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ZCWP02-20 Underlying drivers and barriers for solar photovoltaics diffusion: The case of Vietnam

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Abstract

Vietnam experienced a solar photovoltaic (PV) installation boom in the first half of 2019, with installed capacity increasing to 4,450 MW. This saw Vietnam overtake Thailand to have the largest installed solar PV capacity in Southeast Asia. This paper investigates the underlying drivers of Vietnam's solar boom, barriers to further solar adoption, and suitable strategies for the next stage of solar adoption. Forty-six semi-structured interviews were conducted with experts from government agencies, international organizations, non-governmental organizations, universities, research institutions, and industry. A generous feed-in tariff (FIT) of US$93.5/MWh for new projects, together with supporting policies such as tax exemptions, are found to be the key proximate drivers of Vietnam's solar PV boom. Underlying drivers include the government's desire to enhance energy self-sufficiency and the public's demand for local environmental quality. Limited transmission grid capacity and complex administrative procedures are among the key barriers. Looking forward, Vietnam has substantial potential to continue to scale up solar PV, with market-based mechanisms able to play a large role in this process. Vietnam's case is relevant for broader energy transition discussions.

Keywords: Solar, electricity, feed-in tariff, driver, barrier, Vietnam

Abbreviations[1]

[1] ADB (Asian Development Bank), ASEAN (Association of Southeast Asian Nations), GIZ (German Corporation for International Cooperation), EVN (Electricity Vietnam), FIT, (feed-in tariff), GOV (Government of Vietnam), LCOE (levelized cost of electricity), MOIT (Ministry of Industry and Trade), PPA (power purchase agreement), PV (photovoltaic), RPS (renewable portfolio standard), WB (World Bank).

1. Introduction

Vietnam has the fourth-largest solar generation potential in Southeast Asia, behind Thailand, Myanmar, and Cambodia. Specifically, Lee et al. (2019) estimated that Vietnam has the potential to generate 2,847 GW of electricity from solar photovoltaics (PV) at sites for which the levelized cost of electricity (LCOE) was less than US$ 150/MWh in 2018.[2] This quantity far exceeds Vietnam's current power usage. In the context of this large potential solar resource, the large international decline in the costs of solar PV modules and enabling technologies provides Vietnam with the opportunity to significantly decarbonize its electricity system.

Nevertheless, Vietnam was until recently moving only slowly in the adoption of solar PV. Solar PV was not considered as a viable electricity generation option until 2015, when Vietnam's Renewable Energy Development Strategy was issued. In 2017, the Prime Minister issued Decision 11/2017/QD-TTg on a feed-in tariff (FIT) mechanism for solar power (Government of Vietnam, 2017). Under this decision, solar power projects – both utility-scale and rooftop – that started their operation prior to 30 June 2019 would be able to sell their electricity to the state-owned Vietnam Electricity (EVN) and its subsidiaries at a FIT of US$93.5/MWh for 20 years. For projects installed after 30 June 2019, as at the time of writing in early 2020, there was no available FIT for new solar projects, with the industry awaiting the announcement of a new policy.

The lead-up to the expiration of the initial solar FIT saw a remarkable boom in Vietnam's installed capacity of solar PV. As at the end of 2018, only 86 MW of solar PV capacity was in place. By the end of June 2019, this had increased to 4,450 MW. Over this 6-month period, this represents an annualized renewables installation rate of about 90 W per capita per annum, placing Vietnam among world leaders (Baldwin et al., 2018). As seen in Figure 1, Vietnam moved well past Thailand to have the largest installed capacity for solar power generation in the Association of Southeast Asian Nations (ASEAN) (ASEAN Centre for Energy, 2019). Vietnam accounted for 49% of the total solar PV installed capacity of ASEAN as of mid-2019 (ASEAN Centre for Energy, 2019).

This paper aims to provide insights on Vietnam's solar PV boom by exploring three main questions:

1) What were the underlying drivers of the Vietnam's initial solar PV boom?
2) What barriers exist to further adoption and utilization of solar PV in Vietnam?
3) What approaches would be suited to facilitating the future adoption and utilization of solar PV in Vietnam?

[2] The LCOE is the present value of the cost of electricity from a new project per unit of electricity generated. It includes both up-front costs and ongoing costs.

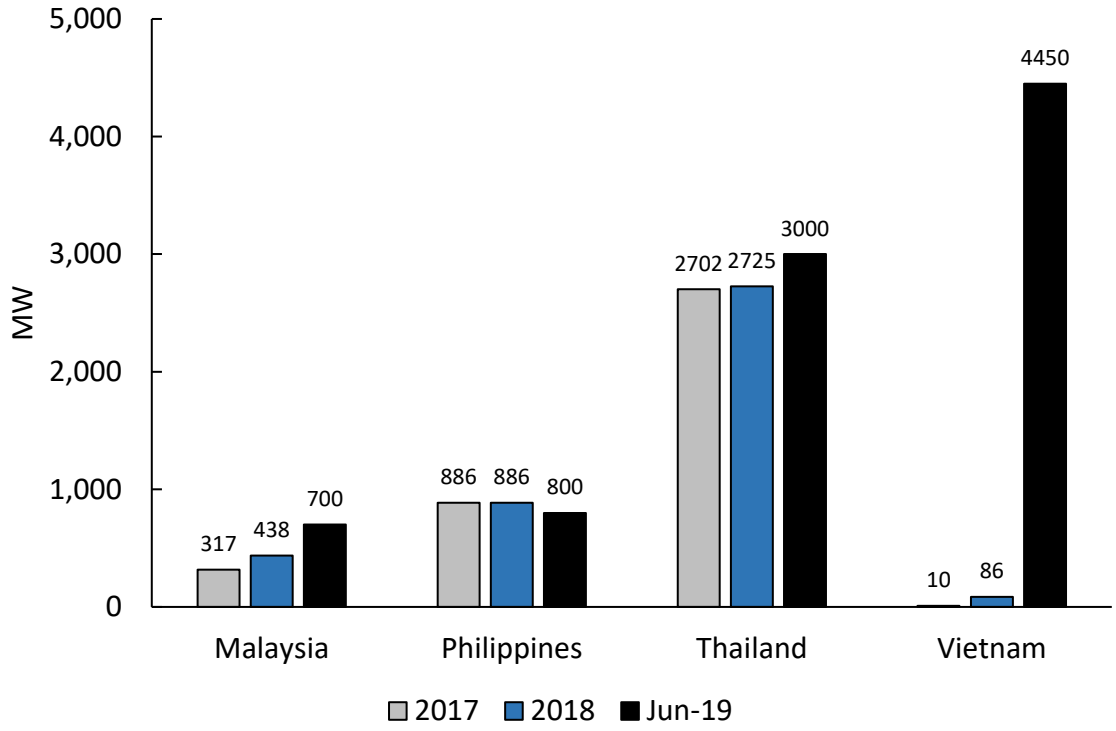

Figure 1. Solar installed capacity in key ASEAN markets, 2017–2019.
Sources: ASEAN Centre for Energy (2019); BP (2019a). Data for 2017 and 2018 are as at the end of the year.

Our analysis will apply an economic, social, and institutional framework using information drawn from 46 interviews of relevant experts. The paper finds that the FIT, together with several supporting policies, were the key proximate drivers of Vietnam's solar PV installation boom. Indirect drivers and complementary policies have also been important. These include rapid electricity demand growth associated with industrialization and urbanization, the government's energy and climate change policies, increasing public awareness about and demand for environmental quality, international influences via energy financing and technical assistance, and rapid solar PV technology and market development. The paper also draws insights on suitable policy approaches to encourage the further uptake of solar PV in Vietnam. Lessons learned from Vietnam's experience are highly relevant for other countries in Southeast Asia and further afield.

The paper is structured as follows. Section 2 provides an overview of Vietnam's electricity sector and its solar PV potential. Section 3 describes the methods used in the study. Section 4 presents the findings. Section 5 concludes and discusses policy implications.

2. **Vietnam's electricity sector and solar PV**

2.1 Electricity sector

Vietnam's electricity sector has developed quickly. The share of the population with residential access to electricity increased from 76% in 2000 to 99% by 2017 (International Energy Agency, 2018). In urban areas, the electrification rate has reached 100%. Annual electricity use per capita has also increased, from only 0.1 MWh in 1990 to 2.2 MWh in 2018 (Figure 2). This is now higher than seen in some other Southeast Asian countries with similar socioeconomic

development levels, such as the Philippines (0.8 MWh) and Indonesia (0.9 MWh). However it is still below the world average of 3.2 MWh per year (International Energy Agency, 2018). Vietnam's aggregate electricity consumption growth rate averaged 11.6% per annum during 2008–2018, which is fast. Total electricity use increased from 71 TWh in 2008 to 213 TWh in 2018 (BP, 2019a).

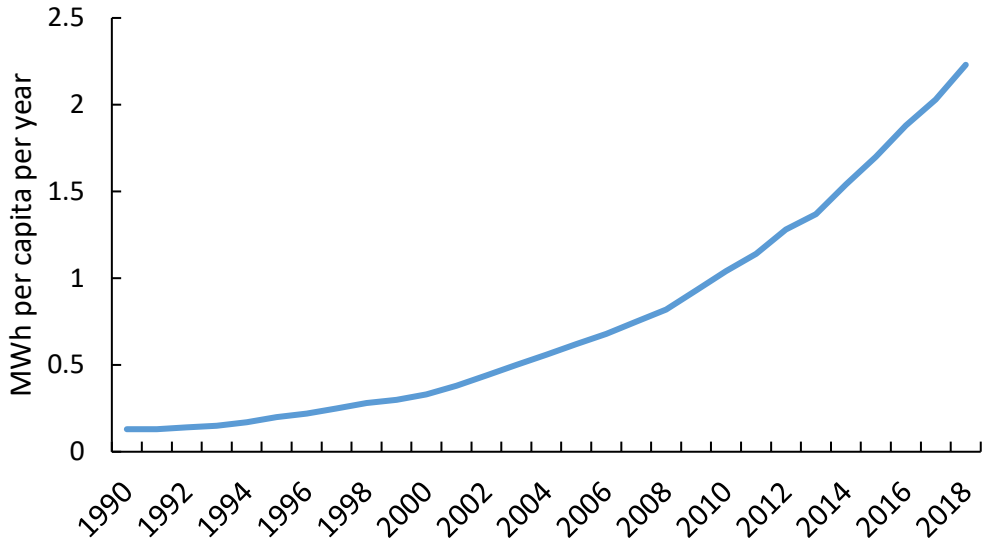

Figure 2. Annual electricity consumption per capita, 1990–2018.
Source: BP (2019a); World Bank (2019d).

Vietnam's electricity mix has changed substantially over the last three decades (Figure 3). During 1990–2003, hydropower was the dominant power source. Between 2004 and 2010, natural gas was the largest single contributor. During 2011–2015, hydro was again the largest source of electricity generation. Since 2016, coal has become the largest source, with substantial investments being made in new coal-fired power generation in order to meet growing demand. This poses a risk of carbon lock-in given that these power plants have the potential to be used for multiple decades. There is also a risk that some of these plants will become stranded assets due to both growing competition from alternative energy sources and increasing environmental concerns. As of 2018, non-hydro renewables – mainly biomass and wind power – accounted for a small share of the electricity mix. The solar share of Vietnam's electricity mix remained at 0% in 2018 when rounded to zero decimal places.

Vietnam's electricity sector is dominated by large state-owned enterprises. EVN controls about two-thirds of the electricity generation capacity in the country, with the remainder operated by other large state-owned enterprises (Vinacomin and Petrol Vietnam), joint stock companies, and other domestic investors (Neefjes and Dang, 2017). Electricity distribution and transmission remains fully controlled by EVN. EVN and its subsidiaries are the combined single buyers in the wholesale market and sell electricity to residential consumers at a government-set price of US 8.1 cents/kWh (Le, 2019). Vietnam has made progress towards the development of a wholesale electricity market, and also has plans to move towards greater retail market competition over coming years. The country has about 450,000 km of distribution lines (Breu et al., 2019).

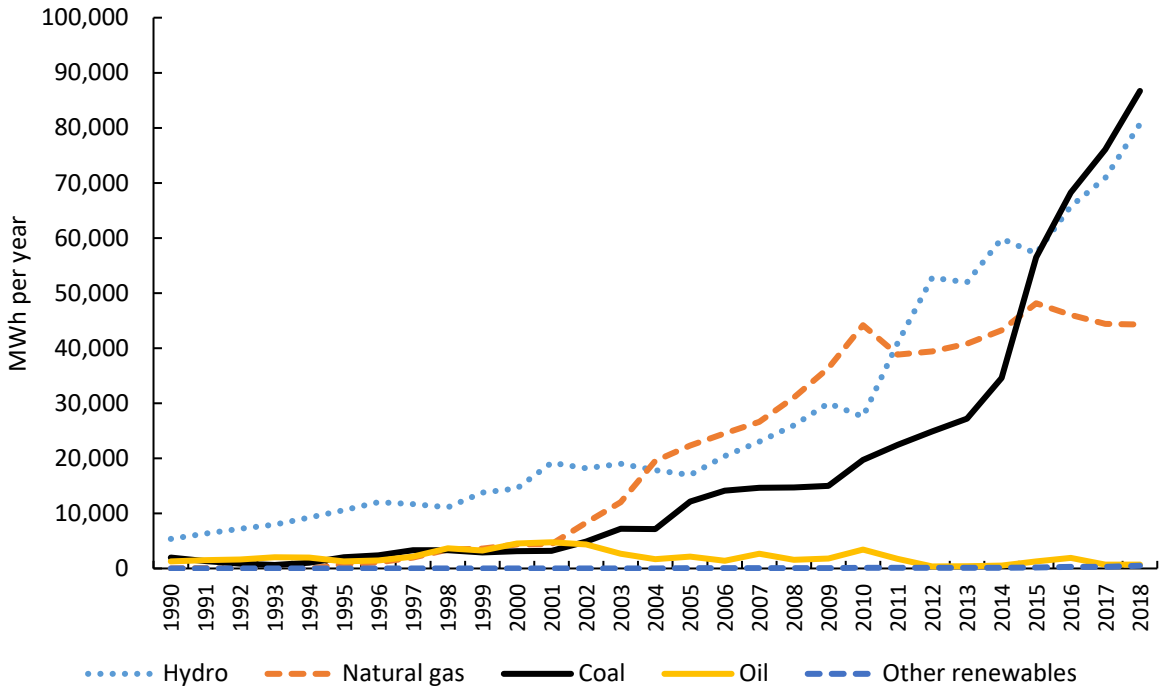

Figure 3. Electricity generation by source, 1990–2018.
Source: IEA (2018); BP (2019a).

The Government of Vietnam has issued several relevant laws and policy measures for the electricity sector. These include the Law on Energy Efficiency and Conservation in 2010; the Electricity Law in 2012, which regulates electricity development planning, investment, and the electricity market; and a Renewable Energy Development Strategy in 2015, which sets renewable energy targets (EREA and DEA, 2019). The key electricity sector planning document is the revised National Power Development Plan for the period 2016–2020 with an orientation to 2030. This is known as Revised Power Development Plan 7.

According to this plan, electricity generation in Vietnam will mainly depend on fossil fuels for the foreseeable future. Coal and natural gas will account for the largest combined share of electricity generation capacity: 58% in 2020, 65% in 2025, and 57% in 2030. Aside from large-scale hydro, renewable energy – solar, wind, small-scale hydro, biomass, and other – is planned to contribute a minority share: 9.9% in 2020, 12.5% in 2025, and 21% in 2030. Vietnam's solar PV generation capacity has already exceeded the planned size of 850 MW by 2020. It is planned to increase this capacity to 12 GW by 2030 (Government of Vietnam, 2016a). The targets for the solar contribution to the electricity mix are 0.5% in 2020, 6% in 2030, and 20% in 2050 (Government of Vietnam, 2016a). As at the time of writing, Vietnam is currently in the process of finalizing Power Development Plan 8 for the period 2021–2030, which is expected to include revised and more ambitious solar targets. The target that is currently under discussion is 18 GW of solar generation capacity by 2030 (World Bank, 2019a).

2.2 Vietnam's solar PV sector

Vietnam's underlying solar potential provides ample opportunity for these planned contributions to be exceeded. The solar PV potential for utility-scale PV stations within 10 km of the existing power grid alone is estimated to be about 48 GW (Teske et al., 2019) which is

roughly equivalent to Vietnam's current electricity generation capacity (in nameplate capacity terms). Given that opportunities for rooftop solar PV and utility-scale installations further afield can also be realised, Vietnam certainly has substantial potential to increase the contribution of solar PV to the electricity system over time.

Growing prioritization of the renewables sector saw the Government of Vietnam introduce a FIT for onshore wind in 2011 (US$ 78/MWh) and then offshore wind in 2016 (US$ 98/MWh). From 2014 the FIT for biomass was set at US$ 58MW/h and for solid waste landfill and biogas-fired power at US$ 72.8/MWh (Neefjes and Dang, 2017). The FIT for solar PV was introduced by Prime Minister Decision 11 in 2017 and allowed utility-scale and rooftop solar PV projects with a commercial date of operation prior to 30 June 2019 to receive a payment for their electricity of US$ 93.5/MWh over the next 20 years (Government of Vietnam, 2017). The FIT is often referred to as a trial solar FIT given the short time window for project eligibility and the fact that a key aim was to test the market's interest in solar power in Vietnam.

The solar FIT was attractive to many investors. Lee et al. (2019) estimated that the average LCOE for solar PV in Vietnam – when excluding protected areas, waterbodies, forested areas, agricultural areas, urban areas, and areas with a slope greater than 5% – is around US$ 87.5/MWh. Because the most attractive projects are developed first, actual projects that have been developed would be expected to have had a lower LCOE than this. One can thus understand how attractive the trial solar PV FIT of US$ 93.5/MWh was to project developers in the best locations in Vietnam, especially in the sunny central and southern regions. The exact expected rate of return would differ for each project, and is heavily influenced by factors such the solar resource, land costs, and the expected rate of curtailment of electricity for each site.

Vietnam's trial solar FIT period saw the first substantial investment in solar generation capacity in the country. As of 30 June 2019, the majority of this solar capacity was in the form of ground-mounted utility-scale solar PV projects with capacities exceeding 1 MW. 87 utility-scale solar projects had been put into operation, mostly in the central and southern regions (Figure 4). The biggest project was Dau Tieng in Tay Ninh Province, which has a capacity of 410 MW. Ninh Thuan is the province with the most projects (18), with a total installed capacity of 1,156 MW. This is thanks to good land availability and high solar irradiation in this province (Figure 5).

Domestic, commercial, and industrial rooftop solar accounts for only 4% of Vietnam's total installed solar electricity capacity (EVN, 2019). The rooftop sector is thus still nascent compared to for example that of Australia, where rooftop solar dominated the early stage of solar adoption. Including both rooftop and utility-scale installations, the solar share of national electricity generation capacity increased from only 0.002% in 2017 to 8% in June 2019 (Pham, 2019). However it should be kept in mind that solar PV tends to have a lower capacity factor than other generation capacity.

Figure 4. Utility-scale solar PV projects in Vietnam as of 30 June 2019. Source: DEVI (2019).

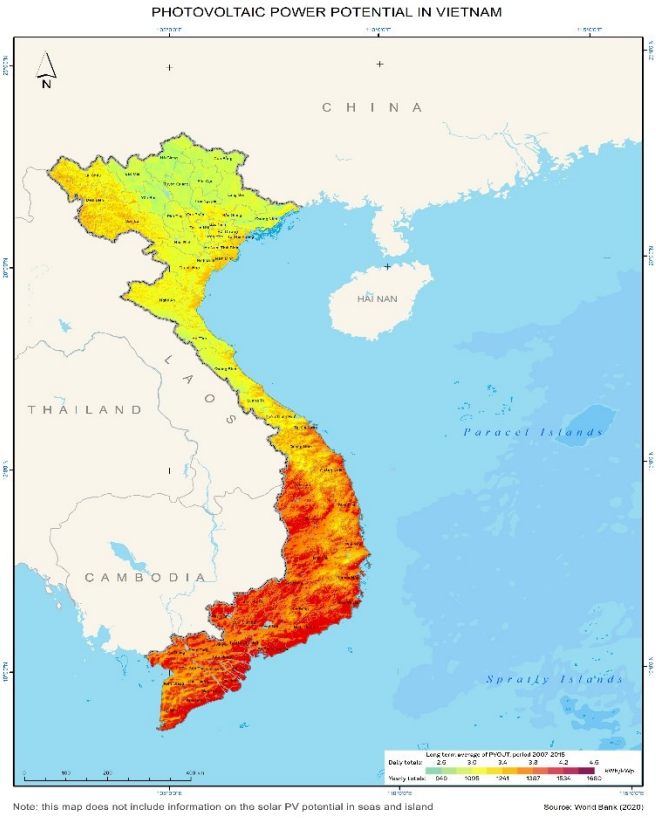

Figure 5. Solar irradiance in Vietnam. Source: World Bank (2020).

3. Methods

This paper uses an economic, social, and institutional framework to identify the drivers of and barriers to solar PV diffusion in Vietnam. Specifically, it follows an inductive approach using semi-structured interviews. This approach is suitable for qualitative policy analyses in the Vietnamese context for two reasons. First, data for quantitative analyses are limited, especially for such a recent issue as solar PV adoption. Second, the approach enables useful insights into the key issues, as voiced by industry experts. This type of approach has been recently used in other studies into energy and climate change policy issues in Vietnam (Zimmer et al., 2015; Urban et al., 2018).

Invitations for interviews were sent to government agencies under the Ministries of: Natural Resources and Environment; Industry and Trade; Planning and Investment; Finance; Science and Technology; and Construction. Invitations were also sent to the Party Central Economics Committee, the National Assembly's Science, and the Technology and Environment Commission. The World Bank, Asian Development Bank, GIZ, WWF, IUCN, local non-governmental organizations, university and research institutions, and industry were also sent invitations. The institutions were able to nominate representatives to attend the survey, with an institutional response rate of 68% being achieved. 46 interviews were carried out, with the language for the interviews being Vietnamese.

A focus group study was initially conducted with potential respondents to identify suitable interview methods and draft questionnaires. Then semi-structured, open-question interviews were carried out in September and October 2019 in Hanoi, Vietnam's capital city. The interviewees belonged to five groups: government agencies (16 interviewees), international organizations (5), non-governmental organizations (5), university and research institutions (9), and industry (11). Interviewees participated in an anonymous manner so as to facilitate open interactions. The standard questionnaire is provided in Appendix 1. Interviews typically developed into extended discussions in order to cover the key issues as identified by interviewees.

The interviewees were asked to identify and discuss the drivers and barriers of Vietnam's solar boom. Discussion points related to economic, technical, social, and institutional aspects, as identified by the focus group, were used to guide the interviews. The responses were then synthesized based on a majority rule. Drivers and barriers mentioned by less than 10% of respondents were considered minor and are not focused on here. Interviewees were also asked to identify and discuss policy options for promoting further development of Vietnam's solar PV sector. After the interviews we assessed the policy options mentioned in the interviews using criteria developed based on the scheme of IRENA (2014). We then presented the results to five experts drawn from the interviewee sample for their comments. We focused this assessment on three potential policy instruments under the government's consideration: a new FIT, reverse auctions for solar PV, and a renewable portfolio standard (RPS).

In addition to IRENA (2014)'s four criteria of effectiveness, efficiency, equity, and institutional feasibility, we also utilized another criterion: timeliness. Timeliness is particularly important when considering policy options in Vietnam given the country's need to meet a rapidly growing electricity demand and the desire to quickly unlock the benefits of solar PV. Definitions of the criteria were refined to facilitate respondents' comprehension as follows:

- Effectiveness: The extent to which intended objectives are met.
- Efficiency: The extent to which outputs are achieved at the least cost.
- Timeliness: How quickly the intended objectives can be met.
- Equity: The extent to which the proposed policy affects different stakeholders in a fair manner.
- Institutional feasibility: The extent to which the proposed policy can be implemented.

The interviews were complemented by desk reviews of academic and non-academic documents, including government reports and non-governmental publications.

4. Results and discussion

4.1 Drivers of the solar PV boom

4.1.1 Solar PV FIT and supporting factors

Our interviews reveal broad agreement that the government's policies have played an important role in influencing enterprises to invest in solar PV. In addition to the FIT, it was identified that the Government issued other supporting policies. First, solar PV developers have been allowed to mobilize funding from all sources, including foreign funding. Second, imported equipment has been exempted from import tariffs. Developers have also been exempted from income tax for the first four years, will receive a 50% reduction for the following nine years, and then a 10% reduction until the 15th year of operation. Third, solar PV projects have received land lease payment exemptions ranging from 14 years to the entire project life, depending on the location (Allens, 2019).

Other enabling factors include technology availability and low investment costs. Vietnam has benefited from imports of solar panels and other equipment from its neighbour, China – the world's biggest solar PV manufacturer. The mass production of solar PV in China for domestic and export markets has helped to drive down the costs of solar modules and other components, feeding into the solar installation boom in Vietnam (BP, 2019b).

4.1.2 Underlying drivers

One matter of interest is what the underlying conditions were for the setting of Vietnam's solar PV FIT. Drivers include both domestic and external factors.

Domestic factors

Interviewees ranked the government's commitment to energy security as the most important motivation for the introduction of the FIT (Figure 6). It had been projected that Vietnam will face an electricity shortage of 3.7–12 TWh per year as early as 2020, particularly in the south, where industrial and economic development is taking place rapidly (Ministry of Industry and Trade, 2019). Delays in new power projects are contributing to this issue, with 47 out of 62 new power projects facing delays due to a mismatch between general planning and electricity development planning, a lack of funding, difficulties in land clearance, and complex administrative procedures. The government has been motivated to take steps to promote new power sources. Solar PV is highly viable thanks to rapid technological improvement and associated cost reductions.

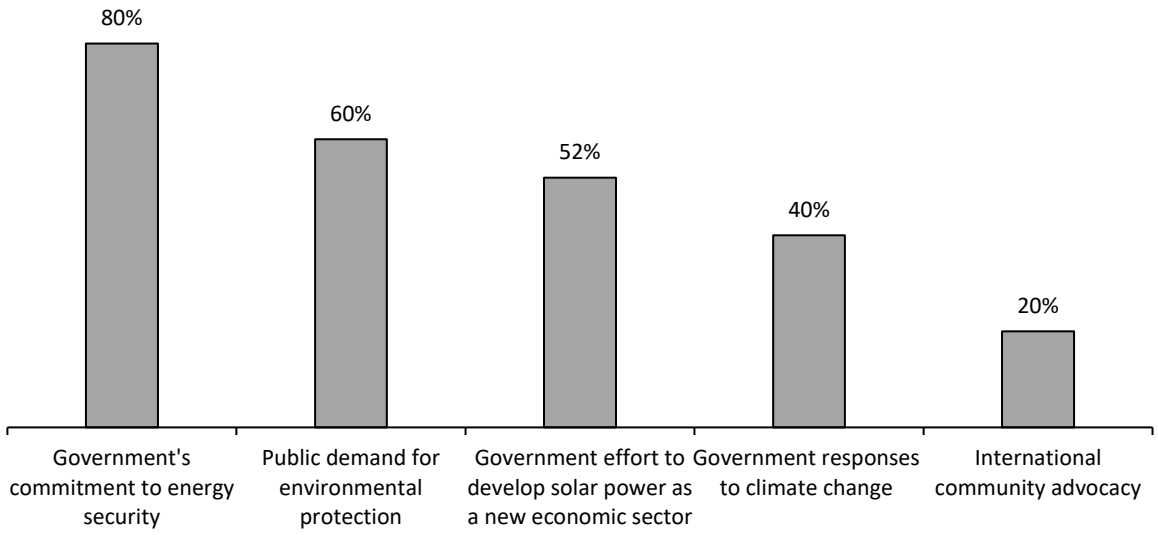

Figure 6. Key drivers for Vietnam's solar PV FIT policy (% of respondents). Source: Interviews. Note: Interviewees could identify more than one drivers.

Interviewees ranked public demand for environmental protection as the second-most important driver. Recently, air pollution in many urban areas has triggered public opposition to the development of new coal power plants. Indeed, coal pollution is estimated to cause about 4,300 premature deaths per year in Vietnam (Ha-Duong et al., 2017). It is common for local authorities to refuse to approve new coal power projects even when they have been included in the power development master plan (Ministry of Industry and Trade, 2019). For example, the Provincial People's Committee of Long An Province has proposed to the Prime Minister to cancel two approved coal-fired power station projects due to public opposition (Tuoi Tre, 2019a).

Another important driver for the solar FIT was the government's intention to develop solar power as a new economic sector. The key policy is the National Strategy for Green Growth of 2012, which has the specific objective of restructuring the economy by greening current sectors and promoting new economic sectors, including renewable energy. Following this, the Renewable Energy Development Strategy of 2015 detailed targets for developing the renewables sector, including for the domestic manufacturing of equipment. Promoting renewable energy, and solar power in particular, is considered to be one of the solutions for overcoming the middle-income trap (Zimmer et al., 2015; Urban et al., 2018; Shem et al., 2019).

External factors

Interviewees suggested that the government's commitment to responding to climate change also played a role in solar PV diffusion in Vietnam, although was of lesser importance than domestic factors. We classify climate change responses as an external factor given the global public good nature of slowing climate change. Climate change responses are legalized in the Law on Environmental Protection and detailed in the National Climate Change Strategy and the National Green Growth Strategy. Vietnam signed the Paris Agreement on Climate Change and has developed a National Action Plan on Implementing the Paris Agreement. Policies for

solar PV deployment are highlighted in the National Action Plan (Government of Vietnam, 2016b).

Vietnam's climate change mitigation targets are not highly ambitious, with commitments to an 8% or 25% reduction in greenhouse gas emissions by 2030 relative to business as usual without and with international assistance, respectively. The pegging of these targets to business as usual means that emissions can still grow. Emission targets for the energy sector are quite modest: reductions of only 4.4% (unconditional) or 9.8% (conditional) relative to business as usual (Neefjes and Dang, 2017). The electricity sector accounts for 38% of Vietnam's CO_2 emissions (International Energy Agency, 2018), but because the business-as-usual trajectory is thought to have been coal-intensive it is quite easy to achieve emissions reductions in this sector. Altogether, our interviewees considered climate change motivations as not being among the key drivers for the introduction of the solar FIT and for Vietnam's 2019 solar boom, even if the adoption of solar PV will play a major role in meeting Vietnam's commitments under the Paris Agreement.

International advocacy for renewable energy has been another catalyst for solar PV adoption. International organisations that are active in Vietnam include the German Corporation for International Cooperation (GIZ), the World Bank (WB), and the Asian Development Bank (ADB). These organizations have provided technical assistance such as via GIZ's Renewable Energy and Energy Efficiency project and the ADB's Enhancing Readiness for Solar Power Deployment in Vietnam project. Financial assistance has included the WB's Vietnam Renewable Energy Development project. Other international organisations that are actively advocating for solar PV development in Vietnam include the World Wide Fund for Nature, the Global Green Growth Institute, and the International Union of Conservation for Nature.

Altogether we conclude that concerns about energy security and meeting energy demand, as well as local air pollution, have been the primary motivations for government efforts to encourage the adoption of solar PV. This conclusion is consistent with the findings of Stadelmann and Castro (2014)'s quantitative study of 112 developing and emerging countries. They concluded that domestic factors tend to play a larger role than international factors in policy adoption for renewable energy in developing countries. Our interviewees believed that the key drivers of the solar sector's development apply to both utility-scale and rooftop solar PV diffusion in Vietnam.

4.2 Barriers for further development of solar PV

Our interviewees identified that utility-scale solar PV faces a larger number of barriers than rooftop solar PV in Vietnam. In addition, the key barriers differ for each. Limited transmission capacity and complex administrative procedures were identified as the most important barriers for utility-scale solar PV. High upfront costs and a lack of technical information and assistance loomed large for rooftop solar PV (Table 1).

Table 1. Ranking barriers to utility and rooftop solar PV.

Barriers	Utility (% of responses)	Rooftop (% of responses)	Type of barrier
Limited transmission capacity	1st (63%)	NA	Technical
Complex procedure	2nd (52%)	3rd (24%)	Institutional
Regulation mismatch	3rd (50%)	NA	Institutional
Policy uncertainty	4th (32%)	4th (22%)	Institutional
Entrenched fossil fuel industry	5th (23%)	NA	Institutional
Fossil fuel subsidy	6th (21%)	NA	Economic
Low foreign investment attractiveness	7th (15%)	NA	Economic
Lack of communication with local community	8th (11%)	NA	Social
High upfront costs	NA	1st (65%)	Economic
Lack of technical information and assistance	NA	2nd (46%)	Technical

Note: 1st is the most important. Interviewees could identify more than one barrier.
NA = not applicable.

4.2.1 Utility-scale solar

Technical barriers

Inadequate transmission infrastructure is seen as the most important barrier to solar PV development in Vietnam. There is no clear link between the Revised Power Development Master Plan 7 and Vietnam's Solar Master Plan (World Bank, 2019a), and the rapid diffusion of solar PV in the southern and central provinces, including Ninh Thuan and Binh Thuan, has led to some real issues related to the overload of transmission grids. In Ninh Thuan, the 18 existing solar power plants faced curtailment rates of about 60% in early July 2019, incurring financial losses as a result (Nang Luong Tai Tao, 2019).

Grid improvement requires large investment expenditure and will take time. It is estimated that Vietnam will in any case need about US$ 2.5 billion per year to upgrade its system to meet growing demand for electricity (GOV, 2016a; VBF, 2019). Due to fairly high public debt, the government has recently tightened public borrowing and ceased government guarantees, and it is becoming somewhat more difficult to access foreign funding for government borrowing (Ministry of Industry and Trade, 2019). Site clearance difficulties, compensation processes for displaced residents, and administrative procedures mean that it usually takes 3–5 years to complete a transmission grid project. Building a solar power plant is typically much faster, at often only about 6 months. In the absence of adequate pre-planning and zoning, there is thus an underlying tension.

Curtailment of solar PV has been seen in other countries also, for example India and Indonesia (Burke et al., 2019). Alagappan et al. (2011) pointed out that transmission planning and renewable energy development is a chicken-and-egg problem. Transmission providers are reluctant to build transmission until they know where generation capacity will be located and how much it will be producing. In turn, power developers often choose locations with good transmission grids to site their projects. Although the solar PV developers were aware of curtailment risks, as their power purchase agreements (PPAs) did not require EVN to buy all

of the generated power from the developers, they reportedly held out hope that the risks would be small. Another implicit assumption is that they could negotiate with EVN to dispatch their generated electricity on something like a first-come first-served basis once their projects were in operation. Importantly, EVN was not ready to incorporate a large volume of solar PV given system limitations and the need to update its operational systems for handling intermittency.

Institutional barriers

Complex administrative procedures are another key barrier. An investor needs to go through 17 administrative steps to start a solar project in Vietnam (World Bank, 2019b). These can be classified into investment approval, environmental impact assessment appraisal, fire prevention appraisal, construction licence processes, and grid connection and electricity sale approvals. Consultations with government agencies are needed for each step, which takes time. The most complex step is inclusion in the national power development master plan, which requires both provincial and national approval. At the provincial level, a project needs to be approved by the provincial Department of Industry and Trade and then the Provincial People's Committee. At the national level, approval is required by the Ministry of Industry and Trade (MOIT) for projects of 50 MW and under. For projects over 50 MW, approval is also needed from the Prime Minister (Ministry of Industry and Trade, 2017).

In addition to slowing solar PV project development, complex procedures result in two types of inefficiency. First, developers seek to avoid complexity by designing projects under 50 MW, which can add to overall costs across the system. Of 87 approved existing projects, only 12 had a capacity above 50 MW. Second, administrative complexity disincentivizes foreign investors from participating. Foreign investors typically need to buy licences from local developers who often lack the capital and expertise to build large-scale projects, but act as a broker and often impose up to a 20% surcharge (Dapice, 2018). This raises project costs for the parties that will actually develop the solar project, and poses the risk of prolonging project development. Transaction costs due to highly complex administrative procedures may account for about one-third of the project costs faced by solar developers (Vietnamplus, 2019).

Mismatches between regulations have also impeded solar PV diffusion. Most notably, there is a lack of harmony between power development master plans and the planning law. The Planning Law of 2019 stipulates that all sectoral master plans, including power development master plans, shall be reviewed and updated only every five years. This prevents regular inclusion of new solar projects, leading to delays (Ministry of Industry and Trade, 2019). It has also impeded the development of transmission grids. A more time-responsive process for new projects would be better suited to fostering rapid solar uptake.

Policy uncertainty has also discouraged businesses. Since early 2019, several rather different drafts for the next phase of solar PV tariffs have been proposed by the MOIT. Early drafts proposed different FITs for four zones, with zones with higher irradiation receiving lower FITs. Later drafts proposed FITs that vary by technology rather than zone. Rooftop solar PV was proposed to receive a FIT of US$ 93.5/MWh, while ground-mounted utility-scale solar PV would receive US$ 70.9/MWh and floating utility-scale PV would receive US$ 76.9/MWh. Taking investors by surprise, the Prime Minister then assigned the MOIT to develop a policy for reverse auctions for utility-scale solar PV. A national strategy for solar PV development has been in consideration for several years, but not yet been issued. As of early March 2020, it

is unknown when a new solar PV policy will be issued and what pricing mechanism it will entail.

Another barrier is from advantages given to fossil fuel power projects. EVN has been relying on coal and gas for decades and is reluctant to accommodate new energy sources such as solar PV, as this would involve costs in updating operational systems. External funding, mainly from China's Belt and Road initiative, has also typically been pro-coal (Southern Post, 2019). For example, Chinese banks provided US$ 9.3 billion in funding for 14 coal-fired power plants in Vietnam over 2000–2018. Solar PV project developers are also responsible for building transmission lines from their projects to the national grid. They have to negotiate with each landholder along the transmission route and acquire or rent the land, which adds substantially to project costs (Dapice, 2018). For coal-fired projects, transmission line costs have historically been shared with EVN (Breu et al., 2019). Solar PV projects thus tend to face higher investment risks than coal and gas projects in the form of curtailment, lower government guarantees, and higher transmission and interconnection risks (Breu et al., 2019).

Economic barriers

Sizable and persistent fossil fuel subsidies also exist. Subsidies for coal are often indirect, in the form of efforts to keep the price of domestic coal used in electricity production below international market prices (thus encouraging coal use), subsidizing coal transport infrastructure, lax environmental regulations, and low-interest credit (Neefjes and Dang, 2017; Le, 2019). Although fossil fuel subsidies for electricity in Vietnam decreased after the government's National Green Growth Strategy was released in 2012, they have increased again since 2016, reaching US$ 259 million in 2018 according to data from the IEA (2018).

According to BloombergNEF's Climatescope assessment of 103 markets worldwide on their ability to attract capital for low carbon energy development, Vietnam is ranked 43rd – below China (2nd), Philippines (6th), India (7th), and Thailand (10th) (REN21, 2019). Vietnam also performs quite poorly in the World Bank's Ease of Doing Business Index, ranked 115th out of 190 countries (World Bank, 2019c) in terms of the ease of starting a business. Solar PV PPAs face bankability problems due to reasons including that take-or-pay obligations currently do not exist for EVN. To date, funding for solar projects has mainly been from local banks, which have limited financing capacity (Breu et al., 2019; Dapice, 2018).

Social barriers

Difficulties in communication and negotiation between developers and local communities are also an issue. Project developers are responsible for compensating landholders, but opposition can occur. For example, local people blocked the road to the Hacom Solar Project in Ninh Thuan Province because they had not agreed with the land acquisition process (Tuoi Tre, 2019b). Another example is local people protesting to stop a 50 MW floating solar project in Phu My, Binh Dinh Province because both they were not adequately informed of the project details and were concerned about potential pollution of the lagoon (Dan Tri, 2019). It is important that local communities are adequately engaged in renewables projects. A lack of engagement with local communities has been identified as a barrier to renewable energy adoption in other countries (Viardot, 2013).

4.2.2 Rooftop solar PV

Economic barriers

The interviews identified the key barriers to rooftop solar PV as high upfront costs faced by households, limited technical information and assistance, complex administrative procedures, and uncertain solar PV policies. On average, a rooftop solar PV installation in Vietnam costs around US$ 1,117 per kW (Lee et al., 2019). A 3 kW system thus costs about US$ 3,350, equal to about 130% of Vietnam's annual per capita GDP (World Bank, 2019d). By comparison, a 3kW solar system in Australia costs about US$ 2,720 (SolarQuotes, 2019), or only about 5% of annual GDP per capita (World Bank, 2019e).

Technical barriers

The interviews revealed that potential rooftop solar PV customers are concerned about a lack of credible information about rooftop solar systems (Baulch et al., 2018). In particular, they are puzzled about the quality and reliability of solar PV systems as well as of service providers (Solar Magazine, 2019). Rooftop solar PV is perceived to be a high-risk investment, with users only tending to become more convinced about the benefits after using it or seeing demonstrated success (Viardot, 2013). Some rooftops are also technically unsuitable for solar PV due to obstructions and weak roofing. In densely-populated areas, rooftops tend to be highly fragmented in that there are many buildings that cover only small surface areas. In the cities of Ho Chi Minh City and Da Nang, rooftop solar PV has been estimated to be suitable for only about one-sixth of the available roof space (World Bank, 2019b).

Institutional barriers

Rooftop PV faces complex administrative procedures and uncertain policies. While procedures are simpler than for utility-scale solar, projects are still subject to five administrative steps. Customers who want to install rooftop PV often need to handle administrative procedures by themselves or pay extra costs to installation companies. In most cases, customers find it difficult to go through this process themselves. The most difficult step is passing the technical requirements set by EVN subsidiaries. While demand for third-party roof leasing exists, procedures facilitating this process remain absent.

4.3 Strategies for further adoption of solar PV

4.3.1 Direct instruments: reverse auctions, RPS or FIT?

Given the current policy vacuum following the expiry of the solar FIT in June 2019, a next step in solar PV policies is needed. Three potential options are reverse auctions, an RPS, and a continued FIT, likely to be set at a new rate. Interviewees were asked for their expert views on the most appropriate way forward.

A reverse auction is a mechanism through which long-term PPAs are signed based on a feed-in price decided on the basis of the lowest submitted bids (Haufe et al., 2018). Internationally, reverse auctions are now becoming the most popular instrument for renewables procurement, with about 100 countries having held a renewable energy reverse auction by 2019 (International Renewable Energy Agency, 2019). Australia was among the leaders in introducing reverse auctions (Baldwin et al., 2018), and the mechanism has contributed to significant price

reductions under contract-for-difference arrangements. The approach has also been highly successful in driving down prices in countries such as China and India (REN21, 2019).

However, reverse auctions rely on having a robust institutional capacity, a large number of market-ready projects, and a competitive pool of qualified bidders (Guild, 2019). In Vietnam, the supporting regulatory infrastructure for reverse auctions is yet to be put in place. One quite likely problem would be that contractors go on to offer low bids and then ask for more funding later on, as has happened for infrastructure projects such as Hanoi's light rail system. This can lead to serious delays. In addition, current regulations stipulate that developers of grid-connected solar PV projects can only finance projects that have been included in power development plans. This often takes years.

An RPS is a statutory obligation requiring a utility to achieve a certain percentage of generation from renewables (Chang et al., 2016). This can be achieved by producing renewable energy directly, by purchasing renewable energy from another supplier, or by buying renewable energy credits if these are allowed. Establishing a well-functioning RPS would take time in Vietnam, as the country has yet to have any experience with green certificate trading schemes. Challenges in monitoring, reporting, and verification would also need to be confronted.

Our interviews suggest that the most straightforward next step to facilitate the development of Vietnam's solar PV industry would be to have a new FIT (Table 2). In its two-year trial to date, the solar FIT has been found to have provided confidence to investors and to work quite well in the Vietnamese context. We summarize that the FIT ranks well in terms of its effectiveness and timeliness, and medium on efficiency, equity, and institutional feasibility. An auction mechanism is ranked 2nd, having medium effectiveness, high efficiency, poor timeliness, medium equity, and low institutional feasibility. The RPS is assessed as the least suitable of the mechanisms at the present time in Vietnam, scoring poorly in terms of timeliness and institutional feasibility. While Australia's RPS shows that the approach certainly can work well (Best et al., 2019), it would take time for a well-functioning RPS to be established in Vietnam.

Table 2. Ranking direct solar PV promoting policy instruments for Vietnam

Criteria	**FIT**	**Reverse auction**	**RPS**
Effectiveness	High	Medium	Medium
Efficiency	Medium	High	Medium
Timeliness	High	Low	Low
Equity	Medium	Medium	Medium
Institutional feasibility	Medium	Low	Low
Overall ranking	1st	2nd	3rd

A caution is that if a new FIT is set too high, it could trigger another solar PV investment rush, which could worsen short-term grid capacity concerns – in addition to overburdening EVN in terms of payments. One way forward is for a new FIT of around US$ 70/MWh to be applied to new solar power projects that have already received investment licences, which is the approach that is currently proposed by MOIT (Vnexpress, 2020). An advantage of extending the FIT rather than moving to a system of reverse auctions is that this would be more like a continuation of the conditions under which these already-licensed projects were planned for.

One option is for Vietnam's fixed 20-year FIT to be designed to progressively reduce over time in order to be compatible with the expected decline in solar PV costs, similar to the approach

followed in countries such as Germany (Hoppmann et al., 2014). What this means is that projects signed up at a later date would receive a lower (but still fixed) 20-year FIT. It also makes sense for regulations to be reviewed and revised to facilitate an eventual transition to a reverse auction mechanism, as the competitive pressures of reverse auctions help to ensure the lowest-price acquisition of renewable energy.

4.3.2 Other policies

Developing renewable energy zones

One opportunity is for Vietnam to begin to develop renewable energy zones in the most prospective provinces for renewable energy generation. This includes provinces with high-quality variable renewable energy resources, suitable topography and land availability, and proximity to transmission lines and demand centers. Provinces such as Ninh Thuan and Binh Thuan are particularly suitable. Floating solar could also be considered within the context of renewable energy zones. Such projects can help to mitigate land requirements, better facilitate the integration of hydropower and solar power, and improve energy yields thanks to the cooling effects of water (World Bank, 2019f).

The renewable energy zone approach would facilitate transmission investment planning and the management of curtailment risks. Project developers could also save on costs for grid integration studies if these are made available to all market participants in a renewable energy zone. Solar parks are also an option for renewable energy zones. Solar parks involve a government agency selecting and preparing project sites, and then inviting competitive bidding for solar power from these sites (World Bank, 2019a). Countries such as Australia and India have been pursuing various forms of the renewable energy zone approach (Australian Electricity Market Commission, 2019).

Revising other regulations

Article 4 Point 2 of the Law Electricity Law 2018 states “The government solely manages transmission grids”. Yet without private sector contributions, it will be challenging to improve Vietnam’s transmission grid to the extent needed to enable large-scale adoption of solar PV. This is due to constraints faced by the state budget and in borrowing. A regulation issued by the Government providing guidance for private sector investment in transmission grids, while retaining EVN’s grid management responsibility, would be timely and feasible.

Point 11 Article 11 of the Law on Electricity 2018 states that new power projects shall be implemented only after being included in power development master plans. There is an opportunity for this requirement to be revised to enable new solar PV projects to be quickly incorporated into plans, as some flexibility over project allocation in the power development master plans would ensure that the inclusion of new projects does not become a bottleneck. Also, an enabling legal framework for competitive selection of independent power producers in the energy market would facilitate reverse auctions (World Bank, 2019a). Other priorities include simplifying administrative procedures for solar PV projects and strengthening the bankability of PPAs by reducing off-take risks. More secure PPAs would allow cheaper international lending rates for longer periods. A new law on renewable energy could potentially be developed to provide a comprehensive and stable legal framework for solar PV.

Energy storage

An important priority for facilitating solar PV development is energy storage. Vietnam has many potential sites for pumped-hydro energy storage (Australian National University, 2019). Batteries have also become increasingly attractive as grid-management tools. Endowed with large reserves of bauxite and titanium, together with strong manufacturing capabilities, Vietnam also stands a chance of attracting further investment in the battery manufacturing industry (ClimateWorks, 2019).

Subsidy reforms

Our interviews indicated strong agreement that fossil fuel subsidy reductions would assist in removing barriers to solar PV adoption. Removing implicit subsidies for fossil fuels would help bring the cost of production closer to the actual cost of generation. Recent negative sentiment against coal-fired power plants and anti-corruption campaigns against the biggest fossil fuel groups (Petrol Vietnam and Vinacomin) are likely to help make fossil fuel subsidy reductions more politically saleable than perhaps they were in the past.

In the meantime, there is the potential for solar PV subsidies to be increased and/or rechannelled, particularly for rooftop systems. At present, subsidies for rooftop solar PV are implemented under Decision 2023/QD-BCT dated 5/7/2019 on the Program for Promoting Rooftop Solar PV period 2019–2025. Under this scheme, households receive a grant of VND 3–9 million (US$ 135–405) for each kW of rooftop solar PV that is installed by 2021. This is to support the target of 1 GW of rooftop solar by 2025. One potential is to introduce some support for market facilitation, including safety initiatives and the provision of information.

Carbon pricing

Carbon pricing, via an emission-trading scheme (ETS) and/or a carbon tax, is another option for Vietnam. This would help to internalize greenhouse gas emission costs into the cost of electricity generation and hence help low-emission technologies such as solar PV become more competitive (Le, 2019).

The choice between an ETS or carbon tax depends on each country's context. In the region, China and Korea have applied an ETS, while Japan and Singapore have introduced a carbon tax (World Bank, 2019g). An ETS is listed as a priority measure for implementing Vietnam's nationally determined contribution under the Paris Agreement (Government of Vietnam, 2016b), and its establishment is being studied under a WB-supported Partnership for Market Readiness project. However, recommendations have converged that carbon trading will not be suitable until after 2025. Ideal conditions for an ETS require adequate administrative capability, capacity in emissions monitoring and enforcement, as well as a properly-functioning market economy that allows price pass-through mechanisms in key sectors such as electricity generation (Wang et al., 2019). These conditions are not yet adequately met in Vietnam.

While on some of these criteria a carbon tax performs no better than an ETS, a carbon tax would involve somewhat less administrative complexity, as trading of permits can be avoided. A carbon tax could also potentially be integrated into the existing environmental protection tax scheme, making it easier to introduce than an ETS. Government agencies are familiar with collecting taxes in Vietnam, but have less experience in trading mechanisms. Altogether, a carbon tax was seen by our interviewees as having greater potential, especially if the political

unpopularity of a new tax could be overcome. Smart scheme designs, and the use of a term such as "charge" or "fee" instead of "tax", may help (Michaelowa et al., 2018).

Other supporting policies

Further solar PV adoption could be supported in various other ways. Incentives for electrification of sectors such as transport and industry would lead to faster growth in electricity demand, which would expand the opportunities for solar energy, including commercial and industrial rooftop solar. There are many opportunities for the development of hybrids of utility-scale and rooftop solar PV, for example medium-scale applications in large industrial zones. Policies and frameworks to help facilitate the up-take of such applications would be important. Improved grid flexibility, including increased used of local real-time electricity pricing and storage and smart grid technologies, would help the integration of solar energy. Research and development could also focus on innovative solutions such as virtual power stations and responsive demand-side management (Teske et al., 2019). Strengthened climate policy, including more ambitious emissions reduction targets and stricter enforcement of targets, would also promote the prioritization of solar PV.

5. Conclusions and policy implications

Vietnam experienced a remarkable boom in its solar PV sector in 2019. Using an economic, social, and institutional framework and information from 46 interviews, this paper investigated drivers and barriers of this solar PV boom. It was found that a generous FIT of US$ 93.5/MWh, together with supporting policies such as tax exemptions, have been the key proximate drivers of the solar PV investment. Underlying drivers include the government's determination to ensure sufficient local electricity supply to cope with increasing power demand, public demand for local environmental quality, and the government's intention to develop solar power as a new economic sector. Climate change policy and advocacy from international organizations have also played contributory roles.

The main barriers for the diffusion of utility-scale solar PV in Vietnam were identified as being limited transmission grid capacity and complex administrative procedures, especially for foreign investors who are unfamiliar with domestic legal systems and have few direct connections with local authorities. Other barriers include regulation mismatches, policy uncertainties, an entrenched fossil fuel industry, fossil fuel subsidies, occasional (and perhaps well-justified) resistance from local communities, and low foreign investment attractiveness. Rooftop solar was found to be slowed by factors including high upfront investment requirements and limited technical information.

Our discussions relate to the two-year trial period of Vietnam's solar FIT. We focused predominantly on the supply side of Vietnam's solar PV boom. Investigating the demand side in the wholesale market, for example EVN's perceptions of solar PV, the extent to which EVN can integrate solar PV without causing system instability, and the overall fiscal impact of high-level solar PV integration on pricing, could be fruitful topics for further research.

A new, lower FIT appears to be the best fit for the next phase of Vietnam's solar PV pricing. Regulations could also be revised to enable private sector investment in upgrading transmission grids. Reforms to administrative procedures, strengthening the bankability of PPAs by reducing off-take risks, reducing fossil fuel subsidies, and introducing a carbon emission fee

are also attractive options. The government could also consider enacting a law on renewable energy to provide a comprehensive and stable legal framework for solar PV.

Vietnam provides a demonstration of the ability for the solar PV sector to boom in a developing country context when the financial and institutional conditions are adequately attractive. A secure FIT can play a key role in this process, and in a way that involves a greater degree of administrative simplicity than mechanisms such as a tradable renewable energy certificate market. There are many opportunities for solar PV uptake to continue to grow. However, Vietnam has only taken the first step on its journey towards increased use of solar energy. Challenges in sustaining solar-sector investments over a multi-year time horizon and successfully integrating large quantities of solar energy into the grid remain ahead.

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Appendix 1. Questionnaire (English version; the original was in Vietnamese)

Drivers and Barriers of Solar PV Recent Boom

This is part of a study conducted by the Australian National University and the Vietnam Institute of Strategy and Policy on Natural Resources and Environment. The questions are to facilitate semi-structured discussions.

Responses will be used for the study only. Respondents are anonymous.

1. How much do you know about the recent solar PV diffusion in Vietnam?
   (Tick the most appropriate box)

1 (nothing)	2 (little)	3 (somewhat)	4 (a lot)	5 (very well)

2. In your opinion, what were the reasons for the government to issue the feed-in tariff?[3]

3. In addition to the FIT, what were the supporting factors for the solar PV development?[4]

4. In your opinion, what are the key barriers for future solar PV development in Vietnam?[5]

   - For utility scale
   - For rooftop

5. Do you think the government should continue to promote solar PV?

   - Yes
   - No
   - No response:
   - Reasons:

6. What policies are needed to further develop solar PV in Vietnam?[6]

The following section is optional
Name:
Position: Institution:

[3] Discussion points: energy security, climate change, international advocacy, environmental protection demand, economic factors, and so on.
[4] Discussion points: technologies, tax policies, investment environment, financing, and so on.
[5] Discussion points: economic, social, institutional, legal, administrative, technical aspects, and so on.
[6] Discussion points: FIT, reverse auction, RPS, taxes and subsidies, regulations, and so on.