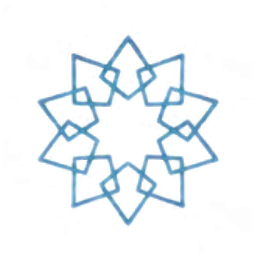
Framing a Nuclear-Powered Future for ASEAN

A Report, May 2025



This report has been developed by the Southeast Asia Public Policy Institute to inform stakeholders about developments in Southeast Asia's on-going energy transition.

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Contents

Key Takeaways

- No ASEAN country currently operates a nuclear power plant, but several are exploring future deployment.
- ASEANTOM and NEC-SSN are key regional mechanisms supporting early-stage nuclear development in ASEAN.
- Global leaders including Russia and China have been engaging ASEAN countries through feasibility studies, training, and technology cooperation.
- ASEAN countries view small modular reactors (SMRs) as scalable, safer options for future clean energy deployment, addressing key concerns around nuclear development.
- Significant gaps in regulation, human capacity, emergency readiness, financing, and grid infrastructure still need to be addressed.

Executive Summary

Nuclear energy is regaining global attention as a clean, reliable, and increasingly viable solution to climate and energy security challenges. Amid mounting concerns over carbon emissions, volatile fuel prices, and growing electricity demand, many countries are revisiting nuclear as part of their long-term energy strategy. **In Southeast Asia, this global momentum has also sparked renewed interest in nuclear energy as a tool for sustainable development, energy diversification, and decarbonization.**

Within ASEAN, several member states have begun laying the groundwork for nuclear energy development. **Although no country in the region currently operates a commercial nuclear power plant, the landscape is shifting.** From policy frameworks and regulatory institutions to human capital and international cooperation, preparations are under way across multiple fronts. Regional mechanisms such as the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) and the Nuclear Energy Cooperation Sub-Sector Network (NEC-SSN) have played instrumental roles in supporting knowledge exchange and capacity building.

External actors have played a significant role in shaping Southeast Asia's nuclear aspirations. Russia and China, in particular, have emerged as key partners by providing infrastructure support, technical training, and cooperation in nuclear technology. Myanmar has signed agreements with Russia to pursue the development of its own small modular reactor, while the Philippines is actively assessing options to revive its long-dormant US-developed Bataan Nuclear Power Plant. Indonesia, Thailand, and Vietnam have also outlined plans to explore nuclear power as part of their long-term energy strategies. Across the region, countries are advancing with caution—carefully weighing their energy needs against public sentiment, regulatory readiness, and safety considerations.

Despite this momentum, significant challenges remain. Regulatory gaps, public skepticism, geopolitical sensitivities, and limited technical capacity all constrain progress. Emerging technologies, particularly Small Modular Reactors (SMRs), offer potential solutions to some of these barriers. SMRs are touted for their scalability, safety features, and suitability for remote or island communities. However, even with these advantages, SMRs cannot solve all the structural issues on their own. **Real progress requires coordinated regional action and stronger political commitment.**

With careful planning, regional cooperation, and transparent governance, nuclear power can become a viable part of Southeast Asia's sustainable energy future. **To support ASEAN's safe and effective development of nuclear energy, this report proposes the following strategic guidelines:**

1. **Establish Regulatory Frameworks and Safety Standards at the Regional Level**
   ASEAN should work toward harmonizing nuclear safety and regulatory frameworks, ensuring that all countries meet international standards. Regional coordination will help address regulatory gaps, reduce duplication of effort, and build confidence among the public and investors.

2. **Invest in Human Capital and Technical Capacity Building**
   ASEAN must invest in education, training, and institutional capacity, including the development of nuclear engineers, scientists, technicians and regulatory professionals. Regional talent-sharing and collaboration with global institutions such as the International Atomic Energy Agency (IAEA) can accelerate progress.

3. **Prioritize Public Engagement and Transparency**
   Public trust will determine the success or failure of nuclear programs. Governments should proactively communicate nuclear plans, safety protocols, and environmental impacts through inclusive and transparent dialogue.

4. **Strengthen Emergency Preparedness and Nuclear Security**
   Robust emergency response systems and nuclear security measures must be in place before any plant is operational. ASEAN should conduct joint exercises, establish rapid response mechanisms, and share best practices to minimize risks from accidents or malicious threats.

5. **Commit to Long-Term Sustainability**
   Nuclear policy must incorporate planning for the full lifecycle of nuclear energy, including waste management, decommissioning, and environmental sustainability. ASEAN should also engage actively with international frameworks to align regional practices with global standards.

6. **Continue Investing in Grid Infrastructure**
   ASEAN countries must develop reliable grid systems by upgrading transmission networks, investing in load balancing technologies, and improving interconnectivity to accommodate baseload generation from nuclear plants and future SMRs.

Introduction

Around 440 power reactors operating across 40 countries contributed approximately 9% of the world's electricity in 2023, reaffirming nuclear energy's long-standing role as a cornerstone of the global power system.[1] While not classified as a renewable resource, nuclear is widely recognized as a clean energy technology due to its extremely low greenhouse gas emissions. It ranks as the world's second-largest source of low-carbon electricity after hydropower, accounting for roughly one-quarter of the global low-carbon electricity supply.

Despite these benefits, the global uptake of nuclear energy has long been hindered by persistent concerns. High upfront capital costs, extended construction timelines, and the complex management of long-lived radioactive waste have all contributed to public and political hesitation. Most notably, operational safety remains a central issue in public perception, shaped by historic incidents such as Chernobyl and Fukushima. These events have left a lasting imprint on global attitudes toward nuclear power and contributed to stalled or abandoned projects in many countries.

Beyond technical and public concerns, the global nuclear marketplace is increasingly shaped by geopolitical considerations. Leadership in this space has historically been dominated by the United States and Western allies such as France, Japan and more recently Korea, who have maintained strict controls over nuclear technology exports—often limiting access to strategic partners and allies.

These restrictions are rooted in longstanding fears that civilian nuclear programs could mask the development of nuclear weapons, increasing geopolitical tensions in some areas such as relations with Iran. Allegations that Iran's nuclear facilities could be repurposed for military use led to extensive sanctions by the United States and European Union in 2010.

The international nuclear market has grown even more complex with the emergence of new players. Russia and China are making substantial advances, both in terms of technology and global market share. Russia's state-owned nuclear corporation, Rosatom, now leads the world in nuclear reactor exports—accounting for over half of the current global market.[2] China, meanwhile, is leveraging its rapid domestic buildout to expand internationally, underpinned by growing ambitions in the sector. Both countries are not only exporting reactor technology but also offering long-term fuel supply arrangements, creating customer dependencies that extend well beyond construction.

For these emerging leaders, nuclear energy is not only a tool of energy diplomacy but a means to expand long-term economic and geopolitical influence. As Southeast Asia begins to explore nuclear energy as part of its clean energy transition, it must navigate not only technical and regulatory challenges, but also the increasingly strategic nature of nuclear power in global affairs.

However, despite the complex global landscape, growing interest in nuclear energy is an undeniable trend. Multiple factors are driving this resurgence, the most critical being the intensifying impacts of climate change. With the Paris Agreement aiming to limit global temperature rise to 1.5°C, countries are under mounting pressure to meet their emissions reduction targets and achieve net-zero status by 2050.[3] Existing tools—particularly in the energy sector—have proven insufficient, prompting many nations to re-evaluate their energy strategies and seek new, scalable alternatives. In this context, nuclear energy has re-emerged as an attractive option among other low-carbon technologies.

Nuclear power offers key characteristics that strengthen energy security. Unlike solar and wind, which depend on intermittent weather conditions and energy storage, nuclear plants require only small amounts of fuel and can operate continuously. This enables them to provide reliable, stable baseload electricity regardless of time, location, or climate.[4] Modern reactor technologies are increasingly flexible, capable of ramping power output up or down to respond to fluctuations in demand. As such, nuclear energy is considered "dispatchable"—a critical advantage over many renewable sources.

This reliability makes nuclear energy particularly well-suited for sectors that depend on uninterrupted electricity supply, such as heavy industry and emerging data-driven sectors like technology and digital infrastructure. These energy-intensive industries require vast, consistent, and low-carbon power sources to operate efficiently and at stable cost. **Nuclear energy, by design, is equipped to meet such demand 24/7.**

Looking ahead, the effects of climate change are expected to make weather patterns more unpredictable, placing additional strain on renewable sources. Coupled with the eventual depletion of fossil fuels, these dynamics enhance the competitiveness of nuclear power. Moreover, global trends such as increasing water scarcity may fuel the adoption of electricity-intensive solutions like desalination. **Nuclear energy is uniquely positioned to support such applications without increasing greenhouse gas emissions.**

These converging trends point toward a growing role for nuclear in the global energy transition. Global trends reflect this shift. According to the International Energy Agency (IEA), nuclear investment is expected to rise from approximately USD 65 billion in 2023 to USD 70 billion by 2030 under current policy settings. By 2050, global nuclear capacity is projected to increase by over 50%, reaching nearly 650 gigawatts (GW).[5]

Asia is emerging as a center of momentum in this shift, with large economies such as China and India accelerating the expansion of their reactor fleets to meet surging electricity demand. In this context, Southeast Asia—and ASEAN member states in particular—are exploring how nuclear energy could play a role in their own energy transitions. As energy demand rises and decarbonization targets loom, nuclear energy is gaining renewed attention across the region as a potential component of future energy strategies.

ASEAN's Progress toward Nuclear Energy

Across Southeast Asia, rising energy demand and the urgency to meet climate commitments are compelling ASEAN member states to diversify their energy portfolios. One of the key drivers of this demand is the rapid growth of future-oriented industries, particularly data centers and electric vehicles (EVs). Southeast Asia is emerging as a global hub for data centers, with approximately 5% of global facilities now located in the region, according to Data Center Map, and this footprint is expected to expand further. In parallel, EV manufacturing is gaining momentum, with Thailand, Indonesia, and Vietnam emerging as leading destinations for investment and production.

These industries are highly energy-intensive. Data centers require continuous electricity to support non-stop digital operations, while the proliferation of EVs contributes to rising electricity demand—especially as automakers seek to power these vehicles with low-carbon energy. As such, clean and reliable energy sources will be indispensable in supporting the sustainable growth of these sectors.

In anticipation of this future, ASEAN member states are increasingly turning their attention to nuclear energy as a potential long-term solution. While no ASEAN country has yet commissioned a nuclear power plant, the region has been steadily laying the groundwork to explore nuclear energy as a viable, long-term solution.

At the regional level, ASEAN has proactively fostered cooperation, capacity building, and institutional development to prepare member states for the possible deployment of nuclear power. **This collective effort recognizes that nuclear energy development requires not only national readiness, but also cross-border coordination in areas such as safety, regulation, and emergency response.**

A key milestone came in 2008 with the formation of the Nuclear Energy Cooperation Sub-Sector Network (NEC-SSN). This body was tasked with leading ASEAN-wide cooperation on nuclear energy for power generation, including facilitating information exchange, providing technical assistance, and building networks for training and knowledge sharing. Its establishment marked the first formal step in promoting regional preparedness for nuclear energy development.

In the wake of the 2011 Fukushima nuclear accident, concerns around nuclear safety, security, and safeguards gained heightened prominence. In response, ASEAN launched the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) in 2013. This network connects national nuclear regulatory agencies across member states and plays a vital role in developing shared safety standards and joint emergency response protocols.

ASEAN's strategic energy blueprint, the ASEAN Plan of Action for Energy Cooperation (APAEC), has further integrated nuclear energy into the region's long-term planning. APAEC Phase I (2016–2025) identified "Civilian Nuclear Energy" as a priority program area.[6] This commitment was reinforced in APAEC Phase II (2021–2025), which introduced the goal of "building human resource capabilities on nuclear science and technology for power generation."[7] These regional strategies have driven continued institutional progress and knowledge development.

Significant technical assessments have also been undertaken to inform future decision-making. In 2018, NEC-SSN completed two landmark studies: a "Pre-Feasibility Study on the Establishment of Nuclear Power Plant in ASEAN" and a "Study on Nuclear Legal and Regulatory Framework in ASEAN." These reports provided an essential foundation for regional and national planning.

In 2019, the ASEAN Secretariat formalized collaboration with the International Atomic Energy Agency (IAEA) through a Practical Arrangement. This partnership aims to support ASEAN's efforts on nuclear safety standards, technical capacity building, and policy development in line with global best practices.[8]

Most recently, the 42nd ASEAN Ministers on Energy Meeting (AMEM), held in September 2024, highlighted the strategic role of civilian nuclear energy in meeting the region's growing energy needs.[9] Following this, the Senior Officials' Meeting on Energy (SOME) directed NEC to intensify activities in capacity building and technology transfer.[10] **Additionally, NEC-SSN was encouraged to explore initiatives related to Small Modular Reactors (SMRs), reflecting global interest in new-generation nuclear technologies that are more adaptable to ASEAN's infrastructure and financial realities.**

In addition to these internal efforts, ASEAN's nuclear energy development has benefited significantly from international support. The International Atomic Energy Agency (IAEA) has served as ASEAN's key partner, providing technical assistance and policy guidance. In 2019, the ASEAN Secretariat formalized its collaboration with the IAEA through a Practical Arrangement focused on enhancing nuclear safety standards, building technical capacity, and supporting policy development in line with international best practices.[11]

Beyond the IAEA, major global powers have increasingly viewed Southeast Asia as a region of strategic interest in what might be termed "nuclear diplomacy." Russia, through its state nuclear corporation Rosatom, has actively pursued partnerships with ASEAN member states. These efforts go beyond exhibitions and technical showcases; they include signed agreements and MoUs with countries such as Cambodia, Lao PDR, and Myanmar to cooperate on research reactors and, in some cases, future nuclear power plants.

China is also expanding its presence in the region's nuclear landscape. Through the China National Nuclear Corporation (CNNC), China has deepened bilateral engagement with ASEAN member. CNNC is actively competing—alongside Russia and the United States—to become the preferred partner in developing Indonesia's future nuclear power infrastructure.

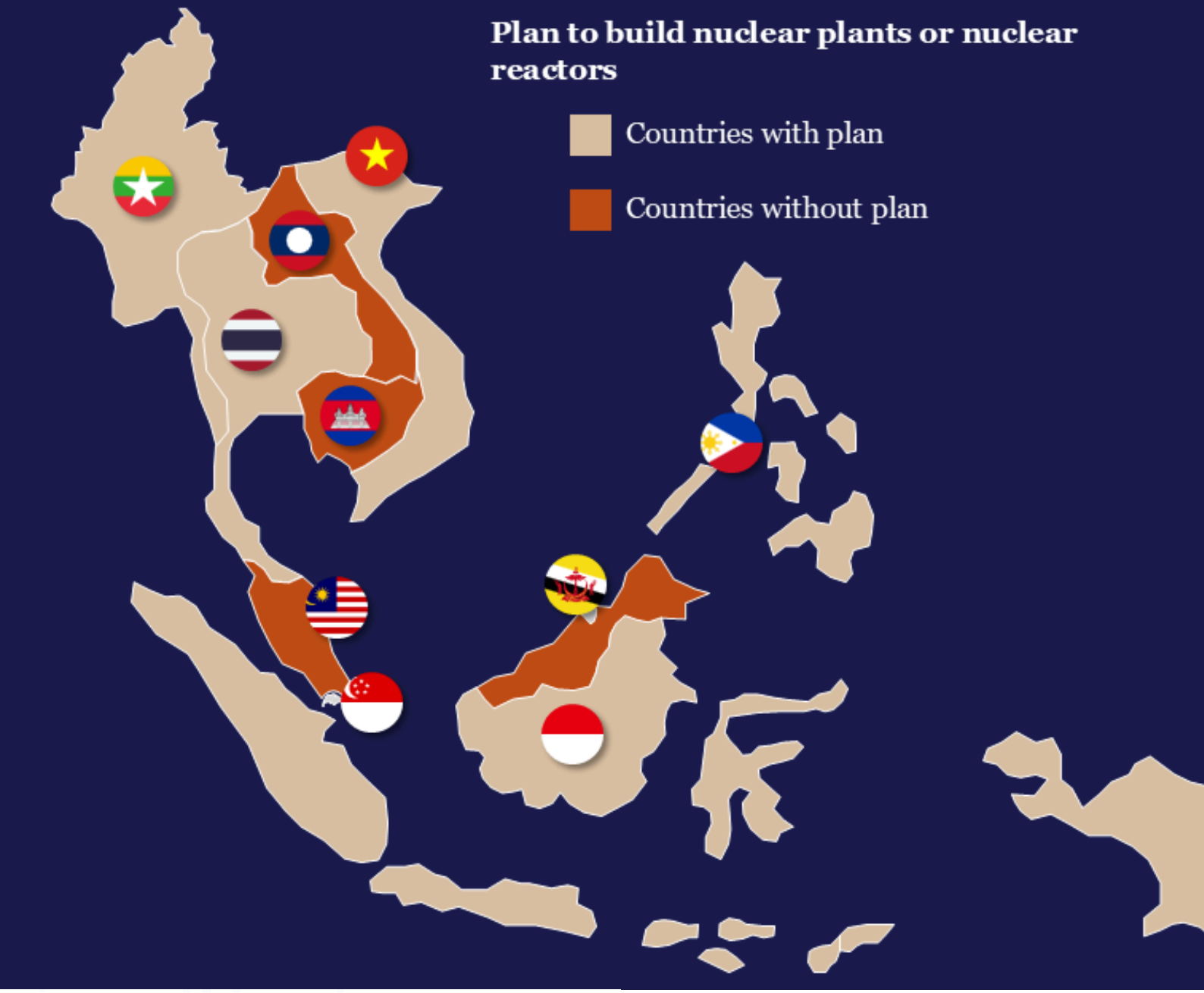
Historically, the United States held a leading role in the region's nuclear energy development—most visibly through the construction of the Bataan Nuclear Power Plant in the Philippines by U.S.-based firm Westinghouse. **While its engagement has declined in recent decades, the U.S. continues to support regional nuclear ambitions through targeted technical cooperation**. Recent 123 Agreements—legally binding frameworks that the U.S. enters into with other countries for peaceful nuclear cooperation—signed with countries such as Thailand and Singapore reflect a renewed effort to re-establish its influence in Southeast Asia's evolving nuclear landscape.

Taken together, these internal and external efforts are creating new momentum for ASEAN countries as they move forward with nuclear energy development. **However, progress varies significantly across member states, depending on national priorities, institutional readiness, and public acceptance.**

Photo credit: Getty

Table 1: Key Developments in ASEAN Countries

Country & Year of Net-Zero Emissions	Energy National Plan	Key Developments in Nuclear Energy
Brunei 2035	-	Brunei is working with the International Atomic Energy Agency (IAEA) to improve its regulatory system, including updating its Radiation Protection Act.
Cambodia 2050	Power Development Master Plan 2022–2040	Cambodia signed an agreement with Russia's Rosatom in 2015 to explore building a research reactor. It also agreed to set up a nuclear information center and formed a joint group to promote peaceful uses of nuclear energy. In 2017, Cambodia also signed a separate cooperation agreement with China's CNNC to develop human resources for nuclear energy.
Indonesia 2060	National Electricity General Plan (RUKN) 2025–2060	Indonesia announced plans in 2022 to build its first nuclear power plant by 2039. In 2024, the Energy Council proposed 29 possible sites for plant development across the country.
Lao PDR 2050	-	Laos signed several agreements with Russia's Rosatom in 2016 to cooperate on peaceful nuclear activities. In 2024, Laos ratified an international convention on nuclear material protection and adopted the IAEA's safety guidelines.
Malaysia 2050	National Energy Transition Roadmap (NETR)	In 2024, the Malaysian government reopened the option of nuclear power for the period after 2035. It appointed MyPOWER as the agency in charge of preparing for a national nuclear energy program.
Myanmar	-	Since 2021, Myanmar has expanded its cooperation with Russia on nuclear energy. In 2023, it opened its first nuclear information center in Yangon with Rosatom. In 2025, Myanmar and Russia signed a formal agreement to build a 110 MW small modular reactor (SMR).
Philippines 2050	Philippine Energy Plan 2023–2050	In 2022, the President signed an order to officially include nuclear energy in the country's energy plans. In 2023, the House of Representatives approved a bill to set up an independent nuclear regulatory body. In 2024, the Department of Energy released a national roadmap for nuclear energy development.
Singapore 2030	Singapore Green Plan 2030	In 2024, Singapore signed a nuclear cooperation agreement with the United States. In 2025, the Energy Market Authority launched a study to assess the potential of different types of nuclear reactors.
Thailand 2065	Power Development Plan (PDP) 2024–2037	In 2023, Thailand began reviewing the role of nuclear energy, especially small modular reactors (SMRs). The draft Power Development Plan for 2025–2037 includes two SMRs towards the end of the plan period. In 2025, Thailand signed a nuclear cooperation agreement with the United States.
Vietnam 2050	8th National Power Development Plan 2021–2030	In 2024, Vietnam renewed its interest in nuclear power as part of its 8th Power Development Plan. It reinstated the Ninh Thuan project, which involves building two nuclear plants by 2030.



Nuclear Plant Development Plan

Estimated Nuclear Capacity	Estimated Year of Operation *	Estimated Nuclear Capacity	Estimated Year of Operation *
35-42 GW by 2060	2032	600 MW by 2037	2037
110-330 MW	To be determined	4-6.4 GW by 2035	2035
1.2 GW by 2032 4.8 GW by 2050	2032		

***First Plant**

Challenges to a Nuclear-Powered Future in Southeast Asia

While not every ASEAN member state is actively pursuing nuclear power, a growing number are clearly signaling their intent to include nuclear energy in their future energy portfolios. The collective direction across the region reflects increasing recognition of nuclear power's potential to contribute to energy security and decarbonization goals.

Yet, translating intent into implementation is no simple task. The development of nuclear power infrastructure faces a range of formidable challenges that have historically delayed or derailed nuclear ambitions, both in ASEAN and globally. These include technical and human resource limitations, financial constraints, gaps in regulatory and institutional capacity, and unresolved issues around nuclear waste management.

For ASEAN countries, many of which are still developing key aspects of their energy systems, the following obstacles present significant barriers to timely and safe nuclear deployment:

1

Limited Technical Expertise and Human Capacity

Establishing and operating a nuclear power program requires a highly specialized workforce—engineers, reactor operators, regulators, and safety experts—with years of dedicated training and hands-on experience. At present, most ASEAN countries are only at the early stages of nuclear development, with limited human resources concentrated in areas such as research reactors and radiation-based applications. These personnel typically lack direct experience in managing commercial nuclear power stations. Without substantial and long-term investment in education, training, and international knowledge transfer, it will be difficult for national governments to build and operate nuclear plants effectively. **Capacity building remains one of the most fundamental gaps that must be filled before safe deployment can be assured.**

2

High Up-Front Costs and Financing Issues

Nuclear power plants require significant capital investment and long development timelines—often exceeding a decade from planning to operation. For developing ASEAN economies, such high upfront costs can pose serious financial burdens, especially when competing with other urgent development needs. Even when financing is secured, nuclear projects are prone to delays and cost overruns, which can erode public and investor confidence. **Before nuclear energy becomes cost-effective in the long term, governments may have to absorb the financial risks of sunk costs during the early phases of development—something not all countries are well-positioned to do.**

3

Regulatory and Legal Framework Gaps

A safe and credible nuclear energy program depends on a robust and independent regulatory framework. Many ASEAN member states have yet to develop comprehensive nuclear legislation or empower autonomous regulatory authorities with sufficient technical capacity and enforcement authority. Although some countries have enacted atomic energy laws, critical gaps remain—particularly in areas such as liability for nuclear damage, the safe transport of radioactive materials, and emergency preparedness. Moreover, national regulatory frameworks often fall short of full alignment with international best practices, including those recommended by the International Atomic Energy Agency (IAEA). **In the absence of strong regulators and clear legal standards, public confidence and international cooperation may be difficult to sustain.**

4

Nuclear Waste Management

The safe and long-term management of radioactive waste, particularly high-level waste such as spent nuclear fuel, is one of the most politically sensitive and technically demanding aspects of nuclear energy deployment. Globally, very few countries have permanent disposal solutions in place. Even developed countries with long-standing experience in nuclear power, such as those in Europe, continue to face challenges in identifying suitable long-term disposal sites for increasing volumes of radioactive waste.[12]

To date, no ASEAN member state has developed a national repository for permanent waste storage. The lack of a clear, regionally acceptable strategy for managing nuclear waste could significantly delay project timelines and raise public concerns. Even temporary waste storage plans may provoke opposition, including from neighboring countries concerned about potential transboundary risks.

Among the various obstacles to nuclear energy development, public perception may well be the most critical. Decades of public fear, fueled by high-profile accidents such as Chernobyl (1986) and Fukushima (2011), as well as by dramatic portrayals in popular media, have left a legacy of skepticism and concern. Across ASEAN, public support for nuclear power remains tepid, with widespread apprehension about reactor safety and radiation risks.

This sensitivity was starkly evident in the aftermath of the Fukushima disaster, when many ASEAN countries chose to freeze or scale back their nuclear plans despite earlier momentum. Even where political will and financial resources exist, nuclear projects cannot proceed without the consent and trust of local communities. Public acceptance is a prerequisite, not an afterthought, and must be built through transparency, education, and inclusive dialogue.

That said, these challenges, though formidable, are not insurmountable. Around the world, countries have developed effective strategies to launch and sustain nuclear programmes despite facing similar barriers. For ASEAN, one particularly promising pathway lies in the advancement of Small Modular Reactors (SMRs), which may help to address many of the region's technical, financial, and societal concerns.

What are Small Modular Reactors?

Small Modular Reactors (SMRs) are advanced nuclear reactors with a capacity of up to 300 MW(e) per unit—about one-third that of traditional nuclear reactors. Their smaller footprint allows them to be built in locations unsuitable for large plants. SMRs also offer reduced costs, shorter construction times, and the flexibility to be deployed incrementally to meet growing energy demand..[13]

In ASEAN, where electricity grids are generally smaller and financial resources more limited compared to larger economies, SMRs offer a more feasible entry point into nuclear energy. Their adaptable scale and design provide practical advantages well-suited to the region's context.

- **Lower Financial Barriers**: With smaller power outputs, SMRs involve lower absolute costs per unit and reduced financial risk. Their modular nature allows phased investment, making them more accessible for countries with limited budgets. As the IAEA notes, "SMRs offer a new nuclear power option for countries and industries for which conventional large reactors are not suitable."[14]

- **Enhanced Safety and Public Acceptanc**e: Many SMR designs feature advanced and passive safety systems. Their smaller reactor cores and reduced fuel volume can significantly limit the consequences of any accidental release, potentially easing public concerns about nuclear safety.

- **Grid and Infrastructure Compatibility**: SMRs, typically ranging from 10 MW to 300 MW, are better suited to ASEAN's smaller or developing power grids. In contrast to introducing a large 1,000 MW reactor, SMRs offer more manageable integration. As highlighted by the IAEA, "Developing countries are looking to SMRs as a more affordable option for smaller grids."[15]

- **Faster Deployment and Incremental Learning**: SMRs allow countries to start small and build capacity gradually. Their shorter construction timelines are more aligned with political cycles and development planning. Early success with one module can build public confidence and pave the way for future expansion.

Successful case studies from around the world highlight how Small Modular Reactors (SMRs) are transitioning from experimental concepts to practical energy solutions, even in developing or geographically challenging contexts. In Russia, the Akademik Lomonosov—a floating SMR stationed in the remote Arctic town of Pevek—is supplying reliable electricity and heat to an off-grid region, replacing ageing coal plants and reducing environmental harm.[16]

In Asia, China's high-temperature gas-cooled SMR (HTR-PM) reached full power in 2023, marking a major technological breakthrough that demonstrates the viability of next-generation nuclear systems.[17] Meanwhile, in North America, Canada is preparing to deploy the BWRX-300, a 300 MW grid-connected SMR, by 2028, further illustrating the global momentum behind this technology.[18]

These developments reinforce the potential for SMRs to play a meaningful role in Southeast Asia's energy future. However, while SMRs offer tailored solutions to many of the region's challenges, they are not a cure-all. The successful integration of nuclear power requires more than technological advancement—it demands strong regulatory oversight, harmonized safety standards, and sustainable waste management practices. These are systemic issues that no single country can address in isolation.

ASEAN countries may chart their own nuclear development paths, but regional collaboration is essential to ensure alignment, safety, and shared resilience. Given the geographic proximity and interconnected nature of Southeast Asian nations, any nuclear incident could have transboundary implications. A region-wide approach is therefore not only practical but imperative. With institutional frameworks such as the NEC-SSN and the ASEANTOM already in place, ASEAN is well-positioned to foster a collaborative environment.

Picture Credit: Holtec International

Guidelines for ASEAN Going Forward

Despite significant institutional groundwork, the development of nuclear energy in ASEAN remains constrained by gaps in region-specific regulatory frameworks, limited public acceptance, and an urgent need to strengthen human capital and nuclear governance. **To move forward, ASEAN must take proactive steps to enhance both national and regional capacities—establishing transparent regulatory institutions, cultivating a strong safety culture, and engaging the public with clarity and confidence.**

This journey must be approached strategically and responsibly. Nuclear energy, if adopted, should serve not only as a tool for achieving climate and energy goals, but also as a catalyst for long-term sustainability and public welfare. **The following guidelines offer a comprehensive roadmap for ASEAN's safe and effective use of nuclear energy. They address both the technical and institutional dimensions, alongside the critical "softer" elements such as societal trust, public communication, and regional collaboration, that will ultimately determine the success of any nuclear program in Southeast Asia.**

1 Invest in Human Capital and Technical Capacity Building

The safe and effective use of nuclear technology depends fundamentally on the availability of skilled human resources. ASEAN governments must prioritize long-term investment in training nuclear engineers, scientists, technicians, and regulatory professionals. This includes expanding domestic nuclear science and engineering programs at universities, providing scholarships for overseas study, and facilitating knowledge transfer from countries with established nuclear expertise.

At the regional level, ASEAN can play a pivotal role by serving as a hub for human capital development. Leveraging resources from NEC-SSN, ASEAN could involve connecting educational institutions, establishing centers of excellence, and creating regional training facilities that support the needs of all member states. Such initiatives would help pool limited national resources and foster consistent technical standards across the region.

Partnerships with leading nuclear countries—such as Japan, South Korea, France, and the United States—can further strengthen ASEAN's capabilities. These partnerships should go beyond bilateral exchanges and support multilateral cooperation for broader impact. Through these efforts, ASEAN can build a sustainable pipeline of expertise essential to the long-term success and safety of nuclear energy deployment.

2 Prioritize Public Engagement and Transparency

Securing and maintaining public trust is critical to the future of nuclear energy in ASEAN. Governments and project developers must engage with citizens, local communities, and civil society early in the planning process—and continue to do so consistently and transparently throughout the lifecycle of any nuclear initiative. Public concerns around safety, environmental impact, and long-term waste management must be acknowledged and addressed through inclusive dialogue.

To improve nuclear literacy, Information, Education, and Communication campaigns should be launched to inform the public in accessible and evidence-based ways. While such outreach efforts are often seen as national responsibilities, ASEAN has an important role to play in supporting member states. The region can generate and disseminate shared resources—such as public education materials, research summaries, and best practice reports—to facilitate informed public dialogue.

Moreover, ASEAN should promote regional learning. Lessons from one country's experience—whether setbacks or successes—can guide others in avoiding pitfalls and adopting effective engagement models. By highlighting case studies and enabling knowledge exchange, ASEAN can help foster a regional culture of transparency and public participation in nuclear governance.

3 Strengthen Emergency Preparedness and Nuclear Security

Regional cooperation is essential for ensuring effective emergency preparedness and nuclear security in ASEAN. A nuclear incident in one country can have transboundary effects—radiation does not recognize national borders. As such, ASEAN member states must work collaboratively to establish integrated response plans and joint protocols for nuclear emergencies.

Key priorities include the standardization of radiation monitoring systems, real-time alert mechanisms, and coordinated emergency communication strategies across the region. Joint drills and simulations should be conducted regularly to test readiness and promote interoperability among national agencies.

NEC-SSN, originally established to facilitate information sharing and technical exchange, holds strong potential to expand its role beyond its current scope. It could serve as a central platform for coordinating region-wide protocols on radiation monitoring, early warning systems, and cross-border emergency response mechanisms. Member states should connect their national alert systems to regional frameworks to ensure timely, transparent communication with the public during crises.

4 Commit to Long-Term Sustainability

ASEAN must adopt a long-term perspective on nuclear energy to ensure that its benefits endure for future generations. This involves not only the safe and efficient operation of reactors, but also careful planning for their eventual decommissioning and the sustainable management of radioactive waste.

A comprehensive waste management policy should accompany any decision to pursue nuclear energy. This policy must address all types of radioactive waste—low- and intermediate-level waste (such as contaminated equipment and materials), as well as high-level waste (including spent fuel). It should also consider protocols for long-term storage, transportation, and, where necessary, cross-border coordination on waste handling and disposal.

ASEAN should engage with relevant international frameworks, such as the IAEA's Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and incorporate these standards into regional practice. This will help ensure that all nuclear waste is managed safely, transparently, and responsibly—avoiding risks to both regional stability and global environmental safety.

5 Continue Investing in Grid Infrastructure

Robust and resilient grid infrastructure is essential to realizing the full benefits of nuclear energy deployment in ASEAN. While nuclear reactors can provide stable baseload electricity, the ability to transmit this power efficiently across national and regional markets depends on the strength and modernity of grid systems. Without reliable transmission infrastructure, the potential of nuclear energy especially from Small Modular Reactors (SMRs) cannot be optimally utilized.

At present, grid interconnectivity in ASEAN remains limited. Cross-border transmission exists only in three subregional groupings: Lao PDR–Thailand–Peninsular Malaysia–Singapore, Vietnam–Cambodia, and East Malaysia–Indonesia (Kalimantan).[19] This fragmented structure restricts the region's ability to balance supply and demand, optimize energy resources, and enhance resilience through regional cooperation.

To address these gaps, ASEAN member states must prioritize sustained investment in upgrading and expanding their electricity grids. This includes modernizing transmission lines, improving grid flexibility, and adopting smart grid technologies capable of integrating variable energy sources alongside nuclear power.

In particular, ASEAN should accelerate progress under the ASEAN Power Grid (APG) initiative. A more integrated regional grid would enable countries with limited domestic demand or land availability to host SMRs and export surplus electricity to neighboring markets—maximizing the collective benefits of nuclear energy investments and fostering a more interconnected, secure, and sustainable regional energy system.

Picture Credit: ASEAN Energy Centre

ASEAN's greatest strength lies in its tradition of regional cooperation—a strength that should now be fully extended to the nuclear energy realm. Not every country in the region needs to develop the full suite of nuclear infrastructure independently. By pooling resources, harmonizing standards, and sharing knowledge, ASEAN can achieve greater efficiency, safety, and public trust.

Building on existing institutional frameworks such as the NEC-SSN and the ASEANTOM, the region has a solid foundation to expand collaboration. As noted in the ASEAN Energy Booklet, "to fully develop nuclear energy, the ASEAN region has to establish legal and regulatory frameworks for nuclear safety, increase nuclear literacy, establish nuclear energy planning coordination, and integrate enabling policies and regulations on nuclear power."[20]

If ASEAN nations can commit to building strong regulatory, technical, and societal foundations—together—nuclear power has the potential to become a vital part of the region's clean energy future, supporting economic development and advancing climate goals for generations to come.

Country Profiles: Status of Nuclear Developments in ASEAN

Brunei Darussalam

Brunei Darussalam currently has no nuclear power plants in operation and does not have an active program to develop one. The country's abundant oil and gas reserves, which account for approximately 99% of its electricity generation, combined with a relatively small population, reduce the immediate urgency for pursuing nuclear energy as part of its energy mix.

Nonetheless, Brunei has adopted a forward-looking stance by engaging with international nuclear governance frameworks. Since becoming a member of the International Atomic Energy Agency (IAEA) in February 2014, the country has worked to strengthen its institutional readiness and safety standards in line with global best practices.[21]

At the forefront of these efforts is the Safety, Health, and Environment National Authority (SHENA), which is actively collaborating with the IAEA to enhance Brunei's regulatory framework. This includes ongoing efforts to strengthen the Radiation Protection Act (Chapter 228), with the aim of ensuring robust nuclear safety and security standards that safeguard workers, the public, and the environment.[22]

While nuclear energy is not a current national priority, Brunei is keeping the option open for future consideration—particularly in light of emerging technologies such as Small Modular Reactors (SMRs), which offer enhanced safety features and may present a more suitable fit for smaller-scale national energy needs.

Cambodia

Cambodia does not currently operate any nuclear power plants, nor is there a nuclear energy program under active development. While the country's 1993 Constitution prohibits the presence of nuclear weapons, it does not explicitly ban the use of nuclear energy for peaceful purposes. This has enabled Cambodia to explore nuclear science and technology in a certain purpose.

Over the past decade, Cambodia has engaged in several international partnerships aimed at building nuclear-related capacity. In 2015, the Russian state nuclear corporation Rosatom signed an agreement with the Cambodian government focused on the development of a research reactor and broader cooperation in nuclear energy.

Subsequent agreements in 2016 and 2017 led to the establishment of a nuclear energy information center and the creation of a joint working group on the peaceful uses of atomic energy.[23] These initiatives were designed to enhance public awareness and build the foundational knowledge necessary for future nuclear cooperation.

In 2017, Cambodia has also signed a separate nuclear cooperation agreement with the China National Nuclear Corporation (CNNC), with an emphasis on human resources development. Despite these strategic alignments, the country still faces significant gaps in technical expertise and higher-level educational infrastructure in nuclear science.

Reflecting this, Cambodia's Power Development Plan (PDP) 2022–2040 does not include nuclear energy within its cleaner energy mix. This suggests that, despite ongoing international cooperation, the country is unlikely to pursue nuclear power deployment in the near term—at least not before 2040.[24]

Indonesia

Indonesia stands out as the most advanced country in Southeast Asia in terms of nuclear technology infrastructure and experience. It currently operates three research reactors: a 30 MW reactor in Serpong, a 2 MW reactor in Bandung, and a 100 kW reactor in Yogyakarta.[25] These facilities are used primarily for scientific research, training, and the production of radioisotopes.

Since 2014, nuclear energy has been recognized as part of Indonesia's broader push for New and Renewable Energy (NRE) under the National Energy Policy (NEP). However, the National Energy General Plan (Rencana Umum Energi Nasional, RUEN) to 2050, signed in 2017, did not initially prioritize large-scale nuclear deployment, instead focusing on expanding oil, gas, and renewable energy sources.

This position began to shift in 2022, when the Indonesian government announced its intention to develop a nuclear power plant by 2039. More recent high-level statements have indicated a significantly accelerated timeline. Under revised plans, the government now aims to bring a small-scale nuclear power plant online by 2032.[26] The initial plant is expected to have a capacity of 250 megawatts (MW), with subsequent expansions targeting 3 GW by 2035 and 9 GW by 2040. By 2060, Indonesia plans to reach between 35 GW and 42 GW of installed nuclear capacity.[27]

To support this ambitious roadmap, the Energy Council of Indonesia proposed 29 potential sites across the archipelago for nuclear power plant development in December 2024[28]. These developments signal Indonesia's serious commitment to integrating nuclear energy into its long-term energy strategy and mark a turning point for nuclear ambitions in the region.

Lao DPR

Laos currently does not operate any nuclear power plants or research reactors. As a small, landlocked country with abundant hydropower resources, its electricity generation is dominated by hydroelectric plants, supplemented by some coal-fired generation. Entitled the "Battery of Southeast Asia," Laos exports at least 6,400 MW of electricity per year to neighboring countries through the regional power grid—a figure expected to rise to 20,000 MW by 2030[29]—highlighting its abundance in power generation capacity among ASEAN countries. Given its relatively low energy demand and sufficient sources, the immediate need for nuclear energy has remained limited.

Nevertheless, Laos has expressed long-term interest in exploring nuclear power as a potential part of its future energy mix. In 2016, the country signed a series of Memoranda of Understanding (MoUs) with Rosatom, Russia's state nuclear corporation, aimed at peaceful cooperation in nuclear energy[30]. At the time, plans were announced for the construction of two 1,000 MW nuclear reactors under a build-operate-transfer arrangement. However, no physical progress has been made on these projects to date.

Although nuclear energy is not included in Laos's current Power Development Plan (PDP) up to 2030, recent developments suggest renewed attention to the nuclear sector. In April 2024, Loas ratified the Amendment to the Convention on the Physical Protection of Nuclear Material (A/CPPNM), and adopted the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources along with its supplementary guidance[31].

Despite these efforts, Laos's engagement in nuclear energy remains at a very early stage. The country has no active nuclear projects and no immediate plans for nuclear power plant construction.

Malaysia

Malaysia has long maintained a foundation in nuclear technology, primarily through its research and institutional capacity. Since 1982, the Malaysian Institute for Nuclear Technology Research (MINT) has operated a 1 MW Triga research reactor, which supports scientific research and isotope production.[32] However, the country has yet to develop a commercial nuclear power plant.

Over the past 15 years, Malaysia has come close to launching a nuclear energy program on multiple occasions, only to retreat due to political shifts and public concerns. In 2011, the government established the Malaysia Nuclear Power Corporation (MNPC) with the intention of integrating nuclear energy into the national grid within 12 years. However, following the Fukushima disaster that same year and a subsequent change in government in 2018, Malaysia suspended its nuclear ambitions. The new administration formally cancelled the program and disbanded MNPC.

The country's National Energy Transition Roadmap (NETR) aims to achieve a 70% renewable energy share in the power mix by 2050. However, nuclear energy is not currently included in this roadmap.

That said, nuclear energy has re-emerged in national discussions. In late 2024, under the leadership of Prime Minister Anwar Ibrahim, the Malaysian Cabinet re-opened the door to nuclear power, identifying it as a potential post-2035 option to help meet climate goals and rising electricity demand.[33] As part of this renewed effort, the agency MyPOWER under the Ministry of Energy Transition and Water Transformation (Petra), has been designated as Malaysia's potential Nuclear Energy Programme Implementation Organisation (NEPIO), tasked with leading the preparatory work should the country proceed with a nuclear energy program.[33]

Myanmar

Myanmar has demonstrated a long-standing interest in nuclear technology, particularly through its strategic relationship with Russia, which dates back to the early 2000s. Initial discussions centered on the development of a small Russian-supplied research reactor, though no such facility has ever been constructed, and the country currently does not operate any nuclear reactors.

Following the military coup in February 2021, the ruling State Administration Council significantly deepened its engagement with Russia, including cooperation in the nuclear energy domain.[35]. Over the years, multiple MoUs have been signed, culminating in an agreement to deploy a small modular reactor (SMR) in Myanmar.

In February 2023, Myanmar in partnership with Rosatom, opened its first nuclear information center in Yangon[36]. The center aims to raise public awareness and improve understanding of nuclear technology, reflecting early steps toward establishing a societal foundation for nuclear energy.

In March 2025, the two governments formalized an intergovernmental agreement to construct a 110 MW SMR, with provisions for potential expansion to 330 MW in the future[37]. The partnership also includes cooperation on nuclear and radiation safety, along with workforce development and training, indicating a comprehensive approach to nuclear capability building.

Through these initiatives, Myanmar is positioning itself to become one of the first ASEAN member states to construct a nuclear power facility, albeit a small-scale one, by leveraging Russian technology and support.

The Philippines

The Philippines holds a unique place in ASEAN's nuclear history as the only country in the region to have completed the construction of a commercial nuclear power plant. In response to the 1973 oil crisis, the government began building the Bataan Nuclear Power Plant (BNPP), a 621 MW Westinghouse unit, which was completed in 1984.[38] However, the facility was never fueled or operated due to political transition following the fall of President Ferdinand Marcos Sr., and rising safety concerns in the aftermath of the Chernobyl disaster.

Since then, the fate of BNPP and nuclear energy more broadly has remained a topic of national debate. The policy direction took a decisive turn in February 2022, when then-President Rodrigo Duterte signed Executive Order No. 164, formally integrating nuclear energy into the country's energy mix.[39] The order also established an inter-agency Nuclear Energy Program Committee tasked with overseeing the development of nuclear infrastructure and policy.

Momentum further accelerated with the election of President Ferdinand "Bongbong" Marcos Jr. in mid-2022. As the son of the original initiator of BNPP, President Marcos Jr. has been a strong advocate for reviving nuclear energy as a means to address the country's persistent issues with high electricity prices and energy supply shortages.[40]

Under his leadership, the Philippines has pursued an ambitious nuclear agenda. Key to this effort is the PhilATOM Bill, which seeks to establish an independent nuclear regulatory authority. The bill passed its third reading in the House of Representatives in 2023, marking a critical step toward building a robust governance framework for nuclear power.[41]

In September 2024, the Department of Energy unveiled the country's nuclear energy roadmap. The plan targets the deployment of eight Small Modular Reactors (SMRs), each with a capacity of 150 MW, by 2032, collectively delivering at least 1.2 GW of nuclear capacity. The roadmap envisions further expansion to 4.8 GW by 2050.[42]

Additionally, in October 2024, the Department of Energy (DOE) signed a MoU with Korea Hydro & Nuclear Power (KHNP). Under the agreement, KHNP committed to conducting a comprehensive feasibility study on the potential activation of the unoperated Bataan Nuclear Power Plant (BNPP). The study will be fully funded by KHNP, with no financial obligation or commitment required from the Philippine government to proceed with the plant's rehabilitation.[43] These efforts reflect the Philippines' strong commitment to making nuclear energy a central pillar of its future energy strategy.

Singapore

Singapore, a densely populated island nation with limited natural resources, relies on natural gas for approximately 95% of its electricity generation[1]. The country does not operate any nuclear power plants and, due to land constraints and high population density, has taken a highly cautious approach to nuclear power. Public support for nuclear energy remains low. According to a 2021 study conducted by Nanyang Technological University, only 22% of Singaporeans expressed support for nuclear energy development, underscoring the significant challenge of public acceptance.[45]

Thus, instead of pursuing nuclear deployment, Singapore has focused on research and international engagement to stay informed about developments in advanced nuclear technologies. In 2012, the Singapore Nuclear Research and Safety Initiative (SNRSI) was established at the National University of Singapore to build local expertise in nuclear safety science and policy.[46]

Recent advances in nuclear technology, particularly Small Modular Reactors (SMRs), have re-opened the conversation. These reactors are designed with inherent safety systems that significantly reduce the risk of severe accidents, making them more compatible with Singapore's dense urban environment and limited space.

As interest in nuclear energy increases globally, Singapore has stepped up its international collaborations. In July 2024, it signed the 123 Agreement on Nuclear Cooperation with the United States.[47] This agreement paves the way for knowledge exchange and scientific collaboration, particularly in areas related to nuclear technology development, safety, and regulatory frameworks.

Following the signing of the agreement with the United States, Singapore's Energy Market Authority (EMA) released a tender notice in February 2025 to study the feasibility of various nuclear reactor models and assess their potential to meet Singapore's future energy needs. Additionally, under the Budget 2025, the Singaporean government announced plans to double the capital of the Future Energy Fund from SGD 5 billion to SGD 10 billion. This fund is intended to support the deployment of clean energy technologies, with the potential to include nuclear power as part of Singapore's future energy mix.[48] These developments confirm that, although no formal decision has been made to pursue nuclear power, it remains one of the low-carbon energy sources Singapore is evaluating as part of its broader strategy to enhance energy security, manage costs, and reduce its carbon footprint. At the same time, these actions also signal the government's intent to gauge public sentiment toward potential nuclear energy development.

Thailand

Thailand does not currently operate any commercial nuclear power plants. However, it maintains a modest research capability through the Office of Atoms for Peace (OAP), which oversees a 2 MW research reactor located in Bangkok. This facility is used for isotope production and scientific research, and OAP works closely with the Energy Regulatory Commission (ERC) on broader issues related to nuclear power and electricity management.

Over the years, Thailand has intermittently explored the possibility of integrating nuclear power into its energy mix. Serious preparations were undertaken in the late 2000s, including the establishment of the Nuclear Power Program Development Office under the Ministry of Energy in 2007, site surveys, and budget allocations for nuclear infrastructure. However, in the aftermath of the Fukushima disaster in 2011 and amid strong public opposition in proposed host communities, these plans were placed on indefinite hold.[49]

Interest in nuclear energy has resurfaced in recent years, driven by Thailand's need to meet its clean energy targets and strengthen energy security. As of 2023, the government has begun to reassess the role of nuclear power, particularly through the lens of Small Modular Reactors (SMRs), which offer greater flexibility and safety compared to traditional large-scale plants.

The draft Power Development Plan (PDP) 2025-2037 reflects this renewed interest. It includes a proposal to develop two SMRs, each with a capacity of 300 MW, scheduled to become operational toward the end of the planning period.[50] To meet this timeline, critical preparatory work—including technology selection, site evaluation, and regulatory approvals—will need to advance steadily throughout the 2020s. Previous studies have identified Ubon Ratchathani in the east and Nakhon Sawan in the north as potential sites for larger reactors, and these may also be considered for SMR deployment. In line with this momentum, Thailand signed a 123 Agreement with the United States in February 2025 to support cooperation on nuclear materials, technology, and research—underscoring its strengthened commitment to developing a national nuclear energy program.[51]

While Thailand's nuclear journey has historically been marked by "stop-start" cycles, there are signs of more sustained political commitment this time. High-level officials have expressed support for moving forward, contingent on successfully managing public perception and securing community buy-in.

Vietnam

Vietnam has a long-standing interest in nuclear power, having first considered the technology as early as 1995. In 2007, the government formally approved a nuclear power development plan and subsequently established a comprehensive legal and regulatory framework to support its implementation.

However, in November 2016, the National Assembly passed a resolution to indefinitely postpone plans for two nuclear power stations. The decision was driven primarily by economic constraints at the time, despite previous momentum and preparation.[52]

Following an eight-year hiatus, Vietnam is now actively reviving its nuclear ambitions in line with the 8th National Power Development Plan (PDP8). This plan seeks to diversify the country's energy mix and reduce its dependence on fossil fuels. As part of this renewed direction, Vietnam has resumed planning for the proposed Ninh Thuan nuclear power project and is exploring the development of new nuclear facilities, while also engaging with foreign partners to renegotiate previous agreements.

The Ninh Thuan project consists of two separate plants, each comprising two reactors. Ninh Thuan 1 is located in Phuoc Dinh commune, Thuan Nam district, while Ninh Thuan 2 is in Vinh Hai commune, Ninh Hai district. These projects were previously halted but remain the cornerstone of Vietnam's revived nuclear development strategy.[53]

To drive this renewed initiative, the government has tasked two state-owned enterprises, Electricity of Vietnam (EVN) and the Vietnam Oil & Gas Group (Petrovietnam), with completing the construction of the nuclear power plants by the end of 2030.[54] This directive signals Vietnam's intention to re-establish nuclear energy as a key pillar of its long-term energy strategy.

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