

Discussion Paper

Research Project on Renewable Energy Economics,
Graduate School of Economics, Kyoto University

**How can Vietnam upgrade its transmission grid system to absorb renewable
energy?**



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Abstract:

This study examines the potential of Vietnam to enhance its power transmission grids with the aim of reducing curtailment issues and accommodating more solar and wind power. A literature review and semi-structured interviews were conducted with experts in the field. The findings suggest that there are several obstacles that Vietnam Electricity (EVN) and the National Power Transmission Corporation (NPT) must overcome to modernize their transmission grid systems to keep pace with power generation. While utilizing Official Development Assistance (ODA) as a component of public finance would be a suitable option for EVN and NPT to upgrade their transmission grids, as they have historically utilized ODA loans, finance from the Just Energy Transition Partnership (JETP) may also be a viable option. JETP's Resource Mobilization Plan focuses on enhancing sustainable transmission in specific locations to reduce curtailment and increase integration of renewable energy (RE) sources. Additionally, it is important to recognize that private sector participation in transmission systems can be categorized into two types: "backbone" transmission and "individual" transmission systems that connect power plants to the national grid. For the former, the Ministry of Industry and Trade (MOIT) should develop regulations based on the Electricity Law amendments, while the latter should be considered based on actual cases of the Xuan Thien Group and the Trungnam Group. Furthermore, the NPT's transmission tariff should be increased from 5% to 10% of the retail tariff for end consumers, to ensure that the NPT can meet its economic costs and investment needs.

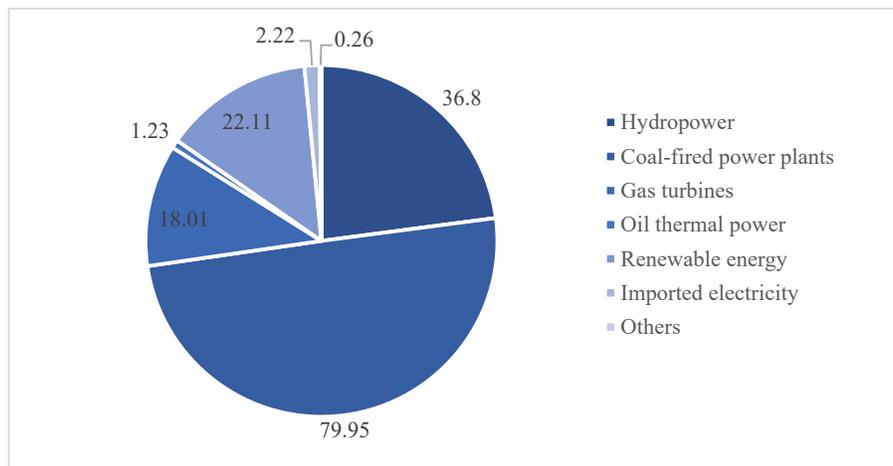
Keywords: transmission grid system, private sector participation, investment, curtailment, renewable energy, Vietnam

1. Introduction

Vietnam's solar and wind power development strategy is distinctive in several respects compared with other ASEAN countries. For example, it provides more generous feed-in tariffs (FITs) and investment policies, which have led to rapid expansion in the sector. Moreover, the government of Vietnam (GoV) has demonstrated more fervent dedication to renewable energy (RE) development than other countries in the region. Another noteworthy aspect is that Vietnam, along with a few other ASEAN countries, has a single-buyer wholesale electricity market and relies heavily on power purchase agreements (PPAs). This market structure varies from that of other countries in the region and may affect the implementation of solar and wind projects, as suggested by Do et al. (2021).

The implementation of FITs accelerated the rapid expansion of RE sources (especially solar power) in Vietnam between 2019 and 2021 (EREA & DEA, 2022). According to data from Vietnam Electricity (EVN), a state-owned corporation, the total system electricity generation as of July 2023 has reached 160.58 billion kWh (see Figure 1). This figure was composed of hydropower (22.90 %) ¹, coal-fired power plants (49.80 %), gas turbines (11.20 %), oil thermal power (0.80 %), RE (13.80 %) ², imported electricity (1.40%), and others (0.10 %), as reported by EVN in its most recent report (Vietnam Energy, 2023).

Figure 1: Electricity generation of power plants (billion kWh) as of July 2023



The Vietnam Energy Outlook 2021, jointly prepared by the Electricity and Renewable Energy Authority (EREA) (see Figure 2) under the Ministry of Industry and Trade (MOIT) in Vietnam, the Danish Energy Agency (DEA), and the Danish Embassy in Hanoi, anticipated the

¹ The percentage refers to the proportion of the total electricity generated by the system.

² Solar power plants generated a total of 15.48 billion kWh, while wind power plants produced 6.06 billion kWh, and other renewable energy (RE) sources contributed 0.57 billion kWh, resulting in a combined 13.8% of the total RE production.



substantial development of RE sources in the southern and central regions. Additionally, it was expected that power demand would increase significantly in the northern and southern regions. To ensure the reliability of the power system with a substantial proportion of non-dispatchable RE sources and prevent curtailment, Vietnam needed to reform its power system operation strategies, power market, and financing regulations as well as make investments in transmission in the short term (EREA and DEA, 2022). However, the insufficiency of evacuation and transmission capacities, as well as delays in the execution of transmission-strengthening plans, have resulted in curtailment in certain provinces (e.g., Ninh Thuan). The limited capacity of transmission lines connecting solar and wind projects to the national grid impedes the optimal utilization of RE outputs, leading to curtailment. These curtailments oblige small-scale energy producers and industrial solar farms to reduce their operations owing to infrastructure constraints, resulting in an excess supply of electricity from RE sources that the grid is unable to absorb. This leads to wasted RE output and financial losses for investors (Lam, 2022).

While formulating Power Development Plan 8 (PDP8) for the period between 2021 and 2030, with a vision of 2050, the GoV has faced difficulties in building new coal-fired power plants owing to an investor's decision to halt financing and inflationary pressures resulting from the conflict between Russia and Ukraine. Globally, nations and businesses are implementing measures to reduce greenhouse gas (GHG) emissions by 2050. In Vietnam, the Prime Minister pledged to attain net-zero emissions by 2050 at COP26 in 2021 (Viet Nam Government Portal, 2021). In December 2022, the GoV and its international partners signed a US\$ 15.5 billion Just Energy Transition Partnership (JETP) to facilitate the reduction of CO₂ emissions and foster the development of RE sources (European Commission, 2022).

GoV introduced the Resource Mobilization Plan for Implementing the Political Declaration on Establishing the Just Energy Transition Partnership in December 2023. This plan emphasizes the importance of investing in high-quality transmission infrastructure and smart grid development to enhance the ability to integrate RE into the power system. It also aims to accelerate RE deployment and develop the necessary expertise to support and manage the power grid as the share of RE in the electricity generation mix increases. Furthermore, it acknowledges the need to address transmission capacity limitations in specific regions to prevent the curtailment of RE generation. This can be achieved through a combination of the increased deployment of variable RE, investment in transmission capacity, and energy storage systems. Overall, JETP is designed to support the transition to a more sustainable energy system by ensuring that the transmission grid is optimized to accommodate a higher RE share, thereby contributing to the overall goal of reducing carbon emissions and promoting a cleaner energy future (Socialist Republic of Vietnam, 2023).

In May 2023, the GoV approved PDP8 following extensive deliberations spanning nearly three years and numerous drafts and revisions (see Table 1). The projections for the average GDP growth rate in PDP8 indicate a rate of 6.6 % from 2021 to 2030. GoV has expressed its intention to reduce its dependence on coal-fired power generation by 2030. Instead, it focuses

on the development of gas/LNG (approximately four times the amount compared with 2020) and wind power generation (approximately 44 times compared with 2020). To implement PDP8, Vietnam will require US\$ 134.7 billion, which includes funding for the construction of power plants (119.8 billion) and a 220-500 kV transmission network (14.9 billion) (Government of Vietnam, 2023).

Table 1. Power Generation Capacity in 2020 and Projected Capacity in 2030 and 2050

Generation capacity (MW) / percentage of total (%)	2020		2030		2050			
	MW	%	MW	%	min.(MW)	max.(MW)	min.(MW)	max.(MW)
(1) Gas- and oil-fired power (2050: LNG+Hydrogen)	9,030	13	37,330	24.8		14,930	3.1	2.6
(2) Coal-fired power	20,431	29.5	30,127	20.0		0		0
Traditional thermal power generation (1)+(2)	29,461	42.5	67,457	44.8		14,930	3.1	2.6
(3) Converted coal (biomass, ammonia, etc.)	0	0	0	0	25,632	32,432	5.3	5.5
(4) Hydrogen conversion (+Hydrogen-fired LNG thermal power generation)	0	0	0	0	20,900	29,900	4.4	5.1
(5) Hydropower	20,685	30	29,346	19.5		36,016	7.5	6.2
(6) Onshore wind power	630	0.9	21,880	14.5	60,050	77,050	12.5	13.2
(7) Offshore wind power	0	0	6,000	4	70,000	91,500	14.6	15.7
(8) Solar power	16,640	24	12,836	8.5	168,594	189,294	35.2	32.4
(9) Biomass	570	0.82	2,270	1.5	6,015		1.3	1.0
Renewable Energy (RE) (6)+(7)+(8)+(9)	17,840.00	25.72	42,986	28.5	304,659	363,859	63.6	62.3
(10) Stored power (2030: Included pumped storage power generation 2,400MW)	0	0	2,700	1.8	30,650	45,550	6.4	7.8
(11) Cogeneration	0	0	2,700	1.8		4,500	0.9	0.8
(12) Imports	1272	1.83	5,000	3.3		11,042	2.3	1.9
(13) Flexible power sources	0	0	300	0.2	30,900	46,200	6.4	7.9
Total (1)-(13)	69,258	100	150,489	100	479,229	584,429	100	100

Note: Recategorized and recalculated the data using the PDP8 (Decision 500/QD-TTg).

Vietnam's public debt has followed a downward trajectory, dropping from approximately 43% of GDP in 2021 to 38% by the end of 2022, as its debt ceiling is set at 60% of GDP. Furthermore, a warning level of 55% has been established to fortify institutions and ensure debt sustainability (Viet Nam Government Portal, 2021; The Ministry of Finance of Socialist Republic of Viet Nam, 2023). With the recent improvement in the situation, the GoV has indicated its intention to utilize Official Development Assistance(ODA) and concessional loans from international development partners for economic development projects. However, the loan portion has not yet reached half of the planned amount (Quynh, 2023).

Vietnam, as a middle-income country, has been grappling with legal constraints on public debt. In order to implement its ambitious PDP8, the private sector's involvement in transmission grids is of paramount importance. The possibility of a Build-Operate-Transfer (BOT) contract between EVN and a private firm is strengthened by EVN's previous experience with BOT contracts for power plants. Additionally, non-sovereign finance from international financial institutes (IFIs) and development banks may be feasible (Urakami, 2023).

The present study investigates the obstacles related to networks that impede the delivery



of more solar and wind power into the electricity system and explores ways to mobilize finance while simultaneously considering ownership, pertinent regulations, and the allocation of the power system costs among consumers. Although several researchers focus on integrating RE into the grid and implementing new transmission pricing mechanisms, few scholars concentrate on the Vietnamese context. When searching academic databases and relevant reports from international development agencies and legal advisory firms, the author found this to be the case. Additionally, some studies simulate the extensive integration of RE resources into the power system in Vietnam; however, these were mostly conducted in 2017-2019, prior to the advancement of RE development.

This research examines the pertinent regulations governing solar and wind power generation, as well as the cost allocation for these systems in Vietnam. The study is organized in the following manner: Section 2 offers an overview of the regulations and current state of the power system in Vietnam. Section 3 elucidates the methods utilized in this research. Section 4 presents the results of semi-structured interviews with experts. Section 5 draws conclusions, offers policy recommendations, and proposes future research avenues.

2. Regulations and the situation for the power systems in Vietnam

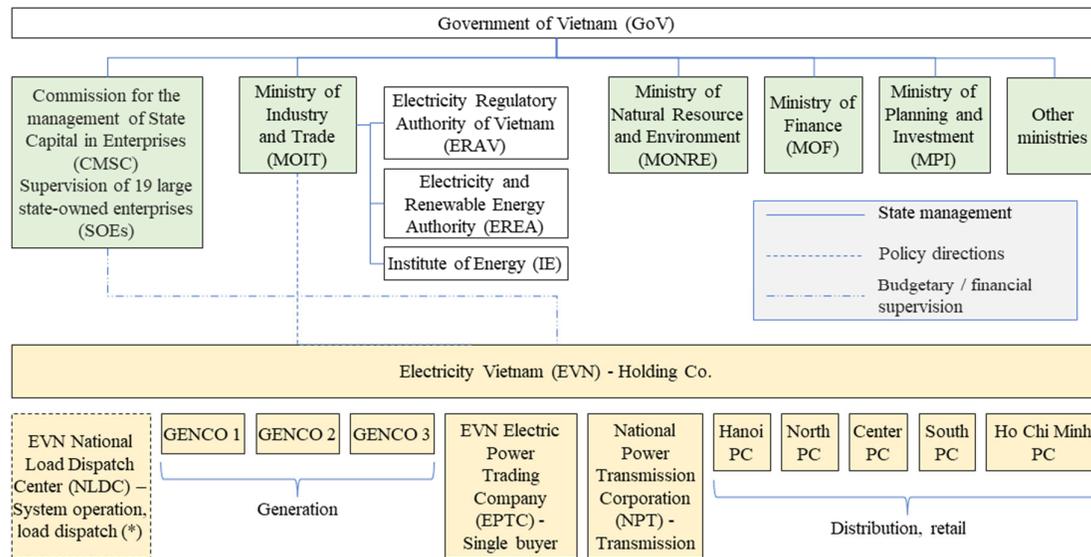
This section outlines the organizational structure of the power sector and delve into the regulatory framework governing the industry, including transmission pricing schemes that adhere to existing regulations.

2.1 Regulations for the power sector in Vietnam

As depicted in Figure 2, Vietnam's power sector is largely governed by MOIT, which functions as a policymaking body. Additionally, the Commission for the Management of State Capital in Enterprises (CMSC), which is responsible for overseeing 19 large state-owned enterprises (SOEs), including Electricity Vietnam (EVN), Petro Vietnam (PVN), and Vietnam National Coal-Mineral Industry (TKV) in the power sector (see Figure 3), supervises EVN from a financial and budgetary perspective. The Electricity Regulatory Authority of Vietnam (ERAV), established in 2005, is responsible for creating regulations for competitive power markets and reviewing electricity tariffs. The Electricity and Renewable Energy Authority (EREA), formed in 2017, is responsible for policy development in the energy sector, including renewables, oil, gas, coal, and power system planning. The Institute of Energy (IE), established in 1995, conducts research on national energy strategies, policies, and development plans. EVN, established in 1995, serves as a holding company for three generation companies (Power Generation Corporation: Genco), a single buyer (Electric Power Trading Company: EPTC), a system operator (National Load Dispatch Center: NLDC), a transmission company (National Power Transmission Corporation: NPT), and five distribution companies (Power Company: PC) (see Figure 3). NLDC functions as the market and system operator for the wholesale market and is anticipated to become an independent accounting unit of EVN by 2021; however, this

has not yet occurred (as of March 2024). EPTC, established in 2008 as a subsidiary of EVN, is responsible for purchasing all power. NPT was formed in 2018 through the consolidation of EVN subsidiaries across the regions (Lee and Gerner, 2020, p.15; JICA, 2021, p.2-9, 2-11).

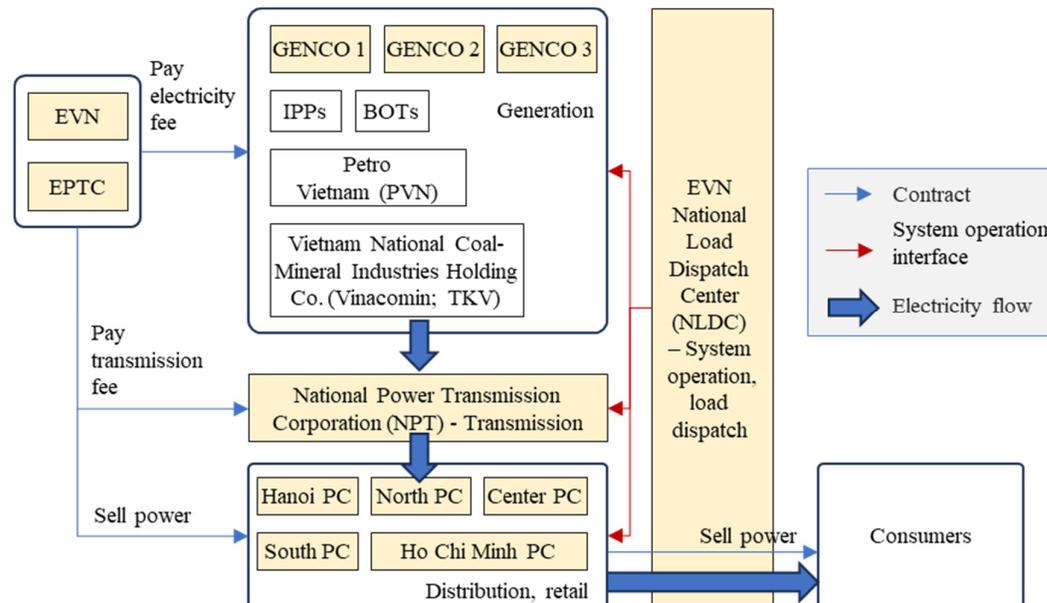
Figure 2: Organizational structure of GoV and relevant institutions in the power sector



(*) In the process/ discussion of completely out of EVN and moving under MOIT (source: interviews in February 2024)

Source: Lee and Gerner (2020), JICA (2021), and interviews with experts (November 2023 and February 2024)

Figure 3: Contract, system operation interface, and electricity flow in Vietnam's power sector

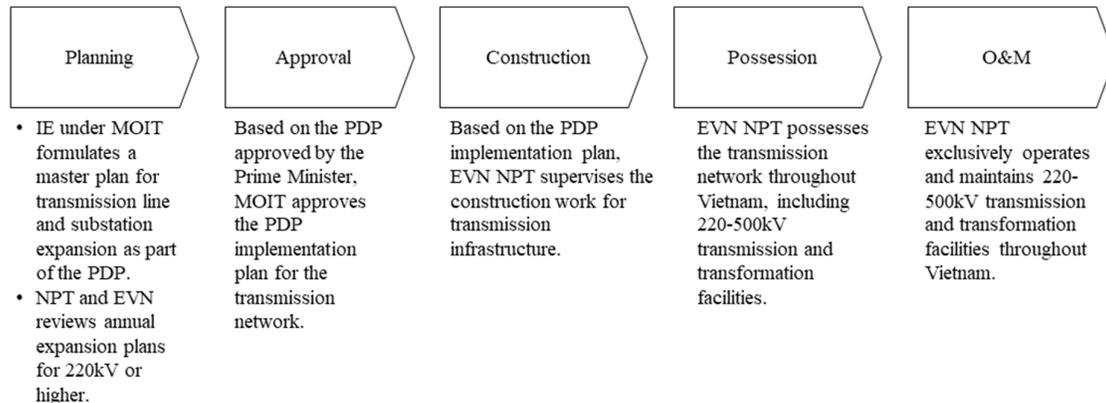


Source; JICA (2021) and interviews with experts (November 2023 and February 2024)

The Electricity Law in Vietnam specifies that only EVN and its affiliated companies are

authorized to construct, manage, and operate transmission and distribution lines. EVN possesses the National Power Transmission Corporation (NPT), encompassing its entire electric power system and transmission infrastructure. Its operations encompass high-voltage transmission systems (500 kV and 220 kV) and involves the construction, investment, and upgrading of transmission systems (Socialist Republic of Viet Nam, 2004). Figure 4 indicates the role of each organization for transmission infrastructure development processes in Vietnam.

Figure 4: Each role of transmission infrastructure development process in Vietnam



Source: JICA (2021)

2.2 Past experiences and potential approaches for securing financial resources to develop transmission infrastructure

Vietnam Electricity (EVN) and National Power Transmission Corporation (NPT) historically relied on commercial banks and long-term loans from bilateral and international development banks to upgrade their transmission grid systems. Currently, approximately 70% of NPT's investment program is financed through commercial bank debt with maturity durations of up to 12 years and a two-year grace period. In contrast, international financial institutions (IFIs) provide loans with a 20-year maturity period and a five-year grace period. However, recent regulatory changes introduced by Decree 114/2021/ND-CP (on the management and use of official development assistance and concessional loans of foreign donors) have made it more challenging to mobilize IFI and ODA support. This support is now prioritized for programs in health, education, vocational education, climate change adaptation, and environmental protection (World Bank, 2023).

According to a survey on power sector (JICA, 2021), the public debt ceiling at 65% of the country's GDP will be relaxed, and new ODA loans will be made available. However, it is important to note that such new ODA loans will be allocated to more fundamental infrastructure with higher priority, such as road transport, and ODA loans to the power sector, where private investment participation has already been made, albeit still limited, will continue to be restricted. EVN and NPT must therefore diversify their fund procurement modes and explore funding

sources beyond ODA, such as non-sovereign loans and financial support from organizations like KfW, the World Bank Group's Multilateral Investment Guarantee Agency (MIGA), and the International Finance Corporation (IFC), which provide higher interest rates and shorter loan duration than ODA.

NPT has undertaken investments in both 500 kV and 220 kV transmission networks, while five power companies (PCs) have developed distribution networks for 110 kV and below. Table 2 and 3 provide information on past and planned network investments respectively. The former covers data for the period 2011-15, while the latter is based on the PDP7 revision (Gerner et al., 2018, p.83-84; Government of Vietnam, 2016). However, the GoV had not taken into account the growing impact of solar and wind power generation when calculating the forecast investment costs (Table 3). To address the issue of curtailment in the southern coastal provinces and to effectively integrate additional solar and wind power into the grid, both EVN and NPT must upgrade their transmission and distribution infrastructure.

Table 2: The past network investment (US\$ billions)

Investment per year	2011	2012	2013	2014	2015
Transmission	0.3	0.4	0.6	0.6	0.7
Distribution	0.4	0.5	0.7	0.8	0.9
Total	0.7	0.9	1.3	1.4	1.6

Table 3: Forecast investment in transmission and distribution by 2030 (US\$ billions)

Investment per year	2016-2020	2021-2025	2026-2030
Transmission	4.6	7.0	7.1
Distribution	5.1	6.2	7.3
Total	9.7	13.2	14.5

According to the assessment report on revised PDP7, the progress of the grid construction as indicated in Table 4, showed that the substations for the 550 kV and 220 kV were approximately 90 % complete, while the transmission lines for 500 kV and 220 kV were less than 80 % complete between 2016 and 2020. Several factors contributed to the incomplete status of the transmission lines, including difficulties in site clearance and compensation, especially in different locations, delays in the bidding process and construction activities, the need for synchronization with power source projects, and regional variations in certain areas (Ministry of Industry and Trade, 2022). This shows a significant capital need of the EVN/NPT to keep pace to upgrade 500 kV and 220 kV transmission grids.

Table 4: The implementation status of grid construction

No	Category	Unit	Investment in 2016-20	
			Volume	Implementation Rate
500kV project				
	500kV substation	MVA	19,100	88.8 %
	500kV line	Km	2,300	77.6 %
220kV project				
	220kV substation	MVA	29,300	90.6 %
	220kV line	Km	5,400	73.9 %



Source: Ministry of Industry and Trade, 2022

In June 2023, power outages occurred in several businesses, commercial areas, and residential regions in the northern provinces due to insufficient water levels in dams, which negatively affected the electricity supply during the dry season. To address this issue, the Prime Minister urged the MOIT to expedite the completion and implementation of the Quang Trach - Pho Noi 500kV transmission line project by June 2024. The project, which spans 514 km and connects Quang Trach in Quang Binh province (the central region) to Pho Noi in Hung Yen province (the north region), is estimated to cost USD 973.85 million. Although the project was originally planned for completion in 2025-2026 in the PDP8, the Prime Minister set a deadline of June 2024 to alleviate power shortages in the northern regions. The Minister of MOIT has requested EVN and NPT to accelerate the necessary procedures in collaboration with local provinces. Despite the EVN group's plans to complete the extended 500 kV transmission lines from the south to the central region and then to the north by May 2025, they have committed to completing the project from central to north region with a special mechanism by June 2024 (Dung, 2023b). After urgent process, EVN and NPT initiated the construction of various 500kV circuit-3 transmission lines in several locations on January 18, 2024 (Viet Nam News, 2024).

2.3 Connection cost allocation policy and transmission network pricing in Vietnam

The Ministry of Industry and Trade (MOIT) is responsible for regulating the connection cost allocation policy for solar and wind power plants as outlined in the FIT-related regulations (see Table 5). For solar and wind power plants (excluding offshore wind power plants), the author interprets that Vietnam had adopted a “super-shallow policy,” which covers the costs of the nearest connection assets of RE generators (e.g., internal substations and transformers) for nearly all developers, particularly solar power plants. This policy option is advantageous for RE generators as it results in the most cost-effective connection of each RE plant to the network (Madrigal & Marcelino, 2012). In Vietnam, all RE projects (e.g., wind, biomass, small hydro) are connected at 110 kV, and five Power Companies (PCs) are responsible for managing all necessary network investments (Gerner et al., 2018, p. 83).

Table 5: Connection cost allocation policy in Vietnam

Types of RE	Regulations	Contents
Solar	Decision 13/2020/QĐ-TTg (mechanisms to promote the development of solar power projects in Vietnam).	<p>Article 7: Connecting solar power projects to electrical systems</p> <ul style="list-style-type: none"> • Paragraph 1: <u>The Electricity Seller shall be responsible for investing, operating, and maintaining transmission lines and booster transformers</u> (if any) from the power plants of the Electricity Seller to the Connection Points of the grid of the Electricity Buyer. • Paragraph 2: Connection Points shall be agreed by the Electricity Seller and Buyer and <u>based on the principle of the nearest Connection Points to the existing grid of the Electricity Buyer according to the capacities of power plants of the Electricity Seller</u> and the approved provincial electrical planning. In case these Connection Points are different from the positions

		of electricity meters, the Electricity Seller shall take liability for energy loss of connection lines and loss of booster transformers of power plants. The MOIT must stipulate the method for the calculation of energy loss of connection lines.
Wind	PPA Appendix G. of Circular 2/2019/TT-BCT (wind power project development and power purchase agreement)	Article 3: Connection, measurement and counting • Paragraph 1a: <u>The Seller is responsible for the investment, construction, operation, and maintenance of connection equipment to connect the power plant to the transmission and delivery of power grids</u> by the regulations on transmission and delivery thereof and other related regulations. <u>The Seller shall bear the costs for installing the metering system at the electrical substation.</u>

There are two options for transmission pricing, as depicted in Table 6. The network usage fee, which is a component of the total electricity delivery fees, is relatively low. This fee encompasses investment and operating expenses, which are required to build and maintain transmission grids, as well as congestion and losses, and sometimes include ancillary services and system operator fees. An essential aspect of transmission network pricing is determining whether load consumers, generation consumers, or both contribute to the transmission system revenues. As consumers ultimately bear all transmission costs, it is not necessary to charge generation for transmission network expenses (Madrigal & Marcelino, 2012, p.18-20).

Table 6: Transmission network pricing (Use of System: UoS)

Options	Description
Postage stamps-based method	<ul style="list-style-type: none"> The concept of a flat rate, where all transmission customers are charged the same average rate regardless of their individual costs or benefits (Hempling (2009), cited by Madrigal & Marcelino (2012)). The rate is determined based on either the amount of energy consumed (in MWh) or the maximum load (in MW).
Usage-based method	<ul style="list-style-type: none"> The use of a metric-based payment system for transmission network customers, in which rates are determined by the range of grid consumptions, has been studied (Madrigal & Marcelino, 2012). This method can be divided in two categories: flow-based and distance-based. The flat rate based on MW (not MWh) would further prevent RE development.

According to MOIT Circular No.2/2017/TT-BCT (Method and procedure for development, appraisal, and approval of the electricity transmission charge), Vietnam utilizes a postage stamps-based method for calculating transmission costs. Under this method, the entire cost of transmission is borne by load customers, whereas some countries require both generation and load customers to share the expense (outlined in Table 7).

Table 7: MOIT Circular No.2/2017/TT-BCT (February, 2017)

Article No.	Content (Excerpt)
3	<ul style="list-style-type: none"> Annual electricity transmission price shall be applied <u>in uniformity across the country</u> regardless of transmission and delivery point distance.
9	<ul style="list-style-type: none"> Vietnam Electricity (EVN) or Electric Power Trading Company (EPTC), power corporations (distribution/retail), and customers (who buy electricity directly from the transmission system) shall be responsible for making payment of electricity transmission price for National Power Transmission Corporation (NTPC) under the signed contract.



The current electricity transmission price (tariff) levels have resulted in challenges for NPT in meeting its economic costs and financing investments. It is widely acknowledged that the tariff for high-voltage power grid companies typically accounts for approximately 10% of the retail tariff for end consumers. In Vietnam, NPT's tariff is less than 5% of the retail tariff, as estimated by Fitch Ratings, specifically 5.5% in 2019 and 4.3% in 2020. Moreover, NPT's tariff experienced a reduction of 8.6% in 2019, 20.9% in 2020, and 2.3% in 2022, in line with the EVN financial plan. Despite a significant increase in transmission volume (approximately 7% compound annual growth rate over the past five years), the reduction in transmission tariff and rising costs (including the cost of borrowing) have adversely impacted the financial sustainability of NPT and contributed to underinvestment in recent years (World Bank, 2023).

Asian Development Bank (ADB) provided recommendations on transmission charges through its technical assistance project; however, MOIT did not incorporate the ADB's main suggestion, which included considerations of time and geographical differences, connection costs, capacity charge, and network congestion, into its revised circular (Lee, 2017). It appears that MOIT plans to maintain the current postage stamp-based method, which is simpler and applies to all customers, rather than making changes. If MOIT were to take distance into account, this could have a significant impact on the Northern Uplands, a region with lower socioeconomic development that should be prioritized (anonymous informant #1). Nonetheless, there may be opportunities to design pricing policies that differentiate between customer categories and consumption levels (anonymous informant #2).

There is ongoing debate regarding the equitable allocation of costs associated with transmission grids. It is crucial that the expenses incurred in constructing, operating, and maintaining the electricity system be fairly distributed. Specifically, investment costs should be the primary factor in determining total transmission costs, as O&M expenses are comparable to the number of assets (Benetti & Sperandio, 2020, p.70-71). The current pricing scheme for transmission does not account for these costs, but instead aims to promote the efficient development of electricity generation. To address this issue, it is recommended that transmission costs that do not reflect economically viable prices be charged uniformly to all users. Additionally, it has been suggested that the authority can charge higher rates to large users while implementing a real-time pricing mechanism to ensure optimal system performance (Madrigal & Marcelino, 2012, p.102-103).

Vietnam would benefit from incorporating a flexibility policy in its PDP8, as this would enable the country to accelerate solar and wind power generation by activating economic and technical flexibility rules, according to Ha-Duong et al. (2020). This approach is crucial, given the lessons learned from European countries and China, where the speed of RE project implementation has been significantly faster than transmission grid upgrade/expansion. Furthermore, RE power development has led to more significant stages in system transactions, curtailment, and undesirable electricity costs. By continuously investing in upgrading capacity and transmission grids, as illustrated by Bird et al. (2016), it is possible to reduce curtailment

issues, provided that the curtailment level exceeds 10 % of RE development. This approach is supported by international experience on curtailment.

The World Bank (2023) proposes various financial measures to aid EVN and NPT in overcoming their financial obstacles in modernizing the transmission grid. Firstly, it suggests that adjusting transmission tariffs could restore NPT's financial sustainability, as the current tariff is significantly lower than the global average of around 10 %. Secondly, it emphasizes the importance of attracting private investments in power transmission to finance capital expenditures more efficiently. It recognizes that the low return on equity is a primary reason for the scarcity of private investments in power transmission. Lastly, it points out the difficulties in obtaining long-term financing for NPT due to the transmission tariff being lower than the economic cost. To address this issue, it recommends implementing sustainable transmission tariffs to encourage private sector investments and enable NPT to finance its capital expenditures more effectively. By adopting these financial measures, EVN and NPT can potentially overcome their financial constraints and secure the necessary funding to upgrade the transmission grid to accommodate additional electricity, including from RE sources.

On the other hand, there is limited evidence of private sector involvement in developing transmission and distribution systems, as well as reducing curtailment levels in developing countries. In their study, Foster and Rana (2020) examine several successful cases of private participation in transmission grid in developing countries. BOT contracts, similar to those for IPPs but with more straightforward terms that include O&M expenses and capital investment costs, were awarded through a bidding process for additional transmission deployment in Latin America. However, most transmission grids are primarily operated by government expenditure, as it is challenging to implement grid O&M exclusively on a commercial basis due to the low margins.

3. Methods

This study explores the potential for improving grid-related barriers to encourage private investment in solar and wind power to fulfill the growing electricity demand in Vietnam. The hypothesis suggests that private investment could be a vital financial resource for expanding and upgrading electric power systems, including transmission grids, to reduce curtailment and accommodate more solar and wind power. The study employs semi-structured interviews with key experts working in RE fields in Vietnam as a primary method of data collection. The participants include policymakers, representatives of local and international companies investing in solar and wind power projects, international development banks and agencies, and researchers and legal advisors specializing in energy-related issues. The semi-structured interviews were utilized to verify the findings of empirical research, which consisted of relevant laws and regulations in Vietnam, reports written by international development banks and agencies, local experts, and academic journals.

According to Kuhnert et al. (2010), experts possess knowledge derived from their



experience. In this study, the author carefully selected twelve practitioners from various positions as experts, taking into account their impartiality. The interviewees included three international experts and nine domestic ones, consisting of a former policymaker, four private companies/institutions, three international development agencies, a researcher, an independent consultant, and two legal advisors. With the exception of one interviewee, the names and institutions of the interviewees were kept confidential due to the sensitive nature of the information and their requests. In Marth 2023, a series of interviews were conducted in Vietnam and Singapore by using questionnaire (see Appendix 1).

Table 8: Summary of the interviewees

Category	Description of interviewees	Number
International	Developer, investor, supplier	2
	Development agency, consultant, and researcher	1
Domestic (Vietnam)	Developer, investor, supplier	2
	Development agency, consultant, researcher, and legal advisor	7
Total		12

Undertaking additional interviews with specialists who possess extensive experience in the domain of transmission grid issues at different levels in Vietnam during the months of November and December 2023, and utilizing different questionnaires (see Appendix 2), yielded valuable insights into the most advancements concerning transmission grids and private sector participation. These findings have been incorporated into the relevant sections of this paper.

4. Results: Electric power system expansion/upgrade and its cost allocation

Based on the findings of semi-structured interviews, this section presents an analysis of the opportunities and challenges associated with expanding and upgrading the transmission system in Vietnam with a focus on cost allocation and private investment mobilization. Specifically, it examines the potential for integrating greater levels of solar and wind power into the system.

4.1 Solution relating to the curtailment and absorption of more solar/wind power

There were diverse perspectives on this topic, which served as a preliminary question. This is linked to the hypothesis of this study, which states that private investment could play a pivotal role in financing the expansion and upgrading of electric power systems, particularly transmission grids.

In Vietnam, either the Vietnam Electricity (EVN) or the National Power Transmission Corporation (NPT) is responsible for investing, operating, and maintaining 220/500 kV substations and transmission lines in accordance with regulations and the PDP. While EVN requests NPT to develop new 220/500 kV substations and transmission lines, including financing arrangements, EVN also implements its own projects. For instance, EVN recently

accomplished a 550 kV substation and a 55 km transmission line in the central region to connect to a wind power plant in Lao. On the other hand, the NPT intends to invest in other transmission infrastructure systems. The finance sources for these projects come from local commercial and international banks, including international development banks. The NPT has received a B+ credit rating from the Fitch Rating for the last three years, which enables them to quickly mobilize foreign banks' finances. NPT submitted a five-year plan for finance mobilization to the EVN and the State Bank. In February 2023, the NPT held a bid for 66 projects worth US\$ 150 million to mobilize finance from domestic banks. However, due to the NPT's perception of the higher value of the U.S. dollar, they abandoned their plan to mobilize international funds. The NPT has restarted efforts to mobilize international finance, which may result in delayed goals for some projects.

Several of the interviewees expressed significant concerns that many investors in Ninh Thuan and Binh Thuan provinces continue to suffer from curtailment (20-40% cut-off) and have lost potential profits due to the transmission system's failure to expand or upgrade to accommodate their solar/wind power generation. This issue has arisen in the southern coastal regions, particularly in Ninh Thuan and Binh Thuan provinces, where solar power projects have concentrated since 2018.

Several reasons have hindered the resolution of the curtailment issue. Firstly, EVN/NPT faces constraints in securing funding for expanding or upgrading the transmission system due to limitations in self-financing, such as the risk associated with the exchange rate in the U.S. dollar, the absence of government guarantees stemming from public debt issues, and compensation-related to land acquisition problems. MOIT has proposed that the National Assembly amend Article 4 of the Electricity Law 2004 to encourage private sector investment in power transmission infrastructure, taking into account the challenges that have emerged. Once the amendment is approved, MOIT will need to draft implementing regulations, such as decrees, circulars, and guidelines. If private companies invest in building transmission infrastructure, it would enable all power plants to connect to the grid through a competitive process.

Two of the interviewees indicated another reason: ENV/NPTC has yet to have any strong incentives to invest in transmission infrastructure to accommodate the capacity of renewable energy (RE) sources. The duration of curtailment was relatively short. From a technical perspective, the transmission system in Vietnam is well-developed and compares favorably to other developing countries in terms of electricity losses. Conversely, other interviewees noted that some large solar farms have experienced curtailment due to the absence of a financial mechanism, as EVN has reduced the utilization rate of solar power in Ninh Thuan province by 40 %. The solar FIT, which was available until the end of 2020, could be applied for an initial capacity of 2,000 MW, as reported by Vu (2022).

The lack of financial resources in the NPT is partly attributable to the fact that the transmission tariff has not yet been increased, as Vietnam has prioritized economic development



following the COVID-19 pandemic.

4.2 Private sector participation in transmission infrastructure upgrades

The majority of the interviewees emphasized the need for investment in transmission systems in order to meet the increasing demand for power generation, while simultaneously expressing their apprehensions about the private sector's involvement in the transmission infrastructure with respect to political, financial, and technical aspects. Among experts, the definition of transmission systems that the private sector can be involved in can be categorized into two types: the backbone (main transmission infrastructure) and the transmission systems that connect power plants and the national grid.

As for the issues related to the backbone transmission infrastructure, some experts have raised concerns about the possible impact of private sector participation on national security. EVN and NPT have argued that the high-voltage backbone of the transmission infrastructure is more critical than independent power plants (IPPs) in Vietnam. According to the interviewees, in the U.S. business delegation's offer of cooperation in transmission upgrades to the GoV, the GoV did not agree. In the Philippines' case, approximately 40% of the country's transmission assets are owned by Chinese firms, leading to issues such as blackouts, causing difficulties for the government to maintain control. Furthermore, other technical experts emphasized that EVN and NPT do not want to allow private sector involvement in the backbone of the 500 kV transmission system. It could be inferred that EVN and NPT possess reservations about the engagement of international private organizations, as they seek to prevent circumstances in which foreign entities may disrupt or modify the transmission system. To address concerns related to PSP on national security, the GoV should establish regulations that specify the contract forms in which EVN and NPT can allow PSP in transmission upgrades. It is essential to provide greater clarity on the process of obtaining a transmission license for private entities, the potential tariffs for private investment, and the extent to which private firms can transfer transmission assets to NPT if the government were to allow private sector participation only in the construction phase.

Some experts indicated financial concerns that the return on transmission infrastructure projects in Vietnam is very low. It takes a long time to recover the investment, and the construction of transmission systems is considerably more complicated than that of power plants. The World Bank (2023) reports that NPT transmission tariff currently stands at around 5 % of the retail tariff for the end consumer. This figure is notably lower than the global average of roughly 10 %. Therefore, most of the interviewees indicated that transmission infrastructure business would be not attractive for the private sector.

On the other hand, one of the industry professionals suggested three technical concerns from a potential perspective of the PSP in the 500 kV transmission systems that 1) GoV should decide on the transmission cost/price for 1 kWh of electricity transmission and provide the data for any business plan to be successful; 2) GoV needs to provide assurance on land acquisition

or provide land assurance for private investors to be able to invest; and 3) the current grid should comply 100 % with the current grid code. Other experts also had severe concerns that land acquisition had recently been more demanding regarding negotiations with landowners and forestland issues across multiple provinces.

As for the issues related to the lines that connect power plants to the national grid, in two exceptional cases in Vietnam, private companies invested in the construction of high-voltage transmission lines and substations to connect their large solar farms. The Build-Own-Operate (BOO) contracts for these construction activities were sanctioned by GoV. Some industry professionals pointed out that the primary purpose of building these transmission lines and substations was to promptly integrate the private companies' solar farms into the grid of EVN. They expressed a willingness to relinquish the assets of the substations and grid lines to the EVN/NPT; however, they have thus far been unable to do so due to the non-existence of implementing regulations, such as decrees and circulars, in Vietnam, pertaining to relating to the transfer of assets for substations and transmission lines based on the amendment of the Electricity Law.

The Xuan Thien Group initiated the first project, connecting a 500 kV transformer substation with a capacity of 1,200 MVA and a 500 kV transmission line spanning 22.2 km to the Xuan Thien Ea Sup solar power plant in Dak Lak province on November 15, 2020. This plant has a capacity of 600 MW in its initial phase. Additionally, the group planned to construct another solar power plant with a capacity of 2,000 MW and a 500 kV/2,400 MVA transformer station (Vietnam Energy, 2020), but there is no information available on the commencement of this project on the website.

In October 2020, the Trungnam Group initiated the construction of a 500 kV transformer station with a capacity of 1,800 MVA, as well as a 220/500 kV transmission line and a 450 MW solar farm in Ninh Thuan province. The primary objective of this transmission system was to supply electricity from the solar power plants to the EVN. Additionally, other renewable energy (RE) developers were connected to this station, which helped to reduce curtailment in the area. Trungnam's solar farm has experienced a significant reduction in its capacity utilization, as the solar power generation in the Ninh Thuan province has surpassed the cap of 2,000 MW, resulting in the sale of only approximately 60% of its total capacity.

In addition, EVN decided not to purchase a 172.12 MW capacity out of 450 MW from September 1, 2022, due to the need for implementing a pricing mechanism. Trungnam Group encountered constraints in remunerating loans. The Ombudsman Commission of the National Assembly Standing Committee indicated that EVN violated Article 4 of PM Decision 13/QD-TTg dated April 6, 2020, on a mechanism to encourage solar power development in Vietnam. The Commission also pointed out that Decision No.21, dated January 7, 2023, on the price range for electricity generated by transitional solar and wind plants, could be a critical legal basis for EVN to negotiate electricity prices with transitional solar developers. However, the absence of regulations on asset transfer relating to substations and transmission lines hinders



EVN from gaining control of management and operation (Dung, 2023a). Despite pessimism expressed by several interviewees regarding Trungham's case, the Ombudsman Commission's findings showed that EVN was in a position to negotiate with Trungham based on the existing legal framework. MOIT will consider the necessary regulations for the Trungham case and other possible cases.

In additional interviews conducted in November 2023, certain technical experts reported that the present intention of GoV present intention is to allocate approximately 80% of investment for transmission to the public sector, while the private sector would contribute approximately 20%. At present, the private sector's share, for instance, Xuan Thien Group and Trungham Group, is negligible. The private sector is expected to invest in limited projects from the power plant to the backbone transmission, which would be similar to the cases of the two aforementioned examples. This opinion is similar to the other expert interviewed in March 2023 indicated that it could be possible for the private sector to implement the investment phase of the transmission infrastructure, considering the project returns based on the investment in the power plant and transmission system for their power plant.

4.3 Connection cost allocation policy and network cost allocation policy (usage)

None of the interviewees objected to the super-shallow policy in Vietnam, which is regulated by the legal framework for solar and wind power generation (see Table 5). Thus far, investors have decided on the location of solar/wind power plants and agreed on the connection point with ENV/NPTC under the PPA. For instance, installing and managing the 110 kV line will be suitable for the developer, even though its length is 30 km.

Several experts understood this context and indicated that MOIT has no intention to change the current method (postage stamp-based method) because the current calculation method is straightforward in that the transmission fee is estimated as an average fee paid by all customers equally, considering the impacts on the poor and economic development. Currently, the transmission cost is included in the electricity tariffs. There is no separation of the transmission costs. Power plants cannot pay the transmission costs directly. The U.S. AID agency shared the draft DPPA pilot program with MOIT in 2020 and MOIT considered the content. However, it will take another 1.5-2 years to begin implementing the pilot project. MOIT considers an appropriate network-usage pricing mechanism.

4.4 Possible options for mobilization on transmission system upgrades

As the issues and possible options were discussed based on the literature reviews in Section 2.2 and 2.3, EVN and NPT have faced various difficulties in mobilizing finance to upgrade transmission systems by keeping pace with power generation development. According to experts who belong to financial institutions and industry sector, all possible financial sources such as national budget, ODA, non-sovereign, private finance, etc. should be mobilized for transmission grid investment; however, the current issues are more the regulatory barriers.

For public financing, ODA funds for grid investment are available by development banks/agencies; however, NPT and Power Corporations (PCs) are not able to access due to several problems. Firstly, there is no line ministry under for state-owned enterprises' subsidiaries (see Figure 2). Secondly, there are issues relating to the on-lending mechanism with ODA financing in case that line ministry exists. ODA funds for energy sector will provide to Ministry of Finance (MOF) and on-lent to NPT or PCs would need to be channeled through a local bank in Vietnam. Currently, most of banks in Vietnam have reached their credit limits to EVN and its subsidiaries such as PCs and therefore, it is very challenging for NPT and PCs to find an on-lending bank which still has sufficient credit room. In terms of national budget, there is no sector budget support allowed by current Vietnamese law and therefore it will be difficult to use ODA fund for power sector budget support program as it was used pretty successfully in the past.

Meanwhile, for private financing, the amended Electricity Law has provided a legal framework for private financing for grid investment; however, there are still a number of open questions and issues. Firstly, the revised Electricity Law is vague and makes it difficult to interpret the specific details necessary for investment decision-making, such as which projects (location, scale, etc.) and how projects are priorities against national defense and security concerns. Secondly, unlike generation projects which have a fixed plot of plan, grid investment requires land compensation along the route, which is very complicated and time consuming. Approval at different levels of local authorities is required and this is almost impossible for private sector to follow. Lastly, the most important factor is no business case yet for private financing in grid investment because of the current transmission fees and retail tariff which are not cost reflective and therefore insufficient for cost recovery investment. Another way might be that the GoV raises bonds in foreign countries or through the JETP facility to build and strengthen the grid.

5. Conclusions and policy recommendations

This paper aims to investigate the difficulties and factors that must be taken into account when upgrading transmission grids and dealing with financial limitations for EVN and NPT, as well as the role of private sector participation in Vietnam's transmission grid systems. The study examines the literature and conducts semi-structured interviews with experts to understand how to meet the growing electricity demand and integrate more renewable energy sources into the system by 2030.

The construction of the planned transmission systems included in the PDP8 requires EVN and NPT to overcome financial constraints. Given the government policy that prioritizes basic infrastructure such as roads and healthcare, it is unlikely that the GoV will allocate the national budget to the power sector. Therefore, other financial options must be considered. As part of public finance, ODA from bilateral/international development agencies/banks such as ADB, JICA, and the World Bank, or non-sovereign finance from international finance institutions like



MIGA and IFC may be suitable options for EVN and NPT, as they have successfully borrowed from these sources in the past. However, some experts argue that ODA is a better option than non-sovereign funds and private finance because of its lower interest rates and longer loan durations. In terms of private finance, EVN and NPT may have the potential to mobilize finance from the JETP, as its Resource Mobilization Plan highlights the importance of investing in high-quality transmission infrastructure to integrate RE into the power system and acknowledges the need to address transmission capacity limitations in specific regions to prevent curtailment of RE generation.

MOIT is thought to have revised the Electricity Law to promote private sector engagement in transmission investments, as the limited capacity of EVN and NPT to secure funding from both public and private sources was recognized. For private sector participation (PSP) in transmission, it is advisable to categorize it into two types: backbone (main transmission infrastructure) and individual transmission systems that primarily connect power plants and the national grid. To draft implementing regulations for backbone transmission based on the amended Electricity Law, MOIT should consider concerns such as transmission licenses, fees to recover investment costs, and national security with relevant stakeholders, including other line ministries, EVN, NPT, and private stakeholders. For individual transmission systems that connect power plants to the national grid, GoV should consider the whole project return based on the investment in the power plant and transmission system, as well as how the transmission assets can be transferred to EVN/NPT if they operate and maintain the transmission systems on behalf of private firms. In this context, it is worth noting that there are at least two actual cases, such as Xuan Thien Group and Trungnam Group, which have constructed 500 kV transmission lines to connect their solar power plants to the national grid.

According to the interviews conducted, private companies mentioned above have experienced significant challenges in operating and maintaining high-voltage transmission systems, and they anticipate transferring their assets to EVN/NPT once the appropriate regulations are established. During these interviews, some experts indicated that the GoV expects the private sector to contribute approximately 20% of the transmission investment. It is possible that the GoV is taking into account cases where RE power projects, including both solar and wind power projects (onshore and offshore), connect to the national grid.

The current rate for transmission tariff is set at 5% of the retail tariff, which is below the global average of 10% of the retail tariff for EVN/NPT. It is recommended to consider increasing this rate to 10% to enable EVN/NPT to invest in the transmission infrastructure and recover their investment costs. Experts have highlighted that the direct PPA scheme has the potential to charge additional fees, such as network charges, SMO fees, and ancillary fees.

Appendix 1

Questionnaire on electric power system expansion/upgrade and its cost allocation, considering increasing penetration of solar/wind power in Vietnam

I want to ask you 1) what the Vietnamese electric power system (mainly transmission infrastructure) really should be, considering the higher penetration of solar/wind power generation as well as increasing electricity demand, and 2) what kinds of barriers there are to develop offshore wind power plants in Vietnam.

In my previous research, I analyzed the barriers to private investment to solar/wind power in Vietnam.³ I led to the result that the main barrier is a limited network capacity expansion for several reasons (e.g., different lead times of constructing RE plants and transmission infrastructure; no rules for private sector participation). I want to learn your views on the below questions.

Confidentiality

Your response will be treated confidentially (the name of the interviewee and organizations will not be cited in any publicly available papers), and the results are used for academic research purposes only. However, if you agree to quote your name in my paper, it will be highly appreciated if you let me know.

Contact:

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Q1: Solution relating to the curtailment issues and absorption of more solar/wind power

How can EVN/NPTC mobilize finance and upgrade the electricity power system (mainly transmission infrastructure) to solve the curtailment issues and absorb more solar/wind power?

Q2: Private participation in transmission infrastructure upgrades

How does the Government want to invite the private sector for transmission infrastructure construction if the Electricity Law is modified and the PPP guideline for transmission infrastructure is developed?

In other words, what kinds of private sector participation forms are feasible for Vietnam?

(e.g., BOT (Build-Operate-Transfer), BOOT (Build-Own-Operate-Transfer), BOO (Build-Own-Operate), Concessions, Privatization etc.)

Q3: How to deal with two exceptional cases of 1) Trungnam Group and Xuan Thien Group

A) Trungnam Group invested in 500/220kV substation and transmission lines

B) Xuan Thien Group invested in a 500kV transformer substation with a capacity of 1,200 MVA and a 500kV transmission line with a length of 22.2km

³ http://www.econ.kyoto-u.ac.jp/renewable_energy/stage2/contents/page0269.html



- 1) If the Electricity Law is modified, does the Government think that two companies' property (high-voltage transmission infrastructure) is transferred to EVN/NPTC by any contract to operate and maintain them?
- 2) Are there any possibilities for EVN/NPTC to utilize the above property to reduce the curtailment issues in some specific areas and absorb more solar/wind power generation?

Q4: Connection cost allocation policy

Do you think the current **connection cost allocation policy, the “shallow policy⁴” in Vietnam** (see especially the below-underlined phrases), is fair for solar/wind power plants?

[Solar] Article 8 “Connecting solar power projects to electrical systems⁵”

- Paragraph 1: *The Electricity Seller shall be responsible for investing, operating, and maintaining transmission lines and booster transformers (if any) from the power plants of the Electricity Seller to the Connection Points of the grid of the Electricity Buyer.*
- Paragraph 2: *Connection Points shall be agreed by the Electricity Seller and Buyer and based on the principle of the nearest Connection Points to the existing grid of the Electricity Buyer according to the capacities of power plants of the Electricity Seller and the approved provincial electrical planning. (Omitted)*

[Wind] Article 3 “Connection, measurement, and counting⁶”

- Paragraph 1a: *The Seller is responsible for the investment, construction, operation, and maintenance of connection equipment to connect the power plant to the transmission and delivery of power grids by the regulations on transmission and delivery thereof and other related regulations. The Seller shall bear the costs for installing the metering system at the electrical substation.*

Q5: Transmission/Network Cost allocation policy (usage)

- 1) Does the Government (MOIT/ERAV) think of revising the method (*1) relating to transmission cost recovery, considering the higher penetration of solar/wind power generation?
- 2) Does the Government (MOIT/ERAV) plan to charge the network price (transmission/distribution cost, SMO cost, and ancillary cost) for solar/wind power plants from a perspective of cost recovery when the Government introduces an auction mechanism and a DPPA mechanism shortly?

*1: MOIT Circular No. 02/2017/TT-BCT regulates that the Government charges the transmission costs for the EPTC, PCs, and customers by the postage stamp-based method.

⁴ A shallow connection policy covers costs of 1) the immediate connection assets of the generator (internal substation and transformer) and 2) the system extension (the long-distance and high-voltage transmission facilities) from solar/wind farm

⁵ PM Decision No.11 /2017/QD-TTg (Support mechanisms for the Development of Solar Power Projects in Vietnam). The content of Article 8 of PM Decision No.11 has been taken over Article 7 of Decision 13/2020/QD-TTg (mechanisms to promote the development of solar power projects in Vietnam).

⁶ Appendix G. PPA of Circular 2/2019/TT-BCT (wind power project development and power purchase agreement)

Appendix 2

<Transmission Grid>

1. GoV announced that the Quang Trach - Pho Noi 500kV transmission line project (circuit 3; 4 projects of 500kV transmission lines: Quang Trach - Quynh Luu, Quynh Luu - Thanh Hoa, Nam Dinh I Thermal Power Plant - Thanh Hoa, Nam Dinh I Thermal Power Plant - Pho Noi) will be completed by June 2024 to supply power to the Northern provinces. Reducing the curtailment in Binh Thuan and Ninh Thuan would be hard.
To reduce the curtailment in two provinces and absorb more solar and onshore/offshore wind power in Vietnam, what should GoV do? (e.g., prioritizing grid upgrades of the specific sites via competitive bidding, etc.)
 2. Experts indicate concerns relating to national energy security in inviting the private sector to invest in transmission grids. How should GoV deal with this?
 3. Are there any possibilities for GoV to plan to charge the network price (transmission/ distribution cost, SMO cost, and ancillary cost) for solar/wind power plants from a cost recovery perspective when GoV introduces a DPPA and an auction?
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