7

Enhancing nuclear energy cooperation in ASEAN: Regional norms and challenges

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Abstract

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 chapter 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 the proliferation of nuclear weapons. In light of ASEAN's vision to establish a political and security community, we argue that member states that plan to use nuclear energy need to address critical issues such as legislative and regulatory frameworks, human resources development, radioactive waste management, nuclear safety, emergency planning, and security and physical protection. With the establishment of the ASEAN Community in 2015, we explore the prospects for strengthening the regional framework for nuclear energy in ASEAN post-2015, spearheaded by the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM).

Introduction

The Fukushima nuclear crisis of March 2011 took place when the nuclear power industry in Asia was on the cusp of a period of growth (IAEA PRIS 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 10-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, ASEAN members 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 7.1).

Table 7.1 ASEAN electricity generation by source

Fuel	Share	
	2013 (%)	2040 (%)
Coal	32	50
Oil	6	1
Gas	44	26
Nuclear	0	1
Renewables (hydro, geothermal, bioenergy, and others)	18	22
Total	100	100

Source: IEA (2015: 39).

Nuclear energy plans in ASEAN

Several countries in Southeast Asia have been articulating their interest in using nuclear power, as they intend to strengthen their energy security though diversification of their energy mix. Vietnam used to be the lead

1 In 2014, there were 439 nuclear reactors operating in 31 countries. Two-thirds of the 69 nuclear reactors under construction are in Asia, led by China, India, and South Korea (IAEA PRIS 2014).

driver of nuclear power development in ASEAN, from 2009 when it decided to build its first nuclear power plant, until November 2016 when its government decided to scrap its plan primarily due to the soaring cost of the project. Prior to the cancellation, Vietnam's 2,400 megawatt (MW) Ninh Thuan 1 nuclear power plant was scheduled to be operative by 2028/29 (after several delays), while the 2,000 MW Ninh Thuan 2 nuclear power plant was set to be commissioned by 2030. Russia's state-owned nuclear firm Rosatom was tipped to build Ninh Thuan 1, while a consortium of Japanese nuclear firms led by Japan Atomic Power was considered for the construction of Ninh Thuan 2 (Pascaline 2016). Nonetheless, although the government already decided to scrap its nuclear power plant project, it will still continue 'promoting' nuclear power (Kyodo News 2016). In this regard, Vietnam plans to build a new research reactor, also known as the Centre for Nuclear Energy Science and Technology, to further enhance the skills and technical know-how of its nuclear professionals and students.

Indonesia has long been preparing for the possible utilisation of nuclear energy with the establishment of three nuclear research reactors: Reactor Triga 2000 in Bandung, established in 1965; Reactor Kartini 250-kilowatt (kW) in Yogyakarta (1979); and RSG-GAS 30 MW in Serpong (1987). In 2006, the International Atomic Energy Agency (IAEA) declared that Indonesia was ready to make a knowledgeable commitment to a nuclear power program, although no government decision has yet been made as to whether Indonesia will proceed to build the nuclear power plants. The Ministry of Energy and Mineral Resources issued a 'White Paper of Indonesia NPPs [nuclear power plants] 5000 MWe in Bangka Belitung 2014–2024', which called for the introduction of nuclear power in order to address Indonesia's rapidly growing energy consumption. Indonesia's electricity demand is projected to increase to 150 gigawatts (GW) by 2025. The contribution of this new energy source is seen as a major energy alternative that can boost the country's power supply (Taryo 2015).

The National Nuclear Energy Agency of Indonesia (BATAN) has recommended that a nuclear power plant be established by 2027. BATAN conducted feasibility studies for possible nuclear power plant sites in Bangka-Belitung Island, West Kalimantan, and Muria and Banten in Java. Bangka-Belitung Island, near Sumatra, has been identified as the site of the country's first nuclear power plant since the island is not within the country's earthquake and volcanic zones. While no official decision

has been made on the use of nuclear power, a nationwide public survey commissioned by BATAN in 2014 reported that 72 per cent of Indonesians agree that nuclear power plants should be setup in the country.[2]

In Malaysia, increasing energy needs are cited 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 per cent), coal (40.2 per cent), hydro (5.2 per cent), and oil (0.4 per cent) (Ramli 2013). Nuclear energy development is mentioned in the Eleventh Malaysia Plan 2016–2020, but without a projected percentage of its total energy mix (see Economic Planning Unit 2015).

Nuclear energy has always engendered strong public opposition in Malaysia.[3] Civil society groups have expressed their objections to the nuclear option in a number of forums, including some organised by the government.[4] 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 a nuclear power plant in 10 years' time and would carry out a comprehensive study including assessing public acceptance, with input from experts and non-governmental organisations (NGOs) (Bernama 2014). The government has already begun conducting the comprehensive feasibility study, although there is no certainty as to when it will be concluded and publicly released.

In November 2016, Philippines President Rodrigo Duterte gave his go-ahead to the Department of Energy to proceed with a feasibility study to reactivate Bataan nuclear power plant to generate 621 MW of electricity, a turnaround from an earlier stand rejecting the use of nuclear energy during his presidency. But he gave clear instructions to pay special attention to the safety and security aspects of operating the 30-year-old power plant (Lucas 2016).

2 Interview with BATAN official, Singapore, 30 October 2015.

3 For further details, see Consumers Association of Penang (n.d.), and Care2 Petitions (n.d.), which is supported by the Malaysian Coalition Against Nuclear.

4 Email interview with a Consumers Association of Penang worker, 10 September 2014.

In May 2016, Cambodia and Russia signed two deals to set up a nuclear energy information centre and a joint working group on peaceful uses of atomic energy. According to Rosatom, the nuclear energy information centre will help Cambodians, especially students, better understand nuclear energy principles and important developments in nuclear energy and industry. The memorandum on a Cambodia–Russia joint working group on the peaceful uses of atomic energy stipulates that the parties will hold regular meetings between experts from the two countries to define and implement joint projects. Russia will provide expertise, research, and training under the terms of the agreement. Although Cambodian Prime Minister Hun Sen had previously stated that his country would not go nuclear, there are repeated calls from within the government to consider nuclear power, prompted by similar interest and moves among its Southeast Asian neighbours. The memorandum and the information centre may lay the groundwork for a nuclear power project in the future if Cambodia chooses to proceed (Tan 2016).

Against these developments, this chapter 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 utilising 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 specifically in three ASEAN members—Vietnam, Indonesia, and Malaysia. These issues are legislative and regulatory frameworks, human resources development, radioactive waste management, nuclear safety, emergency planning, and security and physical protection. With the establishment of the ASEAN Community in 2015, we explore the prospects for strengthening the regional framework for nuclear energy in ASEAN post-2015, spearheaded by the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM).

Enhancing ASEAN's framework on the safe and peaceful use of nuclear energy

What are ASEAN's norms on the peaceful use of nuclear energy that must be observed by member states? ASEAN first articulated regional norms on nuclear safety and non-proliferation 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 recognise 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 IAEA for the protection of health and minimisation of danger to life and property; (3) inform fellow members, if requested, of the outcome of the safety assessment; (4) uphold the international non-proliferation system through strict adherence to the Nuclear Non-Proliferation Treaty and the IAEA safeguard system; and (5) dispose of radioactive wastes and other radioactive material in accordance with IAEA standards and procedures (ASEAN 1995).

ASEAN members have underscored adherence to these norms at annual ASEAN leaders' summit meetings and particularly at the ASEAN ministers of energy meetings, in which ministers accentuate the importance of enhancing capacity-building activities on civilian nuclear energy and pursuing regional nuclear safety cooperation. In the Phnom Penh Declaration on ASEAN: One Community, One Destiny (ASEAN 2012b), 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 (ASEAN 2012a).

The ASEAN Political-Security Community Blueprint 2025 (Section B.5.2) also endorses the development of a regional approach to strengthen nuclear safety, in coordination with the IAEA and other relevant international organisations. But, more importantly, the blueprint promotes the strengthening of ASEANTOM so that it can effectively lead the development of the ASEAN regional approach to nuclear safety (see ASEAN Secretariat 2016).

The emerging role of ASEANTOM in strengthening regional cooperation

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 (ASEAN 2012a).

In this regard, in 2011, Thailand's Office of Atoms for Peace (OAP) proposed the creation of ASEANTOM in an informal consultation and received positive comments from ASEAN regulatory bodies. The proposal was later presented to the ASEAN Summit 2011 and received a warm welcome from member states (ASEANTOM 2014a). ASEANTOM was designated in 2015 as an ASEAN sectoral body under the ASEAN Political-Security Community Pillar in Annex 1 of the ASEAN Charter (ASEAN 2015). Its activities are now reported to foreign ministries of ASEAN members and have been recognised in the ASEAN Summit chairman's statement (Biramontri 2016). Realising that they cannot uphold nuclear safety individually and in isolation in the aftermath of the Fukushima disaster, ASEAN members acknowledged that they need to cooperate and share information through ASEANTOM as part of the building blocks of regional frameworks to institutionalise the culture of nuclear safety and security.

ASEANTOM focuses on four issues of mutual interest: emergency preparedness and response, environmental radiation monitoring, nuclear security, and nuclear safety (Biramontri 2016). In 2012, a preliminary meeting among ASEAN regulators was hosted by Thailand's OAP to finalise ASEANTOM's Terms of Reference to enhance the growth of knowledge and resources to ensure the 3S of peaceful nuclear energy

applications. ASEANTOM has already conducted three annual meetings. The first meeting (Phuket, 2013) facilitated information exchanges and cooperation in the area of nuclear 3S among the member states, and set up the network's work plan. The second meeting (Chiang Mai, 2014) allowed for a review of activities conducted during the past year and discussed further activities under the work plan for 2015–16. These activities included a number of regional workshops and training courses on emergency preparedness and response as well as on nuclear security culture, safety, and management (ASEANTOM 2014a). The third meeting (Kedah, 2015) designated ASEANTOM as a sectoral body under the ASEAN Political-Security Community and also assigned it to be the key point of contact with the IAEA to facilitate greater cooperation and collaboration on issues related to nuclear 3S (Biramontri 2016).

In 2014, Thailand and Vietnam co-hosted a regional meeting on radiation environment monitoring cooperation aimed at facilitating information exchange and seeking opportunities to establish a regional early warning network and a regional data centre; Malaysia hosted a workshop on nuclear regulation establishment and the current and future national regulatory and legal framework; and Singapore hosted a meeting between Euratom and ASEANTOM in which the former shared its relevant experiences (ASEANTOM 2014a). Under the ASEANTOM framework, Malaysia and Thailand since 2015 have been co-hosting annual nuclear security border exercises, including tabletop and field exercises in their shared borders, and have been involving nuclear regulatory bodies, customs, police, and emergency response teams. All ASEAN members are invited to participate in these exercises that test their capability to jointly interdict illicit trafficking of radioactive materials. Furthermore, ASEANTOM has two ongoing projects, with assistance from the IAEA and the European Union (EU), to strengthen joint nuclear emergency preparedness and response cooperation in ASEAN: a Regional Cooperation Project Concept in South East Asia to Support Regional Environmental Radioactivity Database & Nuclear Emergency Preparedness and Response assisted by the IAEA; and Enhancing Emergency Preparedness and Response in ASEAN: Technical Support for Decision Making assisted by the EU (Biramontri 2016).

ASEANTOM has likewise facilitated inter-regional cooperation between ASEAN and the EU, particularly in regard to nuclear safety and emergency preparedness. In early 2016, the European Commission completed its feasibility study on enhancing regional cooperation within ASEAN

on radiological and nuclear emergency preparedness and response. The study was undertaken by the Joint Research Centre of the European Commission, in cooperation with nuclear safety regulatory authorities in six ASEAN members.[5] The study is part of the EU's Instrument for Nuclear Safety Cooperation. It contains a regional strategy, including an action plan for its implementation. It recommends that ASEANTOM implement the action plan with support, inter alia, from the EU and the IAEA. The need for joint emergency preparedness and response in the region has become more urgent due to recent developments, in particular in the context of nuclear power plants being constructed near ASEAN's border in neighbouring countries[6] and plans to use nuclear energy in some ASEAN member states. However, as expressed by some regulatory officials in the region at the International Dissemination Workshop on Enhanced Regional Cooperation on Nuclear Emergency Preparedness and Response, held in Kuala Lumpur in February 2016, one major challenge for ASEANTOM in implementing the regional strategy is the lack of adequate logistical and financial resources of national regulatory bodies.

ASEAN's nuclear 3S regional frameworks and initiatives outlined above clearly demonstrate that its members recognise the importance of upholding the regional norms on the 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 utilising nuclear energy. The particular challenges are the availability of human resources, adequate regulatory and legislative frameworks, and institutionalised national radioactive waste management strategies. For instance, if a member state is unable to institutionalise a comprehensive regulatory framework, ASEAN's norms on nuclear safety and security, as well as adherence to global non-proliferation 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

5 The six ASEAN regulatory bodies were the Nuclear Energy Regulatory Agency of Indonesia (BAPETEN), the Atomic Energy Licensing Board (AELB, Malaysia), the Philippine Nuclear Research Institute, the National Environment Agency (Singapore), the OAP (Thailand), and the Vietnam Agency for Radiation and Nuclear Safety (VARANS).

6 China has begun operating three nuclear power stations near its border with Vietnam.

physical protection (US NRC 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 briefly outlines nuclear energy plans in ASEAN and highlights some of the important issues, particularly regarding nuclear safety and security.

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 of 2011. But nuclear newcomers in Southeast Asia can still derive valuable lessons from states with nuclear power programs when it comes to ensuring safe commissioning and operation of nuclear power plants.

In Southeast Asia, Vietnam, which had the most advanced nuclear power plant plan in the region until the plan was scrapped, has yet to legislate a framework on regulatory independence. The Vietnam Agency for Radiation and Nuclear Safety (VARANS) currently serves as a nuclear regulatory body. Since 2012, Vietnam has been taking steps to develop a more independent regulatory agency. The Ministry of Science and Technology 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 it is only 'partly independent' under the Ministry of Science and Technology, which is the leading agency promoting nuclear energy in Vietnam.[7] VARANS's independence is limited to regulating radioactive sources and materials, mostly for industrial, educational, and medical applications; it cannot regulate nuclear power plant safety and security aspects. The government has yet to act on proposed amendments

7 The IAEA's director-general, Amano Yukiya, has repeatedly emphasised that regulatory independence leads to greater transparency and improves public acceptance (Amano 2015). One of the key lessons from Fukushima has been the need to have an independent nuclear safety regulatory body. The 1994 Convention on Nuclear Safety and the IAEA General 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 (IAEA 1994). The primary reason for having an independent regulatory body is to ensure that judgements are made and enforced without pressure from interests that may conflict with safety and security.

to VARANS and it remains uncertain whether a Vietnamese regulatory agency fully independent of ministries promoting nuclear energy can be established.[8] The Vietnamese government was not keen to make VARANS a fully independent regulatory body as it believed that inter-agency cooperation, involving all concerned ministries and VARANS, was far more important at this stage to make the first nuclear power plant project successful.[9]

A national steering committee was set up by the Vietnamese government to oversee the project management of its nuclear power plant program. The committee is composed of the Ministry of Trade and Industry with Electricity of Vietnam as the attached agency; the Ministry of Science and Technology with VARANS, the Vietnam Atomic Energy Institute (VINATOM), and the Vietnam Atomic Energy Agency as attached agencies; and the Ministry of Education and Training. The management of the committee, however, is not efficient and members do not meet regularly as the deputy prime minister (the chair) has been extremely busy with other tasks.

Contrary to the IAEA's prescription, there is no Nuclear Energy Program Implementing Organisation (NEPIO) in Indonesia to lead and manage the effort to consider and develop a nuclear power plant program.[10] Instead, several institutions such as BATAN, the Nuclear Energy Regulatory Agency of Indonesia (BAPETEN), the Ministry of Energy and Mineral Resources, the Ministry of Environment, and the Ministry of Research and Technology carry out separate functions to prepare for the establishment of nuclear power plants (IAEA 2013). This arrangement may compromise the regulatory impartiality of BAPETEN since it is part of the multi-agency nuclear power plant preparatory program and may be involved in activities leading to possible establishment of a nuclear power plant. In an ideal situation, BAPETEN should have objective regulatory oversight of these preparatory activities.

Another issue in Indonesia is the delegation of nuclear power plant–related responsibilities to different agencies, which requires coordination. The absence of a dedicated steering committee signifies a lack of

8 Interview with a VARANS official, Hanoi, 8 August 2014.

9 Interview with a VINATOM official, Singapore, 30 October 2015.

10 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 2008: 1).

commitment in pursuing nuclear power plants 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. Inter-agency cooperation to further advance the nuclear power plant program remains weak. While it would be highly recommended to ensure that the regulatory body is completely independent from any agency promoting nuclear power, BAPETEN still needs to have robust cooperation with BATAN to fully develop its regulatory capability (Taryo 2015). 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 on the Safety of Radioactive Waste (1997).

In Malaysia, the main legislation relating to nuclear power plants is the *Atomic Energy Licensing Act 1984* (Act 304), which includes detailed provisions on radioactive materials (Bidin 2013). In 2011, the Malaysia Nuclear Power Cooperation (MNPC) was established as a NEPIO. The 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 the MNPC, which may compromise its regulatory independence since it is involved in the preparatory initiative to set up a nuclear power plant in the country. The AELB 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 governmental ministry that has an interest in the establishment and operation of nuclear power plants.

Nuclear safety and security measures

In terms of institutionalising nuclear safety and security measures, Vietnam, Indonesia, and Malaysia have managed to introduce several initiatives that may strengthen their commitment to upholding the

nuclear 3S, although some challenges have been identified by observers and even by state agencies. For instance, Vietnam has no prior experience in utilising 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. A deep understanding of issues related to the safety of nuclear power projects among Vietnamese stakeholders—such as government agencies, 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 modelling exercises, Vietnam is often listed as one of the most vulnerable countries 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) whose coastline is 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 nuclear power plants in Ninh Thuan.

Vietnam works closely with the IAEA to meet all international safety standards and regulatory practices. An IAEA Emergency Preparedness Review was conducted in 2012 to assess Vietnam's radiation emergency preparedness and response capabilities and to provide recommendations (Thiep 2013). Vietnam's national emergency preparedness and response plan was crafted and issued after the conclusion of the review. VARANS has begun to work with relevant national and local government agencies to elucidate a concrete emergency response and evacuation plan. However, there are still implementation challenges for the remaining IAEA recommendations. The director-general of the Vietnam Atomic Energy Agency claimed that staff in key organisations directly working on nuclear infrastructure development have not been trained systematically (Hoang 2013).

Following the 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 12 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 nuclear power plant 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). Realising 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 nuclear power plant, such as Muria (Central Java Province) and Banten (West Java Province), have been found to be located in seismically active zones. Bangka-Belitung Island, east of Sumatra Island, is now the preferred site for the first nuclear power plant. It sits outside the Pacific Ring of Fire and has a low risk of natural disasters.[11] BAPETEN has not received any formal application from BATAN, however, suggesting that the plan to construct a nuclear power plant on Bangka-Belitung 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, challenges in inter-agency coordination including division of authority, chain of command and control, and mobilisation of resources remain the source of sub-standard responses. In anticipation of such challenges, BAPETEN formed the Indonesia Center of Excellence on Nuclear Security and Emergency Preparedness in August 2014 (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).

11 Interview with BAPETEN officials, Jakarta, 14 August 2014.

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 nuclear power plant siting guidelines and, in 2011, five candidate sites were identified. The possible construction of a Malaysian nuclear power plant 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 (*Malaysian Insider* 2012; AELB 2010). To boost emergency response and preparedness, the AELB established a nuclear emergency team, and first responders are located at the northern, southern, eastern, and Sabah–Sarawak parts of Malaysia (Teng 2014). The AELB has regularly conducted national radiological emergency response drills, such as the National Radiological Emergency Drill, in the event of a transport accident. It also conducted a National Field Exercise on Research Reactor Emergency Response and a tabletop exercise on Research Reactor Emergency Response in 2007.

To protect its nuclear facilities and adhere to non-proliferation norms, Malaysia is forging a close partnership with the United States through the Global Threat Reduction Initiative.[12] In February 2012, four Radioactive Sources Category 1 Facilities in Malaysia were assessed under the Initiative framework (Nuclear Security Summit 2014). Malaysia also takes part in the Global Initiative to Combat Nuclear Terrorism.[13] As part of its commitment, Malaysia hosted a tabletop exercise with Australia, New Zealand, and the United States in 2014 (European Leadership Network 2014).

Malaysia is finalising its amendments to the *Atomic Energy Licensing Act 1984* (Act 304), which would incorporate the provisions of the IAEA Convention on Physical Protection of Nuclear Material, and its 2005 Amendment Protocol; the International Convention for the Suppression of Acts of Nuclear Terrorism; and the Additional Protocol to the IAEA Comprehensive Safeguards Agreement (Nuclear Security Summit 2016).

12 This is a US-led initiative that aims to protect against and reduce excessive civilian nuclear and radiological materials worldwide, particularly highly enriched uranium.

13 The Global Initiative to Combat Nuclear Terrorism is an international partnership to strengthen collective capacity to prevent, detect, and respond to nuclear terrorism. Eighty-five countries take part, including Malaysia, Singapore, and Vietnam. The EU, the IAEA, INTERPOL, and the United Nations Office on Drugs and Crimes are observers.

Human resources development

There is still a tremendous need to educate young people and enhance the skills of older professionals in the nuclear field, particularly in nuclear safety and security. It was emphasised that, as some ASEAN members plan to pursue nuclear power, they need to create and maintain a pool of local nuclear professionals with actual relevant experience in the nuclear industry. Furthermore, well-trained and experienced nuclear professionals are also crucial in institutionalising competent and independent regulatory bodies. The region currently does not have enough human resources that can safely operate its future nuclear power plants.

In Vietnam, the largest challenge is human resources development, particularly in terms of specialists and experts in nuclear engineering. 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 cancel the construction of its first nuclear power plant. When the project was still ongoing until 2016, several government initiatives were introduced to bolster human resources training in the nuclear field. Following IAEA recommendations made in its first Integrated Nuclear Infrastructure Review mission in 2009, Vietnam established the National Steering Committee on Human Resource Development in the Field of Atomic Energy. After the second review mission in 2012, Vietnam cooperated with the IAEA to organise an expert mission to support its efforts to develop the National Integrated Plan on Human Resource Development for its nuclear power program (Hoang 2014). In 2010, Prime Minister Nguyen Tan 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 US$150 million to be spent between 2013 and 2020 (Dung 2010; Thiep 2013). The cancelled project was supposed to train 3,000 undergraduate students, 500 master's degree and doctoral students, and 1,000 teachers in atomic energy. Under this mothballed project, Vietnam had sent students overseas for nuclear energy studies (World Nuclear Association 2015).

Vietnam's Ministry of Education and Training aims to train 1,000 students from 2015 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 nuclear power plants. Although Vietnam is now investing in human resources training and capacity building, criticism has been voiced about an emphasis on theory rather than practice (Ninh 2013). One major concern is the immediate impact on manpower development of the cancellation of the construction of the Ninh Thuan nuclear power plant. Thirty students trained in Russia are expected to have returned home in 2016 and, by 2018–19, additional students will be returning from abroad. Three hundred students are currently being trained in Russia, while 15 are studying in Japan, all of whom are expected to work at the Electricity of Vietnam, which was tasked to operate the country's nuclear power plants. But the Ninh Thuan nuclear power plant will not be constructed, resulting in a lost opportunity for these students to apply what they have learned overseas in operating a nuclear power plant.[15]

Vietnam's education system is not yet fully ready to produce young nuclear professionals. Nuclear engineering is offered as a new course in selected Vietnamese universities in Hanoi (Vietnam National University, Polytechnic University, and Electric Power University), Ho Chi Minh City (University of Science–VNU), and Da Lat (Dalat University). However, these universities do not have experienced professors in the field of nuclear engineering. The education system has focused mainly on nuclear physics, nuclear technique, and radiation technology rather than on the much-needed nuclear engineering (Tran 2015).

Overseas training programs on nuclear power mainly consist of short courses offered by the IAEA, Japan, Russia, South Korea, and other nuclear-powered countries. Vietnam's research and development is not yet fully developed. Although Vietnam has had many years of nuclear research, this research has not been properly focused or organised. There are no local leaders in nuclear research and application as Vietnam lacks leading nuclear scientists and engineers. Research and development infrastructure is also insufficient to facilitate nuclear energy research (Tran 2015).

14 Interview with a Ministry of Education and Training official, Hanoi, 8 August 2014.
15 Ibid.

The Vietnamese government views human resources development as key to the success of its nuclear power program. International cooperation will play an essential role in human resources development until Vietnam fully develops its local nuclear expertise. Russia assisted Vietnam in establishing the Centre for Nuclear Energy Science and Technology in 2011. The nuclear energy specialist training program has been recently introduced to train young leaders for Vietnam's nuclear power program. It aims to train 40 top specialists and experts in strategic areas such as nuclear power plant design and construction, nuclear power plant operation and finance, reactor safety, nuclear economics, and nuclear fuel cycles, among others. Trainees undergo nine months training in Vietnam by studying nuclear-related courses. They then receive rigorous training overseas, particularly in the US, Europe, Japan, and South Korea, and on their return to Vietnam they work at nuclear-related agencies such as VINATOM, the Centre for Nuclear Energy Science and Technology, Electricity of Vietnam, and VARANS (Tran 2015).

Meanwhile, Indonesia has a pool of nuclear experts who have worked for over 30 years at BATAN and other nuclear research facilities (Ministry of Energy and Mineral Resources, Republic of Indonesia 2008). Long-serving nuclear experts will soon retire 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 to operate a nuclear power plant.

BATAN invests in engineering and science graduate recruits to develop specialised expertise in nuclear energy through placement in nuclear power plant companies in South Korea, Japan, and Russia (IAEA 2013). Indonesia has also established a national team of human resources development and drafted a plan of action that includes the establishment of a nuclear training centre (National Team of HRD for NPP 2013). The formation of the centre began in 2010 and remains a work in progress, however.

Due to the growing need to further enhance the country's human resources development program and expertise in operating a nuclear reactor, BATAN plans to construct the Indonesia Experimental Power Reactor, which is scheduled to be operational by 2021/2022. The primary objectives of this project are to demonstrate the safe operation of a small-

scale nuclear power plant; to improve the ability of Indonesia's nuclear professionals to master the nuclear power application and technology in preparation for the commissioning of nuclear power plants in the future; to develop research and development for future nuclear power plants and its supporting facilities as well as for human resources development; and to enhance public acceptance of nuclear power plant operation. BATAN also organises site visits for community leaders to experimental reactors as well as public discussions with communities to reassure them that nuclear power plants are safe (Taryo 2015).

In Malaysia, human resources development in nuclear science begins in universities. While the National University of Malaysia is the only tertiary institution 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 non-power applications such as medicine, health, agriculture, industry, and manufacturing (Khair and Hayati 2009).

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

From a long-term perspective, ASEAN members 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 ageing nuclear workforce to the next generation of workers.

Nuclear waste management policy

The failure of states with nuclear power plants 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 nuclear power plants (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 was one key challenge that was supposed to be addressed by Vietnam (Vi 2014). But the cancellation of the project will free up Vietnam from carrying out the difficult task of managing the spent fuel.

Indonesia has ratified the Joint Convention on the Safety of Spent Fuel Management and on 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 nuclear power plant 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 the Lynas rare earth mining site in Pahang 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 the Lynas site 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 Öko-Institut. 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 members against the multiple and overlapping security, safety, and safeguards challenges they all face. These three areas point to institutional and human resources 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 neighbouring countries that can trigger escalating tensions. We therefore argue that it is imperative for ASEAN members to work together to ensure effective governance of nuclear facilities, materials, and wastes, and to adopt a regional disaster preparedness mechanism.

Upholding nuclear safety and security is extremely important to minimise the possibility of mishaps. Nuclear safety and security are indeed a regional issue, particularly because nuclear incidents can range from accidents with localised radiological impact to large-scale nuclear terrorist attacks, or even nuclear disasters that can cause transnational spill-overs (Heinonen 2016).

One important lesson from the Fukushima accident is the need to have broad perspectives on (and preparedness for) 'unthinkable' events and unforeseen circumstances (Suzuki 2016). In this regard, nuclear emergency preparedness is extremely important, the goal of which is to ensure that an adequate capability is in place within the operating organisation as well as at the local, national, and international levels. Such is necessary for an effective response in a nuclear emergency. Response should also consider crises related to transportation of nuclear and radioactive materials through (or near) the territories and possible terrorist acts. It is crucial to be adequately prepared to prevent and quickly respond to new types of events, for instance, cyber-attacks (Heinonen 2016).

Another important lesson from the Fukushima accident is the need to establish clear responsibility in crisis management. As observed, vague or overlapping responsibilities among stakeholders (operators, local governments, national government, and regulators, among others) are ineffective in crisis management. Regular nuclear emergency drills would help improve cooperation and coordination during an emergency response. Drills should involve the nuclear industry, the regulatory bodies, local and national emergency teams, police, military, customs, the

coast guard, local governments, communities, NGOs, and media, among others. Emergency drills should be designed to test the existing response procedures and capabilities of all sectors for various unforeseen scenarios (Heinonen 2016).

Despite criticisms of ASEAN that it is slow and ineffective in tackling regional issues, it remains among the most relevant platform 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 neighbours to address cross-border impacts. As ASEAN members 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 non-intervention 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, as it is considered a national security issue. ASEAN can leverage its strength as an avenue for regional cooperation to address non-traditional security issues such as humanitarian assistance and disaster response in case a nuclear accident occurs. Currently, ASEAN has two sub-groups 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 3S. 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 realised (probably starting with Vietnam in 2026). The blueprint could contain practical and feasible mechanisms, informed by evidence on best practices in other regions, which 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 non-interference 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 centre and joint nuclear emergency drills.

Concerning the drafting of a possible regional framework on spent fuel management, ASEAN can draw on relevant experiences of Euratom's regional legislative framework. In 2011, the EU ratified binding legislation on spent fuel and radioactive waste management, requiring its members to adopt national programs for handling radioactive waste and to 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 centre in which its first responders, health care practitioners, customs officers, law enforcement, and disaster centre 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 centre would act as a special coordinating body for regional and inter-ministerial disaster response. This centre may be formed as a specialised unit within the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management. The specialised unit can help improve regional mechanisms (such as the ASEAN Coordinating Centre) that have so far concentrated on natural disasters to expand their mandate to cover technological disasters including nuclear emergencies, especially since responding to such disasters would require similar efforts.

Relatedly, ASEAN defence ministers can pursue the incorporation of joint nuclear emergency drills into the ASEAN Defence 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.

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 Schemes, 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).

It must also be noted that there exists a double oversight for nuclear energy cooperation in ASEAN, with the existence of two specialised bodies—ASEANTOM and the NEC-SSN. While ASEANTOM is under the purview of the ASEAN Political-Security Community, the NEC-SNN falls under the ASEAN Ministers of Energy Meeting (Hashim 2016). For 2016, the NEC-SSN meeting's main objectives were to enhance capacity-building activities on civilian nuclear energy and to pursue regional nuclear safety cooperation with ASEAN dialogue partners (ASEAN Centre for Energy 2016). The NEC-SSN likewise facilitates information-sharing among member states with regard to nuclear safety and security. The double oversight signifies the strong commitment of the region to uphold nuclear 3S and foster regional cooperation on nuclear energy governance (Hashim 2016).

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 (ASEAN 2012a). Hence, the 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 members can organise joint training workshops for the region's nuclear security professionals in evaluation methodology, helping them conduct site evaluations and interpret the results. ASEAN members 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 2014b)

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 institutionalised 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 non-proliferation. Regional cooperation is the key to achieving adherence and, now with the establishment of an ASEAN Community, consensus on nuclear energy-related issues is possible. Member states will, however, have to work around concerns about non-interference in domestic affairs, giving priority to shared concern and interest in a nuclear-safe and nuclear weapons–free ASEAN.

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