Power from SPPs and VSPPs.

On 8 September 2009, the Cabinet approved the NEPC's resolution on 24 August 2006 to promote power generation from cogeneration system. The promotion scheme encourages power purchase from VSPPs using cogeneration system with unlimited duration and capacity. However, the purchased power from cogeneration VSPPs assembled in PDP 2010 is only 113 MW as estimated by distribution utilities. As of December 2009, there were 17 projects of cogeneration VSPPs with a total capacity of 70.65 MW. They include 2 commissioned projects (6.0 MW), 11 PPA signed projects (53.6 MW), 1 approved project (3.6 MW) and 3 projects under consideration (7.45 MW).

Aspects of Smart Grid

In view of Generation Utility (Private sector) including IPP, SPP and VSPP, there may be not any directly related to smart grid policy. However, IPP, SPP and VSPP schemes are essential parts to promote the decentralised energy and power producer and eventually to support the development of Smart Grid in Thailand. Therefore, the promotion and improvement of policy for IPP, SPP and VSPP is inevitably necessary as infrastructure for smart grid development and deployment in Thailand.

2.4 Relevant Government Agencies in the Energy Sector

Energy Regulatory Commission of Thailand (ERC)

The Energy Regulatory Commission of Thailand (ERC) is appointed by His Majesty King Bhumibol Adulyadej as the independent regulatory agency. The foundation of all functions and responsibilities follows the enactment of the Energy Industry Act B.E. 2550 (2007). ERC consists of seven members and aims to work independently and separately from policy framework as to ensure the equality and fairness nested between consumers, producers, and other relevant interest groups. The primary functions and duties are to oversee the regulations that deal with electricity systems of generation, transmission, distribution, and their system operator. Of particular, ERC'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, to ensure maximum interests of the people and the country.

ERC's mission is to regulate the energy industry operation so as to establish an energy system that is reliable, efficient and fair for both energy consumers and energy suppliers and that is environmentally

friendly, by adhering to fair and transparent execution of defined the duty and responsibilities for the benefit of sustainable development of the country in the social, economic and environmental aspects.

Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy

The Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, with their mission is to support and promote the clean energy production and consumption that is consistent with the situation of each area that is cost effective and sustainable. It aims to develop clean energy technologies commercially for both domestic consumption and export, including creating co-operation networks that will lead Thailand to an energy knowledge base society so that the country's economy will be secure and the people live in social harmony and sustainable happiness.

The duties of DEDE prescribed under the Act on Administrative Organisation of the State Affairs are: to be responsible for energy efficiency promotion, energy conservation regulation, energy sources provision, alternative development of integrated energy uses, energy technology dissemination in systematic and continuous manner to adequately respond the demand from every sector at optimal costs beneficial to the country's development and the people's better living standard.

The duties prescribed under The Energy Conservation Promotion Act B.E.2535 are: to be responsible for regulation, supervision, promotion and assistance provision to the designated factories and buildings to comply with laws and regulations for efficient use of energy and savings.

Energy Policy and Planning Office (EPPO), Ministry of Energy

The Energy Policy and Planning Office (EPPO) is a pivotal agency under the Ministry of Energy, being tasked with the development of national energy policies and planning, including measures to manage and administer the energy sector, with due consideration of economic and social development, concurrently with environmental protection. In order to undertake the mentioned tasks, it is crucial to acquire substantial information and data for analysis and development of recommendation on energy issues to be presented to the management. EPPO, therefore, has developed an energy statistics database system with a view to following up both national and global energy situations.

EPPO is entrusted with the following six missions:

- Recommend energy policies and integrate/review energy management plans of the country;
- Recommend national strategies for energy conservation and alternative energy promotion;
- Recommend measures to solve and prevent oil shortage in both short and long terms;
- Supervise, monitor and evaluate the effectiveness of national energy policy and energy management plans;
- Administer the information and communication technology (ICT) with regard to energy issues of the country; and
- Enhance EPPO to become a strategic organisation.

Aspects of Smart Grid

There is currently no specific Smart Grid related policies coming from relevant government agencies in the energy sector consisting of ERC, DEDE and EPPO,. However, since PEA is now developing Smart Grid systems in its network, these energy related government agencies need to come up with energy regulations and policies as well as promotion of other Smart Grid infrastructure support including renewable and alternative energy.

III. ENERGY RELATED POLICIES

3.1 Power Development Plan

EGAT's Power Development Plan (PDP) is a 20-year investment plan that specifies which power plants and transmission lines are to be added at what time. A new official PDP is issued about once every two years by EGAT. EGAT's PDP is reviewed by the Ministry of Energy and approved by the National Energy Policy Council, then by the Cabinet. After the approval of its PDP, EGAT then undertakes to develop and expand the power system according to the plan.

The current Thailand Power Development Plan or PDP 2010 embraces the horizon of 2010 to 2030. The total contract capacity at the end of 2030 is 65,547 MW comprising a) 29,212 MW existing capacity as of December 2009, b) 54,005 MW of future added capacity from EGAT power plants, power purchase from IPP, SPP and VSPP, and c) 17,671 MW of retired power plants and expiration of Power Purchase Agreement (PPA) term.
Generating Capacity in 2010-2020: Power projects scheduled for commissioning in this period are already under implementation, committed or needed to serve the increasing demand. The additional 21,564 MW include:

- EGAT Power Plants: 4,582 MW
- Power Purchase from IPPs: 4,400 MW
- New Southern Power Plant: 800 MW
- EGAT's Renewable Energy: 239.2 MW
- Power Purchase from Small Power Producers (SPP): 3,539.5 MW
- Power Purchase from Very Small Power Producers (VSPP): 2,249 MW
- Power Purchase from Neighboring Countries: 5,668.6 MW

Generating Capacity in 2021-2030: Power projects coming online during this period are to satisfy the country's demand, though not yet assigned to particular sites. The total added capacity of 32,411 MW can be categorised as follows:

- New Gas Fired Combined Cycle Power Plant (10,400 MW)
- New Clean Coal Thermal Power Plant (6,400 MW)
- New Nuclear Power Plant (4,000 MW)
- EGAT's Renewable Energy Projects (96 MW)
- Power Purchase Projects from SPPs (3,800 MW)
- Power Purchase Projects from VSPPs (1,718 MW)
- Power Purchase Projects from Neighboring Countries (6,000 MW)

Since an intention of PDP 2010 is to respond to environmental policies by lowering greenhouse gas emission, EGAT has prepared to implement the following programs:

- Continuous studies of innovative DSM programs and development
- Improvement on the efficiency of EGAT's aging power plants considering their potential and action plans individually
- Improvement on transmission system to reduce losses
- EGAT Renewable Energy Development Plan in harmony with Thailand PDP 2010 and the 15 Years Alternative Energy Development Plan (AEDP)

The new PDP was designated as a "Green PDP" which highlights on greenhouse gas emission reduction and promotions of efficient energy utilisation and electricity production through cogeneration system, in addition to system reliability. Not only did it incorporate power purchase projects from domestic producers and neighboring countries that were approved by the Cabinet, but also power generation from renewable energy in the Alternative Energy Development Plan (AEDP) 2008–2022. Besides, opinions and comments obtained from the public hearing of PDP 2007 Revision

2 were taken into account. Therefore, the new PDP could be a complete guideline for power system development that encourages generation from renewable energy and lessens greenhouse gas emission, and thus a balance of generation resources.

EGAT, as a member of the subcommittee and the working group, formulated the Thailand Power Development Plan 2010–2030 (PDP 2010) within the following frameworks:

1. Extend the planning horizon from 15 years to 20 years (2010-2030)
2. Revise Thailand's Load Forecast based on National Economic and Social Development Board (NESDB)'s long-term economic growth
3. Analyse and integrate the effects of DSM projects in both the load forecast and the generation expansion planning
4. Combine the re-estimate amount of power purchase from renewable energy regarding AEDP 2008–2022 into the plan
5. Review the amount of power purchase from SPPs in 2009-2015 and further regarding the NEPC's resolution on 24 August 2009 to promote power production by cogeneration system
6. Reconsider power import from neighboring countries and identify only promising projects
7. Lower greenhouse gas emission

PDP 2010 was approved by National Energy Policy Council (NEPC) and endorsed by the Cabinet on 12 March 2010 and 23 March 2010, respectively.

Aspects of Smart Grid

In summary, even though PDP 2010 does not clearly state about Smart Grid issues, it can be implied from the direction it takes that this PDP 2010 gives much priority on clean energy and sustainable environment, as designated by its "Green PDP" label. The document highlights on greenhouse gas emission reduction and promotions of efficient energy utilisation and electricity production, areas where Smart Grid systems could have create significant impacts.

3.2 Pricing Structure

Criteria for Determining the Electricity Tariff Structure

In determining the electricity tariff structure, the following criteria have been taken into consideration:

1) Marginal Costs

Marginal costs mean "the incremental costs resulting from the most appropriate adjustment of the power generation and distribution systems to meet the continuously increasing demand per unit." The electricity tariff calculation that is based on the marginal costs will reflect the actual costs of power generation and distribution. Marginal costs in the power sector can be divided into four levels, i.e. generation, transmission, distribution and retailing.

2) Load Pattern

During the peak period, EGAT would have to operate at full scheme of its generating capacity to the point of the minimum reserve margin, whereas PEA would have to use full dispatch capacity during the same period. As for MEA, the full dispatch capacity takes place in the afternoon when the consumption nationwide is at the moderate level. Consequently, if the demand had increased during the peak period, the power sector would have been required to increase investment in power generation and distribution.

Due to the changing load pattern, in early 1997 the Time of Use (TOU) rate was introduced by the three power utilities. The TOU rate was offered as an alternative rate for the existing Time of Day

(TOD) customers and as a compulsory rate for new power consumers. Under the TOU rate, the tariffs would be expensive during the peak period and would be cheaper during the off-peak. In addition, the whole Sunday was considered to be the off-peak period.

The current load pattern has altered again from what it used to be, i.e. the load curve during Saturday, Sunday and official holidays shows lower demand than that during Monday – Friday. That is, the peak period of the system is during 09.00 – 22.00 hrs from Monday to Friday and the off-peak is during 22.00 – 09.00 hrs from Monday to Friday and the whole day on Saturday, Sunday and public holidays.

Table 2. Current Load Pattern of the System

- Peak	09.00 – 22.00 hrs.	Monday – Friday
- Off-peak	22.00 – 09.00 hrs.	Monday – Friday and the whole day on Saturday, Sunday and public holidays

3) Revenue Requirement of the Power Utilities and Financial Criteria

(i) Revenue Requirement

The three power utilities will undertake an estimate of their financial status and make an estimate of the average electricity tariff that would yield the financial status pursuant to the established criteria. The revenue in each year will be called the "revenue requirement." In order to estimate the financial status, explicit assumptions are essential, particularly assumptions on fuel prices, inflation rates or consumer price index (CPI), efficiency improvement of the transmission system, distribution system and retail business.

(ii) Financial Criteria
The current financial criteria are in line with the conditions for loan guarantee of the World Bank. The criteria are the following:

- Minimum self-financing ratio: the ratio of fund generated from internal sources over the average three-year capital expenditure
- Minimum debt service coverage ratio: the ratio of net cash income before interest over debt service requirement for the year
- Maximum debt/equity ratio: the ratio of long-term debt over total equity
- Maximum ratio of short and medium-term debt ratio: the ratio of all debt to total long-term debt maturing less than five years from the date on which it was issued over total long-term debt

4) Social Criteria for the Electricity Tariff Determination

The key political and social requirements are as follows:

1. Uniform tariffs should be applied nationwide for each individual customer category;
2. Subsidisation for residential consumers should remain, particularly for small residential consumers whose consumption is low; and
3. The structure of electricity tariffs for other consumer categories should be designed to best reflect the marginal costs.

3.3 Bulk Supply and Retail Tariff Structure

Structure of the Bulk Supply Tariff

1) Bulk Supply Tariff by Time of Use (TOU Rate)

The tariff structure of the bulk supply that EGAT sells to the MEA and PEA will be without surcharge onto/deduction from the bulk supply tariff (BST) imposed by EGAT on the sale to the two distribution utilities. Instead, the subsidisation between the MEA and PEA will be in the form of a lump sum financial transfer. The BST comprises the generation and transmission costs. The tariffs will vary according to the voltage levels and periods of time of consumption.

Table 3. Bulk Supply Tariff Structure (Time of Use: TOU Rate)
(since 1st July 2011)

Unit: Baht/kWh

Voltage Level	Generation Cost		Transmission Cost		Total	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
230 kV	2.7497	2.0173	0.2730	-	3.0227	2.0173
Exit of a 230: 115/69 kV sub-station	2.7591	2.0198	0.4913	-	3.2504	2.0198
End of 115/69 kV line *	2.8253	2.0412	0.8528	-	3.6781	2.0412
11-33 kV line	2.8322	2.0424	1.0226	-	3.8548	2.0424

* included 115:115 and 69:69 kV
Peak period: time 09.00-22.00 hrs Monday - Friday
Off-Peak period: time 22.00-09.00 hrs Monday - Friday
: time 00.00-24.00 hrs Saturday – Sunday, National Labour Day, and National holidays (excluded Compensatory Day and Royal Ploughing Day)

2) Automatic Adjustment Mechanism (Ft)

On 29 January 1991 the cabinet passed a resolution approving the Automatic Adjustment Mechanism in order to have the actual costs reflected by the tariffs and to reduce impact of the fuel price volatility on the power utilities' financial status. Thus, the power utilities can adjust electricity tariffs to correspond with the changing actual costs which are beyond control of the utilities, including costs of fuel and energy purchases, impact of foreign exchange rates, affected revenues of the three power utilities, inflation, and DSM expenditures.

Power Factor Charge
A power factor charge, at a rate of 18.68 Baht/kVar/month, will be imposed if the power factor of the bulk supply between EGAT and the MEA/PEA is lower than 0.875 (Lagging).

Value Added Tax
The Bulk Supply Tariff Structure shown in Table 3 above is tax excluded. Value added tax will be shouldered by consumer.

Retail Tariff Structure

The calculation of the retail electricity tariffs comprises two parts as follows: 1) the base tariff and 2) the tariff derived from automatic adjustment mechanism (Ft):

1) Base tariff:

The base tariff includes the costs of generation, transmission, and distribution. The tariff structure for the generation, transmission, distribution and retail is clearly unbundled. Tariff varies according to

each consumer category with its own particular group's load pattern. There are currently eight categories of users. The electricity tariff structure is different in each category. For example, a time of use (TOU) rate is applied for medium and large general services, whereas a progressive rate is applied for the residential and small general services group.

2) Automatic Adjustment Mechanism (Ft):

The calculation of base tariff rests upon certain assumptions regarding fuel prices, inflation rates, exchange rates, operating efficiency and other factors which might not reflect actual costs at the time of consumption. The principle of Ft is to have the actual costs reflected by the tariffs. The mechanism allows for adjustment of electricity tariffs to correspond with the changing actual costs, which are beyond the control of operators. Ft value will be adjusted every four months taking into account factors such as costs of fuel and energy purchased.

The retail electricity rate is classified into eight categories of users as follows:

1) Residential: Applicable to dwellings, monasteries, churches of any religion including its compound through a single Watt–hour meter.
2) Small General Service: Applicable to business, business cum residential, industrial, government industrial institutions, state enterprises, or others including its compound with a maximum 15-minute integrated demand of less than 30 kW through a single Watt-hour meter.
3) Medium General Service: Applicable to business, industrial, government industrial institutions and state enterprises including its compound, with a maximum 15-minute integrated demand of at least 30 kW but less than 1,000 kW and average energy consumption in the last three consecutive months not exceeding 250,000 kWh per month through a single demand meter.
4) Large General Service: Applicable to business, industrial, government institutions, state enterprises, including its compound, with a maximum 15-minute integrated demand of 1,000 kW and over or average energy consumption in the last three consecutive months exceeding 250,000 kWh per month through a single demand meter.
5) Specific Business Service: Applicable to hotel, guest house or other businesses providing lodging to customers including its compound, with a maximum 15-minute integrated demand of 30 kW and over through a single demand meter.
6) Government Institutions and Non-Profit Organisation: Applicable to government institutions or those established by the Local Administrative Act, non-profit organisations offering free of charge service, places conducting religious ceremonies including its compound with average consumption in the last three consecutive months not exceeding 250,000 kWh per month through a single watt-hour meter, but excluding state enterprises, embassies, places for activity related to a foreign country or international organisations.
7) Agricultural Pumping Service: Applicable to government agricultural agencies, officially recognised farmer groups, agricultural co-operatives or farmers operating water pumps, for agricultural pumping through a single Watt-hour meter.
8) Temporary Service: Applicable to temporary used for construction, bazaars, fairs and places without registration number including the consumption is not subject to the conditions set forth in PEA's Rules and Regulations through a single Watt-hour meter.

The structure of retail electricity tariffs will vary depending on consumption and voltage level.

Table 4. Categories of Power Consumers

	Energy consumption	Demand consumption	Marginal cost Per kWh	Base Tariff Per kWh
(1) Residential Service			3.27	2.84
Small	< 150			
Large	>150			
(2) Small General Service		<30 kw	3.06	3.26
(3) Medium General Service	<250,000 kWh/month	30 -999 kw	2.62	2.79
(4) Large General Service	>250,000 kWh/month	>1,000 kw	2.27	2.45
(5) Specific Business Service Hotel		>30 kW	2.40	2.52
(6) Government Institution & NPO	<250,000 kWh/month	<1000 kw	3.02	2.71
(7) Water Pumping for Agricultural Purpose			4.06	2.28
Power Reserve		3.40	4.78	
Average		2.69	2.70	

Source: Thailand Energy Regulatory Developments 2009

Aspects of Smart Grid

In summary, these reviews on Pricing Structure and Bulk Supply and Retail Tariff Structure generally describe each category of pricing and tariff; however, even if there is no current pricing related to Smart Grid, this will definitely be an important aspect to take into consideration when implementing Smart Grid in the country.

3.4 Demand Side Management

Demand Side Management (DSM) is the management of electricity utilisation or promotion of electricity energy efficiency, in general. The idea of DSM occurred in the 1970s due to the rapid growth in electricity demand and energy production without consideration on incoming problems, e.g. natural resources depletion, and environmental pollution from fuel combustion. DSM is an alternative to plan and develop a more efficient system of electricity generation, transmission and distribution.

Electricity management in Thailand was basically classified into two aspects: 1) Supply-Side Management: the planning, construction and provision of power generation to meet power demand for customers; and 2) Demand-Side Management: the measures to adjust volume and/or characteristics of electricity consumption (End-use). The two main purposes of this electricity management are: 1) to balance demand-side with supply-side by efficient technologies or by load pattern adjustment for optimal peak load or peak demand; and 2) to strengthen and promote energy conservation.

DSM programs and measures aim to promote and support target groups of customers to improve their electricity consumption to conform the power supply of electricity industry with the remaining of customer benefits and satisfaction or the better, for instance, reducing the costs of both electricity industry and customers, lowering investment cost of power plant and transmission system construction, and diminishing environmental impacts of power program development and power generation development.

DSM Program for Power Demand Forecast Adjustment

1. The Promotion of New T5 Fluorescent Lamp Program (T8 Fluorescent Lamp Replacement Program)

Program Target: To promote new T5 fluorescent lamps to replace old T8 fluorescent lamps, especially in business and industrial sectors, amounting to 83 million lamps within 2015.

Implementation Guidelines: Encouraging both new and old commercial buildings and industrial buildings to use new T5 fluorescent lamps with financial assistance of two-years loan provision from EGAT without interest.

Table 5. Energy Saving Target of New T5 Fluorescent Lamp Program (Accumulated)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018
Peak (MW)	43	129	215	344	473	584	498	369	198
Energy (MWh)	210	629	1049	1,678	2,307	2,852	2,433	1,804	965

Source: EPPO

2. Future Energy Saving Target of DSM Programs

DSM program of the new T5 fluorescent lamp program promotion will end in 2018. However, EGAT has already planned further energy saving target of new programs for the future. The expectation of energy saving rate of 2019 should be trended to improve greater than that of 2018 of around 21 percent – an average growth of energy saving rate of 2010 to 2018. It is also anticipated that after 2019 the energy saving rate is kept constant throughout the forecast period. Therefore, during 2019 to 2030, the load forecast of peak demand and energy demand are approximately reduced by 240 MW per year and 1,170 MWh per year respectively.

Aspects of Smart Grid

DSM, which generally is the management of electricity utilisation or promotion of electricity energy efficiency, is an important concept needed when implementing Smart Grid. With regards to smart meter or AMI, which is part of Smart Grid system, it is certain that the concept of DSM is necessary in order to manage the electricity utilisation.

3.5 Fifteen Years Alternative Energy Development Plan (year 2008 – 2022)

Thailand Alternative Energy Development Direction and Vision

1) Important driving factors of alternative energy: consists of seeking adequate energy sources for national need; abundance of alternative energy sources in the country; energy security; global warming mitigation
2) Direction of alternative energy in the future
3) Vision of the 15 Years Alternative Energy Development Plan

The objectives of the 15 Years Alternative Energy Development Plan are:

1. To utilise alternative energy as a major energy supply of the country for replacing oil import,
2. To increase energy security of the country,
3. To promote an integrated green energy utilisation in communities,
4. To enhance the development of alternative energy technology industry,
5. To research, develop and encourage high efficiency alternative energy technologies.

The objective of AEDP is to increase the portfolio of renewable energy to 20.3 % of the final energy consumption in 2022. At the end of the plan, the portion of renewable energy in power generation shall be 2.4% or 5,608 MW.

Overview of Alternative Energy Development Plan (AEDP)

The 15 Year AEDP is divided into three phases: the Short term from 2008 to 2011, the Mid term from 2012 to 2016, and the Long term from 2017 to 2011.

Short term (2008 – 2011)
The Short term phase is focusing on proven renewable energy technologies promotion and the high-potential renewable energy resources such as biofuels, power generation, and thermal energy from biomass and biogas with full financial support. The cumulative target to develop the renewable energy during this period is 3,273 MW or equivalent to 1,587 ktoe.

Mid term (2012 – 2016)
The Mid term phase is concentrated on the efforts to promote the renewable energy technology industry, to support the new renewable energy technology prototype development to make it economically sound, and to encourage new technologies in the biofuels production, the green city model development, and the strengthening of the local energy production. The cumulative target to develop the renewable energy during this period is 4,191 MW or equivalent to 1,907 ktoe.

Long term (2017 – 2022)
The Long term phase emphasises on the promotion of economically viable new renewable energy technology including the further implementation of the green city and local energy, and to promote Thailand as the ASEAN biofuels and renewable energy technology export hub. The cumulative target to develop the renewable energy during this period is 5,608 MW or equivalent to 2,290 ktoe.

Output and Outcome of Alternative Energy Development Plan (AEDP)

(1) Economics aspect
- Currency saving on energy import 460,000 Million Thai Baht/year within 2565
- Increase investment of private sector 382,240 Million Thai Baht
- Creates 40,000 clean and new jobs.
- Opportunity to earn 14,000 Million Thai Baht/year form Carbon Credit trading.
- Delay the construction of new fossil fuel power plant 3,800 MW (equivalent to 100,000 Million Thai Baht)
- Create Country's incomes by exporting biofuels, RE technologies (Gasification, biogas fermentation system).

(2) Social aspect
- Migration mitigation due to job creation in rural areas.
- Extra income to farmers.
- Improve quality of life for Thai people.

(3) Environmental aspect
- Low Carbon Society to mitigate the global warming.

Aspects of Smart Grid

The Alternative Energy Development Plan may not have any existing policies or plans that directly relates to Smart Grid; however, the promotion of, and emphasis on, renewable energy resources and technologies is an essential part of the development and deployment of Smart Grid in Thailand.

3.6 Policy Statement of the Council of Ministers

Delivered by Prime Minister Yingluck Shinawatra to the National Assembly
Tuesday 23 August B.E. 2554 (2011)

Energy Policy:

1) Promote and drive the energy sector to generate income for the country. As a strategic industry, investment in energy infrastructure will be increased to make Thailand a regional center for the energy business, building upon the competitiveness of its strategic location.
2) Reinforce energy security through development of the electrical power grid and exploration of new and existing energy sources, both in Thailand and abroad. Energy sources and types will also be diversified so that Thailand will be able to meet its energy needs from a variety of sustainable energy sources.
3) Regulate energy prices to ensure fairness as well as reflect the production costs by adjusting the role of the Oil Fund into a fund which ensures price stability. Subsidies will be available for vulnerable groups. The use of natural gas in the transport sector will also be promoted, while the use of gasohol and biodiesel will be promoted for use in the household sector.
4) Support the production, use, research and development of renewable and alternative energy sources, with the objective of replacing 25% of the energy generated by fossil fuels within the next decade. Comprehensive development of the energy industry will also be promoted.
5) Promote and drive energy conservation through the reduction of power usage in the production process by 25 % within the next two decades. The use of energy efficient equipment and buildings will be promoted, while Clean Development Mechanisms (CDM) will be used to reduce emission of Green House Gases and tackle global climate change. Systematically raise consumer awareness to use energy efficiently in order to conserve power in the production and transport sectors, as well as in the household.

Aspects of Smart Grid

With regards to the Energy Policy under Policy Statement of the Council of Ministers delivered by Prime Minister Yingluck Shinawatra to the National Assembly, one of the policies mentioned is to reinforce energy security through development of the electrical power grid and exploration of new and existing energy sources. It is very likely that Smart Grid development is an appropriate option to reinforce energy security. However, the statement gave no direct policy on the development of Smart Grid in Thailand.

3.7 Energy Industry Act, B.E. 2550 (year 2007)

This Act was published and became effective in December 2007. It establishes a new regulatory regime for electricity and natural gas business. One of the purposes of the Act is to restructure the energy industry management by separating policy making, regulation and operating functions. It provided for establishment of an Energy Regulatory Commission (ERC), whose members have been appointed, and the Office of ERC. Operators of energy business must obtain a license from the ERC. Draft royal decree, regulations and notifications to implement the Act have been published. The ERC is responsible for prevention of abusive use of monopoly power and protection of energy consumers and those adversely affected from the energy industry operation. The contents of Energy Industry Act B.E. 2550 (2007) consist of the following:

- General Provisions: defining objectives which are Fundamental Policy Guidelines on Energy Industry, and Authority and Duties of the Minister
- The Regulatory Body for the Energy Industry Operation: comprises the Energy Regulatory Commission, and the Office of the Energy Regulatory Commission
- Regulation of the Energy Industry Operation: consists of License for the Energy Industry Operation, Tariffs for the Energy Industry Operation, Establishment of Standards and Safety in the Energy Industry Operation, and The Energy Network Systems and the Energy Network System Operators
- Energy Consumer Protection: with information on Service Standards and Service Extension, The Power Development Fund, and Regional Energy Consumer Committees
- Utilisation of Immovable Property
- Redress of Disputes and Lodging of Appeals
- Competent Officials
- Disciplinary Procedures

- Punishment

Other related energy acts include: National Energy Policy Council Act (No. 3) B.E. 2551 (year 2008), Electricity Generating Authority of Thailand Act (No. 5) B.E. 2535 (year 1992), Provincial Electricity Authority Act (No. 4) B.E. 2542 (year 1999), and Metropolitan Electricity Authority Act (No. 3) B.E. 2535 (year 1992), which in general are to identify their objectives, authorities, roles and responsibilities.

Aspects of Smart Grid

One of the main energy industry management restructuring of the Energy Industry Act B.E. 2550 (year 2007) is the initiative on the establishment of the Energy Regulatory Commission (ERC), an agency that will play an important role in energy regulations as well as Smart Grid related rules and regulations for Smart Grid development in Thailand.

3.8 Power Development Fund

The Power Development Fund (PDF) is one of main responsibilities of ERC for the purpose of promoting the participation of energy consumers. The establishment of the PDP is to raise financial support and to thoroughly distribute power service to further develop rural areas and communities possibly affected by the operation of a power plant. The Act allows a fund to be set up to compensate those licensees who provide services to low-income consumers or remote areas at prices below actual costs. Apparently, this is to be used as a tool to support the social objective of uniform tariffs and rural electrification. The Regulator is empowered to assign licensees to extend their services into areas where supply is still insufficient. Currently, uniform tariffs are achieved through a cross-subsidy between MEA and PEA. Arrangements are made for PEA to pay for bulk power from EGAT at rates lower than those paid by MEA, so that PEA can provide power to their customers at the same prices as those paid by MEA customers in Bangkok, Samutprakarn and Nonthaburi. The Fund can also be used in financing development projects in areas affected by power generation. This is apparently aimed at reducing tensions between power plants and nearby community, making it easier to locate power plants in the future.

Aspects of Smart Grid

The Power Development Fund established by ERC has no direct bearing on Smart Grid issues. However, since it promotes the participation of energy consumers, the PDF could serve as an essential supplement for the modernisation and improvement of the generation and transmission and distribution system, areas where Smart Grid development and implementation could play a major role in the future.

IV. POTENTIAL IMPROVEMENTS

In order for Smart Grid to be incorporated in the policies of the government, there are several regulatory challenges that need to be overcome. Smart Grid deployment should be first and foremost market-driven. Investors want the regulatory framework changed to allow greater competition in the distribution sector and the recovery of investments. Possible improvements in this regard include:

1. The Regulatory Commission should develop regulatory incentives for the deployment of Smart Grids; for example, revising the tariff mechanism to accommodate and encourage implementation of Smart Grid systems.

2. Guidelines to define a methodology for the smart meter implementation and cost-benefit analyses.

3. Guidelines for increased renewable to be incorporated by the utilities.

4. Requirements for the format and content of information provision for customers, and for access to information services and demand management (e.g. in-house control of consumption).

5. Creation of a transparent and competitive retail market for the development of services (e.g. time-of-use pricing and demand response) based on Smart Grids and metering.

V. ANALYSIS OF BARRIERS

5.1 Identified Barriers to Smart Grid in Thailand

In every country there are barriers to Smart Grid development. In Thailand, the barriers that are identified can be categorised into five aspects: i.e. policy, legal, technology, market and social perspectives, aspects of which include (but not limited to):

1) Policy
- A historical and persistent tendency by the Thai Load Forecast Subcommittee to overestimate future demand for electricity. This ultimately leads to over-investment in (conventional) power plants.
- Among the three major electric utilities, only PEA has made its policy on Smart Grid publicly available at this time. MEA and EGAT have internal strategic plans on Smart Grid but these are not made public.

2) Legal
- No existing national regulations specific to Smart Grid.
- Legislators and regulators have not yet taken a strong leadership role in support of grid modernisation.

3) Technology
- Only international standards are available. Each Thai agency may follow different international standard. There is currently no Thai standard adapted to specific requirements of the situation in Thailand. Hence, the issue of interoperability remains a big concern.
- Security- Cyber security needs to be employed to protect IT and communications systems in the Smart Grid from digital attack. There is as yet no common standard for cyber security either globally or within key markets.

4) Market
- Cost remains a primary barrier to Smart Grid - The enormous costs of building Smart Grids will affect the speed of implementation, especially where utilities' costs are not offset by government grants. Capital-intensive projects of this type may be hard to justify, especially when macro-economic conditions are poor, as they are at present. Passing through the costs to the customers does not seem to be a viable option.
- Meter Investment and Startup Costs - A requirement of any Smart Grid rollout is the individual purchase of a smart meter, as well as a startup fee for installation and setup. Unfortunately, there is little that can be done about this reality, but one way to offset a negative consumer perception is through education. The more consumers understand the scope and benefits of the project/initiatie, the costs become more of an investment than an unnecessary fee.

5) Social perspectives
- People's awareness and perceptions of smart meters and Smart Grids are inadequate.
- Difficulties in getting public acceptance - Consumer resistance to smart metering has emerged with some early deployments, notably in Australia and the USA, and has in some cases resulted in regulatory invention. Utilities will need to manage and overcome end-user resistance to smart metering. Public utilities must also convince regulators that vulnerable consumer groups (e.g. parents with young children, the sick and the elderly) will not be disadvantaged by time-of-use (TOU) pricing.

- The "not in my backyard" (NIMBY) syndrome must be resolved to reduce the excessive delays experienced today in deploying needed upgrades to the grid.

5.2 Measures to Remove Barriers

Smart Grids have multiple operational mechanisms and have no single shape. Thailand has many opportunities to enhance the grid and provide energy in an efficient and environmentally sound manner. They do however overcome certain barriers and challenges in providing this energy to the end-user.

The following are some recommendations to remove the existing barriers surrounding the development and implementation of Smart Grid systems in Thailand:

1. First and foremost, standardise the Smart Grid definitions and interfaces with the government, regulators, and utilities while setting product requirements and applications. The government, regulators, and utilities should create a strategy and develop standards in participation with industry and stakeholders on an international level to ensure interoperability of system components and reduce risk of technology obsolescence.

2. The government and regulators should collaborate with public/private sector stakeholders to determine regulatory and market solutions that can mobilise private sector investment in the energy sector.

3. Regulators should create, promote, and adopt a real-time energy usage tariff – Generators, transmission system operators, and distribution companies should plan and operate the systems in a coordinated manner.

4. Transmission and distribution system operators should work in coordination to develop operational business models with government and regulators, which ensure that all stakeholders share risks, and are shown the benefits of system reliability, cost, environmental sustainability and security.

5. Generators should be flexible on the methods used by the Smart Grid to meet demand growth and decrease emissions.

6. Create a mechanism for the utilities to invest in research, development and demonstration. The government should actively engage in developing system demonstrations and deployments in order to ensure consumer contribution to and benefit from future electricity systems and markets, while ensuring consumer protection.

7. Support international collaboration with organisations such as WADE and other EU relevant entities and dissemination of Smart Grid RD&D, including business and regulatory experiences.

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