The Successive Development of Nuclear Energy in Southeast Asia

Vivat Chutiprapat, Woraratana Pattaraprakorn and Pornrapeepat Bhasaputra

Abstract*— *Southeast Asian countries are embarking on a program to develop nuclear energy. While this promises to help satisfy the region's growing energy thirst in a high cost-efficient and friendly environmentally friendly way, nuclear power also has its risks. The specter of proliferation looms large and the potential for nuclear accidents exists remains high in a region inclined to natural disasters and averse to strong institutional safeguards and export controls. Policymakers will have to be alert in mitigating these threats in order to ensure the region's safe passage to a nuclear future. Electricity in Southeast Asia is primarily sourced from coal, oil, natural gas, and hydro-power. While the region is awash with energy resources, rising demand has placed as starin on them. Southeast Asia has been a net oil importer for some years and significant natural gas reserves are often located far from demand centers and hence require massive infrastructure investments. Given this gloomy picture, the region is turning to alternative sources, including nuclear power, to meet its growing appetite for energy. Several regional trends suggest that this trend will accelerate in the decades to come.

***Keywords*— Association of Southeast Asian Nations(ASEAN), Foreign Direct Investment (FDI), Asian Development Bank (ADB), Asia Pacific Energy Research Center (APERC), Electricity Generating Authority of Thailand's (EGAT), International Atomic Energy Agency (IAEA),Vietnam Atoms Energy Commission (Vinatoms), European Union's European Atomic Energy Community (EURATOM), Tenaga Nasional Be (TNB) , Korean Electric Power (Kepco), International Atomic Energy Agency (IAEA).**

1. INTRODUCTION

The Association of South East Asia Nations (ASEAN) consists of 10 member countries, namely,Indonesia, Thailand, Malaysia, Singapore, Philippines, Vietnam, Mynmar, Brunei, Cambodia, and Laos. ASEAN has, by and large, been an open and outward looking region. External trade and foreign direct investment (FDI) are the principal means for globalization as well as an engine of economic growth among the ASEAN economics. Economies that are members of ASEAN have been growing at an annual averge rate of 5-6% since 2000 see detail on Fig 1. The volume of trade in the region recorded 18% increase annually,with US$ 7 billion annual trade balance, before the current global economic crisis. Investment in ASEAN has surged at an annual average rate of 37% since 2003. [1]

Energy consumption and economy in the Southeast Asia region have been growing in tandem over the last few decades. This trend is expected to continue into ythe future as Southeast Asia economies move towards the GDP per capita levels of developed nations. The growing energy demand however, is likely to put pressure on existing energy sources and supplies, forcing the government to think about energy security.

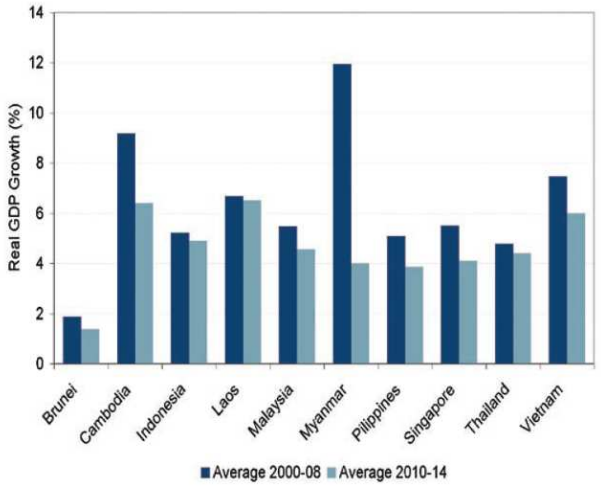

Fig. 1. Economic growth in ASEAN.

The current energy mix in the region is dominated by oil, which accounts for more than half of primary energy consumption in top energy consuming nations. A recent study carried out by Asian Development Bank (ADB) analyzed the energy mix of countries, namely, Indonesia, Thailand, Philippines, and Vietnam. The study pointed towards a rise in energy consumption shown in Fig 2&3. Going forward, the role of coal and gas is expected to increase at a fast rate. Use of alternative energy sources such as nuclear and biomass is also expected to increase overtime. However, while the share of oil consumption in total energy mix is expected to decline, it is still expected to remain a large contribution. The ADB report forecasts oil's share in energy at above 40% by 2020 for the four countries analyzed. [1]

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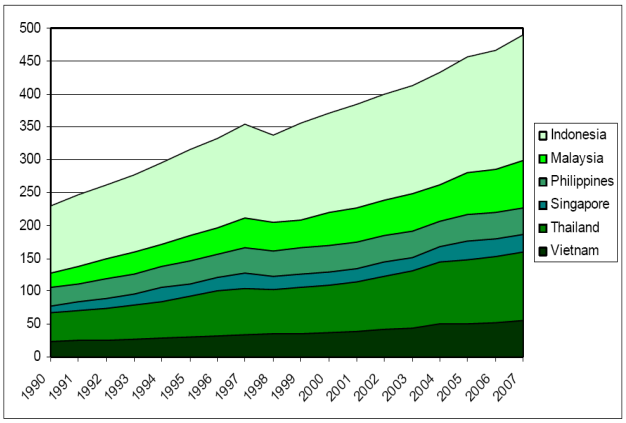

Fig. 2. Primary energy consumption in key ASEAN countries.

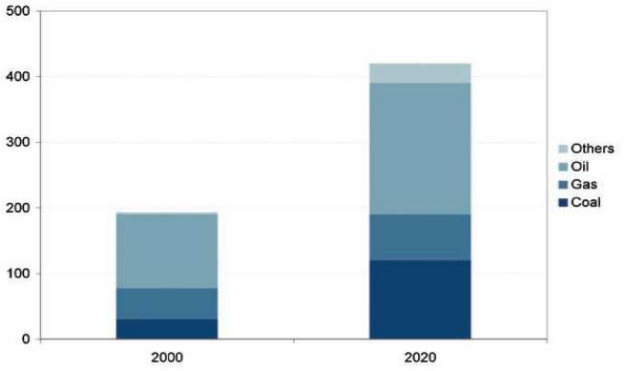

Fig. 3. Primary energy consumption in fours countries, Indonesia, Thailand, Philippines and Vietnam.

Southeast Asia states will similar pursue nuclear energy over the next few decades. Rising energy demand and Energy prices, both with increasing aware about climate change and the relative unattractiveness and unavailability of alternative energy sources, will combine to create a strong impulse to embark on a nuclear path.

According to the Asia Pacific Energy Research Center (APERC), are sustained by at least three main factors: first, Incresing energy demand in the most economies despite price increases; second, the unwillingness of major players to expand production and export capacity coupled with intensifying resource nationalism in oil and natural gas producing economies; and, third, a worsening geopolitical situation in the Middle East [2].

Despite price decreases in the short term, all three factors are not similar to decline in the long term, and energy prices will thus continue only increase. If the prices of conventional energy resources continue their upward turn, the demand for alternatives like nuclear energy will increase. Nuclear power is much high cost-efficient compared with fossil fuels, costing approximately 1.76 cents per kilowatt hour compared to coal (2.47cents), natural gas (6.78 cents) and oil (10.26 cents) that is.

Corresponding to rising prices, there will also be a greater than thirst for energy, particularly as the region emerges from the late economic down turn. Southeast Asia's recovery after the Asian Financial Crisis in 1998, coupled with strong economic reforms and burgeoning industrialization, has expanded regional economic growth rates since 2001. This is turn sharply boosted energy consumption in the region – for example, in the period from 2001 to 2003, consumption increased by 8%. If the region's economies continue the growth trend of the last decade, rising energy consumption will put more pressure on conventional sources and place even more urgency on investing in alternatives way like nuclear energy. Despite the fact that the global economic downturn has put a dent on this growth, Southeast Asian economies are still expected to bounce back strong in 2010 and will likely continue on a path of sustained economic growth. In fact, the International Energy Agency's World Energy Outlook 2009 projects that Southeast Asia's primary demand could expand by 76% between 2007 and 2030 and at an annual growth rate of 2.5% – much faster than the average rate in the rest of the world [3].

The region's rising awareness of global climate change may also cause it to turn toward low emission energy alternatives like nuclear energy. Nuclear energy has a very low carbon footprint, producing minimal levels of carbon dioxide (mostly during certain processes used to build and fuel the plants) comparable to geothermal, hydro power and wind energy detal show in Fig. 4. And while Southeast Asia has relatively low per capita emissions of carbon dioxide compared to the developed world (4.2 tons per capita is expected by 2030 in contrast to 23 tons in the United States), APERC's Institute for Energy Economics expects a whopping fourfold increase in total carbon-dioxide emissions (the green house gas) from 2002 to 2030 produced by energy production and consumption in Southeast Asia [4].

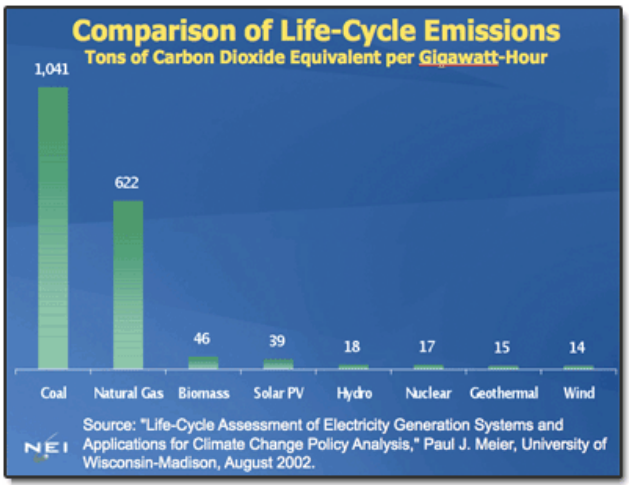

Fig. 4. Comparison of Carbon Footprints for Various Energy Sources.

If Southeast Asian states act on this warming trend, they may consider nuclear power as a path to clearing green house gas emissions. There are already gimplement signs of such climate change consciousness in Southeast Asia. For example, the 'Singapore Declaration on Climate Change, Energy and the Environment, which Southeast Asia states inked at the 3rd annual East Asia Summit in 2007, specifically states they will be a part of their commitment to "urgently act

to address the growth of global green house gas emissions", "intensify ongoing cooperation to improve energy efficiency, and the use of cleaner energy by cooperating for the development and use of civilian nuclear power ".

The increasing consensus on nuclear power as a form of defense against climate change is bolstered by nuclear power's relative availability in comparison to other forms of low emission alternate energy. In case of, Indonesia has learned that natural gas requires too much supply infrastructure – a major structural problem that probably will not be remedied in the near future. Other options, like Capital in Thailand or hydro-power in the Greater Mekong Sub-region, have recently raised the specter of environmental damage and dislocation, and in some cases have generated widespread protests. it shows this region hydropower Dams plan in Fig. 5 In Addition, while they may appear promising in theory, countries are beginning to grasp that energy sources like solar energy can only function as marginal power generators in reality [5].

Fig. 5 Hydropower Dam in the Greater Mekong sub-region.

Nuclear power, by contrast, can produce energy on a much wider scale, effective cost competitiveness, accessible fuel supply, and limited environmental impact. These factors are likely to contribute to nuclear power's attractiveness.

2. THE NUCLEAR ENERGY SITUATION IN SOUTHEAST ASIA

Nuclear power is being explored in Indonesia, Vietnam, Thailand and possibly eleswhere in the region as part of the solution to meeting the need for very large increses in power generation capacity over the next two decades to support the fuel industrial and urban growth. Essentially, nuclear power is seen as a means of strengthening energy supply security (for electricity) by diversifying beyond reliance on fossil fuels. Much less of a driver in planning, at this stage, is concerned over reducing greenhouse gas emissions and threat of climate change. Of course, arguments for nuclear power can be made on the basis of its far lower output of carbon dioxide and other greenhouse gases.

Country wise, Indonesia, Vietnam and Thailand are the "Leader" who have already floated proposals for the election of 17 nuclear reactors, while the Philippines, Malaysia, Cambodia and Myanmar are the "Follower" that are considering the nuclear option. It is possible that by 2020, all six "Leader" and "Follower" could possess some form of nuclear facility. The four "abstainers" – Brunei, Cambodia, Laos, and Singapore, for various reasons, will most likely abstain from nuclear energy, absent any tectonic geo political changes in the region that may compel nuclear ambitions.The advance Southeast Asia have plan for NPP shown in Table 1.

Table 1. Advanced Southeast Asia Nuclear Efforts

Country	Reactors Planned	Proposed	Research reactor	Being rebuilt
1. Indonesia	2	4	3	
2.Thailand	2	4	1	1
3.Vietnam	2	8	1	
.Philippines		1	1	
5.Malaysia			1	
Total	**6**	**17**	**7**	**1**

Remark:
***= Approvals, funding or major commitment in place, mostly expected in operation within 8 year*
***Proposes** = Clear intention or proposal but still without firm commitment*

Indonesia, Thailand and Vietnam are the most serious about developing nuclear energy in Southeast Asia. All three have set targets of possessing a functioning nuclear energy program by 2020, and the International Atomic Energy Agency (IAEA) has concluded that they are very advanced in developing the capabilities necessary for constructing such a program. Their motive thus far, as mentioned earlier, has been purely energy-centric, all three are trying to ease a growing gap between rising electricity demand and the declining availability of other non-nuclear alternatives in a cost-effective fashion with light of stratospheric energy prices [6].

The Follower are countries that are considering the nuclear option but are either not that enthusiastic about and are not yet deeply invested in it, or face significant obstacles that may obstruct a potential pursuit. Malaysia

and Cambodia have both shown signs of considering the nuclear option. However, they probably will not take concrete steps in that direction any time soon since the former has sufficient oil and gas reserves for now, while the later is focused on developing its infrastructure and investing in other forms of renewable energy such as hydro-power in the short term. Resource-rich Myanmar does not need nuclear energy for power generation purposes, but only initiate the early stages of trying to build a small research reactor with Russian assistance. While the Philippines may embark on the project. In a few years, it is still reeling from its failed experience with nuclear energy in the 1980s, when its 630-megawatt Bataan nuclear plant was embroiled in corruption allegations under Goverment Leader. That alone will make nuclear energy a difficult sell in the Philippines.

Although, the resultant nuclear power generation for both Leader and Follower, it must be stressed, will only make a small dent on total projected power demand in these countries. For example, Indonesia , has planed initial tranche of 4,000 MW of nuclear generation which would serve the main Java-Bali grid which meets 75% of total energy demand, where total capacity is projected to increase from 15,000 MW in 2006 to 59,000 MW in 2026. The target is for nuclear power to contribute at least 4% of total enegry output by 2026. Under a 2006 Law on Nuclear reactors, the project seems likely to be given an independent power producer to build and operate, on one the three sites on the central north coast of java, around 450 kilometers east of Jakatar. Plans are to call tender in 2008 for two 1,000 MW units, Muria 1 and 2, leading to adecision in 2010 with construction starting soon after and commercial operation from 2016 and 2017,respectively. The goverment says reastors will be purchased from abroad and fuel world preferably be leased. Used fuel would be stroed centrally in the medium term. Tenders for Muria Units 3 and 4 are expected to be called in 2016, for operation from 2023 [7].

In Thailand, the Electricity Generating Authority of Thailand's (EGAT) has put forward the goal of 5,000 MW of nuclear capacity by 2020, to make a dent into the additional 30,000 MW, where totoal capacity is projected to increse from 26,999 MW in 2006 to 50,000 MW in 2020. The government plans to establish safety and regulatory infrastructure by 2014 and commissioned a three-year feaibility study early in 2008. However, these efforts could also be precursors to much greater country commitments to nuclear energy in the future should they prove effective or should energy demands become more urgent [8].

Vietnam seems determined to establish civilian nuclear power plants. Hanoi wants to have 8,000 MW in operation by 2020 in the Ninh Thuan. To make a dent into the additional at 48,700 MW , where totoal capacity is projected to increasing from 12,000 MW in 2006 to 60,000 MW in 2015 and 120,000 MW in 2025. To ease public concerns over plan, state power utility Electricity Vietnam , the Ministry of Industry and trade and Vietnam Atoms Energy Commission (Vinatoms) have held public exhibitions about nuclear energy and power genergation in Hanoi, Ho chi Minh City, Ninh Thuan and neghbouring Phu Yen, Regulation frameworks are being fashioned. A law on nuclear energy is before the national legislature.

The Philippines, is considering reactive the 621 MW Bataan nuclear power plant in Morong. In April 2007, the philippine goverment made the final payment for the plant and the Philippines Depaertment of Energy set up a project to study the development of nuclear energym in the context of an overall energy plan for the country. In early 2008, Manila asked the IAEA to advise as to whether Bataan could economically and safety be operated, and to recommend a policy framework for nuclear power development in the country. The IAEA in turn has recommended that the goverment undertake an extensive feasibiity study of possible role should nuclear in the Philippines power system [9].

Malaysia is also looking at the atomic power options, with an energy policy study including conseration of nuclear power to be completed before 2010, In March 2008, the Malaysia state power utility, Tenaga Nasional (TNB) signed a prelininary agreement with its South Korean counterpart, Korean Electric Power (Kepco) to co-operate in the sale of region and beyond, as well as other energy resources and electricity business segments. Kepco has strong expertise in nuclear power generation, which a subsidary operating more than 17,000 MW of nuclear plant.

Myanmar's Military leader is embarking on a small research reactor, to be built with Russian assiatance – through Moscow's Federal Agency for Nuclear Energy, Rostaom – which it says would be in line with inetrnational standards and safetguards in place through IAEA.

Abstainers in Southeast Asia are countries that, for various reasons, are similar as pursue nuclear energy in the near future. For Singapore, the complication is technical: it lacks the necessary space for the required safety stand-off range of a nuclear site from urban areas (30 kilometers), which generates the majority of its power from increasing scare gas, has a feasibilty plan for power under way. Neither Brunei nor Laos see a need for nuclear energy in the short- term – the former has a wealth of other resources like oil and natural gas, while the later has significant proven hydro- power capabilities [10].

Table 2. Estimate Nuclear Power Plant in Southeast Asia

Country	Estimate Nuclear Time Line
1. Indonesia	Between 2016 and 2020
2.Thailand	By 2020
3.Vietnam	By 2020
4.Philippines	By 2025
5.Malaysia	By 2023
6.Cambodia	As early as 2020
7.Mynmar	By 2014
8.Singapore	Abstain
9.Loas	Abstain
10.Brunei	Abstain

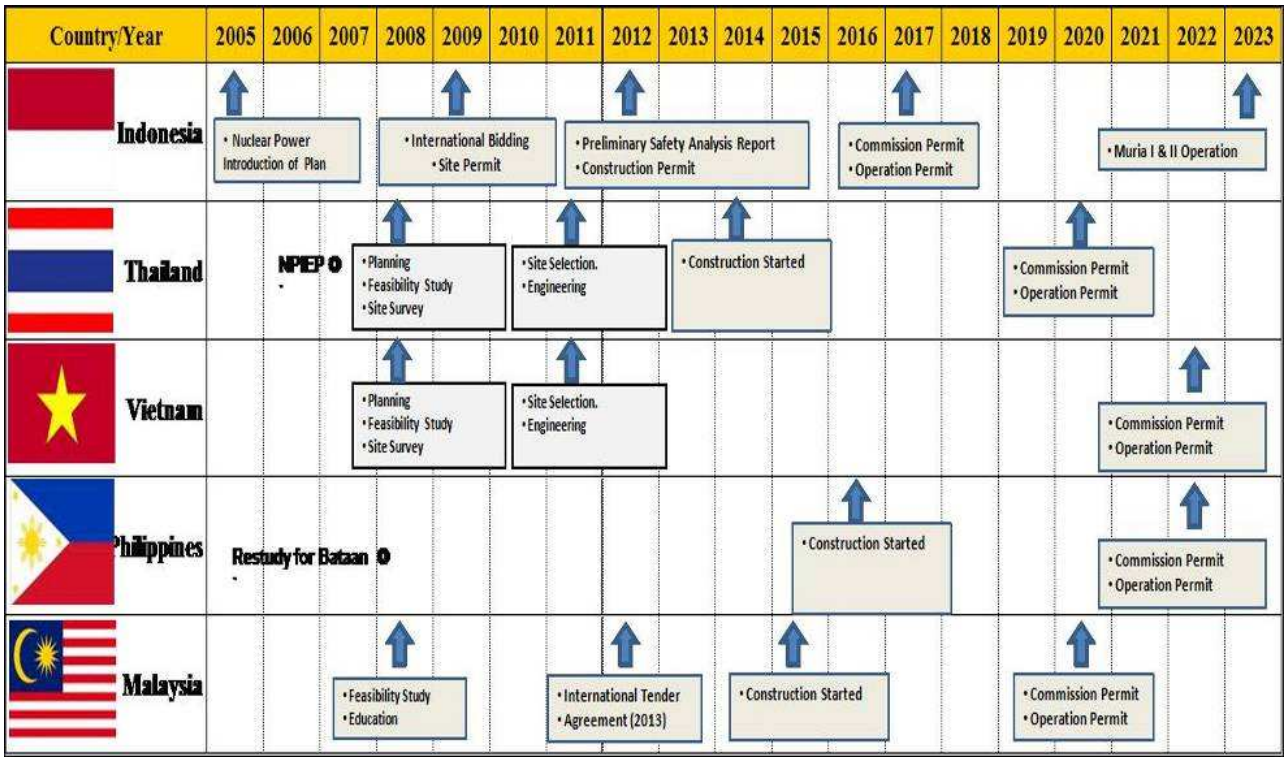

Fig. 6. Road Map of Nuclear Power Plant Development in Southeast Asia.

Overall, as the nuclear timeline below illustrates in Table 2 and Fig. 6, a futuristic assessment of energy portfolios shows that at least three and up to seven Southeast Asian countries could possess some form of nuclear power generation or begin using nuclear power by 2022 [11].

3. THE FUTURE OF NUCLEAR ENERGY IN SOUTHEAST ASIA

There are several sources of anxiety as more South-east Asian nations strive toward a nuclear future. In particular, the environmental and proliferation hazards associated with nuclear power, combined with the lack of strong regional policing and global norm adherence, are worrying trends that ought to concern policymakers going forward.

The environmental and safety sizing of nuclear is especially prominent in Southeast Asia. Since the region is inclined to intense natural disasters, nuclear power experts and managers will have to deal with the challenge of seismic hazard and the risk of radiation leakage in the future. While most plants are designed to withstand these natural disasters, much will depend on how adequate their safety standards are in areas such as radiation protection, predisposal management, and emergency preparedness and response, and how strongly these standards are enforced. According to APERC, the main concern as nuclear energy expands its reach in Southeast Asia will be “safety issues a increasing from fuel handling and the operation of nuclear power”.

History offers several cautionary tales about nuclear safety, such as the Three Mile Island incident in the United States (1979), the Chernobyl disaster in the former Soviet Union (1986), and the Tokaimura and Kashiwazaki incidents in Japan (1999 and 2007). Though Chernobyl was the result of a mechanical error (a chain reaction got out of control), detailed investigations into the Chernobyl and Tokaimura incidents clearly found that they could have been ameliorated or avoided entirely if there with better education, training, quality control and safety standards. And the Kashiwazaki case, where nuclear reactors were placed above a fault plane prone to earthquakes, indicates the importance of knowing the geographical terrain before positioning nuclear facilities.

Such problems are not merely historical or hypothetical for Southeast Asia. For example, Indonesia’s decision to locate its first nuclear power plant on a site near Mt.Muria, a dormant volcano, has already raised eyebrows among engineering safety experts and evoked comparisons to the Kashiwazaki case. Total disaster in Indonesia is recorded in Fig. 7. The concern is even more palpable because Jakarta is particularly susceptible to natural disaster sowing to its location in the “Ring of Fire” – an area where the hightest numbers of earthquakes and volcanic eruptions occur in the Pacific Ocean. Furthermore, Southeast Asian industries are notorious for their poor quality control standards, and some countries like Vietnam face a shortage of necessary technical expertise. These indicators are worrisome given the sensitive operating conditions for nuclear processes [12].

The specter of proliferation will also loom large as more countries pursue nuclear power. As more Southeast Asian countries have their own fuel enrichment capacity, they will also possess the ability to build nuclear weapons indigenously if they wish to do so. This is turn increases the risk that nuclear weapons, or the uranium

and plutonium used to make them, will fall into the hands of non-state terrorist groups or rogue regimes, which can then use them to construct deadly bombs. The Terrorist network, where the father of worild 's nuclear program, terrorist sold critical nuclear technology to Libya, Iran and North Korea. There is also clear evidence that suggests terrorist not only possessed a detailed knowledge of nuclear weapon, but attempted to acquire nuclear material on the black market.

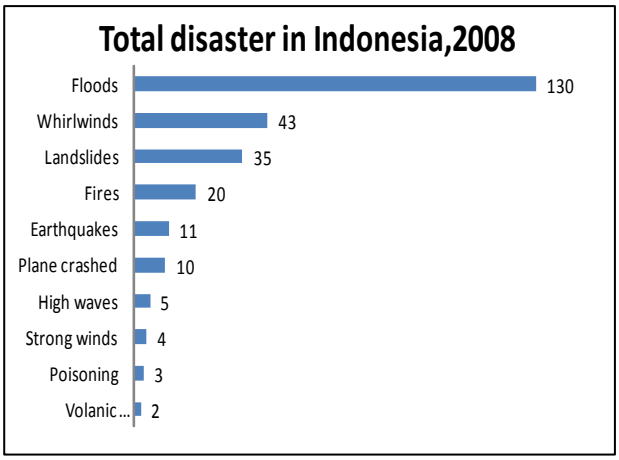

Fig. 7. Total Natural Disasters in Indonesia, 2008.

While this concern is a legitimate one, most Southeast Asian nations have not shown intent to pursue a nuclear weapon or proliferate. Experts find it highly unlikely that either Indonesia or Vietnam will move toward a bomb because they have what is termed a 'responsive view on weaponizing' – they will only veer toward a weapon if they see neighboring countries doing so first. Vietnam, for its part, has also displayed clear intent in this regard by recently agreeing to return weapons-grade uranium from its Da Lat research reactor to Russia for processing via the U.S. - led Global Threat Reduction Initiative.

The more pressing concern for Southeast Asia as it moves forward will be the risk of a targeted and devastating terrorist attack on nuclear facilities. This is particularly salient in the case of Indonesia and Thailand, which are both known transit points for transnational terrorists, along with the persistence of other structural factors conducive to terrorism, indicate that the group still has the capacity for spectacular attacks on key infrastructure.

This lack of regional over sight is compounded by a weak and uneven commitment to global norms. For all the criticism leveled at international agreements, signing key treaties and conventions related to nuclear energy and nuclear power is a powerful marker of a nation's commitment to responsible energy use. Currently, only a few Southeast Asian countries have ratified all the three basic relevant UN documents – the UN Convention on the Physical Protection of Nuclear Material, the UN Convention on Early Notification of a Nuclear Accident, and the UN Joint Convention on the Safety of Spent Fuel Management and Safety of Radioactive Waste Management. If more countries begin handling nuclear power and refuse to be wedded to global norms relating to their use, there will be less legal accountability for potentially irresponsible actions and less confidence about how they will be managed.

4. THE NUCLEAR ENERGY IN THAILAND

Thailand had considered nuclear power plant as an alternative enegry sources from 1966. The goverment set the feasibility study during 1967-1970, approved NPP site on Ao Phi in chonburi province, Approved NPP type as 600 Mw and BWR reactor type in 1972, reserved nuclear fuel with Energy Research and Development Administration (ERDA),US on 1974, proposed call biding on 1976, and proposed this project in 1978. The government was started review the NPP again in 1982-1996.

On 9 April 2007, the National Energy Policy Council (NEPC) had agreed on the principle of PDP 2007 introducing NPP as an alternative future supply. Thereafter, NEPC appointed the Nuclear Power Infrastructure Preparation Committee (NPIPC) and its subcommittees to carry out preparatory works for nuclear power program which were reported as Nuclear Power Infrastructure Establishment Plan (NPIEP). On 30 October 2007, the Nuclear Power Program Development Office (NPPDO) was established under the Ministry of Energy to coordinate the NPIEP implementation during 2008-2010 including work plan and budget for NPPDO. On 18 December 2007, the Cabinet appointed the Nuclear Power Infrastructure Establishment Coordination Committee (NPIECC). The period of Y2008-2010 is in the Pre-Project Activities Phase. Major activities in this phase include work on infrastructure establishment to accommodate a nuclear power program, survey potential sites for construction and perform inital environmental examination, complete NPP feasibility study with human resources development plan, promote public communication and participation.

On March 23, 2010, Thai Cabinet has approved Thailand Power Development Plan 2010 (PDP 2010) often referred see Table 3, to as Green PDP due to its promote emission free energy sources. The PDR 2010, there will mention 5 units of 1,000 MW_e NPP in operation between 2020 and 2028. Nuclear power will consequently contribute up to about 10% Thailand electricity by 2028.

Table 3. Nuclear Power in Thailand Power Development Plan (PDP)

Power Development Plan	Nuclear Power Plant Description
PDP 2007 (15 years: 2007-2021)	4 units of 1,000 MWe: 2020(2 units) and 2021(2 units)
PDP 2007 Revision 2 (15 years: 2007-2021)	2 units of 1,000 MWe: 2020 and 2021
PDP 2010 (20 years: 2010-2030)	5 units of 1,000 MWe: 2020-2021, 2024-2025 and 2028

There are 5 sub-committees under NPIECC to coordinate the NPIEP implementation:

1. The Sub-committee on Legal System, Regulatory System and International Protocols
2. The Sub-committee on Nuclear Power Utility Planning Coordination
3. The Sub-committee on Industrial and Commercial Infrastructure, Technology Development and Transfer, and Human Resources Development
4. The Sub-committee on Nuclear Safety and Environmental Issues
5. The Sub-committee on Public Information and Public Acceptance

EGAT, as the major agency in the Sub-committee on Nuclear Power Utility Planning Coordination, hired Burns and Roe Asia Co., Ltd. to perform feasibility study of NPP development preparation in Thailand in various aspects. The study lasted for 20 months starting from 1 October 2008 and covers:

Task 1: Energy Economics and Financing :

- National energy market analysis,
- Electri system analysis,
- Choice of unit size,
- Nuclear cost estimates,
- Generation set
- Fund review.

Task 2: Technical and Safety Aspects of Nuclear Power:

- Technical aspects,
- Safety aspects,
- Security and safeguards.

Task 3: Fuel Cycle and Waste Management

Task 4: Reactor Technology, Supplier and Fuel Supplier Selection:

- Safety and Technical aspects,
- Economics,
- Performance and realiability.

Task 5: Site and Environmental Study:

- Safety and Engineering aspects,
- Evironment aspects,
- Cost estimate

Task 6: Human Resources Development and Management Aspects:

- Human resources development plan,
- Project development,
- Legal framework and licensing process
- Public information and national parti-cipation.

NPIEP was developed base on IAEA Guideline Technical Document, Consultant with IAEA expert, and current infrastructure and capacity of Thailand from NPIEP, Thailand's nuclear power program can be divided into 5 stages as below Fig. 8.

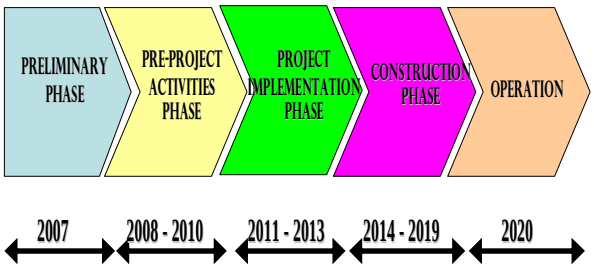

Fig. 8. Milestones in the development of Thailand Infrastructure for Nuclear Power.

For the public Voice, EGAT had conducted preliminary opinion survey on site in late 2008 while commencing survey of potential sites. The Questionnaires were sent to target group by region and occupation via the country. The result was expected as the country as a whole recognized and agreed with the development of nuclear power plant in Thailand, but not in their area or communities. The details are shown in Table 4.

Table 4. The summarizes preliminary opinion survey on nuclear power

Nuclear Power Plant Development in	Agree	Disagree	Not Specified
Thailand	64	32	4
Their provinces	32	59	9
Their communities	24	66	10

Thailand is developing a nuclear power plan for emission free base-load electricity generation. Nuclear Power Plant Technology is a proven technology and the nuclear industry has continuously improved efficiency and safety for the plant. Thailand is conducting the Nuclear Power Pant Feasibility study and preparing necessary infrastructure for support this pan. The study will be complete by the end of this year as planned, and the readiness report will submitted to the Thai Cabinet for approval in the first quarter of next year [13 -15].

5. CONCLUSION

Despite these potential dangers, ASEAN policymakers can take several measures to chart Southeast Asia's safe passage into its nuclear future. First, Southeast Asian countries spotty commitment to international agreements on nuclear security must be addressed. All ASEAN members should sign and ratify key global agreements, at the very least the four basic relevant UN documents – the UN Convention on the Physical Protection of Nuclear Material, the UN Convention on early Notification of a Nuclear Accident, and the UN Joint Convention on the Safety of Spent Fuel Management and Safety of Radioactive Waste Management. Though this

is a first step, it is a necessary benchmark to illustrate their adherence to global standards on the regulation, management and exercise of nuclear power as this and would sooth any international anxieties. While it is unrealistic to expect ASEAN to achieve the same level of cohesion as the EU on nuclear power, several measures can be taken to boost regional over sight and capacity. For example, ASEAN should strengthen cooperation with IAEA, focusing on how ASEAN can better ensure enforcement of regional agreements like SEANWFZ by continuing to work toward institutionalizing regional measures like an early warning system for nuclear accidents and a regional emergency preparedness and response plan, which were both proposed in 2007.

Southeast Asian countries should also enlist international help for expertise if they do not have the commercial operation as specific technical capacity required for handling nuclear power. Countries with greater experience – such as the United States, France, Canada or Russia, may be willing to provide training and assistance since securing nuclear material is in their interests as well. Even if these measures are taken, the fact that nuclear power will gain salience in Southeast Asia in the coming decades means that nuclear dangers and accidents will become more likely. But if ASEAN states, other willing countries, and multilateral organizations work together, they can manage and minimize these risks in order to avert potentially catastrophic disasters from happening while simultaneously tapping the potential of nuclear energy. Only then can the region's safe passage into its nuclear future be assured.

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