REVIEW AND GAP ANALYSIS OF THE EXISTING ABATEMENT SCENARIOS FOR VIETNAM

Executive Summary

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Solar Park Power Plant

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Authors

Vietnam Initiative for Energy Transition

Thi To Nhien Ngo	Project Lead Senior Energy Expert
Hong Phuong Nguyen	Senior Power System Expert Energy / Power Model (DigSILENT)
Thai Trung Tran	Energy / Power Model (DigSILENT)
Hong Lam Le	Power optimization modeler
An Ha Truong	Research Analyst Power optimization modeler
Hoang Anh Tran	Research Analyst Power optimization modeler

Rocky Mountain Institute

Roy Tobert	RMI Team Lead Senior Energy Expert
Justin Locke	Senior Energy Expert RMI Managing Director
Udetanshu	Expert and Core Contributor
Nathaniel Buescher	Energy modeler
Cindy Nguyen	Energy modeler

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For any queries on copyright and content, please send to:

Vietnam Initiative for Energy Transition

Email: info@vietse.vn

Website: www.vietse.vn

Phone: +84 (0) 243 204 5554

Facebook: VIET SE (@vietsehanoi)

LinkedIn: Vietnam Initiative for Energy Transition

Address: 7th floor 18 Ly Thuong Kiet, Hoan Kiem, Ha Noi, Viet Nam.

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List of Acronyms

ADB	Asian Development Bank
AFD	Agence Française du Développement
CMSC	Commission for the Management of State Capital at Enterprises
DOST	Department of Science and Technology
DP	Development Partner
DPM	Deputy Prime Minister
DSNRE	Department for Science, Education, Natural Resources and Environment (MPI)
EE	Energy Efficiency
ETP	Energy Transition Partnership
ETC	Energy Partnership Council
EREA	Electricity and Renewable Energy Authority
ERAV	Electricity Regulatory Authority of Vietnam
EUD	European Union Delegation
EVN	Electricity of Vietnam
GGGI	Global Green Growth Institute
GIZ	Gesellschaft Fur Internationale Zusammenarbeit
GoV	Government of Vietnam
GSO	General Statistics Office
HLM	High Level Meeting
IEA	International Energy Agency
IFC	International Finance Corporation
IoE	Institute of Energy
IR	Inception Report
ISTEA	Industrial Safety Techniques and Environment Agency
JICA	Japan International Cooperation Agency

KfW	German banking group including KfW Development Bank
KOICA	Korea International Cooperation Agency
MARD	Ministry of Agriculture and Rural Development
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
MOF	Ministry of Finance
NLDC	National Load Despatch Centre (EVN)
NPT	National Power Transmission Corporation (EVN)
OECD	Organisation for Economic Cooperation and Development
PM	Prime Minister
PPPs	Public-Private Partnerships
PV	Photovoltaics
RE	Renewable Energy
SOE	State-owned Enterprise
SPRCC	Support Programme to Respond to Climate Change
TA	Technical Assistance
ToRs	Terms of Reference
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VCCI	Vietnam Chamber of Commerce and Industry
VEPG	Vietnam Energy Partnership Group
VM	Vice Minister
WB	World Bank
TWG	Technical Working Group

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VPt Ben Tre Wind Power Plant

Executive Summary

The Government of Vietnam can seize the opportunity to address global climate change while prioritizing continued development, job creation, energy security, and improving national balance of payments. The analysis provided below indicates a compelling opportunity in the power sector, that leverages new technologies in a measured and careful manner, to ensure grid reliability and cost considerations.

By 2030, the optimal scenario described below decreases carbon emissions by 59 percent when compared to the business-as-usual scenario described in Vietnam's Nationally Determined Contribution (NDC). This is achieved by investing over time in additional power generation from offshore wind, solar, liquified natural gas (LNG) generation and limiting coal capacity addition to the assets already under consideration, supported by new energy efficiency programs and battery energy storage and optimizing existing hydropower.

Pursuing that path creates seven hundred and eighty thousand jobs created versus the current business as usual scenario (an increase of 15 percent). Many of these new roles are in manufacturing, construction, installation, and operations and maintenance, which are stable and valuable positions. The pathway offers powerful economic benefits, with total costs (when considered to 2045) decreasing by 16 percent, producing a total savings of 68 billion USD.

These benefits would support an efficient and low-carbon, low-cost power sector, with a greater contribution of renewable energy and with improved grid reliability (the projected loss of load, or chance of a grid outage, would decrease by 68 percent for the grid). Modern manufacturing, technology, and medical services, all require a reliable grid that can seamlessly transition between available generation resources, and our optimized low carbon scenario is also able to deliver this and associated economic benefits.

Despite threats and disruptions from COVID-19 and strained supply chains, the potential for coupling decarbonization and economic growth has never been clearer. Ongoing dependence on imported fossil fuels continue to imperil national finances and create additional financial volatility. Projected investments in long-lived fossil fuel infrastructure options in a timescale where their long-term viability is challenged by cleaner and more economic technologies, raises the potential for disruptions in meeting the growing electricity demand in the country, threatening the ongoing development in Vietnam.

Given the rapid changes in energy technologies in recent years, the importance of power development planning has never been higher. The various pathways presented here, including those that exceed current national climate targets for the power sector, offer significant benefits and should be deeply considered and incorporated.

Looking to the near future, Vietnam can gain by steadily deploying energy efficiency and renewable energy, thereby unlocking further opportunities with the related transportation and heavy industry sectors, including the potential for green hydrogen in the industry, shipping, and power sectors.

Introduction of project

As Southeast Asia's continues to benefit from economic growth, the objectives and opportunities of decoupling carbon emissions from continued development have also become clearer. Recent years have brought new challenges, including from the COVID-19 pandemic, and the continued dependence on fossil fuels, much of which are imported, continue to imperil national finances. Projected investments in long-lived fossil fuel infrastructure options further threaten both the financial and the environmental contexts of the region and will influence global climate disruption with prolonged and severe impacts.

The Rapid Response Facility (RRF) was established at the second meeting of the COP26 Energy Ministerial and helps support country partners with a variety of assistance including strategic planning, capacity building, and technical expertise. In Vietnam, the ETP team, with selected subconsultants VIET-SE and RMI, has engaged broadly with development partners and government leaders to better define scenarios for abatement and carbon reduction. The summary of the conclusions is found herein. This study was conducted from August to November 2021, to provides support for the Vietnamese Government having scientific-based evidence for any commitment and negotiations at the COP26.

These conclusions address the immediate challenges in Vietnam related to power sector decarbonization. Long term planning for the power sector in Vietnam is governed by the Power Development Planning, for which version VIII (hereinafter referred to as 'PDP8') was released in early 2021 and subsequently updated in September and October. This plan envisions a future with a blend of fossil and renewable resources and assesses the required investments (including grid upgrades) over the period 2021 to 2030, with a vision to 2045.

In the past years, Vietnam has advanced rapidly with installations of solar and wind power, reaching almost 35% of total power generation from renewables (when combined with existing hydropower resources) by the end of 2020. From 2017, the country showed impressive leadership with concerted efforts to add renewables – leading to 16.5 GW of solar by the end of 2020 and 600 MW of wind. Vietnam has benefitted in the past from the presence and flexibility of hydro capacity in balancing the carbon intensity of its electricity system. The rapidly installed renewable energy, supported financially through the feed-in-tariff (FIT) mechanism, produced financial and operational pressures. The draft PDP8 notes the new renewable energy resources exceed the total determined to be optimal for the grid in the timeframe until 2030. Due in part to these concerns, the FIT has been reduced with prices reduced for both wind and solar by more than 30 percent. Recent announcements indicate that the Ministry of Industry and Trade (MoIT) is defining a price mechanism to replace the FIT.

These shifts in support for renewable energy, along with planned further investments in fossil fuel infrastructure, will directly and materially impact the national decarbonization strategy, which has since been bolstered by the announcement by Prime Minister Pham Minh Chinh that Vietnam would achieve net zero by 2050. In this context, and with the critical meeting of the Conference of Parties (COP) in Glasgow in November 2021, the time is right to examine a wide range of scenarios for the power sector in Vietnam and assess the potential for carbon reductions as well as the associated grid performance, economic benefits, and social impacts.

Despite the rapid growth in renewable energy, coal has a high and consistent contribution to the total generation capacity – 34% to 37% (depending on the data source) at the end of 2020. With electricity demand in Vietnam increasing at double-digits average growth rate over the last decade[2] , and projected to do so over the next five years, the decisions made now in power sector investments are critical.

Over the course of the last two years, while the renewable energy capacity has increased, so have coal imports to support the operating coal capacity in the country. This creates a risk to national balance of payments (as explored further in this report). Furthermore, the new plants in the pipeline face risks as financial support may be withdrawn by many nations and financiers now avoiding supporting new coal capacity.

To best support Vietnam's NDC targets, the new net zero commitment, and broader needs and opportunities for emissions reductions, the integrated implications of these trends must be thoroughly examined with a variety of scenarios. As part of this initiative, funded by ETC's RRF facility, and on the request of the Vietnamese government, ETP convened the VIET and the RMI teams to examine potential future scenarios for the electricity sector, with an eye on the greenhouse gas emissions measures and its reduction for the electricity sector and also taking into consideration other contemporary scenarios for the electricity sector being used by development institutions. The results here fit within the planning framework as established by MOIT, under the direction of the department of Electricity and Renewable Energy Authority.

Abatement scenarios for emission reduction in the power sector

Scenarios were utilized in this analysis to provide comparisons across different possible futures, and to then assess the impacts of these future choices thoroughly. This section provides an overview of the scenarios and presents the reasonings behind the development of said scenarios. Finally, the characteristics of each scenario are outlined.

There are three scenarios of the development of power sources and two scenarios of demand. The scenarios of power sources aim to promote the reduction of CO2. This means that the coal-fired power plants must be phased out (19.49 GW in total) and replaced by gas-fired power plants or renewable energy. Meanwhile, the scenario of demand aims to consider the impact of saving energy policies, thereby reducing the total consumption in comparison to the forecasted consumption presented in PDP8.

1 Fitch reports the COVID-19 pandemic decreased the growth rate of Vietnamese electricity demand; even still 2020 electricity usage increased 3% and estimated growth for 2021 is 5%.

Table 1: Descriptions of scenarios

Scenario	Description
Business-as-usual (BAU)	This scenario analyzes the currently planned coal developments as outlined in the PDP8 version September 2021. *Supply:* • Coal capacity increases out to 2035 and stays constant thereafter. • Domestic gas capacity stays constant after 2030, but LNG steadily increases throughout the study. • Renewable technologies steadily increase after 2030. *Demand:* • As based on the demand forecast projected in the drafted PDP8. • Elasticity per GDP: 1.35 for 2021 – 2025; 1.24 for 2026 – 2030; 0.96 for 2031 – 2035; 0.64 for 2036 – 2040 and 0.46 for 2041 – 2045.
BLUE	This scenario analyzes no new coal capacity after 2030, which is compensated by LNG and offshore wind (OSW). *Supply:* • OSW capacity increases 5 GW more than OSW capacity in the BAU case, but other renewable energy technologies follow the BAU case projections. • Additional LNG is installed to replace the coal capacity in BAU. • Increase operation efficiency of existing hydro power plants by 10%. *Demand:* • As based on the demand forecast projected in the drafted PDP8. • Elasticity per GDP: 1.35 for 2021 – 2025; 1.24 for 2026 – 2030; 0.96 for 2031 – 2035; 0.64 for 2036 – 2040 and 0.46 for 2041 – 2045.
GREEN	This scenario analyzes no new coal capacity after 2030, which is compensated by renewable energy. *Supply:* • Coal capacity stays constant after 2030, at a lower level than the coal capacity in the BLUE/BAU cases, with a phase down roadmap towards phase out of 3 old coal-fired power plants: Ninh Binh (operated since 1976); Pha Lai 1 (operated since 1986) and Pha Lai 2 (operated since 2001) by 2030. • Domestic gas stays constant after 2030, and no new LNG capacity is installed. • Solar, onshore and offshore wind capacity grows rapidly. • Increase operation efficiency of existing hydro power plants by 10%. *Demand:* • As based on the demand forecast projected in the drafted PDP8. • Elasticity per GDP: 1.35 for 2021 – 2025; 1.24 for 2026 – 2030; 0.96 for 2031 – 2035; 0.64 for 2036 – 2040 and 0.46 for 2041 – 2045.

Scenario	Description
CYAN	This scenario analyzes a mix of the BLUE and GREEN cases. This mix is defined as low carbon development with high renewable additions along with some LNG additions. *Supply:* • Coal capacity stays constant after 2030, at a lower level than the coal capacity in the BLUE/BAU cases, with a phase down roadmap towards phase out of 3 old coal-fired power plants: Ninh Binh (operated since 1976); Pha Lai 1 (operated since 1986) and Pha Lai 2 (operated since 2001) by 2030. • Domestic gas stays constant after 2030. • Solar and wind capacity additions dominate the development. • The growth in wind energy is slightly slower than the GREEN case, which is compensated by LNG. • Increase operation efficiency of existing hydro power plants by 10%. *Demand:* • As based on the demand forecast projected in the drafted PDP8. • Elasticity per GDP: 1.35 for 2021 – 2025; 1.24 for 2026 – 2030; 0.96 for 2031 – 2035; 0.64 for 2036 – 2040 and 0.46 for 2041 – 2045.
BLUE_EE	*Supply:* • Based on the BLUE case. *Demand:* • Lower demand for electricity due to higher energy efficiency measures (energy efficiency measures projected to save 10% of total energy demand in 2030, starting at 4% in 2025 and increasing up to 16% of total energy demand by 2045). • Elasticity per GDP: 1.2 for 2021 – 2025; 1.0 for 2026 – 2030; 0.8 for 2031 – 2035; 0.6 for 2036 – 2040 and 0.4 for 2041 – 2045.
GREEN_EE	*Supply:* • Based on the GREEN case. *Demand:* • Lower demand for electricity due to higher energy efficiency measures (energy efficiency measures projected to save 10% of total energy demand in 2030, starting at 4% in 2025 and increasing up to 16% of total energy demand by 2045). • Elasticity per GDP: 1.2 for 2021 – 2025; 1.0 for 2026 – 2030; 0.8 for 2031 – 2035; 0.6 for 2036 – 2040 and 0.4 for 2041 – 2045.

Scenario	Description
Cyan_EE	*Supply:* • Based on the CYAN case. *Demand:* • Lower demand for electricity due to higher energy efficiency measures (energy efficiency measures projected to save 10% of total energy demand in 2030, starting at 4% in 2025 and increasing up to 16% of total energy demand by 2045). • Elasticity per GDP: 1.2 for 2021 – 2025; 1.0 for 2026 – 2030; 0.8 for 2031 – 2035; 0.6 for 2036 – 2040 and 0.4 for 2041 – 2045.

The socio-economic indicators have been using in this study following the draft PDP8 as follows:

Table 2: Socio-economic assumptions

Assumption	Unit	2021 - 25	2026 - 30	2031 - 35	2036 - 40	2041 - 45
GDP growth rate	%/year	6.8	6.4	6.0	5.6	5.5
Electricity demand growth rate	%/year	9.09	7.95	5.8	3.66	2.61
Elasticity per GDP – BAU scenario		1.35	1.24	0.96	0.64	0.46
Electricity Generation – BAU scenario	TWh	378.3	551.3	727.0	864.9	977.0
Elasticity per GDP – EE scenario		1.2	1.0	0.8	0.6	0.4
Electricity Generation – EE scenario	TWh	364.0	496.4	627.5	740.2	825.3

Source: Draft PDP8, November 2021

Potential GHG emission reduction in the power sector

BAU scenarios – PDP8: The dependency on imported fuel for power generation is reported at 42% in 2030 and 47% in 2045. In this scenario, the emission is estimated at 269 million-ton CO2eq in 2030, which contributes to a reduction of 41% from the power sector compared to the NDC BAU in 2030.

The installed capacity for each resource in the 2030 power mix is structured as follows: solar power at 18.6 GW; wind power at 11.8 GW; biomass and other RE at 1.2 GW; hydropower at 25.5 GW; coal thermal power at 40.6 GW; oil and gas at 27.5 GW and storage at 1.2 GW.

The two indicators assessing the security of supply such as LOLP (Loss of Load Probability) at 0.14% and LOLE (Loss of Load Expectation) at 12.6h for the year of 2030.

➢ **This scenario is still relying on the imported fuel for electricity production for Vietnam in the future, which will raise significant issues regarding the national energy security and create more challenges for decarbonizing the economy as the statement of the Prime Minister's at COP26.**

Three alternative scenarios proposed by the Consultant

Blue scenario: this scenario is presenting a reduction in import dependency compared to the BAU of draft PDP8. This dependency is 34% in 2030 and 39% in 2045. The total emission is calculated at 239 million-ton CO2eq in 2030, 47% lower than the emission of referenced NDC for the power sector in the same year.

This scenario (and its name) shows a prioritization for the marine energies while keeping gas thermal power, solar, onshore wind, and hydropower as their planned capacity. The Consultants are assuming that the coal-fired power plants have not been built up to date because financial arrangements will be excluded in the simulation. The LNG is a balanced resource to fulfill the power demand requirements.

The installed capacity for each resource is planned for 2030 as: 18.6 GW of solar; 11.8 GW of onshore wind; 5.4 GW of offshore wind; 1.2 GW of biomass and other RE. The hydropower maintained its installed capacity as draft PDP8 at 25.5 GW (as same as the projects pipeline in the draft PDP8) with the assumption that the real-time decision support system could be installed for increasing its power generation at 10%. Coal capacity will be installed at 30.1 GW and oil power plants are being to all decommissioned in 2030. Gas power capacity is at 14.4 GW and LNG at 15.7 GW (same as draft PDP8); storage at 2.4 GW (increased 1.2 GW compared to draft PDP8).

The LOLP (Loss of Load Probability) is calculated at 0.38% and LOLE (Loss of Load Expectation) at 33.6h for the year of 2030 in this scenario.

➢ **This scenario is prioritizing the development of the marine energies (such as importing LNG and increasing the share of offshore wind for power generation), reducing the imported coal but could not minimizing the impacts on the national energy security.**

Green scenario: this scenario is showing as well an important reduction in the imported dependency for power purposes. This dependency is presenting 20% in 2030 and 13% at 2045. The total emission is calculated at 207 million-ton CO2eq in 2030, 54% lower than the emission of referenced NDC for the power sector in the same year.

This scenario (as its name) shows a prioritization of renewable energies while keeping concentrated solar power and hydropower as their planned capacity. An additional remarkable point is the decommission of 03 old coal power (operating more than 35 years) at 1.14 GW and the coal-fired power plants have not been built up to date because financial arrangements will be excluded in the simulation. For gas power, only domestic gas power plants in the pipeline are being considered. The variable resources from rooftop/floating solar, onshore and offshore wind will supplement the of non-added capacity from coal and LNG to meet the required demand.

The installed capacity for each resource is planned for 2030 as: 33.2 GW of solar (with 5 GW of rooftop solar and 9.6 GW of floating solar projects); 21.3 GW of onshore wind (increasing of 9.5 GW vs. draft PDP8); 10.2 GW of offshore wind; 1.2 GW of biomass and other RE; 25.5 GW of hydropower (with 10% of increasing generation efficiency); coal at 28.9 MW; oil (0 GW) & gas 14.4 GW; LNG (0 MW) and storage at 3.5 GW (increasing 2.3 GW vs draft PDP8).

The LOLP (Loss of Load Probability) is calculated at 0.74% and LOLE (Loss of Load Expectation) at 64.7h for the year of 2030 in this scenario.

- **This scenario is prioritizing the development of renewable energies (such as mobilizing the rooftop and floating solar; onshore and offshore wind for power generation), proposing the lowest dependency among alternative scenarios on imported fossil fuels for power. However, the highest investment is required to implement this scenario, with the greatest impacts on the power system's stability because of the important integration of variable renewable energies to the system.**

Cyan-EE scenario: this scenario is showing as well an important reduction in imported dependency for power in comparison with BAU scenario. The share of the power from the imported fuels in the total power generation is respectively 29% in 2025; 27% in 2030 and 25% in 2045. The total emission is calculated at 183 million-ton CO2eq in 2030, 59% lower than the emission of referenced NDC for the power sector in the same year.

This scenario enhanced the importance of applying various energy efficiency measures in different sectors (such as industry, services, or residential) to reduce the power demand and combine with the integration of renewable energies. In this scenario, the power elasticity per GDP is assumed to achieve 1.0 by 2030 and 0.4 by 2045 (lower than the taken numbers of PDP8: 1.24 in 2030 and 0.46 in 2045). Respectively, the power demand is reduced to 480 TWh in 2030 and 795 TWh in 2045 (instead of 551 TWh in 2030 and 977 TWh in 2045 of draft PDP8).

In terms of power source, the installed capacity from solar and hydropower are kept as in the BAU scenario. In parallel, 03 old coal power (operating more than 35 years) at 1.14 GW will be decommissioned in 2030 and the coal-fired power plants that have not been built up to date because of financial arrangements will be excluded in the calculation. Domestic gas power plants in the pipeline will be modelled and only 30% of the installed capacity of LNG is allowed to be operated. The required additional capacity will be supplemented by the rooftop and floating solar; onshore and offshore wind.

The simulation results are showing the structure of the power mix in 2030 as follows: 33 GW of solar (with 5 GW of rooftop solar and 9.6 GW of floating solar projects); 11.8 GW of onshore wind (same as draft PDP8); 10.2 GW of offshore wind; 1.2 GW of biomass and other RE; 25.5 GW of hydropower (with 10% of increasing generation efficiency); coal at 28.9 GW; oil plants are all decommissioned & gas 14.4 GW; LNG at 6 MW and storage at 2.2 GW (increasing 1.0 GW vs draft PDP8).

The LOLP (Loss of Load Probability) is calculated at 0.006% and LOLE (Loss of Load Expectation) at 0.5h for the year 2030 in this scenario.

- **The Consultants estimate that this scenario is presenting the most suitable and appropriate roadmap for power sector development in Vietnam, in considering different angles from economic capabilities; abilities to develop power sources in line with supporting infrastructures; lower risk to the national energy security by importing less fossil fuels from international markets; enhance the quality of national labor market and strengthen the economic development of the country.**

Based on our above assessment, the highest potential of emission to be reduced for only power sector could **significantly achieve 59%**, equivalent to nearly **29% of total emission** from overall sectors of the country in **2030** (~ 927.9 Mt CO2). For 2045, the emission is estimated to be reduced by 38% in comparison with government policy (draft PDP 8) in case of following this scenario.

All these assessments are referred to the economic (GDP) growth rate for 2021 – 2025 at 6.8% and 2026 – 2030 at 6.4%. The power demand is forecasted based on the future consumption for the development of different sectors but not yet considering the energy transition from coal, gasoline, and oil to power in industry, agriculture, and transport (e-vehicles).

In summary, Vietnam should consider a long-term roadmap while ensuring promoting economic development. This will increase the financial investment to implement the energy transition sustainably and reliably, especially for the power sector. To achieving to an emission reduction in the **Cyan-EE** scenario, the total investment in 2030 for power sources is US$ 115 billion (compared with BAU-PDP8 of US$ 101 billion), and US$ 297 billion in 2045 (BAU-PDP8 at $ 287 billion); for the transmission and distribution grid infrastructure in 2030 is US$ 42 billion (compared to BAU-PDP8 is US$ 40 billion) and US$ 109 billion for 2045 transmission and distribution grid infrastructure (compared to BAU-PDP8 is US$ 104 billion). The total differential investment to pursue the emission reduction scenario is **US$ 16 billion in 2030** and **US$ 15 billion in 2045**.

Recommendation

Given the rapid changes in energy technologies in recent years, the importance of power development planning has never been higher. Vietnam has exemplified a commitment to green growth and inclusive economic development. Vietnam now has an opportunity to further advance objectives of national development, energy security, job creation, and environmental protection by exploring deep decarbonization pathways. In forthcoming planning processes, Vietnam should continue to consider and examine various pathways, including those that exceed current national climate targets for the power sector.

With continued leadership in deploying energy efficiency and renewable energy, further opportunities will emerge with the related transportation and heavy industry sectors. As urban environments become more critical and exposed to the dangers of a destabilized climate, Vietnam can also find interconnections to improve environmental performance at the city level.

Clean technologies, especially variable renewable energy (VRE) such as wind and solar have seen a huge uptake in Vietnam through their early stages of adoption and can help meet Vietnam's fast growing energy demand cleanly and cost-effectively. However, they face some significant barriers

- VRE resources such as solar and wind face a unique challenge in Vietnam in the lack of contractual protection against curtailment. Many of the initial utility scale solar capacities have struggled with significant curtailments as more resource continues to be added on the grid, struggling to recover their upfront capex. This could raise challenges for capital raising for continued investment in VRE, especially as Vietnam looks to replace higher cost FiTs with more competitive auctions.
- Adequate grid capacity, to transmit the electricity generated through the system is imperative to continue to meet both quality and security of supply needs on the one hand, and to reduce the risk of curtailment or underutilisation of capacities on the other hand. However, Vietnam has struggled in recent years on this front. Extending monopoly grid capacity has a much longer gestation period than building new generation capacity, several of renewable projects already being under construction, creating a time lag between capacity addition and capacity integration, expensive for both suppliers and consumers.

The government of Vietnam has taken cognisance of both of these issues, with the PM issuing Decision 13 in April 2020, instructing EVN, the sole off taker, to purchase all power generated by renewable energy sources. However, technical and capacity constraints at the system level and commercial constraints from the financial health of EVN make these directions difficult to follow, especially unless concerted efforts are made – both short term interventions and implementation of medium-term systemic solutions.

Vietnam and its power planning need to factor specific interventions within its pathways, to match its low carbon transition ambitions:

- Energy efficiency, including the residential, commercial, and industrial sectors, to save up to 16% of total demand projected on the BAU pathway for 2045. This, when combined with the resources below, will create cost optimal scenarios and increase job creation, with the added benefit of a positive impact on Vietnam's balance of payments by improving domestic energy production and reducing fossil fuel imports. MOIT can continue to show a powerful leadership role in driving energy efficiency across multiple sectors and engaging with customers through programs and incentives.
- Investments in renewable energy can be expanded including solar (rising to 51.5 GW in 2045, with a potential for further 14.6 GW), onshore wind (increasing to 27.1 GW in 2045), and offshore wind (increasing to 26.4 GW in 2045, with the potential for additional 10.2 GW)
- Selective LNG installations (in the range of 16 GW equivalent capacity instead of the 50 GW projected) can support the grid in the coming decades. These investments are justified based on their economic benefit and support for grid reliability. While these

investments help diversify the energy mix, Vietnam will remain exposed to price risks from the international market, and could run the risk of asset stranding in the future as other cleaner balancing and flexibility resources reach price competitiveness.

- Expanding the flexibility range of existing resources and adding new capacity for balancing and flexibility can greatly increase the scope for greater generation from cleaner and cheaper VRE sources and even manage the need for expensive LNG capacity and infrastructure spend. Some pathways to explore:
    - Improve flexibility within existing infrastructure through decision support system for hydropower introducing real-time monitoring, and introducing virtual power plants mechanism
    - Upgrade infrastructure of power system, to improve flexibility ranges (reducing Pmin, and increasing Pmax), and where relevant for gas pulverizing systems can increase capacity factor and Pmax
    - Upgrade cross-section of transmission line and electricity poles and invest in substation automation systems, measurement data collection, better monitoring and detecting of substation breakdowns, GIS, and wide area monitoring systems (WAMS)
    - Invest in equipment to increase safety and reliable supply such as Static VAR compensator (SVC) and Thyristor Controlled Series Capacitor (TCSC)
    - Upgrade of substations to increase load capacity by up to 50%
    - Battery storage to firm the grid and displace some of the required gas investments.
- Other energy vectors and utilisations should be considered for further study and preparation
    - Vehicle electrification to improve environmental outcomes and eventually firm up the grid through transactive services and pricing.
    - Hydrogen (ideally green hydrogen – produced from renewable energy) to enable longer duration energy storage
- Finance mechanism
    - Insurance for RE curtailment
        - ✓ One of the primary risks to attracting renewable energy investments in emerging economies is the risk posed by the counterparty. This risk, called offtake risk, is because of the poor credit quality of the counterparty – often the state-owned distribution company, or integrated energy company. In the case of Vietnam, this is a rampant practice for renewable energy projects in Vietnam because of inadequate grid capacity.
        - ✓ Extending grid capacity has a much longer gestation period than that of new renewable energy projects, several of which are already under construction.

In order to address this time mismatch, and create the conditions required for adequate grid strengthening measures to be undertaken, we propose the design and implementation of a grid-integration guarantee that provides renewable energy generators coverage from loss of revenue due to curtailment by EVN. The government has also taken cognisance of this issue, with the PM of Vietnam issuing Decision 13 in April 2020 that requires the purchase all the power generated by renewable energy sources. However, technical constraints of the grid and commercial constraints because of the financial health of EVN will lead to this decision being violated, unless short term interventions and medium-term systemic solutions are put in place.

✓ Designing a financial intervention that underwrites a critical barrier to the flow of capital into renewable energy projects would have multiple benefits, primary among them being addition of clean energy capacity at lower prices. The cost of capital can contribute as much as 80% of the total cost of renewable power, reducing the risk of investment can significantly lower the cost of borrowing for such project, and the rates paid to equity investors – in turn making renewable power cheaper, and accelerating the pace of the energy transition due to the enhanced competitiveness of renewables.

    - Emission Trading System
    - Pilot CRM (State company) from the lesson learn to the realistic strategy consider country context and Energy Storage and Emission score.

- Develop ASEAN Power Market
    - Interconnection Grid code
    - Region Power market mechanism

These explorations and investments will create significant job benefits for Vietnam (up to 8 million new jobs, with greater capacity addition possible with exploration of new energy vectors and expansion of the balancing and flexibility capacities), but the distributional effects will require support for displaced working populations (coal supply chain) through a managed just transition process. This process can consider the differential impacts on regions in Vietnam, as well as the potential for high-skill career development and retraining available to any sectors impacted by the energy transition. By emphasizing the options for energy equipment and services that come from inside Vietnam, the national balance of payments can be improved by $190 billion in the coming decades.

With effective and thorough planning in place, as has already been the hallmark of the Power Development Planning processes, the Government of Vietnam can access new and emerging climate finance flows for new energy efficiency and renewable energy options. These are summarized above, but include opportunities from existing development partners, as well as newer vehicles such as the Green Climate Fund.

Leaders in Vietnam should examine embedded subsidies for fossil fuels, from market developments, and seek ways to create a level playing field by reducing current fossil fuel subsidies (as has already been underway since 2011 as part of Power Development Planning processes). By continuing to advance low-carbon planning and development, Vietnam can remain a leading partner for global business and offer options to support corporate goals as that sector also addresses environmental concerns.

By aligning public and private entities, through an inclusive process, Vietnam can prepare to support any communities and industries impacted by the shift away from legacy energy assets. A council or committee for energy transition, involving both the private and public sector, is recommended (as per the Chile example), to ensure a coordinated and directed transition. As the electricity, transportation, and urban planning sectors all increasingly intersect – the opportunity for an energy transition council to provide valuable guidance and coordination is bound to increase.

Leaders from the Ministry of Industry and Trade, particularly from the Electricity and Renewable Energy Authority, would be well placed to chair this committee and continue the valuable momentum and growing power of Vietnam's economic development.

To ensure the recommendations and analysis summarized above is incorporated into Vietnamese power planning processes will require a focused and multi-pronged communications strategy, consistent messaging on the opportunity of deeper decarbonization options while recognizing the value and integrity of PDP 8, and an accurate and updated understanding of global funding opportunities for the technical assistance and infrastructure required for the recommended shifts. This will be ever more critical given the announcement of the net zero ambition, and the requirements of aligning planning to that future state.

Source: Hoàng Nguyễn, VIỆT SE Solar Park Power Plant

VIET

Address:	7th Floor - Building 18 Ly Thuong Kiet Phan Chu Trinh, Hoan Kiem, Ha Noi, Viet Nam
Telephone:	+84 (0) 243 204 5554
Website:	www.vietse.vn
Email:	info@vietse.vn
LinkedIn	Vietnam Initiative for Energy Transition
Facebook:	VIET SE (@vietsehanoi)