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Assessing the Impact of Feed-in Tariffs and Renewable Portfolio Standards on the Development of Solar Photovoltaic in Vietnam – Opportunities and Challenges

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Abstract

Vietnam has recently become a leader in solar energy in the Southeast Asia region. This development is boosted by pressing domestic demand for energy as well as international commitment to reducing carbon emissions and combatting climate change. The Government of Vietnam plays a pivotal role in leading this transition to renewable energy by directing the growth through renewable energy policies. Among the policies, feed-in tariffs and renewable portfolio standards are found to be the most influential policies. This paper assesses the effectiveness of these two instruments on the development of solar photovoltaic (PV) in Vietnam. Using regression models and an interview with an industry insider, it is found that the enactment of FIT and RPS has greatly enhanced solar PV capacity. Furthermore, the current policy landscape presents Vietnam with various opportunities to continue this development, but also challenges to overcome, prompting suggestions for future development.

Keywords solar photovoltaic, feed-in tariffs, renewable portfolio standards, Vietnam

Table of contents

Preface and acknowledgements

I would like to send my gratitude to my thesis supervisor, Tapio Ranta, for his good advice and guidance. I would also thank Ms. Khe Nguyen of Levanta Renewables for agreeing to participate in this research.

I also want to thank my friends and family for their support.

Mikkeli, 14 April 2024
Nguyen Vo

Symbols and abbreviations

Symbols

LN_CAPACITY	logarithm expression of total solar photovoltaic capacity
LN_ADDEDCAP	logarithm expression of annual addition of solar photovoltaic capacity
TARIFF	feed-in tariff rate
DURATION	feed-in tariff contract duration
QUOTA	renewable portfolio standard quota
β_i	regression coefficient
ε_i	error term

Abbreviations

RE	Renewable energy
FIT(s)	Feed-in Tariff(s)
RPS	Renewable Portfolio Standard
PV	Photovoltaic

1 Introduction

The global pledge to reduce carbon emissions and limit global warming has compelled the development of renewable energy (RE) to be a cornerstone to achieve this dual goal. Central to this effort is the Paris Agreement which sets a limit of 2 degrees Celsius above pre-industrial levels for global warming, achieved primarily through reducing greenhouse gas emissions (United Nations, n.d.). Meeting these objectives necessitates the worldwide renewable energy to triple by 2030 (COP28, 2023). This increase of RE must be accompanied by a simultaneous phase down of fossil-based energy, signaling a significant shift towards more sustainable energy sources.

In alignment with this global imperative, Vietnam has pledged to achieve net-zero by 2050 and transition from a heavily fossil-reliant to a green energy economy (Vietnam Briefing, 2021), aiming to decarbonizing the power sector by around 78% (McKinsey and Company, 2023). Given its geographical advantages, particularly in solar irradiance, the country possesses remarkable potential to harness solar energy to bolster this transition. However, this potential is not officially realized until the issuance of the Renewable Energy Development Strategy in 2015 and the subsequent enactment of feed-in tariff (FIT) in 2017 that spurred the rapid development of solar photovoltaic (PV), positioning Vietnam as a regional leader in this domain.

This instance illustrates the critical reliance of RE in general, and solar PV in particular, on government support to thrive. Hence, this study sets out to study the effectiveness of policy instruments, especially feed-in tariff (FIT) and renewable portfolio standards (RPS) on the development of solar PV in Vietnam.

The paper aims to bridge a significant gap in the existing literature. While the impact of FIT and RPS has been thoroughly research within the context of countries with long-established RE industry, research focusing on emerging economies like Vietnam is still scarce. Additionally, studies that focus on Vietnam has been primarily conducted as policy review or qualitative analysis. By filling in this gap, this paper hopes to contribute to a more comprehensive understanding of the dynamic between essential policy instruments and solar PV development using both quantitative and qualitative analyses, thereby providing a more all-rounded assessment.

This thesis is structured as follows: Section 2 presents a comprehensive literature review to outline key themes and arguments; Section 3 maps out the methodology for the research; Section 4 presents the findings, followed by an in-depth discussion in section 5. Finally, section 6 concludes the paper, providing implications for international business and future studies.

1.1 Research problems

The issuance of RE policies in Vietnam has resulted in a fast-paced development of solar PV energy since 2017, signifying the importance of government support for a successful transition to a renewable-based economy. However, this momentum has significantly slowed down in the early 2020s despite the continuation of supportive policies. Therefore, it is important to assess the impact of these policies through both empirical means as well as practical insights from industrial specialist for the most comprehensive understanding of the current landscape for solar PV development.

1.2 Research questions

To breakdown the research problem, following are the questions that this research aims to answer:

1. How effective are FIT and RPS in stimulating solar PV capacity growth in Vietnam?
2. How do specific design elements of FIT and RPS influence solar PV capacity?
3. What are the opportunities and challenges to developing and investing in solar PV in Vietnam?

1.3 Research objectives

The objective of this research is to evaluate the impact of two RE policy instruments that are FIT and RPS on the growth of solar PV in Vietnam. In-depth research into their influences will lay a foundation to understanding the solar PV market in Vietnam by its opportunities and challenges. Drawing on the insights extracted from the literature review and the outcomes of following analyses, this study aims to offer recommendations to enhance solar PV growth in Vietnam as well as implications on the wider context of international business.

1.4 Main concepts and definitions

Renewable energy (RE): all forms of energy produced from renewable sources in a sustainable manner, which include, inter alia: bioenergy, geothermal energy, hydropower, ocean energy (tidal, wave and ocean thermal energy), solar energy, and wind energy (IRENA, 2009).

Solar photovoltaic (PV): electricity obtained directly from the conversion of solar energy (Sampaio and Gonzaléz, 2017).

Feed-in-Tariffs (FIT): a policy instruments that offers guaranteed prices for electricity through a fixed-term contract in order to stimulate investments into renewable energy projects (Couture and Gagnon, 2010).

Renewable portfolio standards (RPS): a statutory obligation that a utility company or consumers must provide a percentage of installed capacity from renewable energy sources (Chang et al., 2016).

2 Literature review

The aim of this literature review is to specify the area of focus and define the scope and boundaries of the research. The study of government's mandates on renewable energy investment encompasses many complex interactions between a wide variety of different actors, from governments to energy producers, financiers, and investors. Considering these complexities, it is imperative to establish a specific focus for the research. Hence, the focus of the study would be on the solar energy market in Vietnam, as well as the two most important policy instruments: Feed-in Tariffs (FITs) and Renewable Portfolio Standards (RPSs). However, it is important to understand the general context of the renewables status quo in Vietnam along with a brief overview of other relevant policies. Therefore, this literature review will gradually narrow from the broader context to the specific focus aforementioned. Such focus would help pinpoint the determinants pertaining to the research questions, thus form a foundation for the methodology of the study.

This literature review will first provide an overview of all policies pertinent to renewable energy investment. From that, research results of these policies' effectiveness will be synthesized, hence determining the most effective policies that would be the focus of this study. Determinants of policy effectiveness and policy design features will be discussed as well. The latter part of this section will review the energy status quo of Vietnam in general and in solar energy. Subsequently, studies on Vietnam's renewables policies will be discussed to provide a first glimpse on the extent to which Vietnamese government's policies has been effective in stimulating the development. Data used for the literature review is derived from relevant government documents, reports from reputable organizations, and research papers published in trusted journals.

For a brief, the main findings of this literature review are as following:

1. The determinant of renewables investment policies is whether they either mitigate the risk or increase the return of the investment, or both.
2. The specific design elements of the policies contribute greatly to their overall effectiveness in stimulating RE development.
3. Feed-in Tariffs (FIT) and Renewable Portfolio Standards (RPS) are the two most effective policies.
4. Vietnam's energy capacity, especially solar, has demonstrated an accelerated growth from late 2010s to early 2020s. The government of Vietnam has also enacted various policies to improve the renewable investment climate in the country.
5. The implementation of policy support has yielded many positive results for renewable energy growth in Vietnam. However, much

improvement is needed to eliminate the uncertainties in the current policy framework.

2.1 Taxonomy of policies

Criscuolo and Menon (2015) analyzed 9 environmental policies from the Renewable Energy Policy Network for the 21st Century (REN21) and categorized them into 4 main types: (1) price-driven policies (including feed-in tariffs), (2) quantity-driven policies (including renewable portfolio standards/quotas, tradable renewable certificates, and public competitive bidding), (3) sales tax and value-added tax reduction mechanism (including sales tax, energy taxes, excise tax or value-added tax reduction), and (4) fiscal incentives (including public investments, loans or financing, capital subsidies, consumer grants or rebates, investment or other tax credits, and energy production payments or tax credits). The categorization was based on the main mechanism through which a policy is enacted (for example, tradable renewable certificates indicate the certified generation of units of renewable energy (Criscuolo and Menon, 2015)). This approach provided a framework for comparing different policy instruments by understanding their direct effects. However, some overlap in between the categories was present. For instance, Feed-in Tariffs (FIT) can be classified as a price-based policy as it sets a fixed selling price for electricity, but it also functions as a fiscal instrument as it directly impacts public finances.

Advancing the discourse on this field, Polzin et al. (2019) conducted a systematic review of 96 different empirical studies, examining the impact of government policy instruments on renewable energy. The extensive analysis culminated a detailed synopsis of 18 different policy instruments, outnumbering the earlier synopsis by Criscuolo and Menon. Moreover, Polzin et. al leveraged the practice-typology provided IEA and IRENA and sorted the policies into their respective field of application, avoiding the overlap presented in Criscuolo and Menon's work. This results in a more nuanced and systematic overview of policies on renewable energy investment as presented in table 1.

Table 1: Taxonomy of policies. (Adapted from Polzin et al. (2019) in combination with author's own sources.)

Category	Sub-category	Instrument	Definition	Reference
Economic instruments	Public direct investment		Direct acquisition of renewable energy generation capacity by governmental authorities.	Criscuolo and Menon (2015)

Category	Sub-category	Instrument	Definition	Reference
	Fiscal and financial	Feed-in-tariff	Long-term agreement that guarantees a fixed price above market level for energy producers.	Couture and Gagnon (2010)
		Feed-in premium	Agreement of the provision of a premium on top of the market price	Criscuolo and Menon (2015)
		Auction for PPA	Tenders organized by public authorities for a given quota of renewable capacity/supply, where winning bids are compensated with prices above market level.	Criscuolo and Menon (2015)
		Production tax credit/relief	Offer of an annual tax credit to the investor/owner of an eligible asset - the tax credit is calculated based on the amount of energy produced during the respective year	Mitchell et al., (2011)
		Grants	Provision of one-time payments in the form of capital subsidies, consumer grants, or rebates to cover a portion of the capital cost of a renewable energy investment.	Criscuolo and Menon (2015)
		Subsidized investment loans/funds	Provision of ad hoc subsidies for investors.	Criscuolo and Menon (2015)
		Investment tax credit	Permission of complete or partial reduction of income tax liabilities for investment in renewable energy.	Criscuolo and Menon (2015)
		Guarantees	Guarantees for private renewable energy investors, e.g. guarantees to purchase all generated energy.	Becker and Fischer (2013)
		Carbon tax	Tax imposed on fossil fuels or carbon dioxide emissions with the goal of reducing carbon dioxide emission.	Abolhosseini and Heshmati (2015)

Category	Sub-category	Instrument	Definition	Reference
	Market-based	Carbon/GHG certificates	Tradable carbon/GHG permits	Schmidt et al. (2012)
		Green certificates	Tradable renewable energy certificates representing the certified units of renewable energy generated, enabling the trading of renewable energy obligations.	Criscuolo and Menon (2015)
Other instruments	Regulation	Quotas/RE portfolio standards	A statutory obligation that a utility company or consumers must provide a percentage of installed capacity from renewable energy sources.	Chang et al., (2016)
		Net metering	Regulated arrangements in which electricity customers only need to pay for the amount of total electricity consumption minus self-generated electricity	Chang et al. (2016)
		Tech standards	Standards that require actors to undertake specified measures and/or report on specific information	Mitchell et al., (2011)
		Grid preference	Policies that mandate renewable energy to be prioritized to be connected to the energy system before other supplies.	Mitchell et al., (2011)
	Other	Long-term targets/commitments	Steps in the process of developing, supporting and implementing policies, specifying targets and strategic plans that guide policy development.	OECD/IEA and IRENA (2018)
		Research, development, and demonstration (RE&D)	Support for research, development, and deployment, i.e., grants, tax breaks.	Eyraud et al. (2013)

2.2 The effectiveness of RE policies

2.2.1 Characteristics of effective RE policies

a) Risk and return

The literature on the effectiveness of government policies consistently centers around the 2 fundamental investors' metrics: risk and return. Specifically, it is proposed that to effectively attract more investment, policies should address the risk-return profile of the investment. The rationale behind this proposition stemmed from Bergek et al.'s (2013) assertion that investors are typically presumed to behave in an economically rational way; hence they only make a specific investment only if the expected economic return on that investment is as anticipated. This paradigm remains applicable within the specific field of renewable energy investment as Polzin et al.'s (2019) systematic review also reaffirmed the significance of risk-and-return in renewable energy investment policy's effectiveness. In detail, they concluded that effective policies are those that either increase the return or reduce the risk of an investment, or ideally, achieve the combination of both.

Therefore, public policies play a critical role in shaping the perceived risk-and-return profile of investors in renewable energy. As investors aim to maximize expected returns while minimizing risks and uncertainties, the support from public policy takes on more significance to induce investments into renewable energy when juxtaposed against the fact that green energy projects often yield lower rate of return while displays higher risk compared to those of fossil fuel (Yoshino and Taghizadeh-Hesary, 2018). Furthermore, renewable energy investors are also exposed to various sources of risks such as high upfront cost, uncertainty, long payback period, high regulatory and infrastructural dependency (Polzin et al., 2015). Thus, it is critical that the risk of renewable energy must be controlled through the support of government policies.

Advancing on the paradigm of risk and return, Surana and Anadon (2015) further propose that as there are different sources of risks and different sources of returns, sound policies should be those that target the various array of risks and returns of different specific investment contexts. To illustrate this point, the authors synthesized a summary of the determinants of resource mobilization by different actors.

Table 2: Most influential investment determinants and possible mitigating actions that drive renewable energy investments (Surana and Anadon, 2015)

Determinants of resource mobilization by different actors	**Description of the determinant and of possible risk mitigation actions**

Resource & technology availability	Risk and uncertainty about how much renewable energy resources are available at site and how much can be extracted; can be reduced through improved resource assessment and improved technological capabilities of developers and manufacturers
Financing availability	Risk and uncertainty about how much financing will be available at what cost; can be reduced through government guarantees and technological learning
Project implementation risk	Risk and uncertainty about permits, planning, construction, O&M; can be reduced through skilled staff, infrastructure, regulatory streamlining, etc.
Grid & transmission risk	Risk and uncertainty about grid integration and grid management; can be reduced through improved management (e.g. forecasting and scheduling), quality of grid infrastructure, mandates for interconnection of new plants
Counterparty risk	Risk and uncertainty about ability and willingness of offtaker (e.g., electric utility) to make payments to investors; depends on contract enforcement, credit rating, and overall ease of doing business
Power market risk	Risk and uncertainty related to overall market outlook; affected by liberalization policies, long-term energy policy framework, and long-term targets
Type of policy-induced returns	**Description**
Fiscal-based returns	Increase return on investment through tax credits, rebates, tax exemption etc.
Price-based returns	Increase return on investment through price-based support, e.g., guarantee revenue stream for power generation through feed-in tariffs
Quantity-based returns	Increase return on investment through volume/quota obligations, tradable renewable energy certificates, competitive auctions that increase demand for renewable power

b) Policy design

Research on renewables policy effectiveness emphasizes the importance of policy design, denoting that the detailed set-ups of the policy are of equal importance as the introduction of the policies themselves. Jenner et al. (2013) highlight that policy design is one of the elements that makes up the more important determinants of RE development than policy enactment. They further suggest that the mere presence of an RE policy is insufficient without careful consideration of its design elements to provide the effective incentive level for investors and developers. This perspective is supported by Reinhard et al. (2011), who argues that the debate should not be focusing on

choosing the best policy instrument but more on the design criteria of the implemented support schemes. Similarly, Dijkgraaf et al. (2018) criticize studies that overlook the importance of policy design elements of FIT, stating that such oversight underestimates the potential impact of the policy. In short, the literature on RE effectiveness converge on the idea that the success of RE policy implementation relies on the detailed design elements other than its enactment, and that research in this field should shift in focus to studying the optimal design for successful RE development.

Polzin et al. (2019) agree with this notion and further specify that beyond policy type, specific policy design features also have impact on the risk and return of RE investment. Moreover, the authors also acknowledge that standardized and common design elements of policy instrument enable investors to gain experience more quickly, reducing the risk in RE projects.

2.2.2 Types of policies

In their systematic review, Polzin et al. (2019) provided a comprehensive summary of the overall influence of government policy instruments on the investment into renewable energy. The findings indicate that feed-in tariffs and renewable energy portfolio standards exert the most significant effect in promoting the development of renewable energy.

The review highlights FIT as the most effective instrument due to its risk mitigation effect and guarantee of stable and predictable return. RPS are comparable to FIT in term of the premium return offered but is less potent than FIT in terms of its risk mitigation effect. Comparing the effectiveness of FIT and RPS, FITs have been demonstrated to significantly enhance renewable energy development, but this instrument type is more suitable for technologies with low market penetration and in scenarios necessitating the creation of a market (Deng and Guo, 2017). On the other hand, the implementation of a RPS system is recommended once the renewable energy source reaches a certain development.

Other instruments have either mixed evidence, indicating variability in their effectiveness across different contexts and technologies, or limited positive evidence, which suggests the need for further research on their impact. Hence, this paper prioritizes an in-depth examination of the two significant tools as determined, which are FIT and RPS

Feed-in Tariffs (FIT)

a) *FIT policies effectiveness*

Various studies in the literature of energy policy present a consensus on the positive and significant impact of FIT on attracting investment into renewable energy. Polzin et al. (2019) stated that feed-in tariffs exert a larger effect on RE investments compared to other instruments, and if properly implemented, FIT can remove different sources of risks while providing a stable return for investors. In detail, FIT help remove price risk (fluctuation in market price), volume risk (uncertainty in generated quantity of renewable energy), and balancing risk (risk associated with achieving a balance between different aspects of an investment), while ensure a stable return over a guaranteed period. These effects in turn improve the stability and predictability of the investment, thus encouraging the participation of investors. Adding to this notion, Wall et al (2018) and Zhao et al. (2013) contributed that FIT' positive effect remains significant across all RE sources, such as wind, solar and biomass. Moreover, FIT is particularly effective when combined with other fiscal measures like tax incentives to attract more FDI in RE (Wall et al., 2018).

Advancing on the topic of FIT effectiveness, Baldwin et al. (2016) reported that FIT is effective at promoting non-hydroelectric sources of RE in all high-, middle-, and low-income countries. To further clarify he context in which FIT would yield the best result, Azhgaliyeva et al. (2023) further linked the effectiveness of FIT in stimulating private RE investment to the level of technology development. They suggested that FIT yield greater results in countries where RE technologies are less mature. This concurs with the findings of Polzin et al. (2019) and Butler and Neuhoff (2008) that support levels should be contingent to technological maturity, and FIT have design features that favor elements of less mature technologies.

b) FIT design elements

The effectiveness of FIT policies in stimulating RE development is argued to be heavily influenced by their design elements. On the one hand, Dijkgraaf et al. (2018) identify the duration of the FIT contract as one of the design elements that significantly influence the effectiveness of the FIT. On this matter, Polzin et al. (2019) exhibits the same stance, proposing that tariff duration significantly influences the effectiveness of a FIT policy, as it guarantees revenue streams, hence determining the riskiness of the project. The article adds that a long-term contract reduces risk, while variability in duration increases risk. On the other hand, Cárdenas Rodriguez et al. (2015) found a positive effect of tariff level on PR project investments globally. This importance of tariff rate is supported by Do et al. (2021) as the authors attribute the generous FIT rates to Vietnam's RE development success, implying that tariff rate is a critical determinant of FIT's effectiveness. An analysis by Garcia-Alvarez et al. (2017) on wind energy capacity confirms

these notions of the two design elements, reaffirming that both tariff price and contract duration are pivotal in developing RE capacity.

As the two identified elements are the indispensable make-ups of the FIT policy, the maximum effect of a FIT policy is achieved with a high tariff and a long contract duration in combination with a consistent policy (Dijkgraaf, 2018). Conversely, the combination of a low and inconsistent tariff has a large negative effect on FIT's effectiveness. Hence, it is important to set an appropriate tariff rate, as if set improperly, FIT can result in over/under-investment in RE and can distort energy market (Ritzenhofen et al., 2016).

Renewable Portfolio Standards (RPS)

a) RPS policies effectiveness

Overall, the literature on the effectiveness of RPS on renewable energy development reaches an agreement on the increased return effect of the instrument. Romano et al. (2016) and Wall et al. (2018) highlight the effectiveness of RES in increasing investments, especially when combined with FIT to amplify the effectiveness of both instruments. Baldwin (2016) further added a specification to the context in which RPS would work best. He argued that the potential of RPS in attracting investment is more recognized in high-income countries only, suggesting its limited impact in middle- and low-income countries. However, the consensus that RPS has a positive impact on the return of the RE project remains unchanged.

The risk mitigation effect of RPS, on the other hand, is a point of debate. Ritzenhofen (2016) claimed that under RPS scheme, a RE project is exposed to less volatility as RPS ensures better market integration of the renewable energy sources, thus improve the reliability of the investment. This contrasts with Polzin et al's (2019), who maintained that RPS does not mitigate risk (price, volume, and balancing risk).

Focusing specifically on the impact of RPS on PV power generation, Bangjun et al. (2022) discovered many benefits of RPS. The study found that the presence of RPS would facilitate a phased investment approach in specifically photovoltaic power generation projects, which yields much higher investment flexibility. This means investors can adapt their investment strategies over time to respond to changing market conditions and technological advancements. The authors also added that greater project values are achieved through phased investment under RPS. This approach allows for better capital allocation and risk management, increasing the overall value of the investment. In short, RPS facilitates an investment strategy that results in fewer risks for investors: by not committing all resources at once and

instead evaluating and adapting at each phase of investment, risks associated with market volatility and technological changes are mitigated. Moreover, the study observed that under RPS, technical costs are lowered while tradable green certificates (TGC) prices are increased, making the renewable projects more financially attractive to investors. This concurs with Polzin et al.'s (2019) finding that RPS can lead to more cost-effective projects, thus higher returns compared to FIT. Overall, the study's findings suggest that as the costs associated with photovoltaic technology decrease and the market for TGCs becomes more lucrative, investments in photovoltaic projects become more financially attractive.

b) RPS design elements

Within the discourse on RPS design elements, Polzin et al. (2019) lay the groundwork by detailing all the elements that have been the subject of studies in several previous studies. Among the elements identified, capacity/sales requirement (capacity/sales quota) is found to be one of the main features of an RPS policy design structure. The paper also points out the distinction between two types of quotas, which are (1) nominal quotas that are set to be a fixed percentage to achieve until a stated year, and (2) incremental additions, defining the percentage increase of RE within the energy composition of an electricity manufacturer/purchaser. When directly compared, incremental addition mandate is found to be more effective than fixed capacity requirements, as these fixed quotas maybe already be achieved before the implementation (Polzin et al., 2019). From this result, it can be further inferred that incremental addition can ensure a sustainable capacity development, while fixed quota might lead to a rapid growth that is followed by a stall.

To validate whether the quota of RPS would profoundly affect the promotion of renewable energy, Dong (2012) conducted an empirical test of FIT and RPS effectiveness in promoting wind capacity. Results of the study show that RPS is more prone to incentivize competition among different renewable technologies because any technology could satisfy the quota. This conclusion implies the importance of quota as a design element of RPS would promote RE capacity by stimulating competition.

Such confirmation of RPS quota's effectiveness in stimulating RE capacity growth leads to the question of the optimal quota level. Answering this question, Xingang et al. (2022) find that a balanced quota should be set based on RES-E generation expectations and the feedback of RE investment on RPS. The authors report that, a quota set above generation level would increase the financial burdens for obligated entities as it requires higher upfront investment in RE technology to reach the quota. However, a quota below the

generation level makes it challenging to provide enough support for RE companies as they need to be able to sell the generated electricity.

2.3 Renewable energy status in Vietnam

2.3.1 The need for renewable energy expansion and decarbonization

Vietnam is faced with "twin threats" as expressed by McKinsey & Company (2022) that are physical threats and transition adjustment risks, which altogether put the country's general welfare and future development prospects at stake.

First, the drive to decarbonize Vietnam's energy mix stems from the need to mitigate climate change negative influences. Vietnam is among the most vulnerable countries to climate changing, highlighting the importance of the country to limit its carbon emission. The decarbonization pathway of Vietnam relies on greening its energy sources as the emission from coal, oil, and gas electricity production and heating contributed to 42% of the country's total of over 300Mt CO2 emission in 2021 (IRENA, 2023).

Second, the transition to sustainable energy would put the country's economic development and competitiveness at stake if Vietnam lags behind. As a high proportion of Vietnam's GDP is derived from high-carbon sectors, much of the country's capital is locked in fossil-fuel-based sources, hindering its ability to attract more investment in its coal-based thermal plants (Luu, 2021). Moreover, the country is also exposed to the risk of losing international investors. Experiencing rapid economic growth backed by the abundance of skilled workers, Vietnam has been chosen as an investing destination by many multinational corporations as part of their diversifying strategy from China (McKinsey & Co., 2023). However, the country runs the risk of losing these actors if the demand for electricity is not met. When global manufacturers have pledged to transition to 100% renewable energy for their operations, these countries may not choose Vietnam if the quota is not met. This in turns threatens the country's competitive position with neighboring countries if Vietnam fails to take action. Other countries such as India and Malaysia have implemented several incentives to make renewable energy viable, attracting global companies to set up manufacturing hubs. In contrast, Vietnam has limited support for renewable energy projects, possibly leading to a potential loss of foreign investment.

2.3.2 Vietnam's potential for renewable energy development

Vietnam is increasingly being recognized as a major player in the renewable energy sector, especially within the Southeast Asian region. The country has made serious commitments to its net-zero commissions and renewable

energy development pathway, illustrated through not only the adoption of international and regional agreements such as COP27, the Paris agreement and the United Nations Framework Convention on Climate Change (UNFCCC), but also its actual growth in renewable energy capacity.

In 2020, Vietnam attracted a total of USD $7.4 billion, surpassing many countries to become the 7th largest renewable market (Bloomberg, 2021. Recently, according to IRENA, total renewable energy capacity has increased from 14,901 MW in 2013 to 45,327 MW in 2022, marking an exponential growth by 204% (Figure 1). Growth rate was low in the period from 2013 to 2018, but in 2019 the capacity started to take off. In the same period, total energy production has increased by 78%, reaching 104,331 GWh in 2021 (there was no available data for 2022). The country also has high potential for wind and solar energy (McKinsey & Co.), allowing Vietnam to experience the biggest growth in renewables contributing to electricity in ASEAN.). In details, from 2015 to 2021, solar energy in Vietnam took up 10,7% of the national energy mix, surpassing world's average at the time while placing them at par with top Asian solar energy producer such as China and Japan (Figure 2). Vietnam's renewable energy market is more attractive when renewables have become increasingly cost-effective in Vietnam (BloombergNEF, 2023).

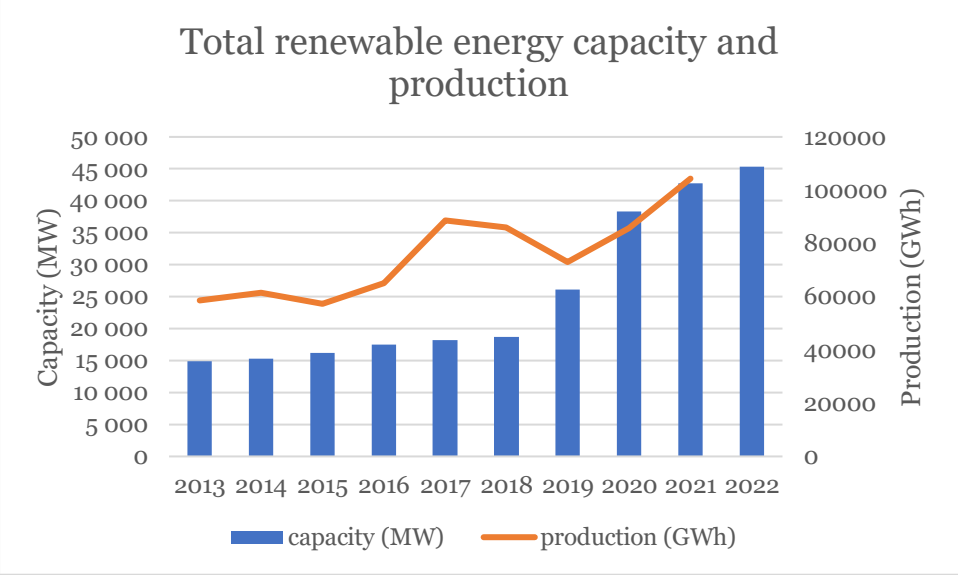

Figure 1: Total renewable energy capacity and production in Vietnam from 2013 to 2022 (Source: IRENA 2023)

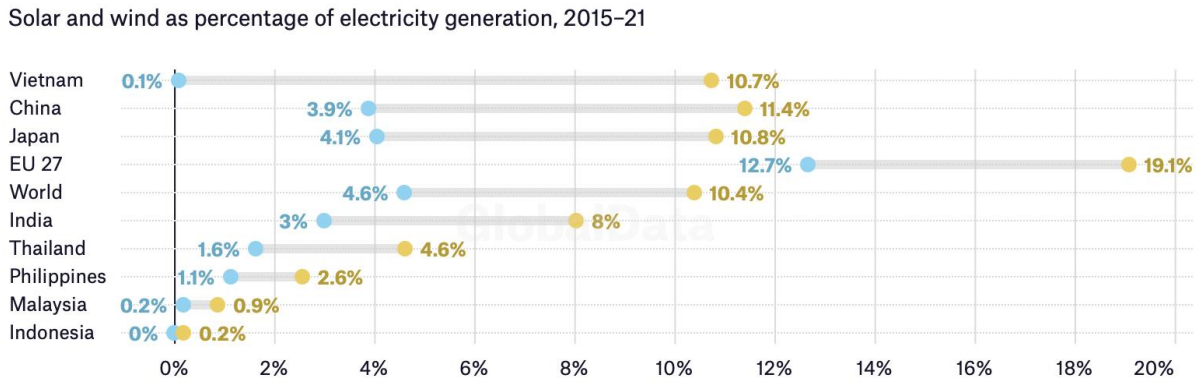

Figure 2: Solar (yellow notes) and wind (blue notes) as percentage of energy generation (Source: Ember's Global Electricity Review, 2022)

In 2022, renewable share has surpassed non-renewable share, taking up to almost 60% of total electricity capacity. However, non-renewable share of electricity production was still dominant in 2021, indicating that despite having greater electricity capacity from renewable sources, the country is still utilizing its traditional depletable energy sources (such as coal and gas).

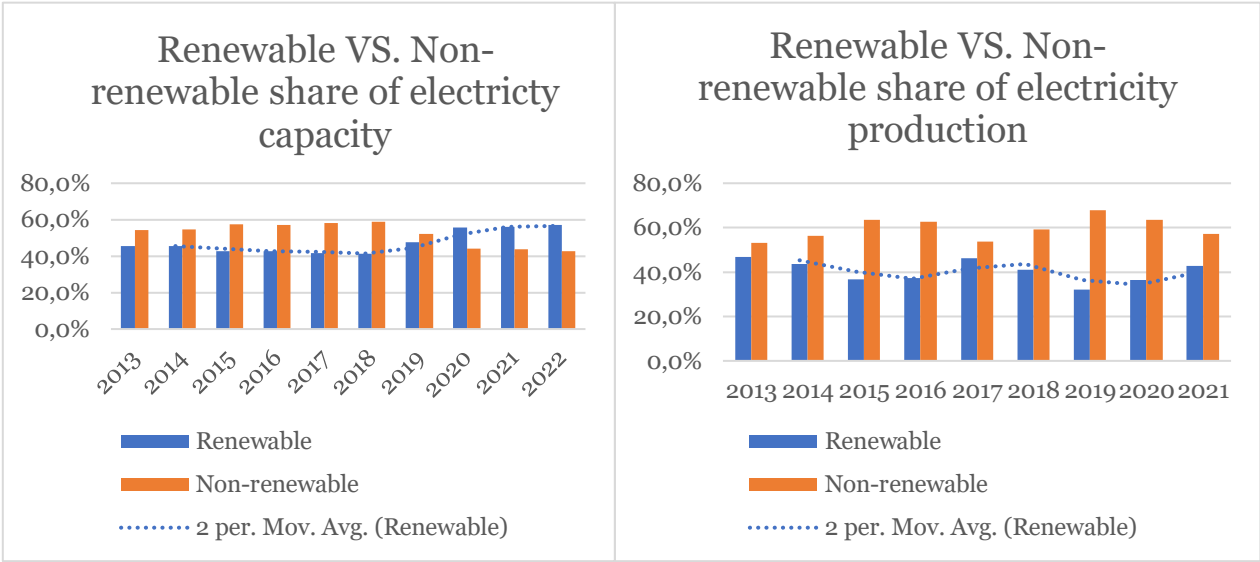

Figure 3: Renewable VS. non-renewable share of electricity capacity and production in Vietnam from 2013 to 2022 (Source: IRENA 2023)

With the goal to completely phase out the use of coal in the national energy mix, the Vietnamese government finalized and announces the 8th Power Development Plan enacted in 2023, setting target to remove coal 100% from the mix and in return increase solar and wind capacity to be the main energy sources in 2050. Further details of this change in the targeted energy mix are illustrated in Figure 4. According to this figure, the country aims to make solar the primary energy source that make up one third (34%) of the total

installed capacity, followed by wind energy at 27%. Moreover, the ambitious goal of complete coal phase-out is also illustrated by the dramatic reduction from a noticeable 28% in 2022 to 0 in 2050. Altogether, through this plan, Vietnam has demonstrated its determination to cut off fossil fuel and simultaneously, its commitment to develop renewable energy with solar energy as the top priority.

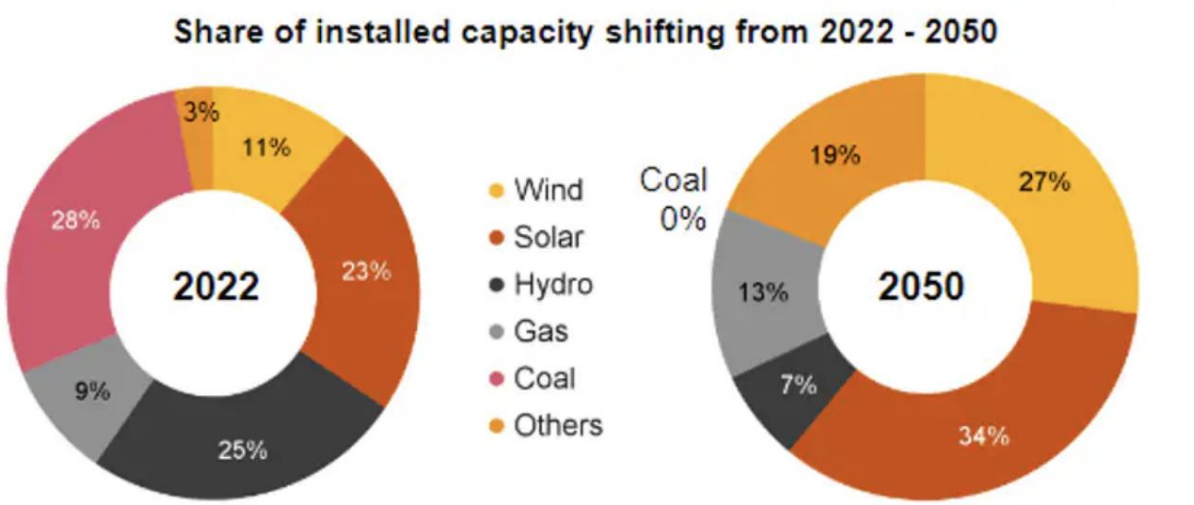

Figure 4: Energy mix in 2022 and target energy mix in 2050 (Source: PwC, 2023)

2.3.3 Renewable energy investment

Implementation of renewable policies has gained success to a certain extent in Vietnam, as shown through the spur in investment and capacity of RE in the country during the early stages. However, investment and development of RE in Vietnam is not without challenges.

The cost of financing in the country is higher than other major economies (Steffen, 2020), creating a barrier for financing renewable energy. This barrier may hinder the country's goal to establish its targeted renewable energy capacity in 2050, as the government declared that such development would require the cumulative investments of USD $128 billion between 2021 to 2023, and USD $192 between 2031 and 2045 (McKenzie, 2021). Much effort is needed to attract more investment to achieve this goal as investment in clean energy in Vietnam was only UDS $559.53 million (BloombergNEF, 2023).

A majority of resources has also been financed in traditional fuel sources. IEA (2023) listed top 5 sources of finance for power generation investment in three categories: renewable power, fossil fuel power, and oil and gas. Total

power generation investment was reported to be US$38,52 billion until 2023 (IEA, 2023), of which investment in renewable power accounted for merely 10.5% of the total investment.

Figure 5 drafts the pattern of total asset investment in Vietnam's renewable energy from 2017 to 2022. The graph shows that increasing renewable investment was made in the beginning as a result of successful policy implementation. However, from 2020 onwards, a steep decline was witnessed as total RE investment plunged from US$10 billion to under US$2 billion in 2022. This boom and bust showcased how proper introduction and implementation of policies can stimulate the rise in RE investment but also how the absence of strategies that reassure a stable development in the future can discourage investors (BloombergNEF, 2023). Although FITs were the right investment propeller, the rate was set too high while there's a lack of clarity in future policies. Additionally, the rapid growth in generation exceeded the grid capacity while grid investment has not extended to private investment, resulting in grid congestion. These bottlenecks have hindered more investment and further expansion into RE, explaining the steep plunge in renewable investment in 2022.

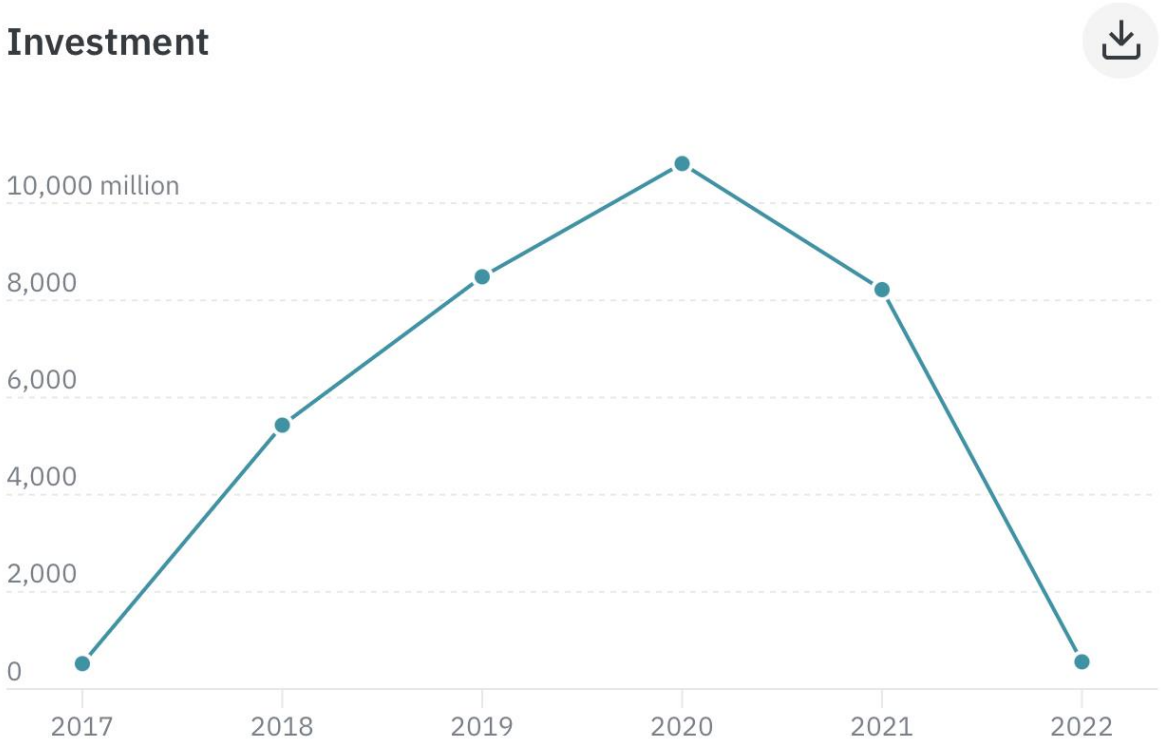

Figure 5: Investment in clean energy in Vietnam, 2017 – 2022 (BloombergNEF, 2023).

2.3.4 Solar energy in Vietnam

Solar energy capacity and production in Vietnam grew from barely non-existent in 2018 to nearly 17,000GWh in production in 2021 and over 18,000MW in capacity, as presented in figure 6. From 2018 to 2021, the share of solar energy grew to account for 11% of installed capacity. This was reported to be the faster growth rate than almost anywhere else in the world (ACE, 2023), recording Vietnam as having the highest installed capacity for solar-generated power capacity among the ASEAN Member States in 2020 and the 8th largest employers for solar PV production (IRENA, 2020).

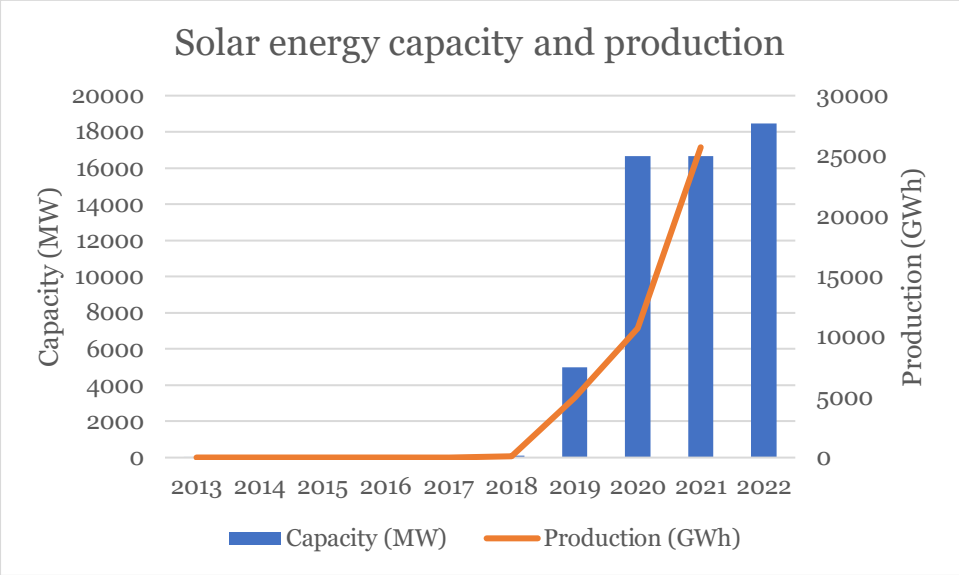

Figure 6: Vietnam's solar energy capacity and production, 2013 – 2022 (IRENA, 2023).

One of the reasons for this substantial growth is the nation's natural endowments with high potential for solar energy due to its high amount of sunshine per year (1600 – 2700 hours) and high solar irradiance (4-5kWh/m2/day). The solar potential of Vietnam is approximately 963,000 MW in total, with an expected additional growth by 4,100 MW to 2030. The projected total capacity in 2050 is estimated between 168,000 and 189,000 MW, and total production is estimated at 29,500 GWh.

2.3.5 Renewable energy policy status

Vietnam set out on its decarbonization pathway by first introducing the Renewable Energy Development Strategy in 2015 to establish goals for the share of renewable energy in Vietnam's electricity mix by 2020, 2030, and 2050. The 7th Power Development Plan was revised in the subsequent year with a stronger emphasis on renewable energy sources and decreased reliance on coal. The focus on this shift from coal power was later reiterated in subsequent reports and resolutions. Most recently, the 8th Power Development Plan was approved in May 2023, aligning Vietnam's goals with international

commitments. More detailed record of RE policies enactment is presented in table 3 below.

Table 3: Relevant policy framework on renewable energy (Urakami, 2023)

2011	National Power Development Master Plan for 2011 – 2020, with a vision to 2030 (PDP7)
2015	Renewable Energy Development Strategy (2016 – 2030) with outlook until 2050 (Decision 2068/2015/QD-TTg)
2016	Revised National PDP 7 (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 Ministry of Industry and Trading)
2020	Resolution 55-NQ/TW of the Politburo on Orientation of national energy development strategy to 2030 and outlook to 2045b (by Central Committee of the Communist Party of Vietnam)
2023	National Power Development Master Plan for 2021-2030, with a vision to 2050 (PDP8) (Decision 500/2023/QD-TTg)

Within these documents, the Government of Vietnam (GoV) outlined various policy instruments to promote the development of RE. Table 4 summarizes the main instruments introduced by the government thus far.

Table 4: Types of renewable energy investment policies in Vietnam (adapted from ACE (2023) with sources from government documents)

Type	**Form**
FIT	The first FIT was introduced in 2017 for solar projects, specifying the selling price of electricity to Vietnam Electricity (EVN) and subsidiaries at USD $93.50 per MWh for 20 years. This was followed by a reduced second FIT in 2019 and third FIT in 2023.
Tax incentives	Those involved in renewables are eligible to tax deduction from income and equipment importation.
Fee exemption	Renewable energy projects are exempted from land use fees and water surface rents.
Preferred rate loans	Renewable energy projects can access preferred rate loans from Vietnam Development Bank (VDP) or Vietnam Environment Protection Fund (VEPF), or interest support from VEPF.

Type	Form
Subsidies	Projects (solar, wind, geothermal, tidal, or methane) where production costs exceed sale price are eligible to subsidies from VEPF.
Renewable Portfolio Standard	Large power generation and distribution companies must maintain a portion of their energy output to be sourced from renewable energy, from 3% by 2020 to 10% by 2030 and 20% by 2050. Investors in solar energy project must maintain an equity ratio of at least 20% of their total investment.
Lending	Existing lenders for renewable energy projects are mostly domestic banks. However, the sector is open to both domestic and foreign investment.

Due to its progressive policies regarding RE, Vietnam has been a key destination for renewable energy financiers and investors worldwide, particularly for solar energy according to the ASEAN Centre for Energy (2023). The country's significant progress alongside flexible terms for project financing has attracted more international and private investment in the recent years. However, more effort to make Vietnam more investment friendly is needed. The recent 8th Power Development Plan stated that the country needs an estimated annual financing of USD $11 billion allocated to renewables, yet the current Vietnamese banks and developers does not have sufficient financial capacity to meet this requirement. This underlines the role of investors, domestic and international, in necessitating the growth of renewables in Vietnam, which can only be achieved by issuing policies that makes Vietnam "a place where private capital can generate healthy returns".

2.3.6 Extant studies on Vietnam's renewable energy policies

The literature on Vietnam's RE policy framework presents a dichotomy. On the one hand, the nation has established a strong foundation for the increasing renewable energy capacity, most evident through the accelerated growth of solar photovoltaic in late 2010s to early 2020s through generous FITs and other fiscal support. On the other hand, the policy framework is not without its challenges as there is a consensus on its current risks and uncertainties.

Do et al. (2021) remarked that FIT was the main driver that enabled the development of renewable energy in Vietnam. In addition, the income tax and lease payment exemption have also been instrumental to the growth. Altogether, these incentives have created a supportive environment for the investment and deployment of renewable energy.

However, notable challenges were noticed in the current policy framework. Although FIT was appropriately utilized for the success in recent years, the current FIT system does not ensure a sustainable mechanism (Le et al. 2022). In details, the FIT prices in Vietnam are fixed and only applicable to grid-connected applications, not promoting the development of rooftop solar applications. This simplicity has led to uneven development between the regions, causing market instability. The future of FIT policy was also unclear (Urakami, 2023) as the three-year eligibility window was too short, leading to installation rushes while creating uncertainty for projects completed pass this horizon. These are elements that would increase financing risks, deterring investment and development of renewable energy.

As observed by Vakulchuk (2022), Vietnam is experiencing an institutional carbon lock-in effect, a status referring to the inertia in changing from carbon-intensive to low-carbon systems (Rentier et al., 2019). This is evident as a substantial amount of national GDP was allocated to fossil fuel subsidies, lowering the price of coal-based sources and electricity (Shem et al, 2019). This made renewable energy artificially more expensive, while in fact the costs of renewables were already on the same level or lower than that of fossil fuel, even without subsidies, taxation, or other incentives (OECD, 2021). The continuing subsidy in depletable energy diverted funds from renewable projects, making them less financially viable to investors (Qadir et al., 2021). However, the country has been making improvements as it is maintaining the lowest fossil fuel subsidy per capita and reducing the subsidy most drastically in the Southeast Asian region (Do et al., 2021).

Another major barrier in Vietnam's policy framework lies in its uncertainty. Le et al. (2022) noted that the solar PV policy in Vietnam has been inconsistent, as exemplified by the inconsistency between the old and new FIT mechanisms and abrupt policy changes. This coincides with Do et al.'s (2021) report on the country's policy uncertainty.

Moreover, RPS is an underutilized instrument in encouraging renewable energy development in Vietnam. A report by OECD stated that, although prioritized, RPS has not been implemented, suggesting a gap in the policy framework. The lack of RPS implementation exacerbates the inefficiency in incentive implementation, making the market not attractive enough to encourage private investors to adopt low carbon technologies or practices (Shem et al., 2019).

Altogether, it is reported that Vietnam policies may still leave Vietnam falling short of its stated net-zero goal (McKinsey & Co., 2022).

2.4 Conceptual framework

As discussed in the literature review, FIT and RPS are the two most effective policy instruments in stimulating the development of renewable energy, specifically solar PV, the main focus of this paper. The extent to which these policies are successful relies heavily on their main design elements, which are tariff rate and duration for FIT, and sales/capacity requirement for RPS. Via these mechanisms, these policies will directly influence the risk and return of the solar PV investment project, subsequently determines the development in capacity of solar PV. The conceptual framework below illustrates this interaction.

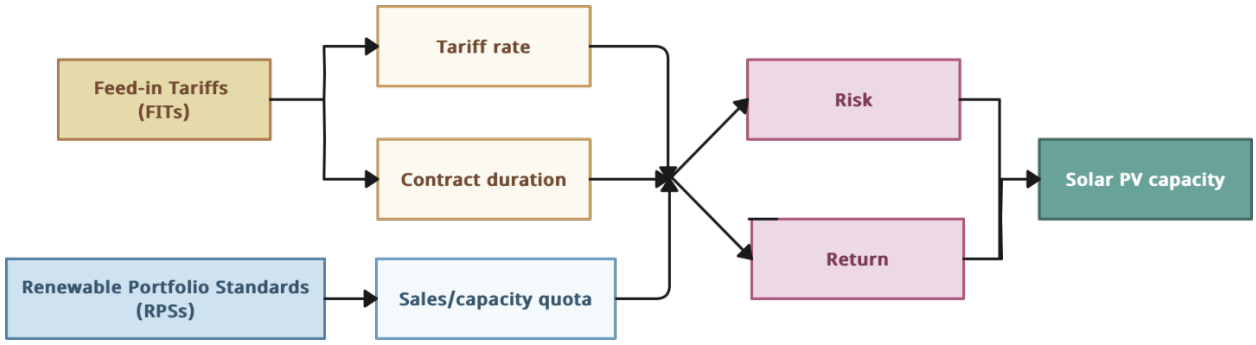

Figure 9: Conceptual framework

3 Methodology

3.1 Quantitative analysis

3.1.1 Data collection

The three chosen countries for the quantitative analysis of this paper are Vietnam, the focus of this paper, and Thailand and the Philippines. These three countries are considered for their similarity in geographical conditions that favor abundant resources for solar energy. Moreover, the countries are often considered regional leaders in solar energy development, hinting at the prominence of solar energy as well as availability of related policies. As for the time frame of the study, the period from 2012 to 2022 is chosen when taking into consideration the years FIT and RPS are enacted in these countries. Data for the variables, which will be discussed below, are collected from government documents and reports from international energy organizations such as IRENA and IEA, ensuring the reliability of the data. Descriptive statistics of the dataset can be found in table A.1. in Appendice A, while the general pattern of solar PV development in the three chosen countries can be seen in Figure 8 and 9 below.

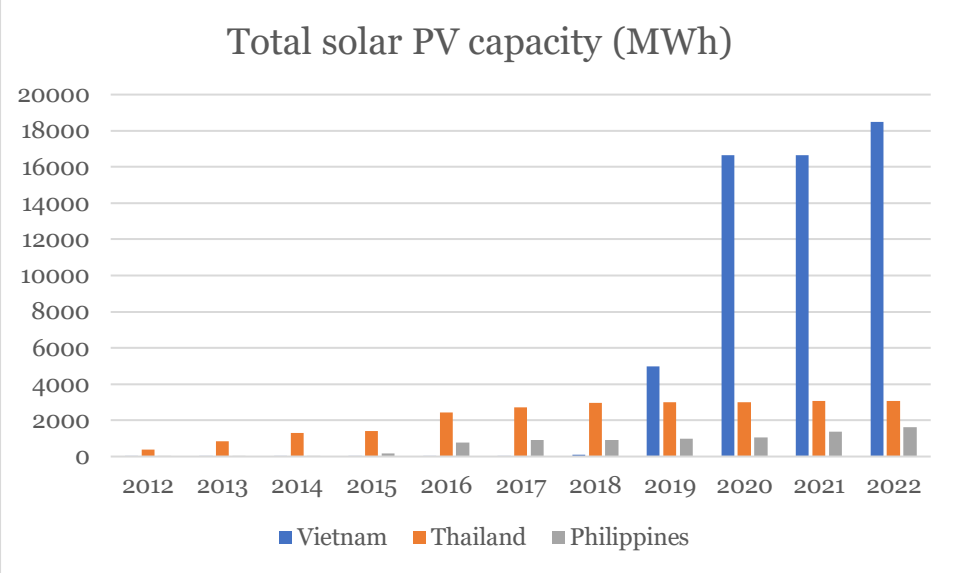

Figure 8: Total solar PV capacity in MWh, 2012 – 2022 in Vietnam, Thailand, and the Philippines (Data source: IRENA, 2023)

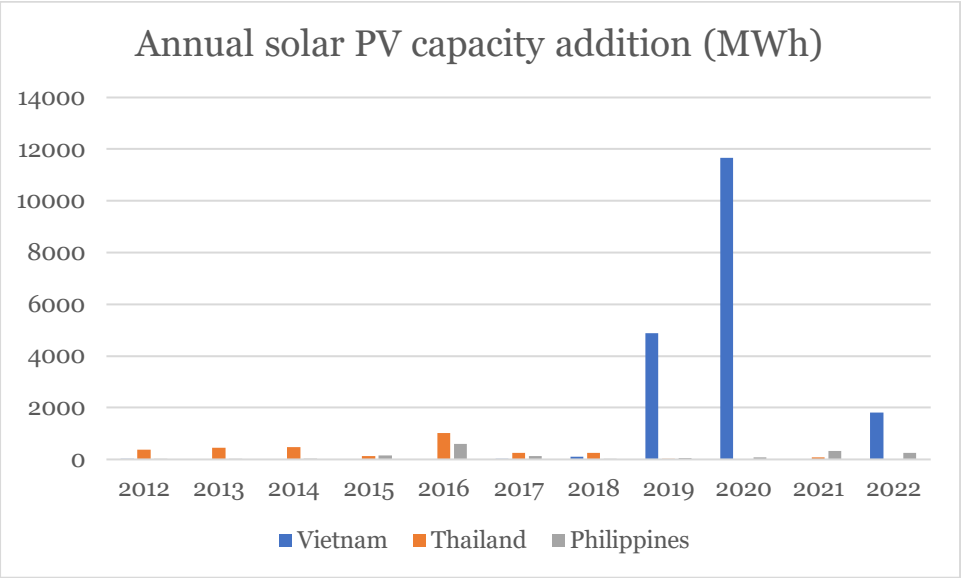

Figure 9: Annual addition of solar PV capacity in MWh, 2012 – 2022 in Vietnam, Thailand, and the Philippines (Data source: IRENA, 2023)

However, there are certain limits and potential issues with the data used for this research. First, the dataset only comprises of variables that are of direct concerns for this study, which are solar energy capacity and metrics related to FIT and RPS. This limited scope might result in possible omission of other influential factors crucial for a comprehensive analysis of solar energy development, such as the presence of other policies, infrastructure capabilities, and other control variables. Secondly, the deliberate focus on only leading countries in solar energy within the Southeast Asia (SEA) region, while allowing easier data retrieval, might introduce an element of selection bias. This might undermine the study's ability to be representative of solar energy development in general.

3.1.2 Statements of hypothesis

Taking into considerations the argument presented in the literature review, following are the hypotheses about the relationship between the chosen independent variable and solar energy capacity:

- *Hypothesis 1:* The presence of FIT and RPS policies results in an increase in total solar PV capacity
- *Hypothesis 2:* The higher the tariff rate of FIT, the more solar PV capacity installed.
- *Hypothesis 3:* The longer the contract duration of FIT, the more solar PV capacity installed.
- *Hypothesis 4:* The higher the sales/capacity quota of RPS, the more solar PV capacity installed.

3.1.3 Regression model

To test if the enactment of FIT and RPS policies does have an impact on the total solar PV capacity, a regression model using dummy variables is used. The dummy variables in this model are employed on a binary basis to indicate the presence of the policies: if the value for the dummy is 1, the policy is present; if the value is 0, the policy is not present. The dependent variable is the total solar PV capacity, logarithmic transformed to see how total capacity reacts to the presence of the policies. The model is as following:

$$Model\ 1:\ LN\_CAPACITY = \beta_0 + \beta_1 FIT\_DUMMY + \beta_2 RPS\_DUMMY + \varepsilon_i$$

To discover how FIT and RPS and their respective design elements influence solar PV capacity development, pooled OLS regression will be used. This regression method is used as it treats the panel data as a large cross-sectional dataset by combining all the time series for each entity (in this analysis, each country) and ignoring the specific different characteristics of each country or year that are beyond what is observed by the included variables. Initially, a panel regression analysis with multilevel fixed-effect (country-fixed effect and time-fixed effect) was considered to account for the unobservable characteristics that change in each country and across the identified time series; however, due to the small number of observations, this method was not applicable as it would not produce a statistically meaningful result.

Furthermore, the log-linear regression would be used for this analysis. In detail, the natural logarithm of annual addition of solar PV capacity (*LN_ADDEDCAP)* will be the dependent variable, while FIT's tariff rates (*RATE)*, contract duration (*DURATION)* and RPS's sales/capacity quota (*QUOTA)* will be the independent variable. The reason for employing this log-linear model is that the relationship between the independent variables and the dependent one seems to be more exponential rather than linear, as observed by the rapid growth as shown in Figure 6. Hence, the log-linear regression model helps to understand the percentage change in the total solar PV capacity for a unit change in each of the independent variable. The model is as following:

$$Model\ 2:\ LN\_ADDEDCAP = \beta_0 + \beta_1 TARIFF + \beta_2 DURATION + \beta_3 QUOTA + \varepsilon_i$$

The regression and other statistical tested are conducted via STATAMP18®. The results of the regression analysis will be interpreted at a 95% confidence level.

By choosing panel regression analysis as an approach to explore this topic, this study hopes to contribute to the existing literature on the influence of government policies on RE development. First, the simplicity of this approach allows for a straightforward interpretation of the relationship between the policies and annual solar energy addition. Hence, this gives a first glance to understanding the effectiveness of policy instruments on solar energy development by isolating the factors of interest from the complex real-life dynamics. Second, this attempt of using quantitative analysis aims to extend the current literature on solar development in Vietnam, which has primarily utilized qualitative means thus far. By incorporating statistical methods and empirical data, this analysis intends to provide a more objective assessment.

However, this approach also exhibits certain limits. First, the isolation of only variables of interest may omit other important factors and control variables that possibly exert influence on the dependent variable, as discussed in the data collection part. Moreover, the pooled OLS regression model used does not account for country-specific characteristics, hence assumes that the effect is constant across countries.

3.2 Qualitative analysis

To achieve the best outcome for this research, it is important to understand how investors/developers perceive the effectiveness of FIT and RPS, specifically in terms of how these policies affect the risk and return of a solar PV project, and how these actors perceive the opportunities and challenges presented by the current policy status. To gain insights on these problems, an interview with an industry insider was conducted. The chosen interviewee was Khe Nguyen, the Business Development Manager at Levanta Renewables, a renewable energy developer in the Southeast Asia region. The interview was conducted as a written interview to allow for better elaboration. To ensure that the interviewee has a grasp of the historical and current status of the changes to FIT and RPS in Vietnam, an overview of the two policies was attached to the set of questions. Data from the interview will be coded into relevant themes that help answer the research questions. To further support the argument, other academic research would be utilized as complementary to the ideas elicited from the interview.

4 Findings

4.1 The impact of FIT and RPS on solar energy capacity development

4.1.1 The presence of the policies

The regression results of Model 1 shows that the enactment of RE support policies such as FIT and RPS would result in solar PV capacity growth, supporting hypothesis 1. Beside the statistically significance of the F-statistics for the overall fit of the model, it was later tested for heteroskedasticity and multicollinearity, for which the result proves homoscedasticity and low correlation between the variables (refer to figure A.2. and table A.3. in Appendice A for more details). Hence, the model is valid, and its result is credible.

Table 5: Model 1 regression result

LN_CAPACITY	**Coefficient**	**Std. err.**	**t**	**P > |t|**	**95% confidence interval**	
FIT_DUMMY	4.355111	1.194545	3.65	0.001	1.915525	6.794697
RPS_DUMMY	2.51057	1.01082	2.48	0.019	0.4461992	4.57494
_cons	1.609438	1.102515	1.46	0.155	-0.6421982	3.861074
Number of observations: 33 F(2, 30): 11.67 Prob > F: 0.0002 R-squared: 0.4376 Adjusted R-squared: 0.4002						

Interpreting the result, it is revealed that FIT helps induce more growth in solar capacity than RPS, as the presence of FIT would lead to a 436% increase in solar capacity compared to 251% of RPS, suggesting that FIT might be more attractive to solar PV developers, thus being more effective in stimulating the growth of this type of energy compared to RPS. However, it is also important to notice the whopping figures, which are likely driven to the abrupt development in Vietnam. Moreover, the R-squared of the model is 0.4376, indicating that the presence of FIT and RPS can explain 43.76% of the change in the total solar capacity, while the remaining 56,42% of the variation is due to other unincluded factors. Hence, the result of this model should be interpreted with caution: although it proves the impact of FIT and RPS, the extent of the impact is only a rough estimate. Moreover, it is worth noticing that the growth of solar capacity was rather abnormal and could be considered an outlier, thus can drive the coefficients to be significantly high.

4.1.2 FIT's and RPS's design elements

Table A.4. (refer to this table in Appendice A) presents the correlation coefficients between the variables in the model as a preliminary test for multicollinearity. Although correlation between two independent variables that are tariff rate (TARIFF) and duration (DURATION) is found, later test using variance inflation factor (VIF) (refer to table A.6. in Appendice A) results in VIF with values less than 5, proving low correlation between the independent variables, thus non-multicollinearity. Additionally, no heteroskedasticity is found (refer to figure A.5. in Appendice A), verifying the accuracy of the model. The results for regression model 2 are shown in table 6.

Table 6: Model 2 regression result

LN_ADDED-CAP	**Coefficient**	**Std. err.**	**t**	**P > |t|**	**95% confidence interval**	
TARIFF	-0.0102809	0.0080449	-1.28	0.215	-0.026965	0.0064031
DURATION	0.2425851	0.095265	2.55	0.018	0.450177	0.4401525
QUOTA	0.855827	0.3859274	2.22	0.037	0.0554624	1.656192
_cons	0.854863	1.683195	0.51	0.617	-2.63587	4.345596
Number of observations: 26 F(2, 30): 5.14 Prob > F: 0.0076 R-squared: 0.4121 Adjusted R-squared: 0.3319						

The result presents that FIT contract duration and RPS quota have a significant positive impact on the annual addition of solar PV capacity. This result supports hypothesis 3 and 4, confirming that longer FIT contract duration and higher required RPS quota positively affect the annual addition of solar PV capacity. Specifically, extending a FIT contract by one year is associated with a 24% increase in solar PV capacity (p-value = 0.018). Moreover, as FIT contract duration is indicative of certainty to some extent, it can be inferred that RE investors prefers policy certainty, and longer-term financial incentives might be effective in promoting solar energy investments. On the other hand, a percentage increase in the required RE proportion (RPS quota) is linked to an 85% increase in the added capacity of solar PV (p-value = 0.037).

Contrary to hypothesis 3 and 4, the result does not support the anticipated positive effect of FITs on the annual addition of solar PV as indicated by hypothesis 2. The hypothesis must be rejected as the coefficient for this variable is not statistically significant. This is in contrary to the assumed relationship

that higher FIT would increase installed capacity. As there is no multicollinearity presented in the model (refer to table A.6. in Appendice A for details), the cause for this insignificance might lie in the dataset. Specifically, the dataset does not account for the lag between the establishment of the policy and the completion of new solar project. Subsequently, this lag is not considered in the regression model, leading to the model's assumption that the relationship between FIT rates and annual capacity is insignificant. Hence, within the context of this model, it is unclear whether an increase in FIT rate would necessarily correlate with an increase in solar capacity.

4.2 The effect of FIT and RPS on solar PV project's risk and return

FIT and RPS have significantly enhanced the attractiveness of solar PV. FIT directly influences a solar PV project's return by ensuring a stable and predictable revenue stream for developers. Via guaranteed income, FIT alleviates the risk of market price volatility. While RPS does not impose any direct influence on the return of the projects, the policy ensures market access for new developers in the sector as well as a market for the electricity generated, providing a proxy against the inability to release the generated electricity to the market.

4.2.1 The effect of FIT and RPS on solar PV project return

In the discourse on the effects of RE policies on solar PV projects' return, FIT is more often than RPS mentioned as having a profound impact on the financial attractiveness of the project. Results from the interview and findings from other studies all emphasize on FIT's ability to ensure a stable revenue stream as the outstanding advantage of this policy. From the perspective of the developer, Khe Nguyen – the interviewee – comments on the financial stability provided by the project, stating that the FIT enacted so far in Vietnam provides fixed, long-term rates for electricity generated from solar PV projects. Nguyen highlighted that this guaranteed rate allows developers to be able to predict stable future revenue stream, increasing the financial appeal of the project to developers and investors alike.

The interviewee did not mention how RPS directly affects the returns of a solar project but referenced the instrument as a proxy to an investment's certainty, thereby enhancing the profitability of the investment.

> "The guaranteed rate from FIT allows developers to be able to predict stable future revenue stream. RPS ensures a market for the electricity. When combined, these policies enhance the stability of the project's returns." (Nguyen, 2024)

Nguyen also discussed how the higher FIT rates in Vietnam give the domestic solar PV market a competitive edge over other energy sectors as well as other countries. She noted that Vietnam offers generous FIT rates that do not only make this market more attractive compared to other countries in the region but also make the return from solar PV higher than that of traditional energy sector of coal, where the market is facing market saturation and price stagnation.

> "The generous FIT rates in Vietnam offer higher potential return [...], making the returns from this sector higher compared to that of the established traditional energy sector such as coal or natural gas, where the market is facing saturation, plus price stagnation. FIT rates in Vietnam are relatively competitive compared to other energy sectors and several other countries as well." (Nguyen, 2024)

In short, while there is little mention of RPS and its impact on a solar PV investment's return, much of the attention is paid to FIT on its effectiveness in increasing the return of the investment. By providing fixed income over a predetermined time span, FIT ensures the certainty of return in the future as well as the predictability of future income of a project.

4.2.2 The effect of FIT and RPS on solar PV project risk

The implementation of FIT and RPS help modulate the potential risks of a solar PV project. FIT, via its stable income mechanism, alleviates the risk of price volatility, thus generally mitigate investment risk. On the other hand, RPS policies ensure a stable demand for RE in general and solar PV in specific through its mechanism of mandating a minimum share of RE resources. This requirement guarantees a market for the electricity generated and easy market integration for new developers, eliminating the risk of market stagnation due to limited demand.

Regarding FIT, Nguyen mentioned that FIT reduces the investment risk by offer fixed and guaranteed returns. This helps shield investors from market fluctuation in electricity price. Regarding RPS, this policy helps alleviate risks associated with demand uncertainty and prevent market stagnation. Nguyen commented that generally RPS does not only guarantee a stable market demand for solar PV but also ensures ease of access into the sector for new developers. In detail, RPS mandates a proportion of RE that electricity distributors must maintain. Compliance to this policy means electricity purchaser/distributor must consistently, and in the future increasing, buy electricity from RE developers in general and solar PV generators in specific. This mandate guarantees a market for the electricity generated, eliminating the

risks of being unable to sell the generated electricity to the market. RPS also allows ease of entry for new RE developers as it requires that the proportion of RE in the total capacity of an electricity generator/distributor must increase after a certain period. This increasing required quota helps expand the market demand for all RE including solar PV, thus mitigate the risk of market saturation, allowing for more developers to join the market.

> "By offering fixed and guaranteed returns, FIT protects investors from market fluctuation in electricity price. RPS guarantees a market for the generated electricity to be sold, eliminating the risk of being unable to sell the electricity. It also lowers the entry barriers for new developers via the quota mandate." (Nguyen, 2024)

Overall, FIT alleviate price risks by offering fixed-term payment against possible price volatility in the market. On the other hand, RPS minimizes risks related to demand uncertainty and market saturation by ensuring an increasing market demand for the generate electricity over time, allowing more RE developers in general and solar PV developers in specific to join the market.

4.3 Opportunities and challenges for Vietnam to develop solar PV energy

4.3.1 Opportunities

The interview with Ms. Khe Nguyen reveals many opportunities for the continued growth of solar PV in Vietnam. These opportunities are presented by not only the enactment of FIT and RPS but also a changing landscape in the market demand for electricity.

The solar PV market in Vietnam presents various opportunities for future development which come from a more focused FIT policy and more competition stimulated by the RPS. Nguyen discussed in the interview that the FIT offered so far has been generous and is relatively competitive compared to other energy sectors and several other countries. This implies the possibility of more developers investing in solar PV in Vietnam due to the attractiveness of the FIT. However, FIT has also led to underdevelopment in low-potential areas in the north and overexpansion in high-potential areas in the south-central and south regions due to difference in solar radiation intensity, causing market instability. Albeit this uneven development across regions, Nguyen underlined this seemingly problem as a unique opportunity for solar PV developers to gain more return by venturing into less developed area, spurred by a new issuance on FIT policy. In detail, Decree No. 19/2023/TT-BCT, dated November 1st, 2023, incorporates solar radiation intensity as a criterion for determining FIT rates. This will lead to variable tariffs across

different regions on the country, influencing investors' choice on where to locate their project. The decree aims to boost solar PV development in areas where there is a less prominent presence of solar PV as the change is designed so that regions where solar radiation intensity would provide higher tariff rates, making investment there more lucrative. In other words, with the enactment of this decree, investors can capitalize on the differentiated FIT rates introduced by the new decree, turning the challenge of lower radiation into an opportunity for higher financial returns.

> "[..] Solar radiation will be included in the FIT rate, meaning that this price will vary for different regions. This is to target investors' choice of location and encourage them to move to regions where solar energy is still underdeveloped, as the FIT is designed to be higher where levels of solar radiation is lower." (Nguyen, 2024)

In addition, Nguyen mentioned several other opportunities for solar PV development in Vietnam by focusing on commercial and industrial (C&I) sector and utility-scale projects, anticipated that this will be an "explosive direction in the future". Nguyen noticed that there is an opportunity for solar installations at C&I facilities to serve the energy needs of businesses ranging from small and medium enterprises to large industrial complexes. Nguyen further discussed that this opportunity stems from a serious electricity shortage, especially in the northern region. She also emphasizes the requirements of FDI and multinational companies to have CO2 certificate. Taking into consideration these two drivers, it is clear that there is a demand for self-consumption solar installations, making C&I a potentially lucrative market for solar PV developers. This indicates that solar PV developers have a prime opportunity to capitalize from this unmet demand, driven by electricity shortages and firms' obligations.

> "There has been a rapid growth in the C&I solar rooftop market, especially for FDI and multinational companies who are required to have CO2 reduction certificate. Currently in the northern Vietnam market, there has been a serious electricity shortage that leads to rotating power cuts, making installing self-consumption rooftop solar extremely necessary." (Nguyen, 2024)

Beside the possible penetration into solar PV market for C&I, Nguyen maintained that developers should continue the development of utility-scale solar PV. The interviewee posited that this continued focus on utility-scale project is needed to fulfil the goals of meeting net zero emission by 2050 stated at the 26th United Nation Climate Change Conference of the Parties (COP26), according to the International Union for Conservation of Nature (2022). Currently, a substantial portion of Vietnam's energy mix relies on

coal, making the transitioning from fossil fuels to RE sources essential for reducing carbon emissions (World Bank, 2022). This highlights the need for the country to prioritize the development of RE sources, thus signals the demand for more clean energy, posing a grand opportunity for solar PV development.

> "The development of utility scale for solar and wind energy should be continued to meet the goal of net-zero emissions by 2050." (Nguyen, 2024)

Commenting on the recently release of the official 8th Power Development Plan from the Government of Vietnam (GoV), Nguyen expressed that this issuance reaffirms the country's determination to shift away from traditional energy sources toward renewable ones, including solar. Via this confirmation, the GoV expresses their commitment and continued support for RE development, which to a certain level provides a proxy for the sustainable long-term growth of this sector. This might serve as an attractive signal for investors, both domestically and internationally, to increase their investment in Vietnam's RE sector.

> "PDP VIII reaffirms Vietnam's intention to shift away from coal power and toward renewable energy sources, including solar. This commitment signals continued support for the solar PV sector and can attract long-term investors." (Nguyen, 2024)

Another institutional movement that potentially create an opportunity for solar PV developers in the future is the slow transition to a competitive retail market for electricity. Nguyen anticipated that the GoV is likely to enact many policy changes that would slowly transform the current state-owned monopoly electricity market to a competitive one. She advocated for this transition, adding that a competitive electricity market will improve market efficiency. Specifically, in a competitive market, electricity price will be determined by market forces, thus making the pricing transparent. Moreover, leaving electricity pricing to the market would provide clear signals to investors about the balance of demand and supply of electricity, thus assisting them in making informed investment decision. In overall, this improved transparency of the market would contribute to improvement of the whole system.

> "If transition to competitive retail electricity market, electricity price will be clearly and transparently determined by market mechanism, thus customers will become less opposed to increased electricity price. Moreover, having the price determined by market mechanism will effectively provide a signal about supply and demand balance, providing more information to investors to make decisions on investing in new power sources. This market mechanism would also force the electricity industry to improve

production and business efficiency, thereby leading to overall efficiency for the entire electricity industry." (Nguyen, 2024)

To sum up, the solar PV landscape in Vietnam is positioned to continued growth that is backed by supportive policies and new market opportunities. The newest FIT adjustment is designed to level the playing field across different regions, thus creating enticing investment opportunities for investment and growth in previously untapped areas. Apart from financial incentives, the GoV's stated goal of achieving carbon neutral and continue development of RE highlights the importance of RE sector, thus providing a guarantee for long-term development of this sector, including solar PV. Beyond formal legislative assistance, the growing energy demand for the C&I sector and an upcoming transition to a competitive electricity retail market also represents a new frontier for solar PV development. This dual impetus of policy support and market demand signals a promising future for solar PV in Vietnam.

4.3.2 Challenges

Despite the stated opportunities, the solar PV sector in Vietnam also faces a fair share of barriers that might curb the growth potential of this sector. Pertaining to this is the fundamental change of one of FIT's main design element, general policy uncertainty, and a potential signal of slowdown in the overall pace of solar PV development.

First, Nguyen addresses that the recent issuance of Decree No. 19/2023/TT-BCT mentioned above does not present just opportunities but also challenges as there are changes to one of FIT's main terms that might discourage investors. In detail, the decree regulates that tariff rates will now be set annually, rather than on a 20-year basis as was previously the case. This means that the rates will fluctuate in the future, making forecasting profits more difficult for developers. This change might discourage developers as this is a complete 180-degree shift from the previous FIT, eliminating the certainty and predictability provided the previously fixed-payment. Although it might be the case that this new mechanism is employed to account for inflation and changes in the electricity price, that the stable revenue stream of FIT would not be longer applicable for projects going into operations after the enactment of the new degree makes it unclear whether the new FIT mechanism would be as effective as the previous one.

"This change presents many implications for investors and operators, especially because the prices will be now set annually compared to the previous 20-year fixed pricing. This means electricity prices could fluctuate in the future, making it hard to forecast profits." (Nguyen, 2024)

Second, policy uncertainty and lack of elaborate legal basis for direct power purchase agreement (DPPA) are also mentioned in the interview as challenges that might hinder continued growth of solar PV in Vietnam. Continuing the discussion on the new policy changes, Nguyen commented that the current policy status is uncertain, and due to this uncertainty, there has been an emerging trend among power developers in Vietnam to move away from government-reliant projects. She revealed that solar PV developers and investors are shifting towards projects that are less dependent on government incentives, such as targeting C&I customers and employing DPPA for solar PV projects.

> "With the current uncertainty policies, as an investor I need to shift my focus towards projects that are less reliant on government incentives, such as self-consumption for C&I and DPPA." (Nguyen, 2024)

However, this shift is not without hinderance as there is an absence of concrete legal basis that leads to obscurity when developing RE projects, especially for DPPAs. DPPAs allow sellers and buyers to freely negotiate and agree on the terms of the power purchase contract themselves; hence, both parties can flexibly adjust and allocate liabilities so that risks are minimized and equally distributed. This greater level of control over the power purchase agreement (PPA) can encourage more C&I firms and RE developers to enter the market. Nguyen also noted that implementing DPPA can help reduce grid overload, relieve energy shortage, and increase market competition. Due to these reasons, DPPA is seen as a major improvement from the existing PPA that has not been very effective in mitigating risks for developers. Despite such benefit, there are currently no specific guidelines for DPPAs for developers to implement this new model, concerned Nguyen. This lack of concrete legal framework for PPA implies that a lot of benefits will not be realized if the framework is not implemented, and that the opportunity to develop solar PV energy to catch up with stated goals might be missed if timely and decisive actions are not taken.

> "However, there are currently no specific guidelines for implementing this model (DPPA). We hope that in the near future, there will be a mechanism in place to allow investors and customers to implement this model. The purpose of encouraging DPPA is to reduce grid overload, relieve capacity shortages in areas with electricity shortages, and increase market competition." (Nguyen, 2024)

Beside these major challenges, Nguyen also mentioned several institutional hurdles for the development of solar PV, which are the underdevelopment of grid infrastructure and a competitive retail market for electricity. She

stressed that in order to keep up the momentum of the recent solar PV growth, continuous improvement of RE related policies and grid infrastructure are pivotal.

> "Continued policy development and grid infrastructure improvements are crucial for sustaining this momentum (solar PV development)" (Nguyen, 2024)

Hence, she continued to point out that the current transmission line needs upgrade in order to keep up with the boom in solar PV; else, the unmatch between the deployed capacity and the infrastructure might risk overloading the system, leading to power security concerns.

> "In terms of national power system security, locally developing renewable energy projects but not promptly upgrading the transmission line system can lead to instability in the power grid." (Nguyen, 2024)

On policy updates, Nguyen briefly commented that although the newly issued 8th Power Development Plan (PDP8) reaffirms Vietnam's commitment towards RE, she specified that this update has lowered the solar targets compared to previous plans and commented that this lowered expectation might be indicative of a slow growth for solar in the future.

> "PDP8 sets more modest solar targets compared to some previous expectations, opting for only a modest increase in rooftop solar by 2030. This could signal a slowdown in the overall pace of solar PV development." (Nguyen, 2024)

To sum up, although opportunities to further boost the development of solar PV are present, complications in the policy landscape might hinder this potential. The newest revision of FIT's fundamental terms to annual tariff rate settings, introduces a level of uncertainty that could deter investor confidence and complicate profit forecasting for developers. Moreover, this shift poses a level of the policy uncertainty that might discourage investors, especially concerning the development of a concrete DPPA framework. Although DPPA can be a catalyst to unlock greater solar PV expansion, delay in the implementation of this can conversely jeopardize the growth of solar PV in specific and the whole RE sector in general. Other institutional problems such as infrastructure underdevelopment and lower RE targets also pose challenge.

5 Discussions

5.1 The effectiveness of Vietnam's FIT and RPS policies in solar PV development

5.1.1 General effectiveness

In general, the result of the quantitative analysis confirmed the positive effect of FIT and RPS on solar PV capacity. The study supported that the presence of these two policies in the policy mix stimulate the development of solar PV by a substantial growth. Comparing the policies, FIT seems to be more effective than RPS as indicated by the result of the first model. The notion is in alignment with Polzin et al.'s (2019) and Dong and Guo's (2017) finding where the authors posit that FIT exerts a larger effect on RE investment compared to other instruments. While holding the same stance, the result of this research extends Polzin et al.'s finding to the specific context of solar PV, confirming the supremacy of FIT over other instruments in developing solar energy. This is supported by Sreenath et al. (2022), who advocate that FIT is the most important scheme to initiate solar PV growth.

However, this does not mean that FIT can be the trump card and the influence of RPS can be ignored. The presence of RPS policy also results in a substantial increase in total solar PV capacity. This contrasts the finding of Baldwin et al. (2016) where it is argued that RPS is most effective only in developed countries and has only limited impact in middle- and low-income countries. The statistic result has proven otherwise, not to mention the real growth of solar PV during the late 2010s that surpassed even developed countries like Singapore. Although it is not to dismiss Baldwin et al.'s finding, this result suggests that it might be better to assess the potential of a RE policy based on the development level of the RE sector rather than the mere general development level of the whole economy.

5.1.2 Influence on risks and returns

Advancing from the general enactment of the policies, their effectiveness is analyzed by their influence on investment metrics: risk and return. Qualitative findings from this study and the literature both reach the consensus on the double effect of FIT that this instrument effectively addresses both the risk and return aspects of an RE project in general and solar PV projects in specific. By offering a fixed price over a guaranteed period, FIT improves the return of a project by providing a stable and guaranteed revenue stream, improving the predictability of future income for investors. Via this mechanism, FIT simultaneously removes the price volatility risks. This is the same as the conclusion by Chang and Li (2016) and Polzin et al. (2019), in which

both studies emphasize how this predictable revenue stream improves income certainty, thus making it easier to finance the project.

Regarding RPS, while study by Polzin et al. (2019) proposes that RPS strengthens return yet have no effect on the risk of an RE project, the result in this paper shows the opposite. The interview's result does not address how RPS improve the return but much of the discussions emphasize how RPS is effective in removing several sources of risks. In detail, RPS does not only help creating a market for the generated electricity but also ensures the demand for the energy by obligating a minimum proportion of renewable sources in the energy mix of power distributors and generators. This requirement put power distributions entities under compliance pressure thus a need to source RE to keep up with the requirements. The market stagnation referred to in the interview might imply off-taker (risk of default by the power purchaser (Urakami, 2023)) and curtailment risks (congestion due to mismatch in production and grid capacity or demand (Dang and Taghizadeh-Hesary, 2019)) Via this dynamic, RPS ultimate offset off-taker and curtailment risks, improving developers' confidence in continuing to expand solar PV. Dong (2012) suggests that instead of a fixed percentage with scheduled increase, an annual incremental increase RPS quota might make this policy even more effective,

As both FIT and RPS are effective in stimulating solar PV development, the question lies in whether a policy mix of both is needed. The literature reveals that it might be best if both FIT and RPS are both utilized in a proper policy mix as suggested by the literature. Both Romano et al. (2016) and Wall et al. (2018) suggest that FIT and RPS should be combined for the best result. The reason for this combination lies in the different influences each policy exerts on the market. While RPS creates and sustain market demand, the quota is a government mandate after all – hence, it might introduce unnecessary strain on the actors to keep up with the requirements, especially when the upfront investment for RE projects is financially intensive. FIT might be able to ease this stress by offering financial incentives.

5.1.3 Design elements

On the effect of specific policy design elements, FIT contract duration and RPS quota are proven to effectively induce higher annual addition of solar PV capacity. This might be due to (1) investor's preference for certainty as guaranteed by the long contract term of FIT, and (2) the market creation potential of RPS quota and its alleviation of off-taker risks and curtailment risks. Although the effect of tariff rate is not found in the quantitative analysis due to the limits of the data and quantitative model, results from the interview is indicative of the positive influence of tariff rates on solar PV

growth as the FIT rate was mentioned as one of the important attributes that leads to the past exponential growth of solar PV in Vietnam, aligning with Do et al. (2021). Moreover, tariff rate is also regarded as a valued financial incentive from the perspective of solar PV developers.

Examining the discussion on the effectiveness of FIT and RPS so far, several keywords can be factored out, which are certainty, stability, and market demand and accessibility and risk mitigation. These keywords reflect solar PV's developers' main concern as well as the required features for RE policies to be effective. In detail, the preference for certainty aligns with investor's need for a stable and predictable revenue stream, underlined by the positive correlation between FIT contract duration and solar PV development. On the other hand, the market creation capability of RPS in combination with its role of mitigating off-taker and curtailment risks emphasized the importance of ensuring demand for RE. Moreover, RPS addresses the demand side of the market, ensuring that there is a continuous need for solar PV, ultimately supports the sector's sustainable growth.

5.2 Suggestions for future solar PV development

The opportunities and challenges revealed in the discussion with Ms. Khe Nguyen hint at several ways to enhance solar PV development in the future. In this section, these suggestions will be discussed and substantiated with established results gained from previous studies.

5.2.1 FIT and RPS implementation

The effectiveness of FIT and RPS as policy instruments to stimulate the growth of solar PV energy has been clearly demonstrated. Hence, the room for improvement lies in how the government can achieve an optimal policy and reduce policy uncertainty.

Le et al. (2023) expressed that one of the weaknesses in RE policies in Vietnam is the uncertainty of FIT. The interviewee for this study also expressed concern about the new change for this instrument, implying that this update might exacerbate the problem. One way to alleviate such uncertainty is for the GoV to devise plan with scheduled changes and announce such changed in advance, especially for FIT in the future. This approach has been adopted by several neighboring countries. For example, Philippines introduced FIT with a degression rate of 6% after the first year for solar PV contract (Simmons & Simmons, 2016), while Thailand announced FIT with a prescheduled three-step degression: 9.75 Thai Baht/kWh for years 1–3, 6.50 Thai Baht/kWh for years 4–10, and 4.50 Thai Baht/kWh for years 11–25 (Govindaraan et al., 2023). Despite different implementation, the shared idea is

that the changes were anticipated and communicated well in advance they announced the changes in advance. This proactive strategy in policy communication ensures that all market actors are well-informed, thus adequately prepare for upcoming changes, reducing the shock that might occurs in case of abrupt policy changes. By clearly define the future trajectory of FIT in specific and RE policy in general, this approach does not only improve the stability of the investment environment but also enhance the overall confidence of investors in the domestic RE market. In order to account for unexpected changes such as inflation or exchange rate, the government should also consider in advance for how such metrics will be accounted for as well.

To encourage even solar PV development across the entire country, it is also recommended that the GoV should extend FIT to be applicable for solar rooftop projects. Le et al. (2022) identified that the limited applicability of FIT to only grid-connected projects has discouraged the development of rooftop solar applications. However, considering the growing demand of rooftop solar PV from the C&I sector, FIT for rooftop is essential for not only the development of solar PV but also the retainment of potential clients for this industry in Vietnam, as several high profiles investors have entered the market for C&I rooftop solar in Vietnam (IEEFA, 2022).

Moreover, the GoV should consider extending the eligibility window for FIT, as indicated by Urakami (2023). McKinsey & Company (2019) also notes that one of the bottlenecks of Vietnam's RE policy is the tight FIT window of 3 years. This strict deadline gives investor little incentive to invest, as they fear the possibility of missing the deadline, thus being ineligible to receive the support. Hence, widening the eligibility window will raises investors' confidence and initiate more investment.

Regarding RPS, it is crucial that the GoV allocate sound capacity quotas for the proportion of RE in the energy mix. These quotas should be ambitious enough to motivate the deployment of solar PV systems, yet not so high as to impose excessive strain on investors. The GoV has laid out a roadmap for RPS quotas that schedules increasing quotas over time, which will maintain the continued compliance pressure for electricity distributors to increase their share of RE while also ensure a growing market demand for current developers to expand their business and newcomers to participate. This strategy can a stable and sustained development of the solar PV market; yet RPS can still be improved if annual incremental increase in RPS quota is employed. Shem et al. (2019) has stated that RPS has been relatively utilize. The GoV can take advantage of this unrealized potential by adopting an incremental addition plan for solar in the future. Polzin et al. (2019) has discovered that incremental addition in RPS quota can outperform nominal requirement as the quota might already be met before RPS is introduces. The incremental increase can

facilitate a stable and sustainable development of solar PV, avoiding the pitfalls of a rapid influx of investments that could potentially stall as the market matures.

In general, the overarching goal for the GoV should be to foster a regulatory environment that supports the predictable and stable expansion of the solar PV market. The implementation of scheduled changes to FIT and a balanced RPS quotas can mitigate the current policy uncertainty that halts investors to actively join the market. In order to guide the development of solar PV, the GoV should also continuously monitor and evaluate policy impacts to prepare for timely adjustments, ensuring that the policy mix remains responsive and relevant to market dynamics as timely implementation and a smooth policy transition play a big role in the sustainable development of solar PV (Sreenath et al., 2022).

5.2.2 Commercial and Industrial (C&I) sector, direct power purchase agreement (DPPA) and competitive electricity market

The discussion on the opportunities and challenges during the interview with Ms. Khe Nguyen also sparks some suggestions for the further development of solar PV in Vietnam. The opportunity for this investment lies in the expansion of the market to C&I customer sector for solar PV developers, and the implementation of DPPA and enabling of a competitive electricity market from the GoV.

The C&I solar PV segment has been growing rapidly in Vietnam. This market, despite its smaller sized compared to the utility scale, has been "quietly driving capacity growth amid the PDP8 policy limbo, as developers and their financiers tap onto Vietnam's largely under-served and growing industrial space" (IEEFA, 2022). IEEFA reported that this segment has been so established that it has evolved to almost detach from tariff deliberations and government policies. Similar to what the interviewee has reported, solar PV developers have transitioned from a FIT-reliant business model to one that flexibly accommodate their energy output with C&I market's demand and consumption pattern, maintaining the project's economic viability even in the absence of state subsidies. Hence, C&I is expected to be major market segment in the future (Apricum, 2023), posing an attractive opportunity for solar PV developers.

Besides its independence from government support, the C&I sector can drive up solar PV development in Vietnam substantially by taking advantage of foreign direct investment. McKinsey and Company (2023) reported that many international manufacturers are avoiding investing solely in China by diversifying into neighboring countries, including into Vietnam. This is the

chance for Vietnam's solar PV investor to expand their business to meet the increasing demand of these C&I customers'. Moreover, C&I customers, who are members of RE100, commit to complete transition to RE, thus can provide 10% green premiums for RE in Vietnam (McKinsey & Company, 2023). If the country can successfully capitalize on this opportunity, Vietnam has the potential to "become a regional champion for both installed renewable capacity and sustainable manufacturing."

The successful capitalization of the emerging C&I segment cannot be realized before the GoV officially establishes a complete legal framework for DPPA. DPPA is a type of contract that allows private electricity buyers and sellers to sign an agreement directly for electricity transactions (Dang and Taghizadeh-Hesary, 2019). This new form of power purchasing contract is an advancement from the traditional PPA, as it allows firms to have more leeway to tailor the contract to their needs compared to the fixed, "take-it-or-leave-it" features of traditional PPA. Under DPPA, parties can negotiate on the terms of a power purchasing contract, including price and fair allocation of liabilities so that developers can offset key project risks of an RE investment. This level of flexibility in customizing contract terms can facilitate the emergence of C&I as DPPA adds to the ease of doing business and ability to negotiate for a more favorable price, subsequently encourage C&I customers to partake in the power purchasing contract, subsequently stimulate solar PV development.

DPPA is not only beneficial for the power purchasers but also power generators. This mechanism is a solution for renewable energy producers facing curtailment or with excess output by securing a direct electricity transaction without having to join the limited local grid infrastructure (Nguyen, 2022). Moreover, off-taker risks are eliminated as off-takers of DPPA are often large, well-known business entities that are generally creditworthy (Dang and Taghizadeh-Hesary, 2019). Better credit rating of off-takers in the contract will improve the bankability of the DPPA, affording developers easier access to more financial sources for their RE projects. In addition, better quality of off-takers will ensure better profitability for the developers. Altogether, DPPA would eliminate the general counterparty risks as identified by Surana and Anadon (2015) that pertains to the willingness and ability of off takers to settle payments as well as the credit rating of the contract.

A further step to foster the development of solar energy in Vietnam is the enabling of a competitive electricity market, as suggested by the interviewee. This notion is supported by Dang and Taghizadeh-Hesary (2019) as the author advocate that the country should form a competitive energy market as it will create a functional and transparent market that enable investors to forecast electricity price better based on the free market's demand-supply

dynamic, thus improving investor's impression on the certainty and stability of Vietnam's solar PV sector. They further propose that the formation of a competitive market should start from restructuring the market from a vertical monopoly of state-owned enterprises (SOEs) to a more competitive, levelled playing fields that allow participations of more private actors. Dang and Taghizadeh-Hesary (2019) state that as Vietnam has completed 100% electricity access for its population, the total control of SOEs is now obsolete, and the transition from a monopoly to a competitive electricity market is a critical strategy if the country wishes to advance further in the field of RE in general.

6 Conclusions

6.1 Main findings

This research sets out to study the effectiveness of two RE policy instruments, namely FIT and RPS, from both empirical and practical perspective. A pooled OLS regression model was used to test the effectiveness of the policies by their existence as well as their specific design policies. To ensure a more diverse perspective and further explores the opportunities and challenges of the solar energy sector in Vietnam, a structured interview with an insider was conducted. The main findings of this study are as following:

1. The establishment of FIT and RPS results in an increase in total solar PV capacity.
2. Longer FIT contract duration and higher RPS quota stimulates higher annual addition to solar PV capacity.
3. Opportunities for solar PV developers lie in the expansion of solar PV to underdeveloped areas, the emerging C&I rooftop solar, the continued commitment for utility-scale solar development, and the transition to a competitive retail electricity market.
4. To optimize solar PV development, it is crucial for Vietnam to overcome policy uncertainty for FIT, lack of legal basis for DPPA framework and improve grid infrastructures.

6.2 Implications for International Business

The study on the dynamic between government policies and RE development suggests several implications for International Business. Although the scope of this study is on Vietnam, some implications can be generalized and projected onto the context of international markets.

First, the findings underscore the pivotal role of government policies in shaping the development of the RE sector. Hence, it is important for investors to gain in-depth understanding of the policy landscape to optimize their decisions. Businesses should navigate these policies and align their strategies with government policies for successful entry and expansion. This involves not mere compliance but also leveraging these policies to enhance their profitability.

This previous idea leads to the second implication: a thorough understanding of the policies as well as their interaction with market forces thoroughly would benefits businesses in identifying and seizing emerging opportunities. Firms should not only leverage the benefits offered by the policies but also notice their weaknesses to uncover potential market niches. This is illustrated by how investors in Vietnam are diverting to C&I rooftop solar

market to meet the sector's growing demand, thus not only capitalize on a burgeoning market but also navigate around policy uncertainties.

6.3 Limitations

It is important to acknowledge the limitations of this research besides those already discussed in the relevant sections. First, the result of the quantitative analysis might be over-generalized due to the small sample size (33 observations). This small size subsequently leads to constraint on the options for regression model. The chosen model does not account for country-specific and time-specific characteristics, leading to an over-generalization of the result. This can be attributed to difficulty in retrieving policy-related information as it is hard to interpret government policies as well as compile a complete collection of relevant data.

On the other hand, only conducting one interviewing might limit the perspective on the topic, potentially leading to biased answers. This is due to limited accessibility to industry insiders that hold similar positions and expertise. Moreover, the structured, written format of the interview does not allow for impromptu, in-depth probing questions that would facilitate a more insightful discussion. However, results from the interview aligns with that of the extant literature despite the constraints.

6.4 Suggestion for further research

This research has suggested many open avenues for future studies. First, to better elaborate on this topic, future studies can benefit from incorporating a larger data set and more nuanced quantitative model to test the effectiveness of RE policy instruments. Second, as the study has hinted at the looming trend of RE investors and developers to shift away from publicly funded areas, investigating private participation as well as the drivers for these actors might assist future policy design that attract even more private capital into. the industry. Last, as risk and returns are direct metrics of financing, a study focusing directly on investment would contribute to an even deeper understanding behind the direct driver of solar PV development.

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Appendices

Appendice A: Quantitative results

Table A.1.: Descriptive statistics for all variables

Variable	Obs	Mean	Std. dev.	Min	Max
LN_CAPACITY	33	5.893124	2.84705	0.6931472	9.82412
LN_ADDEDCAP	26	4,737855	2.309445	0	9.36452
TARIFF	33	125.5545	78.05663	0	229.4
DURATION	33	18.63636	8.317219	0	25
QUOTA	33	0.4545455	1.175024	0	4

```
. hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of LN_CAPACITY

H0: Constant variance

    chi2(1) =   0.28
Prob > chi2 = 0.5955
```

Figure A.2.: Heteroskedasticity test for Model 1. The p-value of the test is insignificant; hence the model is homoscedastic.

Table A.3.: Variance inflation factors for Model 1. All VIFs are less than 5, thus no multicollinearity

Variable	**VIF**	**1/VIF**
FIT_DUMMY	1.03	0.969349
RPS_DUMMY	1.03	0.969349
Mean VIF	1.03	

Table A.4.: Correlation coefficients

		LN_ADDEDCAP	**TARIFF**	**DURATION**	**QUOTA**
LN_ADDEDCAP	*Pearson Correlation*	1			

	Sig. (2-tailed)				
	N	26			
TARIFF	*Pearson Correlation*	-.165	1		
	Sig. (2-tailed)	.421			
	N	26	33		
DURATION	*Pearson Correlation*	.323	.695**	1	
	Sig. (2-tailed)	.107	<.001		
	N	26	33	33	
QUOTA	*Pearson Correlation*	.487*	-.225	0.65	1
	Sig. (2-tailed)	.012	.207	.718	
	N	26	33	33	33

```
. hettest

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of LN_ADDEDCAP

H0: Constant variance

    chi2(1) =   0.48
Prob > chi2 = 0.4884
```

Figure A.5.: Heteroskedasticity test for Model 2. p-value > 0.05, hence homoscedasticity

Table A.6.: Variance inflation factors for Model 2. All VIFs are less than 5, hence no multicollinearity.

Variable	VIF	1/VIF
TARIFF	1.84	0.542081
DURATION	1.53	0.653344
QUOTA	1.27	0.788388
Mean VIF	1.55	

Appendice B: Data used for quantitative analysis

Country	Year	Cumulative solar capacity (MWh)	Annual solar capacity addition (MWh)	Tariff (USD/MWh)	Duration (year)	RPS quota (%)	FIT dummy	RPS dummy
Vietnam	2012	5	5	0,00	0	0	0	0
Vietnam	2013	5	0	0,00	0	0	0	0
Vietnam	2014	5	0	0,00	0	0	0	0
Vietnam	2015	5	0	0,00	0	0	0	0
Vietnam	2016	5	0	0,00	0	0	0	0
Vietnam	2017	8	3	93,50	20	0	1	0
Vietnam	2018	105	97	93,50	20	0	1	0
Vietnam	2019	4993	4888	70,90	20	0	1	0
Vietnam	2020	16660	11667	70,90	20	4	1	1
Vietnam	2021	16660	0	70,90	20	4	1	1
Vietnam	2022	18474	1814	70,90	20	4	1	1
Thailand	2012	382	382	220,00	25	0	1	0
Thailand	2013	829	447	225,60	25	0	1	0
Thailand	2014	1304	475	191,80	25	0	1	0
Thailand	2015	1425	121	187,50	25	0	1	0
Thailand	2016	2451	1026	187,50	25	0	1	0
Thailand	2017	2702	251	187,50	25	0	1	0
Thailand	2018	2967	265	187,50	25	0	1	0
Thailand	2019	2988	21	187,50	25	0	1	0
Thailand	2020	2988	0	60,00	25	0	1	0

Thailand	2021	3065	77	65,00	25	0	1	0
Thailand	2022	3065	0	57,00	25	0	1	0
Philippines	2012	2	2	229,40	20	0	1	0
Philippines	2013	3	1	229,40	20	0	1	0
Philippines	2014	28	25	229,40	20	0	1	0
Philippines	2015	173	145	210,00	20	0	1	0
Philippines	2016	784	611	183,30	20	0	1	0
Philippines	2017	908	124	183,30	20	0	1	0
Philippines	2018	917	9	140,00	20	0	1	0
Philippines	2019	982	65	140,00	20	0	1	0
Philippines	2020	1058	76	140,00	20	1	1	1
Philippines	2021	1377	319	115,50	20	1	1	1
Philippines	2022	1625	248	115,50	20	1	1	1

Appendice C: Interview questions

Section 1: Policy impact on solar PV's project risk and returns

1. Do these policies effectively enhance the attractiveness of solar PV investments in Vietnam compared to other energy sectors or countries?
2. Specifically, how have FITs and RPS policies in Vietnam influenced the expected returns of your solar PV projects?
3. How do the FIT and RPS policies in Vietnam influence your risk assessment for solar project investment and development?
4. Can you describe any specific risks that are alleviated or exacerbated by these policies?

Section 2: Policy stability

5. How do you evaluate the stability and predictability of Vietnam's FITs and RPS policies?
6. Policies for renewables have been changed several times in Vietnam. How have you adapted your investment strategy in response to changes or updates in the FITs and RPS policies?

Section 3: Opportunities and challenges of developing solar PV in Vietnam

7. What opportunities do you see in the Vietnamese market for new and existing players in the solar PV sector?
8. What are the major challenges facing investors and developers of solar PV in Vietnam?
9. There's a recent official introduction of the 8th National Power Development Plan in Vietnam. What impact do you think this will have on the solar PV sector?
10. What are the competitive advantages of Vietnam's policy status compared to other ASEAN member states (AMS) in developing solar PV?
11. What are the best practices implemented by other AMS that Vietnam can adopt in designing policy instruments to develop solar PV?

Section 4: Additional comments

12. Is there anything else you would like to add that we haven't covered?

Appendice D: Interview transcript

Interviewer: Nguyen Vo
Interviewee: Tran Thien Khe Nguyen (Khe Nguyen), Business Development Manager, Vietnam @ Levanta Renewables
Interview format: Structured, written interview through email.

1. Overall, FIT and RPS have significantly enhanced the attractiveness of solar PV. FIT provides fixed, long-term rates for electricity generated from solar PV projects. This reduces investment risk and provides predictable revenue, making solar projects financially viable. RPS creates a mandatory demand for renewable energy, including solar PV. This guarantees a market for the electricity generated, further reducing investment risks.

   The generous FIT rates in Vietnam offer higher potential return, while the RPS guarantees market access for new solar energy developer, making the returns from this sector higher compared to that of the established traditional energy sector such as coal or natural gas, where the market is facing saturation, plus price stagnation. Compared to other countries, FIT rates in Vietnam are relatively competitive compared to other energy sectors and several other countries as well. However, continued policy development and grid infrastructure improvements are crucial for sustaining this momentum.

2. The guaranteed rate from FIT allows developers to be able to predict stable future revenue stream. RPS ensures a market for electricity. When combined, these policies enhance the stability of the project's returns.

3. In terms of national power system security, locally developing renewable energy projects but not promptly upgrading the transmission line system can lead to instability in the power grid.

4. By offering fixed and guaranteed returns, FIT protects investors from market fluctuation in electricity price. RPS guarantees a market for the generated electricity to be sold, eliminating the risk of being unable to sell the electricity. It also lowers the entry barriers for new developers via the quota mandate.

5. Ever since the first introduction of FIT in 2017, Vietnam has continued maintaining this mechanism. The FIT rates that have been offered so far are fixed over an extended period. However, there is a recent change in this policy. Vietnam's Ministry of Industry and Trade

(MOIT) issued Decree No.19/2023/TT_BCT in that started to take effect on December 19, 2023, that stipulates new rules for feed-in tariffs for both solar and wind project. The new mechanism for establishing annual electricity pricing for FITs for different types of solar and wind projects determine that Vietnam Electricity (EVN) will be responsible for computing the annual FIT based on the level of participation, then the rate will be published to the public. This is an important piece of legislation for prospective investors of solar energy projects as it determines the electricity price for the near future. This change presents many implications for investors and operators, especially because the prices will be now set annually compared to the previous 20-year fixed pricing. This means electricity prices could fluctuate in the future, making it hard to forecast profits.

Another main change introduced by the decree is that solar radiation will be included in the FIT rate, meaning that this price will vary for different regions. This is to target investors' choice of location and encourage them to move to regions where solar energy is still underdeveloped, as the FIT is designed to be higher where levels of solar radiation are lower.

6. With the current uncertainty policies, as an investor I need to shift my focus towards projects that are less reliant on government incentives, such as self-consumption for C&I and DPPA (direct power purchase agreement). Personally, I think this will be an explosive direction in the future.

7. There has been a rapid growth in the C&I solar rooftop market, especially for FDI and multinational companies who are required to have CO2 reduction certificate. Currently in the northern Vietnam market, there has been a serious electricity shortage that leads to rotating power cuts, making installing self-consumption rooftop solar extremely necessary.

   The development of utility-scale for solar and wind energy should be continued to meet the goal of net-zero emissions by 2050.

8. The current lack of legal basis leads to obscurity when developing renewable power projects. We are waiting for the government to issue a policy and mechanism for implementing DPPA projects in the near future. Currently, the government is encouraging the development of solar PV under the DPPA model, which stands for Direct Power Purchase Agreement. Under this model, the seller and buyer will negotiate and agree on the terms of the power purchase contract

themselves. However, there are currently no specific guidelines for implementing this model. We hope that in the near future, there will be a mechanism in place to allow investors and customers to implement this model. The purpose of encouraging DPPA is to reduce grid overload, relieve capacity shortages in areas with electricity shortages, and increase market competition.

9. PDP VIII reaffirms Vietnam's intention to shift away from coal power and toward renewable energy sources, including solar. This commitment signals continued support for the solar PV sector and can attract long-term investors.

   PDP VIII sets more modest solar targets compared to some previous expectations, opting for only a modest increase in rooftop solar by 2030. This could signal a slowdown in the overall pace of solar PV development.

10. (no answer)

11. Develop a mechanism for a competitive retail electricity market. Currently the Government of Vietnam has not enacted ant specific issues on this, but it is possible that there will be many policy changes in the future to increase competition and transparency on the market, and limit monopoly when selling electricity as is currently the case in Vietnam. The electricity market in Vietnam is currently operating under monopoly of a state-owned enterprise that controls all stages of electricity generation, transmission, distribution, and retail. This model has the advantage of centralized management and insurance that operations are in close accordance to the state's plan. However, the major disadvantage is that there is no competition, no motivation to improve efficiency, and difficulty in attracting more investment. In contrast, if transition to competitive retail electricity market, electricity price will be clearly and transparently determined by market mechanism, thus customers will become less opposed to increased electricity price. Moreover, having the price determined by market mechanism will effectively provide a signal about supply and demand balance, providing more information to investors to make decisions on investing in new power sources. This market mechanism would also force the electricity industry to improve production and business efficiency, thereby leading to overall efficiency for the entire electricity industry.

12. (no answer)