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Energy Technologies and Decarbonization in Southeast Asia

By Lauren Mai and Andreyka Natalegawa

Introduction

Southeast Asian nations are confronted with the considerable challenge of meeting the energy needs of booming populations and rapid economic growth while living up to ambitious carbon neutrality pledges and climate goals. To balance these demands, countries in the region have turned to a broad range of international partners for financial and technical support, including the United States. With elections in November and President Joe Biden declining to run for another term, the next U.S. administration has an opportunity to reinvigorate and double down on the United States' critical role in Southeast Asia's energy transition plans. To do so, it may face a unique challenge: balancing renewable energy goals while deepening partnerships with regional states, many of which have little hope of meeting their short- and medium-term energy needs with existing renewable power capacity alone.

Across Southeast Asia, governments face a gap between aspirations and reality. They must contend with growing demand that will require major investments not only in mature renewables but also in unproven emerging technologies including small modular nuclear reactors (SMRs) and carbon capture, utilization, and storage (CCUS). Similar to their decarbonization plans, many Southeast Asian nations lack both concrete plans and infrastructure to deploy these emerging energy technologies. To successfully implement these ambitious technologies, countries need external funding and technical support. If countries do not receive such support from the United States, they are likely to either increase dependency on coal usage in the long term or seek funding and technical assistance from China, which would undermine both their own national and energy security goals and those of Washington.

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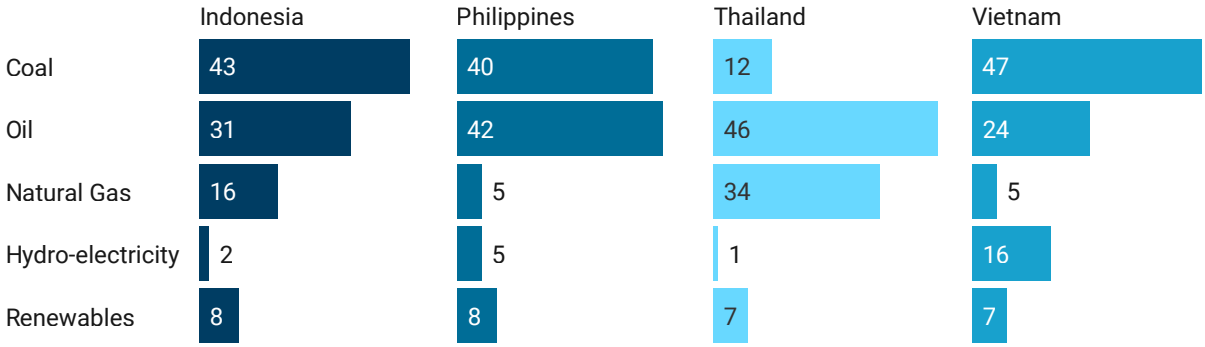
There is an opportunity for the United States and others to set standards in emerging renewable and clean technologies and deepen bilateral and multilateral cooperation across the region by promoting more transparent, sustainable, high-quality, and high-value energy infrastructure development and financing. To assess how Southeast Asian countries have approached the use of emerging energy technologies in pursuit of their respective energy transition plans and how the United States can better tailor programs to help support these technologies, the Southeast Asia Program at CSIS engaged in conversations with experts on the Biden administration's climate plans and with U.S. government officials and representatives from Southeast Asian embassies in Washington. These conversations informed the findings and recommendations in this report, but all opinions presented are solely those of the authors. This report—a follow-up to the program's 2023 **report** on clean energy and decarbonization in the region—focuses specifically on Indonesia, the Philippines, Thailand, and Vietnam, four countries that are at the forefront of developing and adopting emerging energy technologies while also being comparatively open to investment from the United States.

Southeast Asian Approaches to Emerging Energy Technologies

Figure 1: Southeast Asian Energy Mix by Consumption in 2023 (by percent)



Source: "Statistical Review of World Energy," The Energy Institute, https://www.energyinst.org/statistical-review; and authors' calculations.

Indonesia

According to the **Energy Institute**, Indonesia's energy mix as of 2023 remained dominated by coal—at approximately 43 percent of total energy consumption—followed by oil at 31 percent, natural gas at 16 percent, renewables (including wind and solar) at 8 percent, and hydroelectricity at 2 percent.

Indonesia in November 2023 issued a **Comprehensive Investment and Policy Plan** (CIPP) outlining the implementation of the country's Just Energy Transition Partnership (JETP) launched the previous year with the International Partners Group (IPG), a coalition of 10 countries led by the United States and Japan. Indonesia's JETP seeks to catalyze investment in and accelerate the country's energy transition, with the IPG and the Glasgow Financial Alliance for Net Zero collectively providing an initial financing commitment of $20 billion. The CIPP is grounded in a November 2022 statement issued by Indonesia and the IPG defining joint conditional targets for decarbonization as (1) achieving peak power sector emissions by 2030 of no more than 290 million tons (MT) of carbon dioxide (CO_2), followed

by an immediate decline to achieve net zero emissions by 2050, and (2) accelerating the deployment of renewable energy so that it comprises at least 34 percent of all power generation by 2030. The CIPP document further sets out an on-grid emissions target and pathway of total on-grid power sector emissions peaking by 2030. It sets an emissions target of no more than 250 MT CO_2 in 2030 and a renewable energy generation share of 44 percent by that year, with a goal of achieving net-zero emissions in the power sector by 2050.

> *The costs associated with these investment focus areas alone dwarf the IPG's initial $20 billion commitment, pointing to a gap between the ambition of the JETP and the reality that closing funding gaps will require a herculean effort by Indonesia, members of the IPG, and the private sector.*

To achieve these targets, the CIPP document outlines five investment focus areas, including "dispatchable renewable energy acceleration," with a target of an additional 16.1 gigawatts (GW) built out by 2030 costing up to $49.2 billion; "variable renewable energy acceleration," targeting an additional 40.4 GW built out by 2030 at a cost of $25.7 billion; and "renewable energy supply chain enhancement." The costs associated with these investment focus areas alone dwarf the IPG's initial $20 billion commitment, pointing to a gap between the ambition of the JETP and the reality that closing funding gaps will require a herculean effort by Indonesia, members of the IPG, and the private sector.

Moreover, critics remain **concerned** by the fact that Indonesia's energy transition plans still exclude from emissions caps so-called captive power plants that are used to provide power generation for **industrial consumers**. By 2030, these plants alone are **estimated to emit** between 153 and 187 MT CO_2, or between 61 percent and 74 percent of the separate 250 MT CO_2 emissions target for power generation. While the CIPP document notes that the "the JETP Secretariat will carry out a more detailed study and roadmap on decarbonizing Indonesia's off-grid captive power systems" and that "the [government of Indonesia] and IPG share a strong commitment to identifying and implementing viable solutions going forward," the captive power road map that this process produces will not constitute a legally binding document. Ultimately, the broad proliferation of coal-fired power plants as part of Indonesia's expansion of its mining industry threatens gains in decarbonizing the on-grid power sector made through the JETP and points to a disjunction in the government's competing priorities.

In tandem with its efforts via the JETP to boost investment in variable and dispatchable renewable power, Indonesia has also initiated the exploration of novel and emerging energy technologies. In March 2023, the U.S. Trade and Development Agency announced the awarding of a grant to PLN Indonesia Power to provide **technical assistance** in developing Indonesia's first SMRs, with Oregon-based NuScale Power set to carry out this assistance in partnership with a subsidiary of Texas-based Fluor Corporation and Japan's JGC Corporation. Two months later, Indonesia signed a memorandum of understanding with four Danish companies to explore the construction of an **SMR facility** on the island of Borneo designed to produce one million tons of ultra-low emissions ammonia

annually. And in August 2024, President-elect Prabowo Subianto met with Russian president Vladimir Putin and **requested Moscow's support** in nuclear energy cooperation.

Indonesia's forward-leaning approach to SMR technologies is assisted by the fact that, unlike other Southeast Asian countries that are only now exploring opportunities for cooperation with the United States on civilian nuclear technology, Jakarta and Washington have an extensive history of nuclear cooperation, rooted in a 123 agreement, a legally binding framework for **peaceful nuclear cooperation**, dating back to 1981 that will remain in effect until 2031. But at the same time, the country's propensity for seismic activity will likely necessitate that SMR facilities service parts of the archipelago less prone to earthquakes and other natural disasters (primarily the Indonesian portions of Borneo) rather than more populous islands like Java. Such technologies are thus unlikely to be a silver bullet in boosting power generation. This is reflected in the fact that JETP **scenarios** outlined in the CIPP note that nuclear technologies will provide only 5 percent of Indonesia's energy generation by 2050, compared to solar at 26 percent, hydropower at 21 percent, and bioenergy at 17 percent.

Indonesia also has focused efforts on CCUS. Following the issuance of **MEMR 2/2023**, a 2023 order from the Energy Ministry on CCUS in upstream oil and gas exploration and production activities, in January 2024 Indonesia enacted **Presidential Regulation 14/2024,** which addresses the organization of carbon capture and storage activities. The regulation **broadens the scope** of Indonesia's existing rules on CCUS, allowing operators to set aside 30 percent of their storage capacity for imported carbon dioxide, provided that foreign emitters either have invested in Indonesia or were affiliated with companies that have done so, and that the Indonesian government has a bilateral agreement with the government from which the emissions originate. These regulatory efforts have underscored Indonesia's leading role in CCUS in the region, with BP having announced a **CCUS project in November 2023** and other players, including ExxonMobil and Chevron, also exploring investments in CCUS projects.

The Philippines

As of 2023, the Philippines' energy mix consisted of oil—at approximately 42 percent of total energy consumption—followed by coal at 40 percent, natural gas at 5 percent, renewables (including wind and solar) at 8 percent, and hydroelectricity at 5 percent.

The administration of President Ferdinand "Bongbong" Marcos Jr. has made strides toward outlining the Philippines' pathway to a net zero economy, as demonstrated by the launch of the **Philippine Energy Plan (PEP) for 2023 to 2050**. The plan describes three key lines of effort to achieve a sustainable and resilient energy future for the Philippines: securing access to affordable energy; achieving a reliable and resilient energy supply; and developing clean, sustainable, and climate-centered energy resources. These initiatives include a push to **increase** the share of renewable energy in the power generation mix to 30 percent by 2030, 50 percent by 2040, and more than 50 percent by 2050. At the same time, the country will pursue "alternative fuels and emerging technologies," including electric vehicles, hydrogen, energy storage systems, and—most prominently—nuclear power. The PEP document **further declares** the Philippines' intent to "pursue research and development (R&D), and pilot projects involving emerging energy technologies," including "energy storage systems, hydrogen and ammonia, carbon capture utilization storage (CCUS), and utilization of information and communication technology (ICT) for small to large scale energy systems."

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Emerging technologies have a significant role to play in the Marcos administration's forecasts for the Philippine energy sector. The PEP document outlines two **energy pathway scenarios** for the Philippines: a "reference scenario" with a business-as-usual approach and a "clean energy scenario . . . which sets aggressive targets for the energy sector until 2050." While the reference scenario **forecasts** that nuclear and other technologies will play a minimal role in power generation, the clean energy scenario suggests that these emerging technologies could generate 19.4 terawatt hours (TWh)—or 6.9 percent of overall power generation—by 2040 and 38.6 TWh—or 8.9 percent—by 2050. These gains, coupled with an expansion in wind usage, could in turn offset reduced capacities from coal, natural gas, solar, and hydropower.

The PEP identifies the implementation of a Philippine Nuclear Energy Program as an area of strategic focus, building on the formation of the Nuclear Energy Program Implementing Organization in 2016 and the creation of the Nuclear Energy Program Inter-Agency Committee in 2020. Then-president Rodrigo Duterte's **Executive Order 164** on adopting a national position for a nuclear energy program in February 2022 laid the groundwork for the regulatory framework of the Philippines' efforts in nuclear energy, a task that President Marcos has aggressively pursued since taking office.

In November 2023, the United States and the Philippines **signed a 123 agreement** on nuclear cooperation, with President Marcos describing the pact as "[supporting] the development of reliable, affordable and sustainable power in the Philippines" and "[opening] doors for U.S. companies to invest and participate in nuclear power projects." The signing of the agreement, following NuScale Power's **May 2023 announcement** that it plans to develop SMRs worth up to $7.5 billion in the Philippines, also marks what the Philippine Department of Energy **describes** as "the fastest 123 Agreement negotiations completed in seven months," reflecting enthusiasm in both Washington and Manila for pursuing deeper cooperation in nuclear power and other emerging energy technologies.

Thailand

In 2023, **Thailand's energy mix** consisted of oil and natural gas at a combined 80 percent, coal at 12 percent, renewable energy at 7 percent, and hydropower at 1 percent. Thailand's substantial increase in oil and natural gas usage may be attributed to **El Niño–induced droughts** impacting neighboring Laos and Vietnam. Thailand currently imports most of its hydropower from Laos, honoring an **existing agreement** to purchase 10,500 megawatts (MW) of electricity from the nation. With drought causing Laos's hydropower plants to generate less electricity, Thailand has utilized more oil and natural gas to meet energy security challenges. But with domestic gas reserves projected to **dry up** in the next two decades, Thailand is turning to liquefied natural gas (LNG) imports to maximize long-term energy security. It is set to expand gas storage tanks to a maximum capacity of 26 million metric tons per annum by 2037.

Thailand's **Natural Energy Plan** (NEP) includes five initiatives: the Thailand Power Development Plan (PDP); the Renewable and Alternative Energy Development Plan; the Energy Efficiency Plan; the Natural Gas Management Plan; and the Fuel Management Plan. The NEP, implemented in 2023, is in the process of steering Thailand toward carbon neutrality between 2065 and 2070. The first part of the plan, the PDP, is set to be ready by **the third quarter of 2024**, focusing on Thailand's renewable energy capabilities. This PDP will **replace** the one created in 2018 and is set to be implemented from 2024 to 2037. Under the initiative, Thailand will strive to reach 50 percent renewable energy by 2037.

The NEP is working to **implement** new technologies in Thailand, including hydrogen and SMRs. Hydrogen has sparked the interest of the private sector. In June 2024, Japan's Mitsubishi Heavy Industries and the Electricity Generating Authority of Thailand (EGAT) **inked** a memorandum of understanding to research hydrogen cofiring technologies for gas turbine power generation facilities in Thailand. Research under this agreement will strive to facilitate the conversion of thermal power plants to fire clean fuels, beginning with a hydrogen cofiring pilot project at one of EGAT's power plants. Meanwhile, Thailand's PTT Global Chemical is working with other firms to **develop** green hydrogen fuel for vehicles. However, this technology faces financial roadblocks in its development, with the fuel being expensive to produce due to its complex derivation from renewables.

In addition to green hydrogen, Thailand is considering SMRs. Thailand initially intended to build its first nuclear reactor plant in 2020 but was disrupted by the Fukushima disaster in Japan in 2011. Thailand is drawn to SMRs' lower upfront capital costs per unit, aiming to develop an operational plant within the next decade. But while included in the NEP, Thailand has not specified any timeline to roll out SMRs across the nation.

Thailand's electric vehicle (EV) industry continues to boom amid its larger energy goals. In 2023, the country **sold** 78,314 EVs, a substantial increase from the 9,729 sold in 2022. In February 2024, Thailand approved **incentives** for companies to transition their commercial vehicles to EVs. To solidify Thailand as an EV manufacturing hub, additional incentives have included cash grants for EV battery cell manufacturers as well as tax deductions for eligible companies. The incentives, effective until December 2025, allow companies that purchase vehicles manufactured domestically to deduct expenses twice the price of the vehicle; for imported vehicles, they may deduct expenses 1.5 times the cost of the vehicle. Thailand's incentives strive to continue the momentum of EV investment in the country, a critical industry for reaching its climate goals.

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Vietnam

In 2023, **Vietnam's energy mix** consisted of coal at 47 percent, oil and natural gas at 29 percent, hydropower at 16 percent, and renewable energy at 7 percent. While Vietnam has ambitious climate goals and strives to cut its reliance on coal by 2050, its dependence on this energy source will continue

to increase before it is successfully phased out, with **peak usage** expected to be reached in 2035. Vietnam's 2024 coal usage is much higher than last year due to a **severe drought** during the 2023 to 2024 dry season that placed significant strain on the generation of hydroelectric power. With water levels low, Vietnam resorted to burning more fossil fuels to make up for the hydropower shortfall. And with **climate change** driving rising temperatures and sea levels, it is unclear whether Vietnam's droughts will become a long-term problem for its energy usage.

Vietnam's energy mix has also been impacted by its ongoing anticorruption campaign. The government has failed to put forward regulations that would allow offshore wind power to enter the national grid. As a result, plans to develop wind turbines across the country have been **stalled**, with 3.5 GW of turbines having either been built and left unused or under construction. The untapped offshore wind energy would be enough to power 4.4 million households, but with anticorruption crackdowns incapacitating decisionmaking, Vietnam is struggling to maintain foreign investor interest.

In May 2023, the government **approved** its long-awaited energy transition plan, Power Development Plan 8 (PDP8), which was formally **issued** in July 2023. Vietnam is still committed to carbon neutrality by 2050, with the UN Development Program (UNDP) in the country **developing** a road map for transitioning away from coal-fired power toward more sustainable alternatives. The UNDP is working closely with both the Vietnamese public and private sector as well as members of the **IPG** toward long-term, sustainable non-coal solutions.

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Vietnam's JETP is also supporting the country's journey to carbon neutrality, aiming to **mobilize** $15.5 billion in both public and private sector financing to aid the energy transition. At the 2023 UN Climate Change Conference in Dubai (COP28), Vietnam unveiled its **Resource Mobilization Plan** (RMP), which gives greater detail on how the country intends to utilize JETP's funding. The plan takes **guidance** from both the PDP8 and Vietnam's National Energy Master Plan. Under the RMP, the government **addresses** project priorities between 2024 and 2050. Short-term priorities include power grid development support, energy system storage support, and projects on offshore wind development. Long-term priorities beyond 2024 include increasing energy efficiency and solar power use and phasing out coal.

PDP8 also lays out **new technologies** for Vietnam's energy market, such as battery storage, biomass, waste-to-energy, and green hydrogen and ammonia. Energy storage is critical for Vietnam's transition to renewables, with a total capacity of **300 MW** targeted by 2030, notably in areas that face shortages of reserve capacity. Biomass and waste-to-energy technologies are designed to be **utilized** in rural and urban areas, respectively, and are expected to exhibit modest growth up to 2030. Vietnam intends to transition thermal power from coal to biomass and green ammonia, pledging to **stop** building coal thermal power plants by 2030. And by 2050, Vietnam aims to utilize both biomass and green ammonia to create between 25,632 and 32,432 MW of energy, 4.5 to 6.0 percent of the total energy mix. But while having a **development scale potential** of up to 5,000 MW, both green hydrogen and ammonia

face development challenges. As relatively new technologies, they are still in the early stages of development, with unclear paths to advancement and implementation.

While Vietnam is ambitiously pursuing new energy solutions, it continues to develop tried-and-true technologies that will play an instrumental role in its energy transition. Vietnam's PDP8 highlights LNG as a **transition fuel**, with import capacity projected to peak at 11.4 to 13.2 million metric tons per year in 2030 before dropping to 7.7 to 8.8 million metric tons per year in 2050. PDP8 supports the construction of LNG terminals, with Vietnam seeking to prioritize sourcing LNG from Association of Southeast Asian Nations (ASEAN) markets such as Malaysia, Indonesia, and Brunei. Vietnam plans to **construct** 13 new LNG power plants by 2030, reaching a total 22,400 MW capacity. However, Vietnamese market investors are concerned about the plan's scattered small capacity terminals, claiming that by not utilizing Vietnam's current infrastructure, costs will only increase to cover these new LNG terminals.

While Vietnam has historically explored building nuclear power plants, it **scrapped** all its initial plans in 2016 due to both the 2011 Fukushima disaster and budget constraints. In the years since, Vietnam has **considered** resuming its plans toward nuclear power through the support of international suppliers, including Canada, Russia, and South Korea. But in 2024, Vietnam is now officially considering resuming its plans to pursue nuclear power. Vietnam is currently working on a nuclear power development proposal to submit to the Politburo but has not disclosed any timelines toward completion.

Vietnam continues to showcase strong potential in both wind and solar power. While PDP8 plans to increase both solar and wind energy output, Vietnam emphasizes that growth will start **slowly**. Solar power is expected to reach only around 22.6 GW by 2030, yet nearly 170 GW by 2050. Meanwhile, PDP8 calls for wind power to grow to 30 GW by 2030, and to over 130 GW by 2050, though the current logjam in the development of offshore wind makes those targets unlikely. PDP8 aims to establish two interregional renewable energy service centers that will drive renewable generation and manufacture equipment and aims for half of the country's buildings to be powered by rooftop solar by 2050. However, both Vietnam's solar and wind energy plans have limited details on implementation.

In July 2024, Vietnam announced and implemented **Decree 80/2024/ND-CP**, a Direct Power Purchase Agreement set to allow businesses to purchase renewable energy from producers instead of state monopoly Vietnam Electricity. Decree 80 **encourages** more investment in renewable energy, especially for rooftop solar and wind farms, potentially increasing demand for renewable energy infrastructure. Vietnamese analysts also foresee Decree 80 as an opportunity for green technology innovation, energy storage solutions, and education and training in the renewables sector.

Recommendations

The United States should work with ASEAN countries to establish a balance between mature renewables and emerging energy technologies. While investments in emerging and next-generation energy technologies are a critical part of many Southeast Asian countries' pathways to net zero, limited human and financial resources mean that governments may face trade-offs in the extent to which they pursue initiatives focused on novel technologies versus those that center on mature and proven renewable technologies, ranging from solar and wind to geothermal or hydropower. While these mature renewables certainly present their own challenges, including as it relates to transmission and storage

for variable renewables like solar and wind, they still have a key role to play in decarbonizing Southeast Asian economies. As such, the United States must work closely with counterpart governments to ensure balance and complementarity between various lines of effort, both maintaining–and expanding–existing efforts related to traditional renewable technologies while aggressively pursuing cooperation on emerging technologies.

Maintain policy consistency and synergy with existing U.S.-led initiatives in the next administration. President Biden's July 2024 announcement that he would not seek reelection means that the U.S. elections in November will result in a change in administration no matter which party wins the White House. It is critical that the United States focuses on maintaining policy continuity regarding its support for emerging energy technologies in Southeast Asia and synergy between its various lines of effort. The Trump administration's 2017 withdrawal from the Paris Climate Accords severely damaged U.S. credibility on decarbonization and combating the climate crisis in the eyes of Southeast Asian partners. But by the same token, the Biden administration's moves to **freeze approvals of new LNG exports** in January 2024 negatively impacted Southeast Asian countries' confidence in the United States as a provider of a resource that has become increasingly important in efforts to wean off coal dependency. The next U.S. administration needs to factor in the externalities faced by Southeast Asian countries when calibrating its approach to energy policy and communicate and consult closely with Southeast Asian partners in cases where there will be divergences from past policy. Policy consistency and continuity will be essential in fostering a stable investment environment where stakeholders, including Southeast Asian governments and the private sector, feel secure in placing bets on emerging and renewable energy technologies.

Establish a mechanism to better coordinate standards around developing emerging energy technologies. To meet Southeast Asia's ambitious climate goals, the United States and Southeast Asian partners should establish a joint mechanism to improve successful coordination around developing and deploying emerging energy technologies. Successful standards should support transparent development of new technologies, properly disclosing both safety practices and testing methods. Standards can be enhanced with skill-sharing opportunities, allowing the United States to give Southeast Asian countries the resources to develop new technologies efficiently and independently. The United States may consider revitalizing the **Clean Economy pillar** of the Indo-Pacific Economic Framework (IPEF) to develop such standards during the next U.S. administration without having to establish a new platform to do so. Developing a set of standards also gives the United States and ASEAN an opportunity to consider standardized private sector investment in emerging energy technologies. Increased involvement with the private sector catalyzes more funding possibilities to help Southeast Asian nations remain on target to meet their climate goals.

Develop skill-sharing initiatives to allow ASEAN countries to pursue emerging energy technologies independently. Human capacity development remains a key obstacle for many ASEAN countries as they pursue the development and deployment of emerging energy technologies. With an energy and natural resources workforce still largely centered in extractive industries, Southeast Asian countries will face challenges in training and educating a new generation of workers focused on emerging renewable technologies. The United States should leverage its role as a leader in these technologies and provide additional opportunities for education, skills-sharing, and knowledge transfer

for Southeast Asian counterparts. This could include providing scholarships to Southeast Asian students to earn degrees in nuclear engineering or other related fields, boosting the number of exchanges to the United States for Southeast Asian professionals and academics in fields related to emerging energy technologies, and facilitating additional visits to Southeast Asia by leading U.S. private sector executives involved in emerging energy technologies—in line with the annual **Indo-Pacific Business Forum** and the recent **Presidential Trade and Investment Mission** to the Philippines. ■

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