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Cambodia, ASEAN, and the International Atomic Energy Agency (IAEA): Nuclear Energy Recommendations for Cambodia Based on ASEAN's Experience

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Abstract

This article aims to study the perspectives of ASEAN member states on nuclear power plant generation in the region and to consider the possibility of Cambodia building a nuclear power plant for further development. It examines the relationship between Association of Southeast Asia (ASEAN) and the International Atomic Energy Agency (IAEA), which has resulted in some ASEAN member states building nuclear power reactors with financial support and nuclear equipment from the IAEA and other supportive countries such as Russia and United States. With IAEA's assistance, ASEAN has created a treaty and nuclear energy network for member states which has helped to ensure the peaceful activities of nuclear energy usage and has strengthened the safety, security and safeguards in the region. The Royal Government of Cambodia is planning to generate nuclear power plants for improving for many applications in the healthcare industry, agriculture, and other sectors of the economy, but this initiative has received pushback from several groups in the country due to perceived nuclear power plants' negative impacts on the economy, society and environment. This article analyzes the opportunities and challenges inherent in the diversification of energy sources in developing countries and conclusion with research policy recommendations about Cambodia's nuclear future.

I. Introduction

The International Atomic Energy Agency (IAEA) is a global agency that assists the member states to generate nuclear energy for peaceful activities. The IAEA has a relationship with the

ASEAN Secretariat on nuclear power consideration for further development. Currently, oil and coal are the most used energy sources in ASEAN (Trajano, 2015). These types of energy sources will be depleted in the next decade and the price is going to be expensive. The ASEAN member states have considered nuclear power generation for many purposes. Vietnam and Indonesia have started to operate nuclear power plants while Thailand has delayed building nuclear power plants after the Fukushima nuclear accident in Japan. Cambodia is planning to generate nuclear power for improving the healthcare, industrial, agricultural, and other sectors of the economy (Phnom Penh Post, 2014). The Ministry of Mining and Energy in Cambodia has expressed desire to build the nuclear power plant in 2020, but the initiatives have been protested from many groups in the country.

The purpose of this paper is to discover the benefits of IAEA in supporting its member states; to study the perspectives of the ASEAN member states countries on nuclear power generation in the region as well as the relationship between IAEA and ASEAN; to consider the possibility of Cambodia of planning to generate nuclear power; and to discuss the opportunities and challenges inherent in the diversification of energy sources in developing nations; and to provide policy recommendations about Cambodia's nuclear future.

1. Background of the IAEA

The International Atomic Energy Agency (IAEA) is an international organization that was created to promote the peaceful use of nuclear power and to inhibit its use, especially for any military purpose. In the summer of 1954, the US proposed to the General Assembly to create the IAEA to reliably control the fossil material in order to prohibit the proliferation of nuclear weapons worldwide and it was eventually established in 1957 as an entity within the United Nations (IALANA, 2012). There are now 168 member countries.

2. Purpose of the IAEA The purpose of the International Atomic Energy Agency is to:

- Accelerate and enlarge the contribution of atomic energy to peace, health and prosperity over the world
- Ensure that nuclear energy is safe and is not used for any military purpose
- Coordinate the experience and research in the peaceful use of nuclear power
- Prohibit the proliferation of nuclear weapons worldwide

II. Benefits of the IAEA

The IAEA encourages its member states to generate and use nuclear power in a peaceful way. It also assists the member states by advising on the building of the nuclear centers and laboratories as well as by promoting nuclear safety (regulations, safety standards, radiation protection, radioactive waste management and safety assessments). The IAEA supports expert services, equipment and training related to nuclear energy. Moreover, financial support has been providing by the IAEA for building the nuclear energy facility. The agency supported to the member states US $ 78.5 million in 2006 while providing US $ 59.1 million in 2000 (IAEA, 2007). The IAEA agency has increased the availability of energy service usage, which has been generated for telecommunication, information technology and manufacturing. Nuclear energy contributes to the gender equity because in poor countries, the people required to collect wood and dung for cooking are mostly women. Another benefit is that the energy is safe and affordable. However, charcoal and wood are utilized with inadequate ventilation, which may affect human health. Moreover, nuclear energy ensures the environmental quality due to the reduction of hydropower dams and the burning of fossil fuels. These activities seriously impact global climate change, air pollution, water pollution and deforestation (Vera et al., 2005).

III. IAEA's Relationship with ASEAN

ASEAN plays a vital role for enhancing the ASEAN framework on the safe and peaceful use of nuclear energy. Nuclear safety and non-proliferation was established by ASEAN in 1995 in the treaty on the Southeast Asia Nuclear Weapon–Free Zone (Bangkok treaty), which was primarily made to prohibit member states from developing, manufacturing and possessing nuclear weapons. It contains several provisions that the member states can use nuclear energy for peaceful purposes, in particular for economic and social development. It establishes the regional framework that guides member states should they decide to pursue nuclear energy. In the treaty of the nuclear program was a safety assessment concerning the guidelines and standard recommendations by the IAEA for the protection of health and the minimization of danger to life. Moreover, the Bangkok treaty follows the IAEA safeguard in Article 5. Each country that wants to generate nuclear power must create an arrangement with the IAEA to ensure the safeguards for peaceful power within eighteen months. The safeguard agreement with the IAEA is to prevent a nuclear explosive device, radioactive waste and other radioactive matter discharged into the sea (Nuclear Threat Initiative, 2016)

The IAEA has cooperated with ASEAN on the nuclear security program. The potential targets in ASEAN countries related to the nuclear energy are research reactors and fuel fabrication plants. Enhancing this program, the IAEA offers services and instruments for nuclear security such as peer reviews on security, international physical protection advisory services and integrated nuclear security support plans (INSSP). The ASEAN Network of Regulatory Bodies on Atomic Energy was established in 2011 by the ASEAN Secretariat. IAEA has supported the network by providing several possible areas for development and nuclear security training program. Moreover, IAEA is going to support the regional activities requested by ASEAN member states and the ASEANTOM network (Nian and Chou 2014; Trajano, 2015).

IV. Prospective Nuclear Energy in ASEAN

Coal and oil currently dominate the main types of energy used in ASEAN, and they will remain popular over the new few decades (Table 1). Many are concerned that coal and oil pollute the environment (CSIS, 2010). Nuclear power is becoming a new technology for ASEAN. Southeast Asia has planned to generate 16 nuclear energy plants including four in Indonesia, two in Malaysia, four in Thailand, and six in Vietnam by 2025 (Vienna, 2012).

Table I ASEAN Electricity Generation (%)

Type of Energy	Year 2011	Year 2035
Coal	32	49
Oil	44	28
Gas	10	2
Nuclear	0	2
Renewable (hydropower, bioenergy and others)	14	19
Total	100	100

Source: International Atomic Energy Agency (2013)

The Asian Development Bank expects that the demand for electricity in Southeast Asia will increase threefold. Figure 1 shows that the electricity demand has rapidly increased from 600.6 TWh in 2010 to 1733 TWh by 2035.

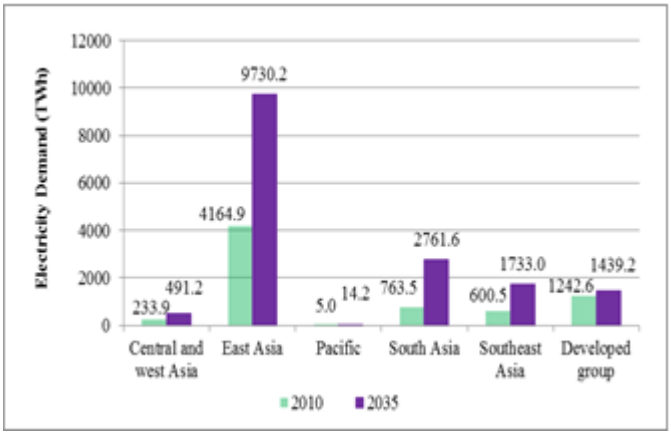

Figure 1 Electricity Demand by Region between 2010-2035. Source: ADB, 2013

1. Indonesia The two main agencies in charge of nuclear power plants development in Indonesia are the National Nuclear Energy Agency and the Nuclear Energy Regulatory Agency. Three experimental reactors have been built in Indonesia to train nuclear engineers in operating a nuclear facility and conducting industrial, educational, and medical applications of nuclear energy. There is currently a plan to build a small experimental nuclear power reactor near Jakarta. The Indonesian government has committed to generate 35,000 MW of nuclear energy by 2020 (Caballero and Tranjano, 2015).

2. Laos Laos signed an agreement with Russia in April 2016 to build two nuclear power plants with a capacity of 1000 to 1200 megawatts each. Currently, Laos has 80 new power projects mainly hydropower dams supported by China; Laos presently exports energy to Thailand, Cambodia and Vietnam (Maierbrugger, 2016).

3. Malaysia Malaysia planned for a small-scale nuclear power plant reactor in 2009, but this plan was objected by civil society groups. Currently, Malaysia has not decided to generate nuclear energy, but the government has already conducted a comprehensive feasibility study for nuclear power.

4. The Philippines The Bataan nuclear power plant (BNPP) was established by the Philippines in 1976 and planned to produce 620 megawatts of electricity. BNPP was almost completed in 1984 at a cost of $2.3 billion. The nuclear power plant never started generating the electricity because it sits on major earthquake fault line and lies near the Pinatubo volcano. The energy secretary Alfonso Cusi mentioned in August 2016 that the old nuclear power plant in Bataan Province will be revived which will require a $1billion investment. The nuclear power plant generation is one of the options for the Philippines to meet the electricity needs in the future. The annual power demand will be expected to grow by an average 5 percent until 2030.

However, the environmentalists are arguing against restarting the power plant because it is unsafe and expensive. Moreover, the Philippine Movement for Climate Justice stated that "We need to move away from fossil fuel like coal, but nuclear energy is not safe and will also harm the people and environment" (Janelle Retka, 2016).

5. Thailand Currently, Thailand does not have any nuclear power plants. According to the Power Development Plan (2010-2030), Thailand originally planned to construct five nuclear power plants (NPP) by 2039. The first two NPPs would be built in 2020 and 2021, the third and fourth NPPs in 2024 and 2025 and the last NPP in 2028. Because of the Fukushima nuclear accident, the Thai government considered to postpone the construction by three year. Thailand has revised the power development plan which will start the first reactor by 2023 and construct only 4 nuclear plants (Vienna, 2012).

6. Vietnam Vietnam approved plans to construct a nuclear power plant 1000 MW at Phuoc Dinh, Ninh Thuan Province in November 2009. It was expected to begin construction in 2014. Russia provided the financial support for the construction and also enhanced the capacity building by providing training to Vietnamese students in nuclear engineering courses. In fact, 344 Vietnamese undergraduate and graduate students were studying in Russian universities to prepare for the project. Moreover, Russia provided opportunities for 150 Vietnamese engineers to learn more about construction of Rostov nuclear power plant in Russia. Vietnam and Russia signed an agreement to build the first nuclear power plant in October 2010. Russia committed to provide financial support of 85% of the plant's construction including fuel. Another agreement was that Russia gave support of US$9 billion for exporting the credit bureau to Vietnam in November 2011 and the second agreement was that Russia provided a US$500 million in loan to build a center for nuclear energy science and technology in Vietnam (International Trade Administration, 2016).

Vietnam and Japan signed a nuclear power agreement for a second nuclear power plant construction in Ninh Thuan province. It was proposed to start the construction in 2015 but it was delayed later on. Japan has committed to train about 1000 staff for Ninh Thuan 2. Moreover, in 2011, Vietnam created the master plan for national power development 2011-2020 which states that the country is available to start the nuclear energy operation. Vietnam expects that the nuclear power plant will be about 10.1% of total energy in 2030 (Anthony and Tranjano, 2015).

7. Other ASEAN nations Brunei does not have a nuclear power plant yet while Singapore has not committed to generate the nuclear power due to its small land area. Moreover, Myanmar has never officially announced a plan to build a nuclear power plant. Myanmar's government stated that it did not plan to build the nuclear power plant due to inadequate resources and concerns about the nuclear impact.

V. Prospective Nuclear Energy in Cambodia

Cambodia does not have a nuclear power plant yet. The Cambodia National Council for Sustainable Development (NCSD) and the State Atomic Energy Cooperation "Rosatom" of the Russian Federation signed three Memoranda of Understanding (MoU) in May 2016 namely, an MoU on Cooperation in the Use of Atomic Energy for Peaceful Purpose, an MoU on the Establishment of a Cambodia-Russia Joint Working Group (JWG) on Cooperation in the Use of Atomic Energy for Peaceful Purposes, and an MoU on the Establishment of Information Center of Nuclear Energy in Cambodia to promote public awareness on nuclear energy and technologies, especially among the youth. Cambodia plans to get nuclear power electricity by 2030 to support many applications in the healthcare, industrial, agriculture and other sectors of the economy. Moreover, Cambodia have plan to further discuss a joint research and training in the field of nuclear energy, and build human capacity in nuclear physics, nuclear and radiation safety, emergency response, radioactive waste management and radiological impact assessment. Cambodia and Russia organized the First Meeting of Cambodia-Russia Joint Working Group on Cooperation in the Use of Atomic Energy for Peaceful Purposes on 17 August 2016 to review and finalize the draft agreement, to discuss the rules of procedure of the Cambodia-Russia JWG and priority activities under the MoU on cooperation in the use of atomic energy for peaceful purposes.

Energy consumption statistics in 2015 show that Cambodia used 1,985 megawatts of electricity in which 1,569 megawatts were produced locally and while the rest was imported from Thailand (135.5 megawatts), Vietnam (277 megawatts), and Laos (4 megawatts) (The Phnom Penh Post, 2015). Figure 2 shows the energy generation in Cambodia. Currently, most of electricity is generated from hydropower dams to support the daily life consumption (EAC, 2015).

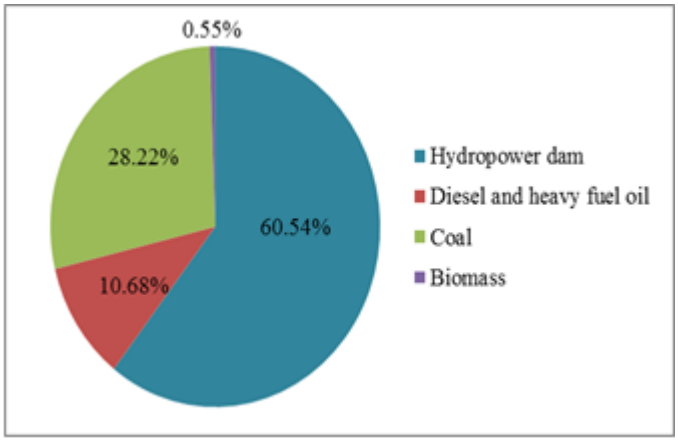

Figure 2 Energy Generation in Cambodia in 2014. Source: Electricity Authority of Cambodia, 2015

The Asian Development Bank (ADB) stated that the energy consumption in Cambodia will be increase up to 2401 megawatts between 2015 and 2025 (ADB, 2013). Cambodia will need to access more energy power by import from neighboring countries. Because of the increase in demand of energy consumption, there are institutions and government offices, especially the Ministry of Mines and Energy, which have planned to cooperate with Russia to generate nuclear power plants. The Royal Government of Cambodia and the Ministry of Mines and Energy plans to construct nuclear power plants due to depleting oil, coal and biomass sources. Cambodia cannot avoid building the nuclear energy power plant as it is the target of the Cambodian government to build the nuclear plants as they see alarm in the diminishing resources, the Minister of Mining and Energy has remarked. In addition, Hiroshi Suzuki, Chief Executive and Economist at the Business Research Institute for Cambodia, stated that nuclear energy was crucial for Cambodia and it requires strengthening human resources before constructing the nuclear power plants. It is highly risky of Cambodia to rely solely on oil, as the future price is uncertain. Cambodia needs to find another energy resource for further supply.

Sat Samy and Ith Praing, Secretaries of State for the Ministry of Mines and Energy, mentioned that hydropower and coal are expected to increase in cost during the next decade. After 10 years, Cambodia will not have enough hydropower to supply its demand in the country; it is only a short-term strategy for the hydropower dam development. Therefore, nuclear energy is the best option for Cambodia. The Ministry of Mines and Energy confirmed that Cambodia expects to build the nuclear energy by 2020-2025.

Dr. Hah Chang Joo, an advisor to the rector and adjunct professor at University of Battambang, is a nuclear researcher and designer from Seoul University in South Korea and provides nuclear

education related to nuclear engineering at the University of Battambang. He argues that Cambodia will be able to generate nuclear energy in the next 10-20 years. This major is in its third generation, currently with 22 students. Improving the capacity building on nuclear power is critical for Cambodia to develop nuclear power plants in the next decade. The university now has a nuclear core simulator machine which cost about US$50,000 sponsored by Seoul University.

Nuclear energy will be important for Cambodia in the future. However, some complaints have been raised by groups of NGOs as well as other institutions in Cambodia. Nguon Meng Tech, Director General for the Cambodia Chamber of Commerce, remarked that nuclear power plants are dangerous because Cambodia does not have enough experts to oversee the nuclear power plants. Moreover, after the plants are built, Cambodia will still face some of the same problems as now, namely poverty and political uncertainty. He argues that instead, Cambodia should focus on its necessities and other investments in the energy sector.

Ngy San, Deputy Executive Director at the NGO Forum, has stated that nuclear power is important for Cambodia but only if it ensures the safeguards. Cambodia may not be ready for building nuclear plants because Cambodia needs more experts and also needs technology to protect the discharged nuclear waste which could destroy the water quality. He added that Cambodia has invested for seven hydropower dams nationwide at a cost of US $1.4 billion.

Mr. San Vibol, an energy researcher and lecturer at the Royal University of Phnom Penh, argued that he thinks that Cambodia should not have the nuclear power because it is dangerous. He also added that Cambodia lacks nuclear engineers and that law enforcement is still limited (Kossov, 2015)

According to the IAEA, countries aspiring to nuclear energy should meet 19 milestones: national position, nuclear safety, management, funding and financing, legislative framework, safeguard, regulatory framework, radiation protection, electrical grid, human resource development, stakeholder involvement, site and supporting facilities, environmental protection, emergency planning, security and physical protection, nuclear fuel cycle, radioactive waste, industrial involvement and procurement (Kovan, 2014). Therefore, if Cambodia truly wants to develop its nuclear energy sector, it must consult with IAEA to meet these particular milestones.

VI. The IAEA's Relationship with Cambodia

Prime Minister Hun Sen met the IAEA Director General Yukiya Amano in Cambodia in January 2014. He suggested the IAEA to help train human resources in Cambodia on how to use the nuclear technology for enhancing the agricultural and health sectors. He asked for help from the IAEA to draft a law on nuclear energy for the Ministry of Mines and Energy. Amano stated that he wants to know the purpose of Cambodia for wanting to use the nuclear technology. He mentioned that nuclear technology can improve the agricultural production and also health sector and he committed to assist Cambodia with help related to these sectors, which were later expanded in 2016 (Sokha, 2014).

VII. Challenges of Nuclear Safety in ASEAN

ASEAN plays an important role to encourage its member states to generate nuclear power. A treaty and nuclear energy network were established by ASEAN to ensure the safeguards in the region. The member states have enabled each other to share their experiences related to nuclear power plant construction during the annual ASEAN meeting in order to strengthen the knowledge related to nuclear power. The IAEA assists ASEAN member states to establish nuclear energy centers and laboratories for nuclear research programs, as well as nuclear equipment for nuclear power plant construction. Moreover, the IAEA supports ASEAN member states to create the safeguard frameworks to ensure the safety and security of the region. Cambodia will eventually be able to use nuclear power to offset its dependency on coal and oil, as well as its need to import energy, and it can work within the framework of ASEAN and the IAEA. While Cambodia may not be currently ready for nuclear energy, the government should continue to prepare for it by working with the appropriate groups and by raising awareness of the issue so that the public can be ready to at least consider alternative energy sources.

1. Scarcity of adequately human resources Human resources is important for nuclear energy development in the region. The training of those involved with nuclear power should be conducted, and they must be educated in all aspects of the infrastructure development in order to deeply understand the process of the operation. Without an educated workforce, nuclear power generation simply is not possible.

2. Terrorism The groups of Jemaah Islamiyah and Abu Sayyaf remain active in Southeast Asia. These groups have not expressed interest in nuclear energy development in the region. However, terrorist groups could in theory attempt to take nuclear and radioactive materials.

Regional actors must consider the material protection and increase their attention to the emergency preparedness and response with nuclear and radioactive materials.

3. Weak Maritime Security Maritime security is a major issue in Southeast Asia. Weak maritime security may have negatives effects on nuclear security by facilitating the illegal transportation of nuclear and radiological materials. The issue of maritime security is not only pertinent to the international transfer materials but also to domestic transfers. The nuclear material will pass through the Philippines, Indonesia, and Malaysia with unclear maritime borders.

VIII. Recommendations

Based on the real practice in ASEAN and the IAEA's requirements for further nuclear energy power generation, Cambodia should do as the following:

1. Cambodia should strengthen the international cooperation with sources of assistance and financial support; it should use this assistance to help build the capacity of nuclear engineers and the radioactive waste technology to ensure the safety for both local and regional facilities. Cambodia could also write an official letter to the IAEA asking for further concrete help to conduct the nuclear energy capacity building for Cambodia's nuclear engineers and the radioactive waste treatment technologies to ensure the safety, security and safeguard for both local and regional facilities. They could also suggest an exchange program for Cambodia's nuclear engineer to work at nuclear power construction in Russia, similar to Vietnam. Russia, or another country, could assist in building nuclear energy centers, laboratories for nuclear research program and financial support for nuclear power plant construction in Cambodia.
2. Learn more the experiences from the successful nuclear energy generation projects from ASEAN member states and ask about the challenges of generating the nuclear energy and other related things during the annual ASEAN meeting session, or at another designated time. These meetings should be bilateral and be in the cooperation of sharing and strengthening the community.
3. Study and deeply understand about the 19 IAEA milestones before planning to generate a nuclear power plant in Cambodia. These milestones ensure the strength of nuclear power generation and ensure the safeguards in the region. Work with the IAEA to help follow the 19 milestone, paying careful attention to the Cambodian context.

4. The government should motivate the University of Battambang which provides a Bachelor's Degree of Nuclear Engineering and assist with the financial support to keep the program healthy and attractive. The government should also encourage Cambodian students to study nuclear engineering for improving further development.

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