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

Are the barriers to private solar/wind investment in Vietnam mainly those that limit network capacity expansion?

August 2020

Akiko URAKAMI
Ph.D. Candidate,
Graduate School of Economics,
Kyoto University

Are the barriers to private solar/wind investment in Vietnam mainly those that limit network capacity expansion?

Akiko URAKAMI
Ph.D. Candidate, Graduate School of Economics, Kyoto University

Abstract:

Vietnam has relied on coal-fired plants as primary baseload power and keeps growing its electricity demand towards 2030. Meanwhile, Vietnam is abundant in renewable energy (RE). Through the solar FIT issued in 2017, solar power projects (approximately 4.5GW) were connected with the grid by the Commercial Operation Date (COD) (30 June 2019). However, connecting large-scale solar power plants in the southern coastal provinces has led to a curtailment in the grid intermittently. Vietnam Electricity (EVN) has expanded 220-500kV transmission lines and substations in the domestic power system to deliver solar power generated in the congested areas in 2020-21. Besides, Vietnam has been reaching its legal public debt constraint. It is difficult for EVN to depend on the Government of Vietnam (GoV) and borrow from local commercial/ international development banks, requiring the government guarantee. Thus, private investment is inevitable to meet electricity demand.

This study aims to discuss whether the main barrier is the network side instead of the generation side and how GoV could reduce the network bottleneck to promote solar/wind power private investment. First, the author identified barriers and broadly categorized into 1) policy, 2) financial, 3) technical, 4) institutional, and 5) social/environmental aspects through the literature review and developed questionnaire. Secondly, the author conducted semi-structured interviews with 41 (investors and stakeholders) in Vietnam and neighboring countries from August to December 2019.

The main findings are as follows: weak grid capacity has become a critical barrier in solar power projects' congested areas. When the owners made investment decisions for their projects in 2017-18, they could not realize the curtailment's possibility in the approval process. After connecting the grid, some owners have suffered from the curtailment. If GoV, EVN, and provincial authorities had managed the capacity of each local grid transparently, controlled to give licenses to investors in the approval process carefully, or pushed some licenses to different provinces where capacity constraints are less severe, investors could have contributed to distributing the additional capacity before the COD. As the Electricity Law does not allow private firms to invest in the grid, RE owners need to wait for the GoV and EVN to upgrade the grid in some means or for a law that allows private investment. Thus, weak grid capacity, the network side issues must be a more critical barrier than that of the generation side for investors. Because of Vietnam's legal public debt constraints, private sector involvement in transmission grids is necessary. The BOT contracts between EVN and the private sector could be possible because EVN has already experienced the BOT contracts for power plants. Also, non-sovereign finance provided by international financial institutes and development banks might be a possible option.

Keywords: renewable energy, private investment, barriers, transmission, Vietnam

(Received 26 June 2020; Received in revised form 31 July 2020; Accepted 3 August 2020)

1. Introduction

Vietnam relies on coal-fired plants as primary baseload power and depends on natural gas in the middle demand, and hydropower in case of the highest demand (p.60, EREA & DEA, 2019). Vietnam has installed the power capacity of 49GW, which consists of coal thermal power plants (38%), hydropower plants (35%), gas turbines (15%), small hydropower plants (6%), and others (imported power and renewable energy (RE)) (6%), by the end of 2018. The peak load of the total generation system in 2018 was 35GW (NLDC, 2018). The Northern regions have a surplus of capacity from coal-based power plants, while the Southern regions have faced a lack of power capacity because of various power plants' delayed construction schedules (p.60, EREA & DEA, 2019).

According to the 7th Power Development Plan Revision (PDP7rev), the electricity demand will keep growing towards 2030 (see Table 1-A). The growth rate of electricity demand will be 10.5% in 2016-20, 8.6% in 2021-25, and 7.4% in 2026-2030. PDP7rev indicates that about USD 150 billion needs to invest in power generation (heavily focusing on coal-fired power) and grid expansion between 2016 and 2030, which consists of USD 40 billion in 2016-20 and nearly USD 110 billion in 2021-30. The Government of Vietnam (GoV) shows intentions to diversify the finance for power development through enhancement of capital accumulation (e.g., issuing bonds and mobilizing FDI) (Government of Vietnam, 2016). Resolution No. 55 (see Table 1-B) shows the increasing RE percentage in the total primary electricity supply mix (CCCV, 2020).

Table 1-A: Power Sources in 2015, 2020 and 2030 (capacity: MW)

Electricity Sources	2015	2020*	2030*
Gas- and oil-fired power	8,501	9,000	19,000
Coal-fired power	12,751	26,000	55,300
Nuclear power	0	0	4,600**
Hydropower (small, medium, large)	16,075	21,600	27,800
Wind power	140	800	6,000
Solar	0	850	12,000
Other, including biomass & import	1,533	1,750	4,800
Total	39,000	60,000	129,500

Source: PDP7rev (Decision 428/QD-TTg, 2016)

* projected; ** halted in 2016 after seven years of preparation

Table 1-B: Future direction (as of February 2020)

	2030	2045
Primary energy	175-195 million TOE	320-350 million TOE

The total capacity of power sources Output	125,000-130,000 MW 550-600 billion kWh	
The share of RE sources in the total primary energy supply mix	15-20%	25-30%
The final energy consumption	105-115 million TOE	160-190 million TOE
GHG reduction from energy activities (compared to the business-as-usual: BAU)	-15%	-20%

Sources: Resolution No.55 on the orientation of national energy development strategy to 2030 and outlook to 2045 (2020)

Vietnam is abundant in RE sources in solar radiation and wind conditions (EREA & DEA, 2019) thanks to geographic location and wind patterns. Through the FIT for solar power (9.35 US cent/kWh) issued in April 2017, 82 solar power plants, whose capacity corresponds to more than 4,460MW (8.28 percent of the gross electricity capacity), was connected with the grid by the Commercial Operation Date (COD) of 30 June 2019 (EVN, 2019a). The rooftop solar power (RSP) accounted for 259.7MWp, which 15,914 clients installed mainly in Ho Chi Minh City and southern provinces under the FIT (EVN, 2019b). In addition to the FIT, rapid declines in solar power's capital costs for the past five years also contributed to dramatic solar electricity growth. It has led to solar being the lowest cost option on the Levelized cost of electricity (LCOE)[1] among other traditional power resources (Breu et al., 2019).

However, connecting large-scale solar power plants in the southern provinces has led to curtailment issues in the grid of 110kV and 220kV intermittently (EVN, 2019a). For example, in Ninh Thuan province, 18 projects (1,180MW), which consist of 15 solar power projects (1,063MW) and three wind power projects (117MW), have been connected to the grid as of 31 October 2019; however, ten projects (359MW) located in southern areas of this province have had to limit their output to a maximum 60% of the full capacity (EVN, 2019c).

According to the Vietnam Electricity (EVN), a state-owned company, deploying the transmission grid takes 3-5 years. Currently, the National Power Transmission Corporation (EVNNPT) has expanded 220kV - 500kV transmission lines and substations in the domestic power system, aiming at delivering the full capacity of solar power generated in Ninh Thuan and Binh Thuan provinces in 2020-21. However, they have been struggling with compensation and site clearance (EVN, 2019d). Furthermore, EVN has suggested a new idea to invite the private sector to temporarily invest and build two 220kV substations (Vinh Tan and Phuoc Thai), which can help all solar power plants (connected to the grid before 30 June 2019) to generate in full capacity (EVN, 2019e). However, the Electricity Law regulates the Government of Vietnam (GoV) installs, manages, and operates transmission systems.

Apart from upgrading the grid capacity, the PDP7rev indicates that small-scale RE

1 The LCOE for solar PV in the *Moderate Technical Potential Scenario* (which excludes protected areas, water bodies, forested areas, and urban areas, but include agricultural areas and areas with a slope greater than 5%) with a capacity factor of more than 10% is 64 USD/MWh, which reflects the different quality of solar resources in the southern and northern region (p.9-11, Lee, N. et al., 2020).

technologies could reduce transmission and distribution losses (Government of Vietnam, 2016). Thus, GoV expects to expand the international private investment on solar/wind power projects continue to meet increasing electricity demand to reduce power losses and limited financial resources from domestic banks. Behind the success of solar power development, some experts indicate critical barriers for international investors. Breu et al. (2019) emphasize that it is vital to eliminate barriers, including PPA's un-bankability. There might be a perception gap in risk-taking between domestic and international investors, which are the difference between Asian countries and others.

As for financial constraints, public debt in Vietnam has increased from nearly 52% of GDP in 2010 to more than 60% of GDP in 2020 because of the recent substantial fiscal deficits. Vietnam has been reaching its legal public debt constraint, whose cap is 65% of GDP. Therefore, it will be difficult for EVN to depend on GoV and borrow directly from local commercial banks and multilateral/bilateral development banks, which have required the government guarantee from the Ministry of Finance (MOF). Also, as Vietnam became a middle-income country, the percent of highly concessional loans has dramatically decreased in the period 2017-18. There are a few public finance options (e.g., less concessional loans and non-sovereign loans) for EVN (Gerner et al., 2018). Thus, private investment in power development, including RE, is expected to meet increasing electricity demand (Gerner et al., 2018; IEA, 2019).

Meanwhile, as the factors in attracting FDI in Vietnam, PwC and VCCI (2019) indicate "political stability," "strategic location," "strengthening institutional and regulatory framework," "emerging middle class," "stable macroeconomy growth," and "competitive labor cost and increasing productivity." However, Ha L.T. (2019) expresses concerns that over-reliance on FDI's exports (more than 70 percent) leads Vietnam to be affected by global market and trade. According to PwC and VCCI (2019), the draft FDI strategy towards 2023, prepared by the Ministry of Planning and Investment (MPI), indicates that the content of Vietnamese investment should concentrate not economic growth but sustainable development (e.g., improvement of jobs and living standard) through FDI. The draft FDI strategy also strengthens partnerships between FDI and domestic firms.

A few academic papers on solar/wind power had focused on private investors' roles/contributions in Vietnam when the author searched academic databases (e.g., Web of Science and Scopus). Although some studies dealt with investment barriers, they are a bit old or have not reflected the dramatic changes in the last few years. Meanwhile, various surveys and articles on private investment barriers are written by development banks/partners and Western consultancy companies, law firms, and Vietnamese/Asian newspapers. Based on reviewing them, the author examines whether a real barrier for private solar/wind investment is not on the generation side but the network side by comparing different stakeholders' views.

This study reviews the regulatory framework on solar/wind in Vietnam and empirical research on its barriers for solar/wind power private investment. It discusses whether the main barrier is the network side instead of the generation side as a hypothesis and how the network-

related barrier could be reduced to encourage more solar/wind power private investment to meet electricity demand in Vietnam. The paper is structured as follows. Section 2 reviews the regulatory framework on solar/wind power, the current status, and the past analysis on solar/wind power private investment. Section 3 explains the methods employed in this paper. Section 4 presents the findings from interviews with investors and relevant stakeholders in Vietnam. Section 5 provides conclusions and policy recommendations as well as future extensions of this research.

2. Regulatory framework on solar/wind power, current status, and empirical research on solar/wind power private investment barriers in Vietnam

2.1 Policy/Regulatory framework on RE and the current status in Vietnam

This subsection provides the policy framework on RE electricity (see Table 2) followed by the regulatory framework on solar/wind power and the current status.

In November 2015, the Prime Minister approved the Renewable Energy Development Strategy (REDS) up to 2030 with a vision of 2050. In the REDS, the ratio of RE development capacity (including large hydropower plants) in the whole electricity generation will be 38% (101 billion kWh) in 2020, 32% (186 billion kWh) in 2030, and 43% (452 billion kWh) in 2050 respectively. It also gives some incentives such as zero import duty for fixed assets, materials and semi-products, exemption/ reduction for corporate income tax and land rental, and government support for pilot projects' research/technology (Government of Vietnam, 2015).

In March 2016, GoV revised its Seventh Power Development Plan (PDP7). In the revised plan (PDP7rev), the average economic growth rate and the total electricity output were revised downward. Also, the PDP7rev decreases the targeted amount of coal-fired power plants and increases RE (including small hydropower, wind, solar, and biomass), which accounts for 21% of the whole power development by 2030 (Government of Vietnam, 2016). GoV also regulated the national/provincial solar power development plan (master plan) and has continuously altered these plans by adding new projects (MOIT, 2017). Since 2019, the Ministry of Industry and Trade (MOIT) has initiated to develop PDP 8 with relevant ministries and stakeholders. In Report 58 (June 2019) and Resolution 55 (February 2020), GoV shows an actual and future shift in planning away from coal power, even compared to PDP7rev (MOIT, 2019a; CCCV, 2020).

Table 2: Relevant policy framework on RE

2011	National Power Development Plan (PDP) 7 (2011-30)
2015	RE Development Strategy (2016-30) with outlook until 2050 (Decision 2068/2015/QD-TTg)
2016	Revised National PDP 7 (2016-30) (Decision 428/2016/QD-TTg)
2019	Report 58/BC-BCT on the Implementation Progress of Power Projects in the Revised Power Development

	Plan 7 (by MOIT)
2020	Resolution 55-NQ/TW of the Politburo on Orientation of national energy development strategy to 2030 and outlook to 2045 (by Central Committee of the Communist Party of Vietnam)

GoV promulgated a series of regulations for the development of wind power projects (see Table 3). As the first incentive mechanism for wind power, GoV regulated the FIT (7.8 US cents/kWh) for 20 years in June 2011 (Government of Vietnam, 2011; MOIT, 2012). GoV also issued the regulations relating to the tax exemption of imported goods, exemption/reduction of enterprise income tax and land use, and land hire levies of wind power projects (MoF, 2012). Besides, GoV provides investors with options including 100 percent foreign ownership of energy companies and PPP. However, 7.8 US cents/kWh could not attract investors' interest because of a very low investment guarantee (Cuong and Dersch, 2014). After GoV issued the revised the FIT for onshore wind power projects (8.5 US cents/kWh) and offshore (9.8 US cents/kWh) in November 2018, the number of project development has increased, aiming at the COD (1 November 2021) (Government of Vietnam, 2018; MOIT, 2019b). According to Ha-Duong et al. (2020), 11 wind power plants (425MW) have operated in February 2020. It is not clear to achieve the 2020 target for wind power (800MW) by 2020.

In March 2020, MOIT proposed the Report 1931 to the Prime Minister (PM) to add more wind energy activities in the PDP by several criteria as well as enhance/increase transmission lines to absorb additional wind power projects, considering the priority of the latest electricity development strategy (Resolution 55; see Table 1-B) and the probability of insufficient electricity (2021-24) (MOIT, 2020a). In April 2020, MOIT submitted the Report 2491/BCT-DL to the PM for consideration to extend to use the FIT to 31 December 2023 (and to start an auction scheme after 2023), taking into account various issues such as the application of the new Planning Law, the building period of onshore/offshore wind power plants, and the influence of the Coronavirus disease 2019 (COVID-19) due to disruption of supply chain and international experts (MOIT, 2020b).

Table 3: Incentive mechanisms on wind power

2011	Decision 37/2011/QD-TTG dated 29 June, on approving the supporting mechanism for the development of wind power project in Vietnam (by Prime Minister)
2012	Circular 32/2012/TT-BCT dated 12 November, issuing the Regulations on the implementation of wind power project development and standardized Power Purchase Agreement (PPA) for Wind Power Projects (by MOIT)
2012	Circular 96/2012/TT-BTC dated 8 June, guiding the financial mechanism of supporting electricity price for grid-connected wind power projects (by MOF)
2013	Circular 6/2013/TT-BCT dated 8 March - Regulation on content, order and procedures for formulation appraising and approving wind power development planning (by MOIT)
2018	Decision 39/2018/QD-TTg – issued on 10 September; Amending and Supplementing many Articles of

	Decision 37/2011/QD-TTg dated 29 June 2011 by the Prime Minister on Support Mechanism to Develop Wind Power Projects in Vietnam (by Prime Minister)
2019	Circular 2/2019/TT-BCT - issued on 15 January; on wind power project development and power purchase agreement
2020	Report 1931/BCT-DL dated 19 March, submitted by MOIT to the Prime Minister for consideration of supplementing wind power projects to PDP
2020	Report 2491/BCT-DL dated 9 April, on the proposal to extend the wind FIT mechanism in Decision 39/2018/QD-TTg issued by MOIT

GoV also initiated the FIT for solar power plants and a net metering mechanism for residential PV (see Table 4), followed by wind power. In April 2017, GoV adopted the single rate of 9.35 US cents/kWh to all types of solar power projects for 20 years and regulated to be adjustable to the fluctuations of the VND-USD exchange rate under the standardized PPA. It set the COD by 30 June 2019 (Government of Vietnam, 2017; MOIT, 2019b). As a result, 4,460MW of solar power facilities were connected with the grid by the deadline (EVN, 2019a). According to the Report No.127/BC/DL dated 31 July 2019, cited by EVN (2019f), the Prime Minister (PM) has requested MOIT to reexamine to balance between solar power generation and transmission grid upgrade, to start an auction scheme for solar power activities as a pilot from 2020 to be implemented broadly from 2021 and to present a structure for the private sector to invest in transmission grids. Also, MOIT approved the promotion program for the development of rooftop solar power (RSP) in Vietnam to help industry/commercial sectors and households develop RSP, aiming to install 100,000 systems by the end of 2025 (Government of Vietnam, 2019).

Concerning renewed incentive mechanisms for solar power generation adopted after 1 July 2019, MOIT has presented various draft decisions and reports to GoV and the PM since early 2019. Approximately nine months after the expiry of the previous FIT, GoV finally issued new FITs (Decision 13/2020) for solar power activities, which consist of 7.69 US cents/kWh for floating solar, 7.09 US cents/kWh for ground-mounted solar, and 8.38 US cents/kWh for RSP in April 2020. Under the new FIT for RSP, project developers can sell power to not only EVN but directly rooftop owners. The new FITs will apply for the projects that got approval before 23 November 2019 and reach their COD by 31 December 2020 (Government of Vietnam, 2020). Also, MOIT applied a unique scheme for solar power projects generated in Ninh Thuan province, which has contemplated as the RE center of Vietnam. This province had made construction preparations for a nuclear plant; however, the national assembly decided to cancel the nuclear option on 22 November 2016 because of several reasons (Green, 2016).

Furthermore, MOIT announced a *draft* circular on project development and standardized PPA for both grid-connected and rooftop solar power projects to replace Circular No.16 early May 2020 for comments. The new standard PPA for grid-connected projects does not reduce

the risks, especially curtailment (MOIT, 2020).

After expiring the solar FIT, MOIT attempts to implement an auction scheme and sell on Vietnam Wholesale Electricity Market (VWEM) towards most ground-mounted solar power projects; however, it has not officially announced the future schemes for solar power yet.

Table 4: Incentive mechanisms on solar power

2017	Decision 11/2017/QD-TTg – issued on 11 April 2017 and expired on 30 June 2020; implementation of a FIT mechanism
2017	Circular 16/2017/TT-BCT – issued on 12 September
2018	Resolution 115/NQ-CP (support mechanism for Ninh Thuan province in 2018-23) – Solar power projects will be implemented until the time to reach the full capacity of 2,000MW or the end of 2020
2019	Decision 2023/QD-BCT (promotion program for the development of rooftop solar power in Vietnam)
2020	Decision 13/2020/QD-TTg dated 6 April 2020 on mechanisms to promote the development of solar power projects in Viet Nam
2020	*Draft* Circular on Project Development and Standardized Power Purchase Agreement for both grid-connected and rooftop solar power projects (by MOIT)

2.2 Literature review of the empirical researches on barriers for solar/wind power private investment in Vietnam

This subsection describes the outcomes of a literature review of the empirical research on barriers to solar/wind power private investment in Vietnam. Based on the analysis, barriers are divided into the following categories: political and policy/regulatory, economic and financial, technical, institutional, and social and environmental aspects.

2.2.1 Political, policy/regulatory barrier

GoV has formulated a series of policy and regulatory frameworks for RE for the past decade. The author takes up six barriers, mainly focusing on solar/wind power (see Table 5).

Breu et al. (2019) and Dang and Taghizadeh-Hesary (2019) show concerns about whether GoV continues some incentive mechanism for solar power generation after July 2019. Multiple experts indicate that Vietnam's standardized PPA includes un-bankable terms, which are quite risky for international investors to accept (Gerner et al., 2018; Neefjes, 2018; Breu et al., 2019; Das, 2019). As examples of un-bankable terms, they list up "off-taker risk," which hinders investors from canceling out risks in cases of curtailment (Breu et al., 2019; IEA, 2019), "termination risk," which could occur in the event of early termination of the PPA (for EVN default) without compensation (Gerner et al., 2018; IEA, 2019), "absence of government guarantee" which makes foreign private investors recognize high risk (Breu et al., 2019; Gerner et al., 2018; Neefjes, 2018; IEA, 2019), "no international arbitration" which entitles Vietnamese authorities to dispute resolution (Stoxplus and Eurocham Vietnam; 2018, IEA, 2019), and "lack

of force majeure" (Breu et al., 2019). In other words, Stoxplus and Eurocham Vietnam (2018) argue that the present PPA does not enable foreign bankers to undertake risks and provide loans to developers. The current legal framework prevents foreign financiers from taking collateral assets if (local) investors default on the loans.

Regarding a series of procedures, it takes time for GoV to issue technical regulations (e.g., circulars) such as the standardized PPA after the decision was issued. The project-approval-process to get a project license consists of complicated and time-consuming steps because potential developers need to talk with relevant departments of appropriate Provincial People's Committee (PPC) as an initial round (Neefjes and Hoai, 2017) and then interact with the central government agencies as well. However, it depends on the project size (>30MW or >50MW). Land acquisition processes also contain risks (Sunderasan and Landmann, 2018; Neefjes, 2018). "Allegations of misconduct by officials, collusion and corruption" are reported by the media (Neefjes and Hoai, 2017; Neefjes, 2018).

Table 5: Summary of political, policy/regulatory barrier

Summary of identified barriers	References
Vague whether FITs remain in the future	Breu et al. (2019), Dang and Taghizadeh-Hesary (2019)
Un-bankable PPA terms	Gerner et al. (2018), Neefjes (2018), Stoxplus and Eurocham Vietnam (2018), Breu et al. (2019), Das (2019), IEA (2019)
Slow and inadequate issue of technical regulations	Neefjes and Hoai (2017)
Lack of clarity and delays in project-approval-process	Neefjes and Hoai (2017)
Delays/ risks in land acquisition processes	Neefjes (2018), Sunderasan and Landmann (2018)
Allegations of misconduct by officials, collusion and corruption	Neefjes and Hoai (2017), Neefjes (2018)

2.2.2 The economic and financial barrier

The economic and financial barriers may influence investors' decisions on RE. One of the significant issues in developing countries, including Vietnam, is limited access to financial resources to cover upfront initial investment costs. The seven barriers are discussed as follows (see Table 6).

Dapice (2018) argues that Vietnam's solar/wind power cost is about twice as high as Indian one because real developers/investors need to buy land licenses from local developers or provide 10-20 percent as local ones' equity. They must also borrow loans (typically 10 percent interest for ten years) from local commercial banks, which is because of a high risk of curtailment built into EVN contracts, which eliminate lower-cost international loans. Furthermore, RE generators need to bear the charge of connecting their plants to the

transmission lines, and its cost and risks may be increasing, depending on the conditions of areas where a line is connected through land inherited by various landowners (Dapice, 2018; Gerner et al., 2018; Stoxplus and Eurocham Vietnam, 2018; Nguyen-Trinh and Rizopoulos, 2018).

Nguyen, T.C. et al. (2018) suggest that GoV should improve the situation to attract private investment in RE and enhance the local financial market. The low-regulated price of electricity based on (fossil fuel) subsidies has prevented the private sector from investing in RE projects because it does not guarantee the required returns, which can offset the generation cost, even though GoV has provided the FIT.

Neefjes and Hoai (2017) develop a comprehensive analysis of the energy transition in Vietnam. As economic and financial barriers to the energy transition, they indicate low electricity tariff and low FITs. GoV still severely controlled the electricity retail tariffs (whose increases have followed nearly the inflation rate and CPI of Vietnam for a decade or so, comparing constant prices (p.4-5, UNDP, 2014; p.20-21, UNDP, 2016)), and they are caused by different tariff scheme among sectors, and it is unclear when the tariff increases. The FIT for wind power (7.8 US$ cent/kWh) set in 2011 is very low, and the solar FIT (9.35 US$ cent/kWh) is still not appealing to investors because a) the costs relating solar/wind power generation remains proportionately high in initiating large-scale projects; b) the ability and enabling environment is undeveloped; and c) the FITs for solar/wind power are higher than the normal retail price, which might discourage EVN subsidiaries from purchasing RE sources. Stoxplus and Eurocham Vietnam (2018) also indicate that Vietnam's FITs are not competitive, considering some constraints such as lower retail electricity prices and comparing to neighbors' FITs.

Breu et al. (2019) show that the LCOEs for solar/wind power in Vietnam are lower than conventional thermal electricity and the sharp decline of the capital costs for solar/wind, even if the externality is not considered. These articles indicate that a rapid decrease of the LCOE for solar/wind power at least for the period 2017-2019 (Neefjes and Hoai, 2017; Stoxplus and Eurocham Vietnam, 2018; Breu et al., 2019).

Concerning limited capital and financial channels, national commercial banks have difficulties providing long-term loans for high initial investment in RE projects regarding their deposits' short-term feature (Neefjes and Hoai, 2017; Gerner et al., 2018). They also have limited internal professional skills to assess RE projects (Nguyen, D.L., 2015; Nguyen et al., 2018; Gerner et al., 2018). Besides, they have a cap of 15 percent of their equity capital to provide debt to each borrower (Dang and Taghizadeh-Hesary, 2019). Regarding the financing structure, local commercial banks require developers to apply for corporate finance instead of project finance (Stoxplus and Eurocham Vietnam, 2018), which requests divergent long-term loan credit appraisal (Dang and Taghizadeh-Hesary, 2019). Also, the present PPA, including unacceptable terms for international financial institutes (IFIs) (see 2.1.1 in detail), has made it difficult for Vietnamese developers to acquire debt finance from IFIs. IFIs can offer a cheaper

lending rate and longer duration loans than Vietnamese lenders, whose shorter-term rate is 7.5-9.5 percent/ year (Gerner et al., 2018). As the above description is based on a limited number of secondary sources, it is essential to interview investors.

As other barriers, domestic financial institutions have provided VND-based loans to solar/wind power facilities because most projects have been deployed by local investors (Gerner et al., 2018).

Table 6: Summary of an economic and financial barrier

Summary of identified barriers	References
The high initial investment cost for solar/ wind power plants	Neefjes and Hoai (2017), Dapice (2018)
Low-regulated price of electricity	Neefjes and Hoai (2017), Nguyen et al. (2018), Dapice (2018), Stoxplus and Eurocham Vietnam (2018)
Lack of clarity in future electricity retail price	UNDP (2014), UNDP (2016), Neefjes and Hoai (2017)
Non-preferential/ still low FITs	Neefjes and Hoai (2017), Nguyen et al. (2018), Stoxplus and Eurocham Vietnam (2018)
Limited capital/ limited financial channels for attracting long-term loan	Nguyen, D.L. (2015), Neefjes and Hoai (2017), Dapice (2018), Gerner et al. (2018), Nguyen et al. (2018), Stoxplus and Eurocham Vietnam (2018), Dang and Taghizadeh-Hesary, 2019
Lending VND-based loans to RE projects	Gerner et al. (2018)
The burden for developers to pay for the prompt connection costs to substation/110kV line	Dapice (2018), Gerner et al. (2018), Nguyen-Trinh and Rizopoulos (2018), Stoxplus and Eurocham Vietnam, 2018

2.2.3 Technical barrier

Solar/wind power technologies at utility-scale are relatively recent compared to traditional electricity sources, including hydropower and coal-fired plants in Vietnam. Technical barriers are six as follows (see Table 7).

Nguyen, D. L. (2015) classifies major obstacles for future wind power deployment, reviewing the existing deployment of wind power plants and relevant policies. He indicates a lack of qualified human resources who can complete the whole wind power facilities (e.g., evaluating wind resources, developing investment reports), simple maintenance service, and O&M after building wind turbines. Lack of accurate data on wind power resource maps of the whole country is also a barrier because of insufficient wind measurements. GoV should also develop national wind power technologies, including R & D, manufacturing, assembling, and repairing wind-power-related equipment and plants based on overseas knowledge and inviting foreign companies to construct manufacturing and assembling factories. Another option is that GoV regulates the inclusion of local content. However, as this research's information was a

short time ago, it is necessary to justify it by semi-structured interviews.

Neefjes and Hoai (2017) examine social views and political practicability towards energy transition in Vietnam. There are barriers such as weak human resources for facility management, construction, and O&M in different levels of public and private sectors and insufficient infrastructure, which includes investment in transmission and distribution grids and smart grid systems to balance demand and supply. Besides, there are a limited number of manufacture and assembly factories in Vietnam, which are owned by Vietnamese and invested by foreign firms, and focus on different components of solar PV systems and wind towers. However, they serve mainly as manufacturers and assembly factories for overseas exports. Those researchers suggest that policy support for the expansion of national RE manufacturing businesses is needed.

World Bank (2019) summarizes possible Vietnam's solar competitive bidding schemes. It indicates that solar PV modules are jointly produced with Chinese and American companies in Vietnam. For example, 5GW of panels were produced in 2017, which accounts for 7 percent of the international market and exclusively assigned to exports. The report stresses the importance of fostering EPCs and other local services relating to PV's supply chain in Vietnam to achieve the long-term target of 12GW for solar power in 2030.

Dang and Taghizadeh-Hesary (2019) analyze substantial problems in encouraging the private sector to invest in the electricity sector, including insufficient progress of transmission grid upgrade for solar/wind power, considering the unplanned situation that numerous solar power plants were connected to the grid by the end of June 2019. EVN is the exclusive buyer for RE plants; however, it does not take risks when curtailment issues occur under the present standardized PPA. It is doubtful whether EVN can deal with RE investors transparently and reasonably so long as they cannot transport RE to where it is needed.

Vietnam Business Forum (2019) is concerned with insufficient grid lines in the south and south-central regions in absorbing increasing solar and wind power generation in the report relating six priorities on Vietnam's future energy strategy. They suggest that MOIT examine whether private sectors (solar and wind power developers) invest in grid infrastructure, especially their transmission grids of 220kV and 500kV.

EREA and DEA (2019) provide long-term views on Vietnam's energy transition based on advanced energy system models and indicate that it has been hard to deploy the transmission lines in being in time for the COD of solar and wind power projects because of the lag of the construction procedure and finance alignment of the transmission network. To connect a large-scale solar/wind power to the transmission grids, GoV should prioritize investing in upgrading the transmission grids on a short-term basis before considering other measures that enable the electricity system to be flexible. Besides, this report recommends that it is essential to build a rigid scheme for offshore wind, which consists of pilot activities, the national goal, available data (e.g., wind speed, sea bed situations, and EIA) at the national level, opportunities for training, and extension of the FITs, to smoothly develop offshore wind projects cost-effectively.

Kies et al. (2017) and Viet et al. (2018) show the optimization model's simulation outcome

to minimize the investment and operation costs in integrating solar and wind power into electric power systems for 2020-30. The previous paper suggests that upgrading the transmission grids should be simultaneously conducted in developing electricity sources, particularly RE, and the grid expansion will achieve a higher percentage of solar and wind power into the current electricity system in Vietnam. Meanwhile, the recent research indicates the upgraded transmission grids could decrease the LCOE by approximately 10 percent when wind power is installed more than solar power.

Table 7: Summary of technical barrier

Summary of identified barriers	References
Lack of qualified human resources	Nguyen, D.L. (2015), Neefjes and Hoai (2017), World Bank (2019)
Too small RE manufacturing businesses in Vietnam	Nguyen, D.L. (2015), Neefjes and Hoai (2017)
Inadequate infrastructure for solar and wind power plants	Nguyen, D.L. (2015), Neefjes and Hoai (2017), Dang and Taghizadeh-Hesary (2019)
Weak grid capacity/ Unreliability and instability of the grid	Dang and Taghizadeh-Hesary (2019), EREA & DEA (2019), Vietnam Business Forum (2019)
Poor quality and data for RE (e.g., available locations, infrastructure capabilities, etc.)	Nguyen, D.L. (2015)
Lack of information on wind energy potential and wind measurements	Nguyen, D.L. (2015), EREA & DEA (2019)

2.2.4 Institutional barrier

Institutional barriers are two as follows (see Table 8).

Nguyen N.T. and Ha-Duong (2009) study RE's financial potentiality for power generation in Vietnam for 2010-30 by utilizing a bottom-up Integrated Resource Planning model and suggest that RE utilization contributes to halting fossil fuel capacity of 4.4GW and promoting energy security. To promote RE deployment, GoV should improve insufficient coordination among different agencies inside the government.

Pham et al. (2013) argue that smooth connection and simplification of roles among government agencies diminish high transaction cost that RE developers need to submit similar papers to multiple organizations at different times. In the context of developing wind power, Nguyen D. L. (2015) also regards the lack of effective coordination among central and provincial agencies and the vague definitions of their roles as significant barriers. GoV should clarify each agency's responsibility at the central and local levels to make investors understand clearly.

Breu et al. (2019) indicate that project-approval-process needs an incredible number of stakeholder involvement with different government institutions. If this process is streamlined,

it may attract international investors to join the market. IRENA (2017) introduces that Thailand enacted the Energy Regulatory Commission (ERC) as an independent administrative institution in 2007, regulating and supervising the overall energy industry such as tariff calculation, procurement operation, and fair competition suitably and transparently. It appears that the ERC is an excellent example of one-stop agencies.

Table 8: Summary of institutional barrier

Summary of identified barriers	References
A remarkable large amount of stakeholder involvement with a variety of government agencies	Nguyen and Ha-Duong (2009), Breu et al. (2019)
Lack of effective coordination among central and local authorities	Nguyen and Ha-Duong (2009), Pham et al. (2013), Nguyen, D.L. (2015)

2.2.5 Social and environmental barrier

Social and environmental barriers are three as follows (see Table 9).

Neefjes and Hoai (2017) argue a few public consultations on the power sector except the compulsory announcement of final drafts for comments before the approval of strategies, plans, and other policies. Besides, various benefits of RE and the danger of fossil fuel energy in terms of environmental, economic, and health aspects may not be fully acknowledged in Vietnam. Meanwhile, they introduce several communities, such as the Vietnam Energy Partnership Group (VEPG), which MOIT has managed and invited development partners and other stakeholders (e.g., business and NGOs) for a series of technical working groups and policy dialogues to help sustainable energy deployment, as a useful vehicle of consultations.

In reality, there are a few examples that several provinces have rejected to build new coal power plants against the plans approved by the central government, because one of the reasons why alternative options such as RE sources and LNG are being pushed forward, considering air pollution and health issues (Viet Nam News, 2018; Le, 2019).

Table 9: Summary of social and environmental barrier

Summary of identified barriers	References
Minimal public consultation relating power-sector strategies, plans and other policies	Neefjes and Hoai (2017)
Lack of appreciation of the advantages of RE and the risks of fossil fuel energy	Neefjes and Hoai (2017)
Social/ community acceptance	Neefjes and Hoai (2017)

3. Methods

This paper aims at identifying barriers to solar/wind power private investment in Vietnam

and then examine whether the main barrier is the transmission grid instead of generation as a hypothesis as well as how grid-related barrier could be improved to promote solar/wind power private investment to meet increasing electricity demand in Vietnam.

Painuly (2001) emphasizes communication with stakeholders such as manufacturers, suppliers, plant owners, consumers, experts, policymakers, and professional associations "through structured interviews and questionnaires" is pivotal to identifying the barriers. First, the author searched keywords such as renewable energy/solar/wind, barriers/issues, and Vietnam through Google and academic databases (e.g., Web of Science and Scopus) for empirical studies, and then identified various barriers that are broadly categorized into 1) political and policy/ regulatory, 2) economic and financial, 3) technical, 4) institutional and 5) social and environmental aspects. In categorizing barriers identified by literature, the author referred to several academic papers on barrier analysis (Nguyen N.T. et al., 2010; Sindhu et al., 2016; Ghimire and Kim, 2018). Secondly, the author developed questionnaires and conducted interviews with stakeholders in Vietnam and neighboring countries to verify barriers and narrow down the number of barriers or add some crucial barriers. In this study, the author regards "stakeholders on solar/wind power projects" as private investors for solar or wind power and others who have supported the generation from different positions. Interviewees were asked to present their views on barriers of five categories, and which barrier(s) is/are considered to be more important or less influential in making the investment decision in solar or wind power projects in Vietnam. In August 2019, the author visited Vietnam to interview mainly international and local experts, who work at multilateral/bilateral development banks/agencies and research institutes to verify the barriers identified by literature review and to collect the information of investors and relevant stakeholders who have been involved with solar/wind power projects in Vietnam.

Based on the first site visit outcomes, the author narrowed down the number of barriers and elaborated description of the barriers (see Appendix 1). The author also reached out to investors and relevant stakeholders through the introduction from the past interviewees and company websites and professional social networks. The number of interviewees' appointment was increased by a snowballing method. The second site visit in Vietnam and neighboring countries was conducted in November and December 2019 to interview investors and relevant stakeholders. The detailed description of the interviewees is shown in Table 10. The interviewees' names and their organizations (locations/countries) are kept confidential due to the information's sensitivity.

Table 10: Summary of the interviewees conducted between August and December 2019

Category	Description of interviewees	Number
International	Developer, investor (including private equity), supplier and EPC (*)	20
	Development agency, NGO, consultant and researcher	5

Local (Vietnam)	Developer, investor, commercial bank and EPC (*)	8
	Consultant, researcher, and legal adviser	8
	Total	41

*: Approximately two-thirds of interviewees have engaged in solar power projects. Less than ten interviewees have worked on wind power projects, while some interviewees are involved with both types of power projects.

4. Results: barriers to private investment in solar and wind power in Vietnam

4.1 Policy/Regulatory framework on RE and the current status in Vietnam

4.1.1 Vague whether FITs remain in the future

Investors who concentrate on solar power plants have not regarded the future FITs' vague situation as a barrier; however, they are worried about the delays in new policy announcements, which decrease their motivation.

Regarding solar power projects, as of August 2019, most of the interviewees showed concerns from a short-term view about whether GoV announces the FIT (especially for solar power projects) or not. Though the COD of the first solar FIT was 30 June 2019, there was no new FIT or another incentive mechanism yet. A few experts presumed that GoV continues to implement the FIT even in lower tariffs because the FIT can help developers invest in solar power generation. As of November 2019, most of the interviewees expected that the next solar FIT would be issued in a few months based on the announcement that MOIT submitted a draft decision on new solar FIT to Prime Minister (PM) for consideration in September 2019 (Thu G., 2019). At the same time, they have worried about severe curtailment that occurred in south-central coastal provinces. In April 2020, GoV finally issued a decision on new FIT for solar power, though it is limited to the short term. Thus, some investors, who have already got approval by 23 November 2019, could enjoy the FIT2 (See Section 2.1).

Meanwhile, investors for wind power projects have prioritized finishing all processes by the COD (1 November 2021) without considering the next FIT. However, they argue that GoV should have fixed the COD, taking into account the time required for approval, land clearance/acquisition, and plants' construction. Considering the actual situation of wind power deployment and the business impact of COVID-19, MOIT sent the Report No.2491 to the PM in April 2020 to request the FIT extension to the end of 2023 (See Section 2.1).

4.1.2 Un-bankable PPA terms / Unnegotiable terms

Most international interviewees indicate that un-bankable PPA terms are among the most critical barriers for equity investors and debt providers (e.g., banks) among the regulatory barrier category. Among the terms, all interviewees stress that "off-take (curtailment) risk" is very critical. For example, in Ninh Thuan province, whose solar radiation is 1,700kWh per

square meter and power transmission lines have not been constructed entirely, 10 out of 25 solar power projects (as of 5 December 2019) have been compelled to operate at only 30-40 percent of the actual capacity, corresponding to the total depletion of approximately USD 21.7 million (Nguyen, H., 2019).

Some international investors mention that the "absence of termination (payment) clause" is also a constraint because it is questionable if investors will be compensated in EVN's default. However, other terms (e.g., absence of government guarantee, force majeure and international arbitration, etc.) could be acceptable, though they should be improved to international standards. Therefore, half of the international investors, whom the author interviewed, have not concluded the PPA with EVN. Instead, some of them were/have been dedicated to conducting the Feasibility Study (FS) and Environmental Impact Assessment (EIA) to support local partners.

Other international investors think the "absence of government guarantee" as critical because they are not sure whether EVN can purchase electricity from solar/wind power for 20 years stipulated in the PPA. Instead of government guarantee, several international investors have succeeded in obtaining the letter of credit (LC) (for debt guarantee) from local commercial banks because international banks require at least the LC to provide loans. As an exception, some of the Asian investors indicate that the guarantee is not always necessary because they can acquire equity stakes and suppliers (or EPCs)' credit (finance) before the completion of the plants, and then can get finance with a lower interest rate from commercial banks of their countries or IFIs such as ADB and IFC. Several local investors point out that approximately 60-70 percent of solar power projects have been invested, operated, and managed by Chinese firms/EPCs. Even though Thai firms have invested in solar power projects, Chinese firms have supported them as suppliers or EPCs.

Some Vietnamese medium-scale developers/investors (conglomerates) could find some international lenders because they have managed a more extensive range of businesses such as real estate and infrastructure and mobilized international finance.

To diversify a range of (non-Asian) investors in the future, EVN should think of improving some critical terms of the present PPA for solar/wind power projects.

4.1.3 Slow and inadequate issue of technical Regulation

This barrier is less critical for investment decisions among interviewees. Neefjes and Hoai (2017) indicated that the standard PPA issuance was delayed after the decision was announced. An international investor mentions that the issuance of the application form for wind power in Taiwan was also delayed, so this matter is not limited in Vietnam. Most local investors did not wait for the official issuance of the standard PPA for solar, and they used the same PPA for hydropower and wind power to proceed with the process smoothly.

4.1.4 Lack of clarity and delays in the project approval process

When the author interviewed with developers/investors who have been involved in a series

of the project approval process, most of the interviewees analyze lack of clarity and delays in the project approval process, especially for the recent few years since the FIT for solar started in 2017; however, it has not been recognized as a severe barrier in making investment decisions. Loy and Coviello (2005) argue that as slow administrative procedures raise the up-front cost, the government should provide explicit guidance for project developers and investors on licenses, permits, audits, site clearances, and all of the procedures should be finalized within one year or less. A majority of investors in Vietnam criticize the complicated and time-consuming project-approval-process. They need to consult with many governmental agencies in both provincial and central levels for a smooth-sailing approval process, including communication with high-ranking government officials. One of the reasons is that there are no clear written guidelines for approval. Besides, different processes and requirements in each province have made investors more confused. Some international investors mentioned that it took more than one and a half years to get a series of approvals, and then they had a few months to construct solar power plants by the COD. Also, international investors for wind power have serious concerns relating to the new Planning Law application's influence because they have been kept waiting for approval for six months (as of August 2019).

To reduce the time-consuming process, some of the investors developed multiple solar power plants (e.g., less than 50MW/plant) so that they did not need to include their projects in the list of projects that MOIT must submit to the Prime Minister (PM) as applicable plan and get approval from the PM.

Some international investors suggest that it is useful to establish a one-stop agency, which manages the whole approval process, including assessing the FS and the impact on transmission lines. As an example of the one-stop agencies, Thailand's Energy Regulatory Commission (ERC) was established as "*the authority to regulate energy industry operations in compliance with the policy framework of the government*" (Office of the Energy Regulatory Commission, 2011), separating from Ministry of Energy in 2007, when Thailand introduced the incentive mechanism for solar power.

4.1.5 Delays/ risks in land acquisition processes

Vietnam's Land Law regulates foreign developers and investors not acquiring land assets and mortgages as securities. Therefore, most of them need to rent land from owners or develop the Special Purpose Companies (SPCs) with a local partner. Another difficulty is that it is not easy for developers to make local people, who rent the land from real owners, understand solar/wind power projects, and agree on their relocation and compensation. There are perception gaps between local governments/owners and local people living at the sites.

In the case of onshore wind power plants, some international investors point out that appropriate land acquisition for onshore wind power plants is critical because appropriate land in Vietnam has already limited due to occupied solar power plants and other purposes (e.g., agriculture). As two international investors have the experiences to learn appropriate land for

wind power plants in other Asian countries, they have made efforts to gain the land use right step by step through the negotiations with local authorities and residents. One of the international wind power developers worried about whether it could complete all approval processes and the construction of the plants by the COD (1 November 2021) because it needs to negotiate with approximately 200 local people after getting a license. The other investor/developer, who has engaged in several solar/wind power projects, reveals that a series of land acquisition activities is the most critical among policy barriers. Because it has struggled to negotiate resettlement compensation with an ethnic minority group who are firmly attached to the land where they live for a long time, it has worried whether it could meet the COD for its wind power project.

International investors strongly expect GoV, primarily provincial authorities, to streamline the bureaucratic process for land clearance/acquisition. Besides, GoV should intermediate the negotiation among project owners/investors, landowners, and local people/ethnic minority groups living at the sites to secure appropriate sites for solar/wind power plants and local people's rights.

4.1.6 Allegations of misconduct by officials, collusion and corruption

Most investors acknowledge that "allegations of misconduct by officials, collusion and corruption" (Neefjes and Hoai, 2017) often occur in Vietnam and are reasonable in other developing countries, unfortunately. Some local developers could get approval quickly (e.g., less than six months), though it is unsure whether they are linked with some corruption and nepotism. However, there are several clear cases that international investors continued to have a series of dialogues with officials of provincial and central authorities tenaciously, and then concluded the PPA without any corruption, though it took a more extended period (18 months) to get approval.

4.2 Economic and financial barriers

4.2.1 The high initial investment cost for solar/wind power plants

Almost all investors think that the initial investment cost for solar/wind power plants is no barrier because it is no longer high even in Vietnam. A few investors argue that it is still expensive to consider the transaction cost of the long process for approval, license, and land acquisition, even if the equipment cost has been decreasing.

4.2.2 Low-regulated electricity price/ lack of clarity in future electricity retail price

The majority of investors think that low electricity price is no a barrier in deciding on investment on solar/wind power projects in Vietnam because the FIT is the fixed tariff that investors can get from EVN based on the PPA. Some experts show severe concerns about the low-regulated electricity price because EVN has less motivation in purchasing solar/wind

power, whose FITs are more expensive than the current average electricity price (Neefjes and Hoai, 2017; Nguyen et al., 2018; Dapice, 2018). Referring to the recent rise in electricity prices, some experts (interviewees) expect that the electricity price will gradually rise in line with the actual situation of the marginal cost of electricity in Vietnam.

An international investor points out that the LCOE in the wind has already been cheaper than coal, oil, and gas; however, the actual situation has not been reflected in the electricity price. Gary, M. et al. (2018) analyze the deployment of new solar power and wind power plants can become cheaper than operating actual coal-fired power plants in Vietnam in 2020 and 2022, respectively. Dapice (2018) indicates marginal costs of coal are approximately 4 US cent/kWh, including fuel and variable O&M costs; however, the total costs increase as capacity utilization decreases since fixed O&M is spread over less output, even though the plant is paid.

4.2.3 Non-preferential/ still low FITs

The past studies suggested that a series of FITs are still low; however, most interviewees indicate the FITs for solar (9.35 US cent/kWh), wind for onshore (8.5 US cent/kWh), and offshore (9.8 US cent/kWh) has attracted many private investors. Notably, the solar FIT has driven many investors to invest in solar power plants for a short period. A few investors suggest that GoV should have considered different technologies (farms, rooftop, and floating) and regions for the FIT for solar power because there is a big gap on irradiance between the Northern and the Southern provinces (However, the regionalization clause was removed from the final version of the FIT2 issued in April 2020). Two international investors consider that the FIT for offshore wind is a bit lower than that of other countries; however, it has not affected the investment decision.

Meanwhile, some researchers indicate that the solar FIT (even the FIT2, 7.09 US cent/kWh) is much higher than other neighboring countries that have implemented auctions. For example, the lowest bid of Cambodia's auction held in 2019 was less than 4 US cent/kWh. As it appears that GoV has a plan to shift the FIT into auction in 2021 officially, they can reflect the lesson learned from neighbors.

4.2.4 Limited capital/ limited financial channels for attracting long-term loan

All of the interviewees agree that limited capital is a very critical barrier for investment decisions for both local and international investors. Due to the un-bankable PPA terms, it is difficult for local investors to mobilize external capital; they need to borrow loans from local commercial banks. According to local investors, Vietnamese commercial banks can provide loans (basically "corporate finance with collateral") with an interest rate of 10-11% for 10-12 years on average. The banks require investors to have at least 30 percent of the total investment capital as minimum equity. Another concern is that each local bank has the ceiling to borrow loans to each company. Therefore, some investors have severe concerns about whether local banks can provide loans with upcoming solar and wind power projects.

Meanwhile, middle-scale local investors (e.g., conglomerates) have succeeded in blending finance from local commercial banks and different international financial sources. According to a local investor, some international banks may consider lending only if project owners can obtain a loan guarantee issued by the top 4 state-owned banks in Vietnam; however, it is unlikely that these banks provide such a guarantee with investors because the service fee of the guarantee is small comparing to the risk that they need to bear.

As for international investors, they are categorized by different types. The first group has mainly engaged in the project development phase, including implementing the feasibility study (FS), the Environmental Impact Assessment (EIA), and the EPC contract for local partners. Even though it puts a small stake of equity, they sell the equity to larger investors. The second group (e.g., Asian conglomerates and large-scale companies) has survived by putting equity and depending on Chinese suppliers' credit (finance) in the development phase of solar and wind power projects. It starts to negotiate with commercial banks of their countries or multilateral development banks on loans after construction completion. The last group (investors other than those mentioned above) has started with a small amount of equity finance and struggled to blend finance from different sources such as international banks, multilateral development banks, and Vietnamese commercial banks. Some international banks have made efforts to provide capacity-development with Vietnamese commercial banks to develop "project finance with non-recourse" because most local commercial banks have not experienced "project finance" yet.

International financial advisers indicate that syndicated loan schemes/customs among local commercial banks do not exist in Vietnam. Thus, if multiple financial actors such as local banks, international banks, and private equities can syndicate, it might become a sustainable structure. However, any actual examples do not yet exist in Vietnam. Besides, several examples of innovative financial solutions, such as Vestas's wind project, could collaborate with the Danish Export Credit Agency (EKF), an offshore bank, and a local bank (Vesta Asia Pacific, 2019).

As there are limitations of local banks' capability to assess RE projects and develop new financing schemes, GoV needs to encourage international lenders and suppliers to provide capacity development with local investors and banks and amendment of the PPA.

4.2.5 Lending VND loans to renewable energy projects

Lending VND-based loans to RE projects in Vietnam is typical if local banks provide loans to investors. Most international interviewees think it is not a serious barrier to making investment decisions, though the VND/USD exchange rate sometimes fluctuates, and local banks' interest rates vary.

4.2.6 The burden for developers to pay for the immediate connection cost

Most investors indicate that the connection cost to the nearest substation or pass 110kV line is not a barrier because project owners regard it as a part of the investment cost, or the

current FIT could cover the connection cost. In some cases of wind power farms, which the distance between the farm and the nearest substation might be far away, there will be possibilities for wind power investors to bear higher costs to connect with a substation. Some researches worry about whether this burden becomes heavier to developers when GoV introduces auction, which might lead to a lower price than the existing FIT.

4.3 Technical barriers

4.3.1 Lack of qualified human resources (system management, construction, and O&M of solar/ wind power plants)

A majority of the interviewees think that the lack of qualified human resources for solar power projects is not a barrier to investment decisions. In the period 2017-19, local engineers have been capable of managing technical aspects of system management, construction, and O&M of solar power plants, which is not technologically sophisticated comparing to traditional power plants. Local engineers could get the opportunity to learn from international engineers under the EPC contract. Some international solar PV system suppliers worry about the shortage of qualified local operators. The latter need to attend a series of training sessions provided by EVN before engaging in actual plants' operation activities because the number of solar power plants has dramatically increased since the introduction of the FIT.

Conversely, international investors, suppliers, and experts emphasize that development and O&M of wind power plants require more knowledge and experience. Thus, international EPCs should engage in implementing the whole process first with local engineers. However, a few international suppliers and technical advisers show severe concerns that as Vietnamese wind power project owners sometimes refuse O&M services from suppliers to reduce costs, some mechanical accidents might happen shortly. According to a Vietnamese newspaper (Tuoi Tre News, 2020), there was the first wind turbine fire in Binh Thuan province in January 2020 because of an electrical fault. This article introduces the other wind power project owner's voice, who mentions this fire would not have happened if workers could perform maintenance on the wind turbine rigorously. This accident suggests that similar incidents will happen in solar power systems without proper O&M activities.

4.3.2 Too small RE manufacturing businesses in Vietnam

Almost all interviewees indicate that it is not a barrier because investors can utilize global supply chains, especially Chinese suppliers, in terms of solar-power-related equipment. Some investors share examples that project owners have imported solar-power-related equipment from not only China but Germany, India, Japan, Korea, and the U.S., while they can import wind turbines from Denmark and the U.S. and have not imported Chinese wind turbines yet. An international supplier mentions that most suppliers have factories for PV panels in China because of cheap manufacturing costs. Another supplier shows concerns that they cannot decide

on establishing a factory in Vietnam because its market is uncertain in terms of the continuation of the regulatory framework and the content of the future long-term strategy.

However, Nguyen, D. L. (2015) suggests that GoV should think of options to develop national RE power technologies, invite foreign firms that construct manufacturing and assembling factories for domestic production or regulate local content requirements in RE policies, along with capacity development of qualified human resources. The World Bank (2019) also indicates that Vietnam can produce modules, cells, ingots/wafers, and inverters for local solar markets, though the existing factories focus on manufacturing for export.

4.3.3 Inadequate infrastructure for solar/wind power plants/ weak grid capacity/ unreliability and instability of the grid

All interviewees agree that weak grid capacity, which hinders solar/wind power from reaching its full potential in Vietnam, might be the most critical barrier to making investment decisions shortly. In Ninh Thuan and Binh Thuan provinces, where most solar power plants have been developed, most transmission grids have been overloaded, causing most solar farms to operate at only 30-50 percent of their actual capacity. According to local experts, the above two provinces need to build 500kV substations. When the author interviewed several local investors (project owners) in August 2019, they showed strong motivation that they are willing to invest in upgrading transmission grids and increase their outputs and accelerate the progress of other projects. However, they need to request GoV to provide a new framework, which designates how EVN will compensate for their initial investment cost. Local legal experts also mention that it has been considered that the private sector invests in upgrading transmission grids as a pilot case, considering the existing situation that it is not easy for EVN to mobilize private finance for the short term. If the National Assembly approves it as a pilot case, it is unnecessary to amend the current Electricity Law, which stipulates that only EVN and its subsidiaries can construct, manage and operate transmission and distribution lines.

Meanwhile, international financial institutes, development partners, and investors have also considered providing non-sovereign finance and technical assistance with EVN to enhance grid capacity in Southern provinces and to strengthen grid operation, which can absorb variable renewable energy sources to improve curtailment level.

Regarding battery storage, nobody mentioned during the semi-structured interviews. It appears that interviewees think it the most critical to enhancing grid capacity. Vietnam Business Forum (2019) suggests that battery storage could provide additional chances to sustain the grid and improve capacity and mitigate the transmission load to the regional grid by installing batteries into the solar power plants in the consumption sites.

4.3.4 Poor quality and data for RE/ lack of information on wind energy potential and wind measurements

Recently, as it has been easier to access the data for RE from open sources (e.g., wind and

solar radiation maps provided by international organizations such as ESMAP and the World Bank Group), developers can estimate potential generation capacity for their business cases by calculating wind measurement onsite for 12 months. Thus, it is not a barrier to making investment decisions in Vietnam.

An international investor concerns the lack of technical standards relating to "setback areas for wind turbines" because there are some risks that local people start to argue if GoV introduces this technical standard in the future.

4.4 Institutional barriers

4.4.1 A remarkable large amount of stakeholder involvement with a variety of government agencies

It is a barrier that developers need to consult with large numbers of officials of government agencies at provincial and central levels to get approval relating license and land acquisition.

4.4.2 Lack of effective coordination among central and local authorities

Most developers had/ have severe concerns about the lack of effective coordination among central and local authorities, causing delays in the project-approval-process. Even though developers finish necessary consultation with local authorities, they need to process a similar central authority process. The majority of the interviewees argue that it is essential to transparently clarify the division of the roles between provincial and central authorities. Besides, another problem is that responses vary by provinces due to a lack of clear guidelines. Several international investors point out that lack of effective coordination during the project-approval-process might have caused curtailment issues in the Southern provinces.

Meanwhile, a few international investors mention that as the Communist Party of Viet Nam (CPV) has led the political system in Vietnam, if they can first consult with high-level officials of the central government, it is easier to reach an agreement with the local authority, compared to, e.g., India which has multiple political parties.

4.5 Social and Environmental barriers

4.5.1 Minimal public consultation relating power-sector strategies, plans and other policies

In Vietnam, public consultations have been held frequently if local people can enjoy the economic benefits.

4.5.2 Lack of appreciation of the advantages of RE and the risks of fossil fuel energy

Whether people appreciate the advantages of RE depends on people and provinces. Some international investors point out that "lack of appreciation of the advantage of RE" is not fair considering the situation of developed countries which have maintained stable electricity

produced by fossil fuels and recently started to invest in RE projects as additional electricity sources.

Meanwhile, a local researcher argues that the power supply from hydropower and coal in recent years was not stable in Vietnam and will become unstable in the South region unless additional capacity is installed. FITs might be a burden compared to the average electricity retail price and the lower costs of coal and hydropower in Vietnam. However, the FITs for RE are not higher than LNG costs or those of new coal if the technology level rises. It is essential to understand that RE is not an expensive option but cheaper, even with balancing the electricity system such as transmission upgrading.

As shown in section 2.2.5, southern provinces have opposed developing new coal power plants because they have RE options in the region and severe environmental pollution concerns caused by coal power plants. It appears that provinces, which have plans to develop new coal power plants, could acknowledge RE's advantages and the risks of fossil fuel energy.

4.5.3 Social/ community acceptance

Social/ community acceptance is not a significant barrier; however, some investors have faced difficulties in making residents of potential project sites understand the development of solar or wind power plants and agree with the relocation and compensation fee in light of international standards. This matter is closely linked to land acquisition. In case international development banks and partners provide loans, they need to organize the consultation with local people based on their own rules.

4.6 Summary of different types of investors

There were also findings on different tendencies among Vietnamese, Asian, and international developers/investors. Though Vietnamese middle-scale enterprises (e.g., conglomerates) and a few Asian investors have been involved with the whole process, local firms with small capital and international enterprises (engaging in most solar power projects) have collaborated by bringing complementary strengths. Local firms have a good connection with central/provincial authorities to approve project license and land clearance, while international firms can provide technical knowledge, experience, and financial options. Some local small firms sell "development package (license and land clearance)" to international firms, while local firms/engineers work under international firms to construct plants and engage in O&M activities. Among solar power projects, approximately 60-70 percent was possessed and managed by Chinese EPCs/firms.

Regarding other international investors, private equities engage in developing feasibility study and EIA for international lenders, while some investors join SPC by putting in equity to get to know the actual market. It appears that it is difficult for international investors (except some Asian) to take the current PPA risk. Meanwhile, a few international investors are very positive in developing and managing solar/wind power plants from the long-term perspective

of Vietnam's future potential, such as increasing population, GDP and electricity demand, and geographic merits for solar/wind power and Vietnamese people's capabilities. Some of the key stakeholders which leverage private investment in solar/wind power are international financial institutes (IFIs) such as ADB and IFC that serve to fill the finance gap by providing finance with preferential conditions.

5. Conclusions, policy recommendations, and future research

This study analyzed barriers to solar/wind power private investment in Vietnam through literature reviews and semi-structured interviews with investors and relevant stakeholders (see Table 10). To meet the increasing electricity demand in Vietnam, private investment for solar/wind power plants, which take a shorter time to build rather than fossil-fuel-based ones, is essential. Considering the public debt issue that GoV has faced for the past few years, private investment is expected to contribute to developing solar/wind power projects. Therefore, it is vital to grasp what kinds of barriers influence investment decisions, and which barriers should be eliminated preferentially for improving the enabling environment for solar/wind power private investment in Vietnam.

In this research, 24 barriers were determined through literature review and the first semi-structured interviews with experts based in Vietnam. These barriers are divided into five categories: political and policy/regulatory, economic and financial, technical, institutional, and social and environmental aspects. Each barrier's background and reason are described in Section 2 and 4 due to the literature review and semi-structured interviews.

One of the most critical regulatory barriers raised by international experts and investors is the standard PPAs, including multiple un-bankable terms, though the PPAs for solar and wind are not precisely the same. The content of the standard PPAs is closely linked to limited access to finance because a majority of the project owners can only borrow loans with high-interest rates and limited duration from local commercial banks. Solar power farms of approximately 4.5GW (more than five times the 2020 target) were connected to the grid by the COD (30 June 2019). However, the leading investors are limited to middle-scale Vietnamese firms (e.g., conglomerates) and Asian investors, who could access Vietnamese commercial banks' loans and external finance with lower interest rates from international financial institutes (IFIs) such as ADB and IFC or Chinese suppliers/EPCs. Thus, Vietnam has not attracted a more extensive range of investors, including non-Asian/institutional investors and lenders. GoV and EVN should think of improving at least two clauses of "off-take" and "termination" in the PPAs, which international investors and lenders regard as red lines. Improvement of the standard PPA diversifies investors/lenders from non-Asian countries and secure access to various finance. It appears that the content of the *draft* standard PPA (see Section 2.1) for solar power projects (announced by MOIT early May in 2020 for comments) still does not diminish the risks, including "off-take" (curtailment). It appears that the draft standard PPA will protect EVN, which needs to improve the grid further.

Meanwhile, as the FIT for solar/wind power was/is higher than the average retail electricity price, EVN was/is reluctant to purchase solar/wind power. If GoV gradually raises the low retail electricity price (through the removal of indirect fossil fuel subsidies) as well as introduces auction schemes for RE projects (e.g., mega-solar power), the enabling environment could be provided for EVN and its subsidiaries as well as investors (Dapice, 2018; Nguyen-Trinh and Rizopoulos, 2018). In reality, GoV has still severely controlled the retail electricity price at a low level; however, it plans to introduce a competitive retail market in the Power Sector Reform process in a few years. It is time for GoV to manage the enabling environment for EVN and RE investors.

A series of approval processes are also significant barriers because investors need to coordinate with officials of both provincial and central authorities in getting licenses and site clearances. As the first step to improve the approval process, GoV should consider establishing a one-stop agency at the central government level and developing an approval guideline for provinces, because investors argue that the approval process is complicated and necessary documents depend on provinces.

As for technical barriers for investors, weak grid capacity in the southern provinces is critical. Most solar power project owners in the congested areas of specific provinces (e.g., Ninh Thuan and Binh Thuan provinces) have not delivered electricity. EVN and its subsidiaries should solve the curtailment issues by upgrading the transmission infrastructure at the earliest time, purchase the full capacity generated from all solar/wind power plants, and deliver electricity to areas with power demand. To deal with the current curtailment issues, GoV and EVN should consider the possibilities to invite private firms to build transmission lines and substations as a pilot case if it is difficult for EVN to allocate its budget or mobilize public or private finance in the short term, taking into account the existing legal public debt constraint. During the interviews, the idea of private firms' involvement was proposed by several owners/ investors on solar power projects, which have faced/ may face severe curtailment. Local legal experts also indicate that GoV does not have to amend the Electricity Law, which does not now allow private firms to build transmission grids if the National Assembly approves private grid expansion as an exception.

Although various barriers exist, as solar power projects of approximately 4.5GW were connected to the grid by the COD, most developers/investors could take risks relating the PPA terms, manage to mobilize the capital, and get approval by themselves. However, weak grid capacity has become a critical barrier, especially in the congested areas (especially Ninh Thuan and Binh Thuan provinces) of solar power projects. When the owners made investment decisions for their solar power projects in 2017-18, they did/could not realize the curtailment issue in the approval process. However, some of them have suffered from the curtailment after connecting the grid. If MOIT, EVN, and provincial authorities would have managed the capacity of each local grid transparently, controlled to give licenses to investors in the approval process carefully, or pushed some licenses to different provinces where capacity constraints are

less severe, investors could have contributed to distributing the additional capacity before the COD (30 June 2019). As the Electricity Law does not allow private firms to contribute to investing in upgrading the grid, RE owners need to wait for GoV/EVN to upgrade the grid in some means or for a law that allows private investment. Thus, weak grid capacity, which is the network side issue, must be more critical than the generation side barriers for investors. If the grid were strengthened and auctions started, the generation side would have a significant bottleneck removed as low-cost capital would drive RE costs below fossil fuel costs.

Regarding the importance of consistently increasing transmission grids in integrating a higher share of RE generation into the electricity system, researchers indicate as follows: Ha-Duong et al. (2020) emphasize that Vietnam should include flexibility rules in its PDP8 (2020-30) because it is essential to implement technical and economic flexibility options in deploying solar/wind power rapidly, considering the lessons in European countries and China that solar/wind power projects have built more rapidly than flexibility options, especially transmission grid expansion, and it brought higher levels of system operation and curtailment as well as unfavorable electricity fees. Bird et al. (2016) also illustrate that continuous investments in increasing capacity and transmission grids could decrease curtailment risks if curtailment status surpasses more than 10 percent of RE generation, based on the reviews on international experience relating curtailment.

However, there is limited evidence relating to private sector involvement in building transmission and distribution lines and reduced curtailment levels in developing countries. Foster and Rana (2020) review private sector involvement in transmission/distributions in 15 developing countries and analyze several good private participation cases in transmission development. Build-operate-transfer (BOT) contracts, which resemble ones for IPPs but have more straightforward elements consisting of O&M fee and capital investment cost, were concluded by the bidding process to develop additional transmission lines in Latin America. Another case was a certain period of the concession method adopted in the Philippines. These authors illustrate that private sector involvement in power sector reform has contributed to RE growth in middle-income countries. However, most transmission grid in the power sector has been driven mainly by government expenditure and official goals because it is challenging to manage grid development and operation on an exclusively commercial basis because of low margins.

In Vietnam, as GoV has faced legal public debt constraints, it appears that private sector involvement in transmission grids is needed. The BOT contracts between EVN and the private sector could be possible because EVN has already experienced to conclude the BOT contracts in building large-scale power plants. Another option, non-sovereign finance provided by IFIs and development partners, might be a possible option as capital investment for the upgrading capacity and transmission grids.

In the near term, EVN should consider upgrading capacity and transmission grids to the existing pipeline of solar and wind power projects, which are more planned to be developed

than the original target (PDP7rev), in preparing for a new plan (PDP8) for 2030.

Future research can consider how Vietnam can integrate higher shares of variable RE sources (solar and wind) into its electricity system. Furthermore, though RE promotion is closely linked to the future power development plan (PDP8) and market reform, this paper could not discuss the details. Future research will consider these aspects.

There are some limitations. First, it was difficult to get information and data relating to Chinese firms engaged in investing in solar power projects. Secondly, as the number of wind power projects is not many, it was impossible to interview wind power investors. Thus, future research will focus more on wind power generation.

Appendix 1

Inquiry: Investor's perspectives on barriers of private investment for solar and wind power generation in Vietnam

I would like to interview actual investors who are working in solar/ wind power generation in Vietnam.

This research sets out to explore barriers that domestic and international private investors have faced in developing/ investing in solar and wind energy projects in Vietnam. At this stage of the research, I have conducted an extensive literature review and identified various barriers that are broadly categorized into 1) political and policy/ regulatory, 2) economic and financial, 3) technical, 4) institutional and, 5) social and environmental aspects (page 2-3). To validate and narrow down the barriers, we would kindly ask you to express your perception of the presented barriers.

The following are the two main questions that will be asked during the interview:
1) How does each barrier influence the decision of investment in Vietnam?
2) Which barriers are considered to be more important/ less important than other barriers of each category?

Confidentiality
Your response will be treated confidentially (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.

Contact:
Akiko Urakami (Ms)
Ph.D. Candidate, Graduate School of Economics, Kyoto University, Japan
Email: urakami.akiko.65a@st.kyoto-u.ac.jp

Identified barriers for RE development/ investment (As of 9 October 2019)

Categories		Summary of identified barriers
Political and Policy/ Regulatory barriers	1	Vague whether FITs remain in the future (Solar: after 1 July 2019; Wind: after 1 November 2021)
	2	Un-bankable PPA terms / Unnegotiable terms • Offtake (Curtailment) risk • Fixed FITs (inflation and exchange rate risk) • Absence of government guarantee • Absence of force majeure • Absence of international arbitration (dispute resolution will be made with EVN and MOIT's relevant department • Absence of termination
	3	Slow and inadequate issue of technical Regulations (e.g., standardized PPAs) after the Decision was issued
	4	Lack of clarity and delays in project-approval-process (e.g., Inclusion of Provincial/National Master Plan; License)
	5	Delays/ risks in land acquisition processes (Foreign developers/ investors cannot acquire land assets and mortgage as securities.)
	6	Allegations of misconduct by officials, collusion and corruption
1) How does each barrier influence the decision of investment in Vietnam? **2) Which barriers are considered to be more important/ less important than other barriers of each category?**		

Economic and financial barriers	1	The high initial investment cost for solar/ wind power plants
	2	Low-regulated (artificial low) price of electricity (Existence of fossil fuel subsidy)
	3	Lack of clarity in future electricity retail price
	4	Non-preferential/ still low FITs (especially near/ offshore wind)
	5	The limited capital/ limited financial channels for attracting long-term loan • Limited capacity of national/domestic banks for substantial upfront investment (lack of necessary in-house technical expertise to evaluate RE projects) • Lack of access for cross-border financing limits
	6	Lending VND loans to renewable energy projects
	7	The burden for developers to pay for the immediate connection costs (to the nearest substation/ passing 110kW line)
1) How does each barrier influence the decision of investment in Vietnam? **2) Which barriers are considered to be more important/ less important than other barriers of each category?**		

Categories		Summary of identified barriers
Technical barriers	1	Lack of qualified human resources (system management, construction, and O&M of solar/ wind power plants (farms)) • Mainly lack of qualified human resources for wind power plants?
	2	Too small RE manufacturing businesses in Vietnam (Only for manufacturing and assembly factories for overseas exports)
	3	Inadequate infrastructure for solar and wind power plants • Absence of smart grid • Lack of transmission lines (Necessary substations of 500kV?) • Lack of distribution lines (especially in Ninh Thuan and Binh Thuan?)
	4	Weak grid capacity/ Unreliability and instability of the grid
	5	Poor quality and data for RE (e.g., available locations, infrastructure capabilities, etc.)
	6	Lack of information on wind energy potential and wind measurements
1) How does each barrier influence the decision of investment in Vietnam? **2) Which barriers are considered to be more important/ less important than other barriers of each category?**		

Institutional barriers	1	A remarkable large amount of stakeholder involvement with a variety of government agencies
	2	Lack of effective coordination among central (e.g., MOIT, MONRE) and local authorities (PPC, DOIT, DONRE, etc.)
1) How does each barrier influence the decision of investment in Vietnam?		

Social and environmental barriers	1	Minimal public consultation relating power-sector strategies, plans and other policies
	2	Lack of appreciation of the advantages of RE and the risks of fossil fuel energy
	3	Social/ community acceptance
1) How does each barrier influence the decision of investment in Vietnam? **2) Which barriers are considered to be more important/ less important than other barriers of each category?**		

Thank you for your kind cooperation.

References

Bird, L., Lew, D., Milligan, M., Carlini, E.M., Estanqueiro, A., Flynn, D., Gomez-Lazaro, E., Holttinen, H., Menemenlis, N., Orths, A., Eriksen, P.B., Smith, J.C., Soder, L., Sorensen, P., Altiparmakis, A., Yasuda, Y. & Miller, J. 2016, "Wind and solar energy curtailment: A review of international experience", *Renewable and Sustainable Energy Reviews*, vol. 65, pp. 577-586.

Breu, M., Castellano, A., Frankel, D. & Rogers, M. 2019, , *Exploring an alternative pathway for Vietnam's energy future* [Homepage of McKinsey & Company], [Online]. Available: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Asia%20Pacific/Exploring%20an%20alternative%20pathway%20for%20Vietnams%20energy%20future/Exploring-an-alternative-pathway-for-Vietnams-energy-future-vF.ashx [2019, September 20].

Central Committee of the Communist Party of Vietnam (CCCV) 2020, *Politburo's Resolution 55-NQ/TW on Orientation of the Vietnam's National Energy Development Strategy to 2030 and Outlook to 2045*, Central Committee of the Communist Party of Vietnam (CCCV), Hanoi, Vietnam.

Cuong, N.D. & Dersch, D. 2014, *Proposal of an appropriate support mechanism for wind power in Vietnam (Short Version)*, GIZ, Hanoi, Vietnam.

D. T. Viet, V. V. Phuong, M. Q. Duong, M. P. Khanh, A. Kies & B. Schyska 2018, "A Cost-Optimal Pathway to Integrate Renewable Energy into the Future Vietnamese Power System", *2018 4th International Conference on Green Technology and Sustainable Development (GTSD)*, pp. 144.

Dang, L.N. & Taghizadeh-Hesary, F. 2019, *Avoiding Energy Insecurity by Promoting Private Investment—The Case of the Vietnamese Power Sector*, Asian Development Bank Institute, Tokyo.

Dapice, D. 2018, *Vietnam's Crisis of Success in Electricity, Options for a Successful Clean Energy Mix*, ASH Center for Democratic Governance and Innovation, HARVARD Kennedy School, Cambridge, U.S.A.

Das, K. 2019, March 1-last update, *Renewables in Vietnam: Current Opportunities and Future Outlook* [Homepage of VIETNAM BRIEFING], [Online].

Available: https://www.vietnam-briefing.com/news/vietnams-push-for-renewable-energy.html/ [2019, July 5].

Electricity and Renewable Energy Authority (EREA) & Danish Energy Agency (DEA) 2019, *Vietnam Energy Outlook Report 2019*, Ministry of Industry and Trade (MOIT), Hanoi, Vietnam.

Foster, V. & Rana, A. 2020, , *Rethinking Power Sector Reform in the Developing World, SUSTAINABLE INFRASTRUCTURE SERIES* [Homepage of World Bank], [Online].
Available: https://openknowledge.worldbank.org/bitstream/handle/10986/32335/9781464814426.pdf?sequence=10&isAllowed=y [2020, March, 30].

Gary, M., Kok, I., Ljungwaldh, S. & Watson, L. 2018, , *Economic and financial risks of coal power in Vietnam* [Homepage of Carbon Tracker Initiative], [Online].
Available: https://carbontransfer.wpengine.com/wp-content/uploads/2019/06/VIE_CTI_Brief_Designed-RC_Amended_HG.pdf [2019, December 10].

Gerner, F., Giblett, M.A., Alatabani, A.F., Behrend, O.P., Eckardt, S., Foster, V. & Santley, D.J. 2018, *Vietnam – Maximizing Finance for Development in the Energy Sector (English)*, World Bank, Washington, D.C.

Ghimire, L.P. & Kim, Y. 2018, "An analysis on barriers to renewable energy development in the context of Nepal using AHP", *Renewable Energy*, vol. 129, pp. 446-456.

Government of Vietnam 2020, *Decision 13/2020/QD-TTg on Mechanism for Encouragement of the Development of Solar Power in Vietnam*, Government of Vietnam, Hanoi, Vietnam.

Government of Vietnam 2019, *Decision 2023/QD-BCT on Promotion Program for the Development of Rooftop Solar Power in Vietnam*, Government of Vietnam, Hanoi, Vietnam.

Government of Vietnam 2018, *Decision 39/2018/QD-TTg on Amending and Supplementing a Number of Articles of Decision 37/2011/QD-TTg dated June 29, 2011 by the Prime Minister on Support Mechanism to Develop Wind Power Projects in Vietnam*, Government of Vietnam, Hanoi, Vietnam.

Government of Vietnam 2017, *Decision 11/2017/QD-TTg on Mechanism for Encouragement of the Development of Solar Power Projects in Vietnam*, Government of Vietnam, Hanoi, Vietnam.

Government of Vietnam 2016, *Decision 428/QD-TTg of Approval of the Revised National Power Development Plan for the 2011-2020 Period with the Vision to 2030*, Government of Vietnam, Hanoi, Vietnam.

Government of Vietnam 2015, *Decision 2068/QD-TTg of Approving the Vietnam's Renewable Energy Development Strategy up to 2030 with an Outlook to 2050*, Government of Vietnam, Hanoi, Vietnam.

Government of Vietnam 2011, *Decision 37/2011/QD-TTg on Approving the Supporting Mechanism for the Development of Wind Power Project in Vietnam*, Government of Vietnam, Hanoi, Vietnam.

Green, J. 2016, November 29-last update*, Vietnam's amazing nuclear journey – why it ended, what it means for South East Asia* [Homepage of Energy Post], [Online]. Available: https://energypost.eu/vietnam-dumps-nuclear-power-economic-reasons-rest-south-east-asia-may-follow/ [2020, June 10].

Ha, L.T. 2019, *Chinese FDI in Vietnam: Trends, Status and Challenges*, ISEAS, Singapore.

Ha, L. 2019, 17 November-last update, *Vietnam supports private investment in electricity transmission lines* [Homepage of Vietnam net GLOBAL], [Online]. Available: https://vietnamnet.vn/en/business/moit-supports-private-investment-in-electricity-transmission-lines-588334.html [2020, 10 March].

Ha-Duong, M., Teske, S., Pescia, D. & Pujantoro, M. 2020, March 5-last update, *Options for wind power in Vietnam by 2030*. Available: https://hal-enpc.archives-ouvertes.fr/hal-02329698v2/document [2020, March 15].

International Energy Agency (IEA) 2019, *Southeast Asia Energy Outlook 2019*, International Energy Agency (IEA), Paris, France.

IRENA 2017, *Renewable Energy Outlook: Thailand*, International Renewable Energy Agency, Abu Dhabi.

Kies, A., Schyska, B., Thanh Viet, D., von Bremen, L., Heinemann, D. & Schramm, S. 2017, "Large-Scale Integration of Renewable Power Sources into the Vietnamese Power System", *Energy Procedia*, vol. 125, pp. 207-213.

Le, Q. 2019, March 7-last update, *Vietnamese provinces say "no" to coal plants–government and industry still want more* [Homepage of Mekong Eye], [Online]. Available: https://www.mekongeye.com/2019/03/07/vietnamese-provinces-say-no-to-coal-plants-but-the-government-and-industry-build-more/ [2020, June 7].

Lee, N., Flores-Espino, F., Oliveira, R., Roberts, B., Bowen, T. & Katz, J. 2020, June-last update, *EXPLORING RENEWABLE ENERGY OPPORTUNITIES IN SELECT SOUTHEAST ASIAN COUNTRIES - A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics* - [Homepage of National Renewable Energy Laboratory (NREL)], [Online]. Available: https://www.nrel.gov/docs/fy19osti/71814.pdf [2020, June 30].

Loy, D. & Coviello, M. 2005, *Renewable Energies Potential in Jamaica*, United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and GTZ.

Ministry of Finance (MoF) 2012, *Circular 96/2012/TT-BTC on Guiding the Financial Mechanism of Supporting Electricity Price for Grid-Connected Wind Power Projects*, Ministry of Finance (MoF), Hanoi, Vietnam.

Ministry of Industry and Trade (MOIT) 2020a, *Report 1931/BCT-DL to the Prime Minister of Vietnam for consideration of supplementing wind power projects to Vietnam's power development plan* , Ministry of Industry and Trade (MOIT), Hanoi, Vietnam.

Ministry of Industry and Trade (MOIT) 2020, , *Draft Circular - Stipulating Project Development and Standardized Power Purchase Agreement for Solar Power Projects*. Available: http://vepg.vn/wp-content/uploads/2020/05/Draft_Circular_Solar_SPPA_EN_fin.pdf [2020, 30 May].

Ministry of Industry and Trade (MOIT) 2019b, *Circular 2/2019/TT-BCT on wind power project development and power purchase agreement*, Ministry of Industry and Trade (MOIT), Hanoi, Vietnam.

Ministry of Industry and Trade (MOIT) 2019a, *Report 58/BC-BCT on Implementation of Power Projects in the Revised Power Development Plan 7*, Ministry of Industry and Trade (MOIT), Hanoi, Vietnam.

Ministry of Industry and Trade (MOIT) 2017, *Circular 16/2017/TT-BCT on Project Development and Standardized Power Purchase Agreements for Solar Power Projects*, Ministry of Industry and Trade (MOIT), Hanoi, Vietnam.

Ministry of Industry and Trade (MOIT) 2012, *Circular 32/2012/TT-BCT on issuing the Regulations on Implementation of Wind Power Project Development and Standardized Power Purchase Agreement (PPA) for Wind Power Projects*, Ministry of Industry and Trade (MOIT), Hanoi, Vietnam.

National Load Dispatch Center (NLDC) 2018, *Operation Statistic of Vietnam power system*, Vietnam.

Neefjes, K. 2018, *LONG-TERM GREENHOUSE GAS EMISSION MITIGATION OPPORTUNITIES AND DRIVERS IN VIET NAM*, United Nations Development Programme, Viet Nam.

Neefjes, K. & Hoai, D.T.T. 2017, , *Towards a Socially Just Energy Transition in Viet Nam Challenges and Opportunities* [Homepage of Friedrich-Ebert-Stiftung], [Online]. Available: https://library.fes.de/pdf-files/bueros/vietnam/13684.pdf [2019, January 20].

Nguyen, D.L. 2015, "A critical review on potential and current status of wind energy in Vietnam", *Renewable and Sustainable Energy Reviews*, vol. 43, pp. 440-448.

Nguyen, H. 2019, , *Vietnam's Auction Plan for Solar Energy* [Homepage of VIETNAM BRIEFING], [Online]. Available: https://www.vietnam-briefing.com/news/vietnams-auction-plan-for-solar-energy.html/?hilite=%27Vietnam%E2%80%99s%27%2C%27Auction%27%2C%27Plan%27%2C%27Solar%27%2C%27Energy%27 [2019, December 10].

Nguyen, N.T., Ha-Duong, M., Tran, T.C., Shrestha, R.M. & Nadaud, F. 2010, "Barriers to the adoption of renewable and energy-efficient technologies in the Vietnamese power sector", *GMSARN International Journal*, [Online], vol. 4, no. 2, pp. 89-104. Available from: https://halshs.archives-ouvertes.fr/halshs-00444826/document.

Nguyen, T.C., Chuc, A.T. & Dang, L.N. 2018, *Green Finance in Viet Nam: Barriers and Solutions*, Asian Development Bank Institute, Tokyo.

Nguyen, N.T. & Ha-Duong, M. 2009, "Economic potential of renewable energy in Vietnam's power sector", *Energy Policy*, vol. 37, no. 5, pp. 1601-1613.

Nguyen-Trinh, H.A. & Rizopoulos, Y. 2018, "Market Conditions and Change for Low-Carbon Electricity Transition in Vietnam", *Journal of Energy and Development, International Research Center for Energy and Economic Development*, vol. 43, no. 1-2, pp. 1-26.

Office of the Energy Regulatory Commission 2011, , *Establishment of the Energy Regulatory Commission* [Homepage of Office of the Energy Regulatory Commission (OERC)], [Online].
Available: http://www.erc.or.th/ERCWeb2/EN/Front/StaticPage/StaticPageEN.aspx?p=1&Tag=History&muid=12&prid=2 [2019, December 29].

Painuly, J. 2001, "Barriers to renewable energy penetration; a framework for analysis", *Renewable Energy*, vol. 24, no. 1, pp. 73-89.

Sindhu, S.P., Nehra, V. & Luthra, S. 2016, "Recognition and prioritization of challenges in growth of solar energy using analytical hierarchy process: Indian outlook", *Energy*, vol. 100, pp. 332-348.

StoxPlus & Eurocham Vietnam 2018, "International Conference, Vietnam Renewable Energy: Challenges and Practical Solutions", , ed. StoxPlus & Eurocham Vietnam, HCMC, Vietnam, August 23.

Sunderasan, S. & Landmann, L. 2018, , *Study on private funding opportunities for renewable energy and energy efficiency investments in Viet Nam* [Homepage of UNDP-Viet Nam], [Online].
Available: https://www.undp.org/content/dam/vietnam/docs/Publications/EXECUTIVE%20SUMMARY-final.pdf [2019, August 15].

Thu, G. 2019, , *New FiT rate expected to promote investment in solar energy* [Homepage of Viet Nam News], [Online]. Available: https://vietnamnews.vn/economy/535898/new-fit-rate-expected-to-promote-investment-in-solar-energy.html#FewfUqUb1oldQd6r.97 [2019, September 30].

Tuoi Tre News 2020, January 7-last update, *$3mn in damage after wind turbine catches fire in south-central Vietnam* [Homepage of Tuoi Tre News], [Online].
Available: https://tuoitrenews.vn/news/business/20200107/3mn-in-damage-after-wind-turbine-catches-fire-in-southcentral-vietnam/52483.html [2020, June 10].

United Nations Development Programmes (UNDP) 2016, *GREENING THE POWER MIX: Policies for Expanding Solar Photovoltaic Electricity in Viet Nam*, UNDP, Ha Noi, Viet Nam.

United Nations Development Programmes (UNDP) 2014, *Green Growth and Fossil Fuel Fiscal Policies in Viet Nam - Recommendations on a Roadmap for Policy Reform*, UNDP, Ha Noi, Viet Nam.

Vestas Asia Pacific 2019, *Vestas and Danish Export Credit Agency unlock Vietnamese wind energy project through innovative financing structure that can be used in other emerging markets*, https://www.globenewswire.com/news-release/2019/03/13/1752301/0/en/Vestas-and-Danish-Export-Credit-Agency-unlock-Vietnamese-wind-energy-project-through-innovative-financing-structure-that-can-be-used-in-other-emerging-markets.html edn, Vestas, Singapore.

Viet Nam News 2018, October 25-last update, *Southern provinces want environmentally-friendly LNG power, not coal power* [Homepage of Viet Nam News], [Online]. Available: https://vietnamnews.vn/society/468524/southern-provinces-want-environmentally-friendly-lng-power-not-coal-power.html [2020, June 7].

Vietnam Business Forum 2019, 31 July-last update, *Made in Vietnam Energy Plan 2.0* [Homepage of Vietnam Business Forum (VBF)], [Online]. Available: https://www.amchamvietnam.com/wp-content/uploads/2019/08/MVEP-2.0_final_ENG-9-Aug.pdf [2019, 15 December].

Vietnam Electricity 2019e, October 15-last update, *Solar energy development is in a standstill state* [Homepage of Vietnam Electricity (EVN)], [Online]. Available: https://en.evn.com.vn/d6/news/Solar-energy-development-is-in-a-standstill-state-66-163-1677.aspx [2019, December 21].

Vietnam Electricity (EVN) 2019f, August 6-last update, *Solar energy development must be compatible with transmission grid development* [Homepage of Vietnam Electricity (EVN)], [Online]. Available: https://en.evn.com.vn/d6/news/Solar-energy-development-must-be-compatible-with-transmission-grid-development-66-163-1580.aspx [2019, November 20].

Vietnam Electricity (EVN) 2019d, July 16-last update, *Studying on the problems impacting on the construction progress of power grids releasing power capacity for solar power projects* [Homepage of Vietnam Electricity (EVN)], [Online]. Available: https://en.evn.com.vn/d6/news/Studying-on-the-problems-impacting-on-the-construction-progress-of-power-grids-releasing-power-capacity-for-solar-power-projects-66-142-1545.aspx [2019, August 20].

Vietnam Electricity (EVN) 2019c, October 31-last update, *Energizing to raise capacity of 220kV Thap Cham - Ninh Thuan transformer station* [Homepage of Vietnam Electricity (EVN)], [Online]. Available: https://en.evn.com.vn/d6/news/Energizing-to-raise-capacity-of-220kV-Thap-Cham-Ninh-Thuan-transformer-station-66-163-1679.aspx [2020, January 26].

Vietnam Electricity (EVN) 2019b, November 11-last update, *Development of rooftop solar power: Customers wait for prices?* [Homepage of Vietnam Electricity (EVN)], [Online]. Available: https://en.evn.com.vn/d6/news/Development-of-rooftop-solar-power-Customers-wait-for-prices-66-163-1692.aspx [2019, December 20].

Vietnam Electricity (EVN) 2019a, July 1-last update, *As of June 30, 2019: More than 4,460MW of solar power has been integrated into the grid* [Homepage of Vietnam Electricity (EVN)], [Online]. Available: https://en.evn.com.vn/d6/news/As-of-June-30-2019-More-than-4460MW-of-solar-power-has-been-integrated-into-the-grid-66-163-1518.aspx [2019, November 20].

World Bank 2019, *Vietnam Solar Competitive Bidding Strategy and Framework*, World Bank, Washington, DC.