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The State of Nuclear Energy in ASEAN: Regional Norms and Challenges

Mely Caballero-Anthony and Julius Cesar I. Trajano

The Fukushima nuclear disaster in 2011 did not dampen plans by Southeast Asian countries to develop nuclear power plants, despite safety concerns. The strong interest in nuclear power development is being driven by strategic considerations as states view nuclear power as an alternative energy source that can help address the dual objectives of energy security and mitigation of climate change effects. Our article examines the prospects for the Association of Southeast Asian Nations (ASEAN) to build a stronger regional normative framework to promote nuclear safety and security and prevent proliferation of nuclear weapons. In light of ASEAN's vision to establish a political and security community in 2015, we argue that member states that plan to use nuclear energy need to address critical issues such as legislative and regulatory frameworks, human resource development, radioactive waste management, nuclear safety, emergency planning, and security and physical protection. ***Keywords:*** *nuclear safety, security and safeguards, ASEAN political and security community, ASEAN norms, energy security, ASEANTOM.*

The Fukushima nuclear crisis in March 2011 took place when the nuclear power industry in Asia was on the cusp of a period of growth (International Atomic Energy Agency 2014).[1] However, after an initial wait-and-see period, nuclear energy development plans in Southeast Asia remain mostly in place, despite safety concerns. Some countries in the ten-member Association of Southeast Asian Nations (ASEAN) plan to integrate nuclear power into their long-term energy plans, reflecting their governments' view of nuclear power as an alternative energy source that can help address the dual objectives of energy security and mitigation of climate change effects (Nian and Chou 2014).

To ensure that their energy supplies are secure, affordable, and environmentally sustainable, Vietnam, Malaysia, and Indone-

sia are moving toward diversifying their energy mix, reducing their overdependence on fossil energy, and gradually integrating nuclear power into their long-term energy plans (see Table 1). Nuclear power is projected to enter the region's energy mix after 2020, when Vietnam is scheduled to complete construction of its first nuclear power plant (NPP). Meanwhile, despite strong public opposition, Indonesia is still planning to build a small experimental power reactor (Gaspar 2015), while Malaysia has started to conduct a feasibility study on exploiting nuclear energy that includes addressing public acceptance.

The region's interest in NPPs is significant in light of not only the Fukushima crisis but also the failed experience of the Philippines in building its own NPP. In what was supposed to be the first NPP in Southeast Asia, the Bataan Nuclear Power Plant (BNPP), built in 1984, never took off. Despite its high cost, estimated at $2.3 billion, BNPP has never been commissioned, due among other reasons to charges of massive corruption and safety concerns (Norimitsu 2012). BNPP is located near an active volcano and a fault line.[2]

The Philippine experience notwithstanding, the plans of some ASEAN member states to invest in developing nuclear power have implications for the regionalization of nuclear energy governance in the ASEAN region. This trend presents both challenges and opportunities, including better coordination, sharing of best practices, regional capacity building, and the strengthening of nonproliferation norms.

Table 1 ASEAN Electricity Generation by Source (percentage)

	2011	2035
Coal	32	48
Oil	44	28
Gas	10	2
Nuclear	0	2
Renewables (hydro, geothermal, bioenergy, and others)	14	20
Total	100	100

Source: International Atomic Energy Agency (2013).

Against these developments, our article examines the prospects for building a stronger regional normative framework in promoting nuclear safety and security and preventing proliferation of nuclear weapons in the region. We argue that while ASEAN has already established regional cooperative norms on nuclear safety, security, and safeguards (3S), the extent to which this normative framework is upheld and enhanced in the region still mainly depends on how member states interested in utilizing nuclear energy address critical infrastructure issues during the preparatory stages of their respective nuclear power programs. The existing nuclear infrastructure issues, if they remain unaddressed, can pose challenges to these ASEAN norms. We elucidate some of the major nuclear infrastructure issues in Vietnam, Indonesia, and Malaysia—namely, legislative framework, regulatory framework, human resource development, radioactive waste management, nuclear safety, emergency planning, and security and physical protection. With the establishment of the ASEAN Community by the end of 2015, we explore the prospects for strengthening the regional framework for nuclear energy in ASEAN post-2015.

Enhancing ASEAN's Framework on the Safe and Peaceful Use of Nuclear Energy

What are the ASEAN norms on the peaceful use of nuclear energy that must be observed by member states? ASEAN first articulated regional norms on nuclear safety and nonproliferation in the 1995 Treaty on the Southeast Asia Nuclear Weapon–Free Zone (the Bangkok Treaty). While this treaty is primarily intended to prohibit member states from developing, manufacturing, and possessing nuclear weapons, it contains several provisions that recognize each state's right to use nuclear energy for peaceful purposes, in particular for economic development and social progress. As such, it establishes the regional normative framework that guides member states should they decide to pursue nuclear energy.

The major regional norms established by the Bangkok Treaty are the following: a state pursuing nuclear energy must (1) use

nuclear material and facilities within its territory exclusively for peaceful purposes; (2) subject its nuclear program to rigorous safety assessment, conforming to guidelines and standards recommended by the International Atomic Energy Agency (IAEA) for the protection of health and minimization of danger to life and property; (3) inform fellow members, if requested, of the outcome of the safety assessment; (4) uphold the international nonproliferation system through strict adherence to the Treaty on the Non-Proliferation of Nuclear Weapons and the IAEA safeguard system; and (5) dispose of radioactive wastes and other radioactive material in accordance with IAEA standards and procedures (Association of Southeast Asian Nations 1995).

ASEAN members have underscored adherence to these norms at annual ASEAN leaders' summit meetings and particularly at the ASEAN Ministers of Energy Meeting (AMEM), in which ministers accentuate the importance of enhancing capacity-building activities on civilian nuclear energy and pursuing regional nuclear safety cooperation. In the 2012 "Phnom Penh Declaration on ASEAN: One Community, One Destiny," ASEAN leaders agreed to "develop a coordinated ASEAN approach that would contribute to global undertakings to improve nuclear safety, in cooperation with the IAEA and other relevant partners, as well as promote and uphold IAEA standards of safety and security in the development of nuclear energy for peaceful use" (Joint Ministerial Statement 2012).

ASEAN leaders likewise encourage the development of a "network amongst nuclear regulatory bodies in Southeast Asia which would enable regulators to exchange nuclear related information and experiences on best practices, enhance cooperation and develop capacities on nuclear safety, security and safeguards" (Joint Ministerial Statement 2012). In this regard, the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) was convened in 2011 and has conducted four meetings since then. This network focuses on issues of mutual interest, such as enhancing regulatory capacity through training courses and technical collaboration; sharing of best practices and relevant experiences in regulating nuclear activities to ensure nuclear safety, security, and safeguards; exchange of information on nuclear activities in each country to promote transparency and build confidence in safe, secure, and peaceful uses of atomic energy within

the region; and forging cooperation in nuclear emergency preparedness and response, as well as radiation monitoring in the region (Nian and Chou 2014).

The ASEAN statements and initiatives outlined above clearly demonstrate that its members recognize the importance of upholding the regional norms on peaceful use of nuclear energy through regional cooperation.

However, a regional normative framework on the use of nuclear energy is clearly not sufficient if there are still structural challenges to the preparatory nuclear infrastructure in each of the member countries that are considering utilizing nuclear energy. The particular challenges are the availability of human resources, adequate regulatory and legislative frameworks, and institutionalized national radioactive waste management strategies. For instance, if a member state is unable to institutionalize a comprehensive regulatory framework, the ASEAN norms on nuclear safety and security, as well as adherence to global nonproliferation obligations, may not be implemented. A competent nuclear regulatory body typically addresses proliferation concerns by inspecting and verifying that licensees are meeting all applicable safety and security requirements related to material control and accounting, information security, waste management, emergency preparedness, fire safety, radiation safety, and physical protection (US Nuclear Regulatory Commission 2015). If the regulatory body cannot fully monitor nuclear facilities, misuse of nuclear materials may occur, posing not only safety and security challenges but also nuclear proliferation risks. The next section will briefly outline nuclear energy plans in ASEAN and highlight some of the important issues, particularly regarding nuclear safety and security.

Nuclear Energy Plans in ASEAN[3]

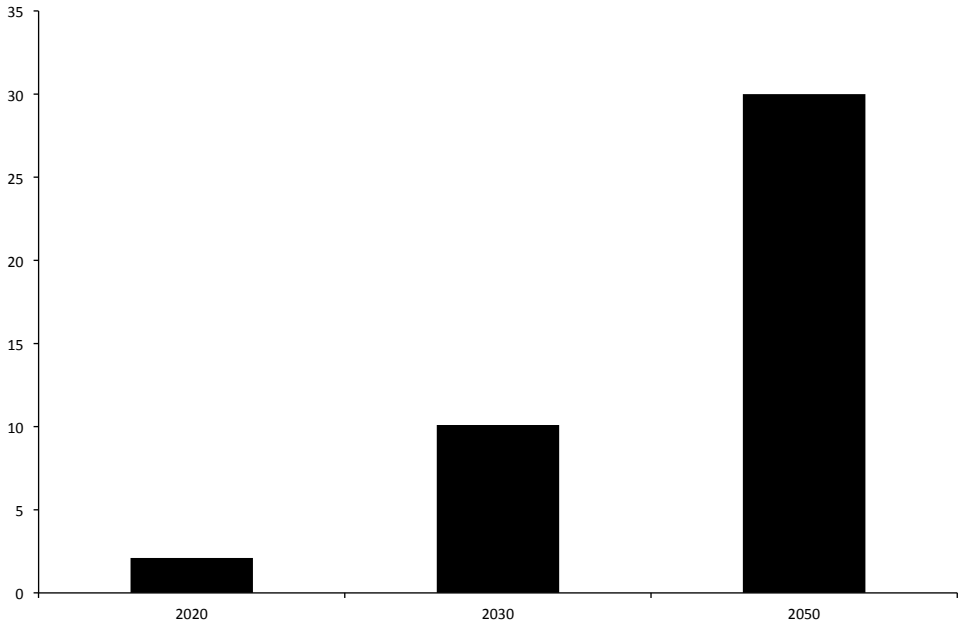
Vietnam

In November 2009 Vietnam's national assembly approved plans for construction of the first two Russian-built 1,000 MWe reactors at Phuoc Dinh, Ninh Thuan province, by 2014. Russia committed

to provide loans to finance the construction and the training of Vietnamese students in nuclear engineering. In October 2010, Vietnam and Russia signed an agreement to build the country's first power plant, the Ninh Thuan 1 nuclear power plant equipped with two Russian-made reactors (Stratfor 2014; Tuoitrenews 2014). Japan and Vietnam also signed a nuclear cooperation agreement for the construction of a second nuclear power plant at Vinh Hai in Ninh Thuan province; it was supposed to start by 2015 but was postponed later on. In preparation for the project, Japan committed to train about 1,000 staff for Ninh Thuan 2 (World Nuclear Association 2015).

In 2011, Vietnam produced a Master Plan for National Power Development 2011–2020, which envisioned that by 2020, the country would begin tapping nuclear energy. Nuclear power is

Figure 1 Projected Share (%) of Nuclear Power in Vietnam's Energy Mix



Sources: Office of the Prime Minister, Vietnam (2011); Ninh (2013).

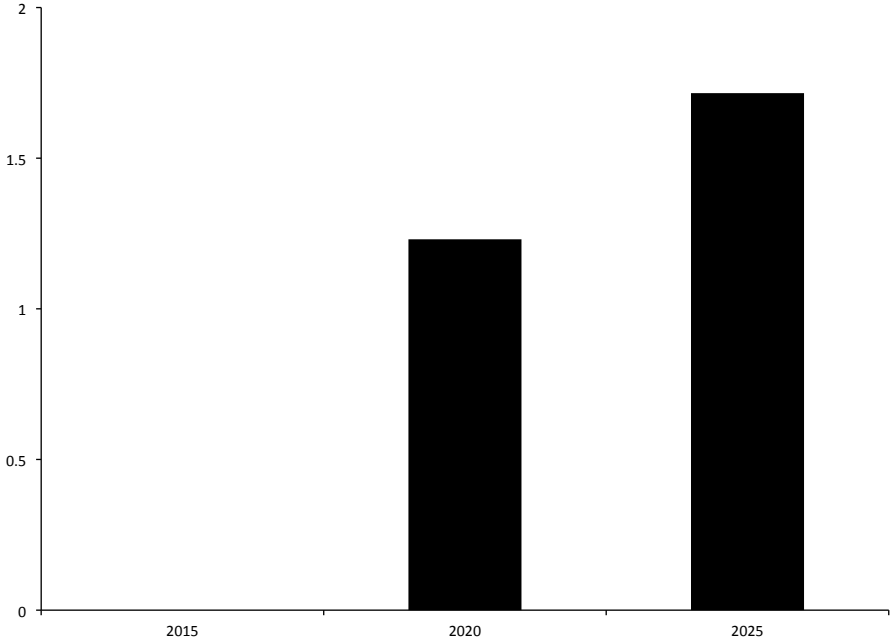
projected to account for 10.1 percent of electricity production by 2030. The construction of the first NPP was set to begin in 2014 (Office of the Prime Minister, Vietnam 2011). However, in January 2014, Prime Minister Nguyen Tan Dung announced that construction would be delayed (Stratfor 2014; Tuoitrenews 2014). The government wanted to ensure that all accuracy and safety aspects of the program are addressed before constructing the NPP, since Vietnam is still developing its human resources in the nuclear field and strengthening relevant laws and regulations.[4]

Indonesia

Since 1956, Indonesia has entertained the idea of nuclear power in anticipation of its future energy needs (IAEA 2001). Extensive preparations in accordance with IAEA guidelines and standards have been undertaken by the National Nuclear Energy Agency (BATAN) and the Nuclear Energy Regulatory Agency (BAPETEN)—the two main agencies in charge of nuclear power development in Indonesia. For research purposes, 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.[5] There is currently a plan to build a small experimental nuclear power reactor near Jakarta to advance Indonesia's preparation in case its government decides to tap nuclear power in the future.

The current government of President Joko Widodo has committed to build more power plants that can generate 35,000 megawatts (MW) in the first five years of his presidency to augment the current production capacity of 40,000 MW, due to rapidly rising domestic demand. As the country is running out of oil reserves, Indonesia will definitely need additional sources of energy. While President Widodo has not yet declared his stance on nuclear energy, some senior officials who are dealing with the energy sector believe that nuclear energy should be utilized. For instance, the director for electricity energy in the Ministry of Energy and Natural Resources asserted in November 2014 that nuclear power is greatly needed in the foreseeable future. He added, however, that NPPs should be built in the right location,

Figure 2 Projected Share (%) of Nuclear Power in Indonesia's Energy Mix



Source: Ministry of Energy and Mineral Resources, Republic of Indonesia (2008).

reflecting domestic opposition to nuclear energy based on Indonesia's location within the Pacific Ring of Fire, with frequent tectonic activities such as earthquakes and volcanic eruptions. Nonetheless, the energy director projected that Indonesia could start building an NPP in 2025 with a required capacity of at least 5,000 MW (Sunaryo 2015).

Nuclear energy is projected to make up 1.2 percent and 1.7 percent of Indonesia's energy mix in 2020 and 2025, respectively, according to Presidential Decree No. 5 in 2006. That projection has not changed and is still cited by current officials. In several public forums they have cited national pride in successfully operating an NPP as one important factor that might drive Indonesia to pursue nuclear energy in the future, regardless of the low projected contribution of nuclear energy to the future energy mix.

Malaysia

Increasing energy needs are also cited in Malaysia to justify development of nuclear power. In 2009, Prime Minister Najib Razak announced a plan for a small-scale nuclear reactor. In 2010, the energy mix in peninsular Malaysia consisted of gas (54.2 percent), coal (40.2 percent), hydro (5.2 percent), and oil (0.4 percent) (Ramli 2013). Nuclear energy development is mentioned in the New Energy Policy 2011–2014, but without a projected percentage of its total energy mix.

Nuclear energy has always engendered strong public opposition in Malaysia.[6] Civil society groups have expressed their objections to the nuclear option in a number of forums, including some organized by the government.[7] Despite this opposition, the Malaysian government does not completely rule out the nuclear option. In July 2014, Dato' Mah Siew Keong, minister in the Prime Minister's Department, stated that the government would conduct a feasibility study aimed at building an NPP in ten years' time and carry out a comprehensive study including assessing public acceptance, with input from experts and nongovernmental organizations (Bernama 2014). The government has already begun conducting the comprehensive feasibility study, though there is no certainty as to when it will be concluded and publicly released.

Legislative and Regulatory Frameworks

Nuclear industry players, including exporters of nuclear technology, have claimed that necessary improvements have been made in nuclear safety all over the world since the Fukushima accident in 2011. But still nuclear newcomers in Southeast Asia can derive valuable lessons from states with nuclear power programs when it comes to ensuring safe commissioning and operation of NPPs.

IAEA's director-general, Amano Yukiya, has repeatedly emphasized that regulatory independence leads to greater transparency and improves public acceptance (Amano 2015). One of the key lessons from Fukushima is the need to have an inde-

pendent nuclear safety regulatory body. The 1994 Convention on Nuclear Safety and the IAEA Safety Requirements call for the establishment of a regulatory body and the need for its separation, or independence, from the promoters of nuclear technology, such as government ministries (International Atomic Energy Agency n.d.). The primary reason for having an independent regulatory body is to ensure that judgments are made and enforced without pressure from interests that may conflict with safety and security.

In Southeast Asia, Vietnam, which has the most advanced NPP plan in the region, has yet to legislate a framework on regulatory independence. The Vietnam Agency for Radiation and Nuclear Safety (VARANS), which is attached to the Ministry of Science and Technology (MoST), currently serves as a nuclear regulatory body. Since 2012, Vietnam has been taking steps to develop a more independent regulatory agency. MoST and Japan's Ministry of Economy, Trade, and Industry signed an agreement to enhance the technical and safety competence of Vietnam's nuclear regulatory body. One of the proposed amendments to Vietnam's Atomic Energy Law is to make VARANS an effectively independent regulatory body, since at present it is only "partly independent" under MoST, the leading agency promoting nuclear energy in Vietnam.[8] VARANS's independence is limited to regulating radioactive sources and materials, mostly for industrial, educational, and medical applications; it cannot regulate NPP safety and security aspects. The government has yet to act on proposed amendments to VARANS and it remains uncertain whether a Vietnamese regulatory agency fully independent of ministries promoting nuclear energy can be established.

In Indonesia, contrary to what the IAEA prescribes, there is no Nuclear Energy Implementing Organization (NEPIO) to lead and manage the effort to consider and develop an NPP program.[9] Instead, several institutions such as the National Nuclear Energy Agency (BATAN), BAPETEN, the Ministry of Energy and Mineral Resources, the Ministry of Environment, and the Ministry of Research and Technology carry out separate functions in preparing for the establishment of NPPs (IAEA 2013). This arrangement

may compromise the regulatory impartiality of BAPETEN since it is part of the multiagency NPP preparatory program and may be involved in activities leading to possible establishment of an NPP. In an ideal situation, BAPETEN should have objective regulatory oversight of these preparatory activities.

Another issue in Indonesia is the delegation of NPP-related responsibilities to different agencies, which requires coordination. The absence of a dedicated steering committee signifies a lack of commitment in pursuing NPPs because although BATAN is the primary institution working on nuclear power as it reports directly to the president, it does not have any authority over other agencies. More importantly, BAPETEN itself admitted that Indonesia's legislative framework is not yet in full compliance with IAEA standards (Sunaryo 2015). And while existing legal frameworks govern the potential use of nuclear power, they require amendments to incorporate some international conventions, such as the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste.

In Malaysia, the main legislation relating to NPPs is the Atomic Energy Licensing Act 1984 (Act 304), which includes detailed provisions on radioactive materials (Bidin 2013). In 2011, Malaysia Nuclear Power Cooperation (MNPC) was established as a NEPIO. MNPC is under the supervision of the Prime Minister's Department and assumed the functions of the Nuclear Power Development Steering Committee (Markandu 2013).

The Atomic Energy Licensing Board (AELB) is the assigned nuclear regulatory body in Malaysia. However, it is also part of the Nuclear Power Development Steering Committee chaired by MNPC, which may compromise its regulatory independence since it is involved in the preparatory initiative to set up an NPP in the country. The board is also an agency attached to the Ministry of Science, Technology, and Innovation, which actively promotes the use of nuclear energy, and a member of the MNPC board of directors. In accordance with IAEA recommendations, a regulatory body should be completely independent of any government ministry that has an interest in the establishment and operations of NPPs.

Nuclear Safety and Security Measures

In terms of institutionalizing nuclear safety and security measures, the three countries have managed to introduce several initiatives that may strengthen their commitment to upholding the nuclear 3S, though some challenges have been identified by observers and even by state agencies.

For instance, Vietnam has no prior experience in utilizing nuclear energy in terms of scientific and technical knowledge as well as nuclear emergency management. The concept of safety culture even within the regulatory body is not explicitly defined since public awareness of safety culture remains low. Until today, a deep understanding of issues related to the safety of nuclear power projects among Vietnamese stakeholders, from government agencies to scientists and communities, is still very limited (Vuong 2015). Several Vietnamese nuclear experts have voiced concerns over nuclear safety and the absence of an independent regulatory body, coupled with widespread corruption and transparency issues, and a record of poor safety standards (Ninh 2013).

The Fukushima nuclear disaster raised concerns over Vietnam's capacity to administer and regulate nuclear energy. Based on climate modeling exercises, Vietnam is often listed as one of the countries most vulnerable to the impacts of climate change, such as rising sea levels and stronger typhoons, particularly around the location of the Ninh Thuan nuclear power plant. Ninh Thuan is identified as a disaster-prone coastal province (Mulder 2006). Its coastline is also vulnerable to tsunamis potentially originating from a strong tremor in the South China Sea. Despite these risks, the government remains determined to set up its NPPs in Ninh Thuan.

Vietnam works closely with the IAEA to meet all international safety standards and regulatory practices. An IAEA Emergency Preparedness Review (EPREV) was conducted in 2012 to assess Vietnam's radiation emergency preparedness and response capabilities and provide recommendations (Thiep 2013). Vietnam's national emergency preparedness and response plan was crafted and issued after the conclusion of the EPREV. VARANS has just started working with relevant national and local govern-

ment agencies to come up with a concrete emergency response and evacuation plan. However, there are still implementation challenges for the remaining IAEA recommendations. The director-general of Vietnam Atomic Energy Agency claimed that staff in key organizations directly working on nuclear infrastructure development have not been trained systematically (Tuan 2013).

Following IAEA recommendations, Vietnam started devising and implementing nuclear security measures, including a licensing system under VARANS for the transhipment of nuclear material and radioactive sources. The IAEA also provided most of the twelve radiation portal monitors and related systems that have been installed at three ports of Cai Mep, southeast of Ho Chi Minh City: Thi Vai, Ba Ria, and Vung Tau (Vi 2014).

In Indonesia, the plans for NPP development draw concern both domestically and internationally due to the frequent occurrence of natural disasters such as volcanic eruptions, earthquakes, tsunamis, floods, and landslides (National Agency for Disaster Response 2012). Realizing the implications of such geological vulnerability, BATAN has conducted site selection processes based on IAEA guidelines—BCR no. 5/2007 on the Safety Provision for Site Evaluation for a Nuclear Reactor—and best practices from other countries (Suntoko and Ismail 2013). Several proposed sites for the NPP, such as Muria (Central Java province) and Banten (West Java province), have been found to be located in seismically active zones. Bangka Island, east of Sumatra Island, is now the preferred site for the first NPP. It sits outside the Ring of Fire and has a low risk of natural disasters.[10] BAPETEN has not received any formal application from BATAN, however, suggesting that the plan to construct an NPP on Bangka Island is still at the feasibility study stage.

In order to prepare for nuclear accidents, Indonesia has held a number of nuclear emergency exercises and drills, and Fatmawati Hospital in South Jakarta is a designated referral hospital for nuclear emergencies. Reflecting on recent natural disaster responses performed by the Indonesian National Board for Disaster Management (BNPB), challenges in interagency coordination including division of authority, chain of command and control, and mobilization of resources remain the source of subpar

responses. In anticipation of such challenges, in August 2014 BAPETEN formed the Indonesian Center of Excellence on Nuclear Security and Emergency Preparedness (Bambang Sutopo Hadi 2014), a special platform where BAPETEN, BATAN, police, customs, the foreign ministry, and intelligence services communicate and coordinate their efforts for nuclear security and emergency responses (Haditjahyano 2014). To strengthen nuclear security and reduce nuclear proliferation risks, Indonesia has radiation portal monitors at several ports of the archipelago (Sinaga 2012).

Since Malaysia is located outside the Pacific Ring of Fire and typhoon belt, it is less susceptible to hazards such as earthquakes, volcanic eruptions, and typhoons (Disaster Management Division of Prime Minister's Department 2011). Floods and landslides are among the few natural disasters that typically hit Malaysia (Asian Disaster Reduction Center 2011). In 2009, Malaysia completed NPP siting guidelines and in 2011, five candidate sites were identified. The possible construction of a Malaysian NPP is still at a very early planning stage, as site selection was made based on digital mapping and no fieldwork has been carried out to date (Atomic Energy Licensing Board 2010; *Malaysian Insider* 2012). To boost emergency response and preparedness, AELB established a Nuclear Emergency Team, and first responders are located at the northern, southern, eastern, and Sabah-Sarawak parts of Malaysia (Teng 2014). AELB has regularly conducted national radiological emergency response drills, such as the National Radiological Emergency Drill, in the event of a transport accident. It has also conducted a National Field Exercise on Research Reactor Emergency Response, and a Table Top Exercise on Research Reactor Emergency Response in 2007.

To protect its nuclear facilities and adhere to nonproliferation norms, Malaysia is forging a close partnership with the United States through the Global Threat Reduction Initiative (GTRI).[11] In February 2012, four Radioactive Sources Category 1 Facilities in Malaysia were assessed under the GTRI framework (National Security Summit 2014). Malaysia also takes part in the Global Initiative to Combat Nuclear Terrorism (GICNT).[12] As part of its commitment to this initiative, Malaysia hosted a tabletop exercise

with Australia, New Zealand, and the United States in 2014 (US Department of State 2014).

Human Resources Development

Since it takes years and even decades for a country to master nuclear power technology, depending on a country's existing infrastructure and technical skill base, it is not surprising that Vietnam decided to postpone the construction of its first nuclear plant until 2017. Several government initiatives were introduced to bolster human resource training in the nuclear field. Following IAEA recommendations made in its first Integrated Nuclear Infrastructure Review (INIR) mission in 2009, Vietnam established the National Steering Committee on Human Resource Development in the Field of Atomic Energy. After the second INIR mission in 2012, Vietnam cooperated with the IAEA to organize an expert mission to support its efforts to develop the National Integrated Plan on Human Resource Development for its nuclear power program (Tuan 2014). In 2010, Prime Minister Dung approved the National Project for the Training and Development of Human Resources for Atomic Energy, otherwise known as Program No. 1558, with a budget of $150 million to be spent between 2013 and 2020 for this purpose (Dung 2010; Thiep 2013). The project aims at training 3,000 undergraduate students, 500 master's degree and doctoral students, and 1,000 teachers in atomic energy. Under this project, Vietnam has begun sending students overseas for nuclear energy studies (World Nuclear Association 2015).

Five universities in Vietnam have been selected to carry out nuclear energy training and are expected to take in thirty students each year starting in 2014 (Ninh 2013; Vi 2014).[13] In preparation for inauguration of the Ninh Thuan NPP, the Ministry of Education and Training (MOET) is to train 1,000 students from now up to 2020, while those studying overseas are being trained for three to five years in Russia and Japan.[14] However, a challenge for nuclear programs is the shortage of trained professionals in the construction and operation of NPPs. Although Vietnam is now

investing in human resource training and capacity building, criticisms have been voiced about an emphasis on theory rather than practice (Ninh 2013). One major concern is the immediate impact of the postponement of the construction of the Ninh Thuan NPP on manpower development. Thirty students trained in Russia will start returning home by 2016.[15] By 2018–2019, additional students will be returning from abroad. But the Ninh Thuan NPP will not have been constructed, resulting in a lost opportunity for these students to apply what they have learned overseas in operating an NPP. To address this issue, MOET plans to send them overseas again to pursue higher education while waiting for the first NPP to become operational.

Meanwhile, Indonesia has a pool of nuclear experts who have worked for over thirty years at BATAN and other nuclear research facilities (Ministry of Energy and Mineral Resources, Republic of Indonesia 2008). Long-serving nuclear experts will soon enter their retirement age and Indonesia needs to recruit and develop human resources to replace them (*Antara News* 2013). BATAN established four-year bachelor programs in nuclear techno-chemistry and nuclear techno-physics at the College of Nuclear Technology in 2001, but this program is not designed to produce nuclear engineers and technicians needed in operating an NPP.

BATAN invests in engineering and science graduate recruits to develop specialized expertise in nuclear energy through placement in NPP companies in South Korea, Japan, and Russia (IAEA 2013). Indonesia has also established a National Team of Human Resource Development and drafted a plan of action that includes the establishment of a Nuclear Training Center (NTC) (National Team of Human Resource Development for Nuclear Power Plants 2013). The formation of the NTC began in 2010 and remains a work in progress, however.

In Malaysia, human resource development in nuclear science begins in universities. While the National University of Malaysia is the only university with a nuclear science department (Adnan, Ngadiron, and Ali 2012), other universities also offer nuclear-related subjects. The focus of nuclear knowledge and expertise, however, is primarily on nonpower applications such as medicine,

health, agriculture, industry, and manufacturing (Khair and Hayati 2009).

To operate NPPs, more specialized subjects such as nuclear reactor design, nuclear safety engineering, and nuclear fuels and materials are needed. However, at present, experienced personnel to teach nuclear engineering courses are insufficient. Malaysia does not have a dedicated human development program for NPPs, and it remains unclear whether Malaysia would have the necessary qualified people by the time it constructed its first NPP (Khair and Hayati 2009).

From a long-term perspective, ASEAN states may emulate the French and US capacity-building programs in maintaining a local pool of highly qualified nuclear engineers and technicians. Those education and training programs ensure knowledge transfer from an aging nuclear workforce to the next generation of workers.

Nuclear Waste Management Policy

The failure of states with NPPs to address the disposal of high-level nuclear waste (i.e., spent/used reactor fuel) from the day they started exploring nuclear energy should serve as a crucial takeaway for newcomers in Southeast Asia. Presently, there is no final repository site for high-level waste accumulated globally over six decades. Nevertheless significant progress has been made in France, Sweden, and Finland in developing deep geological disposal sites that are tentatively to be made available after 2020 (Amano 2015).

But the IAEA has strongly advised newcomers in Asia to first address the waste issue by developing national policy and infrastructure for radioactive waste management, even before commissioning NPPs (Amano 2015). Vietnam has yet to come up with a permanent disposal strategy. As part of its nuclear deal with Moscow, its future spent fuel will be reprocessed in Russia, but the treated wastes will still be returned to Vietnam, where a disposal facility will be required. The lack of a comprehensive plan on the disposal of spent fuel is one key challenge that has yet to be addressed by Vietnam (Vi 2014).

Indonesia has ratified the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management. Its nuclear research facilities are capable of managing and disposing of low- and intermediate-level radioactive waste produced from educational, medical, and industrial activities. But no comprehensive plan has yet emerged on the final disposal of high-level waste should Indonesia decide to commission nuclear power plants.

In Malaysia, significant capacity concerns exist around the safe disposal of nuclear waste. The implications for NPP development and the future safe disposal of nuclear waste are significant. Malaysia has not yet ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The controversy over a rare earth mining site is often cited by local critics of nuclear energy to demonstrate the lack of capacity of Malaysian authorities to deal with radioactive waste. The radioactive waste facility at Lynas rare earth mining site in Pahang allegedly lacks a sustainable plan for the long-term disposal of radioactive wastes under acceptable conditions, with possible leakage of harmful waste into the environment, according to a report by a German environmental research group, the Oeko-Institute. It argues that deficiencies should have already been detected in the licensing process, when application documents were being checked by the nuclear regulator (Schmidt 2013).

Policy Pathways to Enhance Nuclear Safety and Security in ASEAN

Our discussion has assessed the plans for nuclear power plants of three ASEAN countries against the multiple and overlapping security, safety, and safeguards challenges they all face. These three areas point to institutional and human resource capacity and the need to develop a coordinated approach to nuclear energy safeguards, safety, and security. To be sure, nuclear capabilities engender a certain level of apprehension among neighboring countries that can trigger escalating tensions. We therefore argue

that it is imperative for ASEAN member states to work together to ensure effective governance of nuclear facilities, materials, and wastes and to adopt a regional disaster preparedness mechanism.

Despite criticisms of ASEAN that it is slow and ineffective in tackling regional issues, it remains among the most relevant platforms for developing policies and frameworks at the regional level. ASEAN can facilitate regional cooperation on capacity building, information dissemination, and emergency preparedness and response. As there is a risk of radioactive contamination spreading across borders, ASEAN governments must clearly and transparently manage nuclear activities and waste and explore channels for communication with neighbors to address cross-border impacts. As ASEAN member states work to establish an ASEAN Community, fostering an ASEAN consensus on nuclear energy–related issues becomes possible.

One key impediment to cooperation, however, is ASEAN's guiding principle of nonintervention in another state's domestic affairs. Many states still perceive energy security as a national security issue and are reluctant to discuss their nuclear energy programs at the regional level. Finding the right balance between national sovereignty and regional cooperation is often challenging since nuclear security always entails confidentiality, since it is considered a national security issue. ASEAN can leverage its strength as an avenue for regional cooperation to address nontraditional security issues such as humanitarian assistance and disaster response in case a nuclear accident occurs. Currently, ASEAN has two subgroups that promote regional cooperation on nuclear energy: ASEANTOM and a Nuclear Energy Cooperation Sub-Sector Network (NEC-SSN), which is composed of senior officials involved in energy policy and trade. The efficacy of their activities could be boosted by a number of national and regional initiatives.

To complement the normative framework on nuclear energy embodied in the 1995 Bangkok Treaty, ASEAN could explore drafting a blueprint on nuclear safety, security, and safeguards. The objective would be the establishment of a robust nuclear governance regime in ASEAN to ensure that nuclear 3S processes are in place in good time before any ASEAN member's nuclear power plans are realized (probably starting with Vietnam in 2025). The

blueprint could contain practical and feasible mechanisms, informed by evidence on best practices in other regions, that can facilitate regional cooperation on capacity building, information sharing/dissemination, enhancement of regulatory frameworks, and emergency preparedness and response frameworks. All these subjects would be within the bounds of ASEAN's principle of noninterference in domestic affairs. The important elements of this blueprint might include a regional framework on spent fuel management, cooperation on human resources development, and a feasibility study on a regional nuclear crisis center and joint nuclear emergency drills.

Concerning the drafting of a possible regional framework on spent fuel management, ASEAN can draw on relevant experiences of the European Atomic Energy Community's (EURATOM) regional legislative framework. In 2011, the European Union ratified binding legislation on spent fuel and radioactive waste management, requiring its members to adopt national programs for handling radioactive waste and develop specific plans for building waste disposal facilities (European Commission 2014). An ASEAN framework could spell out how the member states can cooperate to contribute to global efforts to find a sustainable approach to disposing of nuclear waste, as well as encourage members interested in pursuing nuclear power to craft their respective comprehensive national plans for management of high-level radioactive waste.

Considering the need to strengthen responses to nuclear crises for the protection of people and the environment, ASEAN could set up a regional nuclear crisis center in which its first responders, health-care practitioners, customs officers, law enforcement, and disaster center personnel can come together and participate in workshops, training, and joint drills. This cooperative effort would facilitate information and knowledge exchange, and increase response coordination in case member states are affected by radiation plumes. In times of crisis, the center would act as a special coordinating body for regional and interministerial disaster response.

Relatedly, ASEAN defense ministers can pursue the incorporation of joint nuclear emergency drills into the ASEAN Defense

Ministers Meeting–Plus Humanitarian Assistance and Disaster Response/Military Medicine Exercise. To this end, ASEAN could establish a regional contingent of specially trained nuclear disaster emergency responders, similar to the ASEAN–Emergency Rapid Assessment Team found in the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management.

Finally, since human resources development is a key nuclear infrastructure issue that needs to be addressed by member states interested in nuclear power, regional cooperation on this issue can be part of the ASEAN framework on nuclear 3S. They can derive valuable lessons from EURATOM's initiatives such as its regional human resources training program. Under the EURATOM Fusion Training Scheme, various training actions have been launched since 2006 to ensure that adequate human resources will be available in the future in terms of numbers, range of skills, and high-level training and experience (European Commission 2013).

The NEC-SSN was tasked by ASEAN energy ministers in 2012 to continue to promote and intensify capacity-building efforts, in collaboration with the IAEA and other relevant partners, so that the region will be more informed and kept updated on the latest nuclear safety standards, developments, and technologies (Joint Ministerial Statement of the 30th ASEAN Ministers of Energy Meeting 2012). Hence, NEC-SSN needs to accelerate and strengthen its programs under the ASEAN Action Plan on Public Education on Nuclear Energy and Nuclear as the Clean Energy Alternative Option with a view to enhancing public awareness and acceptance of the use of nuclear energy for power generation.

With the assistance of the IAEA, ASEAN member states can organize joint training workshops for the region's nuclear security professionals in evaluation methodology, helping them conduct site evaluations and interpret the results. ASEAN member states need to ensure that they will be able to conduct the activities already identified during the 2014 meeting of ASEANTOM. These activities include a number of regional workshops and training courses on emergency preparedness and response as well as on nuclear security culture and management (ASEANTOM 2014).

In conclusion, we reiterate that any nuclear energy program is a long-term commitment that should be expected to take decades, from planning and construction to operation, waste management, and capacity building. It is a sophisticated, uniquely hazardous and proliferation-prone technology that requires rigorous planning. Vietnam, Malaysia, and Indonesia have already institutionalized several measures that adhere to the region's normative framework on the peaceful use of nuclear energy. Yet the safe development of nuclear power in Southeast Asia faces hurdles to ensure adherence to nuclear 3S norms, including on nonproliferation. Regional cooperation is the key to achieving adherence, and with the establishment of an ASEAN Community by the end of 2015, consensus on nuclear energy–related issues is possible. Member states will, however, have to work around concerns about noninterference in domestic affairs, giving priority to shared concern and interest in a nuclear-safe and nuclear weapons–free ASEAN.

Notes

Mely Caballero-Anthony is associate professor and head of the Centre for Non-Traditional Security Studies at the S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University, Singapore. She is a member of the UN Secretary-General's Advisory Board on Disarmament Matters and the UN Academic Advisory Council on Mediation and Conflict Prevention. Her research interests are regional security in ASEAN and the Asia Pacific region, conflict prevention and management, and human security. Among her recent books are *Non-Traditional Security in Asia* (2013), *ASEAN and Climate Change: Building Resilience Through Regional Initiative* (2012), and *Energy and Non-Traditional Security in Asia* (2012). She can be reached at ISMCAnthony@ntu.edu.sg.

Julius Cesar I. Trajano is senior analyst with the Centre for Non-Traditional Security Studies at RSIS. His research interests include energy security, humanitarian assistance, territorial disputes in East Asia, and conflict prevention. He has published on the South China Sea disputes, Japan-Philippines security relations, and renewable energy and nuclear energy governance in Southeast Asia, and is coauthor of the 2014 RSIS Policy Report, "The Sustainability of Nuclear Energy in Southeast Asia: Opportunities and Challenges." He can be reached at isjtrajano@ntu.edu.sg.

1. In 2014, there were 439 nuclear reactors worldwide operating in thirty-one countries. Two-thirds of the sixty-nine nuclear reactors under construction are in Asia, led by China, India, and South Korea (International Atomic Energy Agency 2014).

2. BNPP was built between 1976 and 1984, during the authoritarian regime of Ferdinand Marcos. But it was mothballed by President Corazon Aquino in 1986. Succeeding administrations strained to pay off the debt incurred for the BNPP's construction, and today, public funds have been used to maintain the nuclear power plant.

3. Information on nuclear power plans in ASEAN is based on fieldwork in the region conducted August 6–15, 2014, and part of the report *Sustainability of Nuclear Energy in ASEAN: Opportunities and Challenges* published by the Centre for Non-Traditional Security Studies, S. Rajaratnam School of International Studies (RSIS). The authors are contributors to the report.

4. Interview with officials of the Vietnam Academy of Science and Technology, Hanoi, August 7, 2014.

5. Interview with engineers of the Serpong nuclear research reactor in Banten, Indonesia, August 2014.

6. For further details, visit www.consumer.org.my, organized by the Consumer Association of Penang, and www.thepetitionsite.com/745/599/785/public-petition-to-stop-nuclear-power-plants-in-malaysia, supported by the Malaysian Coalition Against Nuclear, MY-CAN.

7. E-mail interview with a worker for the Consumer Association of Penang.

8. Interview with an official of VARANS, Hanoi, August 8, 2014.

9. NEPIO implements "a nuclear power programme, which may be preparing for a decision to implement, coordinating the implementation among other entities or carrying out the implementation itself" (IAEA 2009).

10. Interview with officials of the Nuclear Energy Regulatory Agency of Indonesia (BAPETEN), Jakarta, August 14, 2014.

11. GTRI is a US-led initiative that aims at protecting against and reducing excessive civilian nuclear and radiological materials worldwide, particularly highly enriched uranium.

12. GICNT is an international partnership to strengthen collective capacity to prevent, detect, and respond to nuclear terrorism. Eighty-five countries take part in GICNT including Malaysia, Singapore, and Vietnam; the European Union, IAEA, INTERPOL, and the United Nations Office on Drugs and Crimes are observers.

13. These universities are Vietnam National University (VNU, Hanoi), Polytechnic University (Hanoi), University of Science–VNU (Ho Chi Minh City), Dalat University, and Electric Power University (Hanoi). None of the five universities is included in the QS World University Rankings 2013.

14. Interview with an official of the Ministry of Education and Training (MOET), Hanoi, August 8, 2014.

15. Interview with an official of MOET, Hanoi, August 8, 2014.

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