The Policy and Regulatory Framework for Smart Grid Development in Thailand

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Abstract

Electric system is facing a period of rapid evolution. The current regulation of natural monopolies does not offer sufficient way for network operators and network users to participate in this process. The deployment of smart grids in electricity network which amalgamates information and communications technology ('ICT') and electrical capabilities is seen as an additional instrument to achieve goals for improving flexibility, security, reliability, efficiency and the safety of the electricity system as well as combating climate change. This paper draws on the issue of the policy and regulatory framework for smart grid development in Thailand. This paper applies analytical, theoretical and doctrinal legal study approaches to evaluate how policy and regulation are designed and applied in other country to analyze an appropriate regulatory pathway to deliver solutions for smart grid development in Thailand. It is argued that the effectiveness of a policy and regulation for smart grid development relies on how well it is designed and enforces.

Keywords: Smart Grid, Regulation, Electric Power System, Thailand

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1. Introduction

Power system does not only face rapid increase in demand; they are also experiencing rapid changes due to the integration distributed Renewable Energy Sources (RES).[2] Smart grid is the innovation designed to upgrade electric power grids with the modern information and communication technologies (ICT) as well as advanced power grid components for metering, measurement and control, and automation.[3] Smart grid technologies open up many new possibilities in power grid management and control.[4] Many countries throughout the world are under way to develop smart grids in their electricity network. Nevertheless, there are different factors driving policy and regulation for smart grid development such as the maturity of their electricity supply industry (ESI), economic and political priority, the way in which a suitable smart grid system should be designed and built.[5] Thailand as a developing country is facing the challenges of high demand of electrical energy, negative environment impact, and changes in economic situation. In order to deal with these problems, smart grid technologies are expected to cope with the most pressing problems and challenges for power systems more effectively and efficiently than the conventional grid technology. This paper illustrates an approach to the policy and regulatory framework which play a key role for the road to success on how the smart grid can be implemented at the national policy level in Thailand. This paper begins with the definition of smart grid and the role of policy and regulation for the smart grid development. The current policy and regulatory framework for smart grid development in Thailand is reviewed and the policy and regulatory framework from Australia experiences is discussed to provide lesson learn to Thailand. Finally, the discussion on the policy and regulatory pathway towards smart grid development in Thailand is presented.

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[2] Luca Lo Schiavo, Maurizio Delfanti, Elena Fumagalli and Valeria Olivieri, "Changing the Regulation for Regulating the Change: Innovation-Driven Regulatory Developments for Smart Grid, Smart Metering and E-Mobility in Italy," *Energy Policy* 57, (2015): 1375-1389.

[3] Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt and Concettina Buccella, "Smart Grid Technologies: Communication Technologies and Standards," *IEEE Transactions on Industrial Informatics* 7, no.4, (2011): 529-538.

[4] Rosemary Lyster, "Smart Grids: Opportunities for Climate Change Mitigation and Adaptation," *Monash University Law Review* 36, no.1 (2010): 173-191.

[5] Nopporn Leeprechanon, Prakornchai Phonrattanasak and Hugh Vanijpratpha, "Transforming to a Smart Grid in Thailand: A Road to Success," *Advanced Materials Research* 361-363, (2012): 1300-1310.

2. Smart Grids and its impact on the electricity supply chain

Smart grids represent a promising new technological concept for promoting competition, increasing the safety of electricity systems and combating climate change.[6] This part provides the definition of smart grids and its contribution to the electricity supply chain.

2.1 Definition of smart grids

The explanation of smart grids has found widespread been acclaimed in the professional community coming from the International Energy Agency (IEA) as[7]

"An Electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation to meet the varying electricity demands of end users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, resilience and stability."

Another definition of the smart grid concept comes from the International Electrotechnical Commission (IEC)[8]

"The general understanding is that the Smart Grid is the concept of modernizing the electric grid. The Smart Grid comprises everything related to the electric system in between any point of generation and any point of consumption. Through the addition of Smart Grid technologies, the grid becomes more flexible, interactive and is able to provide real time feedback.

It is an electricity network that can intelligently integrate the actions of all users connected to it –generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies."

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[6] Cédric Clastre, "Smart Grids: Another Step towards Competition, Energy Security and Climate Change Objectives," *Energy Policy* 39, (2011): 5399-5408.

[7] International Energy Agency (IEA), *Technology Roadmap: Smart Grids*, (Paris: IEA, 2011), 6.

[8] International Electrotechnical Commission (IEC), "What is a Smart Grid?," last modified n.d., accessed January 15, 2018, http://www.iec.ch/smartgrid/background/explained.htm.

Smart grids refer to a modernization of the electricity delivery system from the centralized generation system to decentralized generation system through the transmission and distribution networks into industrial users, end-use consumers, micro grid connected to RES energy storage and Electric Vehicles (EV).[9]

The term of smart grid may apply to several types of technology. In upstream (generator) or downstream (consumer) markets, smart grids are synomous with smart meters measuring actual output or consumption in real time. In contrast, smart grids, in the context of electricity network, are communicating instruments (sensors and communication networks) transmitting data on the network's status in real time.[10]

2.2 How smart grids impact on the electricity system

Smart grid technologies open up many new possibilities in power grid management and control. Its ability is to provide bi-directional flows of energy, and two-way communication and control capabilities, and also provides new functionalities and applications that can assist service providers to adapt more flexibly where electricity infrastructure has been impacted by climate change.[11] There are three main benefits when applied smart grid in the electricity system.

2.2.1 Supply side consideration[12]

Smart grids enhance the quality of energy supplied to end users as well as promote innovation related to load handling. Smart grids facilitate the grid connection and operation of generators of all sizes and technologies. It helps to integrate electricity generated from intermittent renewable and energy storage in electricity networks, while optimizing their use and contribution to system services and wholesale market.[13] Moreover, smart grids help anticipating outages with the necessary upgrading or maintenance of self-adapting networks and also optimizing the use of new or less recent electrical assets.

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[9] Richard J. Campbell, *The Smart Grid: Status and Outlook*, (Congressional Research Service, 2018), 1-14, accessed January 10, 2018, https://fas.org/sgp/crs/misc/R45156.pdf

[10] Cédric Clastre, "Smart Grids: Another Step towards Competition, Energy Security and Climate Change Objectives," 5399-5408.

[11] Rosemary Lyster, "Smart Grids: Opportunities for Climate Change Mitigation and Adaptation," 173-191.

[12] Cédric Clastre, "Smart Grids: Another Step towards Competition, Energy Security and Climate Change Objectives," 5399-5408.

[13] Napaporn Phuangpornpitak and Suvit Tia, "Opportunities and Challenges of Integrating Renewable Energy in Smart Grid System," *Energy Procedia* 34, (2013); 282-290.

2.2.2 Demand side consideration[14]

Smart grids allow industrial, commercial, and the residential consumer to play a part in optimizing the operation of the system by adjusting electricity consumption behavior according to the supply. This system integrates consumers as active players in the electricity system; saving, achieved by reducing peaks in demand and improving energy efficiency, are one of the ways of reaching the appointed goals, particularly for cutting greenhouse gas emission.

2.2.3 Information and Communication[15]

Smart grids develop information networks, data storage and management, and regulate governing access by the various players in power system. Smart grids provide consumers with greater information on their electricity consumption which enables electricity conservation.

3. The Role of Policy and Regulatory Areas for the Electricity System Development

The energy trilemma is rooted in the overarching philosophy of sustainable development in the Brundtland Report[16] which characterized the goals of sustainable development as economic viability, security of supply and environmental protection.[17] The complete and simultaneous achievement of all three policy goals is virtually impossible. Therefore, most countries place a priority on one or sometimes two policy goals while try to achieve or maintain acceptable levels with regard to the non-prioritized policy goals.[18]

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[14] Laura Antonia Faerbera, Nazmiye Balta-Ozkanb and Peter M. Connorc, "Innovative Network Pricing to Support the Transition to a smart Grid in a Low Carbon Economy," *Energy Policy* 118, (2018): 210-219.

[15] Cédric Clastre, "Smart Grids: Another Step towards Competition, Energy Security and Climate Change Objectives," 5399-5408.

[16] World Commission on the Environment and Development Report: Our Common Future generally referred to as the Brundtland Report, Report of the World Commission on Environment and Development: Our Common Future, UNGAOR, 42th sess, Supp No 25, UN Doc A/42/25, August 4, 1987, annex.

[17] Jeannie Oliver and Benjamin Sovacool, "The Energy Trilemma and the Smart Grid: Implication Beyond the United States," *Asia and the Pacific Policy Studies* 4, no.1 (2015):70-84.

[18] Ibid.

According to energy policy, the provision of widespread and reliable access to electricity was often the initial motivation, affordability of electric power emerged as a second driver of energy policy after the initial build-up phase. Finally, the ecological sustainability of the electric power system has often been formulated as a third important priority.[19]

With respect to regulatory areas for smart grid development, there are 6 regulatory areas used to describe the regulatory environment of power system[20] that are policy setting and fundamental institutions (government leadership in form of policies, laws and regulation to promote smart grid development); market structure (all players involved in the various stages of the power sector supply chain); market design and RES integration (electricity prices are of crucial importance according to the utilization of different sources of power generation); development of infrastructure and network regulation (how investments in the smart grid infrastructure can be incentivized through power grid of network regulation); coordination of generation and consumption (government policies for balancing electricity generation and consumption); the role of information and communication (integration of ICT with power system component across the supply chain).

4. Australia's Experience from Conventional Power Grids towards Smart Grids

Australia's reliance on coal-fired power gives it one of the world's highest per-capita Green House Gas (GHG) emission rates. In recent years, the global Australia power industry has observed the need for a paradigm shift, both technical and methodological in nature, away from the traditional styles of energy distribution involving centralized generation and outward distribution.[21]

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[19] Gert Brunekreeft et al., eds., *Regulatory Pathways for Smart Grid Development in China* (Wiesbaden: Springer Vieweg, 2015), 11-12, accessed January 10, 2018, https://link.springer.com/book/10.1007%2F978-3-658-08463-9

[20] Gert Brunekreeft et al., eds, *Regulatory Pathways for Smart Grid Development in China*, 8-9.

[21] M.A. Ahmed Haidar, Kashem Muttaqi and Danny Sutanto. "Smart Grid and Its Future Perspectives in Australia" *Renewable and Sustainable Energy Reviews* 51, (2015): 1375-1389.

4.1 Smart Grid, Smart City: A New Direction for a New Energy Era

The principal policy document for Australia's transition to a Smart Grid is Smart Grid, Smart City: A New Direction for a New Energy Era.[22] Accordingly, the Australian roadmap for smart grids standard sought to develop logic based framework for the identification of those standards to support the commercialization of smart grids in Australia.[23] This document envisages both grid-side applications to reduce line loss and improve fault detection and restoration, and customer-side applications to assist consumers to manage their energy consumption. The consumer-side applications would include information (provide information on energy use of Green House Gas (GHG) emission), control (using in-home display, automate controls for appliances and programmable thermostats with communication) and tariff (fluctuate according the time of use, critical peak pricing and real time pricing) by using smart metering infrastructure.[24] The smart grid communications network will comprise three key elements including home area networks, wide area networks and backhaul networks.[25] It is proposed that a pilot study be distributor-led and adopted in a single distributor's network, which could include urban, suburban and rural areas and which should provide a reasonable representation of the grid, customers, geography and climate.

4.2 The Smart Meters

The roll out of smart meters is taking place under the auspices of Australia's National Framework for Energy Efficiency ('NFEE')[26] which is administered by the Ministerial Council on Energy ('MCE'). In particular, the NFEE promotes demand-side energy efficiency in the residential, commercial and industrial sectors, and also seeks to overcome the barriers and challenges to energy efficiency measures.

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[22] Department *of* the Environment, *Smart Grid Smart City: A New Direction for a New Energy Era Water, Heritage and the Arts*, (Australia: Department of the Environment, 2009), 89-101.

[23] Jason Lazar and McKenzie Mark, Australian Standards for Smart Grids – Standards Roadmap (Canberra: Australian Government, Department of Recourses, Energy and Tourism, 2012), 10-13.

[24] Department *of* the Environment, *Smart Grid Smart City: A New Direction for a New Energy Era Water, Heritage and the Arts*, 17.

[25] Ibid.

[26] Department of Resources, Energy and Tourism, "National Framework for Energy Efficiency," last modified n.d., accessed February 18, 2010, http://www.ret.gov.aulDocuments/mce/energy-eff/nfee/default.html

To further support the accelerated roll-out and trials of smart meters in participating jurisdictions, the MCE Standing Committee of Officials ('SCO') has approved for public exposure and consultation changes to the NEL. This is the first component of the national smart metering legislative framework being developed by MCE which includes cost recovery arrangements, consumer protection measures and safety standards for a national framework.[27]

4.3 Facilitating the Large-Scale New Renewable Energy Sources

Barriers to the uptake of large-scale new renewable energy sources have long been acknowledged in Australia. Some of the key enabling elements of the Smart Grid are: facilitating the installation of distributed generation plants close to the point of consumption; facilitating the uptake of large-scale new renewable energy sources; and introducing pricing and control systems to integrate distributed energy resources such as solar panels.

4.3.1 Government Funding for Renewable Energy Programs

The Australian government has given the budget to implement a range of climate change measures and to support the development and use of new clean energy technologies. It is clear that these sources of funding will increase the deployment and commercialization of energy efficiency and renewable energy technologies. This links to the Smart Grid in two significant ways. Firstly, the uptake of these technologies will be further enabled by the establishment of a Smart Grid and, secondly, the funding could also be regarded as creating an enabling environment for the establishment the Smart Grid.[28]

4.3.2 Legislation Encouraging the Uptake of Renewable Energy Sources

In 2000, the Renewable Energy (Electricity) Act 2000 (Cth) was enacted. The Act in its original form introduced a 2 per cent Renewable Portfolio Standard ('RPS') for Australia which would be achieved by 2010. The legislation is directed primarily at electricity retailers which are 'liable entities'[29] under the Act. They are required to achieve

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[27] Rosemary Lyster, "Smart Grids: Opportunities for Climate Change Mitigation and Adaptation," 173-191.

[28] Ibid.

[29] Renewable Energy (Electricity), Act 2000 (Cth) s 35.

individual renewable energy targets based on their projected market share of consumption. Renewable energy certificates are generated by accredited power stations[30] when they generate power using eligible renewable energy sources[31] that exceed the 1997 baseline.[32] Certificates can also be created by installations of solar hot water heaters.

'Feed-in' legislation is another mechanism that requires an electricity utility to let independent producers of renewable power 'feed' their electricity into the grid against a guaranteed payment of a certain fee.[33] The Act requires retailers to purchase electricity from small wind, solar, hydro and biomass energy generation facilities[34] and to publish the prices and terms and conditions of the purchase (feed-in tariffs) in the Government Gazette and on the retailers' website. The Essential Services Commission can review the prices, upon the Minister's request, if the Minister believes that the prices offered by a retailer are unfair or unreasonable.[35] The Commission issued a Guidance Paper entitled Methodology for Assessment of Fair and Reasonable Feed-In Tariffs and Terms and Conditions[36] in 2008.

4.3.3 Enduring Barriers to Distributed Generation

Despite the recognition of the barriers to distributed generation, it seems a though legislative reform in this area has installed. The report in 2002, namely *Towards a Truly National and Efficient Energy Market*,[37] recommended that a mandatory code of practice governing arrangement between distribution companies and prospective embeded generators be introduced into the National Electricity Law. The MCE notes that the Utility Regulators Forum was originally given the task of developing a consistent and

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[30] Renewable Energy (Electricity), Act 2000 (Cth) s 13.

[31] Renewable Energy (Electricity), Act 2000 (Cth) s 17.

[32] Renewable Energy (Electricity), Act 2000 (Cth) s 18.

[33] For instance, in Victoria where a new Division 5A has been inserted into Part 2 of the Electricity Industry Act 2000 (Vic) by the Energy Legislation Amendment Act 2007 (Vic).

[34] A small generating facility is one which has an installed generating capacity of less than 100kWs.

[35] Rosemary Lyster, "Smart Grids: Opportunities for Climate Change Mitigation and Adaptation," 173-191.

[36] Essential Services Commission, *Guidance Paper: Methodology for Assessment of Fair and Reasonable Feed-In Tariffs and Terms and Conditions* (Melbourne Victoria: Essential Services Commission, 2008).

[37] Ministerial Council on Energy, *Towards a Truly National and Efficient Energy Market* (Final Report) (Australian: Council of Australian Governments' Independent Review of Energy Market Directions, 2002).

comprehensive Code of Practice for distributors across the NEM. In 2006, the MCE Standing Committee of Officials released a discussion paper entitled Impediments to the Uptake of Renewable and Distributed Energy.[38]

A review conducted in relation to smart grid development in Australia provides a clear view in relation to future requirements of the power grid and the changes being undertaken by the energy sector in Thailand. With respect to the Australian context, smart grid systems are discussed and along with successful deployment strategies for the priming of smart meter in Australia. At the distribution level, interconnection of distributed generation and active distribution management through smart meters provides real-time information for home electricity consumption and estimated costs.[39] Smart city projects are holistic efforts to testing and upgrading integrated systems of smart infrastructure. It is important to recognize that smart electricity networks where utilities and services converge to a common information and communication technologies will set the foundation for smarter communities, smarter cities and a smarter country.

5. A Smart Grid Development in Thailand

From time to time, Thailand faces the challenges of the continuous growth in energy demand. In 2015, the primary energy consumption was at 2,595 thousand barrels of oil equivalent per day, increased by 1.8 percent from the year before. Natural gas accounted for 35 percent of the most commonly used, followed by oil, gasoline, coal / lignite and hydroelectric power/electricity imports, respectively.[40] Energy security has long been a top priority for Thailand. More than half of its energy supply relies on imported energy aproportion that is likely to increase further while depleting domestic reserves of energy resource. This has not only challenged security of supply, but has also had significant

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[38] Ministerial Council on Energy Standing Committee of Officials, *Renewable and Distributed Generation Working Group*, *Impediments to the Uptake of Renewable and Distributed Energy: Discussion Paper* (Australia: Ministerial Council on Energy Standing Committee of Officials, 2006).

[39] Ahmed M. A. Haidar, Kashem Muttaqi and Danny Sutanto, "Smart Grid and Its Future Perspectives in Australia," *Renewable and Sustainable Energy Reviews* 51, (2015): 1375-1389.

[40] Energy Policy and Planning Office (EPPO), "Energy Situation in Year 2015 and Trend in Year 2016," last modified March 31, 2016, accessed January 10, 2018, http://www.eppo.go.th/index.php/en/energy-information-services/energy-situation/energy-situation-in-year-2015-and-trend-in-year-2016

implications for overall energy expenditure. Additionally, the Government of Thailand has made the commitment in the Nationally Determined Contributions (NDC) to reduce greenhouse gas emissions by 20-25% from the business-as-usual scenario by 2030 under the Paris Agreement in November 2016.[41] This drives Thailand to require concerted action for decarbonization of the energy sector.

In case of electricity supply, the electricity generated by natural gas and hard coal and lignite accounted for nearly 90% while renewable electricity contributed only 10%.[42] The electricity supply industry (ESI) in Thailand is challenged by high demand of electrical energy, new requirements from consumers, increase of primary fuel, negative environment impact. In order to manage these problems, smart grid technology will play an important role in mitigating the three major concerns ensuring that country's development is socially, economically and environmentally sustainable.[43]

5.1 Policy and Legal Framework for Smart Grid Development

5.1.1 Energy Policy and Plan

Thailand has explicitly set energy security as the top policy objective, followed by economic affordability and environmental sustainability in the Thailand Integrated Energy Blueprint (TIEB) underpinned by 5 individual but interrelated energy plans including natural gas, oil, energy efficiency, the power sector and alternative energy sources, respectively.[44] Thailand has set a new renewable energy target of 30% of total final energy consumption by 2036 under the Alternative Energy Development Plan (AEDP) 2015.[45]

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[41] United Nation Framework Convention on Climate Change, "Thailand's Intended Nationally Determined Contribution (INDC), letter, Offices of Natural Resources and Environment Policy and Planning, Bangkok, 2015," last modified n.d., accessed December 2017, htttp://www4.unfccc.int/submissions/INDC/Published%20Documents/Thailand/1/Thailand_INDC.pdf

[42] Energy Policy and Planning Office (EPPO), "Energy Economic Statistics," last modified n.d., accessed January 10, 2018, http://www.eppo.go.th/index.php/en/en-energystatistics/energy-economy-static?orders[publishUp]=publishUp&issearch=1

[43] Jeannie Oliver and Benjamin Sovacool, "The Energy Trilemma and the Smart Grid: Implication Beyond the United States," 70-84.

[44] International Renewable Energy Agency, *Renewable Energy Outlook: Thailand* (Abu Dhabi: International Renewable Energy Agency, 2017), 7-17.

[45] Department of Alternative Energy Development and Efficiency, "Alternative Energy Development Plan: AEDP 2015," last modified 2015, accessed November 15, 2017, www.dede.go.th/download/files/AEDP2015_Final_version.pdf

In order to develop smart grid in Thailand, the Energy Policy and Planning (Eppo) has established the Thailand Smart Grid Master Plan 2015-2036[46] to set the general framework for smart grid development in Thailand for all stakeholders especially government organizations. The vision of this master plan is to promote sufficiency in energy supply, efficiency, sustainable, good quality and service in power sector for optimal benefits of the country.

The Thailand Master Plan for Smart Grid Development sets out five main strategies that are: Power Reliability and Quality, Energy Sustainability and Efficiency, Utility Operation and Service, Integration and Interoperability and Economic and Industrial Competitiveness.[47] This is to upgrade the capacities of electricity system to create a smart system and smart life for consumer and green society. Nevertheless, the responsibility for smart grid development does not remain entirely with the utilities. It is rather on the entire influential stakeholders which involved in various elements to ensure efficient smart grid development.

5.1.2 Key Energy Legislation

There are three important pieces of energy legislation that were related to smart grid development in Thailand namely,

1) National Energy Policy Council Act, B.E. 2535 (1992) amended by the National Energy Policy Council Act(no.2), B.E. 2550 (2007) and National Energy Policy Council Act(no.3), B.E. 2551 (2008)

This Act determined the mandates, powers, duties and operational mechanism and institutional structure of, and under, the National Energy Policy Council (the highest governmental entity to oversee the energy sector management reporting to the Cabinet in Thailand). The National Energy Policy Council (NEPC) is responsible for the making of Thailand's energy policies and plans. The NEPC is also responsible for managing the energy sector in Thailand, including granting energy operating licenses and issuing energy pricing regulations.[48]

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[46] Energy Policy and Planning Office (EPPO), *Thailand Smart Grid Master Plan 2015-2036*. (Bangkok: Ministry of Energy, 2015), 3.

[47] Ibid, 14-15.

[48] Chacrit Sitdhiwej, "Renewable Energy Law and Policy in Thailand," *Renewable Energy Law and Policy Review* 7, no. 2 (2016): 184-189.

2) Energy Conservation Promotion Act, B.E. 2535 (1992) amended by the Energy Conservation Promotion Act (no.2), B.E. 2550 (2007) -ENCON Act

This Act focused on key energy end-use sectors, including industrial and buildings sectors, with respect to energy conservation and efficiency improvement. This Act referred to as a guidance for policy, strategy and program development as far as energy conservation is concerned, with the aim of promoting application of high-efficiency measures in end-use sector.

The Energy Conservation Promotion Fund (ENCON Fund) is the main driver for providing financial support (besides tariff mechanisms) for energy efficiency and renewable energy programs in Thailand. The ENCON Fund was established under the Energy Conservation Promotion Act 1992[49] and has typically had annual inflows of around USD50 million (THB 2,000 million), from a levy on petroleum products.[50]

Under the ENCON Act, there are three types of programs: compulsory, voluntary, and complementary. The Department of Alternative Energy Development and Efficiency (DEDE) oversees the compulsory program, which requires that large ('designed') factories and buildings conduct energy audits and submit energy conservation targets, plans, and reports every three years.

3) Energy Industry Act, B.E. 2550 (2007)

This Act consolidated the laws relating to the electricity supply industry and natural gas transmission network with the goal of promoting competition and private participation and providing fair and transparent electricity and gas network access in the energy sector.[51] The principal rationale to enact this Act was to identify and separate the tasks to be performed as appropriate by the policy makers, the regulators and the operators. The establishment of the Energy Regulatory Commission (ERC) as a regulator was one of its cornerstones. The authority and duties of the Regulator cover most of regulatory tasks. These include supply-side regulatory tasks such as licensing, developing load forecast, maintaining energy security and reliability, monitoring energy business operation, issuing

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[49] The Energy Conservation Promotion, Act 1992 (Thailand)

[50] Dennis Unkovic, *On the horizon – Renewable energy in Asia: Thailand* (Minnesota: Meritas, 2011), 167.

[51] The Energy Industry, Act 2007 (Thailand) s 7.

regulations on energy industry operation and equipment standards and quality, and promoting the use of renewable energy.[52]

5.2 Regulatory Framework for Smart Grid Development

5.2.1 Key Institutions and their interaction

The institutional framework that guides energy policy in Thailand is developed by the National Policy Council (NEPC) with the Energy Policy and Planning (EPPO) acting as the secretariat. The recommended and evaluated national energy policies implemented by the Ministry of Energy (MOE) and its responsible departments, namely the Department of Alternative Energy Development and Efficiency (DEDE) who is responsible for the promotion of renewable energies and energy efficiency, regulating energy conservation, developing integrated alternative energies and disseminating energy technology systematically. The Energy Regulatory Commission (ERC) has responsibility for ensuring that the policies are enacted and followed as intended.[53]

The electricity supply industry (ESI) of Thailand consists of three state enterprises. The Electricity Generating Authority of Thailand (EGAT) is responsible for generation and transmission. The Metropolitan Electricity Authority (MEA) is responsible for electric distribution and services in Bangkok, Nonthaburi and Sumuthprakarn. The Provincial Electricity Authority (PEA) is responsible for electric distribution and services in remaining provinces.

EGAT acts as the monopolistic single agent in generating and transmitting electricity to PEA and MEA under “Enhance Single Buyer” Market structure. The MEA and PEA is in charge of power distribution to provinces. Independent Power Producers (IPPs)[54] and Small Power Producers (SPPs)[55] are required to sell electricity via power purchase agreement to the high-voltage transmission system owned by the only buyer (EGAT) which subsequently sells the power to the distribution companies. Very Small Power

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[52] The Energy Industry, Act 2007 (Thailand) s 11.

[53] International Energy Agency, *Thailand Electricity Security Assessment 2016* (Bangkok: International Energy Agency, 2016), 25.

[54] IPPs are private producers who have installed capacity more than 90 Megawatt (MW)

[55] SPPs are private producers who have installed capacity from 10 to 90 MW.

Producers (VSPPs)[56] must sell power through the two state-owned distribution systems, the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).[57]

EGAT, MEA and PEA as the power grid operators that are the key drivers for smart grid development. Although three major electric utilities are forming their own platform to work on how to transform their existing infrastructure and working process to meet smart grid criteria and setting their organizational roadmap to meet their internal goal, there still is a need to find way to lift up this issue at the national level. Additionally, ERC is another main driver in relation to set the regulatory framework which provides the efficiency in smart grid development.

With respect to the stakeholder roles in smart grid development, Thailand Smart Grid Master Plan was established by EPPO under MOE is a policy plan to set the directions for overall policy and development. ERC has the roles for setting regulatory framework to be action plan for the regulated organization and implementation guidelines and standardization. Smart Grid development in each utility was adjusted in line with the national master plan and regulatory framework. At the same time, academics and non-governmental organizations (NGOs) have the roles in research and development collaboration, stakeholders' awareness and consumers are getting involved in active demand response.

5.2.2 Regulatory Instruments Facilitating the Uptake Renewable Energy Sources (RES)

To promote and integrate RES in power system, the regulatory instrument in its original form is the tariff structure comprised a premium paid on top of prevailing wholesale electricity rates, and hence the program was called the "Adder" program from 2007 to 2013. The program is called 'Adder (Feed-in Premium)' because it adds additional payments to renewable energy generators on top of the normal prices that power producers would receive when selling electricity to the power utilities.[58]

Currently, the program has a "fixed feed in tariff" structure. On 22nd October 2014, the NEPC acknowledged the principle of employing a new feed-in tariff (FIT) developed by

[56] VSPPs are private producers who have installed capacity less than 10 MW.

[57] International Energy Agency, *Thailand Electricity Security Assessment 2016*, 25.

[58] Sopitsuda Tongsopit and Chis Greacen, "An Assessment of Thailand's Feed-in Program," *Renewable Energy* 60, (2013): 439-445.

the Ministry of Energy, which would replace the former Adder program that had been in place for several years.[59] The full policy for the FIT for Very Small Power Producer (VSPP) of less than 10 Megawatt (MW) installed capacity was approved by NEPC on 15th December 2014. The FIT rates differ greatly depending on power plant sizes and fuel types and different bonuses are being granted for certain systems.[60] The quota, or target, for certain areas is being determined by the Ministry of Energy in cooperation with EGAT/PEA and MEA. This should allow the EGAT to improve transmission systems and to be able to support the increase of electricity from renewable energy sources in the future as well as opening calls for more projects.[61]

The supplementary regulatory instruments in Thailand include financial and fiscal support from the ECON Fund, investment incentives from the Investment Promotion Act, and the Carbon Credit Facility.

6. The Way Forward for Smart Grid Development in Thailand

This article suggests that although a preliminary framework for the establishment of a smart grid has already been established in Thailand through the Master Plan for Smart Grid Development 2015-2036, legislative framework for energy systems, Feed-in Tariff, other incentives, a regulation to roll-out smart grids, more work need to be done. Regulatory Pathway for smart grid development needs the participation of all players in electricity system. The clearer directives from the government must be given to stakeholders to strengthen the smart grid development in Thailand. This must be supported by careful studies, statistics and recommendations by relevant experts from academic institutions, utility companies and the private sector. Additionally, an effective Public Private Partnership (PPP) is encourage private sector to participate in the policy and regulatory discussions, involving the financial institutions. Furthermore, the general public must

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[59] Federal Ministry of Economic Affairs and Energy, *Thailand Renewable Energy Policy Update 01/2017* (Germany: Federal Ministry of Economic Affairs and Energy, 2017), 3.

[60] Federal Ministry of Economic Affairs and Energy, *Thailand Renewable Energy Policy Update: New Power Development Plan announced in May (Status May 2015)* (Germany: Federal Ministry of Economic Affairs and Energy, 2015), 3.

[61] Federal Ministry of Economic Affairs and Energy, *Thailand Renewable Energy Policy Update: New Power Development Plan announced in May (Status May 2015),* 3.

be given information and knowledge of smart grid system and its contribution on the electricity system.

Government needs to do the core responsible to set up regulation in four main dimensions: information gain; consumer response and demand management; regulating new networks and investment incentives; integration of intermittent renewable energy sources in electricity systems.

6.1 Information gain

Information is necessary for energy players, and for decision-makers and regulators who must establish rules and mechanisms to provide a framework for a competitive market and allow smart grids to achieve optimal efficiency. The main forms of information which energy players should obtain are instantaneous consumption, an unbiased price signal—reflecting the status of the system or market, and competitive and regulatory guidelines, in particular for access to metering data. Regulators and policy makers will above all need information on the business model, in order to redistribute revenue and design competitive and regulatory policies, and on costs related to the activity and the distribution of such costs along the value chain.

6.2 Consumer response and demand management

Demand-side management (DSM) can shift or reduce peak periods, or save electricity consumption. Smart grids and the data transmitted to consumers gain effectiveness if they are combined with dynamic tariffing. To make such system more effective, segmentation of the various loads needs to be refined. An authority is needed to complete these experiments and help consumers take the plunge. Regulatory bodies will play an essential role encouraging a long-term change in behavior. Remote control of smart devices by transmission and distribution network operators, and energy suppliers seems to be the preferred solution, in order to prevent system from being too complicated for end-users.

The need for regulatory incentives was first highlighted by the difficulty calculating precisely the costs avoided by demand-side management and by utilities' quest for short-term gains, which often reduced the impact of these measures on collective welfare.[62]

[62] Pollitt, M.G., "The Future of Electricity (and Gas) Regulation in a Low-Carbon Policy World," 63–94.

6.3 Regulating new networks and investment incentives

Regulation for new networks will be needed to launch investments. Regulation and pricing must offer a sufficient incentive to trigger viable investment, stipulating the gains involved for each player in order to distribute regulation-induced revenue.[63] Recent policies supporting the development of renewable energy sources have resulted in a substantial increase in the number of decentralized generators.[64] Incentive regulation will be needed to enable investments, free-rider strategies potentially leading to waiting games if distribution system operators alone are required to invest, shouldering the full cost of investment but having to pass on information to other players. Regulation cutting both ways is needed, on the one hand to carry out investments and manage data, and on the other hand to provide the various players with information from smart grids. Regulators may choose to integrate new investments in existing regulatory measures—the mechanism which sets the network access tariff, or to take account of the fact that such investments are subject to an additional risk, known as stranded costs.[65]

6.4 Integration of intermittent renewable energy sources in electricity systems

The drive to feed increasing amounts of renewable energy into the grid, assisted by new technologies, has already substantially altered the electricity market. Renewable energy sources are intermittent and the power they generate may be fed into the system via a large number of nodes. The development of storage infrastructures and plug-in electric vehicles will boost the flow of electricity in networks, with a corresponding increase in system complexity. Data gathered by smart-grid technology will be valuable in arbitrating between such flows.[66]

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[63] Fox-Penner, P., *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities* (Washington, DC: Island, 2010), 50-60.

[64] Ibid.

[65] Cédric Clastre, "Smart Grids: Another Step towards Competition, Energy Security and Climate Change Objectives," 5399-5408.

[66] Ibid.

7. Conclusion and Recommendation

The development of smart-grid technology has raised high hopes of reconciling targets for climate-change (cutting greenhouse gas emissions), energy (managing consumption, energy efficiency), competition, and safety of systems and technology (to integrate renewable energy sources, storage and plug-in electric vehicles in electricity systems). To develop smart grid in power system in Thailand by choosing a suitable form of regulation is one of the key steps towards successful development of smart grid in particular due to uncertainty regarding the gains achieved by this technology and even greater uncertainty as to consumer behavior; and doubts as to how such gains should be shared out between players. The existing policy and regulatory framework in Thailand provides legal and regulatory basis to development the smart grid. Experiences from Australia provide lessons learnt on how to design policy and regulatory framework for smart grid development in Thailand. The regulatory pathway to develop smart grid system is the vital role of government to set up regulation in four main dimensions: information gain; consumer response and demand management; regulating new networks and investment incentives; integration of intermittent renewable energy sources in electricity systems.

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