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การกำกับการใช้พลังงานนิวเคลียร์เพื่อผลิตไฟฟ้า กรณีโครงการโรงไฟฟ้าพลังงานนิวเคลียร์ในประเทศไทย*

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บทคัดย่อ

การใช้พลังงานนิวเคลียร์เพื่อผลิตไฟฟ้าเป็นทางเลือกหนึ่งที่ถูกบรรจุลงในแผนพัฒนาพลังงานไฟฟ้าของประเทศไทยเนื่องจากเป็นทางเลือกที่มีศักยภาพสามารถลดการพึ่งพาก๊าซธรรมชาติในการผลิตไฟฟ้า ซึ่งปัจจุบันมีการพึ่งพาก๊าซธรรมชาติถึงร้อยละ 70 ของกำลังการผลิตไฟฟ้ารวมของประเทศ และสามารถช่วยลดการปล่อยก๊าซเรือนกระจกจากการผลิตไฟฟ้า การเตรียมการเพื่อรองรับโครงการโรงไฟฟ้าพลังงานนิวเคลียร์ที่ท้าทายนี้ได้ดำเนินโดยยึดถือหลักการและแนวทางที่เป็นที่ยอมรับในระดับสากลอีกทั้งยังได้รับคำแนะนำในการเตรียมการจากคณะผู้เชี่ยวชาญจากทบวงการพลังงานปรมาณูระหว่างประเทศ (IAEA: International Atomic Energy Agency) โดยคณะผู้เชี่ยวชาญดังกล่าวได้แนะนำให้จัดตั้งหน่วยงานอิสระเพื่อปฏิบัติหน้าที่กำกับการใช้พลังงานนิวเคลียร์เพื่อผลิตไฟฟ้าตามแบบอย่างสากลซึ่งหน่วยงานกำกับดังกล่าวควรมีความเป็นอิสระและมีความเข้มแข็งทั้งด้านความคิดและการทำงาน ปัจจุบันหน่วยงานในประเทศไทยที่เกี่ยวข้องกับการกำกับดูแลการใช้พลังงานนิวเคลียร์ประกอบด้วย คณะกรรมการพลังงานนิวเคลียร์ (Thai Atomic Energy Commission: AEC) และ สำนักงานปรมาณูเพื่อสันติ (The Office of Atoms for Peace: OAP) และคณะกรรมการกำกับกิจการพลังงาน (Energy Regulatory Commission: ERC) โดยคณะกรรมการพลังงานนิวเคลียร์ และสำนักงานปรมาณูเพื่อสันติมีบทบาทร่วมกันในการกำกับดูแลความปลอดภัยในการใช้พลังงานนิวเคลียร์ ขณะที่คณะกรรมการกำกับกิจการพลังงานซึ่งถูกตั้งขึ้นตามพระราชบัญญัติการประกอบกิจการพลังงาน พ.ศ.2550 มีอำนาจหน้าที่ในการกำกับดูแลการประกอบกิจการไฟฟ้า ในการศึกษานี้การกำกับดูแลของหน่วยงานทั้งสองได้ถูกศึกษา ทบทวนและวิเคราะห์ พร้อมกันนี้ได้นำเสนอแนวทางในการพัฒนาการจัดการด้านการกำกับดูแลการใช้พลังงานนิวเคลียร์เพื่อผลิตไฟฟ้าให้เป็นไปอย่างมีความเหมาะสมและปลอดภัยยิ่งขึ้น

คำสำคัญ: นโยบายพลังงาน, การกำกับการใช้พลังงานนิวเคลียร์เพื่อผลิตไฟฟ้า, การจัดการโครงการโรงไฟฟ้าพลังงานนิวเคลียร์

*บทความนี้เป็นส่วนหนึ่งของวิทยานิพนธ์ ระดับปริญญาเอก

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Nuclear Power Regulation:Nuclear power plant project in Thailand*

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Abstract

Nuclear power generation option was integrated into the national power development plan for its potential of minimizing the over-dependency on natural gas and reducing greenhouse gas emission. Several preparation activities are being carefully progressed to handle this challenging project. As international practices and International Atomic Energy Agency (IAEA) specialist's suggestions, one most important requirement for the nuclear power plant project is to establish strong and independent nuclear power regulatory body. Currently, Thai Atomic Energy Commission (AEC) and the Office of Atoms for Peace (OAP), and Energy Regulatory Commission (ERC) play an important role as nuclear power regulatory bodies. AEC and OAP regulate on nuclear safety, while the ERC is responsible for electricity industry regulation. In this study, both regulatory bodies are reviewed and analyzed, and suitable approaches to regulatory management are suggested.

Keywords: Energy Policy, Nuclear power regulatory, Nuclear Power Project management

Introduction

History of Nuclear Power Plant (NPP) Project in Thailand

The nuclear power plant (NPP) project in Thailand (Apisit 2010 and Somporn 2008) had been first proposed in 1966 by Electricity Generating Authority of Thailand (EGAT). One year later, Royal Thai Government appointed the nuclear sub-committee to conduct feasibility study and site selection. After the study and site selection process, Royal Thai Government approved AoPhai in Chonburi Province as NPP site and selected a 600 MWe Boiler Water Reactor (BWR) as nuclear reactor type for the NPP project. Moreover, nuclear fuel for the NPP project had been reserved with Energy Research and Development Administration (ERDA), USA. After that, international bidding was initiated. However, the NPP project had been postponed indefinitely in 1978 because of the discovery of natural gas in the gulf of Thailand and the project resistance from the public sector.

After the NPP project was definitely delayed, natural gas especially from the gulf of Thailand has been significantly used for the national power generation. Furthermore, during 1982 to 1991, EGAT, again, carried out site survey and selection study. Parliament Energy Commission subsequently studied nuclear power generation during 1993 to 1994, while EGAT and NEWJEC Inc., Japan co-performed initial environmental examination and site evaluation study during 1992 to 1995. In addition, Cabinet appointed a committee to conduct study on economic and infrastructure for NPP project in 1996.

* This paper is a part of Ph.D. Dissertation

Oil crisis

Since 2004, the oil price has significantly risen over 137 U.S. Dollars per Barrel as can be seen in Figure 1. After the hamburger crisis, the oil price was around 80 U.S. Dollars per Barrel. The hiking up of oil price directly drove the world energy cost to increase substantially. Not only the high energy cost but also environmental concerns have forced countries around the world to develop suitable and sustainable energy policies, strategies, plans, and management schemes for coping with the energy crisis while sustaining the national economic growth. Royal Thai government is also concerned with these global issues and has developed the national green Power Development Plan (PDP) to address the upcoming national energy needs.

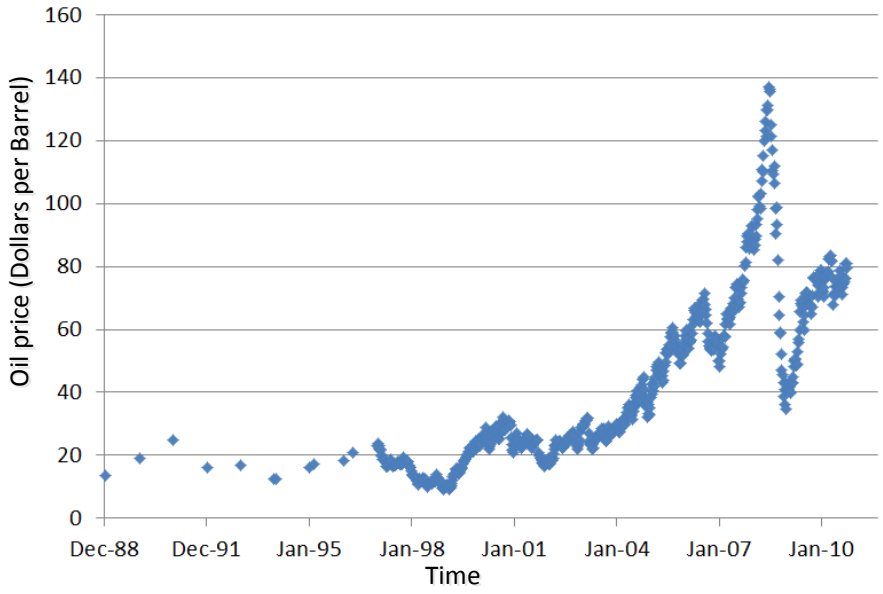

Figure 1. All countries spot price free on board (FOB) weighted by estimated export volume (DOE, 2010)

Power Development Plan

On 19 June 2007, the Thai Cabinet acknowledged and approved Thailand's Power Development Plan 2007-2021 (PDP 2007) (EGAT 2007) which covers a power source development plan up to 2021. Major challenge targets in PDP 2007 were not only to encourage green energy market but to overcome the risk due to over-dependency on natural gas since the main source of supply shouldered the growing electricity demand in natural gas that gg accounts for around 70% of the current power generation output by diversifying the fuel types. Figure 2 shows the shares of electricity production by fuel type (EPPO 2010a). In order to decrease the portion of natural gas-fired power plant, the promising candidate for such diversified sources is coal. However, the introduction of coal power can directly cause environmental issues such as CO_2, NO_x and SO_x emissions. PDP 2007 predicts that the introduction of coal-fired thermal power generation will not move forward until

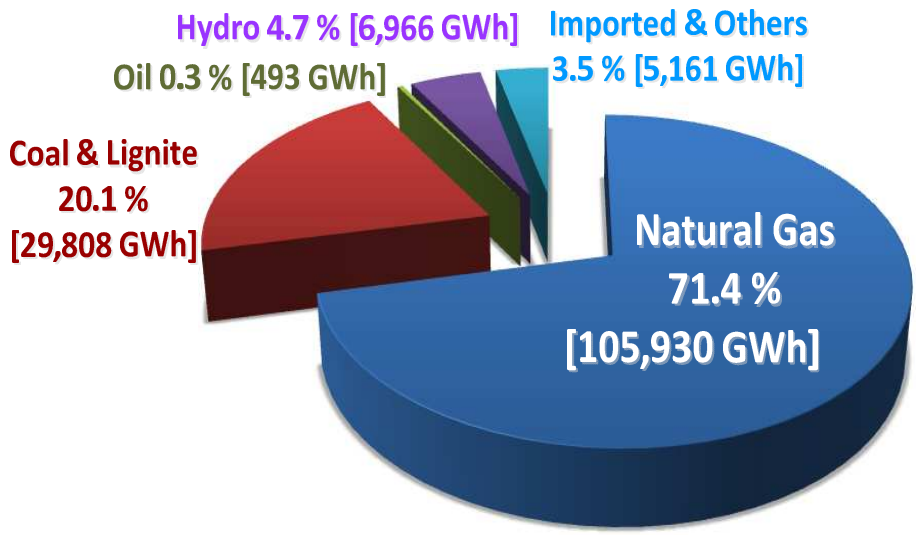

Figure 2. Shares of power generation by fuel type in 2009

2021, and despite the decreasing natural gas production, its share will remain as high as ever. For national security, it is not desirable to further increase dependency upon natural gas from a viewpoint of securing a stable power supply together with the mitigation of carbon emission increases. Therefore, with the continued rise of the price of natural gas for the future, it seems there are good grounds to designate nuclear power generation option to produce 2,000 MW each in 2020 and 2021, 4,000 MW in total. This is the first time that the nuclear power generation option is integrated into the national PDP. According to this plan, it is projected that the share of natural gas will then be lower than 60 % by 2021.

In 2009, PDP 2007 was revised because of the global economic recession and called Thailand's Power Development Plan 2008-2021 revision 2 (PDP 2007 rev. 2) (EGAT 2009). PDP 2007 rev. 2, which was approved by the Thai Cabinet on 24 March 2009, also provided a power generation forecast by fuel type up to 2021 as illustrated in Figure 3. The nuclear power generation option in PDP 2007 rev. 2 was reduced to a half of the first revision.

More recently, a new version of Thailand's Power Development Plan, Power Development Plan 2010 (PDP 2010) or green PDP (EPPO 2010b), which was approved by the Thai Cabinet on 23 March 2010, has been introduced. PDP 2010 was based on three major assumptions; energy securities, sustainable energy and energy efficiency policies, and load forecast. This latest PDP has also integrated nuclear power option in the future plan up to 5,000 MW by 2030. Figure 4 provides the power generation forecast by fuel type up to 2030 based on PDP 2010.

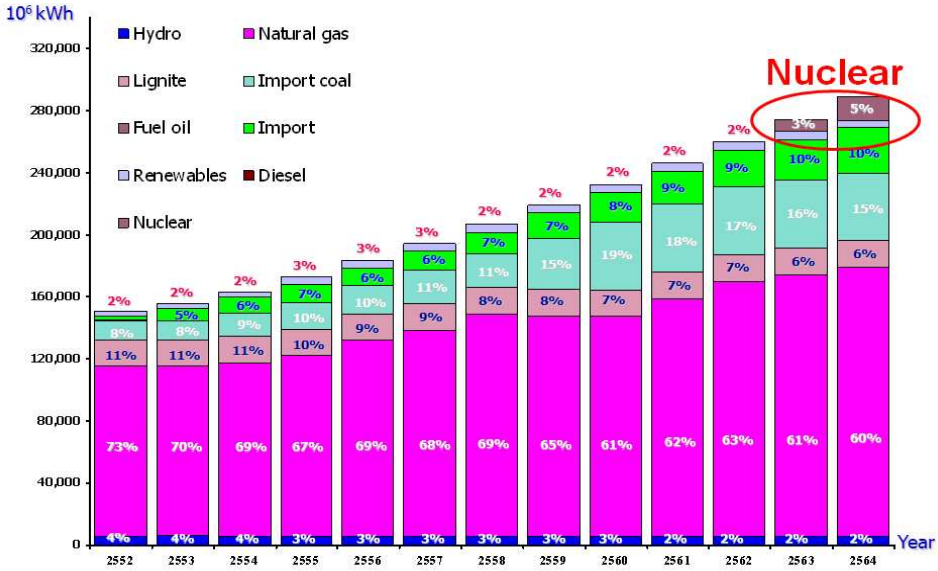

Figure 3. Power generation forecast by fuel type up to 2021 based on the PDP 2007 rev. 2

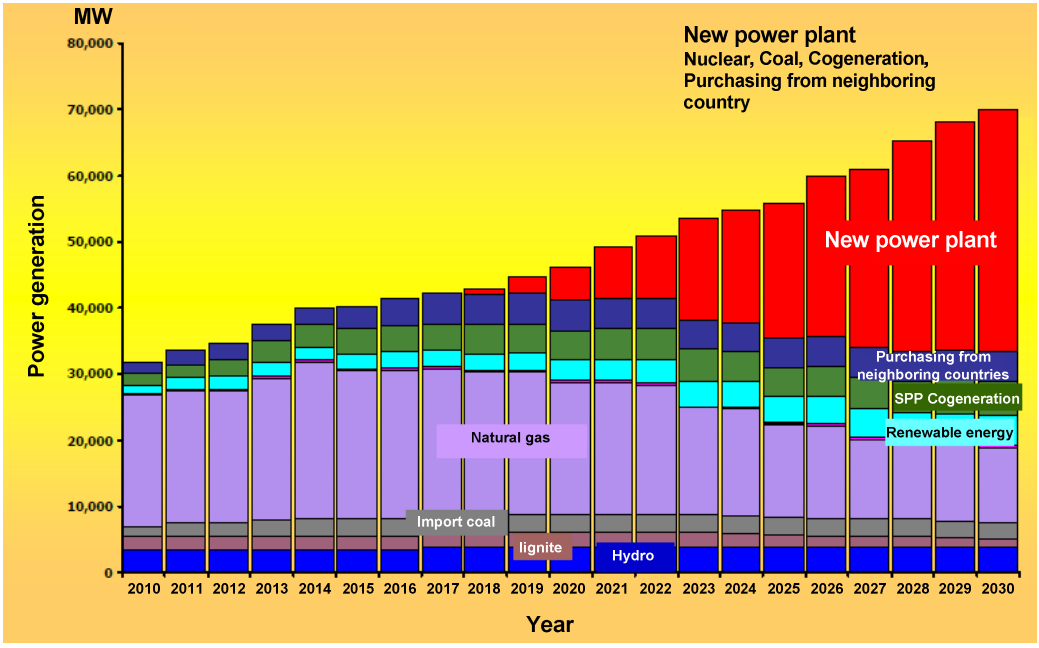

Figure 4. Power generation forecast by fuel type up to 2030 based on PDP 2010

To launch the preparatory work for the first nuclear power plant project in Thailand, NEPC appointed Nuclear Power Infrastructure Preparation Committee

(NPIPC) which is responsible for developing the preliminary Nuclear Power Infrastructure Establishment Plan (NPIEP) in April 2007. On 30 October 2007, the Thai Cabinet (Apisit 2008 and Kopr 2008) approved NPIEP and the establishment of Nuclear Power Program Development Office (NPPDO), which was launched officially in January 2008, under the Ministry of Energy to coordinate the NPIEP implementation, and the work plan for NPPDO during 2008-2010 (3 years). On 18 December 2007, the Cabinet further approved the Final NPIEP and the appointment of Nuclear Power Infrastructure Establishment Coordination Committee (NPIECC)

NPIEPwas composed of five phases;Phase 0.1 Preliminary phase, Phase 1 Pre-project activity phase, Phase 2 Program implementation phase, Phase 3 Construction phase, and Phase 4 Operation phase. Figure 5 shows NPIEP Milestones for Nuclear Power Program Implementation (EPPO 2010b).

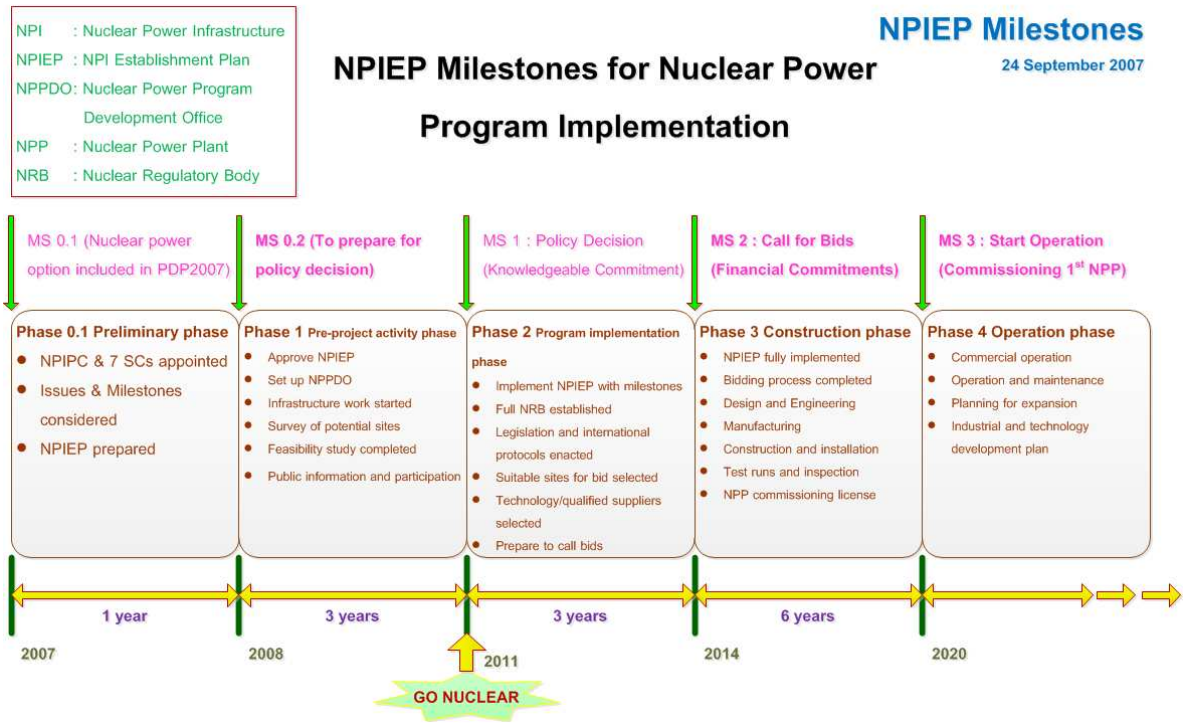

Figure 5. NPIEP Milestones for Nuclear Power Program Implementation (EPPO 2009)

Following Phase 0.1 Preliminary phase when the NPIEP was developed, nuclear power infrastructure preparation work such as Legislation and Organizational Structure Framework development, National Infrastructure Survey, Feasibility Study, Potential Sites Survey, Manpower Survey, Power System Planning etc. was started in Phase 1 for supporting policy decision “GO NUCLEAR” (Nuclear power project go ahead). All the preparatory works in Phase 1 followed the 3S concept; Safety, Security, and Safeguard (non-proliferation). If the decision is given to “GO

NUCLEAR", National Regulatory Body (NRB) will be fully established and the construction site, qualified technology, and bidding process will be chosen during Phase 2. The construction in Phase 3, planned for 2014 onwards, is preferred to utilize local content as much as possible. When the commissioning process is complete, Scheduled Commercial Operation Date (SCOD), Phase 4, will be in 2020 for the first 1000-MW class of the NPP.

In order to realize the NPP project in Thailand, International Atomic Energy Agency (IAEA)(EPPO 2009) suggested that the basic fundamental infrastructure for the first NPP project in Thailand would require national laws on nuclear power, NRB, physical facilities, knowledge base and human resources, and guidance and standards related with infrastructure issues. Regarding the NRB issue in particular, IAEA recommended the establishment of the independent nuclear safety organization to proceed systematically, the nuclear law focusing on NRB issues will need to be carefully reviewed, licensing schemes for nuclear power will need to be issued, as well as nuclear waste management and nuclear decommissioning licenses, as soon as possible, and membership of related nuclear treaties and agreements will need to be arranged. Furthermore, Firdausy (2010) recommended that legal and regulatory framework development is required for nuclear power development in Asia. In addition, Philbe (2009) suggested that one of the keys for the success of a NPP project is a strong safety authority for safety control. To ensure the standards of international practice are reached, Thailand needs a strong and independent regulatory body for the first NPP project in Thailand.

Nuclear Power Regulatory Body (NPRB)

International atomic energy agency

International atomic energy agency (IAEA) (IAEA 2007a and 2007b) suggests that a national nuclear power program necessarily requires an independent and competent nuclear power regulatory body (NPRB) for the long term success in the nuclear power program. NPRB, which is typically designated by the government, is responsible for implementing nuclear regulations and following the national policies and the strategies set forth in its regulations or in national standards. The anticipated NPRB should be completely separated from the promotional and implementing organizations, and the political process to ensure safety and credibility. Furthermore, NPRB also needs to develop competent staff and physical resources such as technical training, knowledge and capability building for the regulators for competent interaction with the owner/operator, supplier organizations, licensee and consultants. The major responsibilities of NPRB are the development of regulations, for licensing, review and assessment, inspection, enforcement and public information from the beginning to the end of the NPP project. In addition, IAEA specialists (EPPO 2009) have already recommended to NPPDO the steps to develop NPRB for the preparation of the first NPP in Thailand systemically.

NPRB in Thailand

In order to regulate the first NPP in Thailand, NPRB should develop and regulate the NPP project by using tools such as licensing, license conditions, safety standard, code of practice, etc. Nuclear safety and power industry regulation, which are main consideration issues for the NPP project in Thailand, are regulated by Thai Atomic Energy Commission (AEC) and Office of Atoms for Peace (OAP), and Energy Regulatory Commission (ERC), respectively.

1. Nuclear Safety Regulatory Body (NSRB)

Currently, Thai Atomic Energy Commission (AEC) and Office of Atoms for Peace (OAP), which are under Ministry of Science and Technology (MOST), Royal Thai Government, are collaborating to regulate nuclear industry including nuclear safety for NPP project, through the so-called Nuclear Safety Regulatory Body (NSRB). The organization structure of the current NSRB is illustrated in Figure 6.

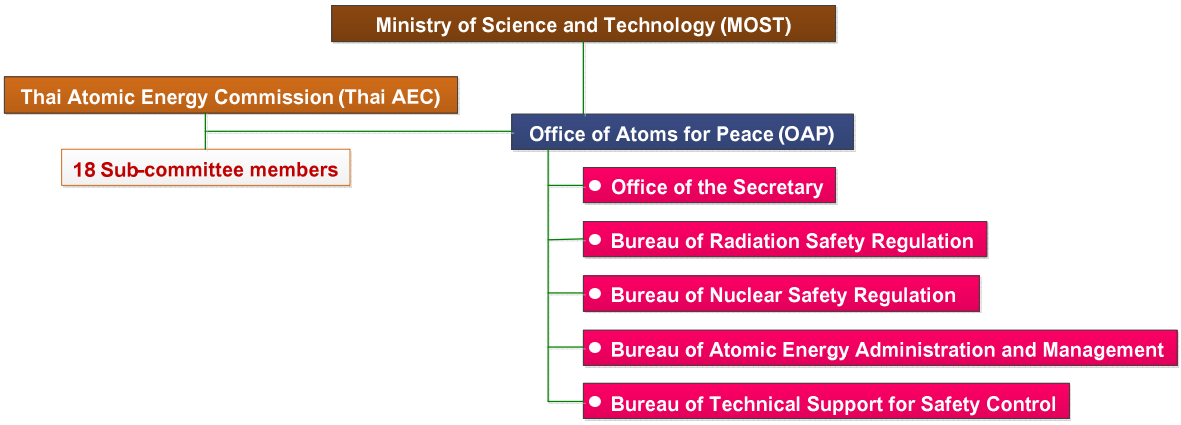

Figure 6. Organization structure of the existing Nuclear Safety Regulatory Body (Office of Atoms for Peace) (Somporn 2008)

Thai AEC Sub-Committees (Thai AEC)(Somporn 2008) are responsible for the regulation on licensing for nuclear materials, licensing for x-ray machines, reactor safety, radiation safety officers, emergency preparedness, nuclear applications in medicine, nuclear applications in agriculture, nuclear applications in industry, nuclear applications in food and nutrition, and nuclear energy policy and planning.

OAP, which was formed on 25 April 1961 under the Atomic Energy for Peace Act of 1961(SOC 1961), officially plays an important role on ensuring safety of users and public from radiation and nuclear utilizations by educating the public, and regulating the use of nuclear energy. OAP's functions and duties are to be the secretariat of Thai AEC, to regulate safety utilizations of radiation and nuclear materials, to coordinate the formulation of national policy and strategic plans on peaceful utilization of atomic energy, to coordinate and support national security

relevant to atomic energy issues, to coordinate and carry out commitments and obligations with international organizations and with foreign institutes, and to coordinate and carry out technical co-operation with organizations in Thailand and abroad. The major goal of OAP is to regulate peaceful uses of nuclear energy in Thailand and keep up with international practices and standards for sustainable development.

NSRB's roles in the NPP project

NSRB's roles in the NPP project involve several areas such as nuclear safety standard determination, licensing for nuclear materials and nuclear power reactor, organizing signings of national and international agreements and/or treaties,nuclear safety regulatory and law developments etc.

OAP, who play role as the NSRB, has already adopted several IAEA safety standards for instances basic safety standards (BSS) for nuclear applications etc. as OAP safety regulations. However, the current regulation is designed for industrial and medical business as can be seen in figure 7. During the preparation phase of the NPP project, OAP should adapt IAEA safety standards for NPPs (IAEA 2011) because they cover the safety standards from planning phase to decommissioning phase. In order to improve the nuclear law enforcement, the penalty section of the act, which has been enforced since 1961, should be amended to provide stronger penalties.

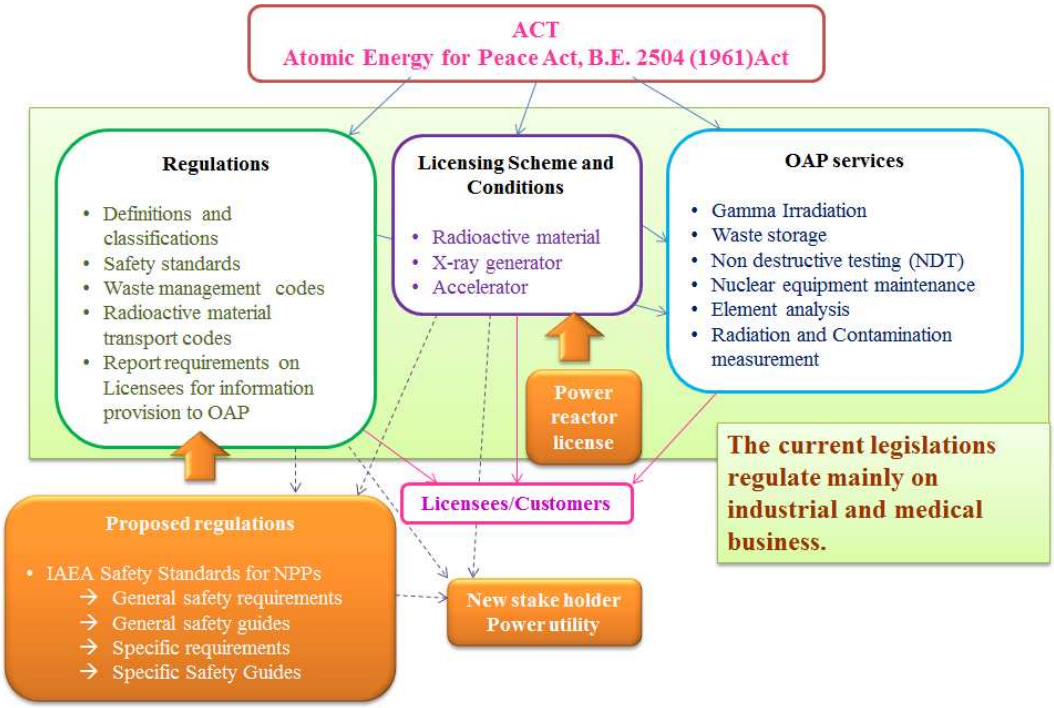

Figure 7. Regulatory scheme of the Atomic Energy for Peace Act of 1961and proposed regulations

If the government decides to "GO NUCLEAR", the utility will need to apply for a nuclear power reactor license and other related licenses. Thus, the supporting regulatory processes and/or ordinances have to be systematically developed and in place by that time.

Furthermore, several agreements and treaties such as non-proliferation treaty (NPT), comprehensive safeguard agreements, the convention on early notification of a nuclear accident, the international convention for the suppression of acts of nuclear terrorism, etc., should be signed and NSRB will be responsible for the signing processes. Additionally, the number and skills of regulatory staffs are currently inadequate. Therefore, regulatory team development programs should be integrated into the human resource development program of the national NPP program.

2. Energy Regulatory Body

Energy Regulatory Commission (ERC)

The regulatory body for the energy industry operations has been established after Energy Industry Act B.E. 2550 (EIA 2007) (SOC 2007) has been enforced since 11 December 2007. The chairman and six other members of Energy Regulatory Commission making up the Board of ERC have been graciously appointed by His Majesty the King since 1 February 2008. ERC regulates electricity and natural gas industry under the government policy framework. The objectives of the Energy Industry Act are to promote adequate and secure energy service provision, while maintaining fairness for both energy consumers and licensees; to protect energy consumers' benefits in terms of both tariffs and service quality; to promote competition and prevent abusive use of dominance in the energy industry operations; to promote fairness and transparency of the service provision of the energy network systems, without unjust discrimination; to promote the efficient energy industry operations and ensure fairness for both licensees and energy consumers; to protect the rights and liberty of the energy consumers, local communities, general public and licensees in terms of participation, accessibility, utilization and management of energy under the criteria that are fair for stakeholders; to promote economical and efficient use of energy and resources in the energy industry operations, with due consideration of the environmental impact and the balance of natural resources; and to promote the use renewable energy that has less adverse impact on the environment in the electricity industry operations. Moreover, ERC's authorities and duties are to regulate the energy industry operations to ensure the compliance with the objectives of this Act under the policy framework of the government; to issue the announcement determining the types of licenses for energy industry operation, and recommend the issuance of a Royal Decree to determine the categories, capacities and characteristics of energy industry that are exempted from the license requirement; to establish measures to ensure security and reliability of the power system; to establish the regulations and criteria of the electricity procurement and the issuance of Requests for Proposals for the purchase of power as well as monitor the selection procedures to ensure fairness for all stakeholders; to provide comments on the power development plan, the investment plans of the electricity industry, the

natural gas procurement plan and the energy network system expansion plans for submission to the Minister; to inspect the energy industry operations of the licensees to ensure efficiency and transparency; to issue regulations or announcements establishing the customer service standards and quality, including measures to protect energy consumers against adverse impacts resulting from the energy industry operations; to issue regulations or announcements on the determination of the policy and guidelines with regards to the stakeholding or the conflict of interests of the Board Members and the competent officials; to issue regulations or announcements on the determination of criteria, methods and conditions of the contributions to the Fund and the Fund utilization in line with the NEPC policy. 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 the defined duty and responsibilities for the benefit of sustainable development of the country in the social, economic and environmental aspects.

ERC's Roles in the NPP Project

ERC' roles on the NPP project involve several areas such as issuing energy industry licenses, implementing the power development fund (PDF), comment on PDP, review power tariff, etc.

Energy industry licenses

ERC has issued five types of licenses in the electricity sector: power generation licenses, transmission system licenses, distribution system licenses, retail supply licenses, and system operator licenses. The NPP project requires the Power Generation License before the project implementation. In order to obtain the license, other legislation's requirements, for instance Environmental and Health Impact Assessment (E/HIA) etc., have to be ready.

Power Development Funds

Power Development Funds (PDFs)(SOC 2010) are to be used as a channel for implementing the subsidy arrangements for underprivileged power consumers; rehabilitating localities; compensating people affected by power plant operations, and the promotion of renewable and environmentally friendly energy. Revenue for the funds is provided by a levy on power generators through the electricity tariffs. All power plants have to pay a levy to the Funds during the plant commissioning at the following rates:

During the plant construction, power plants have to pay 50,000 baht per KW-year so that 5 x 1000 MW-class NPPs in PDP 2010 have to pay 50 million baht each, while any power plant that has a PPA with the Utility from 6 MW and greater has to pay money to the Funds during the plant commissioning at the following rates:

Table 1. Tariff rates for the PDFs

Fuel Type	Baht per kWh
Natural Gas	0.010
Fuel Oil/Diesel	0.015
Lignite/Coal	0.020
Renewable ❖ Wind/Solar ❖ Biomass/MSW ❖ Hydro	 0 0.010 0.020

Although the current tariff rates have not included the rates for nuclear power generation yet, ERC can consider the rates for NPP, if the government decides to "GO NUCLEAR".

Currently, the funds are used for such activities as:

1. to compensate/subsidize for the licensees who have provided services for underprivileged power consumers or to enhance extensive electrification;
2. to reimburse the users who paid for higher tariff in the case that the dispatcher breached Section 87 of Energy Industry Act 2007 Paragraph 2 "The licensee with the power system operator shall fairly instruct licensees operating the electricity industry to generate electricity and shall not exert unjust discrimination."
3. to rehabilitate a locality that is affected by the power plant operation;
4. to promote the use of renewable energy and technologies for electricity industry operations that have less impact on the environment;
5. to increase knowledge, awareness and participation of the society and people in power-related issues; and
6. to pay for the costs of the Funds management.

Plan Comments

ERC is responsible for commenting on PDP, the investment plans of the electricity industry, power network system expansion plans for submission to the minister under Section 9 (3) of EIA 2007. Therefore, if the government decides to "GO NUCLEAR", ERC will comment on the NPP project plan and power network system expansion plans supporting the NPP project proposed by EGAT before submitting to the minister of energy to submit to the cabinet for approval. ERC will consider return on investment, social impact study, securities and safeties of the plans.

Power Tariff

ERC will set the criteria for determining the tariffs under the policy framework and guidelines approved by NEPC. The tariff will be based on these

criteria: reflecting the actual costs with the appropriate return, being able to enhance efficient and adequate energy supply to fit to the demand, suitable dispatching and scheduling, inducing efficiency improvement in electricity industry operations, fairness for licensees and consumers, assistance to underprivileged power consumers, transparent, and non-discrimination. The tariff rate for nuclear power generation may include decommissioning tax and waste management tax for the NPP project.

Standards and Safety Regulations in the Electricity Industry Operations

Standards and safety regulations in the electricity industry operations, which are established by ERC, are not to create an undue burden on the licensees, limit the competition, bias, and are to be transparency. If utility or licensee cannot provide the operation in compliance with the standards or safeties, ERC will have an authority to order the licensee to improve the operations.

3. Shortcoming in Nuclear Power Regulation between the NSRB and the ERC

One significant shortcoming between NSRB and ERC is the redundancy in safety regulations. NSRB will mainly regulate nuclear safety in NPP from fuel preparation process to reactor operation including nuclear waste management while ERC will regulate following the tools from EIA 2007 including standards and safety regulations in NPP that include nuclear reactor building and operations in NPP. To avoid the redundancy, both regulators should identify the boundary of their works. Nuclear power creates radiation emissions that differentiate from other types of generation and these emissions are quite difficult to protect and control. Radioactive safety specialists are needed for the regulator to monitor and regulate. It is quite clear that NSRB has more experience on radioactive safety than ERC. Therefore, the work related to radioactive safety of NPP should be regulated by NSRB, while ERC can play a more significant role on dispatching and scheduling regulation through the system operation (S.O.) licenses.

Conclusions

Nuclear power generation has been introduced in Thailand's power development plan since 2007. Several preparation activities are being carefully progressed to handle this challenging project. International Atomic Energy Agency (IAEA) specialists strongly suggested Nuclear Power Program Development Office (NPPDO), Ministry of Energy, Royal Thai Government to systemically establish a strong and independent nuclear power regulatory body. Indeed, Thai Atomic Energy Commission (AEC) and Office of Atoms for Peace (OAP), and Energy Regulatory Commission (ERC) play an important role in nuclear power regulatory body. Thai AEC and OAP regulate on nuclear safety, while ERC is responsible for electricity industry regulation.

Nuclear safety regulator has responsibility to prevent the nuclear safety operations relating to the nuclear power plant project, to protect people health and environment impact from radioactive damage. Indeed, nuclearsafety regulator should be independent from the policy sectors. The power industry regulator is mainly responsible for power tariff, fair competition, power system security and power

service quality. The nuclearsafety regulator and the power industry regulator should collaborate to minimize the redundancy for maintaining the safety of the public, economies and environment.

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