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History and Prospects of Nuclear Power in Vietnam

Abstract. The Socialist Republic of Vietnam is currently considering the option of adding nuclear power to its energy mix. The paper is dedicated to examining the historical retrospective as well as prospects of nuclear energy use in Vietnam. Apart from scrutinizing some official documents, from Power Development Plan #8 (PDP8) to intergovernmental agreements (IGAs), the paper employs SWOT analysis methodology to assess the prospects of nuclear power in Vietnam. The author finds the urgent need to balance between the rapidly growing power demand and lowering carbon dioxide emission and accesses the nuclear option as a viable choice for Hanoi's policy. Russia represents the most likely partner for Vietnam in this regard. Vietnam could become a pioneer in this hi-tech sphere in the Southeast Asia (SEA).

Keywords: Vietnam, nuclear power, peaceful use of atomic energy, Ninh Thuan Nuclear Power Plant (NPP), SWOT analysis.

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История и перспективы атомной энергетики во Вьетнаме

Аннотация. Социалистическая Республика Вьетнам рассматривает возможности добавления ядерной энергетики в свой энергобаланс. Статья посвящена раскрытию предыстории этого решения, а также перспектив внедрения энергии атома во Вьетнаме. Помимо изучения официальных документов, от VIII Плана развития электроэнергетики до межправительственных соглашений, в статье используется методология SWOT-анализа для оценки перспектив внедрения ядерной энергетики во Вьетнаме. Выводы показывают, что острая необходимость балансировать между растущим спросом на электроэнергию и снижением выбросов углекислого газа приводит Ханой к политическому выбору в пользу атомной энергетики. Россия представляет собой наиболее вероятного партнёра для Вьетнама в данной области. Вьетнам мог бы стать первопроходцем в этой высокотехнологичной сфере в Юго-Восточной Азии.

Ключевые слова: Вьетнам, ядерная энергетика, мирное использование атомной энергии, АЭС «Ниньтхуан», SWOT-анализ.

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Introduction

In recent years, Vietnam has been labelled as one of the few ASEAN nations ready to embrace nuclear power [Trajano, Caballero-Anthony 2024; Do, Burke 2024]. E.g. according to Dr. V. Nian (Centre for Strategic Energy and Resources, Singapore), out of all the SEA countries, only Vietnam and to some limit Thailand are capable of embarking on an internationally credible nuclear power program due to the availability of regulatory infrastructure, proliferation resistance and other factors [N-word No Longer... 2024]. The revitalization of Hanoi's nuclear program announced in 2024—2025 renders the issue all the more relevant.

This article is thus devoted to evaluating the prospects of adding nuclear power into Vietnam's energy mix. Scarcity of relevant scholarly literature represents both a challenge and an opportunity to fill the research gap. The methods utilized in this study encompass document analysis, substantiated by semi-structured interviews conducted by the author during his fellowship at Hue University International School in the spring term of 2023: a business person and a member of the academia were surveyed. However, the paper predominantly relies on SWOT analysis, which makes it possible to assess the advantages and downsides of the country's potential transition to nuclear power.

The rest of the paper is structured as follows. First, a brief literature review is provided. Afterward, Vietnam's positions in the global nuclear nonproliferation regime and IAEA safeguards system are unveiled. Then, the national legislation and corresponding infrastructure are highlighted. Next comes a concise overview of Vietnam's energy sector and nuclear fuel cycle (NFC). As a case study, the paper focuses on the Ninh Thuan NPP project from both historical and contemporary perspectives. A SWOT analysis is presented further to identify both premises and obstacles in external and internal environments. The article concludes with recommendations.

Literature review

The prospects of Vietnam introducing nuclear power into its energy mix have been scrutinised in papers by international authors. These secondary sources can be divided based on their perception of the decision in favour of the nuclear option.

The first group of papers, including by Russian scholars, highlight numerous advantages nuclear power can bring to Vietnam. Dr. R. Ramaswak [2024] makes a conjecture that China's and ROK's intention to increase their nuclear capacity may positively influence Vietnam's decision-making in terms of following their suit. Nguyen Thi Ngoc Lan and in Vietnam's community. L. Naidu and R. Moorthy [2022] also add environmental and ethical concerns, making an assumption that Vietnam's decision to halt the nuclear project was temporary. J.C. Trajano and M. Caballero-Anthony [2024] claim that ASEAN states' interest in small nuclear reactors (SMRs) may necessitate additional safety and security measures. C. Wang, Q. Wang and F. Wang [2012], in turn, underline the need for Vietnam to perfect the national legislation, drawing special attention to choosing the location for NPPs. The selection of a proper site for Vietnam's

first NPP is addressed by C.-N. Wang, C.-C. Su and Nguyen Van Thanh [2018]: Binh Thuan is suggested as an optimal solution.

Thus, it would be necessary to synthesize the achievements of previous studies to provide an objective picture. A re-evaluation of the state of affairs in Vietnam's prospective nuclear program is also sought for, given the recent developments.

E.F. Chernenko [2018] stress the historical role of Vietnam's bilateral energy projects with the USSR and later Russian Federation as a premise for successful cooperation in the nuclear sphere. T.I. Borzunova, A.S. Maksimova and G.F. Morozova [2017] give a specific account of the impact of possible NPP construction in Ninh Thuan province with an overall positive assessment of multiplicative effect. M.A. Gordeev-Burgvic, M.V. Minaeva and Yu.M. Gordeeva [2014] evaluate Vietnam's potential choice in favour of nuclear power as a way to deal with the carbon dioxide emissions from coal power plants. D. Do, I.-H. Ahn, S. Kim [2009] also underline this effect, at the same time warning about infrastructure problems and lack of human resources. The survey conducted by T.N. Do and P.J. Burke [2024] demonstrates the openness of Vietnam's expert community to atomic energy as an alternative to coal power.

The second group of articles tends to focus on perceived dangers attributed to nuclear power and concomitant obstacles. S.S. Ho et al. [2019] cite risk of nuclear accidents as a reason for probable apprehensions

Vietnam in the global nuclear nonproliferation regime and IAEA safeguards system

The involvement of the country in the international nuclear nonproliferation regime and safeguards system result in its perception as a responsible member of the global community, decreasing the probability of militarisation of its prospective nuclear program. Saigon regime signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) on August 1, 1968 and ratified it on September 10, 1971. In spite of the declaration of the Socialist Republic of Vietnam (SRV) that it does not consider itself bound by the respective obligations of the previous administration [The Text of the Agreement... 1980], the nation acceded to NPT as SRV on June 14, 1982. Of note is Hanoi's active participation in NPT Review Conferences, especially as part of SEA group and Non-Aligned Movement (NAM). Vietnam, among more than a hundred member states, was also vocal in the Humanitarian Initiative in the mid-2010s. Vietnam signed the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in 1996 and ratified it a decade later. Importantly, the country is an Annex II state, meaning it is one of the 44 nations possessing nuclear reactor technologies.

Vietnam is also a member of the SEA Nuclear Weapon-Free Zone (SEANWFZ) in accordance with the Treaty of Bangkok effective since 1997. Regardless the question of nuclear-weapon states' (NWSs') ratifying the Protocol thus providing the security assurances, this document remains an important instrument of the regional security.

The country's peaceful stance and adherence to Global Zero (i.e. universal nuclear disarmament) is in line with the positions of ASEAN member states in general. Pham

Binh Minh, then head of Vietnam's MFA, signed the Treaty on the Prohibition of Nuclear Weapons (TPNW) on September 22, 2017. Vietnam subsequently ratified it on May 17, 2018.

NPT Article IV prescribes that no discrimination should take place with regard to any country's inalienable right to peacefully use nuclear power. Duong Chi Dung, former Head of Vietnam's permanent delegation to the United Nations Office, specifically underscored this opportunity in 2018. IAEA safeguards are crucial in this regard. The first agreement of this kind was signed on October 2, 1989, namely INFCIRC/376 that entered into force on February 23, 1990. On August 10, 2007 Hanoi signed the Additional Protocol (AP) based on INFCIRC/540, which presupposes a new level of commitment and concrete specification on the materials and verification procedures. The original agreement was essentially reviewed on September 26, 2012, when the AP entered into force for Vietnam. Some gaps are to be mentioned as well, e.g. Hanoi is not a party to 1963 Vienna Convention on Civil Liability for Nuclear Damage.

Vietnam's national nuclear legislation and NFC infrastructure

Relevant internal legislation is represented in the first place by the Law on Atomic Energy passed by the National Assembly (NA) in June 2008. The Law entered into force in 2009. Vietnam Atomic Energy Commission, in turn, was established in 1976. Since 1993 it has functioned jointly with Vietnam Atomic Energy Institute (VINATOM) and is mostly focused on fundamental research. Vietnam Agency for Radiation and Nuclear Safety (VARANS) plays its role as a regulator, while Vietnam Electricity (EVN) corporation is a potential operator [Do, Burke 2024]. Sometimes scholars express concerns over interdepartmental communication challenges against the background of potential threats [Naidu, Moorthy 2022]. The abovementioned does not preclude the need for further development of the legislation, e.g. radioactive waste management principles [Ibid.] through explicitly expressing the country's adherence to IAEA guidelines, composing a detailed plan with regard to specific sites etc.

Vietnam's research reactor, initially 250 kW TRIGA-MARK II, was constructed in Da Lat, Lam Dong Province under American Atoms for Peace program, launched as early as 1963 and shut down by the US shortly before the end of the war. In 1984, Vietnam managed to double its capacity with the Soviet assistance thanks to loading the 36%-enriched fuel, essentially high-enriched uranium (HEU). In 2010, it was decided to switch the fuel to low-enriched uranium (LEU), which was implemented by late 2011, as HEU was returned to Russia. A replacement of the reactor in Da Lat Nuclear Research Institute, now used for fabricating various isotopes and personnel training, has been named as a necessary prerequisite for actual development of nuclear power in the country [Nuclear power could solve...].

Vietnam's NFC is understandably still in its stage of inception. The potential exists for front-end activities, in light of the low-grade uranium ore deposits in Northern and Central Vietnam (esp. Quang Nam province). Be that as it may, Vietnam plans to import reactor fuel at the initial stage, because uranium mining alone is not enough, it is necessary to establish a technological process from scratch.

Vietnam's energy sector: a brief overview

Vietnam's growing deficit of the electricity, namely, 10 % per year [Nuclear Power in Vietnam 2024], leads to habitual power outages. Overcoming the intermittency issue is thus one of the key problems for Vietnamese households and industries. The increasing demand for energy is even predicted to surpass the 10 % mark around 2030, additionally substantiated by the development of the IT sector as well as ambitious infrastructure projects such as North-South express railway. The trend can be extrapolated to the whole subregion: the energy demand in ASEAN is predicted to double by 2040 compared with 2023 [Nuclear Power: Curse or Cure... 2024].

Vietnam has been struggling to diversify its energy mix for decades as the nation's reliance on fossil fuels is barely balanced by hydropower. The latter is notably contingent upon the changing climatic conditions [Ramsawak 2024]. Nevertheless, Vietnam follows the global trend striving to decrease its dependence on fossil fuels in the fulfilment of its long-term objective of reducing their share in the energy mix [Wang, Wang, Wang 2012]. At the UN Climate Change Conference (COP26) held in Glasgow in 2021, Vietnam committed to achieve the goal of securing net zero carbon emissions by 2050 [Honney 2022]. As an interim target, Hanoi undertook obligations to eliminate coal consumption by 2040 for the purpose of mitigating greenhouse gas (GHG) emissions [Do, Anh, Kim 2009].

The country's energy development roadmap, PDP8, has been designed to address these restrictions. In accordance with the document, Vietnam's total electricity capacity is projected to reach 150 GW(e) by 2030 in contrast to 80 GW(e) in 2023.

Ninh Thuan NPP project: back to where it started?

To comprehend the current situation with the Ninh Thuan NPP, it is necessary to turn to a retrospective case study of the project's previous iteration, which dates back to the 2000s. On March 26, 2002, Russian-Vietnamese IGA on cooperation on peaceful uses of nuclear energy was signed. Vietnam's first NPP was initially planned as early as 2006, and a corresponding NA Resolution No. 41 [National Assembly of the SRV 2009] was passed in 2009. A preliminary understanding with Moscow on the construction of the power plant was reached the same year [Nuclear Power: Curse or Cure 2024]. EVN and Rosatom signed a detailed agreement on the NPP construction on October 31, 2010. The project by Rosatom's subsidiary, Atomstroyexport, presupposed two VVER-1200 power units, i.e. a capacity of 2.4 GW(e), with two more identical reactors to be added in the future. Ninh Thuận NPP construction was supposed to begin in 2017 and be finished by 2023—2024 [«Росатом» актуализирует... 2025]. The original plan was to introduce the first reactor in 2020. By 2030, 13 units with the total capacity of 15 GW(e) should have already been built. It was assumed that nuclear power would reach one fifth or even one fourth in the energy mix by 2050 [Wang, Wang, Wang 2012].

The IGA on credit loan was inked on November 21, 2011: Russia agreed to provide an equivalent of USD 9 billion for the period of 2014 to 2021. Comprehensive Strategic Partnership effective since July 2012 also influenced the bilateral relations in the energy

sector [Nguyen Thi Ngoc Lan, Chernenko 2018]. By 2015, Hanoi had spent some USD 86 million for R&D and other works related to the project, including training its engineers in Russia. A program on training some 2,400 Vietnamese specialists by 2020 was announced in 2010. E.g. only in 2017 a group of 28 Vietnamese students graduated from National Research Nuclear University MEPhI. In 6 years, more than 400 Vietnamese students of nuclear-related disciplines completed their training in Russia and 31 more in Japan [Skilled workforce... 2025]. Some 150 Vietnamese engineers were involved in the construction of Rostov NPP [Nuclear Power in Vietnam 2024].

All that notwithstanding, the plans were regularly being rescheduled while the budget was inflated to as much as USD 19 billion. On November 10, 2016 NA suspended — but not abrogated — the undertaking with its Resolution No. 31 in favour of coal (which made roughly one half of all the power generation as of 2022), gas, electricity imports from Laos as well as already existing hydropower plants, the latter being highly contingent on weather conditions [Gordeev-Burgvic, Minaeva, Gordeeva 2014]. Moreover, according to Nguyen Hong Dien, Minister of Industry and Trade, the potential of hydropower has been exhausted to the full extent [Honney 2022]. Another reason for the decision to put the costly NPP project on hold was external national debt. As a result, a Protocol on the cancellation of the previous agreement was signed on July 17, 2019.

Still, in May 2017, the two sides declared a joint cooperation program on peaceful use of nuclear energy in Hanoi. Roughly in a month, the leaders of both nations publicly supported bilateral cooperation in the nuclear realm in their joint statement [Vietnam, Russia issue joint statement 2017]. President Tran Dai Quang during his visit to Russia in June 2017 also discussed the possibility of establishing a Nuclear Science and Technology Centre [Nguyen Thi Ngoc Lan, Chernenko 2018]. Russia promised to provide a preferential loan of 0.5 billion USD for the construction of the Centre. Nonetheless, it took seven more years for the parties to finalise the decision (see below).

Vietnam was also considering possible projects with Japan and the Republic of Korea (ROK). The project with Japan was also agreed upon in 2009 [Ibid.] followed by an IGA in October 2010 (in effect since January 2012). The cost for both Japanese and Russian parts was 8.9 billion USD [Vietnam approves... 2024], however, according to another source, Japan offered Vietnam USD 11 billion contract in 2010 [Nuclear Power in Vietnam 2024]. Japan's plan consisted in adding 2.2 GW(e) of nuclear power generation capacity [Ibid.], even if without clarity pertaining to the reactor type. Nevertheless, the 2011 Fukushima Dai-Ichi nuclear accident had its effect on nuclear projects worldwide, especially with Japan's participation.

Of significance is the issue of the NPP location. At first Ninh Thuan 1 was supposed to be built with Russia's assistance in Vinh Truong Village, Phuoc Dinh Commune, Thuan Nam District [Việt Nam resumes... 2024], while Ninh Thuan 2 was planned to be constructed by Japan Atomic Power Company (JAPC) at Vinh Hai [Wang, Wang, Wang 2012] in Vinh Hai Commune, Ninh Hai District [Việt Nam resumes... 2024]. The 2015 Roadmap confirmed these plans [Roadmap deployed... 2015]. The Ninh Thuan location, being geologically stable [Nuclear Power in Vietnam 2024], presumably can suffer from tsunami [Wang, Wang, Wang 2012], which, however, could be forewarned

thanks to the possible establishment of an advanced meteorological observation station. The choice preference in favour of the southeast of the country [Smertina 2022] is geographically substantiated by both consumption patterns and the proximity to Ho Chi Minh City (HCMC) and closeness to water source used both as a coolant and a moderator in VVER-type reactors. In one of the papers [Wang, Su, Nguyen 2018], the neighbouring Binh Thuan province is designated as an optimal location for the future NPP. On a side note, Phuoc Dinh is now in a peculiar state of liminality, as the uncertainty takes its toll on the locals. At the same time, the land allotted to a construction site was never used for other purposes.

In parallel, Hanoi even tried to establish contact with the US in this area. In 2014, it signed an Agreement without the "gold standard" provision, i.e. allowing Vietnam to potentially retain its own reprocessing and enrichment capabilities. Still, in a non-binding supplementary memorandum Hanoi unilaterally forgoes such a right.

In mid-2022, NA Economic Committee suggested that the government reconsider the nuclear power policy to endorse the previous plan related to two units in Ninh Thuan [Honney 2022], essentially recommending to resume the project [Vietnam approves... 2024]. The final version of Electricity Law adopted in November 2024 contains mentions of nuclear power as an important energy source which was not the case in the previous law adopted in 2004 [National Assembly of the Socialist Republic of Vietnam 2004].

The visit of Russian top officials to Hanoi in June 2024 reinvigorated the bilateral cooperation between the two sides. June 20, 2024 was marked by signing the memorandum on creating the Centre for Nuclear Science and Technology in Hanoi by 2027. After the resolution on resuming the study of peaceful nuclear program by CPV Central Committee adopted on November 25, 2024, NA passed its resolution on amending the legislation (including the Law on Atomic Energy) on November 30, 2024, effectively reinvigorating the Ninh Thuan project [Việt Nam resumes... 2024]. Law on Electricity passed on the same day also envisions the development of atomic power. Symptomatically, Nguyen Quan, Minister of Science and Technology, admitted that traditional energy sources have already been exhausted [Nuclear power could solve...: 31.01.2025].

As of January 2025, Vietnam announced its plans to finish the construction of the Ninh Thuan NPP by 2030, as PM Pham Minh Chinh ordered the Ministry of Industry and Trade (MoIT) to present a detailed plan [Vietnam to finish...2025]. After resetting the project, the planned capacity was supposed to reach the planned capacity of 4 GW(e) with a total of 4 reactors [Vietnam approves... 2024]. In January 2025, Russian PM M. Mishustin visited Vietnam signing an agreement on cooperation in nuclear power backed by an MoU between Rosatom and EVN, the investor of the project. On a broader scale, M. Mishustin reached an agreement on enhancing the comprehensive strategic partnership with Pham Minh Chinh [Vietnam holds Russia talks 2025]. As stated by A. Likhachev, Rosatom's Director General, it was decided to confirm the original plan of constructing two VVER-1200 reactors, currently used in Russia and Belarus [Лихачев: РФ построит... 2025], later commissioning two more reactors. Next practical step would be finding the correct scheme for ensuring initial investment capital [Safe nuclear power... 2024].

At the same time, as of 2024, Rosatom was ready to provide other NPP plans than Ninh Thuan, should it be deemed necessary by Ha Noi. These, according to A. Likhachev, might include SMRs, be they ground-based or floating [«Росатом предоставил»...2024]. These options are also contemplated in Vietnam.

SWOT Analysis Matrix

To qualitatively analyze the benefits and drawbacks in external and internal environments pertaining to introducing nuclear power in Vietnam, the author utilises SWOT analysis, particularly concentrating on Russia as a presumptive technology supplier.

The findings are summarised in Table 1.

Table 1. **SWOT analysis matrix: a case study of nuclear power introduction in Vietnam**

Strengths	**Weaknesses**
Extensive coastline Openness to innovative developments (SMRs, floating NPPs etc.) Decarbonisation plans (2050 as a milestone), Rosatom's expertise in renewables Multiplier effect (creating jobs, educating staff, boosting other sectors etc.) Other applications of nuclear technology: agriculture (food irradiation), desalination, producing medical and industrial isotopes	Challenges related to political will, public perception, peculiarities of decision-making Imperfection of internal legislation in the nuclear realm Lack of highly-qualified HR, concerns regarding nuclear safety culture High capital cost, long period of return on investment
Opportunities	**Threats**
Favourable regional context Historical connections and extensive experience of joint energy projects with Russia (oil, gas, hydropower) Rosatom's expertise as a leading nuclear technology exporter Prospects of gaining technological leadership in ASEAN and becoming an energy exporter	Environmental concerns (risks of tsunamis etc.) Geopolitical volatility External political pressure to increase the odds for alternative suppliers

Conclusion

Even though Vietnam has reached a certain level of nonproliferation maturity and a corresponding administrative agency, it is likely to continue forging a robust legal basis for its nuclear project both domestically and bilaterally through updating the legislation as appropriate. The unceasing training process of the engineering personnel on a competitive basis is another prerequisite for success. Conducting public opinion polls could assist in developing a framework aimed to avoid social tensions and meet the needs of the local population. It is imperative to continue educating the general public, including through Atomic Energy Information Centres, to raise awareness of atomic

energy and its peaceful uses. Other recommendations include adopting best practices in nuclear safety and security, as well as nuclear culture in general. Successful cooperation in this strategic realm is predicated on consistency in implementing critical political resolutions already made, so as to avoid setbacks similar to that happened in 2016: Ha Noi's decision to introduce nuclear power was delayed by almost a decade resulting in a downtime, periodical energy deficit and a loss of opportunity.

Opting for nuclear power is supported by the positive multiplicative effect in demographics, social and economic development, urbanisation, and education level. Developing a national nuclear industry is a strategic investment that will pay off in a matter of decades.

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