CEBI
Clean Energy Buyers Institute

allotrope PARTNERS

VIETNAM CORPORATE CLEAN ENERGY PROCUREMENT:

MARKET OVERVIEW REPORT

for Commercial and Industrial Energy Customers

JANUARY 2024

TABLE OF CONTENTS

1 Authors and Acknowledgments

2 List of Acronyms

4 Executive Summary

4 Vietnam Power Market Background

5 Clean Energy Barriers and Opportunities

6 Clean Energy Procurement Pathways in Vietnam

7 Vietnam Power Market Background

7 Country Overview

8 Energy Landscape and Power Generation Capacity

9 Vietnam's Climate and Energy Goals

11 Energy Market Structure

12 Policy Developments and Gaps

14 Corporate Clean Energy Demand and Key Stakeholders

16 Current State of Play: Market-Level Opportunities and Barriers

17 Clean Energy Procurement Pathways in Vietnam

17 Current Corporate Procurement Options

31 Emerging Off-Site Corporate Procurement Options

36 Conclusion

37 Appendix

AUTHORS AND ACKNOWLEDGMENTS

This report is a knowledge product developed by Allotrope Partners that draws upon Allotrope's deep understanding of Vietnam's clean energy market and related barriers and opportunities. Insights in this report leverage six years of in-depth work that Allotrope has led in Vietnam to grow networks of in-country stakeholders, cultivate market-level knowledge, and deliver technical support to advance first-in-market clean energy procurement and decarbonization solutions in the Vietnam market context. This includes extensive engagement with commercial and industrial (C&I) energy customers, supply chain manufacturers, investors, developers, government officials, and other stakeholders to facilitate clean energy transactions. Under the leadership of Allotrope's local team in Vietnam, Allotrope has engaged in clean energy advisory work with a range of corporate clients. Allotrope has led foundational public-private sector collaboration initiatives like the Clean Energy Investment Accelerator, which Allotrope has jointly led since 2017 alongside the U.S. National Renewable Energy Laboratory and World Resources Institute.

The contents of this report draw upon Allotrope's policy analysis, ongoing stakeholder engagement, and recent interviews with C&I energy customers and other local market experts. The report further taps Allotrope's previous experience facilitating numerous renewable energy procurement processes in partnership with brands and supply chain companies in Vietnam.

PURPOSE

- This report presents a high-level overview of Vietnam's clean energy market to provide C&I energy customers with a snapshot of the current situation for clean energy procurement in the country.
- This report details Vietnam's goals, market-level barriers and opportunities, and current clean energy procurement options. It also provides insights on emerging options, like the Direct Power Purchase Agreement mechanism.
- This report draws upon market insights and direct feedback from C&I energy customers and local stakeholders.

AUDIENCE

This report aims to provide actionable, high-level insights to an audience of stakeholders who are new to the Vietnam market generally or corporate clean energy procurement in Vietnam specifically. Target readers include multinational C&I energy customers and local supply chain manufacturing companies that have not yet engaged in clean energy procurement in Vietnam or are seeking to better understand the market landscape and available or emerging clean energy opportunities.

LIST OF ACRONYMS

BESS	battery energy storage system
C&I	commercial and industrial
CapEx	capital expenditure
CEBA	Clean Energy Buyers Association
CEIA	Clean Energy Investment Accelerator
CfD	contract for differences
COP26	26th Conference of the Parties
DPPA	Direct Power Purchase Agreement
EA	environmental attribute
EPC	engineering, procurement, and construction
EVN	Vietnam Electricity, Vietnam's national state-owned utility
FIT	feed-in tariff
GDP	gross domestic product
GW, GWh	gigawatts, gigawatt-hours
IP	industrial park
JETP	Just Energy Transition Partnership
kW, kWh, kWp	kilowatt, kilowatt-hour, kilowatt-peak
LNG	liquefied natural gas
MOF	Ministry of Finance
MOIT	Ministry of Industry and Trade
MOJ	Ministry of Justice
MW, MWh, MWp	megawatt, megawatt-hour, megawatt-peak
NDC	Nationally Determined Contribution
NLDC	National Load Dispatch Center
NREL	U.S. National Renewable Energy Laboratory
O&M	operation and maintenance
PDP8	Power Development Plan 8
PPA	power purchase agreement
PV	photovoltaic
RE	renewable energy

REC	renewable energy certificate
RTS	rooftop solar
SBTi	Science Based Targets initiative
tCO_2e	metric-tons of carbon dioxide equivalent
TIGRs	Tradable Instrument for Global Renewables
VCGM	Vietnam Competitive Generation Market
V-LEEP II	Vietnam Low Emissions Energy Program II
VBF	Vietnam Business Forum
VSIP	Vietnam Singapore Industrial Parks

EXECUTIVE SUMMARY

VIETNAM POWER MARKET BACKGROUND

- **Vietnam has been one of the world's fastest growing economies over the past decade**. The commercial and industrial (C&I) sector is a driving force in Vietnam's economy that represents 60% of Vietnam's total electricity consumption. The C&I sector includes hundreds of private sector companies seeking renewable energy (RE) solutions across major industries like textile and apparel, technology, and food and beverage.
- Economic growth has been accompanied by **demand for abundant, inexpensive, and sustainable energy** to meet increasing power demand across the C&I sector. This demand can be harnessed to accelerate Vietnam's clean energy transition.
- Vietnam is in the early stages of its clean energy transition, with **solar and wind rising to make up 27% of Vietnam's installed power generation capacity by 2022**. However, fossil fuels currently represent more than one-third of generation capacity (coal 32% and liquefied natural gas 9%), resulting in an emissions-intensive grid.
- To meet growing power demand, Vietnam aims to **scale its energy generation capacity from 76 gigawatts (GW) in 2022 to 150 GW by 2030**. This includes a projected expansion in RE and coal-fired power as well as major increases in liquefied natural gas.

- In support of its clean energy transition, Vietnam has established emissions reductions targets, including a **net zero scenario goal by 2050 and a pledge for no new coal power plants after 2030**. Specific plans and targets to expand electricity generation by source have been set in Vietnam's recently released Power Development Plan 8.
- Key market stakeholders include government, Vietnam Electricity (EVN, Vietnam's state-owned utility), RE developers and service providers, investors, multinational C&I companies, local supply chain manufacturers, and aligned technical support initiatives and industry associations. All are part of a crucial ecosystem that has the **potential to work collaboratively** in support of a rapid, affordable, and sustainable energy transition in Vietnam.
- Key **regulatory entities with decision-making authority** and influence over Vietnam's energy market include the Prime Minister, the Ministry of Industry and Trade, and EVN, among other government and regulatory bodies.
- Vietnam's centralized energy market, for which EVN is responsible for generation, transmission, and distribution, is in the process of being liberalized and is **anticipated to allow greater private sector participation** over time.[1]
- Vietnam's ability to achieve its climate targets is contingent upon **continued support of international public and private sector partners**. Private sector investment and aligned action to drive clean energy procurement and industrial decarbonization will be critical to guiding economic growth and supporting clean energy transition in Vietnam.

CLEAN ENERGY BARRIERS AND OPPORTUNITIES

- Clean energy customers in Vietnam, however, **face significant market-level barriers**, including grid, market, and policy challenges that limit opportunities to scale RE.
- Grid transmission and distribution challenges have **led to RE curtailment and blackouts and continue to dampen** Vietnam's RE market growth.
- Vietnam's RE industry faces a range of policy and regulatory risks that **limit the economic viability of current projects** and constrain the country's potential to meet its emission reduction and net zero goals.
- Key policy gaps include **permitting challenges and lack of a net metering mechanism** for on-site solar, lack of clarity for battery energy storage and emerging solutions, and lack of implementable off-site RE procurement options with continued delays of the Direct Power Purchase Agreement (DPPA) mechanism.

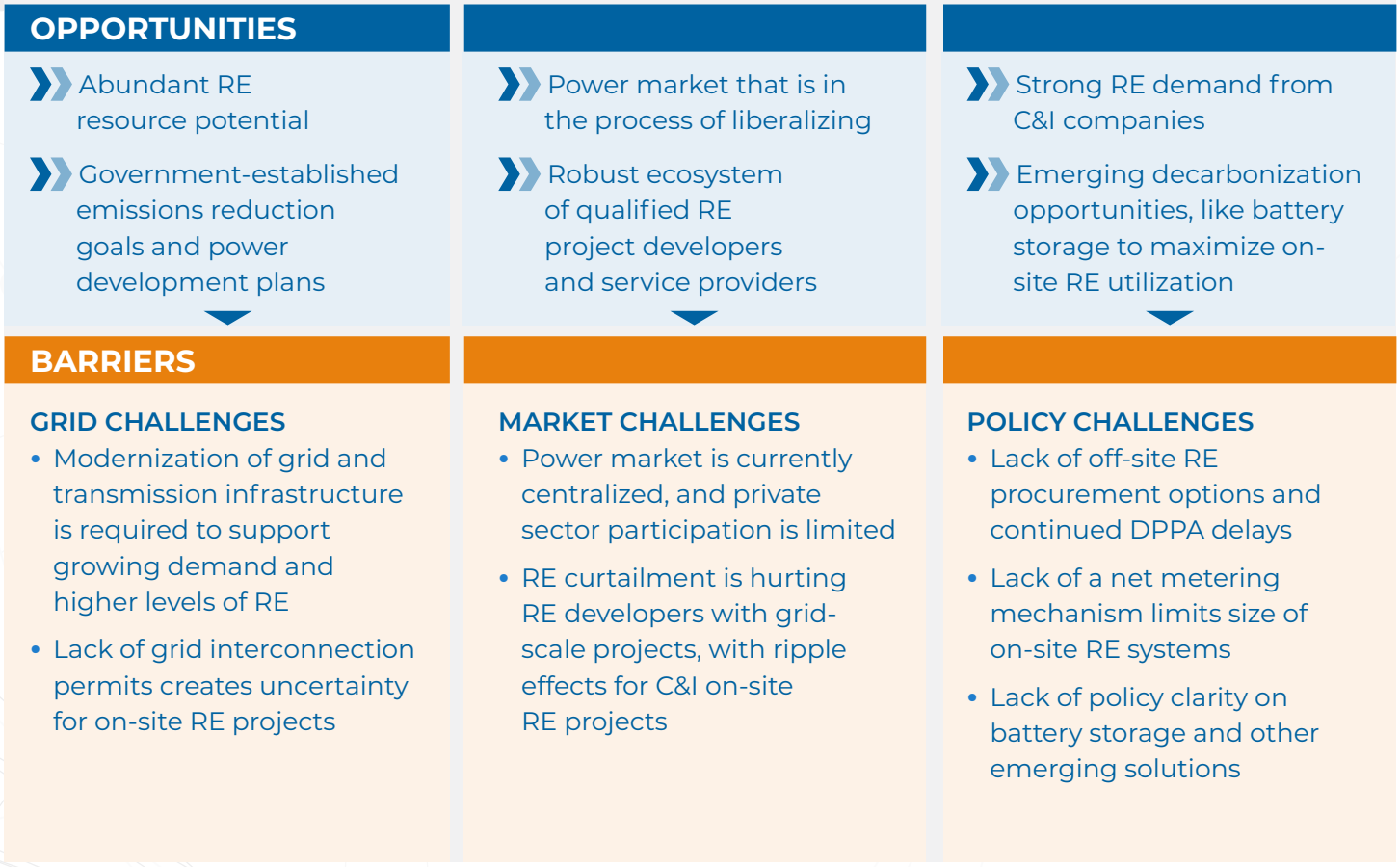
- See Figure 1 for a summary of Vietnam's market-level barriers and opportunities.

1 Power market liberalization is the process of expanding private sector involvement in power generation, distribution, and sale by breaking up existing monopolies and opening the market to more free competition.

CLEAN ENERGY PROCUREMENT PATHWAYS IN VIETNAM

- Currently, the primary RE procurement options for C&I energy customers in Vietnam are on-site turnkey purchases and power purchase agreements (PPAs). Both involve installing rooftop solar systems at the customer's site.
- **On-site turnkey purchases** offer the lowest cost per kilowatt-hour over the system's lifetime and long-term price stability but require significant capital investment, technical expertise, and long-term facility use.
- **On-site PPAs** enable energy customers to procure RE without upfront financing but require signing a long-term contract, consuming a minimum percentage of the system's generation, and often accepting variable pricing terms.
- Vietnam's **long-anticipated DPPA** mechanism has been under development and review for over six years. The DPPA would enable companies to purchase off-site RE and has the potential to circumvent some of the physical and technical limitations of on-site RE options by offering greater flexibility and scalability. Continued delays and lack of clarity have prevented off-site RE procurement to date and are major barriers for energy customers seeking solutions in Vietnam.
- **Vietnam's renewable energy certificate (REC) market** suffers from lack of additionality and unclear ownership. The REC market reflects the current grid oversupply of RE and the lack of a clear national regulatory framework or standardization system for RECs. These issues undermine the credibility and impact of RECs in Vietnam, which require further clarification and improvement through a national-level REC system.

Figure 1. Vietnam's market-level barriers and opportunities



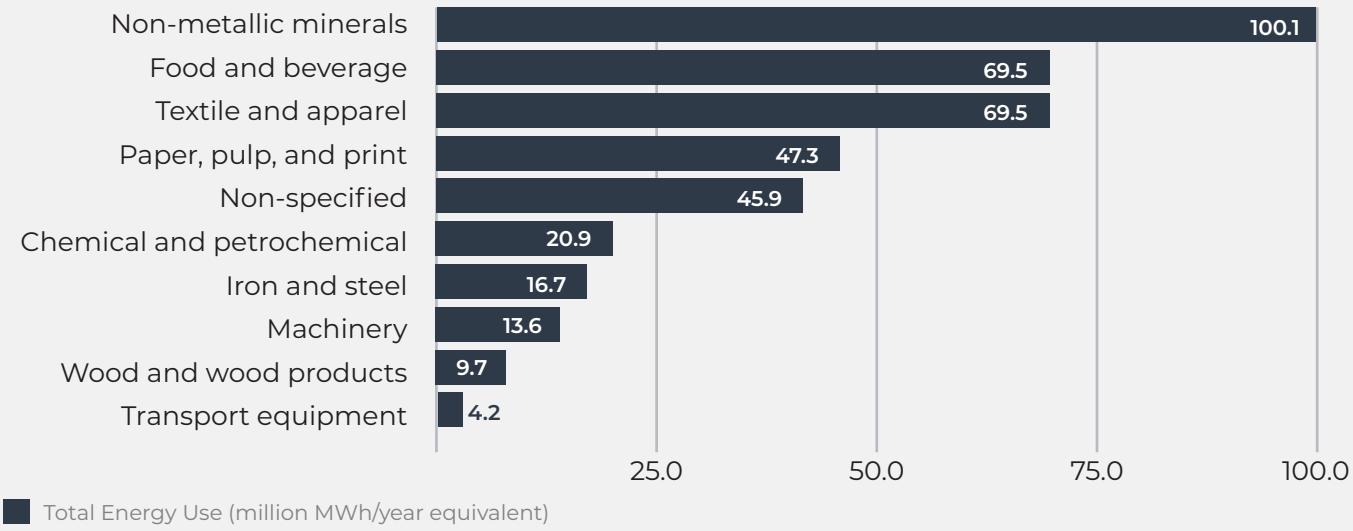
VIETNAM POWER MARKET BACKGROUND

COUNTRY OVERVIEW

Vietnam is one of the fastest growing and most dynamic economies in Southeast Asia, with a 10-year gross domestic product (GDP) compound annual growth rate of 12.8%.[2] The commercial and industrial (C&I) sector plays a key role in Vietnam's economy, and the services and industry subsectors are the central pillars of economic growth and investment in Vietnam. In 2022, Vietnam's services economy accounted for 41% of the country's GDP, and the industrial sector represented 39% of GDP, with major growth in goods processing and manufacturing.[3,4]

Vietnam has become a regional production hub in Southeast Asia for many multinational companies and ranks 21st globally in total exports.[5] As major corporations have sought to diversify their supply chain manufacturing across Asia, production in Vietnam has increased. Foreign direct investment commitments have risen roughly 15% over the past year to US$28.85 billion in 2023.[6] Vietnam is seeking to increase its competitiveness, trade relationships, and integration into global supply chains, particularly with key strategic partners, including the United States, China, South Korea, and Japan.[7] Non-metallic minerals (specifically cement), textile and apparel, and food and beverage represent the top three industries in Vietnam in terms of energy consumption. Other key energy consumers include the paper, chemical, iron and steel, machinery, wood and wood products, and transport equipment industries (see Figure 2).[8]

Figure 2. Energy consumption by industry in Vietnam



2 World Economics. (2024). *Vietnam's GDP compound annual growth rates* [Data set]. https://www.worldeconomics.com/Countries-With-Highest-Growth/Vietnam.aspx

3 Asia Fund Managers. (n.d.). *Vietnam economy*. https://asiafundmanagers.com/us/vietnam-economy

4 Vietnam General Statistics Office. (2022, December 29). *Socio-economic situation in the fourth quarter and 2022*. https://www.gso.gov.vn/en/data-and-statistics/2023/01/socio-economic-situation-in-the-fourth-quarter-and-2022

5 Dezan Shira & Associates. (2023, July 26). *Vietnam's imports-exports top US$55.8 billion in June*. Vietnam Briefing. https://www.vietnam-briefing.com/news/vietnam-imports-exports.html

6 Barnes, M. (2023, December 15). *Recap: Vietnam's economy in 2023*. Vietnam Briefing. https://www.vietnam-briefing.com/news/recap-vietnams-economy-in-2023.html

7 Nguyen, T., & Kyssha, M. (2022, March 18). *An introduction to Vietnam's import and export industries*. Vietnam Briefing. https://www.vietnam-briefing.com/news/introduction-vietnams-export-import-industries.html

8 Hasanbeigi, A., & Khutal, H. (2021, January). Industrial supply chains decarbonization in Southeast Asia. Global Efficiency Intelligence. https://www.globalefficiencyintel.com/industrial-supply-chains-decarbonization-in-southeast-asia

ENERGY LANDSCAPE AND POWER GENERATION CAPACITY

Vietnam's rapid economic growth has been accompanied by increasing demand for abundant, inexpensive, sustainable power across the C&I sector. Electricity demand is expected to further increase by 10% to 12% each year over the next decade.[9] Growing demand coupled with extreme weather events like droughts has prompted Vietnam to lessen its traditional dependence on hydropower and turn to coal, solar, wind, and liquefied natural gas (LNG) to supply power to the country's national grid.

As of 2022, Vietnam's total installed power generation capacity reached nearly 80 gigawatts (GW). The power generation mix is 32% coal-fired power, 29% hydropower, 22% solar power (utility-scale solar farms and rooftop solar [RTS]), 9% LNG-fired power, and 5% wind power (see Figure 3).[10]

By 2030, Vietnam aims to significantly expand its energy generation capacity to 150 GW. According to Vietnam's Power Development Plan 8 (PDP8), LNG and wind generation are expected to grow in both GW of installed capacity and as a percentage of the overall grid mix, expanding to 25% and 19% of Vietnam's generation capacity, respectively. Despite growth in installed capacity, the proportions of coal, hydropower, and solar in the overall grid mix are projected to decrease to 21%, 22%, and 9%, respectively, by 2030.[11] This is particularly noteworthy with regards to solar. Current installed capacity of solar is being curtailed and not fully utilized in Vietnam's generation mix. PDP8 lacks significant increases in new utility-scale solar and includes limited insights on RTS growth over the next six years, resulting in a projected decrease in the overall proportion of solar in Vietnam's 2030 power generation capacity.

Vietnam's most recent grid emission factor was reported to be **0.7221** metric tons of carbon dioxide per megawatt-hour (tCO_2/MWh) in 2021. That was lower than the 0.8041 tCO_2/MWh reported in 2020 but still significantly higher than the average grid emission factor of **0.5620** tCO_2/MWh across the Association of Southeast Asian Nations countries in 2021.[12,13] This means that Vietnam's grid-based electricity **emits more greenhouse gas emissions per unit of electricity than its neighboring countries**, which poses a challenge for C&I companies seeking to reduce emissions in Vietnam.

9 Business Wire. (2022, September 15). Vietnam electricity industry report 2022: Demand is expected to grow by 10% to 12% per year over the next decade. https://www.businesswire.com/news/home/20220915005608/en/Vietnam-Electricity-Industry-Report-2022-Demand-is-Expected-to-Grow-by-10-to-12-Per-Year-Over-the-Next-Decade---ResearchAndMarkets.com

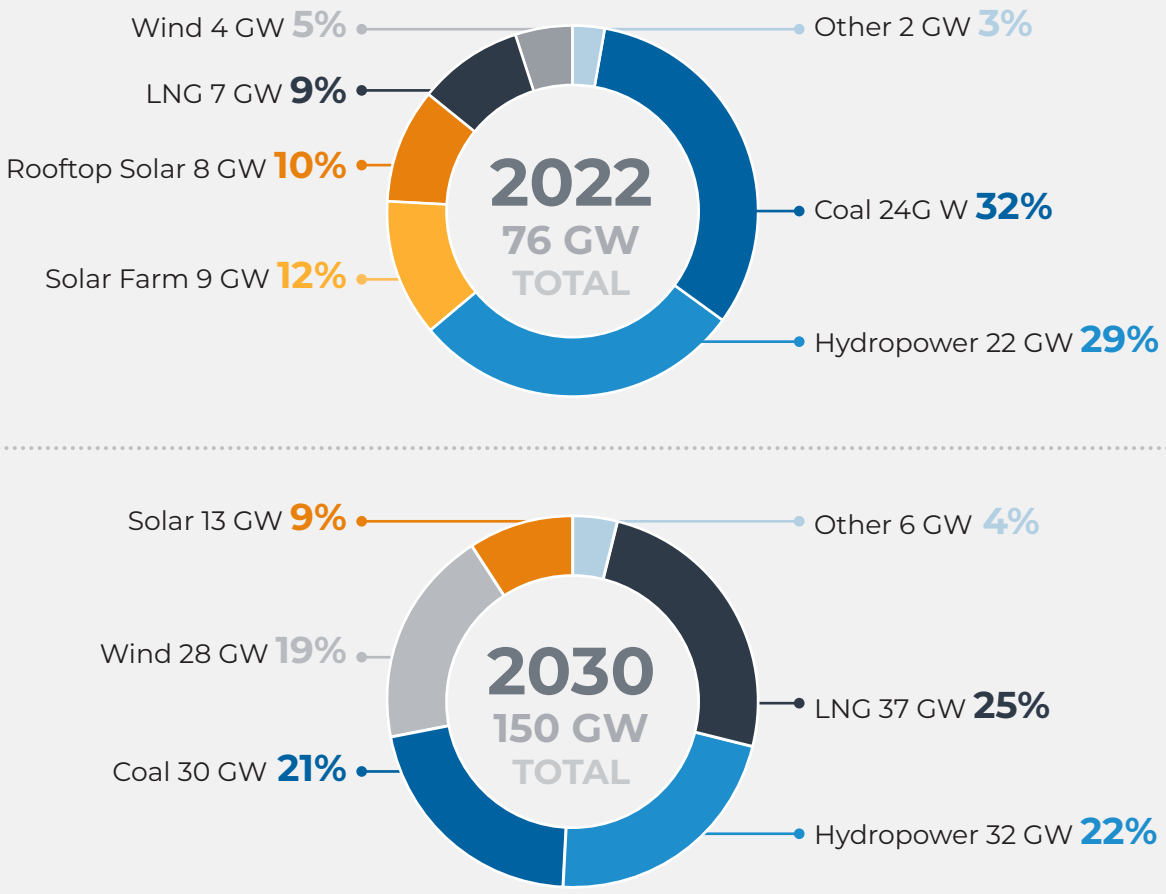
10 Socialist Republic of Viet Nam. (2023, November). *Resource mobilisation plan: Implementing Viet Nam's just energy transition partnership (JETP). European Commission Climate Action*. https://climate.ec.europa.eu/system/files/2023-12/RMP_Viet%20Nam_Eng_(Final%20to%20publication).pdf

11 Socialist Republic of Vietnam. (2023, May 15). *Decision No. 500/QD-TTg: Approval of national electricity development plan for the period of 2021–2030, with a vision to 2050*. https://thuvienphapluat.vn/van-ban/Thuong-mai/Quyet-dinh-500-QD-TTg-2023-Quy-hoach-phat-trien-dien-luc-quoc-gia-2021-2030-tam-nhin-2050-566461.aspx

12 Socialist Republic of Vietnam Department of Climate Change. (2022, December 31). *Vietnam power grid emission factor 2021*. http://dcc.gov.vn/van-ban-phap-luat/1101/He-so-phat-thai-luoi-dien-Viet-Nam-2021.html

13 Schaper, M. T., & Yang, R. W. Y. (2021, December 24). *Calculating the carbon footprint and minimum greenhouse gas production of SMEs in Southeast Asia*. ISEAS Yusof Ishak Institute. http://www.iseas.edu.sg/articles-commentaries/iseas-perspective/2021-169-calculating-the-carbon-footprint-and-minimum-greenhouse-gas-production-of-smes-in-southeast-asia-by-michael-t-schaper-and-ryan-wong-yee-yang

Figure 3. Installed power generation capacity by source in 2022 (top) and planned power generation capacity by source in 2030 (bottom)



VIETNAM'S CLIMATE AND ENERGY GOALS

During the 2021 United Nations Climate Change Conference in Glasgow, Scotland (known as the 26th Conference of the Parties, or COP26), Vietnam announced a target to achieve net zero emissions by 2050 and a pledge to develop no new coal power plants after 2030. Over the past few years, Vietnam has continued to advance long-term strategies to support its net zero ambitions. These included adopting the National Climate Change Strategy for 2050 and developing the Long-Term Strategy on Environment Decision to 2030 with vision to 2050.[14,15]

In October 2022, Vietnam updated its Nationally Determined Contribution (NDC) under the Paris Agreement. Vietnam also reaffirmed its unconditional target to reduce emissions by 15.8% by 2030 and its conditional target to reduce emissions by 43.5% with international support compared to a business as usual scenario.[16] Vietnam's net zero emission scenario for 2050 can be found in Appendix A.

14 Socialist Republic of Vietnam. (2022, July 26). Decision No. 896/QD-TTg: *Approving the national strategy on climate change until 2050.* https://thuvienphapluat.vn/van-ban/EN/Tai-nguyen-Moi-truong/Decision-896-QD-TTg-2022-approving-the-National-strategy-for-climate-change-until-2050/525126/tieng-anh.aspx

15 Socialist Republic of Vietnam. (2022, April 13). Decision No. 450/QD-TTg: Approving national environmental protection strategy until 2030 and vision until 2050. https://thuvienphapluat.vn/van-ban/EN/Tai-nguyen-Moi-truong/Decision-450-QD-TTg-2022-Approving-national-environmental-protection-strategy-until-2030/510740/tieng-anh.aspx

16 Socialist Republic of Vietnam. (2022, October). *Nationally Determined Contribution (Updated in 2022).* United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/NDC/2022-11/Viet%20Nam_NDC_2022_Eng.pdf

Figure 4. Recent updates on Vietnam's climate and energy goals, plans, and long-term strategies

Vietnam's PDP8 was approved in May 2023 and is in the process of being implemented. This national planning document lays out a series of targets that will guide Vietnam's power sector planning across all generation sources for the period of 2021 to 2030, with a vision to 2050. PDP8 reflects reductions in planned coal capacity and coal phaseout by 2050 as well as increases in planned renewable energy (RE), which is anticipated to make up 60% of installed generation capacity by 2050. Despite plans to phase out coal and reduce emissions, the PDP8 also establishes targets for Vietnam to significantly increase its reliance on LNG. This reflects an overarching goal to expand power generation capacity; however, the scale of planned increases in LNG may impair Vietnam's ability to achieve its net zero goal by 2050. Simultaneously, planned RE growth under PDP8 is more limited than may be necessary for Vietnam to achieve its climate and energy goals. Specifically, PDP8 does not include significant growth in new solar installations by 2030 is not included in PDP8 despite Vietnam's tremendous natural resource potential for increased solar energy generation and strong interest from C&I energy customers in supporting on-site and off-site solar installations.

Public and private sector partners have expressed interest in supporting Vietnam to reach its climate and energy goals. In December 2022, leaders from Vietnam, the U.S., and other aligned countries established a Just Energy Transition Partnership (JETP) for Vietnam that aims to mobilize US$15.5 billion in public and private finance to support Vietnam's clean energy transition. Vietnam's JETP aims to help level off power sector emissions at 451.4 million metric tons and increase the share of RE generation to 33% by 2030 and 55% by 2050.[17,18] Additional initiatives led by the U.S Government and other partners are emerging to support energy transition in developing countries. An example is the Energy Transition Accelerator that aims to bring together government and private sector stakeholders to achieve earlier and deeper emissions reductions.[19]

Vietnam's ability to meet and exceed its climate targets is contingent upon continued support of international public and private sector partners. Public sector investment through the JETP and other mechanisms will undoubtedly play an important role. **Private sector investment and aligned action to drive clean energy procurement and industrial decarbonization will be critical** to driving Vietnam's economic growth and supporting Vietnam's clean energy transition.

ENERGY MARKET STRUCTURE

Vietnam is in the midst of a long-term shift from a centralized monopolistic power market to a liberalized power market. In 2004, Vietnam passed an Electricity Law to reform Vietnam's power sector. The intent was to break apart Vietnam Electricity (EVN) and move toward a competitive power market that would enhance the delivery of efficient and affordable power, increase energy security, and encourage increased private sector involvement. Despite the legal framework and initial steps to liberalize the market, key decision-making authority remains centralized within EVN, in close coordination with the Ministry of Industry and Trade (MOIT).[20] That authority includes the management of the national transmission, distribution, and retail segments of the power market.

Several key regulatory entities have decision-making authority and influence over Vietnam's energy market. The most critical government and utility stakeholders in terms of advancing corporate clean energy procurement include:

- **The Office of the Prime Minister of Vietnam:** The Prime Minister's office issues final approvals of national power development plans as well as major policies and regulations affecting RE procurement options in Vietnam.
- **MOIT** is responsible for managing Vietnam's energy sector, including drafting and overseeing the implementation of national power development plans and key energy policies. Several key regulatory bodies are structured as entities under MOIT, including the Electricity and Renewable Energy Authority, which advises on renewable energy support mechanisms; Electricity Regulatory Authority of Vietnam, which regulates the power sector; and the Energy Efficiency and Sustainable Development Department, which is in charge of energy efficiency and conservation.

17 U.S. Embassy and Consulate in Vietnam. (2022, December 15). *International agreement to support Vietnam's ambitious climate and energy goals.* https://vn.usembassy.gov/international-agreement-to-support-vietnams-ambitious-climate-and-energy-goals/

18 See footnote 10

19 Energy Transition Accelerator. (n.d.). https://www.etaccelerator.org/

20 EVN is still largely influenced by the MOIT and, by extension, the central government through its role in directing investments and appointing board members and management.

- **Other key government and regulatory entities** play roles in developing, overseeing, and shaping Vietnam's energy sector. They include the Ministry of Planning and Investment for investment policies, the Ministry of Finance for fiscal policies, the Ministry of Natural Resources and Environment for climate change strategy, the **National Assembly**, and **People's Committees** of the provinces and major cities.[21]
- **EVN** is Vietnam's state-owned utility that is responsible for meeting electricity demand and advancing power generation and transmission projects. EVN is the primary provider of electricity to residential, commercial, and industrial customers across Vietnam, and EVN and its subsidiary generation companies produce the majority of Vietnam's electricity.[22] EVN controls the transmission and distribution of electricity in Vietnam across the national electricity grid. Key units under EVN include the National Power Transmission Corporation and the Electricity Power Trading Company.

Grid transmission and distribution challenges continue to raise concerns among C&I energy customers and dampen Vietnam's RE market growth. In May and June of 2023, Northern Vietnam experienced rolling blackouts and major power outages as a severe drought impaired hydropower generation and an intense heat wave increased energy demand, significantly affecting the limited supply. These blackouts affected major industrial parks, multinational C&I companies, and supply chain manufacturers like Samsung and Foxconn and were estimated to have cost 0.3% of Vietnam's GDP (~US$1.4 billion) in 2023.

These outages and corresponding grid concerns have reignited efforts to further decentralize Vietnam's power sector. Steps are being taken to limit EVN's control by separating the National Load Dispatch Center (NLDC) from EVN and turning the NLDC into a public, nonbusiness unit. The NLDC is in charge of monitoring power supply and demand and dispatching electricity supply accordingly to ensure stability across the system. Spinning off the NLDC is an important step toward **increasing competitive market decision-making** for the purchase of generated electricity. This is part of the larger effort to liberalize Vietnam's energy market and attract increased private sector finance to support necessary large-scale investments in energy generation and grid updates.[23]

POLICY DEVELOPMENTS AND GAPS

Vietnam's clean energy policy environment is marked by significant gaps hindering further RE growth and deployment, including the policy challenges noted in the Executive Summary and described in further detail in this section.

POLICY CHALLENGES

- Lack of an off-site procurement option and continued DPPA delays
- Lack of a net-metering mechanism, limiting the size of on-site RE systems
- Lack of policy clarity on battery storage and other emerging solutions

21 Asian Development Bank. (2015). *Assessment of power sector reforms in Viet Nam: Country report*. https://www.adb.org/sites/default/files/institutional-document/173769/vie-power-sector-reforms.pdf

22 Organisation for Economic Co-operation and Development. (2021, November 5). *Clean energy finance and investment policy review of Viet Nam*. https://read.oecd.org/10.1787/61c33f7f-en?format=pdf

23 Luong, L. (2023, August 18). *The implications of separating NLDC from EVN. AMPERES*. https://www.amperes.com.au/library/the-implications-of-separating-nldc-from-evn

From 2019 through 2021, Vietnam experienced record-breaking RE growth spurred by a government-led **feed-in tariff (FIT) mechanism** that catalyzed enormous solar and wind development throughout the country. This included utility-scale solar and wind as well as RTS driven by demand from a range of C&I companies across Vietnam. For example, installed RTS capacity expanded from only 20 megawatts (MW) in 2019 to over 10,000 MW by 2021.

This growth was foundational to the initial development of Vietnam's RE market. This growth drove the establishment of a mature RE service economy and a robust ecosystem of RE project developers and service providers capable of supporting continued demand for RE. However, Vietnam's rapid RE growth in 2019–2021 was short-lived. Concerns about the influx of RE onto Vietnam's power grid and transmission and distribution challenges prompted the government to discontinue the FIT in 2021. Without adequate regulatory and policy adjustments to address grid and market constraints and ensure transparency within the industry, RE growth slowed. As a result, Vietnam's RE potential remains underutilized. Policy and regulatory barriers pose a serious threat to Vietnam's ability to meet its emissions reduction and net zero goals as well as its vision to increase foreign direct investment from C&I customers.

Since the expiration of the FIT, the **lack of policy clarity** for on-site solar has led to a halt in the issuance of grid interconnection permits. Permitting challenges paired with the **lack of a net metering mechanism** has limited the private sector's ability to deploy and fully leverage the benefits of on-site solar systems. The most recent PDP8 implementation plan proposes a pipeline of an additional 2,600 MW of RTS power systems with zero export capabilities to the national grid between 2023 and 2030. A new system to allot additional RTS capacity quotas to be installed per province was under review by the government. In general, provinces with higher electricity demand and higher levels of industrial activity are anticipated to have greater quotas for increased RTS installations. The highest proposed quotas of 229 MW, 185 MW, and 153 MW are proposed for Dong Nai, Bing Duong, and Long An provinces, respectively, which are among the largest industrial provinces in Southern Vietnam.[24] A visualization of provincial RTS quotas can be found in Appendix B. The impact that this quota system will have on the regulatory and permitting process or overall RTS growth in Vietnam is currently unclear.

Some of the policy challenges related to on-site solar and broader grid challenges could potentially be mitigated through the installation of battery energy storage systems (BESS). Lack of a national storage policy, however, is another key regulatory gap in Vietnam. PDP8 includes targets for BESS capacity to reach 300 MW by 2030 and 31–46 GW by 2050. Yet Vietnam has not established a policy framework or incentive structures for storage or other emerging decarbonization solutions that have the potential to support Vietnam's energy transition.

Additionally, the lack of a national renewable energy certificate (REC) policy in Vietnam has resulted in a lack of additionality and unclear ownership. These issues undermine the credibility and impact of RECs in Vietnam and require further clarification and improvement through a national-level REC system.

To date, **lack of an off-site RE procurement mechanism** has been highlighted by private sector stakeholders as one of the most significant policy barriers limiting corporate RE procurement in Vietnam. Vietnam's **long-anticipated Direct Power Purchase Agreement (DPPA)** mechanism has been under development and review for over six years. The DPPA mechanism represents a significant step in Vietnam's long-term efforts to establish a wholesale electricity market and the underlying regulations that allow private selling and buying of electricity. More in-depth information about DPPA is included in Emerging Off-Site Corporate Procurement Options.

24 Electricity Regulatory Authority of Vietnam. (2023, October 24). *The implementation plan of Power Plan VIII was submitted to the government for the 3rd time*. https://www.erav.vn/tin-tuc/t13206/ke-hoach-thuc-hien-quy-hoach-dien-viii-duoc-trinh-len-chinh-phu-lan-thu-3.html

CORPORATE CLEAN ENERGY DEMAND AND KEY STAKEHOLDERS

A key driver for RE development in Vietnam is growing demand from the private sector, especially from multinational C&I energy customers that have operations or supply chains in Vietnam. The C&I sector represents approximately **60%** of Vietnam's total electricity consumption, and harnessing the economic potential of this market presents a critical opportunity to accelerate Vietnam's clean energy transition. **Hundreds of C&I companies have set clean energy and net zero goals** for their global supply chain operations and made public commitments through platforms like RE100 or the Science Based Targets initiative (SBTi). In Vietnam, 19 companies are listed on the SBTi dashboards, and at least 20 international signatories of RE100 are actively engaging in clean energy procurement efforts.[25,26] These companies are sending a **strong demand signal** for accessible, reliable, and affordable clean energy procurement options to meet their corporate sustainability commitments and goals.

For example, demand from C&I companies has played a critical role in building momentum for an off-site RE procurement option in Vietnam since the earliest stages of the DPPA mechanism's design and conceptualization.[27] Surveys conducted as early as 2020 demonstrated that more than two dozen companies in Vietnam representing over 1 GW of RE demand were eager to participate in the emerging DPPA program.[28] A more recent MOIT survey from 2022 showed that out of 41 C&I energy customers surveyed, 24 confirmed that they wanted to participate in the DPPA program, with a total estimated demand of 1.125 GW.[29] Developers representing 24 RE projects with nearly 1.8 GW capacity confirmed their interest in DPPA participation, and another 17 RE projects representing over 2.8 GW were exploring participation.

Key stakeholders have played foundational roles in supporting Vietnam's initial clean energy market development and have the potential to further collaborate in support of Vietnam's clean energy transition into the future. In addition to regulatory entities noted in Energy Market Structure, target stakeholders for this report include the following:

- **Multinational C&I brands with a presence in Vietnam:** Numerous C&I companies across prominent economic sectors in Vietnam, such as apparel, technology, food and beverage, and other key market segments, have set clean energy and emissions reductions targets for their operations in Vietnam. They have provided inputs into policy development processes to expand corporate procurement opportunities. They have also actively engaged with their supply chain manufacturers and technical support initiatives like the Clean Energy Investment Accelerator (CEIA) to advance groundbreaking on-site solar projects in Vietnam and pave the way for future decarbonization action.

25 Climate Group RE100. (n.d.). *RE100 members*. Retrieved January 30, 2024, from https://www.there100.org/re100-members

26 Science Based Targets. (n.d.). *Companies taking action*. Retrieved January 30, 2024, from sciencebasedtargets.org/companies-taking-action

27 As early as 2018, the Clean Energy Investment Accelerator and USAID V-LEEP led a declaration of support for DPPA that was signed by over two dozen major companies representing 16 million megawatt-hours of annual electricity consumption and a total investment of US$1.4 billion in total economic investment in Vietnam. In 2021, the CEIA led a coalition of multinational companies to issue a joint statement urging the finalization of DPPA and high-ambition power development planning in Vietnam.

28 Internal data based on a survey led by CEIA and the USAID Vietnam Low Emissions Energy Program II among buyers and developers in Vietnam.

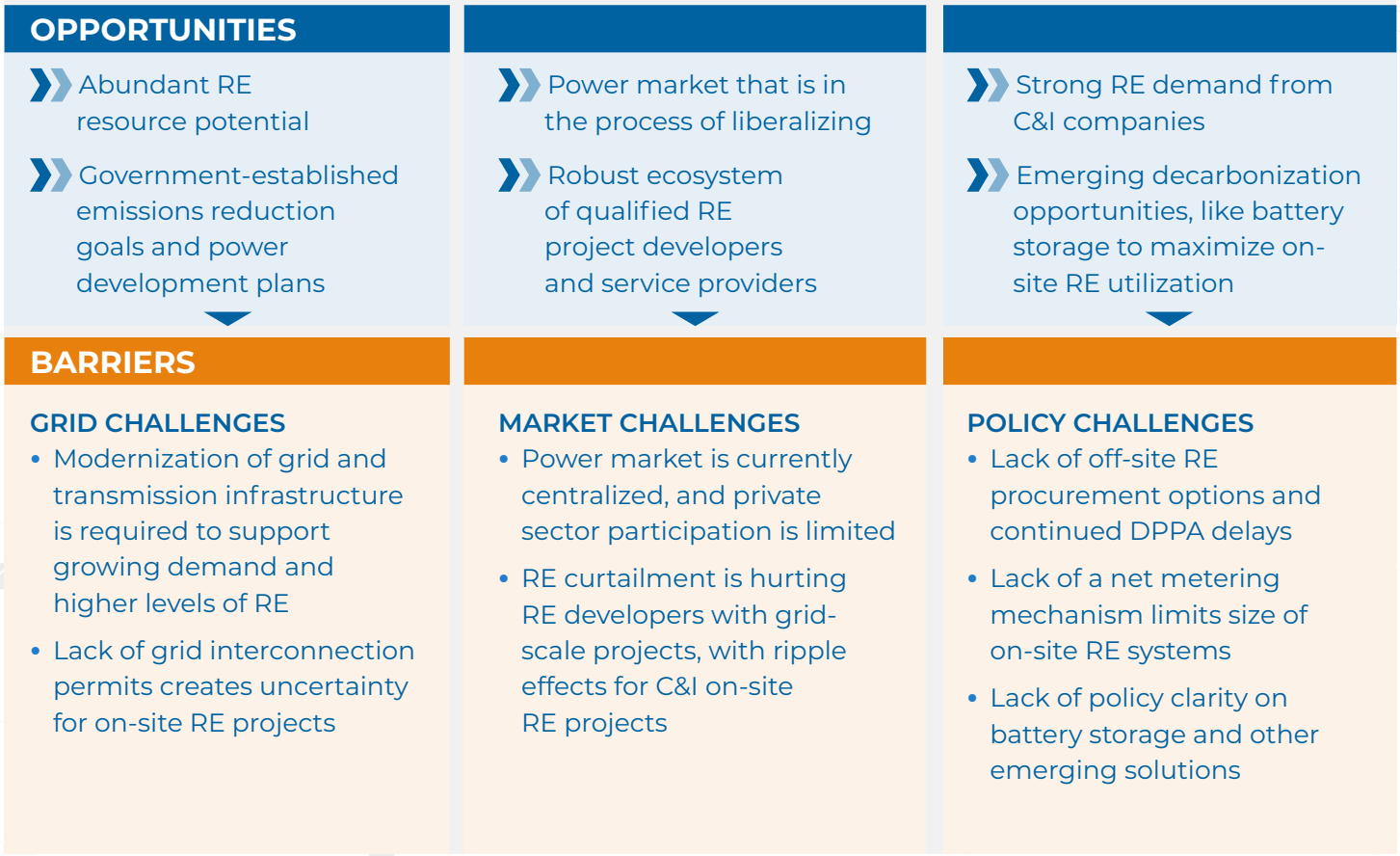
29 Ministry of Industry and Trade of the Socialist Republic of Vietnam. (2023, October 25). *Efforts to complete the direct electricity trading mechanism*. https://moit.gov.vn/tin-tuc/phat-trien-nang-luong/bo-cong-thuong-no-luc-hoan-thanh-co-che-mua-ban-dien-truc-tiep.html

- **Supply chain manufacturing companies operating in Vietnam:** These local and regional manufacturers supply multinational C&I brands and are the electricity end users ultimately responsible for procuring RE for their facilities. In collaboration with brands, numerous supply chain manufacturers in Vietnam have provided policy inputs and executed on-site solar transactions with support from aligned technical support initiatives and other technical partners.
- **Technical support initiatives and industry associations:** A subset of relevant technical assistance and development programs, industry and business associations, and other aligned support organizations are noted here. This includes some of the primary market actors that have supported and continue to support Vietnam's clean energy and climate goals but is by no means an exhaustive list:
    - **Clean Energy Buyers Association (CEBA)** is a network of multinational corporations that aims to cultivate a global community of energy customers driving clean energy.
    - **Clean Energy Demand Initiative**, is a joint secretariat of the U.S. Department of State and CEBA that aims to foster public-private collaboration to accelerate the deployment of clean energy in global energy markets.
    - **CEIA** is an initiative jointly led by Allotrope Partners, the U.S. National Renewable Energy Laboratory, and World Resources Institute since 2017. CEIA has actively engaged over 150 C&I companies and developers in Vietnam and delivered in-depth technical support for on-site RE projects ranging from 100 kilowatt to 22 MW multisite procurements. CEIA has mobilized more than US$50 million in investment and supported policies to enable on-site and off-site RE procurement at scale.
    - **Vietnam Low Emissions Energy Program II (V-LEEP II)** is a U.S. Agency for International Development-funded project that supports energy efficiency, renewable energy, and grid modernization in Vietnam. V-LEEP II has been closely involved in DPPA development and other clean energy capacity building efforts in partnership with the Government of Vietnam.
    - **Asia Clean Energy Coalition** is a newly formed regional coalition of clean energy buyers seeking to strategically shift policy in key Asian national and regional markets.
    - **Vietnam Business Forum (VBF)** is a platform for policy dialogue between the government and the private sector. VBF includes the Power and Energy Working Group and helps shape clean energy policies in Vietnam by offering feedback and recommendations to the government and other stakeholders.
    - **Vietnam Energy Partnership Group** is a multi-stakeholder forum that aims to enhance coordination and harmonization among development partners, government agencies, and other actors in the energy sector.
    - **German Corporation for International Cooperation** is the German international development agency that implements various technical assistance efforts on renewable energy, energy efficiency, and climate change mitigation and adaptation in Vietnam.

CURRENT STATE OF PLAY: MARKET-LEVEL OPPORTUNITIES AND BARRIERS

As described earlier, Vietnam faces a series of market-level opportunities and barriers to unlocking and scaling corporate clean energy procurement in support of its broader clean energy transition. See the Executive Summary and Figure 5 for a summary of market-level opportunities and barriers in Vietnam.

Figure 5. Summary of market-level opportunities and barriers

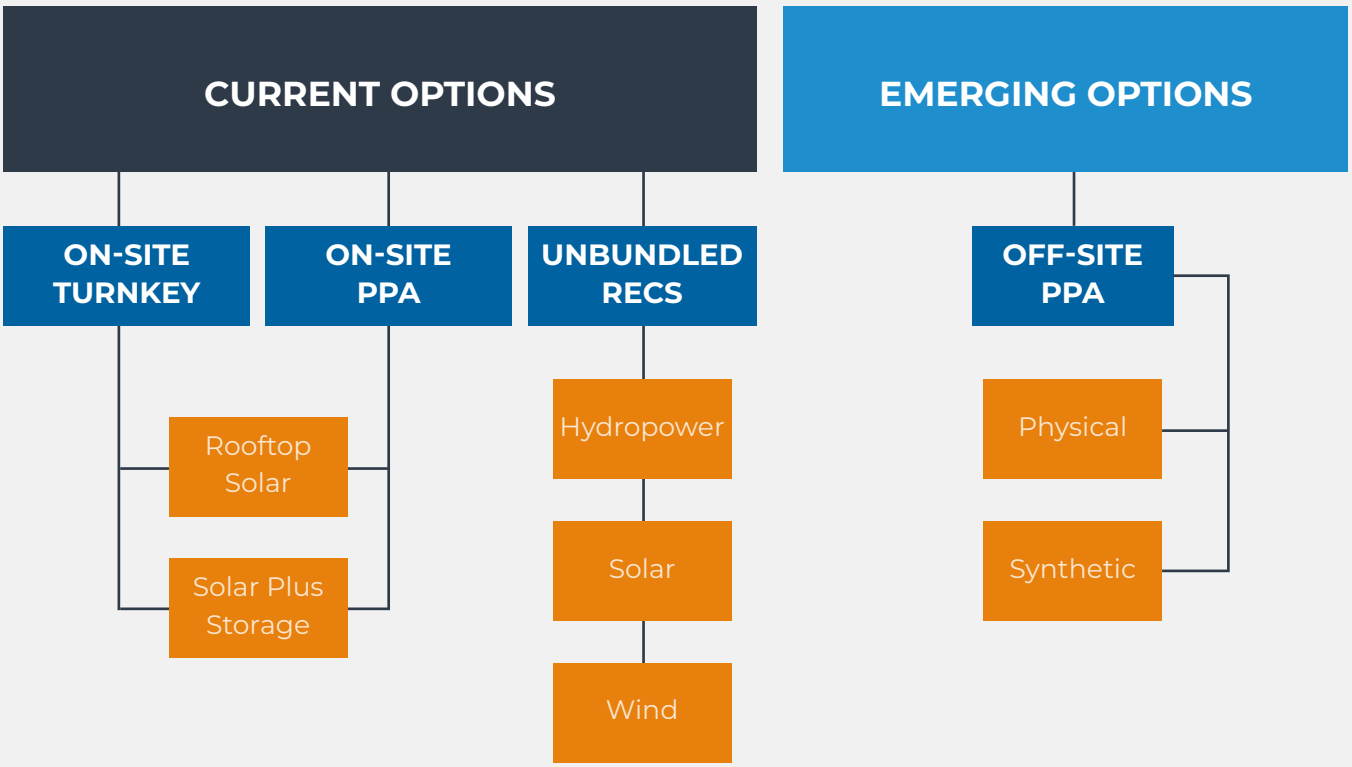


CLEAN ENERGY PROCUREMENT PATHWAYS IN VIETNAM

CURRENT CORPORATE PROCUREMENT OPTIONS

This section offers a snapshot of currently available opportunities for private sector energy customers to procure clean energy in Vietnam. Local stakeholder inputs have shaped the insights included. Each option includes a high-level description, insights on relevant users, a summary of barriers and opportunities, and brief case study examples.

Figure 6. Clean energy procurement options in Vietnam in 2023



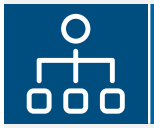
ON-SITE TURNKEY PURCHASES

OVERVIEW

A turnkey purchase (see Figure 7) is an on-site procurement model under which a renewable energy (RE) system is purchased upfront and installed at the customer's site, and the customer is responsible for expenses related to operation and maintenance (O&M). In the Vietnam market context, ground-mounted solar systems are not viable for individual commercial and industrial (C&I) energy customers and can trigger additional regulatory, permitting, and cost requirements. As a result, customers seeking on-site RE turnkey solutions in Vietnam primarily use rooftop solar (RTS) photovoltaic (PV) systems. This procurement option requires energy users to have suitable facilities with available roof space. An on-site turnkey installation differs from other on-site procurement models due to the level of upfront capital investment required to purchase and own the installation outright and the customer's ability to own all of the electricity generated over the lifetime of the system.

Turnkey systems are relevant for energy customers with access to sufficient capital or debt financing options to support both the initial capital expenditure (CapEx) and limited recurring costs of O&M of the installation. See Table 1 for the typical financing considerations for on-site turnkey installations. This mechanism is most relevant for customers with planned long-term use of their facilities (at least 10 years) so that the customer can maximize cost savings after the system is paid off. As with any on-site solar installation, pursuing a RTS turnkey purchase in Vietnam requires customers to have a roof with sufficient available space, sunlight, and structural elements (see Appendix C). An additional critical consideration for turnkey customers in Vietnam is the need to size their systems for on-site self-consumption, given the lack of net metering and grid interconnection challenges.

Figure 7. Key features of the on-site turnkey purchase model in Vietnam



THE MODEL

Customer pays upfront for an on-site RE system and is responsible for O&M

THE USERS

Most relevant for customers that have access to capital or financing to purchase a system and that own their facilities and have viable roof space

ADVANTAGES

- Available in Vietnam today
- Significant cost savings
- Often offers lowest cost per kWh over lifetime
- Supports long-term electricity price stability
- Less financial disclosure required
- Qualified developers/service providers available to support

DISADVANTAGES

- Significant upfront investment required
- Customer responsible for O&M costs/risks
- Long-term facility ownership needed to maximize cost savings
- Interconnection and permitting challenges
- Excess electricity cannot be sold to grid
- System size is limited to self-consumption
- Typically covers only a portion of demand

Table 1. Illustrative lending terms for an on-site turnkey installation in Vietnam[30,31]

Bank	Interest	Tenure	Collateral	Estimated Due Diligence Process
Local	11%–12%	8–12 years, with possible extension to 15 years for prioritized borrowers	Real estate	~1 month

C&I companies seeking to pursue on-site turnkey solutions typically work with a qualified solar engineering, procurement, and construction (EPC) company that leads technical delivery, installation, and commissioning of the RE system. Furthermore, customers can outsource O&M services to solar O&M specialists for ongoing monitoring and maintenance of their on-site system.

POTENTIAL BENEFITS AND COST CONSIDERATIONS

Upfront costs can be a significant barrier for energy customers considering on-site turnkey installations. But owning solar power generation assets can provide long-term price stability for a significant portion of a customer's energy costs, which is beneficial to a company's long-term operational planning. In Vietnam, on-site turnkey RTS systems typically offer customers the lowest cost of electricity (in $/kilowatt-hour [kWh]) over the more than 20-year lifetime of the solar system compared to alternative procurement models and grid-purchased electricity. This is evident with the levelized cost of energy for RTS in Vietnam at US$0.046/kWh to be significantly lower than the weighted retail tariff of US$0.085/kWh for industrial users.[32]

Table 2. Estimated costs and considerations for an on-site turnkey purchase in Vietnam[33]

Country	Est. CapEx Cost	Est. O&M Cost	Payback	Internal Rate of Return
Vietnam	US$450–US$550 per kilowatt-peak (kWp)	US$5–US$10 per kWp/year	4–7 years	11%–20%

30 VR Energy. (2023, February 22). *Banks support capital to install solar power*. https://vrenergy.vn/ngan-hang-ho-tro-von-lap-dien-mat-troi

31 Data based on Allotrope market insights and recent engagement with local banks, investors, developers, and other market stakeholders in Vietnam.

32 Taylor, M., Al-Zoghoul, S., & Ralon, P. (2023, August). *Renewable power generation costs in 2022*. International Renewable Energy Agency. https://www.irena.org/Publications/2023/Aug/Renewable-Power-Generation-Costs-in-2022

33 Data based on Allotrope market insights and recent engagement with local banks, investors, developers, and other market stakeholders in Vietnam.

Customers whose facilities consume electricity during daylight hours when there is the highest solar generation and plan to utilize these facilities for 10 years or longer will benefit significantly from on-site turnkey systems. O&M costs for solar PV systems are generally low, as these systems have no moving parts and most standard solar modules have 25-year warranties. Warranties do not cover the costs of the inverters, which typically need to be replaced after 10 years, but O&M service providers can support customers to navigate any warranty or replacement considerations.

The capital investment payback period for on-site turnkey systems in Vietnam ranges from four to five years for commercial ratepayers to five to seven years for industrial ratepayers.[34] Afterward, electricity produced by the system is free to the customer. Differences in payback periods depend on multiple variables, including the equity-to-debt ratio, the size of the system, the quality of components, and cost of utility tariffs.

Table 3. Typical milestones for on-site turnkey purchases over the course of an estimated 25-year system lifespan

Year 0	4–5 Years	5–7 Years	10–15 years	25 years
On-site turnkey RTS installation	Typical payback period for commercial ratepayers	Typical payback period for industrial ratepayers	End of standard warranty period for solar system inverters	End of standard warranty period for solar panels. (Typical return on investment ranges from 230% to 280% percent for C&I ratepayers.[35])

LEGAL AND PERMITTING CONSIDERATIONS

RTS installations in Vietnam require various approvals from relevant authorities. The process for filing the necessary paperwork and securing the permits is typically led by an energy customer's chosen RE developer or EPC service provider. Approval of these permits has no standardized timeframe, and details are often case-specific, but the entire process should not last longer than a maximum one-year project development cycle. Required permits include the following, in the order of attainment:

1. **Certificate for Construction:** According to the legal classifications in Vietnam, installing on-site solar systems is considered to be construction; therefore, this certification process is required to verify the eligibility of investors or contractors to undertake construction activities.[36] This certificate is issued by either the Ministry of Construction or the provincial Department of Construction, depending on the project's size and location. This certificate should be obtained prior to the start of construction.

34 Commercial and industrial rates refer to electricity tariff rates that a customer previously was classified with an electricity utility.

35 Data based on Allotrope market insights and recent engagement with local banks, investors, developers, and other market stakeholders in Vietnam.

36 In some cases, exemptions may apply, but eligibility criteria is unclear.

2. **Firefighting Appraisal:** This permitting process evaluates the fire safety design and equipment of the project and is conducted by the Police Bureau of Fire Prevention, Fighting and Rescue under the Ministry of Public Security, or provincial People's Committees. This is specifically required for projects that are subject to special fire safety prerequisites in Vietnam, such as industrial buildings, warehouses, and high-rise structures. The application process entails providing documentation such as fire safety designs, fire prevention and firefighting equipment certificates, test records, and inspection reports. This appraisal should be completed by the commercial operation date of the system.
3. **Grid Connection Permit:** A Grid Connection Permit issued by Vietnam Electricity (EVN) is required to link the project to Vietnam's electricity transmission and distribution grid. These permits have not been available since 2021. This has resulted in a situation where on-site RE projects are still being developed, but they are being sized for self-consumption and are not connected to the grid.
4. **Others:** Additional permits that may be required include environmental impact assessments or investment certificates in specific provinces.

EVN has the authority to disconnect systems that do not comply with the required technical standards, legal regulations, and contractual obligations, such as obtaining the appropriate fire prevention, grid connection, and construction approvals. In this scenario, project owners and developers could face legal consequences and financial penalties.

It is important to note that the process for **acquiring permits for on-site solar installations in Vietnam is currently challenging**. In addition to the lack of interconnection permits, Allotrope's local team has heard concerns from a range of market stakeholders regarding inability to secure required permits and inconsistencies between provinces. Additional insights are available upon request as our local team monitors this evolving situation.

ADVANTAGES AND DISADVANTAGES

For companies seeking to own on-site clean energy systems that have the ability to pay for or finance the project and ongoing O&M, turnkey projects offer the strongest per kWh cost savings. Turnkey projects eventually result in free electricity for the remainder of the system's lifetime after the initial system costs are paid off. However, upfront capital needs can be a significant barrier for many companies. Mechanisms that previously helped offset system costs, such as feed-in tariffs (FITs) and selling electricity back to the national grid through net metering, are no longer available in Vietnam.

CASE STUDY SNAPSHOT

ON-SITE TURNKEY PURCHASE	
Customer	DEEP C Industrial Zone (industrial estate developer and owner)
Business Model	RTS Turnkey Purchase
System Size	2,100 kWp
Project Timeline	2020–present
Key Components Enabling Success	• DEEP C chose the turnkey purchase model due to the unique attributes of the site considering DEEP C's high self-consumption level, grid ownership for the industrial zone, and available roof area (see Appendix C). • Allotrope and the Clean Energy Investment Accelerator (CEIA) team conducted an in-depth techno-economic feasibility study. They supported DEEP C throughout the procurement process and reviewed the technical system design to ensure the system adhered to local market needs, permitting requirements, and safety standards. • DEEP C used an open bidding process to identify and confirm the most attractive offer for its needs. DEEP C confirmed Bestiani Engineering Company as its EPC contractor. • DEEP C secured approximately **17% cost savings** on its average monthly electricity bill in 2020. The system cost was US$520 per kWp. • The EPC contractor and DEEP C obtained all necessary permits and approvals from relevant authorities, following administrative procedures and compliance. • This RTS purchase served as a critical first step in DEEP C's aim to deploy 30–50 megawatts (MW) of RE across the industrial zone.

ON-SITE POWER PURCHASE AGREEMENTS

OVERVIEW

A power purchase agreement (PPA) is a long-term, legally binding bilateral agreement between a power producer (typically an RE developer or EPC provider) and an electricity customer in which the two parties come to an agreement on long-term pricing (typically 15–25 years in Vietnam) for the electricity supplied by the generator to the customer. If a customer operating in Vietnam has available and suitable roof space, it can utilize an on-site PPA to procure renewable electricity at a stable price. The customer's third-party RE developer or EPC partner secures the financing; oversees installation; and owns, operates, and maintains the on-site solar system for the lifetime of the agreement.

PPA models can offer a cost-effective procurement option for energy customers that have sufficient roof space and energy demand and an ability to enter into long-term contracts but may lack access to capital for turnkey purchases. PPA customers with businesses that operate six to seven days per week and have energy demand that aligns with the peak hours of solar generation can experience the greatest levels of cost savings.

As noted in earlier sections, Vietnam does not have current policy mechanisms to enable excess energy generated by the solar PV system to be exported back to the grid. As a result, systems are sized for self-consumption, and customers are typically obligated to consume 75%–90% of a solar system's generation, as witnessed under recent on-site PPA offers in Vietnam. Precise figures can be negotiated during the PPA signing process, where the discount is compared to the customer's utility tariff and any potential penalties are finalized.

Figure 8. Key features of the on-site PPA model in Vietnam

THE MODEL

Customer enters into a long-term agreement with a power producer that installs and maintains an on-site RE system and sells the electricity to the customer at a negotiated price per kWh

THE USERS

Most relevant for customers that have the ability to enter into long-term contracts (15–25 years) and that have access to viable roof space

ADVANTAGES

- Available in Vietnam today
- Offers immediate savings on monthly utility bills (~5%–25%)
- No upfront investment required
- Customer not responsible for O&M
- Available to customers that own or rent (without owner permission)
- Qualified developers/service providers available to support

DISADVANTAGES

- Customer required to sign 15–25 year agreement
- Often requires minimum electricity offtake
- Interconnection and permitting challenges
- Excess electricity cannot be sold to grid
- System size is limited to self-consumption
- Typically covers only a portion of demand
- Recent shifts impacting level of cost savings and preferred RE system sizes

On-site PPAs can also be available to customers that rent their facilities, provided the facility owner approves of the installation. C&I tenant companies within industrial parks (IPs) seeking on-site PPAs are often limited by the discretion of the IP operators. This is especially true for park operators with wholesale electricity licenses because there is a lack of an incentive to allow tenants to procure alternative electricity supply due to the risk of lost revenue. There are opportunities to work in collaboration with IP operators to explore mutually beneficial on-site procurement pathways.

POTENTIAL BENEFITS AND COST CONSIDERATIONS

On-site PPAs offer significant cost saving opportunities for C&I companies operating in Vietnam because savings on monthly electricity costs begin immediately after the system is installed. The Allotrope team has frequently witnessed C&I manufacturers in Vietnam secure 5%–25% cost savings on their monthly electricity bills compared to their blended utility tariff rates, with some energy customers seeing savings as high as 30%.

Table 4. Estimated cost savings and considerations for on-site PPAs in Vietnam[37]

Region	Discount Rate[38]	Average Contract Length	Capacity Preferred by Local Developers	Offtake Commitment
North	5%–15%	15–25 years	>1 megawatt-peak	80%–90%
Central and South	10%–25%	15–25 years	>600 kWp	75%–90%

On-site PPA pricing terms can be fixed or on a variable floating basis. In most cases observed in Vietnam, the rate paid by the customer to the PV system owner is directly correlated with the volume of solar electricity generated and consumed by the customer. However, facility characteristics, including the solar system size, electricity demand, and the facility's EVN ratepayer classification as an industrial or commercial customer, can all affect the price. Precise contract details must be negotiated between the solar developer or service provider and the customer prior to PPA execution.

Recently, an emerging challenge for on-site PPAs has been less attractive offers from solar developers compared to offers witnessed in previous years. This is due to various local and global factors that are affecting the solar market, including supply chain disruptions, currency exchange fluctuations, and policy changes. Seeking both on-site PPA and turnkey offers through an open competitive process is an approach other energy customers in Vietnam have used to attract the most cost-effective offers from potential developers.

37 Clean Energy Investment Accelerator. (n.d.). Rooftop solar toolkit for industrial energy users. https://www.cleanenergyinvest.org/rooftop-solar-toolkit-for-industrial-energy-users

38 Discount rates are compared to utility tariff rates and vary depending on location, system size, and contract length.

LEGAL AND PERMITTING CONSIDERATIONS

Systems installed through an on-site PPA model are subject to the same legal and permitting requirements by the provincial authority as noted in the On-Site Turnkey Purchases section.

On-site PPAs also involve a range of additional legal considerations specific to the performance and reliability of the solar system and the solar developer. Energy customers will need to carefully review those within the terms and conditions of the PPA prior to execution, such as:

- Price discount details, payment terms, incentives, and financial considerations (if any)
- Performance guarantee details and explanatory calculation for shortfall mechanism
- Penalty for energy demand shortfall (if any)
- End of contract terms, including buyout price schedule, if offered
- Overview of warranty coverage
- Overview of insurance coverage
- Statement on ownership of renewable energy certificates (RECs)/environmental attributes (EAs)

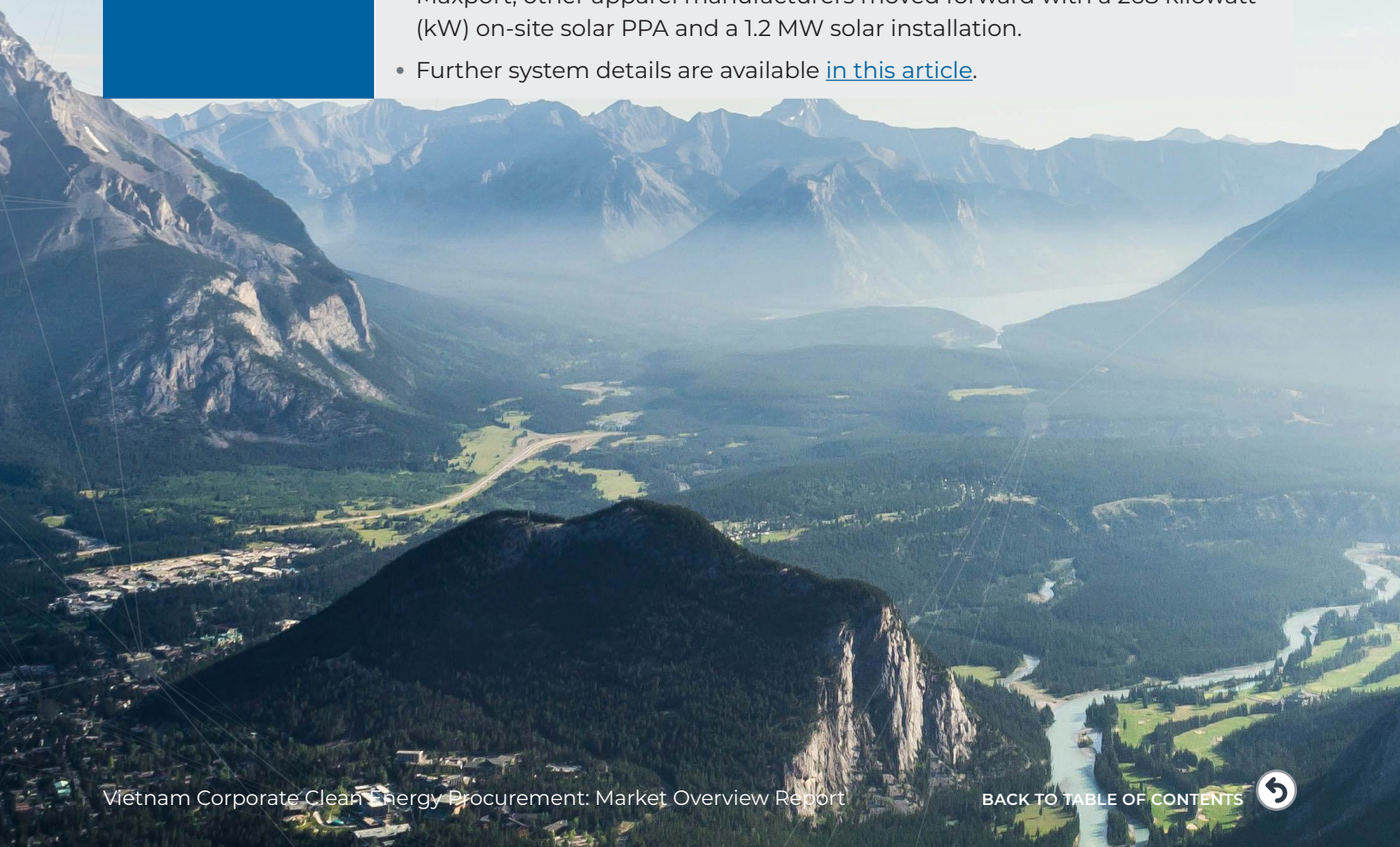
Energy customers entering into PPAs will also need to consider the creditworthiness and qualifications of the RE developer and seek appropriate guarantees to mitigate any anticipated risks.

ADVANTAGES AND DISADVANTAGES

While both on-site turnkey and on-site PPAs have strong cost savings on electricity, the key advantage of an on-site PPA is its immediate cost savings. Given evolving market considerations in Vietnam, significant cost savings from PPAs are less widely accessible than in previous years, and developers have advised potential customers to temper their expectations.

CASE STUDY SNAPSHOT

ON-SITE PPA	
Customer	Maxport Limited Vietnam (apparel manufacturer)
Business Model	20-year RTS PPA; build, own, operate with ownership transfer to customer at end of contract
System Size	1,600 kWp at a single site
Project Timeline	2021–2022
Key Components Enabling Success	• The customer worked with GreenYellow as an RE project developer and equity investor. The developer received a loan from a local bank to help with financing. • The system is primarily for self-consumption, with an estimated 50% demand coverage. No excess power is able to be sold back to the grid. • Allotrope and the CEIA team provided in-depth technical support to help Maxport navigate each step of the procurement process. In addition to Maxport, other apparel manufacturers moved forward with a 268 kilowatt (kW) on-site solar PPA and a 1.2 MW solar installation. • Further system details are available in this article.



COMPARISON BETWEEN TURNKEY PURCHASES AND ON-SITE PPA MODELS

Both on-site turnkey purchases and on-site PPAs offer energy customers cost-effective and currently available options for procuring RE in Vietnam (see Figure 9). The primary difference lies in whether the energy customer has the ability and desire to purchase or finance the upfront cost of an on-site system and pay for minor O&M costs over the lifetime of the system. Drawing upon market experience in Vietnam, both models can offer significant cost savings for the customer. The level of savings will vary based on the chosen procurement model, as well as system size, energy consumption, average times of demand, and other factors.

Figure 9. Summary comparison of on-site RE procurement options in Vietnam

	ON-SITE TURNKEY PURCHASES	ON-SITE PPAs
ADVANTAGES	• Lowest cost per kWh over lifetime • Less financial disclosure required • Customer owns system and associated benefits	• No upfront investment required • Immediate savings on monthly utility bills (~5%–25%) • Not responsible for O&M • Available to customers that own or rent (with owner permission)
DISADVANTAGES	• Significant upfront investment required • Responsible for O&M • Typically only available to facility owners	• Customer required to sign 15–25 year agreement • Often requires minimum electricity offtake • Recent shifts in level of cost savings and preferred system size

ADDITIONAL CONSIDERATIONS TO MAXIMIZE ON-SITE RE PROCUREMENT

BEHIND-THE-METER SOLAR PLUS STORAGE

On-site solar has expanded significantly in Vietnam over the past several years. However, limitations on connecting on-site systems and exporting excess electricity to the national grid have resulted in undersized projects that are only capable of providing an average of 15%–20% of a site's electricity demand.[39] Integrating a battery energy storage system (BESS) with on-site solar is a potential pathway to help customers maximize their on-site renewable electricity usage, increase the size of their installed solar systems, further reduce their emissions, and improve their energy security by reducing their dependence on fossil-heavy grid electricity that is subject to power outages and price fluctuations.

To date, a limited number of solar plus storage systems have been implemented in Vietnam's C&I sector. This is due to cost constraints, lack of market-specific resources tailored to customers' needs, and limited awareness among manufacturers on how to implement storage solutions. However, based on early-stage pilots and analysis led by Allotrope and others, BESS has the potential to enable larger on-site solar system sizes and support energy security and reliability.[40] For example, CEIA recently conducted a techno-economic analysis of solar plus storage options for an IP in Vietnam and found that prices in Vietnam are approaching a cost-competitive range for C&I applications.[41] The payment for a pilot BESS equipment, made in 2021, amounted to US$72,400 for a 100 kW/224 kWh BESS system, resulting in a unit cost of US$724 per kW. Initial estimates indicate that BESS begins to become cost-effective in Vietnam if costs cross below approximately US$550 per kW for all-in two-hour BESS.[42]

Additional analysis is needed on potential costs and project-level economics for C&I energy customers in Vietnam to enable enhanced understanding and uptake of BESS. Additionally, the absence of regulatory frameworks or incentives that have been utilized in other markets prevents potential energy customers in Vietnam from being able to fully monetize their energy storage systems. Local market stakeholders and regulatory bodies, including the Ministry of Industry and Trade (MOIT) and EVN, have indicated that BESS policy frameworks are being planned via future pilot projects, but official draft policy guidance has not yet been published.[43] Vietnam's Power Development Plan 8 (PDP8) notes that the government will "research, develop, and promulgate laws on renewable energy" and sets goals for BESS that would require suitable regulations to be enacted, but specific details have not yet been released.

AGGREGATED PROCUREMENT APPROACHES

Aggregated procurement is a model where multiple offtakers partner to pursue clean energy solutions as a group. Aggregated procurement can be applied to both on-site and off-site clean energy options but has been limited to on-site RTS to date, in line with the currently available procurement options in Vietnam outlined earlier. Aggregated procurement can help participants overcome barriers such as unfavorable market conditions, high costs, or inability to unilaterally navigate complex technical considerations throughout the procurement process. Aggregation can also increase the commercial offer for the entire group by 3%–4% while allowing factories with smaller potential system sizing (<600 kWp) to attract bids from qualified project developers.[44] Bringing groups of facilities together can help

39 Source: CEIA data from solar procurement processes in Vietnam

40 Allotrope Partners. (2023, May 3). *Allotrope Partners supports the deployment of one of Vietnam's first industrial battery energy storage systems.* https://bit.ly/Allotrope-Partners

41 Further details on the analysis and the open source tool used can be found in Appendix D.

42 Krah, K., & Morgenstein, J. (2023, March). *Lessons learned from techno-economic analysis of solar photovoltaics and battery energy storage at a Vietnam industrial park.* Clean Energy Investment Accelerator. https://www.nrel.gov/docs/fy23osti/84424.pdf

43 Vietnam Electricity. (2023, March 30). *EVN promotes cooperation with ADB and GEAPP to concretize energy transformation projects.* https://en.evn.com.vn/d6/news/EVN-promotes-cooperation-with-ADB-and-GEAPP-to-concretize-energy-transformation-projects-6-12-3404.aspx

44 Data based on Allotrope market insights and engagement with local developers, investors, and other market stakeholders in Vietnam.

send a strong demand signal for RE within a market and ultimately attract more competitive offers from RE project developers or service providers and result in lower energy costs for participating customers. For example, Allotrope and the CEIA team have worked with major multinational brands and their supply chain manufacturers to spearhead aggregated requests for proposal in Vietnam, ranging from 10 MW single-buyer, multisite processes to 22 MW multi-buyer, multisite processes.

PROCUREMENT IN INDUSTRIAL PARKS

Green IPs are emerging as a potential solution for manufacturers that lease their facilities within an IP to adopt clean energy and reduce their environmental impact. One of the key features of green IPs is the integration of renewable energy into the grid by using smart technologies, energy storage, and demand response mechanisms. By the end of 2023, the Global Eco-Industrial Park Programme under UNIDO Vietnam has supported major players such as DEEP C and Vietnam Singapore Industrial Parks (VSIP) to implement 300 resource-efficient and cleaner solutions. This has saved 23 million kWh of electricity, 384,000 cubic meters of water, US$31 million, and 24,000 tons of carbon dioxide annually.[45] In addition, DEEP C has a target to supply 50% of its electricity using renewable sources by 2030. And VSIP is supporting LEGO to attain the first carbon neutrality target in Vietnam using a physical Direct Power Purchase Agreement (DPPA) mechanism. These examples show some promising signs for future development, but they represent only a small fraction of the 28.8 gigawatts (GW) of potential energy demand by all IPs in Vietnam.[46] To plan for clean energy development, other industrial estate developers and owners need more technical and financial support, as the current RTS installation progress is slow due to permitting challenges.[47] Further clarification on how IPs can leverage the physical DPPA component will also be crucial for scaling clean energy supply.

RECs

RECs, also known as energy attribute certificates, are a market-based instrument designed to enable the tracking and claims of the EAs associated with 1 megawatt-hour (MWh) of electricity generated from renewable resources. RECs generally include information about RE generation resources, the generator's location, date of generation, the emissions profile of the power plant, and a unique serial number for tracking and auditing purposes.

RECs can be sold either together (bundled) or separately (unbundled) from the underlying physical electricity from the RE generation. Bundled RECs are typically considered higher quality. All energy customers exploring the direct on-site or off-site RE procurement options noted throughout this document should ensure that all contracts include the associated attributes from all renewable electricity generation. Unbundled RECs are sold separately from the underlying energy and are typically purchased on an annual basis, although multiyear contracts do occur.

In Vietnam, there are **significant concerns about the additionality of unbundled RECs** that are currently available. An estimated 95% of solar and wind RECs are from FIT-based projects, and additionality is questionable. Hydropower RECs are even more common, are traded at a lower price, and carry even greater risk of low additionality.

45 Viet Nam News. (2023, December 23). *Việt Nam promotes development of green industrial parks.* https://vietnamnews.vn/economy/1638429/viet-nam-promotes-development-of-green-industrial-parks.html

46 Socialist Republic of Vietnam Ministry of Construction. (2020, July 29). *Planning for construction of industrial parks in Vietnam*. https://moc.gov.vn/vn/Pages/chitiettin.aspx?ChuyenmucID=1145&IDNews=63606

47 BAOMOI. (2023, December 31). *It is difficult to develop rooftop solar power in industrial parks.* https://baomoi.com/kho-phat-trien-dien-mat-troi-mai-nha-trong-khu-cong-nghiep-c47959437.epi

A national REC mechanism has not yet been established in Vietnam, but **global REC registries**, including **I-REC and APX**, each use their own specific instruments. In Vietnam, I-REC-issued RECs are more common than APX's Tradable Instrument for Global Renewables (TIGRs), but TIGRs are often utilized by U.S.-based energy customers. I-RECs and TIGRs have comparable prices in Vietnam. Market stakeholders have noted prices ranging from **US$0.5 to $1.5** per MWh, or from US$0.7 to $2 per metric tons of carbon dioxide equivalent (tCO_2e), based on a grid emission factor of 0.7221 tCO_2e/MWh.[48]

Not all RECs are equal, and quality varies widely depending upon the attribute's vintage (the year the MWh was generated), generation technology (e.g., solar, wind, or hydro), age of generation asset, location, and demonstrated additionality. **Global ecolabels like Green-e and EKOenergy** have been developed to certify renewable electricity products that meet higher standards of environmental and social benefits. Customers can use them to make sure the MWh of renewable energy being purchased meets independent quality standards.

The current state of RECs in Vietnam is problematic for the growth of RE. According to a technical report developed by the U.S. Agency for International Development Vietnam Low Emissions Energy Program II, Vietnam's current REC market suffers from low pricing, lack of additionality, and unclear ownership.[49] The low pricing of RECs reflects the current grid oversupply of RE and the lack of a clear national regulatory framework or standardization system for RECs in Vietnam. The lack of additionality means that it is unclear whether the REC purchases actually cause more renewable energy to be added to the grid or simply support existing projects that would have happened anyway. Specifically, in Vietnam, there are additionality concerns around the solar and wind RECs being sold based on FIT projects. The unclear ownership of RECs refers to the ambiguity of who owns the RECs when RE from utility-scale projects is sold to EVN. This creates confusion and uncertainty for both buyers and sellers of RECs and may lead to double counting. These issues undermine the credibility and impact of unbundled RECs in Vietnam and require further clarification and improvement through a national-level REC system.

48 Source: internal

49 U.S. Agency for International Development. (2022, September 26). USAID Vietnam Low Emission Energy Program II (V-LEEP II): Renewable Energy Certificate Status Brief. https://pdf.usaid.gov/pdf_docs/PA0211C6.pdf

EMERGING OFF-SITE CORPORATE PROCUREMENT OPTIONS

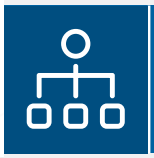
DIRECT POWER PURCHASE AGREEMENTS

OVERVIEW

A DPPA is a contractual agreement between an RE generator and a customer that enables the customer to procure renewable electricity from off-site sources, including utility-scale solar and wind installations. Under this procurement model, the customer pays two power bills: one to the utility for the supply of power from the grid and the second to the energy generator. The electricity producer generates revenue through the sale of electricity from the system to the customer at the rate difference determined in the PPA, in addition to the sale of excess electricity to the grid at a rate regulated by the government.

To date, off-site RE procurement has been unavailable in Vietnam. Spurred by strong demand from C&I energy customers, the Government of Vietnam has been in the process of developing an anticipated DPPA program for the past six years. Delays in the approval and finalization process persist. The insights in this report offer the most recent information based on inputs from local market stakeholders.

Figure 10. Key features of the draft DPPA model in Vietnam



THE MODEL
Customer enters into a contract with an RE generator to procure renewable electricity from off-site sources, with the potential for physical or synthetic transactions

THE USERS
Relevant for customers seeking 100% RE at large volumes who may be willing to pay a premium

ADVANTAGES

- Enables customers to meet up to 100% of demand with RE
- Available for customers who do not own their facilities or lack conditions for on-site RE
- Larger off-site projects can drive down RE costs
- Long-term price stability and predictability
- Represents an important step toward Vietnam's power market liberalization and clean energy goals

DISADVANTAGES

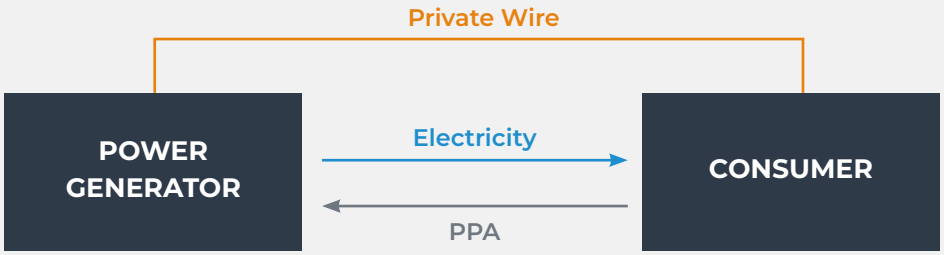
- Not currently available
- Price premiums are anticipated
- Continued delays create confusion and prevent effective planning
- Timeline for implementation is still unclear
- Details of physical and synthetic models are still evolving
- Customers bear transmission costs and risks
- Availability constraints anticipated upon finalization

This model is currently under review in Vietnam

Based on the most recent available information, the Government of Vietnam has proposed two mechanisms, a physical DPPA option and a synthetic DPPA option using spot market pricing. While these mechanisms have yet to be finalized and approved by the government, local stakeholder insights suggest that these mechanisms are anticipated to be structured as follows:

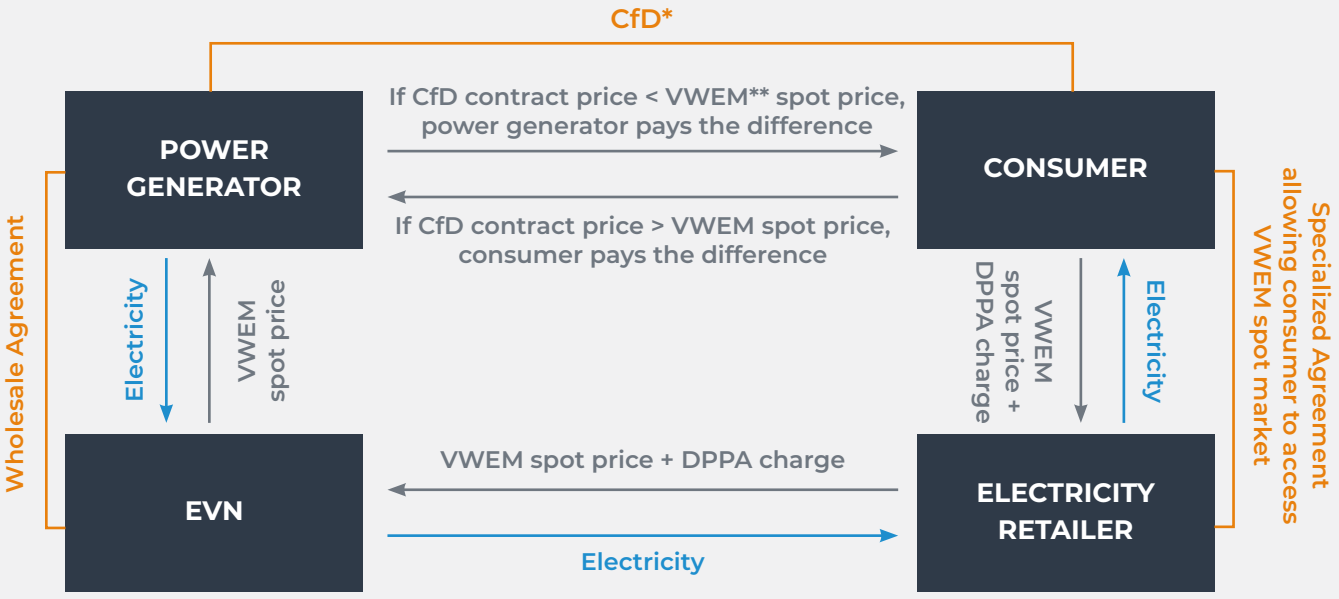
Physical DPPA (Figure 11): This model would enable energy customers and electricity generators to engage in direct electricity trading using a separate, dedicated transmission line, which circumvents the need to utilize the national grid. This method of electricity exchange is clearly defined and possible under the current legal framework in Vietnam and will allow interested parties to follow established protocols. Furthermore, this approach does not place constraints on the eligibility criteria, such as capacity, output, terminal power supply, or electricity usage purposes, for the electricity generators and customers participating in the transaction.

Figure 11. Current draft design of the anticipated physical DDPA model



Synthetic DPPA (Figure 12): This model would enable energy customers and electricity generators to enter into a forward contract, also known as a contract for differences (CfD), as part of a virtual or synthetic PPA. Under this model, generators would sell their electricity into the spot market, and energy customers would purchase electricity from EVN's Regional Power Corporation. Customers would pay the spot market price in addition to various service charges that encompass costs for the electricity transmission, distribution, system operations, market transactions costs, and auxiliary service charges. Based on updates from MOIT and other stakeholders, implementing this model in Vietnam will require the finalization of additional regulations, including those governing the prices of electricity distribution, system operations and dispatching, transaction management, auxiliary service charges, and contract templates.[50]

Figure 12. Current draft design of the anticipated synthetic DDPA model



*Contract for Difference (CfD) **Vietnam Wholesale Electricity Market (VWEM)

50 See footnote 29

POTENTIAL BENEFITS AND COST CONSIDERATIONS

DPPA has the potential to be a cost-effective RE procurement option for customers that lack the capital or facility capacity to support on-site RE options. This includes customers that lease their facilities, plan to move their operations within the next 10 years, or whose timing of operations does not align with the peak hours for on-site solar generation. Corporate energy customers, such as multinational companies or large domestic enterprises, may be able to access a range of benefits from participating in the DPPA mechanism in Vietnam. Some of these benefits include:

- **Meeting sustainability goals and 100% RE targets:** Many corporate energy customers have set targets to reduce their greenhouse gas emissions or utilize 100% clean energy in their operations. Given the limitations in on-site RE procurement and the lack of off-site options in Vietnam, DPPA has the potential to offer a pathway for customers to directly procure 100% RE from generators and demonstrate their leadership in support of Vietnam's clean energy transition.
- **Hedging against electricity price volatility and increases:** Corporate energy customers can face uncertainty and risk in their electricity costs due to fluctuations in the regulated national tariff or the retail market price. DPPA has the potential to help customers secure a long-term contract with a fixed or predictable price for RE, which can help them plan their operational expenses and hedge against potential tariff increases in the future.
- **Enhancing energy security and reliability under the physical DPPA model:** Corporate energy customers in Vietnam have experienced blackouts due to national grid reliability issues. By entering into a physical DPPA, customers could access RE generation sources that are located closer to their load centers using dedicated transmission lines, which has the potential to improve their energy security and reliability.[51]

However, corporate energy customers also face challenges and a range of considerations related to DPPA, such as:

- **Uncertainty and continued delays:** Despite strong demand among market participants and several draft versions of a DPPA pilot program and associated mechanisms released over the past six years, the program is still facing further delays. Recent delays involve additional rounds of coordination across multiple government ministries. Details on engagement between ministries is further elaborated in the next section. Ongoing delays suggest that a fully implementable, widely-accessible DPPA mechanism is likely still far from finalization, despite mounting pressure from public and private sector stakeholders.
- **Paying a premium for RE:** While the final details are still evolving, corporate energy customers may have to pay a higher price for RE than under the regulated national tariff or the wholesale market price. This depends on the supply and demand conditions, the negotiation power of the parties on the strike price, and transmission and distribution costs under the two evolving DPPA models.
- **Bearing transmission and distribution costs and risks:** Under the physical model, energy customers would have to bear the costs of a private transmission line, which may be prohibitively expensive. Under the synthetic model, energy customers would still have to pay a DPPA charge for use of EVN's transmission and distribution grid. They would also still face risks of grid curtailment, losses, or outages, which could affect RE availability and supply.

51 Vietnam Low Emission Energy Program. (2018, September 21). "V-LEEP Technical report: Market Demand demand Assessment assessment of Potential potential Renewable renewable Energy energy Corporate corporate Offoff-Takerstakers." U.S. Agency for International Development. Development Experience Clearinghouse, 31 March 2020, https://dec.usaid.gov/dec/content/Detail_Presto.aspx?vID=47&ctID=ODVhZjk4NWQtM2YyMi00YjRmLTkxNjktZTcxMjM2NDBmY2Uy&rID=NTU4OTI5

- **Compliance with legal and regulatory requirements:** Corporate energy customers will have to comply with the legal and regulatory framework for their chosen DPPA mechanism, which is still under development and may change over time. This may include obtaining permits, licenses, or approvals from the relevant authorities, such as the MOIT, Electricity Regulatory Authority of Vietnam, and EVN.

LEGAL AND PERMITTING CONSIDERATIONS

The Government of Vietnam has noted DPPA as a critical component of its roadmap toward developing a competitive retail electricity market, where offtakers can choose their retailers and participate in the electricity spot market. Article 47 of Vietnam's Electricity Law grants the right to buy electricity under a forward contract or from the electricity market. However, the implementation of the DPPA mechanism, especially the synthetic DPPA model, requires further clarification and regulation from the relevant authorities. As noted in Corporate Clean Energy Demand and Key Stakeholders, MOIT's official survey from 2022 documented interest from at least 41 C&I customers seeking to join the program, representing a total demand of over 1 GW of RE. Developers with RE projects totaling more than 4.6 GW of potential RE capacity also expressed interest in engaging or exploring participation. If DPPA does not move forward soon, Vietnam risks losing investment from these energy customers seeking clean off-site energy solutions.

The development of DPPA in Vietnam has gone through several iterations since 2018, involving different levels of approval authority and regulatory frameworks. The latest correspondence on the DPPA policy, Report Number 202/BC-BCT, was submitted to the Prime Minister in November 2023. As explained earlier, it proposed two scenarios for electricity transactions: the physical DPPA that uses private transmission lines and the synthetic DPPA that uses the national grid.[52] The physical DPPA model is considered to be permissible under Vietnam's current legal framework, although challenges and deliberations are still ongoing within various government and regulatory bodies. The synthetic DPPA model faces several legal and regulatory obstacles. Recent updates suggest that synthetic DPPA will require an amendment to Vietnam's Electricity Law, cost regulation, development of a CfD template, and further grid infrastructure upgrades before it can be implemented.

52 Government Electronic Portal. (2023, December 26). *Before December 31, 2023: Complete and submit to competent authorities the direct electricity trading mechanism*. https://xaydungchinhsach.chinhphu.vn/truoc-31-12-2023-hoan-thien-trinh-cap-co-tham-quyen-co-che-mua-ban-dien-truc-tiep-119231226070833702.htm

As discussed earlier, the synthetic DPPA model would be based upon the spot market price plus various service costs, which will require regulatory changes and guidelines on how to calculate these costs and structure the PPAs. Key regulatory changes were included in the Price Law of 2023. Once its related guidelines take effect, the synthetic DPPA model may be able to move toward finalization.

However, **internal coordination among government bodies is still ongoing and could result in further delays**. Recently, the Ministry of Justice (MOJ) and the Ministry of Finance (MOF) have shared comments and suggestions on the draft DPPA mechanism that will require additional time and effort for the government to sort out. The MOJ noted that the Electricity Law does not have a provision that entitles the government to regulate the DPPA mechanism in detail. The MOJ suggested that the legal basis and authority to issue a government decree on this matter must be further clarified. The MOF stated that the CfD has not yet been regulated in law. The MOJ requested that MOIT submit a proposal to the relevant authority for the regulation of CfD to determine the taxation mechanism that will be applicable to this form of contract.[53]

The timeline and approval authority for DPPA remains unclear, and the government remains cautious about enacting DPPA in advance of other legislative or regulatory processes. In an effort to expedite the finalization of DPPA, international government agencies, C&I energy customers, and aligned market stakeholders have continued to express strong industry demand for DPPA. They have attempted to maintain momentum by leveraging recent progress on PDP8 and instructions from the Prime Minister and Deputy Prime Minister. They have also engaged with government and other stakeholders through workshops, dialogues, joint statements, white papers, and media campaigns.

ADVANTAGES AND DISADVANTAGES

DPPA represents a critical step to further liberalize Vietnam's power market and offer energy customers significant opportunities to procure and scale clean energy use. Both the evolving physical and synthetic DPPA options have the potential to help customers cover up to 100% of their electricity load with RE. They both expand RE availability for customers that lack sufficient on-site RE capabilities or do not own their facilities and support price stability and predictability. Despite these potential benefits, significant hurdles remain, namely, the final approval and adoption of the DPPA mechanism, as well as potential price premiums, transmission and distribution costs, and other legal and regulatory challenges.

Based on stakeholder feedback, many energy customers in Vietnam aim to utilize the DPPA as a central element in their clean energy procurement strategies when the final program is made available. Additionally, many stakeholders view the continued DPPA delays as the most significant barrier to scaling their RE efforts in Vietnam. Some cite the delay of this program as preventing their entrance into the Vietnamese market.

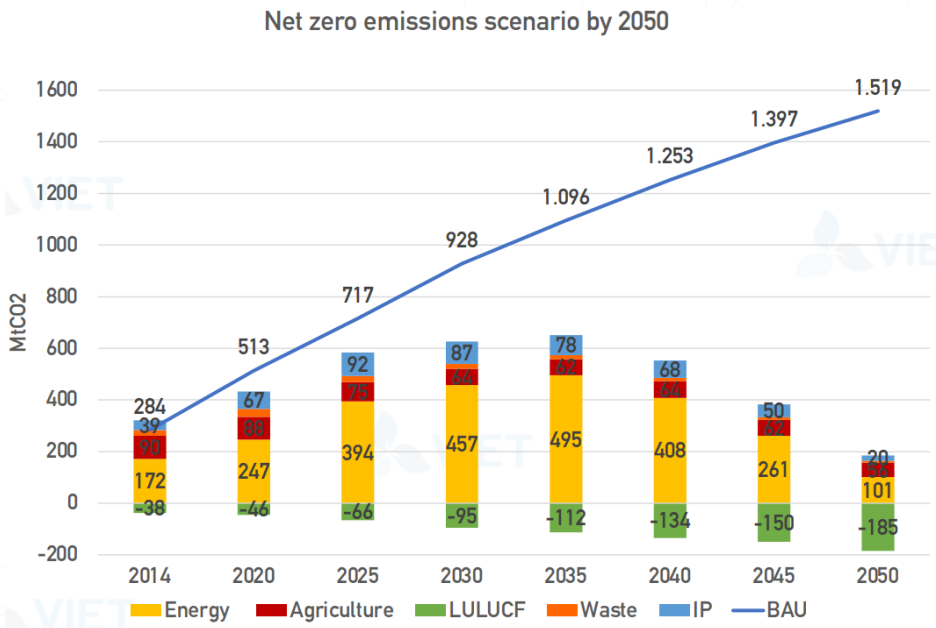
53 See footnote 29

CONCLUSION

To sustain Vietnam's strong economic growth and ensure the country's net zero emissions target by 2050, Vietnam needs to greatly increase the generation of and access to abundant and inexpensive clean energy. To achieve these outcomes, Vietnam has established a power development plan that includes substantial increases in generation capacity and is in the process of further liberalizing its power market to enable greater private sector participation. The interests of the private sector, especially those of C&I energy customers, has a significant impact on Vietnam's economy. Many companies with C&I footprints in Vietnam are already utilizing currently available clean energy procurement options, such as on-site turnkey installations and on-site PPAs, and supplementing with RECs where appropriate. Unlocking several key market barriers is critical to enabling C&I decarbonization efforts and driving Vietnam's clean energy transition. These barriers include a lack of off-site RE procurement options, policy gaps and permitting challenges, and grid transmission and distribution issues. These barriers can be addressed if key market stakeholders from the public and private sector work together on collective, market-shifting efforts that amplify the demand for clean energy, establish enabling policies, and provide expansive technical support for corporate clean energy implementation. The key stakeholders include Vietnam's national and provincial-level government agencies, EVN, corporate energy customers, industry associations, RE developers and service providers, and aligned technical support initiatives. The authors of this report stand ready to engage with aligned market stakeholders to advance this shared vision for Vietnam's corporate clean energy transition.

APPENDIX A

VIETNAM'S NET ZERO EMISSIONS SCENARIO FOR 2050



NDC BAU scenario 2030

Energy sector:

73% CO2 emissions ~ 678.4 $MtCO_2eq$

Power sector emission:

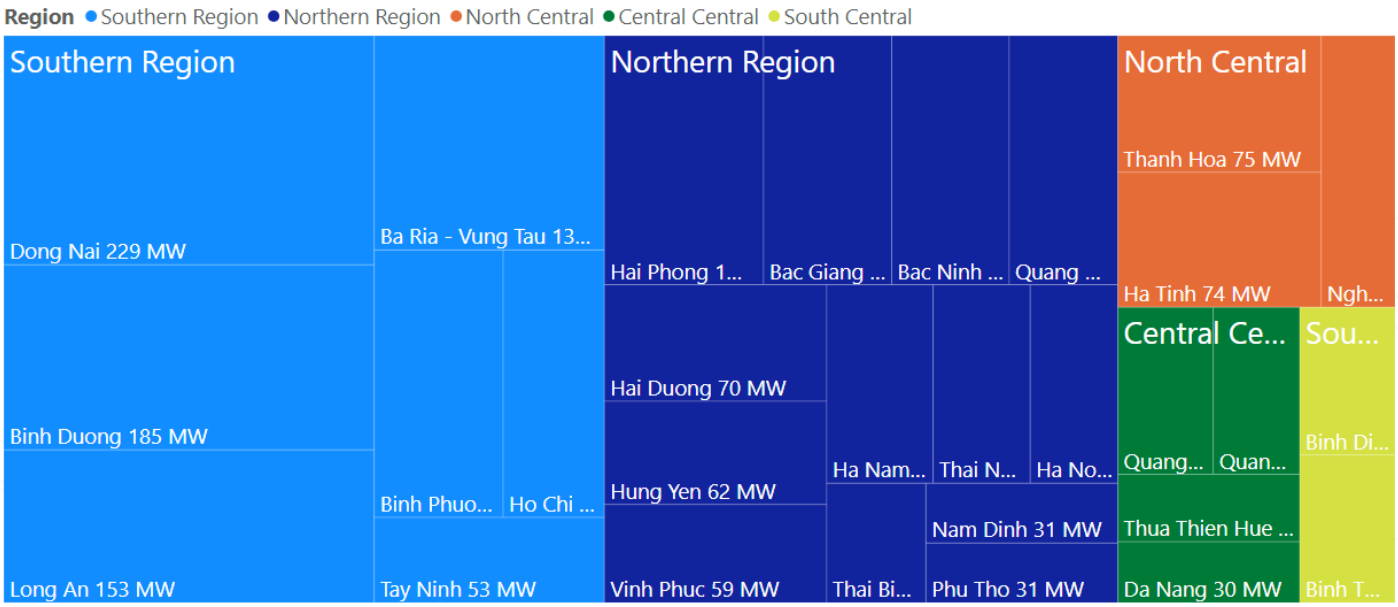
49% CO2 emissions ~ 452.3 $MtCO_2eq$

Source: Minh, H. D. (2023, March 24). *Vietnam's energy security in 2023: Global coal and LNG markets*. https://vietse.vn/en/publication/vietnams-energy-security-in-2023-global-coal-and-lng-markets

APPENDIX B

ROOFTOP SOLAR QUOTA VISUALIZATION VIETNAM'S POWER DEVELOPMENT PLAN 8

Proposed provincial quotas for additional rooftop solar capacity to be installed from 2023 to 2030.



Source: Electricity Regulation Authority of Vietnam. (2023, October 24). *The implementation plan of the VIII Power Plan is VIII was submitted to the 3rd Ggovernment for the 3rd time*. Energy Development, 24 October 2023, https://www.erav.vn/tin-tuc/t13206/ke-hoach-thuc-hien-quy-hoach-dien-viii-duoc-trinh-len-chinh-phu-lan-thu-3.html

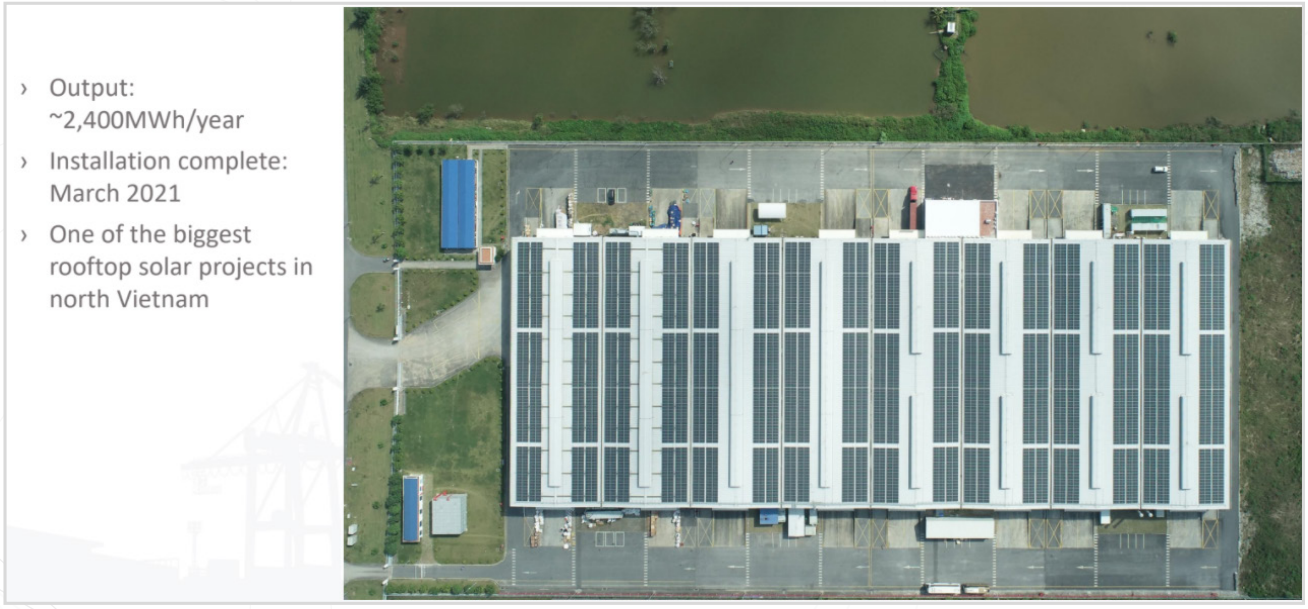
APPENDIX C

PHOTOS OF IMPLEMENTED ROOFTOP SOLAR SYSTEMS

An example of roof space required for a typical rooftop solar system in Vietnam.

Source: Maxport Limited Vietnam

On-site turnkey purchase case study snapshot: DEEP C Industrial Zone's Rooftop Turnkey Solar System totaling 2.1 megawatt-peak

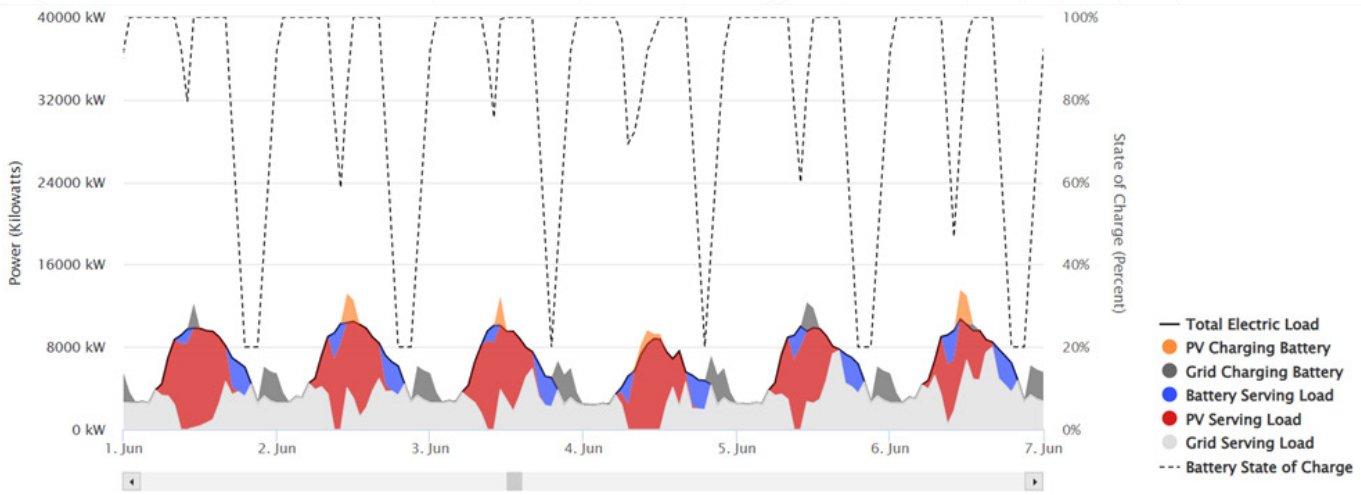


Source: DEEP C Industrial Zone

APPENDIX D

RENEWABLES PLUS STORAGE TOOLS FOR SIZING AND COST OPTIMIZATION

Example of how a battery energy storage system can maximize clean energy utilization from an on-site solar system in Vietnam



Source: NREL

This graph utilizes data from the U.S. National Renewable Energy Laboratory (NREL) REopt tool. It illustrates the pivotal role that battery energy storage systems play in enhancing the integration of renewable energy sources, such as solar power, into a distributed energy system. By storing excess energy produced during peak solar generation times, batteries ensure that the surplus is not wasted. As solar generation ceases after sunset, the battery discharges, covering the electric load and preventing a steep reliance on grid power.

Energy storage has the potential to become an increasingly cost-effective solution for electricity customers in Vietnam. The expansion of solar plus storage is expected to increase as adoption continues to increase in other markets and sectors around the world. Battery prices continue to fall, and advances in technologies and business models like energy storage as a service have the potential to expand adoption and drive down costs in Vietnam.

Regardless of these initial challenges, on-site storage offers a critical, previously untapped near-term opportunity for customers in Vietnam to increase the size of on-site solar systems, protect against grid outages, and enable up to 100% of a facility's electricity to come from clean energy sources.

ADDRESS
Clean Energy Buyers Institute (CEBI)
1425 K St. NW, Suite 1110, Washington, DC 20005

PHONE
1.888.458.2322

EMAIL/WEB
info@cebi.org
www.cebi.org

ADDRESS
Allotrope Partners
1301 Clay Street, #71180, Oakland, California 94612

PHONE
1.510.338.6950

EMAIL/WEB
info@allotropepartners.com
www.allotropepartners.com