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COMMISSION FOR THE MANAGEMENT
OF STATE CAPITAL AT ENTERPRISES



FINAL REPORT

Roadmap for the Commission for
Management of State Capital
toward Net-Zero Emission in Energy
State-Owned Enterprises in Vietnam

June 2023



nhquang&associates





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Acronyms

ADB	Asian Development Bank
BESS	Battery Energy Storage System
CCUS	Carbon Capture, Usage, and Storage
CFPPs	Coal-fired Power Plants
CMSC	Commission For The Management Of State Capital
ESS	Energy Storage System
ETP	Energy Transition Partnership
EVN	Vietnam Electricity
GHGs	Greenhouse Gases
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
JETP	Just Energy Transition Partnership
LNG	Liquefied Natural Gas
NDC	Nationally Determined Contribution
NZE	Net Zero Emissions
PHS	Pump Hydro Storage
PTSC	PetroVietnam Technical Services Corporation
PVD	PetroVietnam Drilling & Well Services Corporation
PVN	PetroVietnam
PVTrans	PetroVietnam Transportation Corporation
RE	Renewable Energy
SOEs	State-owned Enterprises
VCGM	Vietnam Competitive Generation Market
VINACOMIN/TKV	Vietnam National Coal – Mineral Industries Holding Corporation Limited
VREM	Vietnam Retail Electricity Market
VWEM	Vietnam Wholesale Electricity Market



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Executive summary

The Commission for State Capital Management (CMSC) exercises the rights and responsibilities of the state owner's representative for state-invested enterprises, with a particular focus on managing the utilization and retrieval of the State capital of the three State-owned Enterprises (SOEs) in Vietnam's energy sector, including Vietnam Electricity (EVN), Vietnam National Coal – Mineral Industries Holding Corporation Limited (VINACOMIN or TKV) and PetroVietnam. Together, these enterprises still accounted for 58% of the total electricity output by 2021 and remained crucial in providing electricity for the country's socioeconomic development. Given that the majority of dispatchable sources, such as thermal and large hydropower plants, are owned by the SOEs, they play a vital role in ensuring the reliability of the power supply. This is especially significant since the state continues to regulate electricity prices to guarantee affordability and accessibility for all, aligning with the Sustainable Development Goal SDG 7 set by the United Nations.

At the landmark COP26, Vietnam made strong commitments to climate protection. Prime Minister Pham Minh Chinh affirmed that with international support on technology transfer, finance and capacity building, Vietnam aims to reach Net Zero Carbon Emissions (NZE) by 2050. Vietnam is also one of the 47 signatories of the Global Coal to Clean Power Transition Statement, committing to promoting power generation from clean sources and transit the unabated coal power generation by 2040s.

The energy transition is an unavoidable necessity to achieve the goal of becoming independent from depleting fossil fuel sources and to protect our climate by the middle of this century. Scientific evidence has demonstrated that accelerating clean, inclusive and just energy transitions is a prerequisite for implementing a long-term climate protection strategy. Aligning with the global development trends, the Prime Minister's Decision 888/QD-TTg on tasks and solutions to execute the results from COP26 and Decision 896/QD-TTg on National Strategy on Climate change in July also emphasized the pivotal role of energy transition in achieving the NZE target. As the key stakeholders in Vietnam's energy sector, the three SOEs will play an important factor role the country in fulfilling the NZE commitment.

However, Vietnam is currently grappling to a crisis of energy shortage, especially power generation. International coal and natural gas prices have skyrocketed, posing challenges to maintain stable electricity price and below the electricity production cost. From 2021 to 2022, Europe competed with Asia to buy all the gas produced from the United States,

making a significant increasing of gas price (36.5 \$/MMBTU at European market, 10 times higher than \$3.3/MMBTU in 2020). The crisis is also impacting the coal market, through the sudden increase in coal prices when reaching about \$ 400/ton in mid-2022 compared to the level of \$50-130/ton in the period 2009 to mid-2020. For low-middle-income countries like Vietnam, it becomes challenging to compete with developed nations to purchase fossil fuels at market prices that are acceptable for their economies. The global energy market outlook highlights that ensuring long-term energy security is a significant challenge for Vietnam. The electricity shortages resulting from high fuel prices, limited supply access, and extreme climate events experienced in 2023 serve as a crucial reminder of the necessity to ensure stability and sustainability in the country's energy system.

Additionally, CMSC and the three energy SOEs in Vietnam face both drivers and challenges to plan and implement the effective and just energy transition toward the NZE target. CMSC has placed significant emphasis on supporting the SoEs to move towards sustainability, improving governance capacity, enhancing business efficiency, developing the emission reduction roadmap, and creating favorable conditions for promotion of the clean energy market. After identifying the challenges as well as implementation requirements, CMSC cooperated with ETP to develop the technical assistance. This assignment aims to provide science-based evidence to support the CMSC in developing a roadmap for energy SOEs in Vietnam, contributing to the nation's net-zero emission target by 2050. The key findings are summarized below:

Technical implication

According to the Terms of Reference's (TOR) requirements, the Consulting team have developed ***emissions reduction solutions in the long-term for three SOEs, with a specific focus on power generation*** and excluding the other business activities such as oil, coal and gas exploitation, etc.

In line with the TOR requirements, the Consulting team have built several scenarios based on a comprehensive approach and tailored them specifically for the energy SOEs. Utilizing technical, financial and legal analysis, the team has identified two (02) potential scenarios for achieving SOEs' emissions reduction goals by 2050. These scenarios primarily focus on reducing emissions from fossil-fuel-based power plants, considering their substantial contribution to greenhouse gas emissions and the potential risks associated with securing imported fuels. Moreover, these scenarios take into account the crucial roles of the SOEs in ensuring national energy security and their significant contributions to the country's socioeconomic development.

The development of these scenarios adheres to key principles, namely ensuring energy security, affordability, and emissions reduction. The scenarios consider the maximum capacity factors of various generation technologies: hydropower 41%; onshore and offshore wind 39% - 48% ~ operation hour of 3400 – 4200h/year; ground-mounted solar and floating solar 17% - 18% ~ operation hour of 1450 – 1550h/year; gas power 76% ~ maximum operation hour of over 6000 h/year. The power sources are mobilized as follows:

- ▲ Deep Decarbonization Scenario – **KB_DD**: In 2030, maintaining operation of gas-fired thermal power plants with an installed capacity of about 15.3 GW; LNG over 7.4 GW; hydroelectricity is 29 GW; onshore and nearshore wind power about 16 GW; offshore wind power about 10 GW; ground-mounted solar power is over 12 GW, and floating solar is 4.3 GW. Accelerate emission reduction in some coal-fired power plants through: reviewing and applying emission reduction technologies in place for plants with less than 8 years of operation; 30% reduction in power generation output of some units after 10 years of operation; 60% after 15 years of operation and retire after 20 years of operation.
- ▲ Accelerated Reduction Scenario – **KB_AR**: In 2030, the installed power sources are similar to KB_DD. The option to reduce emissions at a more sustainable rate in some coal-fired power plants through: application of on-site emission reduction technologies for plants with operating years of less than 10 years; reduce 10% of power generation output of some units after 10 years of operation; 30% after 15 years of operation and decommissioning after 25 years of operation.

The Consultants emphasize that when establishing the emission reduction scenario, priority must be given to national energy security. Therefore, the possibility of implementing emission reductions for coal fired power plants can only be realized if alternative sources of power generation such as renewable energies to ensure the supply demand balance and flexibility options are available.

Both simulation scenarios demonstrate Vietnam's power system has the potential to achieve the CO₂ emission reduction target stated in the updated NDC 2022. Accordingly, by 2030, the emission reduction potential of KB_DD is 251 MtCO₂ and KB_AR is 221 MtCO₂ (60% and 53% respectively of the emission levels under the BAU scenario). By 2050, the total emissions of the power system in both scenarios will reach 30 MtCO₂, aligning with the target of the National Strategy on Climate Change.

The KB_DD scenario results indicate that the future CO₂ emissions of the three SOEs in power generation activities (coal, gas and oil) will decrease proportionally to the electricity output from fossil fuels. SOEs' emissions from power generation activities are projected to peak in 2026. The largest emissions from coal fired power plants are occurring in 2025 as certain coal power plants reduce and cease generating power after 20 years of operation. In 2030, the emission reduction potential from power plants of all three SOEs is 57 MtCO₂ (48% reduction compared to the case of no emission reduction measures could be applied in the SOE's coal power plants) and after 2050 will be no more emissions from SOE's coal power plants.

For KB_AR, the emission reduction rate shown by SOEs' emissions curve to 2050 will be slower than in KB_DD. Emissions from power generation activities as well as from coal power plants will reach their peak in 2030. The potential to reduce emissions from SOEs' power plants is 28 MtCO₂ (a decrease of 23.4% compared to the case of no emission reduction measures could be applied in the SOE's coal power plants). By 2050, the three SOEs will still emit 5 MtCO₂ (96% reduction compared to the no-action scenario).

The scenarios' simulation results indicate the need to increase more renewable energy (RE) capacity to compensate for the reduced power output from SOEs' coal power plants. To support the integration of RE while ensuring the full generation and transmission capacity of the entire power system, 7 GW of storage capacity is required in KB_DD and 6 GW in KB_AR (including pump hydro storage).

The Consulting team has evaluated SOEs' share in the electricity system based on their installed capacity and power output derived from the current investment portfolio. The results show that, if SOEs do not increase their investment in clean energy in the next 7 years and implement emission reductions according to the two scenarios mentioned above, SOE's share of electricity output in the total system output will decrease significantly, especially after 2030 when emissions peak. In 2021, SOE's share in the electricity market is 58% of total output, but by 2030, this will drop to 38% for KB_DD and 41% for KB_AR. This market share will continue to decline further in 2050, to 10% for KB_DD and 9% for KB_AR.

To mitigate the impact of reduced power output as well as revenue impact due to coal power cuts, it is recommended that corporations adopt a long-term investment strategy to develop RE sources and storage systems depending on their power strength, financial health in order to retain their future strategic role in the power industry.

- 🔹 **Recommendations for EVN:** focus on investing in floating solar power projects on hydropower reservoirs owned by EVN, with a capacity of 4.3 GW and 6.6 GW of offshore wind by 2030. An important state-owned enterprise in the power sector, EVN is also recommended to invest in the development of storage systems (storage hydroelectricity and battery storage) to play a key role in ensuring the security and stability of the power system.
- 🔹 **Recommendations for PVN:** Consider investing or participating in upgrading infrastructure of the existing industrial ports and developing new offshore wind power projects, given the availability high-quality technical human resources with experience in offshore projects. PVN has many subsidiaries specializing in different offshore engineering fields. For example, PetroVietnam Drilling & Well Services Corporation (PVD), PetroVietnam Technical Services Corporation (PTSC) of PVN is the leading contractor in Vietnam with special capacity is EPCIC (Engineering, Procurement, Construction, Transportation and Installation, Operation) and has some experience in designing the base of offshore works, especially won international bids for several offshore projects in other countries. In terms of infrastructure capacity, PTSC already has a system of service ports and supply bases for assembling super-heavy-weight components, capability for seismic, geological and underground works; Installation, operation and maintenance of marine works; and Services for RE projects.
- 🔹 **Recommendations for TKV:** Consider investing in new RE projects, storage batteries, explore the possibility of making use of land recovered after the mine closure. Additionally, TKV could investigate biomass co-firing technology as a potential application for some of its coal power plants.

Financial implications

If there are no additional new sources to compensate for the decrease in coal power output, the power generation revenue of these corporations will experience a sharp decline, leading to the necessity of reducing their workforce in the coal power sector.

🔹 **KB_DD:** The total revenue of the three corporations from 2022 to 2025 will decrease by a substantial amount of 72.4 trillion VND (3.0 bill USD) and then 744.1 trillion dong (\$31 billion) from 2046 to 2050. In this scenario, a total of 29 thousand workers will be affected by 2050 in total.

🔹 **KB_AR:** The revenue reduction of the three corporations will be 38.7 trillion VND (\$1.6 billion) from 2022 to 2025 and 689.2 trillion VND (\$28.7 billion) from 2046 to 2050. The number of workers affected in this scenario is 27.2 thousand jobs by 2050.

Among the three SOEs, EVN will be the most affected due to its reliance on coal-fired power plants, having a much larger power output compared to TKV and PVN. EVN is expected to face the biggest challenge, with about 19,700 jobs expected to be lost by 2050. Therefore, addressing the issue of redundant labor resulting from the transition should be one of the priorities of all three corporations. One solution is to consider providing financial support packages for employees who are laid off due to the implementation of transition scenarios. In addition, training and skills improvement programs should also be offered to prepare workers for a new job opportunity within the corporations or at other companies.

The analysis of the financial health of the three SOEs reveals the necessity of borrowing to finance and support the energy transition, given the substantial capital investment required. This investment plays a critical role in developing new clean energy sources, ensuring future revenue, maintaining the corporations' role in the power system, and facilitating a fair transition. Using retained earnings to increase the equity of the three groups is limited due to the relatively low return on equity of EVN, TKV and PVN is only at 6.0%, 9.7%, and 8.1% in 2021. Additionally, EVN experienced a significant loss of \$1.2 billion in 2022, and there were considerable fluctuations in the profits of TKV and PVN. Therefore, debt financing emerges as a more viable option for the three corporations to fund the energy transition. This debt can take various forms, such as bank loans, loans through bond issuance, loans from donors, State credit, loans guaranteed by the Government or any other suitable forms of borrowing.

However, there is a regulation that the debt-to-equity ratio in SOEs cannot exceed 3 times. Consequently, EVN can only borrow a maximum of \$9.66 billion, while TKV's limit is \$2.48 billion, and PVN can go up to \$43.81 billion. Currently, the total amount that the three corporations can take on as additional debt, based on their current equity levels, is \$55.9 billion. Unless the equity of the three corporations increases, this remains the maximum borrowing capacity available to them.

Legal implications

The assessment of legal issues arising when CMSC or SOEs implement the roadmap towards the NZE target is carried out in 06 main prominent matters, including

- i. The ownership matter, which is related to decision-making authority in the situation;
- ii. Issues related to input contracts (mainly coal supply contract), output contracts (mainly power purchase agreement), and
- iii. Loan contracts/capital arrangement contracts;
- iv. Labour and employment issues;
- v. Property settlement issues;
- vi. Industrial safety (focusing on regulatory requirements for plant dismantling) and environmental remediation.

These matters are considered as the main legal matters that CFPPs or owners need to consider when implementing the phase-out/down of a CFPP.

Our analysis shows 03 risk levels for each of the 06 foregoing legal matters when implementing KB_DD and KB_AR scenarios: high, moderate, and low. Determining the level of legal risk will depend on the content of each scenario and legal issue.

The level of risk is analyzed based on the possibility of disputes arising, especially disputes between investors, employees, the social community and SOEs owning thermal power plants or state agencies.

Regarding the legal aspects of implementing the emission reduction scenarios, SOEs are advised to:

- ▲ Estimate the economic losses incurred in the transition scenarios;
- ▲ Develop plans for discussing with the shareholders at the CFPPs of which SOEs do not own 100% capital;
- ▲ Request each CFPP or companies that owned CFPPs under SOEs' management to specifically assess the legal risks (along with technical and economic assessments) and propose the solutions for risk minimization in implementing transition scenarios;
- ▲ Based on the risk assessment, CFPPs or companies that owned CFPPs under SOEs' management should formulate an implementation plan, which at least comprises the business plan for each CFPP, a plan for fuel procurement, a plan for addressing employment and social impacts mitigation, plan for investments in new power sources and/or upgrading and renovating CFPPs.



1

Introduction

The project “Roadmap for the Commission for Management of State Capital toward Net-Zero Emission in Energy State-Owned Enterprises in Vietnam” has been initiated in accordance with the CMSC requirements for ETP according to ToR published by ETP in April 2022.

Prime Minister Pham Minh Chinh's announcement at COP26 in November 2021, aiming toward a Net-zero emission (NZE) target by 2050, has solidified Vietnam's commitment to climate protection. As an emerging economy with greenhouse gas (GHG) emissions on the rise, significant actions are necessary across all sectors to achieve this ambitious goal. The energy sector, being responsible for the largest portion of GHG emissions, accounts for 65% of the total national emissions¹ and thus requires particular attention and focus. Due to the power sector's heavy reliance on fossil fuels (coal accounting for 32.5% of installed capacity and 46% of generation, and oil and gas accounting for 11.6% and 11% respectively), it becomes imperative for Vietnam to accelerate its efforts in decarbonizing the power sector to achieve the Net-Zero Emission (NZE) target.

Vietnam's energy sector is built on three pillars to ensure national energy security: Vietnam Electricity – EVN, PetroVietnam – PVN and Vietnam National Coal – Mineral Industries Holding Corporation Limited – TKV. The SOEs also own a significant majority of coal-fired power plants (67% of the existing ~25 GW in 2021) and gas power (80% of the existing 7.4 GW). As a result, these corporations will be a crucial role in driving the energy transition in Vietnam towards the NZE goal.

The Committee State Capital Management at Enterprises (CMSC) serves as the Vietnamese government's capital management agency in these corporations. CMSC has partnered with the Southeast Asia Energy Transition Partnership (ETP) Fund to assist three energy SOEs in developing and implementing the NZE roadmap. In particular, this roadmap will encompass long-term development strategies that consider factors such as emissions reduction, improved governance, efficient and sustainable business practices, and foster

¹ MONRE. 2020. Third Biennial Report to UNFCCC. <https://unfccc.int/documents/273503>

transparent development and sustainable competition of the energy market in general and the electricity market in particular. This report is the final report of the Consulting team within the framework of ETP's first Technical Assistance activity for CMSC, entitled "Roadmap for the commission for management of state capital toward net-zero emission in energy state-owned enterprises in Vietnam". By terms of reference (TOR), technical assistance is targeted:

- Research and propose an appropriate roadmap for CMSC to support SOEs to reduce emissions in power generation, contributing to the achievement of the national NZE target while ensuring energy security, sustainability and reliability in power supply;
- Identify the legal, financial and social conditions for SOEs to realize this roadmap;
- Propose recommendations to CMSC and SOEs (as well as key stakeholders in the decision-making process) to accelerate the implementation of the transition roadmap.

This report is conducted by a group of consultants consists of the Vietnam Initiative for Energy Transition - VIETSE, Economica, NHQuang&Associate and Carbon Trust under the TOR published by ETP in April 2022. The scope of the assignment is focused on the power activities of the three SOEs. The outcomes of the work will support CMSC and SOEs to identify the appropriate roadmap:

- "To take firm actions toward energy transition and contribute to the country's commitment to Energy Transition agenda and to contribute to the achievement of the Paris Agreement.
- To propose policy interventions to relevant authorities to create an investment climate that is conducive to investment and financial flows into renewable energy and energy efficiency."

To achieve the outcomes, the TOR expects the following outputs:

- Deliverable 1: Consolidation and analysis through the review of the current documentation and stakeholder engagement to describe the technical and financial conditions of the existing and planned coal power plants under SOEs' management.
- Deliverable 2: A roadmap for SOEs' power plants to align with the NZE target, including emissions reduction through reducing coal power generation based on solid, technologically and financially viable alternative scenarios. Technical and financial solutions to fill in the gap left by coal power reduction.
- Deliverable 3: A list of recommended technical assistance and capacity building for CMSC and SOEs to realize the roadmap.

Deliverable 1 focuses on the general analysis of technical and financial conditions of the investment projects managed by the SOEs and was handed over to ETP and CMSC in November 2022. Deliverable 2 focuses on developing a roadmap to reduce emissions. This final report will summarize the findings of the study and include a list of technical assistance and capacity building activities. This report consists of 7 chapters. Chapter 1 provides an overview of the study and expected results. Chapter 2 analyzes the

world's energy context with major fluctuations in the past few years that have an impact on the energy transition. Chapter 3 introduces an overview of Vietnam's electricity industry and its development orientation, about the three energy SOEs in Vietnam, the role of each group in the electricity industry, SOE's motivations and challenges in charting the energy transition roadmap towards the NZE goal. Chapter 4 analyzes the factors affecting the development of scenarios for the SOEs to contribute to the national NZE target. Chapter 5 results from simulation and evaluation of emission reduction scenarios on the role of SOE, financial, legal and social impacts of each SOE along with a review of international experience in supporting the just and inclusive transition. Finally, Chapters 6 and 7 provide recommendations and lists of technical assistance for CMSC and SOEs.



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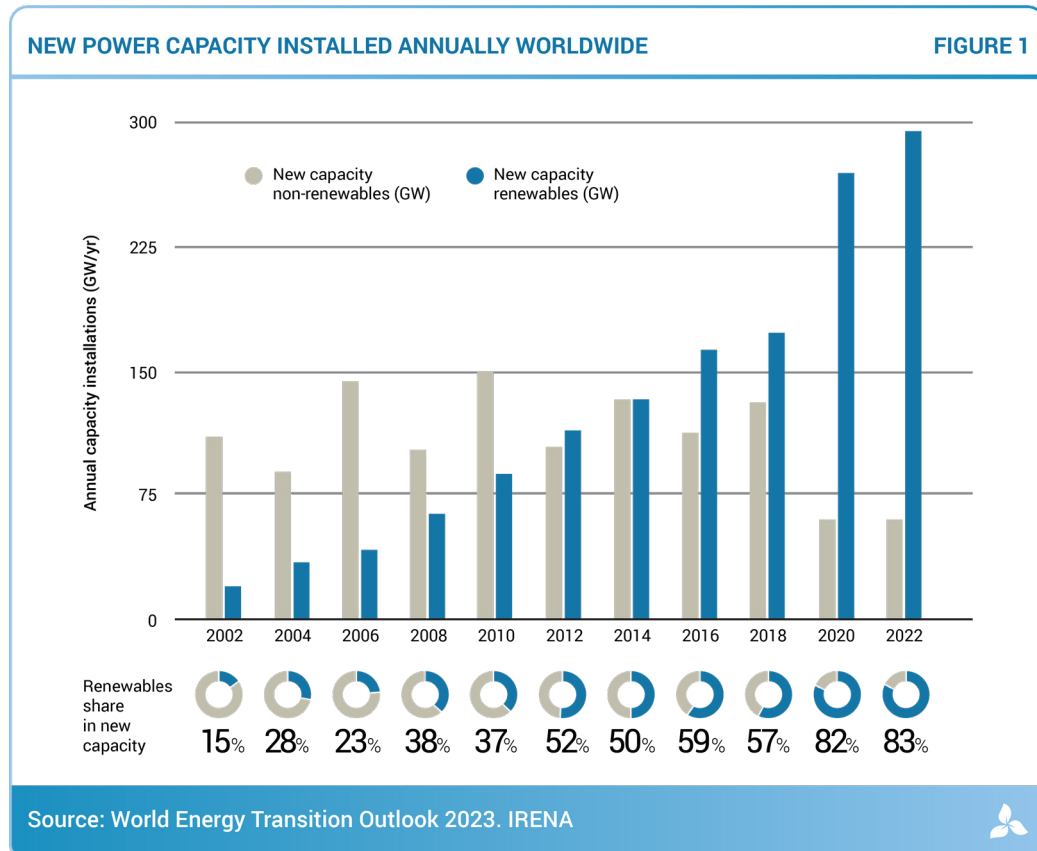
2

World's energy context

2.1. Energy transition

The energy transition trend is both inevitable and global, propelled by endeavors to prevent climate change and its detrimental, irreversible consequences on human survival. A significant shift in our energy exploitation and consumption methods, aimed at reducing greenhouse gas emissions, is considered vital for attaining Sustainable Development Goal 7 (SDG7) and achieving Net Zero Emissions target.

In recent decades, remarkable progress has been made worldwide in the energy transition, most notably in power generation. Renewable energy has experienced rapid growth, with RE installed capacity accounted for up to 83% of the total new power capacity by 2022 (Figure 1).



However, according to the 2023 update report of the International Renewable Energy Agency (IRENA)², due to the impact of Covid-19 the *current global energy transition rate is insufficient to meet the climate target set in the 2015 Paris Agreement*, which aims to limit global temperature rise to no more than 1.5°C. In a report published in March 2023³, the Intergovernmental Panel on Climate Change (IPCC) also highlighted that despite strengthened climate policies, there exists a significant gap between projected emissions and the targets set in countries' Nationally Determined Contributions (NDC). Additionally, inadequate financial flows further impede the achievement of climate goals.

The recent update of the Net Zero roadmap by the International Energy Agency (IEA)⁴ emphasized that *the acceleration of energy transition relies on investments*. According to the report, in order to align with the Net Zero Emissions (NZE) goal by 2050, clean energy investment must increase from the current \$1.3 trillion/year to \$4 trillion/year by 2030. Of particular concern is the substantial gap in clean energy investment observed in developing countries and emerging economies. This is worrisome because these countries are expected to experience significant growth in energy demand.

2.2. The global energy market

In recent years, the world has witnessed significant fluctuations due to the impact of the Covid-19 pandemic including reduced investments and increased electricity demand during economic recovery, as well as geopolitical conflicts. The energy market has been particularly affected by *disruptions in supply chain leading to severe supply shortages and triggering a global energy crisis in 2021-2022*.

Unlike previous crises that primarily affected oil prices, the current crisis extends to all fossil fuels. The record-high prices of coal and natural gas (Figure 2) have resulted in soaring electricity prices in Europe, primarily due to the heavy reliance on Russian gas supplies (accounting for 45% of the total gas imported)⁵. The escalating energy prices have exacerbated inflationary pressures in many developed countries. Meanwhile, emerging economies face challenges as the cost of imported fuel rises and securing a stable supply becomes increasingly difficult. In response to the crisis, European countries have resorted to purchasing and stockpiling fossil fuels as a short-term solution, creating a scarcity in the market. In 2022, Europe increased its LNG imports by 60% compared to 2021⁶, with the amount of LNG imported from the United States doubling. This led to intense competition between Europe and Asia for the available gas supply from the United States, driving gas prices to record levels (reaching \$36.5/MMBTU in the European market, which is ten times higher than the \$3.3/MMBTU in 2020)⁷ (Figure 3). Furthermore,

² IRENA. 2023. World Energy Transition Outlook 2023: 1.5oC Pathway.

³ IPCC. 2023. Synthesis report of the IPCC sixth assessment report (AR6). Intergovernmental Panel on Climate Change.

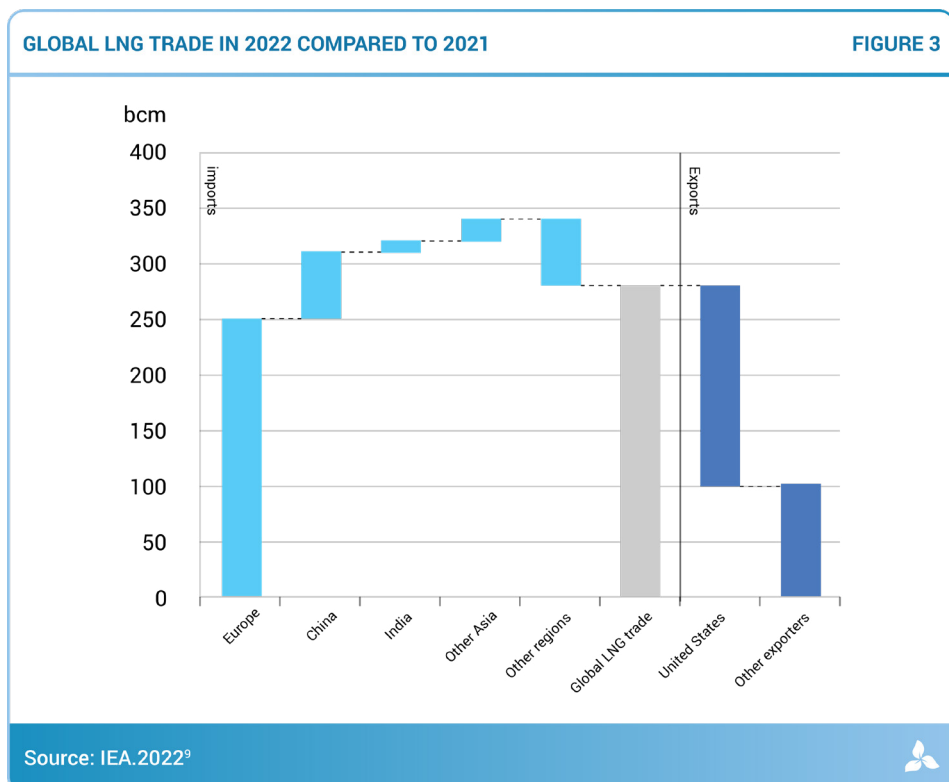
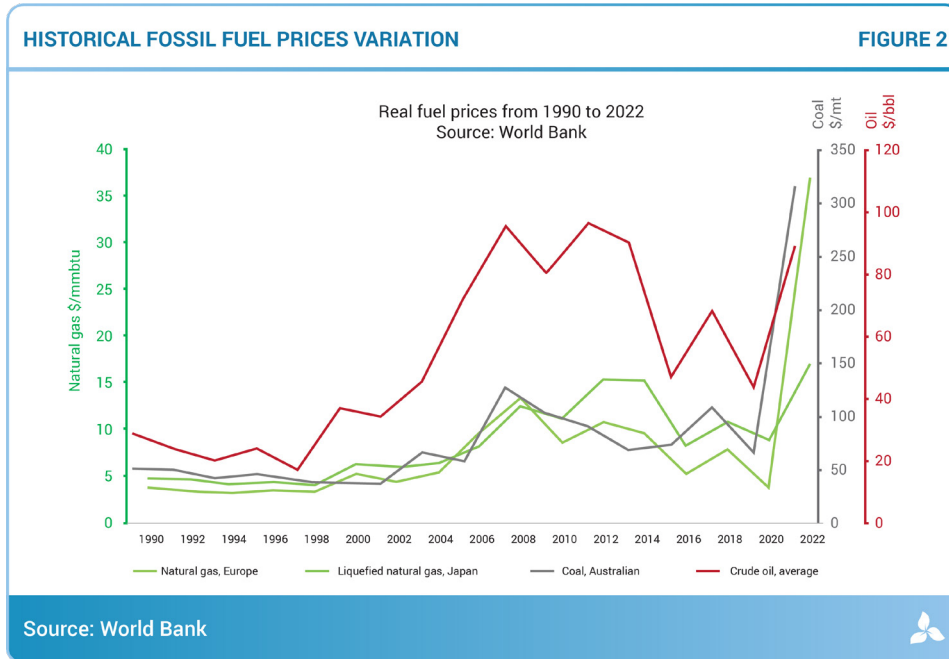
⁴ IEA. 2022. World Energy Outlook 2022. Paris: International Energy Agency.

⁵ Szymon Kardas. 2023. Conscious uncoupling: Europeans' Russian gas challenge in 2023. European Council on Foreign Relations. <http://ecfr.eu>

⁶ <https://www.politico.eu/article/europe-huge-excess-lng-liquefied-natural-gas-import-capacity-expert-warn/#:~:text=LNG%20imports%20into%20Europe%20increased,in%20LNG%20imports%20from%20Russia>.

⁷ <https://www.worldbank.org/en/research/commodity-markets>

the crisis is evident in the significant spike in coal prices, reaching approximately \$400/t in mid-2022 compared to the range of \$50-130/t observed between 2009 to mid-2020⁸. Consequently, middle-income countries struggle to compete with developed nations in purchasing fossil fuels at economically acceptable prices.



⁸ <http://tradingeconomics.com>

⁹ <https://www.iea.org/data-and-statistics/charts/global-lng-balance-year-on-year-change-2021-2022>

The resurgence in the use of fossil fuels in many countries poses a challenge to the energy transition. During the crisis, companies have shifted towards greater reliance on coal instead of gas. As a result, global CO₂ emissions increased by 0.9% to an all-time high of 36.8 Gt¹⁰. The International Energy Agency sees the shock in the global energy market as a stark reminder of the fragility and unsustainability of the current energy system.

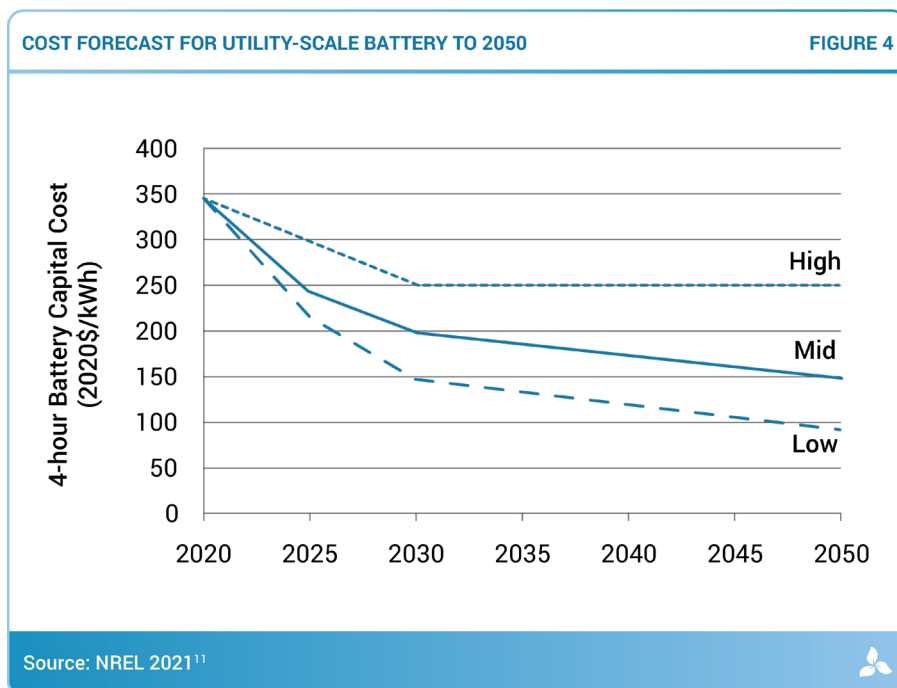
Nevertheless, this crisis also serves as a catalyst for countries to expedite the restructuring of their energy systems, enhance energy security, increase the resilience of the power grid, and simultaneously strive to meet climate protection goals.

2.3. Technology trends

Technology development has always been instrumental in driving transformative changes in society. In the context of energy transition and climate protection, and the need for enhanced energy security, countries are investing in research and development of new energy technologies.

Increasing exploitation of domestic RE sources is a solution that helps ensure energy security, reduces dependence on imported fossil fuels, and simultaneously aims to mitigate greenhouse gas emissions. However, in an electricity system with a high percentage of RE, technological solutions are necessary to ensure a reliable and stable power supply.¹¹

Numerous technological solutions have been developed to integrate a higher share of RE such as storage technologies, smart grids, digitization, and virtual power plants, etc. These solutions enable the conversion of excess electricity into other forms of energy, such as

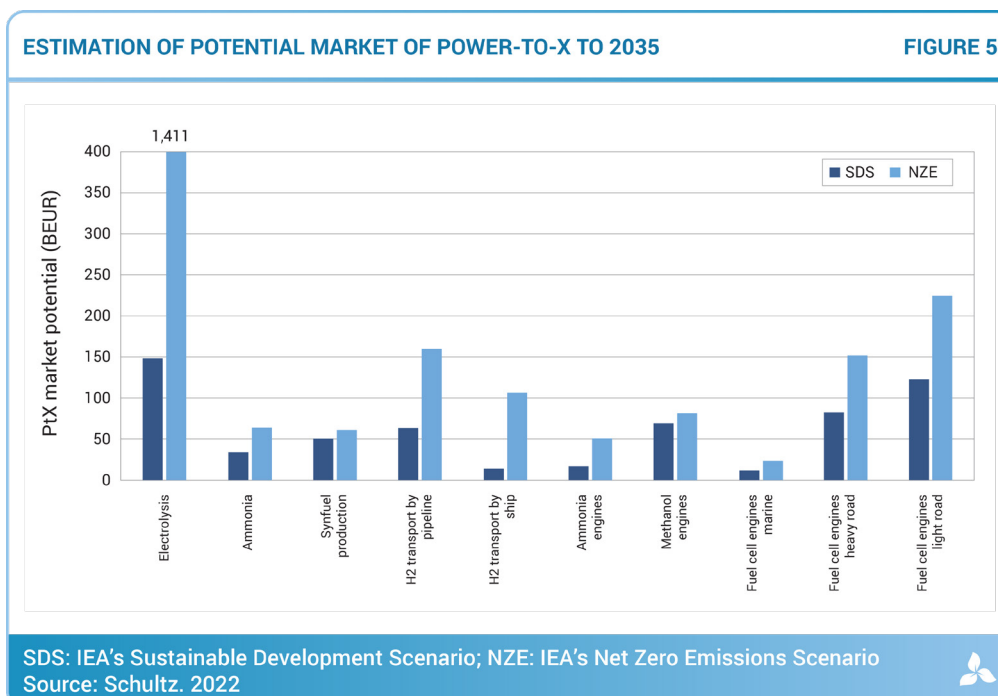


¹⁰ <https://www.iea.org/reports/co2-emissions-in-2022>

¹¹ Cole, Wesley, A. Will Frazier, and Chad Augustine. 2021. Cost Projections for Utility-Scale Battery Storage: 2021 Update. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-79236. <https://www.nrel.gov/docs/fy21osti/79236.pdf>

chemical energy (in storage batteries or hydrogen), kinetic energy (in flywheels), potential energy (storage hydroelectricity), heat energy (in molten salts)..., which can be easily converted back to electricity when needed. The shift towards these energy conversion technologies helps accelerate their development and reduce costs of storage technology. Storage batteries serve as a prime example, with prices in the US for large-scale storage batteries declining by 70% between 2015 and 2018¹². The US National Renewable Energy Laboratory (NREL) further forecasts a continued cost reduction of 28% to 57% for large-scale storage battery systems by 2030 (Figure 4).

Digitization within the energy sector offers opportunities to integrate a higher share of RE by enhancing system flexibility, providing flexible solutions for demand and energy storage. Digital technologies will transform energy systems into interconnected, smart, efficient, reliable and sustainable systems in the coming decades. For instance, Virtual Power Plant (VPP) technology provides a software-based platform that aggregates small scale and distributed power sources, such as RE plants, storage systems as well as other controllable load into a single, dispatchable source equivalent to a large-scale conventional power plant. VPP enhances the flexibility and controllability of each individual distributed power source and provides ancillary services for the power system operators. VPP enables distributed power plants to participate in the competitive electricity market, optimizing their economic efficiency and increasing profits¹³. Digital technologies, including information and communication technology (ICT), modern sensors, big data and artificial intelligence, and the internet of things, can improve energy efficiency and help find decarbonization solutions for energy systems.



¹² U.S. Energy Information Administration. 2020. Utility-scale battery storage costs decreased nearly 70% between 2015 and 2018. <https://www.eia.gov/todayinenergy/detail.php?id=45596>

¹³ Vietnam Initiative for Energy Transition. 2021. Virtual Power Plant: Digital Utility Technology in the Vietnam's Competitive Electricity Market.

Energy transition extends beyond the electricity sector but is also strongly promoted in other sectors such as industry and transport. *Power-to-X technologies have been developed to reduce greenhouse gas emissions in sectors that are difficult to electrify.* Power-to-X includes the production of other forms of energy such as hydrogen, methanol, ammonia, etc. from electricity. These products can be utilized in various industries, such as transportation, industry, chemicals, etc. With the sustainable development and NZE goals, power-to-X technologies are expected to experience rapid growth and market size could reach 601-2,319 billion EUR by 2035¹⁴ (Figure 5).

Carbon capture, use and storage (CCUS) technologies are being researched as a means to decarbonize industries that are difficult to reduce emissions, such as cement or steel production. Instead of releasing CO₂ into the environment, CO₂ emitted from power plants or industry is captured and recovered. The recovered CO₂ can then be utilized for other industrial purposes such as, enhancing oil recovery, enhancing gas recovery or producing fertilizers. However, the amount of CO₂ utilized for these purposes is still much smaller than the amount of CO₂ recovered from the plants. Any excess CO₂ can be stored in special geological formations deep underground, such as deep saline aquifers, depleted oil and gas reservoirs, etc. As of September 2022, there are a total of 196 projects being implemented worldwide according to IEA¹⁵. In Vietnam, the potential for CO₂ storage is estimated at 11.8 billion tons with 10.4 Gt in deep saline aquifers and 1.4 Gt in depleted oil and gas basins¹⁶.

Currently, *the supply chain of clean energy technology is primarily concentrated in developed countries.* This creates a significant technology gap in emerging economies and developing countries, where energy demand is growing rapidly. Meanwhile, the IEA has emphasized that the decisions made by emerging economies will play a crucial role in shaping the future of global climate and energy¹⁷.

Previous discussions on energy security have largely focused on fossil fuel supply chains. However, recent trends highlight a *close connection and interaction between the technology supply chain and the raw material supply chain in ensuring energy security.* Most of the existing technology is being produced and traded between countries. Production is dispersed globally, often driven by factors, such as the availability of skilled labor and cost-effective materials, resulting in an uneven distribution of production capabilities. Equipment inputs and components for the clean energy supply chain depend on various essential minerals including rare earths and metallic elements such as copper, nickel, lithium, cobalt, manganese, graphite, silicon or platinum. The increasing demand for clean energy in countries leads to a growing demand for these minerals. Therefore, it is crucial to establish a global supply chain for these essential minerals. This is not only necessary to accelerate the transition to clean energy but also to ensure a sustainable energy system for the future.

¹⁴ Schultz (2022), Prospects for the global green hydrogen and Power-to-X markets. <https://ramboll.com/net-zero-explorers/articles/from-potential-to-profit>

¹⁵ Global CCS Institute. 2022. Global status of CCS.

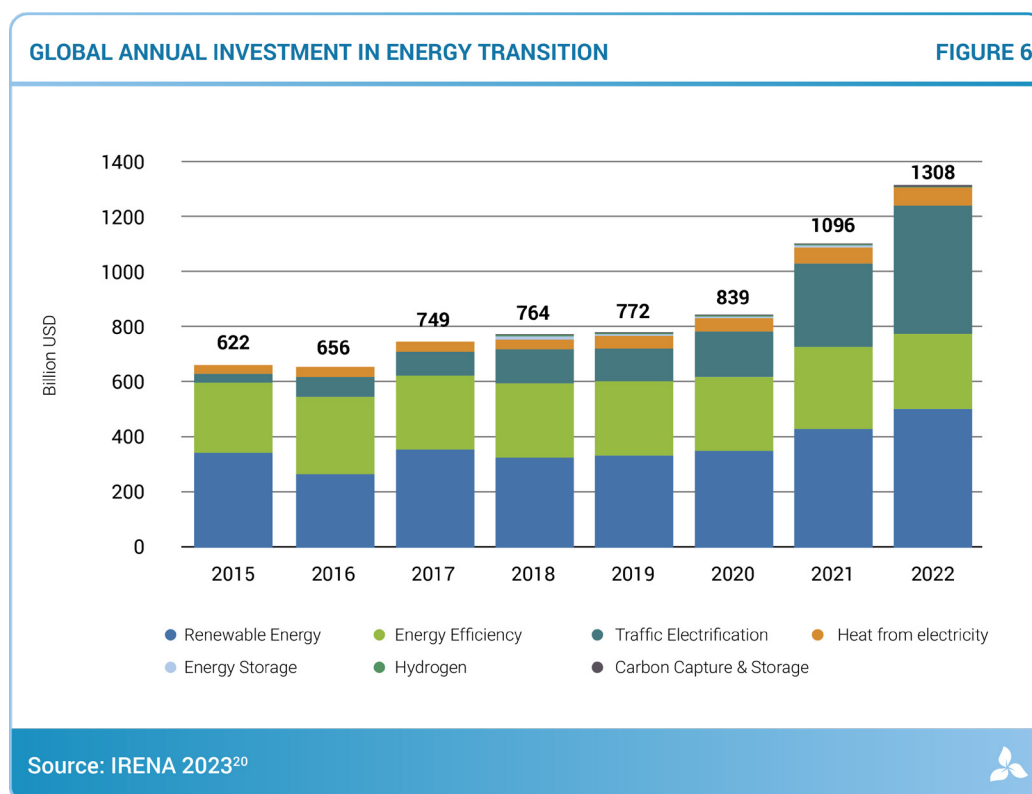
¹⁶ IEA. 2021. Carbon capture, utilisation and storage: The opportunity in southeast Asia.

¹⁷ IEA. 2021. Financing clean energy transitions in emerging and developing economies, IEA, Paris <https://www.iea.org/reports/financing-clean-energy-transitions-in-emerging-and-developing-economies>

2.4. Finance for energy transition

The acceleration of the energy transition relies heavily on investment. International organizations have assessed that the financial requirements for carrying out the energy transition are substantial. According to IRENA, annual investments in energy transition technologies need to quadruple from the \$1.3 trillion invested in 2022¹⁸.

Although there has been an increase in investment in the energy transition over the years (Figure 6), *the gap between financial demand and supply is still very large*, especially in emerging economies. This gap has been further widened due to the impact of the Covid-19 pandemic. In 2020, investment in clean energy in developing countries and emerging economies fell by 8%, falling to less than \$150 billion. The IEA asserts that capital flows for clean energy investment in these countries need to exceed \$1 trillion by the end of the decade for the world to align with Net-Zero by 2050¹⁹.



¹⁸ IRENA. 2023. World Energy Transition Outlook 2023: 1.5oC Pathway.

¹⁹ IEA. 2021. Financing clean energy transitions in emerging and developing economies.

²⁰ IRENA. 2023. Global Landscape of Renewable Energy Finance. <https://www.irena.org/Publications/2023/Feb/Global-landscape-of-renewable-energy-finance-2023>

Reducing emissions in developing countries and emerging economies is a cost-effective solution to climate change. The IEA estimates that, on average, these countries have approximately half the cost of emissions reduction compared to developed countries²¹.

There is a growing interest in the financing the energy transition from both the public and private finance sectors, particularly in emerging and fossil fuel-dependent economies such as Vietnam, Indonesia, Philippines and South Africa... The Declaration on Just Energy Transition Partnership (JETP) has been signed between the International Partners' Group (IPG) and South Africa, Indonesia and Vietnam, in which IPG commits to mobilizing billions of dollars in public finance to catalyze private financing, helping these countries accelerate their energy transition and achieve more ambitious emissions reductions.

²¹ IEA. 2021. Financing clean energy transitions in emerging and developing economies.

3

Factors that affect Vietnam energy transition

This chapter examines the factors and trends that will influence the future development of Vietnam's electricity industry. These factors are carefully considered and integrated during the development of scenarios for SOEs to contribute to emission reductions in the power sector, aligning with the national NZE target by 2050.

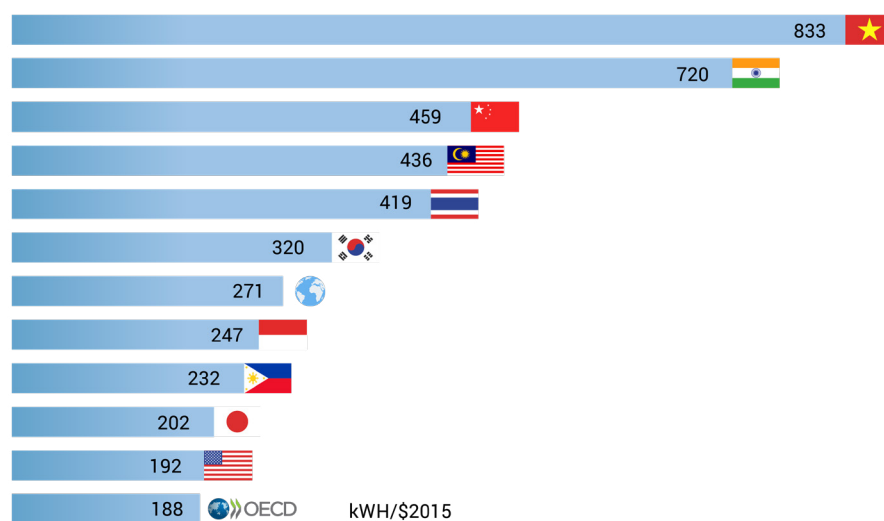
3.1. Overview of Vietnam's power sector

Vietnam's electricity industry has a rich history of construction and development, playing a crucial role in socio-economic advancement and improving living standards. The power system has witnessed rapid growth, to meet the *increasing demand for electricity, with an average annual growth rate of about 11% per year pre-Covid*. After experiencing a period of stagnation and decline due to the epidemic, the economy's recovery has led to a gradual return of electricity demand to pre-Covid levels.

However, the growth in electricity demand is not sustainable, as evidenced by the high ratio of electricity use to GDP compared to other countries in the region (Figure 7). This indicates that Vietnam has great potential for achieving economical and efficient use of energy. This potential needs to be fully explored to bring economic benefits to the whole society.

COMPARING ELECTRICITY EFFICIENCY OVER A UNIT OF GDP IN 2019

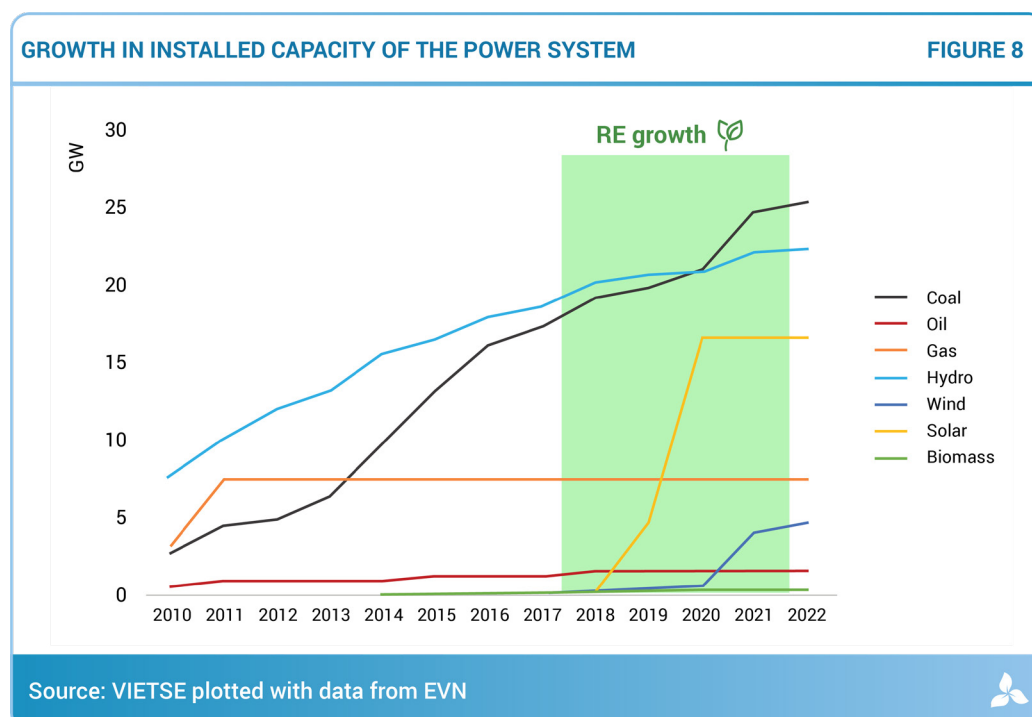
FIGURE 7



Source: General Statistic Office of Vietnam, 2020



Vietnam currently ranks first in the Southeast Asia region in terms of total installed power system capacity, reaching 79 GW by 2022. Vietnam's energy mix includes hydropower (28%), coal (32%), gas-to-power plants (9%), diesel (2%), solar (21%), wind (6%), and biomass (1%). Before 2018, conventional sources (hydro, coal, and gas) dominated the power system, accounting for a majority of the electricity supply, with coal contributing 42%, hydropower for 38%, and gas for 19% by end of 2018 (Figure 8).



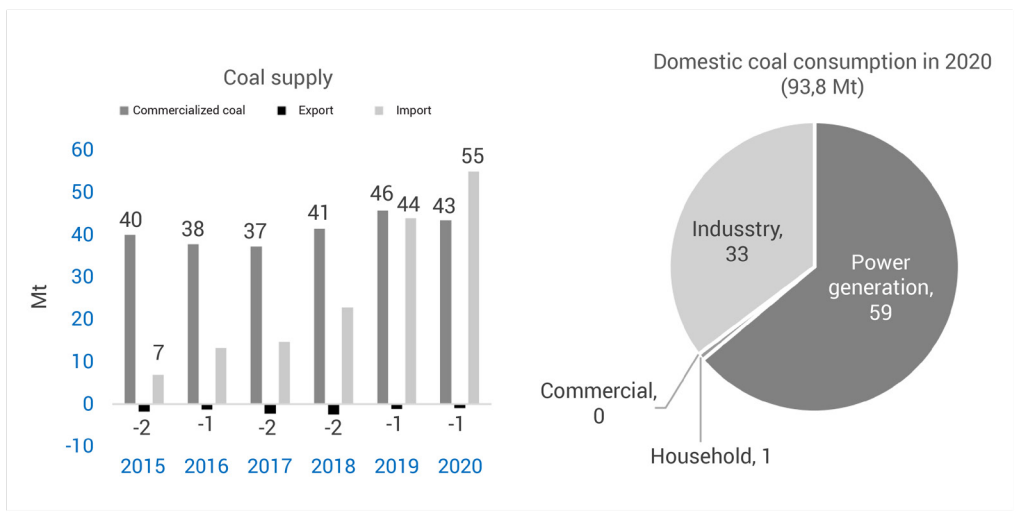
Vietnam also becomes a leader in renewable energy capacity growth in Southeast Asia. Since the implementation of the FIT scheme in 2018, solar and wind sources have dominated new additions. As a result, the share of VRE in the energy mix by installed capacity reached 27% by late 2022. In terms of electricity production, VRE accounted for approximately 13% of the total power generation during the same period. The increasing share of VRE in total electricity production puts high pressure on power system operators, urging them to accelerate the grid development projects to accommodate new VRE projects. However, the share of fossil fuels in power generation remains high, and there has been a swift increase in dependence on imported coal (Figure 9). While Vietnam has significant hydropower potential, it has already been largely exploited. Moreover, areas with high renewable energy potential are located far from load centers, leading to increased demand for inter-regional transmission.

Over the years, the reliability of power supply has improved, as indicated by several indicators such as System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Momentary Average Interruption Frequency Index (MAIFI), and power loss rate²².

²² EVN's annual report

COAL SUPPLY AND CONSUMPTION IN VIETNAM

FIGURE 9



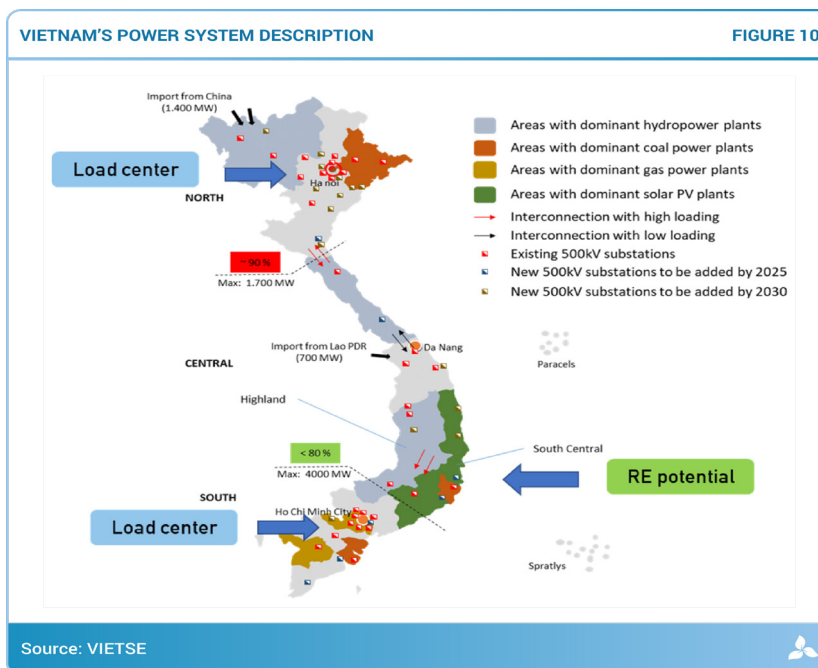
Source: VIETSE plotted based on the data of Vietnam Energy Balance 2020

Vietnam’s grid system comprises transmission and distribution networks. The transmission grid includes substations and transmission lines operating at voltages of 500 kV and 220 kV, while the distribution grid includes substations and transmission lines operating at voltages of 110 kV downwards. Notably, Vietnam has achieved a high electrification rate, with 99.7% of households having access the national power grid.

The 500 kV grid serves as the backbone of Vietnam’s power grid system, connecting 3 regions of North, Central, and South, with a total length of nearly 10,000 km and 35 substations, providing a total capacity of 43,800 MVA. Additionally, the 220 kV power grid spans approximately 18,650 km and 143 substations, offering a total capacity of 68,125 MVA²³. The transmission capacity between the North and Central regions is 2200 MW, while the capacity between the Central and South regions is 4300 MW. Three 500 kV gridlines, namely Ha Tinh – Da Nang, Vang Ang - Da Nang, and Vung Ang - Quang Trach - Doc Soi, are used to connect the North and Central regions. Moreover, four 500 kV gridlines link the Central and South regions.

The competitive generation market of Vietnam (VCGM) was officially established in 2012, allowing power plants to sell electricity, although Vietnam Electricity (EVN) has been the sole buyer. The wholesale electricity market of Vietnam (VWEM) commenced operations in January 2019, involving 91 power plants and 6 buyers (EVNEPTC and 5 EVNGENCOs). However, all the buyers are under EVN. While the State still regulates the electricity retail prices, the development of the competitive retail electricity market (VREM) is currently underway. The next phase of VREM design involves allowing large household consumers to purchase directly from the wholesale market, and in the final phase, consumers will have the right to choose their electricity retailer.

²³ EVNNPT. 2022. The challenges of the transmission grid in line with new power sources development rates in the context of the energy transition.



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By the end of 2021, a total of 104 power plants were directly participating in VWEM, with a total capacity of 29.2 GW, accounting for 37.4% of the system's capacity²⁴. In 2022, an additional four power plants joined VWEM, bringing capacity in the direct market to 30.9 GW. The proportion of power plants participating in the power market is still relatively low due to the majority of newly operated sources nor directly participated in the power market (renewable energy, BOT plants).

3.2. Legal framework and policies for energy sector development

3.2.1. Electricity Law

Regarding the legal framework, power activities are regulated by Electricity Law and relevant sub-law documents. The Electricity Law (N. 28/2004/QH11) was issued in 2004 "This Law prescribes the electricity development planning and investment; electricity saving; electricity markets; rights and obligations of organizations and individuals conducting electricity activities and using electricity; protection of electric equipment and facilities, electricity works and electric safety" (Article 1: Regulation scope). This law and sub-law documents created a legal basis for objects involved in the power sector.

²⁴ EVN's 2022 activity report

The Electricity Law was amended in 2012 (Law No 24/2012/QH13²⁵) to accelerate the development of the power market (According to Article 9. Elaboration, approval, announcement and adjustment of the electricity development plannings, Point 8: *"2. The Prime Minister shall provide conditions, structure of electricity sector to form and develop levels of electricity market; provide the roadmap of development of electricity markets, review and adjust to push up the roadmap in conformity with the socio-economic situation under each period."*). The adjustment of electricity selling price based on the market mechanism with the regulation of the State is following the development stages of the power market. Those regulations not only ensure the legality of the principle that electricity prices operate in line with market mechanisms but also secure the executive role of the State to electricity price which is a special commodity (According to Article 25. Testing, gauging, experiment of the electricity-measuring or -counting equipment, Point 13: *"1a. The electricity sale price is implemented according to the market mechanism with the regulation of State in conformity with level of development of electricity market."*).

The Electricity Law was revised in 2018 (Law No 28/2018/QH14) on the contents related to the power sector development plan to be consistent with Planning Law enacted in 2017 (According to Article 6. Amendments to some Articles of the Law on Electricity, Point 1: *"Electricity development planning is the national sector planning and serves as a basis for electricity development"*). Accordingly, the power development plan is a national plan, and provincial power development plans are not allowed to establish as independent plans but integrated into provincial master plans.

In January 2022, the Electricity Law was amended by Law No 03/2022/QH15²⁶ which regulated the issue of transmission grid investment. Previously, the State executed the monopoly in transmission and load dispatch of the national power system, building and operating big power plants with particular importance in terms of socio-economic, national defense, and security *"2. To build up and develop the electricity market on the principle of publicity, equality, fair competition with the State's regulation to raise efficiency in electricity activities; to ensure the legitimate rights and interests of electricity units and electricity-using customers; to attract all economic sectors to participate in investment in the construction of transmission power grids on the basis of ensuring national defense and security and according to the power development plan, electricity generation, electricity distribution, electricity wholesaling, electricity retailing and/or specialized electricity consultancy. Non-state economic sectors are allowed to operate the transmission power grid built by themselves"* (According to Article 6. Amendments to certain articles of the Law on Electricity, Point 1). With this amendment, non-state economic entities are allowed to invest in and operate transmission networks on the basis of ensuring national defense and security and in line with the power development plan.

²⁵ Law No 24/2012/QH13 dated 20/11/2021 on amending and supplementing some articles of Electricity Law

²⁶ Law No 03/2022/QH15 dated 11/1/2022 on amending and supplementing some articles of 9 laws

3.2.2. Policies for energy sector development

Policies for renewables development

On June 20, 2011, the Prime Minister issued Decision 37/2011/QĐ-TTg, which introduced mechanisms to support wind power projects in Vietnam. These mechanisms included a Feed-in Tariff (FIT) of 1,614 VND/kWh (7.8 US cents/kWh) for a period of 20 years, as well as tax and land infrastructure incentives. However, at that time, the global cost of onshore wind power technology was high, with an average Levelized Cost of Electricity (LCOE) of 7.2 US cents/kWh²⁷. However, at that time, Vietnam's wind power market was at very early stage and the system had fully relied on imported technologies, making that wind power projects not attractive enough to investors. By the end of 2017, only a capacity of 189 MW of wind power had been installed, accounting for 0.4% of the total installed capacity.

On November 25, 2015, the Prime Minister issued Decision 2068/QĐ-TTg on approving the Renewable energy development strategy of Vietnam to 2030, with a vision to 2050, in which recognizing the importance of renewable energy (RE) for energy security; reducing dependence on fossil fuels; addressing climate change; and providing energy access to rural areas; promoting production growth, including RE supply chain at industrial scale.

The incentive for solar power projects in Vietnam was issued by the Prime Minister on April 11, 2017, which included a FIT scheme with 2,086 VND/kWh (9.35 UScent/kWh) in 20 years, and incentives on tax and land infrastructure. Those incentives sparked an investment wave in solar power, resulting in a total installed capacity of 4.5 GW by the end of June 2019 when this scheme expired. On April 6, 2020, the Prime Minister issued Decision 13/2020/QĐ-TTg with new FIT: 1,783 VND/kWh (7.69 UScent/kWh) for floating solar, 1,664 VND/kWh (7.09 UScent/kWh) for ground solar, 1,943 VND/kWh (8.38 UScent/kWh) for rooftop solar. By the time the new FIT scheme expired on December 31, 2020, solar accounted for a total of 16.5 GW in the power system (with 7.7 GW rooftop solar).

In 2018, Decision 39/2018/QĐ-TTg dated September 10, 2018, by the Prime Minister on adjusting the FIT scheme for onshore wind power to 1,928 VND/kWh (~8.5 UScent/kWh) and 2,233 VND/kWh (9.8 UScent/kWh) for offshore wind. This new motivation attracted a large number of investments in wind power projects. By the end of October 2021, when this FIT scheme expired, 84 projects (3.98 GW) were put into COD, out of 146 projects that signed PPA with EVN (8.2 GW)²⁸.

After the FIT scheme expired, 85 solar and wind projects that already deployed but missed the FIT deadline (transition projects)²⁹ faced a pricing gap for RE generation while waiting for an alternative policy to be issued. On October 3, 2022, the MOIT announced Circular 15/2022/TT-BCT on regulating the methodology of designing price range for transitional

²⁷ Tegen et al. 2013. 2011 Cost of wind energy review. National Renewable Energy Laboratory. <https://www.nrel.gov/docs/fy13osti/56266.pdf>

²⁸ Document 6742/EVN-TTĐ dated November 2, 2021, by EVN on COD results of wind power projects up to October 31, 2021.

²⁹ <https://baochinhphu.vn/can-som-co-gia-dien-cho-cac-du-an-nang-luong-tai-tao-chuyen-tiep-102230323112751902.htm>

solar and wind projects. Accordingly, on January 7, 2023, The MOIT issued the price range for solar and wind power generation during the transitional phase, with a ceiling price for ground solar (1,184.90 VND/kWh), floating solar (1,508.27 VND/kWh), onshore wind (1,587.12 VND/kWh), and offshore wind (1,815.95 VND/kWh). The electricity generators will negotiate the generation price directly with EVN based on these prices.

Policies for grid development

The grid is an integral part of the power system and is regulated by the Electricity Law. The Government issued Decree 137/2103/ND-CP dated October 21, 2013, on regulating details of Electricity Law implementation. In line with the revised Electricity law in 2022, the MOIT has been revising Decree 137 to comply with the provisions on transmission grid investment and operation specified in the revised Electricity Law.

Transmission costs are also a component of electricity prices and are regulated by the government, as electricity is classified as a special commodity under the Pricing Law. The transmission price is annually announced by the MOIT, following methods of designing, appraising, and approving transmission price outlined in Circular 02/2017/TT-BCT issued February 10, 2017.

Based on the revised provisions of the Electricity Law in 2022, the MOIT issued Decree 14/2022/TT-BCT dated September 30, 2022, to amend Decree 02/2017. The adjustments include:

- New Decree 14/2022: Regulate that the transmission price is annually determined on the basis of valid and reasonable expenses for transmission activities by power transmission agencies, with interest rate return on equity determined through the power transmission method. The option of retail electricity price can be applied at the time of transmission cost calculation or followed the decision of authorized agencies.
- Decree 02/2017: the transmission price is annually determined on the principle of ensuring valid expenses and approved return to operate the transmission grid in line with regulatory quality and financial criteria for transmission grid investment.

Policies for power market development

In 2006, the Prime Minister approved the pathway of power market development in Vietnam (Decision 26/2006/QD-TTg) with the aims of (i) Shaping a complete competitive power market, gradually terminating the State's subsidiary in the power sector, and increasing the customers' choice for power suppliers, (ii) Attracting investment of domestic and overseas entities in the power sector as well as reducing public investment, (iii) Improving the efficiency of energy enterprises and releasing the pressure of electricity price increase (iv) Ensuring quality and stability of power supply and (v) Ensuring the sustainable development of the power sector. This pathway was updated by Decision 63/2013/QD-TTg dated November 8, 2013, on regulating pathway, criteria, and structure of the power sector to formulate a power market in Vietnam with 3 levels: (i) VCGM (level 1), (ii) VWEM (level 2), (iii) VREM (level 3). The country has been operating VWEM and preparing for VREM operation under the Scheme on designing a competitive retail electricity market model approved by Decision 2093/QD-BCT dated August 7, 2020, of the MOIT. The preparation includes:

- ✦ Developing a scheme on the power sector reform for VREM;
- ✦ Transforming EVN NLDC into an independent agency for operating the power system and power market under the model of one-member limited liability company;
- ✦ Reviewing, amending, and supplementing operation guidelines for VWEM and relevant legal documents to pilot the DPPA mechanism between renewable generators and consumers.

According to the pathway outlined in Decision 2093/QĐ-BCT, the preparation phase was supposed to be completed by the end of 2021. However as of April 2023, VREM was still in this phase.

3.3. The orientation of power sector development

Resolution 55-NQ/TW by the Politburo dated September 11, 2020, on the orientation of the National power development strategy up to 2030, with a vision to 2045, gave guiding perspectives for the power sector in general and the electricity sub-sector in particular, which highlighted the importance of national energy security, energy development must be consistent with the market economic institution with socialism orientation, prioritize the effective exploitation and usage of renewable energy, clean energy, develop a reasonable pathway to reduce coal power, foster digital transformation and energy efficiency, energy saving to protect the environment.

"1. Direction viewpoints

National energy security is both a foundation and an important premise for socio-economic development. Prioritize fast and sustainable energy development in connection with environmental protection, national defense and security and social equality and progress, which shall be one major mission of industrialization and modernization.

National energy development must be in line with the socialist-oriented market economy and international integration; facilitate establishment of a consistent, competitive and transparent energy market with diverse types of ownership and businesses; and apply market-based pricing to all types of energy. Encourage and enable all types of ownership, especially private ownership, to participate in energy development; and effectively eliminate subsidization, monopoly, unfair competition and lack of transparency in the energy sector.

Generate synchronized and suitable growth, diversify types of energy; prioritize utilization of renewable energy, new energy and clean energy; extract and use domestic fossil fuels reasonably, focusing on stabilization, regulation and required national energy reserves; prioritize LNG, formulate a roadmap to suitable reduction of coal-fired power; and actively import fuels for power plants. Optimize distribution from the national power system to all areas based on the comparative advantages of each locality.

Focus on studying and applying achievements from the fourth industrial revolution to development of all energy subsectors and areas; boost digital transformation in the energy sector; and gradually grasp modern technology and strive for self-production of most energy equipment.

Economical and efficient use of energy and environmental protection are the national policy and responsibility of the whole society. Enhance energy audit; formulate consistent policies and mechanisms and strict and feasible sanctions to encourage investment in and use of energy-efficient and eco-friendly technologies and equipment, contributing to productivity improvement and renovation of growth models.”



Resolution 81/2023/QH15 and Resolution 55-NQ/TW is the two key resolutions with that the development of PDP8 for 2021-2030 period, with a vision to 2050 must be aligned. The development perspectives of the PDP8 are summarized in Figure 11. Compared to the revised PDP7 in 2016³⁰, development perspectives in PDP8 includes new points, such as the orientation of implementing the energy transition roadmap, fuels transitioning in the thermal power plants, prioritizing RE development... make a breakthrough in ensuring

³⁰ Decision 428/QĐ-TTg dated 18/3/2016 by the Prime Minister on approval of revised PDP between 2011-2020 considering the year 2030.

energy security. Synchronous development between power source and grid. Focus on developing distributed power sources. Develop a transmission network to ensure safety, reliability and economy. Attracting all economic sectors to invest in electricity development. Electricity planning needs to closely follow the development of science and technology, international support, the economic transformation process, and the actual implementation of the plan. Proactive, flexible and effective planning management.

The Government holding a monopoly in the transmission grid to ensure national energy security as articulated in revised PDP7 has been changed after the issuance of Law No 03/2022/QH15 allowing the private sector to invest in and operate the transmission grid in case of ensuring national energy security.

The MOIT has been assigned to develop Vietnam Power Sectoral development strategy between 2021-2030, with a vision to 2050, strictly follows the Party's policies and orientations, Government's directions, and development perspectives as well as orientation for planning solutions.

3.4. Socio-economic development context

The global economy has experienced various challenges, including the ongoing impacts of the Covid-19 pandemic, the Russia-Ukraine conflict in early 2022, and a global energy crisis. These factors have contributed to a downward spiral and increased inflation in many countries, forcing governments to implement tighter monetary policies. Additionally, climate change has led to extreme weather events (storms, floods, heat waves, forest fires...), resulting in human and economic losses. These circumstances have made 2023 a year of continuous difficulties for the global economy³¹. In April 2023, IMF lowered the global economic growth rate this year to 2.8%, compared to 3.4% in 2022³². WB released a relatively low forecast of 2% (only slightly higher than a forecast in January 2023) and predicting that low growth would persist until the end of 2024.³³

The global economic outlook significantly affects Vietnam due to the country's increasing integration with the global economy. In January 2023, the Central Institute for Economic Management (CIEM) launched the report "Vietnam's Economy in 2022 and Outlook in 2023" which also stated that Vietnam's economy will be impacted by more factors and projecting a GDP growth rate 6.47% in low growth scenario, and 6.83% in high growth scenario, respectively. These growth rates are lower than before Covid-19 levels (in 2018 and 2019 GDP growth rates were 7.47 and 7.36%) and 8.02% in 2022³⁴. In March 2023, WB forecasted Vietnam's economy to grow by 6.3% in 2023³⁵ while IMF's forecast in April 2023 indicated a lower rate of 5.8%³⁶.

³¹ United Nations (2023), World Economic Situation and Prospect: February 2023 Briefing, No. 169.

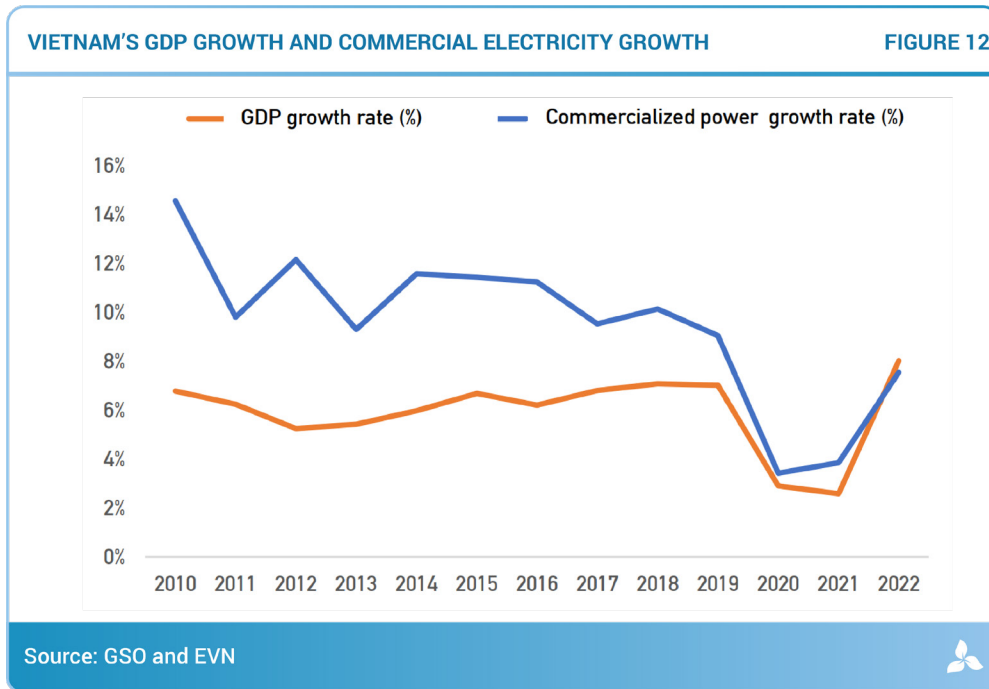
³² IMF (2023), World Economic Outlook: A rocky recovery.

³³ <https://www.reuters.com/markets/world-bank-boosts-2023-global-growth-forecast-slightly-malpass-2023-04-10>

³⁴ GSO (2022), Highlights of the socio-economic overview in the fourth quarter and 2022

³⁵ <https://www.worldbank.org/en/news/press-release/2023/03/13/vietnam-s-economy-forecast-to-grow-by-6-3-in-2023-world-bank-report-says>

³⁶ IMF (2023), World Economic Outlook: A rocky Recovery



The power demand is closely linked to GDP growth. Figure 12 showed that power growth declined during the Covid-19 pandemic and rebounded as the economy recovered, albeit not reaching pre-pandemic levels.

3.5. Impact of the world energy market

As discussed in section 2.2, coal and gas prices were observed historic increases in 2022 (gas prices increased 10 times and coal prices increased 4-8 times compared to pre-Covid-19 period). Imported coal accounted for a significant proportion of the total coal supplied to power plants in 2020 (34%) leading to a significant impact on electricity production. This resulted in a high electricity production and trading loss of nearly VND 29 trillion for the state-owned utility, EVN, in 2022³⁷, the highest level in history. The main reason was the doubling of fuel costs, which increased EVN's electricity purchase costs. In January 2021, the price of blended coal supplied to power plants was 1.5- 1.8 million VND/ton, but by May 2022, the price has increased to 2.4-3 million VND/ton³⁸. The rise in coal prices leads to the cost of generating electricity from imported coal reaching 3,500- 4,000 VND/kWh, twice the average electricity selling price of 1,864 VND/kWh³⁹. Figure 13 clearly illustrates the increasing cost of electricity production in 2022, surpassing the average electricity selling price, explaining EVN's loss.

The global energy crisis has led to a surge in coal demand, driving up coal prices on the world market, making it challenging for importers to secure coal for thermal power plants. As per EVN's report, the coal supply situation for most thermal power plants did not go as

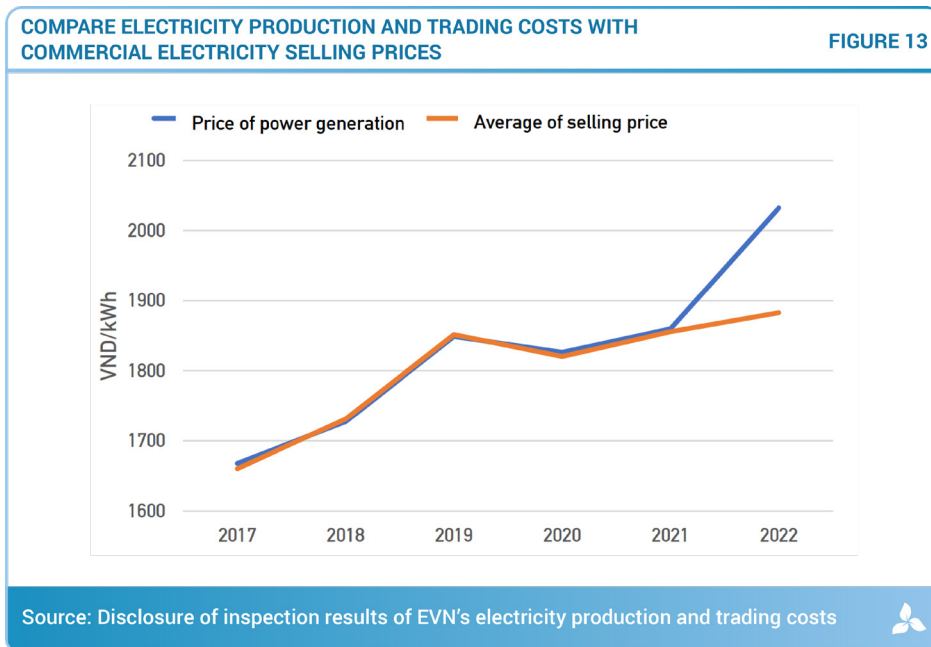
³⁷ <https://nhandan.vn/nam-2022-evn-lo-hon-26235-ty-dong-do-chi-phi-san-xuat-dien-tang-cao-post745711.html>

³⁸ MOIT. 2023. Transparent disclosure of electricity and petroleum trading activities http://minhbach.moit.gov.vn/?page=electricity_define&key=electricity_thongso&menu_id=72

³⁹ MOIT. 2023. Công khai minh bạch hoạt động kinh doanh điện, xăng dầu http://minhbach.moit.gov.vn/?page=electricity_define&key=electricity_thongso&menu_id=72

planned, leading to disruptions in production activities. Many plants were compelled to operate at minimum capacity, and some units had to be shut down. Coal shortage remains a risk for power generation in 2023.

So far, Vietnam has not imported LNG yet, so it is not directly affected by the sudden increase in LNG prices in 2022. However, the growth of LNG projects in Vietnam is indirectly impacted by changes in global fuel costs. European nations have increased LNG imports from various sources in response to the gas shortage, driving record high gas prices. This has caused some LNG suppliers (such as Sri Lanka and Pakistan) to breach long-term contracts to sell gas to Europe. The traditional LNG supply contract model, with large volumes, long terms (over 20 years), and relatively "hard" terms on gas extraction at the wellhead (point of origin) and LNG destination, has transitioned to contracts with shorter terms, smaller volumes, and more flexibility in terms of destinations and pricing methods. In 2022, it has been challenging to secure LNG contracts for delivery in 2026 at pre-crisis prices. Lower-middle-income nations like Vietnam may face difficulties competing when developed nations participate in auctions.



3.6. Impacts of technology development trends

The trend of accelerating the development of storage technology and the global digital transformation have enabled the integration of renewable energy into the system while ensuring reliable electricity supply. Vietnam possesses substantial potential for constructing hydro pump storage, with a capacity exceeding 21,9 GW⁴⁰ and it has begun implementing its first hydro pump storage project (Bac Ai 1.2 GW in Ninh Thuan). However, as of the end of 2022, large-scale deployment of battery storage systems in Vietnam remains limited. Nonetheless, Vietnam's power system exhibits highly favorable characteristics for implementing storage technology to reduce operating costs and

⁴⁰ Institute of Energy (2021) Project on the National Power Development Plan for the period of 2021-2030, vision to 2045 (draft PDP VIII).

enhance system reliability³³. Experience from other countries demonstrates that technological advancements and appropriate policies can foster the growth of the energy storage market⁴¹.

The electricity industry has been actively promoting the application of digital transformation throughout all the power supply chain. EVN has researched and implemented AGC (Automatic Generation Control) at renewable energy plants to monitor and automatically control their generating capacity in areas where capacity release is restrained. This ensures the safety of transmission grid operation and promotes fairness and transparency among related power generation units⁴². In 2022, the corporation converted all 110 kV substations nationwide into remote-controllable stations⁴³. The global technological advancements drives the growing trend of deploying digital technology to enhance the system's capacity for safe and cost-effective operation.

Concerning hydrogen production, Vietnam currently produces hydrogen primarily from fossil fuels (crude oil, natural gas, and coal) through gasification and reformation (grey hydrogen). Hydrogen is utilized primarily in oil refineries, fertilizers, and in minor quantities in the steel annealing and floating glass industries.

Converting renewable electricity to hydrogen is less efficient than direct consumption. For instance, utilizing hydrogen or ammonia as fuel in gas or coal power facilities leads to considerable energy loss after conversion, resulting in only 20% of the total green electricity needed for hydrogen production⁴⁴. In contrast, when using direct renewable energy, transmission losses are as low as 4%, allowing 96% of the total green electricity input to be injected directly into the power grid.

The development of green hydrogen is a standout point for Vietnam in the energy transition process. Based on the analysis of international experience, energy efficiency, technological readiness, and theoretical hydrogen production, the potential roles of green hydrogen in a low-carbon economy are proposed as follows⁴⁵:

- In the industry sector, hydrogen can be used in steel and cement production, replacing grey hydrogen currently used in oil refineries, fertilizers, chemical industries, steel production, and cement;
- In the transportation sector, green hydrogen can serve as an alternative fuel for passenger cars, trucks, railways, sea transport, and aviation
- In the power sector, green hydrogen is used for storage and flexible source
- Green hydrogen production for export.

⁴¹ VIETSE (2021). Energy Storage System in Vietnam: Recommendation on technology, financial and legal mechanism support.

⁴² <https://cosodulieu.evn.com.vn/pages/cms/news-evn-ung-dung-manh-me-thanh-tuu-cua-cmcn-40-vaot-dong-san-xuat-kinh-doanh-id-5717.html>

⁴³ <https://www.evn.com.vn/d6/news/So-hoa-cac-dich-vu-dien-triet-de-va-toan-dien-6-14-118821.aspx>

⁴⁴ David Cebon. 2022. Hydrogen and Ammonia for Heating and Power. Presented at JETP Workshop in Hanoi on 30 September 2022

⁴⁵ Vietnam Initiative for Energy Transition. 2023. Options for green hydrogen development in Vietnam. Vietnam Initiative for Energy Transition

Vietnam has not implemented CCUS due to limited availability of these technologies. The cost of carbon capture technology remains high (ranging from 50 to 100 USD/tCO₂ for CO₂ capture at power plants, excluding transportation and storage costs)⁴⁶. As a result, the application of CCUS technology at power plants in Vietnam is currently not economically feasible. According to research conducted by the Asian Development Bank (ADB)⁴⁷ estimates that installing CCUS technology will increase Levelized cost of electricity (LCOE) by 78% at supercritical coal power plants. Vietnam does not mandate power plants to install CO₂ removal technology, and the carbon market roadmap is not scheduled to be implemented until 2028. One potential factor that could make CCUS more economically viable is Enhance Oil Recovery (EOR). However, a challenge is that most of the existing coal power plants are concentrated in the North, while the oil fields are in the South Sea. The ADB study also recommends a road map for the first commercial-scale CCUS project in Vietnam to become operational after 2030. Additionally, another study suggests that coal-fired power plants will be able to implement CCUS by 2035⁴⁸.

Vietnam's research on CCUS is extremely limited. In 2009, the French Geological Research Agency and the Vietnam Department of Geology and Minerals mapped areas with potential for CO₂ storage⁴⁹. An ADB study evaluated the 10 most promising individual storage sites in Vietnam, with capacities ranging from 23 to 357 MtCO₂; it also identified 8 offshore storage locations in the Mekong basin with a storage capacity of 19 MtCO₂. The study published in 2023⁵⁰ on the decarbonization potential of Vietnam's power and industrial sectors with CCS estimated the CO₂ storage capacity of gas fields at 2800 Mt and oil fields at 500 Mt.

Therefore, CCUS will be regarded as a viable long-term solution to support the achievement of NZE objectives, especially for industries and sectors hard-to-abate, such as cement and metallurgy. Corporations, particularly PVN, may consider adopting this technology in Vietnam if it proves to be both technically and economically feasible.

Biomass co-combustion technology in coal-fired power facilities is evaluated as a potential technology for reducing emissions, addressing environmental issues, and maximizing domestic raw materials. The technology has been commercialized in countries such as the United Kingdom (16 projects), Germany (15 projects), Denmark (5 projects), Finland (14 projects), Belgium (5 projects), Austria (5 factories)⁵¹ and Japan (31 projects)⁵². As a dominant country in agricultural development, Vietnam has a biomass potential estimated at about 1500 PJ/year, corresponding to a theoretical potential of about

⁴⁶ Baylin-Stern and Berghout (2021), Is carbon capture too expensive? <https://www.iea.org/commentaries/is-carbon-capture-too-expensive>

⁴⁷ ADB (2012) Prospects for Carbon Capture and Storage in Southeast Asia

⁴⁸ M. Ha-Duong and H. A. Nguyen-Trinh, "Two scenarios for carbon capture and storage in Vietnam," *Energy Policy*, vol. 110, pp. 559–569, Nov. 2017, doi: 10.1016/j.enpol.2017.08.040.

⁴⁹ ADB (2012) Prospects for Carbon Capture and Storage in Southeast Asia

⁵⁰ H. K. Bokka and H. C. Lau, "Decarbonising Vietnam's power and industry sectors by carbon capture and storage," *Energy*, vol. 262, p. 125361, Jan. 2023, doi: 10.1016/j.energy.2022.125361.

⁵¹ IEA Bioenergy Task 32, updated to 2017.

⁵² The Ministry of Economy, Trade and Industry (METI), Outline of Interim Report of the Working Group to Study Coal-fired Power Plants, p.27 https://www.meti.go.jp/shingikai/enecho/denryoku_gas/denryoku_gas/sekitan_karyoku_wg/20210423_report.html

150 TWh/year⁵³. GIZ's report "Application of co-combustion technology in coal-fired power plants in Vietnam: Biomass potential and existing technology" demonstrates that Vietnam can use wood pellets for co-burning in coal-fired power plants to reduce CO₂ emissions⁵⁴. Ninh Binh Thermal Power Plant (capacity of 100 MW, 4 units and operation since 1976) has conducted co-combustion tests with wood pellets at the rate of 15% and 20% biomass, with no discernible impact on incinerator operating efficiency⁵⁵. However, the use of biomass for co-combustion technology must be evaluated holistically, taking into account the seasonal variability of the raw material supply and the economic benefits of the biomass supply chain for other production purposes.

3.7. National commitments on emissions reductions

Over the past three decades, Vietnam has witnessed a fast-growing economy, which has been accompanied by a rise in GHG emissions. However, at the same time, Vietnam is among the most vulnerable countries when it comes to the impacts of climate change. Recognizing the pressing need to tackle the climate crisis, Vietnam has demonstrated its commitment to participating in the global endeavor to achieve the ambitious 1.5°C target set forth in the Paris Agreement.

Net Zero Emissions (NZE) announcement

During COP26, Prime Minister Pham Minh Chinh made a significant announcement, stating the country's goal to achieve "net zero" emissions by the year 2050. Vietnam also signed both the Global Coal to Clean Power Transition Statement and the Global Methane Pledge. These actions reflect Vietnam's responsible, strong, and ambitious commitment to combat climate change, aligning with the global trend and receiving support from many countries.

Following COP26, the Vietnamese Government wasted no time in taking action to implement this commitment. In July 2022, the Prime Minister approved the National Strategy on Climate Change, which outlines the path towards achieving net-zero emissions by 2050. Emissions are expected to peak in 2035, and the energy sector, encompassing power, transport, industry, residential, and services, stands as the largest emitter of greenhouse gases, needing to reduce emissions by 91.6% compared to business-as-usual (BAU) levels by 2050⁵⁶.

Updated NDC 2022

As a signatory of the Paris Agreement, Vietnam initially submitted its INDC in 2016 with an unconditional contribution of 8% and a conditional contribution of 25% compared to BAU. In 2020, the NDC was slightly increased to 9% with domestic resources and to 27% with

⁵³ Vietnam Initiative for Energy Transition. 2020. Biomass Co-firing and Renewable Portfolio Standard scenarios to 2030

⁵⁴ <https://www.evn.com.vn/d6/tnkl-d/Ung-dung-cong-nghe-dong-dot-tai-cac-nha-may-nhiet-dien-o-Viet-Nam-tiem-nang-sinh-khoi-va-cong-nghe-hien-co-100-668-56146.aspx>

⁵⁵ Consultation meeting with representative from Ninh Binh CFPP on 06/10/2022

⁵⁶ BAU emissions for energy activities in the updated National Strategy on Climate Change and NDC 2022 are forecast based on the revised National Power Development Plan VII (2016) covering 55.3 GW of electricity from coal.

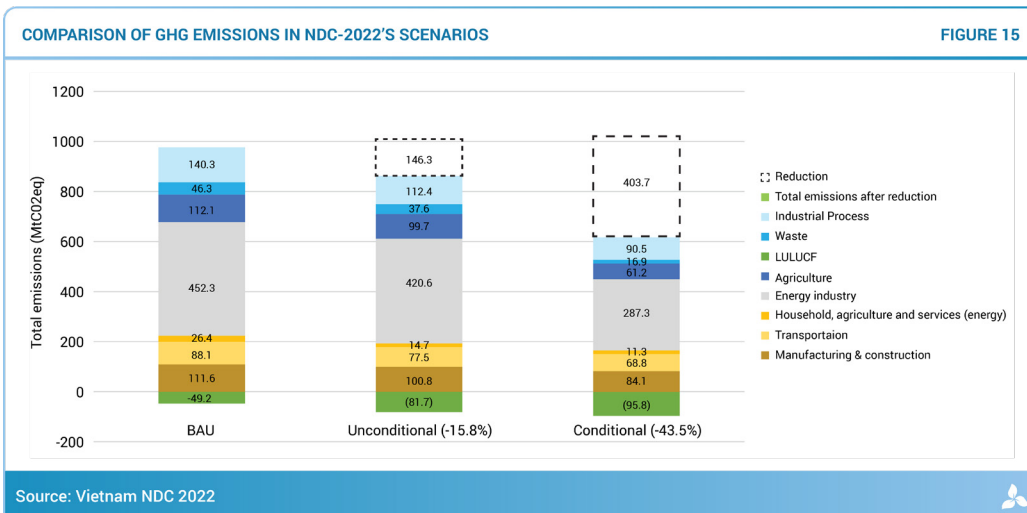
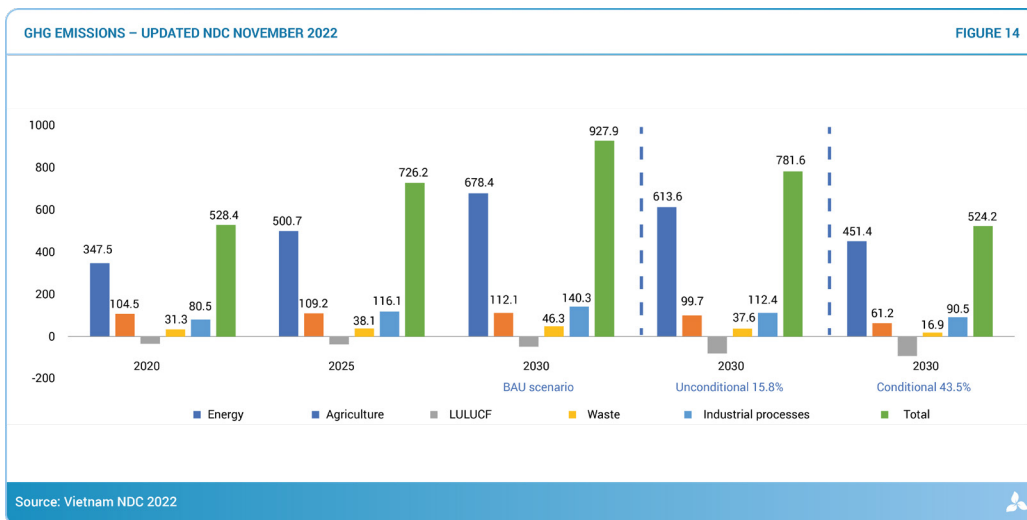
international support. However, after COP26, the NDC was revised and updated to align with the NZE target.

On 8th November 2022, Vietnam submitted the updated NDC at COP 27, which raised the emissions reduction contribution by nearly two folds:

- Unconditional contribution: -15.8% GHG emissions by 2030 compared to BAU, equivalent to 146.3 MtCO₂eq (NDC 2020 is -9%).
- Conditional contribution: -43.5% GHG emissions by 2030 compared to BAU, equivalent to 403.7 MtCO₂eq (NDC 2020 is -27%).

The updated NDC's BAU emissions remain consistent with the BAU of the National Strategy on Climate Change. Sectoral emissions for both unconditional and conditional contribution scenarios are depicted in Figure 14.

By 2030, the energy sector is expected to reduce emissions by 10% unconditionally and by 33% conditionally. The contributions are estimated by calculating the emissions reduction potential of each sector, with the power sector's potential estimated at 165 MtCO₂ with international support and 31.7 MtCO₂ without. Based on the emissions reduction potential, the remaining emissions in Conditional and Unconditional scenarios are broken down by sector, as presented in Figure 15.



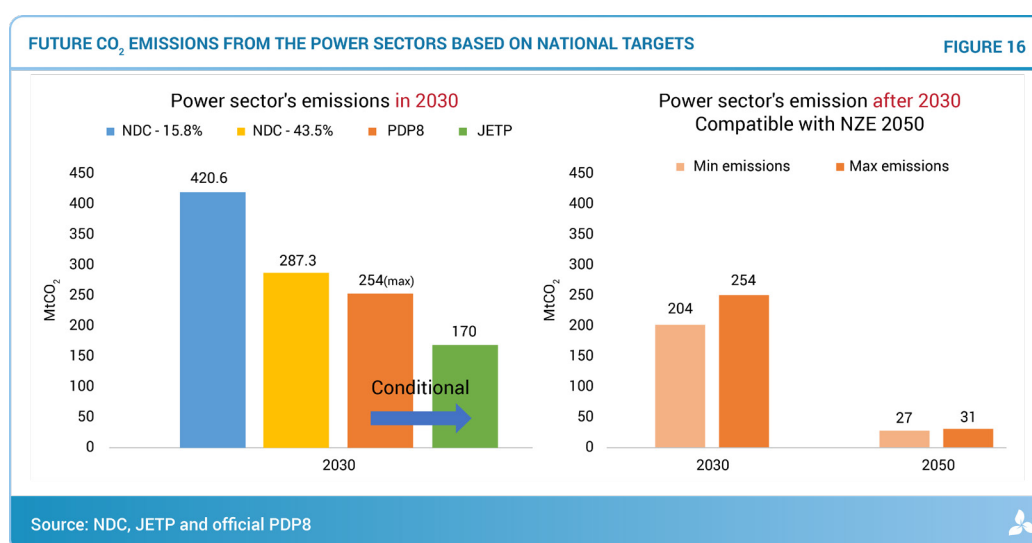
Just Energy Transition Partnership (JETP)

After negotiation, a JETP was established between Vietnam and the IPG (EU, UK, US, Japan, Germany, France, Italy, Canada, Denmark and Norway) in December 2022⁵⁷. JETP will mobilize the initial amount of 15.5 B\$ in the next 3-5 years (7.75 B\$ from the public sector and 7.75 B\$ in private finance) to support Vietnam to:

- Accelerate decarbonization of the electricity system to peak emissions at 170 MtCO₂ in 2030 instead of 240 MtCO₂ by 2030.
- Reduce the CFPPs pipeline from 37 GW peak toward a peak of 30.2 GW and provide a credible and ambitious emissions reduction pathway to phasing out unabated CFPP.
- Accelerate the deployment of RE and support the power grid to absorb a higher share of RE (including hydro to reach at least 47% of total power generation by 2030).

The JETP finance will be facilitated by the adoption of the JETP Resource Mobilization Plan (JETP – RMP), mobilizing 15.5 B\$. This package will represent a part of Vietnam's larger investment needs, as will be presented in the JETP-RMP, to be developed and published by November 2023.

Figure 16 represents the the future CO₂ emissions from the power sectors based on different targets (NDC, JETP and official PDP8). Note that the projected emissions in the NDC are estimated by subtracting the BAU emissions of the energy sector (~electricity) from the emission reduction potential in the NDC technical report.



⁵⁷ Political Declaration on establishing the Just Energy Transition Partnership with Viet Nam. https://ec.europa.eu/commission/presscorner/detail/en/statement_22_7724



Source: Shutterstock



Scenarios design for emissions reductions in power sector and related to SoEs

4.1. Energy SOEs in Vietnam

Vietnam Electricity (EVN), Vietnam National Coal and Mineral Industries Group (VINACOMIN) and Vietnam Oil and Gas Group (PVN) are the three important SOEs in ensuring national energy security.

Vietnam Electricity (EVN) was formed in 1995 as a vertically integrated, state-owned corporation responsible for Vietnam's power subsector. In mid-2006, EVN became a holding group. EVN is still the main actor in the power subsector with wholly owned subsidiaries:

- Three power generation corporations (GENCO): have an essential role in the ownership and investment funding in the electricity market. Altogether, the three GENCOs owned about 21 GW of installed capacity (about 27% of the total system capacity). They play a vital role in the country's socioeconomic development and national security. GENCO 3 started to equitize in 2017, and GENCO 2 in 2018 while GENCO 1 is still in progress. GENCOs will continue participating in the competitive wholesale power market after their equitization.
- National Power Transmission Corporation (NPT) is responsible for power transmission.
- Five-power corporation (Hanoi Power Corporation, Northern Power Corporation, Central Power Corporation, Southern Power Corporation, and Ho Chi Minh City Power Corporation) responsible for power distribution.
- National Load Dispatch Center, which serves as the system and market operator (SMO).
- Electric Power Trading Company (EPTC).
- EVN also owns strategic power plants, including 8.6 GW multipurpose hydropower plants. It is the majority shareholder of partially privatized power plants in the Vietnam Competitive Generation Market (VCGM).

Vietnam Oil and Gas Group (PetroVietnam or PVN) is a state-owned corporation established in 1975. PVN is engaged in the energy sector, including oil and gas and renewable energy. PVN has been growing into a fully integrated business model, ranging from exploration - production, refinery – petrochemical, gas industry, gas to power/fertilizer and petroleum technical services. Related to the power sector, PVN supplies

natural gas for thermal gas power plants. The SOEs also owned power plants with a sum of 5.6 GW by 2021, about 7% of the total installed capacity.

PetroVietnam Power Corporation (PV Power) – formerly a one-member limited liability company 100% invested by PVN – was established under Decision 1468/QD-DKVN dated 17th May 2007 by the Board of Directors of PVN. The company was equitized in accordance with Decision No. 1977/QD-TTg dated 8th December 2017 of the Prime Minister approving the equitization plan of the parent company - PetroVietnam Power Corporation. As of January 2022, PVN is holding 79,94% charter capital of PV Power⁵⁸. PVN directly manages the power plants such as Thai Binh 2, Song Hau 1 and Long Phu 1.

Vietnam National Coal-Mineral Industries Holding Corporation Limited (VINACOMIN or TKV) is a state-owned corporation established in 1994. TKV exercises the rights and obligations of owners of capital shares in subsidiaries and affiliated companies in proportion to its investment capital in these enterprises. The State assigns TKV to manage the mineral resources of coal, bauxite, copper, iron, gold, silver, tin, zinc and other minerals according to the provisions of the laws. TKV is assigned by the State to manage and use coal, bauxite and other mineral reserves in accordance with law; state capital invested in TKV; a number of infrastructures works of inter-mine and inter-regional nature. Aside from supplying coal for power generation, TKV also owns some coal power plants (1.6 GW) and hydropower plants (150 MW). Their coal power plants are built near the coal mines and use Circulating Fluidized Bed (CFB) boilers to utilize the low-rank coal from the mines.

TKV - Power Holding Corporation Limited (TKV Power) was established under Decision 5211/QD-BCT of the Ministry of Industry and Trade (MOIT) on 21st October 2009 as one-member limited liability company with 100% with 100% charter capital owned by TKV. The corporation officially operated under the model of a joint stock company since 15th January 2016. TKV Power does business in the fields of investment, construction, exploitation and operation of thermal power plants, hydroelectric power plants, electronic factories using new energy, renewable energy and power grids, power supply systems; Power production; Power transmission and distribution; Buying and selling electricity; Management of investment projects for construction of electrical works... However, TKV Power is mostly focusing on investment, construction, exploitation and operation of power plants.

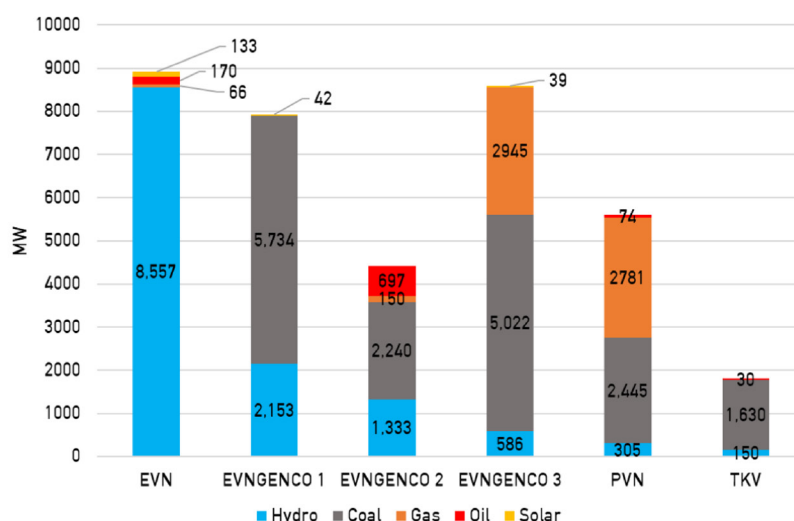
With a very important role in the power sector in Vietnam from upstream to downstream, the 3 SoEs will be the key players in the long-term energy transition of towards NZE 2050 emissions.

Since the total emissions of the 3 SoEs from power generation is accounting 69% of total national emission (138 MtCO₂) in 2021, Therefore, the contribution of the three groups will become the key factors that play an important role in the energy transition to achieve Vietnam's NZE target.

⁵⁸ Document of the Conference of Representatives of Vietnam Oil and Gas Group in 2021, issued in January 2022

INSTALLED CAPACITY OF SOE IN 2021

FIGURE 17



Source: VIETSE plotted based on EVN's data



Before the renewable energy “boom” during 2019-2021, the three energy SOEs dominated power generation, accounting for 69% of the total installed capacity at the end of 2018⁵⁹. However, by the end of 2021, the share of SOEs in power capacity ownership sunk to 48%, indicating that more generation capacity is now owned by the private sector than by EVN, PVN, and VINACOMIN combined.

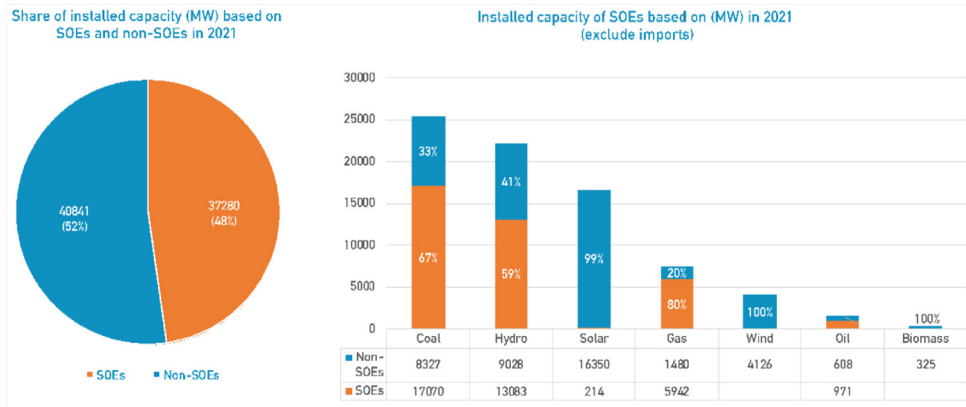
Figure 18 illustrates the comparison of the power mix between SOEs and non-SOEs. The three SOEs predominantly own conventional power plants such as coal, gas and hydro, while the private sector owns the majority of renewable power plants (solar and wind).

Despite the shift in capacity ownership, the three SOEs still contributed 58% of the total electricity output (Figure 18). This is because SOEs' plants mainly consist of hydro, coal, and gas power, which have higher capacity factors compared to renewable energy plants. As a result, SOEs continue to play a crucial role in providing electricity for the country's socioeconomic development. Their ownership of dispatchable sources also supports the reliability of the power supply, which is essential given that the state is still regulating the electricity price to ensure affordability and universal access to electricity – a target aligned with the United Nations' Sustainable Development Goal SDG 7.

⁵⁹ EVN's Power system operation report 2018.

SOEs SHARE IN POWER SYSTEM BY INSTALLED CAPACITY

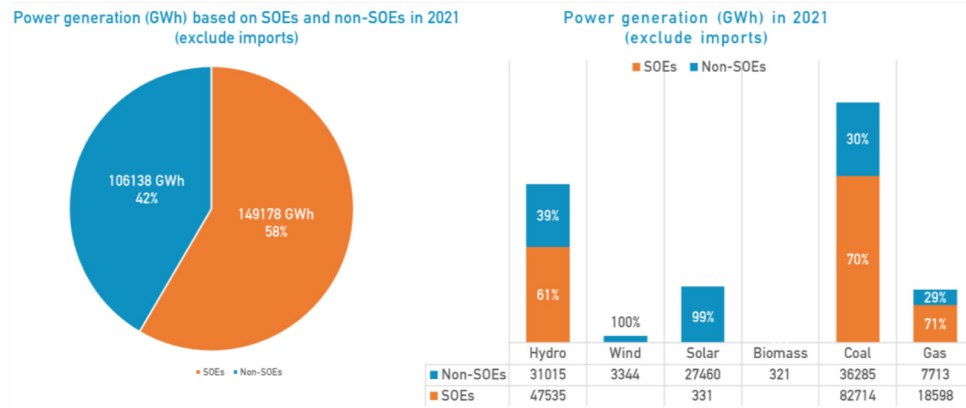
FIGURE 18



Source: VIETSE visualized based on data from EVN

SOEs' SHARE IN POWER SYSTEM BY ELECTRICITY OUTPUT

FIGURE 19



Source: VIETSE visualized based on data from EVN

4.2. Challenges for SOEs to chart the energy transition

This part summarizes the findings from the consultation discussion with the 3 SoE on the challenges for SoEs to chart the energy transition.

4.2.1. Institutional challenges

- Both EVN and PVN have identified the significance of energy transition (ET) and are in the process of developing their ET strategies. PVN is currently collaborating with two consulting firms on ET and emissions reduction, while EVN is in the process of sourcing one. However, their progress is dependent on the approval of the National Energy Master Plan and Power Development Plan, which will provide more specific guidelines for their ET strategies.
- PVN expressed their keen interest in its business ventures to include investments in renewable energy. However, PVN requires approval from Politburo to proceed with investments in renewable energy, particular in offshore wind sector.

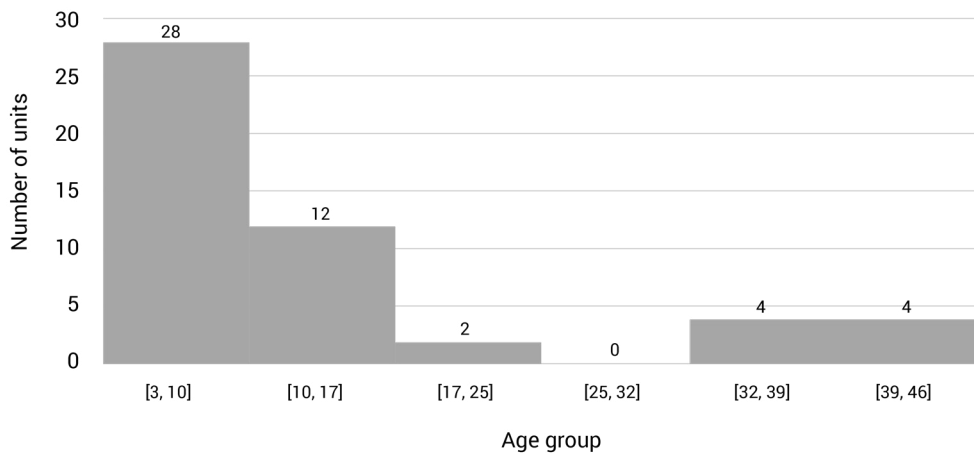
TKV has been actively engaged with partners such as World Bank, ADB Bank, Erex Joint Stock Company (Japan) to conduct research, assess the current status, and evaluate the potential for biomass co-firing technology applied for 06 coal-fired power plants of TKV power. TKV is currently considering the possibility of initiating a pilot project for biomass cofiring at Cao Ngan Thermal Power Plant from 2028.

4.2.2. Technical challenges

- The SOEs, especially EVN, bear the responsibility of ensuring the energy security of the entire country. They must balance between transitioning to cleaner and lower-emission energy sources while maintaining the stability and reliability of the power system, which involves a higher integration of variable energies.
- SOEs currently own 67% of coal power capacity. Despite a few older plants like Ninh Binh and Pha Lai, the majority of SOEs' coal fleet is quite young (Figure 13), making it harder to reduce their emissions by cutting down power generation or initiating early retirement.
- During the meetings with the Consultants, SOEs highlighted difficulties in project assessment and pre-feasibility planning for the fuel conversion solutions. They also expressed concerns about the lack of comprehensive assessments on how these solutions can be effectively implemented.
- The readiness of mitigation technologies such as Carbon Capture, Usage and Storage (CCUS), green hydrogen production and application is still low in Vietnam, both within the country and internationally.

AGE DISTRIBUTION OF EXISTING COAL POWER UNITS OF SOEs

FIGURE 20



Source: VIETSE visualized based on data from EVN

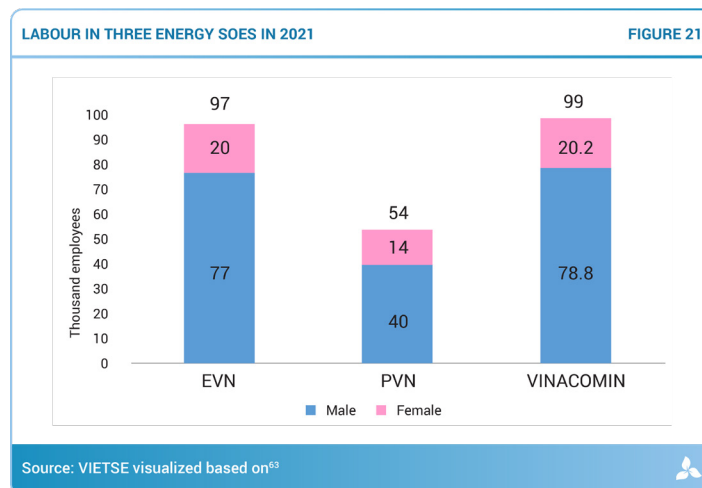


4.2.3. Financial challenges

- ▲ Obtaining financing for investing in new power sources and expanding the power grid will face numerous challenges due to limited credibility and the average selling price of commercial electricity being lower than the electricity production and business cost (9.27%), leading to substantial losses (in 2022: approximately 26,200 billion VND), particularly in meeting the power demand in the next 5 years. The estimated financing required for power development is substantial, ranging from 105 to 142 B\$ for 2021-2030 and 325 – 483 USD for 2031 – 2050⁶⁰. Obtaining the required financing poses a significant challenge for Vietnam's electricity sector, particularly given the prevailing energy crisis, which has led to rising input fuel costs (coal, oil, gas), an economic downturn, and an annual national public debt ceiling set at no more than 60% of GDP⁶¹ (as of 2021: 43.1%) for the period 2021-2025.
- ▲ EVN conveyed that their primary challenge for energy transition is the substantial investment costs, during the meeting with the Consultant on 13th September 2022, while ensuring that electricity prices remain balanced, affordable and approved by the Government. According to calculations, from 2025 to 2030, EVN needs to mobilize an annual investment capital of up to 6 B\$ for power source and grid projects, with limited access to concessional loans⁶².

4.2.4. Social challenges

- ▲ Ensuring social security for SOEs' ~250,000 employees (Figure 21) and minimizing the potential adverse impact of the energy transition is a key challenge.
- ▲ TKV also expressed their concern about the transition's impact on people and communities that are relying on CFPPs and the coal sector as well as energy security.



⁶⁰ Letter 7194/TTr-BCT of MOIT to the Prime Minister dated 11th November 2022 on approving the Power Development Plan 8

⁶¹ Resolution 23/2021/QH15 dated 28 July 2021

⁶² <https://www.evn.com.vn/d6/news/EVN-Can-vuot-qua-thach-thuc-nao-de-dap-ung-nhu-cau-chuyen-dich-nang-luong-6-12-30894.aspx>

⁶³ <https://www.evn.com/d6/news/Lao-dong-nu-cua-EVN-Tang-ca-luong-va-chat-0-12-29327.aspx>
<https://pvn.vn/chuyen-muc/doan-the/phu-nu-dau-khi-vung-/6f119208-fa824e2d-9a15-9542bc69abe9>
<http://www.vinacomin.vn/tintucvinacomin/tkv-tichcuc-cham-lodoi-songlao-dongnu-2020102016629325>

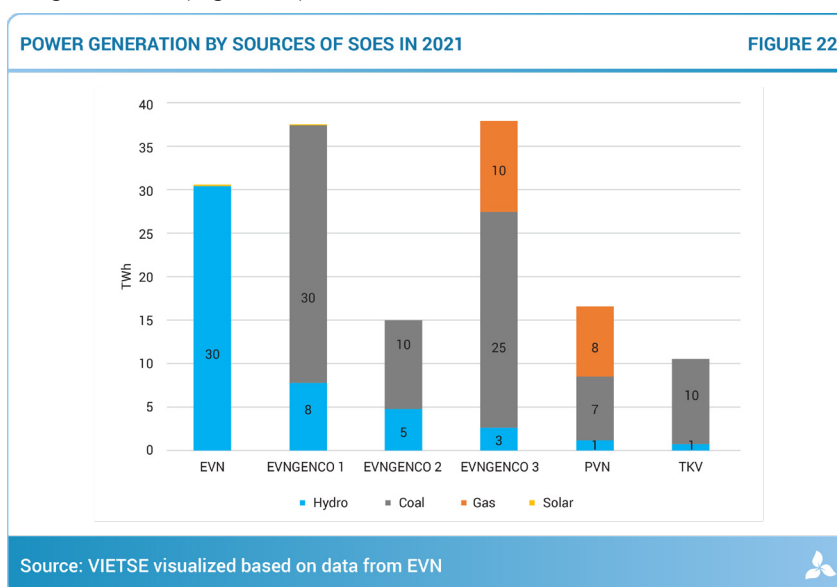
4.3. Drivers for SOEs to develop NZE strategy

Vietnam made strong commitments to climate protection during the landmark COP26 summit. Prime Minister Pham Minh Chinh reaffirmed the country's determination to achieve Net Zero Emissions (NZE) by 2050 with the support of technology transfer, finance, and capacity building from the international community. Vietnam is also among the 47 signatories of the Global Coal to Clean Power Transition Statement⁶⁴, pledging to halt the construction of new CFPPs.

To solidify the statement, the Government of Vietnam has issued several important Decisions, such as Decision 888/QĐ-TTg dated 25/7/2022 on approval of tasks and solutions for the implementation of outcomes of the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (Decision 888) and Decision 896/QĐ-TTg dated 26/7/2022 approving the national strategy for climate change until 2050 (Decision 896).

The energy transition is imperative to achieve climate neutrality by the mid-century target. Scientific evidence underscores that accelerating clean and inclusive energy transitions is a key element in climate protection. Decision 888 and Decision 896 also emphasize the role of energy transition in reaching the NZE goal. As significant stakeholders in Vietnam's energy sector, the three State-Owned Enterprises undoubtedly play a crucial role in fulfilling the country's NZE commitment.

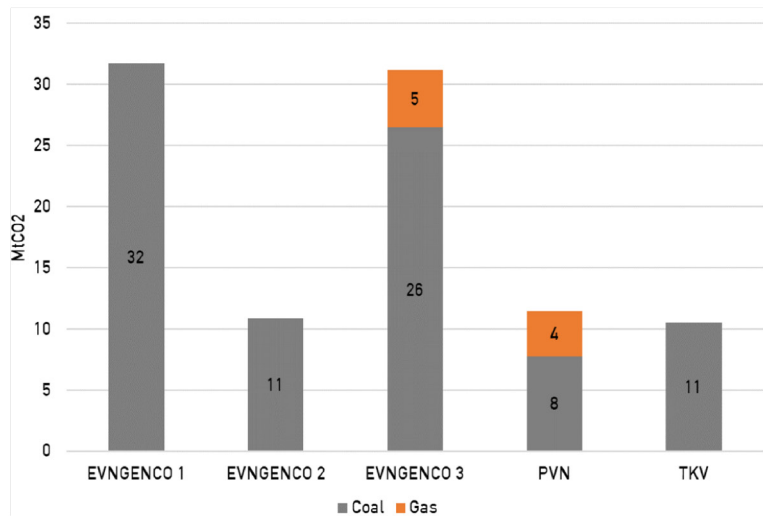
The power sector remains a significant source of greenhouse gas emissions, with SOEs being major contributors. Figure 22 shows that apart from EVN, which owns the large strategic hydropower plants, EVN's GENCOs have a generation mix heavily reliant on fossil fuels (accounted for 79%, 67% and 92% power output of GENCO 1, 2 and 3, respectively). Similarly, PVN and VINACOMIN have high shares of 94% and 91%, respectively. Coal power generation is the primary focus for SoEs, as it accounts for the majority of emissions from their power generation (Figure 23).



⁶⁴ <https://dangcongsan.vn/kinh-te/thuc-day-qua-trinh-chuyen-doi-tu-su-dung-than-sang-nang-luong-sach-617159.html>

ESTIMATED CO₂ EMISSIONS FROM POWER GENERATION FOR SOES IN 2021

FIGURE 23



Source: VIETSE visualized based on data from EVN



4.4. Approach and scenarios narrative

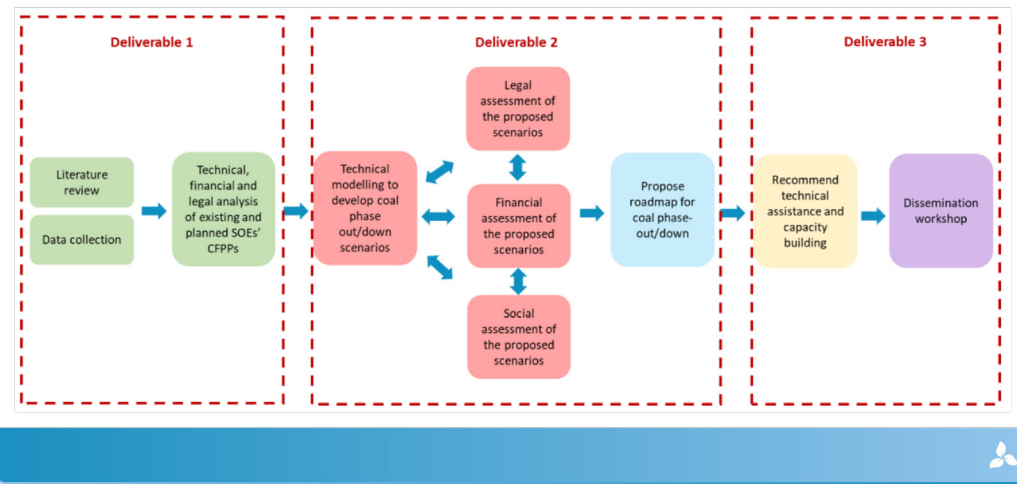
As explained earlier and in accordance with the ToR, the roadmap toward NZE must encompass emissions reduction from all fossil fuels combustion for power generation, with a specific focus on reducing emissions from the largest source, which is coal-fired power plants of SoEs. Therefore, the Consultant has developed the overall methodology to address this issue. The study implementation process, depicted in (Figure 24), consists of four steps outlined below:

Step 1: Assess the current operating conditions of 403 power plants in the system (excluding the rooftop solar and small hydropower plants). Additionally, the Consultants will assess the financial, employment situation, and ownership structure of coal power plants in Vietnam. Review of international experience on phasing down/out of coal power plants would be conducted.

Step 2: Conduct the technical modelling of various alternative scenarios for emissions reduction in the power sector. Develop a suitable roadmap based on the principle of reducing emissions from fossil fuels, especially through reasonable phasing out coal and replacing it with cleaner energy while ensuring the power system stability and security of supply in a least-cost manner.

Step 3: Evaluate the technical, financial, social, and legal requirements and impacts of implementing the roadmap. This evaluation also provides feedback on the technical modelling work for necessary adjustment to derive a suitable solution.

Step 4: Synthesize and propose recommendations.



4.4.1. Scenarios narrative

The scenarios have been developed based on three principles: energy security, affordability and emission reduction:

- Energy security: Ensuring the stability and reliability of power supply, reducing the dependency on imported fossil fuels;
- Affordability: Cost minimizing of the power system;
- Emission reduction: in line with national targets and commitment to climate protection.

To meet TOR's requirements, the Consulting team have built several scenarios, then based on the technical, financial and legal analysis to choose two (02) potential scenarios.

- Accelerated Reduction scenario – KB_AR
- Deep decarbonization scenario – KB_DD

In both scenarios, the Consultants identify energy efficiency as an indispensable factor to help the power system move towards the NZE goal. The scenario description is presented in Table 1.

Table 1. Scenarios narrative

Scenario	Emission reduction roadmap for power sector
KB_AR	<p>Demand:</p> <ul style="list-style-type: none"> Based on the power demand projected in the PDP8 combining with enhancing the energy efficiency measures and rooftop solar for self consumption → Reduce the power demand by 10% in 2030 and 38% in 2050 compared with the PDP8. <p>Supply:</p> <ul style="list-style-type: none"> Maximizing hydro power exploitation by applying real time forecasting technology. Enhancing the RE integration combining with other emission reductions measures. Maximizing domestic gas utilization. LNG development with a suitable capacity to increase system flexibility. Emission reduction measures in the CFPPs: <ul style="list-style-type: none"> 10% after 10 years of operation 30% after 15 years of operation Phase out CFPPs after 25 years of operation. <p>Emissions reductions:</p> <ul style="list-style-type: none"> Emission roadmap towards NZE 2050.
KB_DD	<p>Demand:</p> <ul style="list-style-type: none"> Based on the power demand projected in the PDP8 combining with enhancing the energy efficiency measures and rooftop solar for self consumption → Reduce the power demand by 10% in 2030 and 38% in 2050 compared with the PDP8. <p>Supply:</p> <ul style="list-style-type: none"> Maximizing hydro power exploitation by applying real time forecasting technology. Enhancing the RE integration combining with other emission reductions measures. Maximizing domestic gas utilization. LNG development with a suitable capacity to increase system flexibility. Accelerating to put the LNG power plants in operation earlier than KB_AR in order to deeply decarbonize the power sector. Emission reduction measures in the CFPPs: <ul style="list-style-type: none"> 30% after 10 years of operation 60% after 15 years of operation Phase out CFPPs after 20 years of operation(*). <p>Emissions reductions:</p> <ul style="list-style-type: none"> Deep decarbonization of the power sector to be in line with JETP declaration in 2030 and emission roadmap towards NZE 2050.

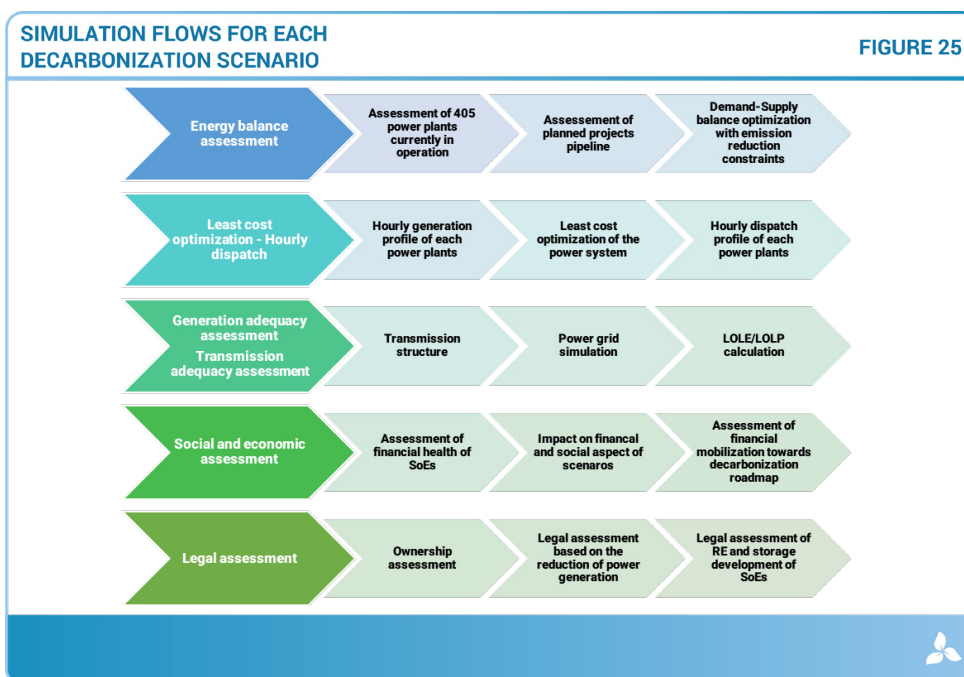
(*) The emission reduction roadmaps mentioned above draw inspiration from international experience and research reviews⁶⁵. The alternative scenarios on CFPPs decarbonization in Indonesia proposed that the CFPPs should not operate for more than 20 years.

For each scenario, the technical assessment is conducted to answer the following questions:

- How much of the power generation from coal will be reduced?
- How much renewable energy is required to compensate for the reduced power outputs when coal generation is phased down/out?
- What is the extent of CO₂ emissions reduction?
- How secure is the power supply for each scenario up to 2030, considering grid constraints?
- What are the energy storage system requirements to ensure the flexibility of the power system?

To address the first three questions, the Consultants use a model built in LEAP, simulating the energy balance for the period 2023-2050. The years 2023-2030 are evaluated with a one-year time step, while 2031-2050 are evaluated with a five-year time step. The security of the power supply is assessed using Digsilent Power Factory software's Unit Commitment and Power Flow modules.

This study integrates a comprehensive model of Vietnam's power system in Digsilent/Powerfactory to assess the technical impact of the developed scenarios on the security of supply of the whole system. Both generation adequacy and transmission adequacy are investigated using the Unit Commitment and Power Flow modules.



⁶⁵ Cui, R., M. Zhu, D. Cui, F. Tumiwa, D. Arinaldo, D. Li, S. Li (March 2023). "How an accelerated coal transition in Indonesia may affect Chinese developers." Center for Global Sustainability, University of Maryland and Institute for Essential Services Reform

4.4.2. Generation adequacy assessment

Generation adequacy refers to the ability of the power system to meet the demand, and it's assessed by calculating the LOLE/LOLP parameters. These parameters are important to analyse the effect of increasing the integration of RE sources with high discontinuity and variability on the reliability of the power supply. In order to calculate the random variation of power sources, particularly RE sources, the detailed generation characteristic curve has been developed for each type of generation (offshore wind power, onshore wind power, and solar power), for the entire simulation year. However, there is no need to develop detailed operating parameters for conventional power plants (thermal and hydroelectric). Instead, random generation models for these plants will be based on the number of operating hours per year and estimated maintenance hours for each unit.

The generation adequacy is determined using random probabilities in a Monte-Carlo loop, which is repeated 10,000 times. The LOLE and LOLP values are calculated through multiple runs of the Monte Carlo loop using onshore wind, offshore wind, and random solar models.

4.4.3. Transmission adequacy assessment

Based on hourly load demand profiles, economic dispatch is conducted to determine the optimized power mix for developed scenarios. The Unit Commitment and Dispatch Optimization is carried out for the entire year of 2025 and 2030, equivalent to 8760-time steps. The simulation begins with a DC-load-flow-based approach to identify the optimal dispatch for each generation unit, considering cost constraints only. Subsequently, an AC-load-flow-based simulation is performed to redispatch all generation units, ensuring compliance with network constraints such as inter-regional capacity and voltage limits.

The tool optimizes the hourly output power of each power plant unit in each region, considering the overall cost and network constraints. The AC load flow is then performed to validate the optimal results by assessing the voltage level, loading of transformers and transmission lines, and inter-regional transmission capacity. The results of the most critical dispatch hours (or snapshots) are selected to demonstrate the grid operation and response of the transmission system with optimal outcomes. If the system operates effectively in critical snapshots, it's expected to perform well in other operational cases. The interesting snapshots are described Table 2.

Table 2. Six critical snapshots for transmission adequacy assessment

	Dry season March	Rainy season July	Water reserve season December
Highest demand	Weekday	Weekday	Weekday
Highest RE	Afternoon	Afternoon	Afternoon
Highest demand	Weekday	Weekday	Weekday
Lowest RE	Evening	Evening	Evening

4.4.4. Inputs and assumption

Based on the working sessions with EVN, TKV, PVN as well as surveys at various power plants of the three SoEs, essential information and financial capacity about the plants will be compiled and presented as inputs for modelling works. This information will serve as the foundation for evaluating the financial and economic implications under the chosen scenarios and determining the capital and investment requirements of enterprises that own coal power plants, which will be converted under different scenarios.

The data inputs in the models include technical parameters, cost, constraints on technical operation and emissions such as:

- Name and location of power plants
- Number of units and its capacity
- COD
- Fuels consumption
- Technical lifetime
- Minimum capacity
- Capacity factors of each technology:
 - The capacity factors of the CFPPs, gas power plants, hydropower plants are estimated based on the historical operating conditions during the last 10 years.
 - The capacity factors of RE power plants are estimated based on consultations with RE experts and Technology Catalogue 2020.
- Emission factors for fossil fuels technology
- Investment cost, fixed and variable O&M cost
- Project pipeline until 2050.

These data are collected from different official resources:

- Existing legal documents
- Draft Energy Master plan and Power development plan VIII
- Published annual reports of power sector and annual operation reports
- Consultation meetings with CMSC and SoEs during September 2022
- Field trip to coal fired power plants during October 2022
- Published international and national research reports

The socio-economic development indicators used in this study are based on the the socio-economic development scenario of Vietnam to 2030, with a vision to 2050 set out in the Document of the Second National Party Congress XIII (as the same using in the PDP8) and summarized in the table below:

Table 3. Social-economic development indicators

		2021- 2025	2026- 2030	2031- 2035	2036- 2040	2041- 2045	2046- 2050
GDP growth rate	%/year	7,0	7,0	6,5 – 7,5	6,5 – 7,5	6,5 – 7,5	6,5 – 7,5
Power demand growth rate	%/year	9,08	8,56	6,31 – 7,27	4,45 – 5,14	3,06 – 3,53	2,36 – 2,73
Elasticity / GDP		1,3	1,22	0,96	0,68	0,47	0,37

Source: PDP8, May 2023

Table 4. Capacity factors of each technology

Capacity factor	2025	2030	2035	2040	2045	2050
Coal	0.68	0.68	0.68	0.68	0.68	0.68
Gas	0.76	0.76	0.76	0.76	0.76	0.76
LNG	0.76	0.76	0.76	0.76	0.76	0.76
Oil	0.21	0.21	0.21	0.21	0.21	0.21
Solar farm	0.17	0.17	0.17	0.17	0.17	0.17
Floating solar	0.18	0.18	0.18	0.18	0.18	0.18
Onshore wind	0.39	0.39	0.39	0.39	0.39	0.39
Offshore wind	0.43	0.48	0.5	0.52	0.52	0.55
Hydropower	0.41	0.41	0.40	0.40	0.40	0.40
Biomass	0.50	0.50	0.50	0.50	0.50	0.50

Source: Technology catalogue, DEA, 2021 and Operation report of national power system, EVN

Table 5. Emission factors of each technology

Emission factor (tCO ₂ /kWh)	2025	2030	2035	2040	2045	2050
Gas	0.451	0.451	0.451	0.451	0.451	0.451
Oil	0.773	0.773	0.773	0.773	0.773	0.773
Coal	0.980	0.980	0.980	0.980	0.980	0.980
CHP	0.980	0.980	0.980	0.980	0.980	0.980

Source: Report on Emission Factor (EF) of Vietnam's electricity grid in 2020



5

Simulation result of emissions reduction scenarios for the SoEs

5.1. Technical findings

Based on the requirements outlined in the ToR, the Consultant will present only in this section the simulation results of the emissions reduction scenarios of coal power plants owned by the 3 SoEs. The main findings of technical modeling of emission reduction scenarios KB_AR and KB_DD for SOEs are summarized below. *The detailed analysis is presented in the Preliminary report, refer to Annex 1.*

5.1.1. Potential of emission reductions

National power system

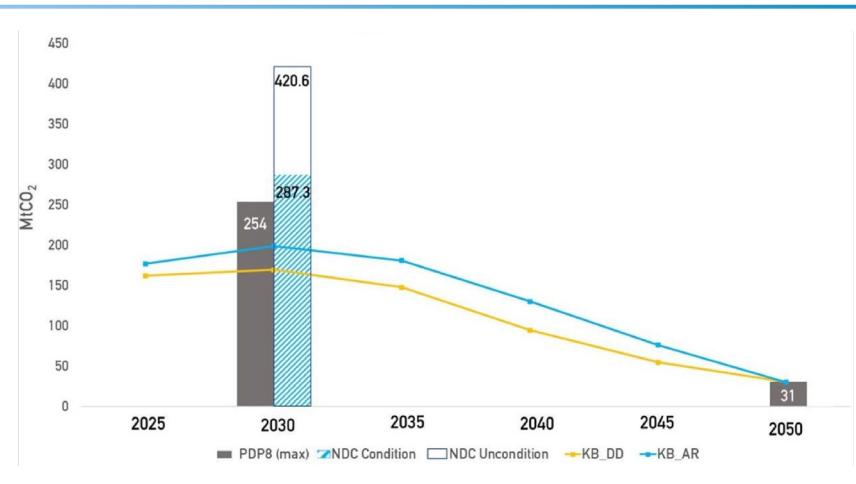
The CO₂ emissions for each fossil fuel technology are calculated based on the electricity production and the corresponding emission factors, as presented in section 4.4.4. Inputs and Assumptions.

With the technical assumptions stated in section 4.4, the results of technical modeling indicate that emissions from the Vietnamese power system could reach their maximum value by 2030. Under these scenarios, KB_DD has the potential to reduce 251 MtCO₂ while KB_AR could reduce 221 MtCO₂ by 2030 when compared to the emissions of the unconditional NDC commitment (NDC – 15.8%). This reduction is equivalent to a 60% reduction in KB_DD and a 53% reduction in KB_AR. Although KB_AR has a lower emission reduction rate than KB_DD, both pathways align with the NZE emission reduction target specified in the National Strategy on Climate Change, where emissions allowed for the power sector in 2050 are set at 30 MtCO₂.

The PDP8 (published in May 2023) predicts that the emissions of Vietnam's power system in 2030 may vary between 204 MtCO₂ and 254 MtCO₂. Consequently, when comparing these values to the 2030 peak emission of the two simulation scenarios, KB_DD has emission reduction potential of 84 MtCO₂ and KB_AR has emission reduction potential of 55 MtCO₂.

EMISSIONS OF VIETNAM'S POWER SYSTEM IN EACH SCENARIO

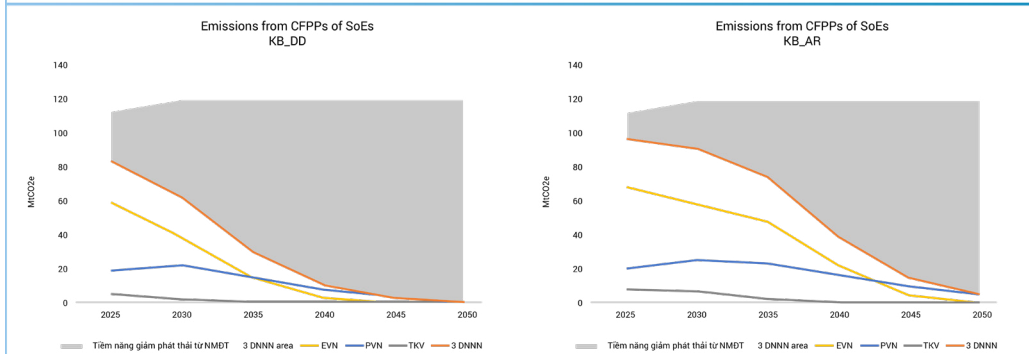
FIGURE 26



Source: Simulation results of VIETSE

EMISSIONS FROM COAL POWER PLANTS OF EACH SOE AND EMISSION REDUCTION POTENTIAL OF EACH SCENARIO

FIGURE 27



Source: VIETSE visualized based on data from EVN

Note: Emission reduction potential (grey part) is compared with the case of no emission reduction interventions applied for SoEs' coal power plants.

Integrated measures to reduce emissions in the power system as well as for electricity generation, particularly for SoEs' coal-fired power can be effectively implemented by coupling with investment in renewable energy resources, suitable storage sources and grid infrastructure. This approach ensures national energy security while gradually reducing dependence on international market fluctuations, all while maintaining primary energy diversification and the state's market regulation role.

5.1.2. Developing renewable energy sources

Apart from reducing emissions, the 3 SoEs also play an important role in investing in clean energy sources (such as floating solar power, ground-mounted solar power, onshore and offshore wind power) to ensure national energy supply security while reducing the reliance on imported fuel. Based on simulation results, each SoE has its potential investment in renewable energy (RE) sources to ensure the electricity generation market share of each group as the current development plan, with the roadmap and additional investment needs as follows:

Table 6. EVN's RE investment needs

Scenario		KB_DD		KB_AR	
Roadmap		2023 – 2030	2031 – 2050	2023 – 2030	2031 – 2050
Investment volume In Renewable energy (GW)	Floating solar	4.3	5.4	4.3	5.4
	Ground-mounted solar	0.7	2.9	0.0	2.9
	Onshore wind	2.3	5.5	2.4	3.6
	Offshore wind	6.6	1.8	1.8	7.8
Investment needs (Billion USD)		30.2	24.1	17.1	34.7

Table 7. PVN's RE investment needs

Scenario		KB_DD		KB_AR	
Roadmap		2023 – 2030	2031 – 2050	2023 – 2030	2031 – 2050
Investment volume In Renewable energy (GW)	Floating solar	0.0	0.0	0.0	0.0
	Ground-mounted solar	0.1	0.7	0.3	0.0
	Onshore wind	0.6	1.2	0.0	1.1
	Offshore wind	1.0	3.8	0.6	3.7
Investment needs (Billion USD)		3.6	10.2	1.8	9.4

Table 8. TKV's RE investment needs

Scenario		KB_DD		KB_AR	
Roadmap		2023 – 2030	2031 – 2050	2023 – 2030	2031 – 2050
Investment volume In Renewable energy (GW)	Floating solar	0.0	0.0	0.0	0.0
	Ground-mounted solar	1.3	1.3	0.6	1.9
	Onshore wind	1.9	0.0	0.7	1.3
	Offshore wind	0.0	0.0	0.0	0.0
Investment needs (Billion USD)		3.7	0.9	1.5	2.9

Source: Simulation results of VIETSE

The demand for investment in renewable energy of each SoE in KB_DD is higher than in KB_AR due to the faster and stronger level as well as speed of emission reduction. EVN owns 35 large hydropower plants (with a total capacity of 12.6 GW) in the basins of Dong Nai, Se San, Srepok, Dong Nai, Red River, Ma River, etc. Therefore, the Consultants recommends that EVN consider investing in floating solar on hydroelectric reservoirs (Da Mi, Ham Thuan, Ialy, Thac Mo, Tri An, Se San 4, Buon Tua Srah, Buon Kuop), with a total capacity of 4.3 GW by 2030 and 5.4 GW from 2031 to 2050. The priority for the development of floating solar power sources is based on the criteria of optimizing solar radiation potential, existing grid infrastructure of the operating hydroelectric power plants as well as minimizing the social and environmental impacts.

From the research report on the ability to participate in the supply chain for offshore wind power development that was carried out in 2021, the Consultants proposes that PVN focus on investing in offshore wind power, with capacity of 1 GW by 2030 and 3.8 GW by 2050 due to advantages and experience in offshore engineering.

After assessing the factors of financial status and land uses, the Consultants proposed TKV to focus on ground-mounted solar power (with low investment cost and short construction period) with a total of 2.6 GW of capacity by 2050 and 2 GW of onshore wind power.

By following these investment paths, the proportion of RE output for power production (including hydroelectricity) of each group respectively in 2030: 40% (KB_AR) to 52% (KB_DD) of EVN, 7% (KB_AR) to 13% (KB_DD) of PVN and 35% (KB_AR) to 83% (KB_DD) of TKV. By 2050, the proportion of TKV's renewable energy sources in both scenarios will reach 100%, followed by EVN at 74% and PVN at 44% (KB_AR) and 53% (KB_DD). The total market share of all three SOEs in the national electricity demand will account for 49% in 2030 and 30% in 2050.

Investing in renewable energy (RE) will generate economic benefits and revenue for each SoE through the sale of RE power output. The estimates of the maximum revenue that each group can earn are presented in Table 9, taking into account the ceiling price applied to solar and wind power plants in transitioning process according to Decision 21/QĐ- BCT.

Table 9. Estimated maximum revenue from selling RE electricity of each SOE

Estimated revenue (thousands billion of VND)	2024-2030	2031-2050
EVN	203	2.498,5
PVN	40,1	693,5
TKV	58,9	289,6

Estimated revenue (Billion USD)	2024-2030	2031-2050
EVN	8,65	106,4
PVN	1,71	29,54
TKV	2,51	12,34

Note: 1 USD = 23,472 VND

Source: Simulation results of VIETSE

Total investment required for renewable energy sources by 2050 may vary as follows: EVN: 51.8 - 54.3 billion USD | PVN: 11.2 - 13.8 billion USD | TKV: 4.3 - 4.6 billion USD. However, the investment capacity of each group depends on the ability to raise capital within the limits of their debt ceiling, as presented in section 5.2. For EVN, the investment demand in the period 2023-2030 is USD 30.2 billion while EVN's debt capacity is estimated at USD 9.66 billion. Similar to TKV, the investment demand in the period of 2023-2030 is 3.7 billion USD, which is 1.5 times higher than TKV's debt room, which is estimated at 2.48 billion USD. PVN has the highest borrowing capacity among the three SoEs, with room to borrow up to 43.81 billion USD to be able to invest in new renewable energy sources as mentioned above.

5.1.3. Potential to enhance energy security

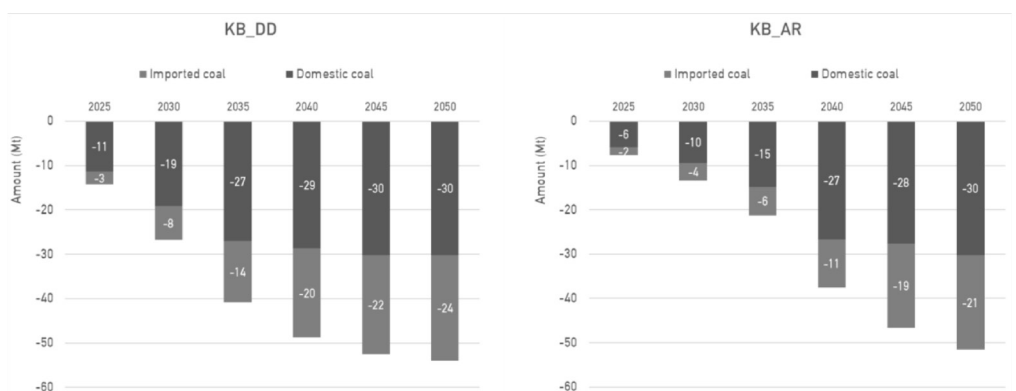
Along with the reduction of electricity production from coal, the 3 SoEs also also addressing the issue of dependence on the imported fuel market, which has experienced significant fluctuations in the global market recently. In the two scenarios, KB_DD yields lower coal demand for power generation than KB_AR, owing to the implementation of more

robust production reduction measures. In KB_DD, EVN is projected to have the highest potential for reducing fossil coal use, with total coal consumption expected to decrease by 99.4 Mt (32% from imported coal and 68% from domestic coal) for 2024 -2030 and 132.3 Mt (46% from imported coal and 54% from domestic coal) for the period 2031-2050. PVN will reduce coal demand by 10.3 Mt in 2030 and 39.6 Mt in 2031-2050 while TKV is expected to reduce by 26.9 Mt in 2030 and 24.1 Mt in 2031-2050.

It is evident that in both scenarios, the reduction of coal consumption at power plants owned by the three corporations will have a positive impact on Vietnam's coal import-export trade balance. 2020 is the year having the largest net coal import volume of 54 Mt, resulting in a trade deficit of \$3.6 billion. Despite the net import volume of 31 Mt in 2022, the trade deficit soared to \$6.8 billion, primarily due to the significant increase in coal prices (averaging about \$224 USD/ton for imported coal into Vietnam) (Figure 29). Reducing the amount of imported coal for power generation at the SOEs power plants could save \$2.4-3.1 billion by 2030 and \$4.7-5.4 billion (estimated based on average imported coal prices in 2022).

REDUCED AMOUNT OF COAL CONSUMED FOR POWER GENERATION IN TWO SCENARIOS

FIGURE 28

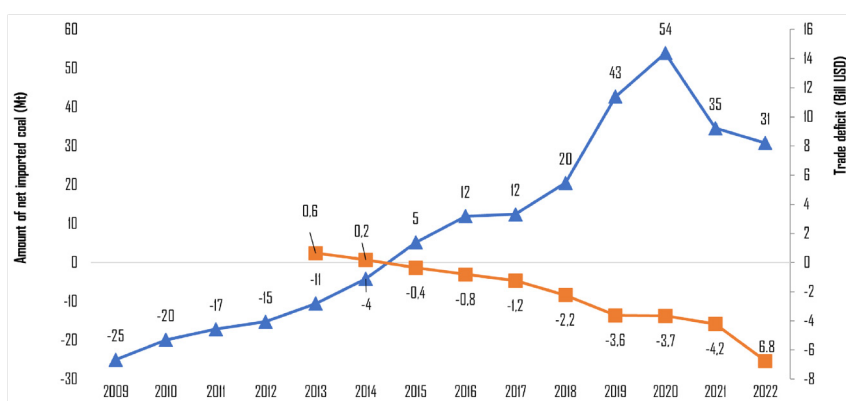


Source: Simulation results of VIETSE

Assumption: The power plants operate with the same type of coal (domestic, imported, blended) as in 2021. In the case of mixed coal, the mixing ratio is assumed to be 40%.

NET IMPORTED COAL AND TRADE DEFICIT OF COAL IMPORT EXPORT OF VIETNAM

FIGURE 29

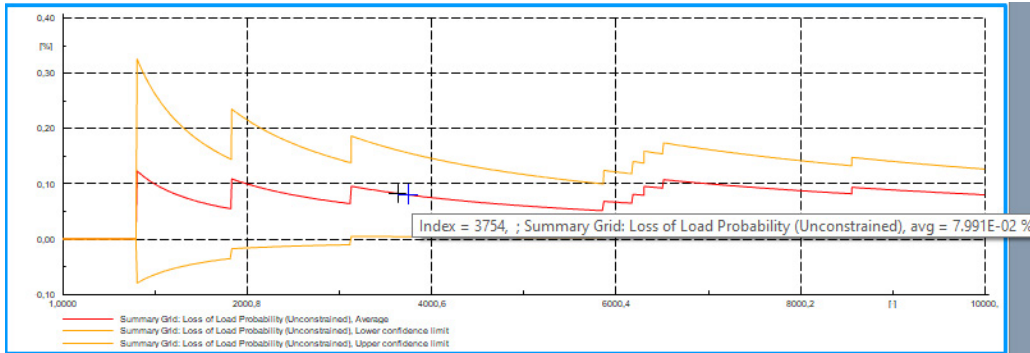


Source: Customs Statistics

5.1.4. Generation adequacy assessment

Generation adequacy assessment

The Consultants evaluated the reliability of the power system through the development roadmap of the recently approved PDP8. The simulation shows the LOLP value below 12h/year. This LOLP is resulting from the power mix covering a high share of coal fired power plants (30%), combining with a high capacity of LNG power plants (14.9%). The below figure represents the modelling results LOLP at 0.07991%, which is equivalent to a LOLE of 7h/year.



Based on the simulation results, the reliability could be enhanced by installing the energy storage system. With a significant reduction of coal-fired power, the proposed scenarios have average LOLP values of 0,0091% for KB_DD and 0,0067% for KB_AR, equivalent to expected LOLE of 79,7 hours and 58,7 hours per year, respectively. These results show that the proposed scenario cannot meet the requirement of safe operation of the system (EVN stipulates a LOLE level of less than 24 hours per year). Therefore, flexible sources need to be installed to meet the shortfall. The calculation of required additional energy storage system (BESS and pump hydro storage) to commit with LOLE/LOLP standards is presented below.

The results show that the operation of ESS can significantly improve the LOLE/LOLP indices. For the year 2025, with the given generation mix, around 3000 MW ESS is needed to achieve LOLE value less than 24 hours per year. For the year 2030, around 6000-7000 MW ESS is required for both the KB_DD and KB_AR scenario to reduce the LOLE level to less than 24 hours per year.

Table 10. LOLE/LOLP calculation for 2 scenarios for 2025

Storage capacity [MW]	KB_DD				KB_AR			
	LOLP [%]			LOLE [hr/yr]	LOLP [%]			LOLE [hr/yr]
	Low	Medium	High		Low	Medium	High	
50	0,970%	0,808%	1,131%	84,97	1,310%	1,122%	1,497%	114,76
500	0,800%	0,634%	0,947%	70,08	1,030%	0,863%	1,196%	90,23
1000	0,650%	0,518%	0,782%	56,94	0,920%	0,762%	1,077%	80,59
2000	0,430%	0,322%	0,538%	37,67	0,570%	0,446%	0,694%	49,93
3000	0,290%	0,202%	0,378%	25,40	0,330%	0,236%	0,424%	28,91
4000	0,200%	0,127%	0,274%	17,52	0,220%	0,143%	0,297%	19,27

Table 11. LOLE/LOLP calculation for 2 scenarios for 2030

Storage capacity [MW]	KB_DD				KB_AR			
	LOLP [%]			LOLE [hr/yr]	LOLP [%]			LOLE [hr/yr]
	Low	Medium	High		Low	Medium	High	
2700	0,0091	0,00754	0,01066	79,7	0,0067	0,00535	0,00804	58,7
3000	0,0074	0,00599	0,00881	64,8	0,0058	0,00455	0,00705	50,8
4000	0,0058	0,00455	0,00705	50,8	0,0050	0,00384	0,00616	43,8
5000	0,0050	0,00383	0,00616	43,8	0,0032	0,00227	0,00413	28,0
6000	0,0042	0,00314	0,00526	36,8	0,0026	0,00193	0,00367	22,8
7000	0,0028	0,00193	0,00367	24,5	0,0022	0,00143	0,00297	19,3
8000	0,0021	0,00135	0,00285	18,4	0,0017	0,00144	0,00186	14,5

From the above analysis, in the two scenarios, the system requires a huge capacity of EES (3 GW in 2025 and about 6-7 GW in 2030 for BESS and pump hydro storage). Recently, EVN is implementing the construction of Bac Ai pump hydro storage with 1.2 GW capacity at Ninh Thuan province, tentatively operating in 2028 to increase the flexibility and increase the RE integration at South Central region. The Phuoc Hoa pump hydro storage at 1.2 GW is also included in the PDP8 for the 2021-2030 period. Increasing investment and ownership of storage capacity helps SoEs strengthen their role in ensuring electricity supply security in the short and medium term.

Transmission adequacy assessment

The assessment of KB_DD scenario has slight differences from the KB_AR scenario, with the capacity of coal power plants less than 2.14 GW and higher capacity of 3.56 GW of solar power. The grid impact of the KB_DD scenario is higher as it might lead to high power flows from the Center to the North to compensate for the lack of generation due to the decrease in coal generation. Therefore, the KB_DD scenario is used to address the transmission adequacy.

The generation adequacy assessment shows that it requires to install 3 GW of storage capacity by 2025 and 6-7 GW in 2030 to ensure the LOLP/LOLE at a value equal or below 24h. The allocation of ESS capacity will be divided into several small bloc of 500 MW per each, bringing some of the following benefits:

- The ESS allocation has been decided to address the grid congestion on the intra-regional connection, especially through the interfaces North to the North Central and North Central to the Central Central.
- Within each region, the ESS allocation has been placed where the CFPPs are being reduced their generation in order to take advantage of the available land use.
- Based on the power flows calculation of the without ESS scenario, the ESS allocation will be selected at the end point of the worst overloaded lines.
- Prioritized for the regions having a highest penetration of RE (preferably at the largest renewable units).

The ESS allocations are proposed beyond the planned capacity of PDP8 as followings:

Table 12. ESS allocation

ESS	Location	Note
ESS_2030_1	Lai Châu	Near to the new built 500 kV
ESS_2030_2	Vĩnh Yên	Near to the new built 500 kV
ESS_2030_3	Hải Phòng	Near to the CFPP Hải Phòng 1, benefiting the existing infrastructure
ESS_2030_4	Quảng Ninh	Near to the CFPP Hải Phòng 1 and 2, benefiting the existing infrastructure
ESS_2030_5	Quảng Trị	Near to the high density of RE
ESS_2030_6	Quảng Nam	Near to the high density of RE
ESS_2030_7	Gia Lai	Near to the high density of RE
ESS_2030_8	Kon Tum	Near to the high density of RE
ESS_2030_9	Đắk Nông	Near to the high density of RE

Based on the above assessment, the ESS allocated for different regions until 2030 will be: 3 GW in the North, 1.5 GW in the North Central and 1.5 GW in the Highland region. This capacity of ESS is equivalent to the current BESS capacity in Germany (3.9 GW in 2022)⁶⁶. With a suitable incentive support mechanisms and transparent regulatory framework, this ambitious storage could be potentially feasible to increase the flexibility of the Vietnamese power system.

The generation adequacy assessment for different snapshots is presented below. More details could be found in the Annex 1.

March 2030 (dry season)

These results describe the operation of the power system during the dry season of the year. Hydropower plants are limited in terms of generation capacity and are mainly used to cover peak loads. Meanwhile, thermal power plants (coal-fired, gas, LNG) are used to provide electricity for a certain part of the demand, and the remaining sources are mobilized depending on the fluctuation of RE sources, such as wind and solar power. A high operation of BESS is required throughout the country, especially at the peak load demand at noon and in the evening.

The high loading occurs at the extreme snapshot (14h) at the weekend, as there is a significant shortage to supply the local demand in the North region. This shortage requires compensation by the generation from the North Central and Highland through the North–North Central interface, resulting in overloading on this interface (100,5%). At 14:00 and 19:00, there are several transmission lines, and substations carry high loading, including:

- 220 kV transmission lines: Vung Ang 3 – Formosa (142%), Ba Queo – Dam Sen (141,5%), Gia Vien – Nho Quan (135,1%), Hoa Binh – Xuan Mai (120,5%), Thanh Xuan – Tay Ha Noi (118,3%), Phu Lam – Dam Sen (108,9%), Sa Dec – O Mon (104,8%), Nam Sum – Nong Cong (90,7%).

⁶⁶ <https://www.statista.com/statistics/1330754/battery-installed-capacity-europe-by-country/>

- Transformer stations: Tan Yen 220 kV (110%), Pho Noi 220 kV (99,6%), Ba Thien, Vung Ang (90,6%), Tay Ho (89,6%).

July 2030 (water season)

In the water season, no high loading occurs on the inter-regional interface because hydropower sources in the North region can generate power at high levels in the peak load period to supply the local demand. In addition, 3 GW ESS installed in this region also ensures the electricity supply. At 14:00 and 19:00, there are several transmission lines, and substations carry high loading (mainly concentrated in the North region due to having to receive a large amount of capacity from ESS), including:

- 220 kV transmission lines: Vung Ang 3 – Formosa (118,9%), Gia Vien – Nho Quan (105,1%), Hoa Binh – Xuan Mai (100,5%), Thanh Xuan – Tay Ha Noi (98,3%), Nam Sum – Nong Cong (90,7%), Phuoc Thuan – Tan Thanh (105,9%), Lao Bao – Huong Linh (104,7%), Ha Giang – Bac Me (84%).
- Transformer stations: Tan Yen 220 kV (102%), Pho Noi 220 kV (92,6%), Ba Thien, Vung Ang (90,6%), Tay Ho (89,6%), Nho Quan 500 kV (89,5%), Pho Noi 500 kV (82,9%).

December 2030 (water accumulating season)

This scenario describes the process of operating the power system during the water storage season of the year. During this season, hydropower plants operate at a limited capacity to store water for the upcoming dry season and to support irrigation. The simulation results shown in the following figures show that the capacity from hydropower plants is only highly mobilized at peak load times in the afternoon and evening. At other times, hydropower plants only generate about 40% of their rated capacity to supply a part of the demand and to support the frequency regulation. At times of power shortage (e.g. due to a decrease in RE sources at 19:00), BESS and pump hydro storages must also be mobilized to meet the load demand, although this will increase the total operating costs.

The inter-regional transmission in this season is not significant, as each region can fulfil their demand by local generations. However, it should be noted that the supply from BESS cannot be extended for a long period due to both the operation characteristics and the high operating cost. Therefore, it is necessary to find other solutions to supply the shortage of demand, especially during peak load at noon and in the evening.

Price sensitivity analysis

A sensitivity analysis is performed to evaluate the operation of ESS under the change of the willing to pay price, varying from 45 \$/MWh to 65 \$/MWh. As can be seen from the comparison (Table 13), the price ranges from 55 - 60 \$/MWh would give a balance for the uptime and generated energy from ESS and the revenue gained. Having lower willing-to-pay prices implies higher up time and more generated energy but leading to a challenge for the investor to cover the investment cost. With the price higher than 60 \$/MWh, ESS will need to compete with other generation technologies unless there is a specific regulatory framework to ensure the annual generated energy and up time of ESS.

Table 13. Sensitivity analysis of ESS operation

Price	Generated energy (MWh)	Consumed energy (MWh)	Up time (hours/month)
45 \$/MWh	13.882	10.282	79
50 \$/MWh	10.995	7.398	63
55 \$/MWh	4.624	1.024	23
60 \$/MWh	4.100	500	16
65 \$/MWh	4.910	1.309	29

The Unit Commitment and Dispatch Optimization is run for September of 2030, equivalent to 720-time steps, and the results are presented below.

Table 14. Sensitivity analysis of ESS operation

ESS units	Generated energy (MWh)	Consumed energy (MWh)	Total up time (hours)	Total down time (hours)
45 \$/MWh				
ESS_500MVA_2030_1	1502,52	1102,52	7	713
ESS_500MVA_2030_2	1502,52	1102,52	7	713
ESS_500MVA_2030_3	1200	800	6	714
ESS_500MVA_2030_4	1200	800	6	714
ESS_500MVA_2030_5	1600	1200	8	712
ESS_500MVA_2030_6	1600	1200	9	711
ESS_500MVA_2030_7	1690,159	1290,159	12	708
ESS_500MVA_2030_8	1600	1200	9	711
ESS_500MVA_2030_9	1986,717	1586,717	15	705
Total	13881,916	10281,916	79	
50 \$/MWh				
ESS_500MVA_2030_1	1200	800	6	714
ESS_500MVA_2030_2	900	500	4	716
ESS_500MVA_2030_3	614,5877	214,5877	3	717
ESS_500MVA_2030_4	900	500	3	717
ESS_500MVA_2030_5	1600	1200	9	711
ESS_500MVA_2030_6	1700	1300	9	711
ESS_500MVA_2030_7	1300	900	8	712
ESS_500MVA_2030_8	1331,387	931,3874	9	711
ESS_500MVA_2030_9	1451,509	1051,509	12	708
Total	10997,4837	7397,4841	63	
55 \$/MWh				
ESS_500MVA_2030_1	400	0	1	719
ESS_500MVA_2030_2	400	0	1	719
ESS_500MVA_2030_3	400	0	1	719
ESS_500MVA_2030_4	400	0	2	718

ESS units	Generated energy (MWh)	Consumed energy (MWh)	Total up time (hours)	Total down time (hours)
ESS_500MVA_2030_5	400	0	1	719
ESS_500MVA_2030_6	400	0	1	719
ESS_500MVA_2030_7	900	500	6	714
ESS_500MVA_2030_8	424,4235	24,42345	4	716
ESS_500MVA_2030_9	900	500	6	714
Total	4624,4235	1024,42345	23	
60 \$/MWh				
ESS_500MVA_2030_1	400	0	1	719
ESS_500MVA_2030_2	400	0	1	719
ESS_500MVA_2030_3	400	0	2	718
ESS_500MVA_2030_4	400	0	1	719
ESS_500MVA_2030_5	400	0	1	719
ESS_500MVA_2030_6	400	0	4	716
ESS_500MVA_2030_7	400	0	1	719
ESS_500MVA_2030_8	900	500	4	716
ESS_500MVA_2030_9	400	0	1	719
Total	4100	500	16	
65 \$/MWh				
ESS_500MVA_2030_1	400	0	1	719
ESS_500MVA_2030_2	400	0	3	717
ESS_500MVA_2030_3	400	0	1	719
ESS_500MVA_2030_4	400	0	2	718
ESS_500MVA_2030_5	400	0	3	717
ESS_500MVA_2030_6	400	0	3	717
ESS_500MVA_2030_7	1109,663	709,6629	6	714
ESS_500MVA_2030_8	900	500	7	713
ESS_500MVA_2030_9	500	100	3	717
Total	4909,663	1309,6629	29	

5.2. Financial findings

The data used in this report is sourced from the consolidated financial statements of three SOEs. PVN and Vinacomin's data are from the 2021 consolidated financial statements, whereas EVN's data is based on the 2020 consolidated financial statements since the 2021 statements have not been published yet. When referring to EVN's data for 2021 in this section, it indicates that the data from 2020 is being used as a reference.

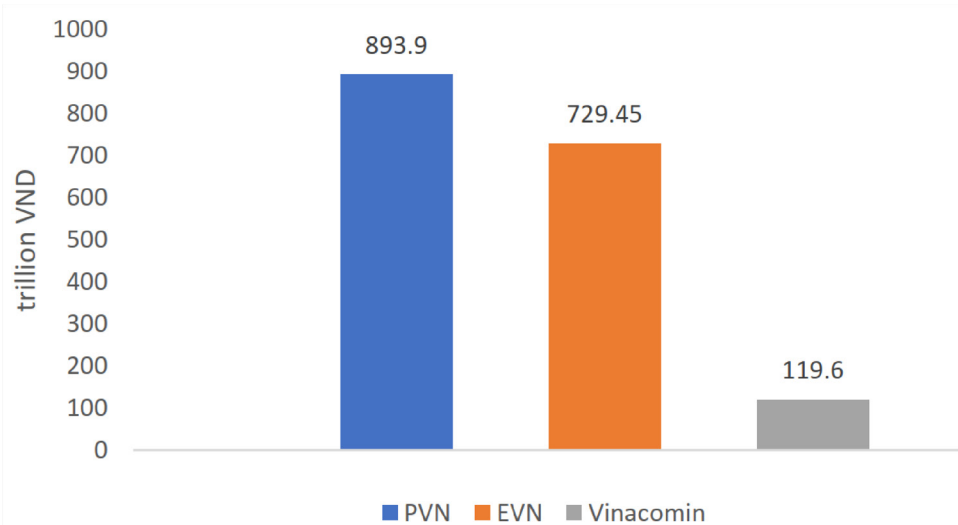
5.2.1. Financial conditions of EVN, Vinacomin and PVN

As of the end of 2021, the combined total assets of the three groups reached VND 1,744 trillion (approximately USD 74.8 billion), constituting for 47.67% of the total assets of the state-owned enterprise sector.⁶⁷

⁶⁷ According to the Government's report to the National Assembly on the investment, management and use of state capital in enterprises, the total assets of State-owned enterprises (SOEs) in 2021 is nearly 3,650 trillion VND.

ASSETS OF EVN, VINACOMIN AND PVN AS OF DECEMBER 31, 2021

FIGURE 30



Source: Auditors' reports, reports on production and business activities, and published reports of corporations.



By the end of 2021, the equity of EVN, TKV, and PVN stood at VND 240.2 trillion, VND 44.8 trillion, and VND 486.3 trillion, respectively. The combined equity of the three groups amounted to VND 771.35 trillion (equivalent to USD 32.9 billion). This total equity represents 43% of the total equity of the SOE sector⁶⁸.

In terms of equity to total capital ratio, PVN had the highest ratio at 54%, followed by EVN (37%) and TKV (33%). PVN, thus, has a more robust position in terms of owner capital (equity) as compared with EVN and Vinacomin.

The total debts of EVN in 2021 were VND 489 trillion, while the figure for Vinacomin was VND 74.8 trillion, and PVN was VND 408 trillion. Although having the lowest debt in absolute value, EVN's debt-to-total liability plus equity ratio was the highest at 67%, indicating that EVN utilized financial leverage at a higher level. In comparison, Vinacomin had a lower ratio of 63%, while PVN's ratio was even lower at 46%. Among the three corporations, PVN has the lowest debt ratio, with a ratio only 0.84 times its equity. In contrast, EVN's debt was 2.04 times more than its equity.

⁶⁸ According to the Government's report to the National Assembly reporting on investment, management and use of state capital in enterprises nationwide in 2021, the total assets of 826 SOEs (673 state-owned enterprises and 153 state-owned enterprises). Enterprises with shares and contributed capital by the State is VND 3.74 million billion, up 2% compared to 2020. Owner's equity is VND 1.79 million billion, up 3% compared to 2020. Total capital which is invested by the State in 826 enterprises is VND 1.67 million billion, up 3% compared to 2020 (VND 1.5 million billion in enterprises in which State hold 100% of charter capital, and the rest VND 162,806 billion VND in enterprises which are partly owned by the State).

**Table 15: Total liabilities and equity, debts of EVN, TKV, and PVN
(as of December 31, 2021)**

Items	Unit	EVN	Vinacomin	PVN
Total liabilities and equity, in which:	Trillion VND	729.45	119.6	893.9
<i>Debts</i>	<i>Trillion VND</i>	489.3	74.8	407.6
<i>Equity</i>	<i>Trillion VND</i>	240.2	44.8	486.3
Debts/total liabilities and equity	%	67%	63%	46%
Equity/ total liabilities and equity	%	33%	37%	54%
Debts/Equity (D/E)	time	2.04	1.67	0.84

Source: Auditors' reports, reports on production and business activities, and published reports of corporations.

Moving on to the revenue figures for 2021, EVN recorded a total revenue of VND 409.1 trillion, Vinacomin reached VND 114.4 trillion, and PVN earned VND 382 trillion (Table 16). The combined revenue of the three groups amounted VND 847.4 trillion, accounting for 40% of the total revenue generated by all SOEs in 2021⁶⁹.

Table 16: Revenue of EVN, Vinacomin, and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN
Total revenue, of which:	Trillion VND	409.1	114.4	382
Revenue from electricity sales, in which:	Trillion VND	351.3	13.1	22.1
<i>Revenue from sale of coal power</i>	<i>Trillion VND</i>	<i>88.79</i>	<i>11.8</i>	<i>8.7</i>
Proportion of revenue from electricity sales to total revenue	%	85.8%	11.4%	5.8%
Proportion of revenue from coal-fired power to total revenue	%	25.3%	10.3%	2.3%

Source: Auditors' reports, reports on production and business activities, and published reports of corporations.

Among the three groups, EVN's total revenue in 2021 was significantly driven by revenue from electricity production, transmission, and trading, accounting for approximately 86%. On the other hand, for Vinacomin, revenue from electricity sales accounted for 11.4% of their total revenue, and for PVN, it was at 5.8%. However, if we consider coal power separately, revenue from coal power contributed to 10.3% of Vinacomin's total revenue and 2.3% of PVN's total revenue. Based on the ratio of coal power production to the total commercial power output of EVN, it is estimated that revenue from coal power constituted about 25.3% of EVN's total electricity sales. These figures show that EVN and Vinacomin rely more on CFPPs to generate revenue. Energy transition initiatives and policies for CFPPs are likely to affect the total revenue of EVN and Vinacomin more than PVN.

⁶⁹ According to the Government's report submitted to the National Assembly, the report on investment, management and use of state capital in enterprises nationwide in 2021, total revenue of SOEs reached 2.12 million billion VND, 8% higher as compared to 2020.

Table 17: Costs of EVN, Vinacomin, and PVN (until December 31, 2021)

Items	Unit	EVN*	TKV	PVN
Total cost, of which:	Trillion VND	385.6	109.1	331.3
<i>Interest expenses</i>	<i>Trillion VND</i>	<i>23.0</i>	<i>2.6</i>	<i>1.5</i>
Proportion of interest expenses to total expenses.	%	6%	2.4%	0.5%

Source: Auditors' reports, reports on production and business activities, and published reports of corporations.

** Financial expenses in the case of EVN.*

Due to its level of indebtedness, TKV's interest expenses amounted to VND 2.6 trillion, accounting for 2.4% of total expenses (Table 17). In the auditors' report, the breakdown of EVN's interest expenses was not provided separately. However, its total financial expenses amounted to VND 23 trillion, representing 6% of EVN's total cost of VND 385.6 trillion. PVN has the lowest interest expense, totaling VND 1.5 trillion, accounting for merely 0.5% of total expenses of VND 331.3 trillion of this group.

Table 18: Production of EVN, Vinacomin and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN ⁷⁰
Total cost, of which:	Trillion VND	385.6	109.1	331.3
<i>Interest expenses</i>	<i>Trillion VND</i>	<i>23.0</i>	<i>2.6</i>	<i>1.5</i>
Proportion of interest expenses to total expenses.	%	6%	2.4%	0.5%

Source: Auditors' reports, reports on production and business activities, and published reports of corporations.

The proportion of electricity generated from coal power in TKV's total electricity production was 84.1%, while for EVN, it was 25.7%, and PVN was 37.7%. Therefore, solely considering electricity production, the impact of transitioning away from coal power generation on total electricity output and power activities will be more significant for Vinacomin and EVN. In other words, efforts to transition away from coal-fired power plants CFPPs will make a more stressful and faster impact to Vinacomin and PVN.

However, when evaluating the absolute numbers, the effort to shift away from coal power generation will be more challenging for EVN because its coal power output is 60,082 million kWh, which is considerably higher than the cases of Vinacomin and PVN.

Business performance and profitability

In 2021, all three groups, EVN, Vinacomin, and PVN, recorded profits of VND 15.3 trillion, VND 5.3 trillion, and VND 51.7 trillion, before tax, respectively.

⁷⁰ In 2021, the power plants directly under PVN have not been put into operation and therefore do not generate output. Therefore, the group's electricity output mainly comes from PVPower. In PVPower, Vung Ang is the only CFPP of the Corporation that has been put into operation and generated output.

Table 19: Efficiency of production and business activities of EVN, Vinacomin, and PVN (as of December 31, 2021)

Items	Unit	EVN	Vinacomin	PVN
Profit before tax	Trillion VND	15.3	5.3	51.7
Profit after tax	Trillion VND	14.5	4.4	39.3
Return on Equity (ROE)	%	6.0%	9.7%	8.1%
Return on Assets (ROA)	%	2.0%	3.7%	4.4%

Source: Auditors' reports, reports on production and business activities, and published reports of corporations.

In terms of profitability, Vinacomin boasted a higher return on equity (ROE) of 9.7%, compared to EVN's 8.1% and PVN's 6%. Similarly, when calculated on total assets, PVN achieved the highest return on total assets (ROA) at 4.4%, surpassing 3.7% of Vinacomin and 2% of EVN.

However, the profit of EVN has become negative in 2022. EVN faced a significant downturn as it reported a loss of VND 29 trillion (equivalent to USD 1.2 billion). If the current electricity power tariff remains unchanged, this loss is projected to double to reach VND 64.9 trillion (USD 2.7 billion) in 2023⁷¹. On the other hand, Vinacomin's profit nearly tripled to VND 8.1 trillion in 2022⁷², while PVN doubled its profit to VND 82 trillion⁷³. The sharp increase in profit of the two SOEs is largely attributed to the rise in commodity prices in international markets. This highlights the high volatility of the profitability of these three SOEs and their vulnerability to international market conditions.

As of 2021, EVN employed a total of 97,250 individuals, while Vinacomin and PVN employed 94,000 and 60,000 individuals, respectively. The total combined workforce of the three corporations was 251,250, accounting for 22.69% of the total number of employees in all corporations⁷⁴.

Notably, the number of employees at CFPPs was relatively low compared to the total number of employees at these two corporations, with 1,619 individuals at Vinacomin and 450 individuals at PVN. Although the exact number for EVN is unavailable, it is presumed to be higher due to the larger number of CFPPs owned by this SOE and the higher coal power output generated by EVN in its overall electricity generation.

5.2.1. Financial implications of the scenarios to EVN, TKV and PVN

The immediate financial implications of transition scenarios for EVN, Vinacomin and PVN can be measured in terms of decline in sales and employment resulting from the phasing down and phasing out of CFPPs.

⁷¹ <https://moit.gov.vn/tin-tuc/bao-chi-voi-nguoi-dan/evn-lo-tai-chinh-u-am-lo-lich-su-trong-nam-2023.html>

⁷² <https://www.vinacomin.vn/tin-tuc/Vinacomin-cung-nhung-cong-trinh-phuc-loi-vi-cong-dong-202302061112081208.htm>

⁷³ <https://vov.vn/chinh-tri/thu-tuong-mong-pvn-thi-dua-lap-ky-luc-moi-trong-nam-2023-post995654.vov>

⁷⁴ According to the Government's report to the National Assembly reporting on investment, management and use of state capital in enterprises nationwide, in 2021 the whole country counts 826 SOEs, of which 673 are wholly owned by the State and 153 enterprises with shares and capital contributed by the State. According to the General Statistics Office, the total number of employees at SOEs in 2021 is 1.1 million.

Decrease in sale⁷⁵

The early retirement of CFPPs will lead to a decrease in coal-fired power production for the three SOEs. Among the transition scenarios, the KB_DD scenario will have the earliest and most significant impact on the production and thus revenue of the three SOEs. Under this scenario, the total revenue of the three SOEs between 2022 and 2025 will decrease VND 72.4 trillion (USD 3.0 billion) and then VND 744.1 trillion (USD 31.0 billion) between 2046 and 2050. On the other hand, KB_AR scenario will result in a less drastic initial decline in annual revenue.

For instance, the revenue of the three SOEs is estimated to decrease by only VND 38.7 trillion (USD 1.6 billion) between 2022 and 2025 and VND 136.5 trillion (USD 5.7 billion) between 2026 and 2030. Then, between 2046 and 2050, the total revenue of SOEs would dramatically drop by VND 689.2 trillion (USD 28.7 billion).

Table 20: Combined decrease in revenue as result of the phase out/ phase down scenarios of EVN, TKV and PVN (trillion VND)

	2022- 2025	2026- 2030	2031- 2035	2036- 2040	2041- 2045	2046- 2050	2022- 2050
KB_DD	72.4	270.4	460.8	623.1	709.8	744.1	2,880.7
KB_AR	38.7	136.5	230.5	394.9	580.8	689.2	2,070.6

Source: VIETSE, *Economica Vietnam*, *NHQuang& Associates*, and *Carbon Trust (2023)*

Among the three SOEs, EVN will suffer the most substantial decline due to its high level of coal-fired power production. Under the KB_DD scenario, EVN is projected to incur a revenue loss of VND 54.3 trillion (USD 2.3 billion) between 2022 and 2025 and a more substantial decrease of VND 510.4 trillion (USD 21.3 billion) between 2046 and 2050. The rate of decrease is slower in the KB_AR scenario, but it will eventually reach the same level as KB_DD between 2046 and 2050.

Vinacomin will witness a fall of VND 12.8 trillion (USD 0.5 billion) between 2022 and 2025 in the KB_DD scenario. However, if the KB_AR scenario is implemented, TKV can postpone the rate of revenue decline until 2040 when the revenue decrease for this corporation will be equivalent under both the KB_DD and KB_AR scenarios.

PVN follows a different revenue decline pattern in these scenarios. In all cases, PVN seems to be able to delay the decrease in revenue from coal-fired power until after 2022-2025. Between 2022-2025, the revenue of PVN only decreases VND 1.8 trillion (USD 0.1 billion) and VND 5.4 trillion (USD 0.2 billion) under KB_AR and KB_DD scenario, respectively. The relatively low revenue decline for PVN in the earlier years in both scenarios can be attributed to the fact that most of its CFPPs are equipped with new and modern equipment and facilities. However, starting from 2036, PVN is projected to experience a significant drop in revenue.

⁷⁵ The study computes the revenue decreases of the three SOEs using the formula: total revenue drop = coal power price x coal power output decline. The reduced coal power output is the coal power output computed for each scenario, and the coal power price is the median of the average coal power selling price acquired by the research team when surveying coal power plants owned by three SOEs.

Reduction in employment

The transition plans will have an impact on employment of the three SOEs. Following the decarbonization pathways, the three SOEs will need to reduce their workforce. If the KB_DD scenario is implemented, it is estimated that the three SOEs will have to lay off a total of 29 thousand workers until 2050. The total number of workers who will be made redundant as direct consequence of the phase out and phase down of CFPPs under the transition plan is 27,3 thousand people in KB_AR scenario and 29 thousand in the KB_DD scenario between 2022 and 2050.

Table 21: Job lost under the KB_AR and KB_DD scenarios

	2022-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050
KB_AR						
EVN	1,630	1,630	3,389	11,862	17,954	19,670
Vinacomin	-	157	1,609	2,281	2,324	2,481
PVN	-	-	-	1,716	3,432	5,148
Total	1,630	1,788	4,998	15,859	23,709	27,299
KB_DD						
EVN	1,630	3,389	11,862	17,954	19,670	19,670
Vinacomin	157	1,609	2,281	2,324	2,481	2,481
PVN	-	-	1,716	3,432	5,148	6,864
Total	1,788	4,998	15,859	23,709	27,299	29,015

Source: VIETSE, *Economica Vietnam*, NHQuang& Associates, and Carbon Trust (2023)

In both scenarios, EVN will be most affected by this problem, as approximately 19,7 thousand jobs are projected to be lost by 2050. The number of jobs lost in the case of Vinacomin and PVN are less than EVN and Vinacomin must be faced the issue earlier than PVN.

5.2.2. Implications of the three SOEs' financial conditions and the ability to mobilize fund to finance the transition

Increase in debt and borrowing is needed to finance the transition

Both scenarios will have significant and immediate impacts on the total revenue of the three SOEs. It is estimated that from now to 2050, the three SOEs will have to forgo a total revenue of VND 2,070.6 trillion (USD 86.3 billion) in the KB_AR scenario and VND 2,880.7 trillion (USD 120 billion) in the KB_DD scenario. The fall in sales resulting from these scenarios will have a negative impact on the liquidity, solvency and profitability of the three SOEs. Additionally, the three SOEs will need to address the fact that about 27.3 thousand and 29 thousand workers will be laid off respectively in the KB_AR and KB_DD scenarios.

Therefore, it is crucial that whichever scenario, the KB_AR or KB_DD is adopted, measures must be taken to absorb the financial losses they will suffer. Such financial measures could include providing cashflow incentives to the three SOE in proportion to the reduction in coal-fired production and revenue of the three SOEs or providing financing for the three SOEs to invest in green energy capacity to substitute the production and the revenue lost from the phasing down and phasing out of their CFPPs under the selected scenario.

The financing needed to implement the transition under either the KB_AR or KB_DD scenario will be sourced from either the equity or the loans of the three SOEs. However, due to the low Return on Equity (ROE) of EVN, Vinacomin and PVN, which stood at only 6.0%, 9.7%, 8.1% respectively in 2021, and considering the significant financial loss of USD 1.2 billion by EVN in 2022 and the high volatility in profitability of Vinacomin and PVN, the possibility of using retained earnings to increase equity of the three SOEs is limited. Moreover, the three SOEs are all fully owned by the State, it is unlikely that they can launch IPO to raise additional capital to increase their equity to finance their investment projects, including those related to RE projects.

Hence, the more feasible approach for the three SOEs to secure financing for transitioning from coal-fired power to renewable energy is through borrowing and debts arrangements. The debts take various forms, such as bank loans, bond issuances, borrowing from donors, State credit, borrowing with Government guarantees.

Borrowing and debt ceiling of the three SOEs

However, there is a ceiling to how much the three SOEs and borrow further. According to current prevailing regulations⁷⁶, the debt-to-equity ratio at SOEs cannot exceed 3 times.

Table 22: Room for more debt and borrowing of the three SOEs as of 2021

Items	Unit	EVN	Vinacomin	PVN	Total
Debts	Trillion VND	489.3	74.8	407.6	971.6
Equity	Trillion VND	240.2	44.8	486.3	771.3
Debt/Equity (D/E)	time	2.0	1.7	0.8	N/A
Debt ceiling*	Trillion VND	720.6	134.4	1,459.0	2,314.0
Room for more debt or borrowing	Trillion VND	231.3	59.6	1,051.4	1,342.4

Source: VIETSE, *Economica Vietnam*, NHQuang& Associates, and Carbon Trust (2023)

* According to prevailing regulations, the D/E of the three SOEs cannot exceed 3

As such given the current level of equity of the three SOEs, the maximum amount of debt that EVN can borrow further is VND 231.3 trillion (USD 9.66 billion). The figures are respectively VND 59.6 trillion (USD 2.48 billion) in the case of Vinacomin and VND 1,051.4 trillion (43.81 billion) in the case of PVN. Unless there is an increase in the equity of the three SOEs, the total combined amount that the three SOEs can borrow is VND 1,342.4 trillion (USD 55.9 billion) given its current equity by end of 2022.

Apart from other factors as the profitability of each individual investment project, any transition scenario should take this ceiling into account to ensure financial feasibility of the scenario. The transition scenario need to be in line with the capacity of EVN, Vinacomin and PVN to handle the decline in revenue and consequent profits, as well as their ability to secure capital for meeting investment needs given its current indebtedness. This entails a thorough assessment of existing debts, the ability to repay the new debts, the overall financial prudential indicators, and the prevailing debt ceiling that applies to the three SOEs.

⁷⁶ Decree No. 09/2009/ND-CP dated February 5, 2009 of the Government promulgating the Regulation on financial management of state-owned companies and management of state capital invested in other enterprises and Circular 242/2009 /TT-BTC Guiding the implementation of a number of articles of the Regulation on financial management of state companies and management of state capital invested in enterprises.

Capacity of SOEs for financial leverage to finance the transition of CFPP towards renewable energy

Among the three SoEs, PVN boasts the strongest financial conditions. PVN possesses the largest amount of assets and outperforms EVN and Vinacomin in terms of financial ratio such as liquidity, debt-to-equity, ROA or contribution to the State Budget. In terms of productivity, and PVN employee also produce much higher average-per-employee revenue and profit than EVN and Vinacomin.

In terms of debt to equity (D/E), the maximum applicable D/E ratio for all three SOEs is 3. From this perspective, PVN has the largest room to increase its debt for investing in or supporting initiatives and projects for energy transition, especially for CFPPs of the group and its subsidiaries. As of 2021, PVN's debt-to-equity ratio is 0.84 while EVN and Vinacomin's ratio are respectively 2.04 and 1.67. In terms of D/E, EVN has less capacity to borrow more capital to finance its energy transition projects compared to Vinacomin and EVN.

As for total debt to total equity and liabilities, EVN and Vinacomin has less room to borrow more for energy transition projects due to their higher financial leverage. Total debt of EVN and Vinacomin are respectively 67% and 63% of total assets.

Due to its level of debt, Vinacomin's interest expense amounts to VND 2.6 trillion, accounting for 2.4% of total expenses. In the auditors' report, EVN's interest expense was not explicitly disaggregated out of the total of VND 23 trillion financial expenses. However, the total financial expenses of EVN accounted for 6% of VND 385.6 trillion of EVN's total cost. This implies that EVN faces greater pressure to servicing further debts and borrowing compared to TKV and PVN. PVN has the lowest interest expense of VND 1.5 trillion, accounting for only 0.5% of its total expenses of VND 331.3 trillion of this group. The proportion of interest expense in the total cost of Vinacomin and EVN creates obstacles for those corporations, forcing these corporations to weigh in carefully in their decisions to borrow more capital, especially from sources with high-interest rates and less favorable conditions for energy transition projects and initiatives for CFPPs within the group.

Considering these financial indicators, all the three SOEs can borrow more to finance energy transition projects as long as the projects are financially viable and adhere to the overall debt ceiling and Prudential Financial indicators of the three SOEs. However, PVN is in a better financial position compared with EVN and Vinacomin and has a greater capability to borrow more for financing energy transition projects. Vinacomin ranks second in this regard, followed by EVN.

5.3. Legal findings

Legal basis and policy in the energy sector

The State of Vietnam aligns the national energy development strategy with the prevailing socio-economic development goals. At present, several policies have been promulgated, which are as follows:

Resolution No. 55-NQ/TW of the Politburo orienting Vietnam's national energy development strategy to 2030, with a vision to 2045 (Resolution No. 55-NQ/TW) dated 11/02/2020. Following such resolution, the Government issued **Resolution 140/NQ-CP** dated October 2, 2020, on the Government's action program to implement Resolution No. 55-NQ/TW⁷⁷.

Decision No. 888/QD-TTg of the Prime Minister approving the project on tasks and solutions to implement the results of the 26th conference of the Parties to the United Nations Framework Convention on Climate Change dated 25/07/2022, **Decision No. 896/QD-TTg** of the Prime Minister approving the National Strategy on Climate Change for the period up to 2050, which stipulates the target to reduce GHG emissions according to net zero emissions target (**NZE target**) by 2050, in line with the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (**COP26**) on 26/07/2022. This is the fundamental legal basis for the SOEs and CFPP owner enterprises to reduce coal power generation and invest in developing renewable energy and energy storage to achieve the NZE target.

On the basis of legal documents, industry strategies and the enterprises (refer to in the Annex) and information collected during the survey and research process, the results of the legal assessment are summarized as follows:

5.3.1. Reduction of coal power generation

When phasing down or phasing out a CFPP, the SOEs and CFPP owner enterprises should assess 06 main prominent legal matters: **(a)** the ownership matter which is related to decision-making authority in the scenarios; **(b)** issues related to input contracts (mainly coal supply contract), output contracts (mainly power purchase agreement), and **(c)** loan contracts/capital arrangement contracts; **(d)** labor and employment issues; **(e)** property settlement issues; **(f)** industrial safety (*focusing on regulatory requirements for plant dismantling*) and environmental remediation. Each of the above legal issues can be assessed at three risk levels: high risk, moderate risk or low risk, depending on the content of each scenario. The level of risk is analyzed based on the possibility of disputes arising, especially disputes between investors, employees, the social community and CFPP owner enterprises, or state agencies (*refer to the risk assessment in each scenario of each legal matter in Annex 1 of this report*).

⁷⁷ Resolution 140/NQ-CP stipulates:

- i. Develop coal-fired thermal power at reasonable level towards giving priority to machine units with large capacity, high performance, modern, advanced technologies such as ultra-supercritical technology; ensure to fully follow law on ecological environment safety, environmental protection.
- ii. Develop mechanisms for plants, plant clusters which use hybrid technologies to make use of different energy sources in combination with renewable energy such as: solar power, wind power, hydropower, coal-fired thermal power, biomass, biogas; and
- iii. Develop incentive mechanisms, policies for investment and purchase of energy storage equipment/technologies in areas which have potentiality for solar power but are limited to the distribution grid, with the aim to promote capacity of the system, achieve savings of investment resource and ensure security of the power system.

a. Ownership: EVN has low legal risk when deciding to phase out/phase down CFPPs of Model 1 and Model 2 in all scenarios. Notably, EVN has no CFPP of Model 4. With EVN's CFPPs under Model 3, the legal implications are analyzed on a case-by-case basis due to varying State capital ownership ratios and operational durations. However, most CFPPs have low possibility of legal risk in all scenarios.

PVN also encounters low legal risk when deciding to phase out/phase down the CFPPs of Model 1 and Model 2 in all scenarios. PVN has no CFPP of Model 3 and 4.

VINACOMIN nearly has the full authority to make decisions on phasing out/phasing down CFPPs of Model 2 in all scenarios, resulting in a low possibility of legal risk. VINACOMIN has one CFPP of Model 4, therefore, the possibility that legal risks for phasing out/phasing down is high in KB_DD due to VINACOMIN' insufficient authority in this model.

The legal risk is low for KB_AR the

power to operate the CFPP is transferred from the CFPP foreign owner enterprises to VINACOMIN after 25 years⁷⁸. VINACOMIN has no CFPP of Model 1 and 3.

b. Commercial input and output contracts: When implementing the phase out/down of a CFPP, the SOEs and CFPP owner enterprises should consider **(i)** amending and **(ii)** terminating 02 main contracts which are Power Purchase Agreement (PPA) and coal supply contract.

• PPA: All PPAs have been executed in accordance with the standard form promulgated by the Ministry of Industry and Trade (MOIT) from time to time. When amending the PPA, the CFPP owner enterprises are required to obtain written agreement from the other party and be obliged to apply for approval, comments or report to the Electricity Regulatory Authority (ERAV). When early terminating the PPA, the parties must comply with the conditions and procedures in the PPA, in case a force majeure event leads to the contract termination, they must provide evidence of having taken appropriate measures to minimize the loss or impact caused by the event.

Model of state capital ownership of the CFPPs: According to the SOE's decisional impact on the CFPP owner enterprises, there are 04 models of the CFPPs to be grouped:

- Model #1 (CFPPs with 100% state capital): including CFPPs whose phase out/phase down are under the complete impact (100%) of the SOEs, either directly or through their subsidiaries/affiliates).
- Model #2 (CFPPs with 75% to less than 100% of state capital): including CFPPs with 75% to less than 100% State capital ratio majorly influencing the decision-making authority).
- Model #3 (CFPPs with 51% to less than 75% of state capital): including CFPPs with State capital from 51% to less than 75% significantly influencing the decision-making authority;
- Model #4 (CFPPs with less than 51% of state capital): including CFPPs with no SOEs' control over the decision on their phase out/phase down).

⁷⁸ <https://nld.com.vn/thoi-su-trong-nuoc/khoi-cong-xay-dung-nha-may-nhiet-dien-vinh-tan-1-20150718231129497.htm>

- ✦ Coal supply contract: According to review and interview with CFPPs, most coal supply contracts are framework contracts for raw material purchase, with additional agreements on the quantity of coal to be supplied in each specific period. When amending the contract, the CFPP owner enterprises should take note of (i) the obligation to notify the other party of the proposed amendment and (ii) the requirement to obtain written agreement from the other party (coal supplier) for the contract amendment, or (iii) consider the possibility of renegotiating the contract in the event of basic change of circumstances in Article 420 of the Civil Code. When terminating the contract, the CFPP owner enterprises need to (i) negotiate to agree to early terminate the contract with the coal supplier and (ii) evaluate other objective factors or factors in four cases of early termination of the contract⁷⁹.

The amendment or termination of the aforementioned contracts by the CFPP owner enterprises may entail legal risks, including conflicts of interest between the State and private investors as well as the possibility of breaching contractual obligations. Some CFPPs with high proportion of private ownership (such as Pha Lai 1 & 2, Vinh Tan 1, Ninh Binh) are at a higher high risk. Conversely, the remaining CFPPs have a lower risk because the CFPP owner enterprises have a majority state ownership rate which allows them to proactively decide on contract amendments or terminations. If implementing KB_AR scenario, most of the CFPP owner enterprises have a longer time to negotiate and complete the procedures for contract amendment and termination than the KB_DD scenario, which leads to low risks.

- c. Loan/capital arrangement: most of the long-term loans between CFPP owner enterprises and domestic and foreign commercial banks are paid off and terminated. There are some remaining short- and medium-term loans that will be paid off by 2024. Since the scenarios for SOEs are planned for the period of 2025 to 2050, it is likely that these short- and medium-term loans of CFPP owner enterprises shall have been fully paid off and may not require much attention from these enterprises. However, some CPFFs owner companies may encounter issues relating to the ECA Loans when considering phasing out a CFPP, and making prepayment of the loan if they have to implement the phase down/out scenario, which affects on the existing ECA Loans

When assessing risks of implementing the proposed scenarios for loans agreements/ capital arrangements of CFPPs, two circumstances exist for each scenario:

- ✦ Low-risk or no-risk circumstances for all scenarios when these short- and medium-term loans of CFPPs are likely to be paid off before or during the period (2025-2050), as planned for the SoEs.
- ✦ High risk in the scenarios for many CFPPs because these CFPPs still have the capital demands to operate, upgrade, and maintain their CPFFs to meet technical, safety, and environmental, and other requirements while lending policies for CFPPs are being tightened.

⁷⁹ Cases such as: termination due to force majeure event; decision of a competent state authority; dissolution, bankruptcy, cessation of operation of a Party under a decision of a competent state authority; or breach of contract

Given that long-term loans (i.e., ECA) typically have a term of about 10-12 years, scenarios with shorter durations may increase higher credit risk concerning the early termination of the loan contracts.

- d. Labor: If CFPPs intend to reduce their workforce, reducing power generation is not considered a valid reason for terminating labor contracts for economic reasons according to current regulations⁸⁰. The CFPP owner enterprises can choose to maintain the current number of employees or reduce it by either **(i)** terminating the contract with the employee at the end of the labor contract term⁸¹, **(ii)** reaching an agreement with the employee on early termination of the labor contract⁸², or **(iii)** unilaterally early terminating the labor contract with the employee when all measures have been exhausted, but they are still compelled to downsize the workforce due to production and business constraints at the request of state agencies⁸³.

In case of phasing out, CFPP owner enterprises could consider **(i)** terminating labor contracts based on the reasons of “changing the organizational structure” or “reorganizing labor”⁸⁴ or **(ii)** unilaterally terminating the labor contracts with employees early when all alternatives have been explored but they are still forced to reduce the workforce as a result of production and business downsizing at the request of the competent state agency⁸⁵.

In the suggested scenarios, CFPPs that will not phase down, or phase down gradually from now to 2025 will have low legal risks. The longer duration the scenario’s plan, the more time is given to CFPP owner enterprises to arrange capital sources and adequately prepare the human resources for gradual workforce reduction until the generation units are completely phased out. The KB_DD scenario is assessed to face considerable pressure in term of labor issues, as it includes several CFPPs of high and medium risk, which will be phased out in 2025, such as Ninh Binh, Pha Lai 1, Pha Lai 2, Na Duong 1; or which will be phased down by 60% in 2025 and phased out in 2030 such as Cam Pha, Cao Nga, Son Dong, Extended Uong Bi...

- e. Properties: Companies owning CFPPs exercise their rights and fulfill their obligations regarding their properties based on legislative principles, particularly in accordance with the Law on Management and Use of Public Property 2017, Law on Management and utilization of state capital invested in the enterprise’s manufacturing and business activities 2014 and their respective corporate charters, and internal regulations. To achieve the goal of NZE target in all scenarios, certain properties will need to be liquidated, such as those exclusively dedicated to old coal fired power generation technology, while others will require investments, construction and purchases.

⁸⁰ Labor Code, Article 42, Clause 2

⁸¹ Labor Code, Article 34, Clause 1

⁸² Labor Code, Article 34, Clause 3

⁸³ Labor Code, Article 36, Clause 1, point c

⁸⁴ Labor Code, Article 42, Clause 1, point a

⁸⁵ Labor Code, Article 36, Clause 1, point c

business areas and may be not permitted under regulations of the applicable laws. For PVN, The Resolution No. 41-NQ/TW on the strategy for developing Vietnam's oil and gas industry to 2025 and vision to 2035 has limited PVN's business operation to exclude the offshore wind power sector. Therefore, to transit from coal-fired sources to renewable energy sources, CFPP owner enterprises need to **(i)** address the foregoing issues and **(ii)** seek permission from the competent authorities to invest and do business in renewable energy.

- b. **Commercial input and output contract:** If the CFPPs decide to sell electricity generated from renewable energy, the new PPAs must be signed between the CFPP owner enterprises (electricity seller) and EVN. The Government needs to promulgate an electricity pricing regime for renewable energy. This matter should be addressed synchronously when the CFPP owner enterprises negotiate with EVN on contract amendments according to the approved phase down/out scenario.
- c. **Loan/Capital Arrangements:** In scenarios require where the CFPPs must be majority owned by SOEs' capital for the period of 2025-2050, the SOEs need to be allocated capital (possibly through loan agreements or state budget funding). Given the current tightening of loans for CFPPs, these loans could be included under Government's green credit policies to facilitate the transition from coal to renewable energy sources.
- d. **Labor:** CFPP owner enterprises have planning to build renewable energy plants and electricity storage facilities can transfer and utilize their current employees. Depending on the working conditions and location, this transfer and re-employment may require agreements with the employee and plans for skill retraining if necessary.
- e. **Properties:** The investment in renewable energy and energy storage will involve procurement, management, operation, maintenance of new assets for CFPPs in general and assets for SOEs in particular. For long-term investments in valuable equipment and machinery to generate electricity from renewable energy sources, the approval authority should be assessed and determined, as analyzed in the Ownership section. For properties related to land use rights of CFPPs, the SOEs and CFPP owner have to implement the legal procedures on land in line with the renewable energy, energy storage investment and on the areas utilized for coal power activities⁸⁷.
- f. **Industrial safety and environment:** When implementing projects of generating electricity from renewable energy sources and storing energy, the following issues should be considered:
 - Renewable energy projects must comply with regulations on environmental impact assessment (EIA), such as preparing the EIA reports⁸⁸.
 - Renewable energy projects must pay attention to solid waste and hazardous waste, especially solar power projects and electricity storage projects in accordance with the

⁸⁷ Legal procedures on land such as: changing the land use purpose to the purpose of generating electricity from renewable energy sources and storing energy, renewing the land use term in cases where the land area has expired use, unless the locality has a land use plan for other purposes

⁸⁸ Law on Environmental Protection 2020, Article 30; Decree No. 08/2022/NĐ-CP of the Government guiding the Law on Environmental Protection.

law⁸⁹. The disposed solar panels (photovoltaic panels) must be managed according to waste management regulations.

The current TCVN system still lacks the standards related to wind power plants (such as design requirements for wind turbines, methods for measuring and evaluating wind turbine performance, methods for controlling and monitoring wind power plants⁹⁰), especially the standards related to offshore wind power and electricity transmission from offshore to the onshore power system⁹¹. This shortage may create difficulties in procuring and installing equipment manufactured or procured from abroad, given the existing standards and regulations in the renewable energy sector.

5.4. International experiences for just energy transition

Key Findings and Policy Recommendations

Based on an international review of best practices related to coal transition, the following lessons and recommendations have been identified as relevant to Vietnam.

5.4.1. Investment in community resilience for coal-dependent regions is a key priority for policymakers to minimise the socio-economic risks of an energy transition.

Coal asset closures risk the jobs of those directly employed by coal assets, as well as those dependent on 'indirect' industries along the value chain. Rapid and poorly managed change poses a risk to the workers and communities whose livelihoods rely on coal assets and related industry, including those in coal mining, coal transport and steel manufacturing. In rural or isolated areas with high economic dependency on the coal industry, there may be limited alternative employment opportunities, and available jobs might be of lower pay or quality or require a different skillset. Programmes that prioritise asset-level transitions without due consideration to just transition factors will not only be more expensive but will limit the scale and success of the transition due to community backlash.

As such, the Vietnam Government should prioritise international climate finance towards alternative livelihoods planning prior to supporting asset-level transactions. Policy solutions that can be considered include developing redundancy benefits, early retirement packages, and unemployment insurance for workers. In addition, policies or programmes can support worker upskilling on alternative employment opportunities through training subsidies, relocation subsidies, job transfer schemes and by offering comprehensive social services to workers and families to facilitate the transition to re-employment opportunities.

⁸⁹ Decree No. 08/2022/ND-CP of the Government guiding the Law on Environmental Protection; Circular No. 18/2020/TT-BCT of the Ministry of Industry and Trade stipulating project development and sample power purchase agreement applicable to solar power projects, Article 8.

⁹⁰ General Department of Standards, Metrology and Quality; finalizing the TCVN system on wind power, promoting the development of green energy sources, Ministry of Environmental Science and Technology, 2022, <https://www.most.gov.vn/vn/tin-tuc/22425/hoan-thien-he-thong-tcvn-ve-dien-gio-thuc-day-phat-trien-nguon-nang-luong-xanh.aspx>.

⁹¹ Nguyen Anh Tuan, Vietnam develops offshore wind power: potentials, challenges and plans, Vietnam Energy Magazine, 2022, <https://nangluongvietnam.vn/viet-nam-phat-trien-dien-gio-ngoai-khoi-tiem-nang-thach-thuc-va-ke-hoach-hanh-dong-28858.html>

5.4.2. Policy solutions for coal reform and just transition planning can be most effective when coordinated by the government and includes the participation of inter-governmental ministries, non-governmental bodies including trade unions, NGOs, and private entities.

Prior to initiating plant level retirement or repurposing, it is recommended that the government introduces reforms affecting coal use. Policy solutions can cover land reclamation rights, economic revitalization, coal mine and plant closure procedures, social protection and labour transition programmes. Given the labour impacts of coal reform policies, it is necessary to coordinate across multiple affected stakeholders to ensure that there is sufficient buy-in and opportunities for inclusive dialogue in the development of these policies.

The Vietnam Government can consider introducing an Inter-Agency Commission or Steering Group to coordinate policy decision-making and inter-ministerial cooperation required to transition away from coal mining and coal power generation. The Inter-Agency Commission or Steering Group should be responsible for engaging with industry and communities beyond internal government bodies to ensure that they have the opportunity to feed into the design of the just transition planning approach in order to mitigate pushback against coal phase out.

5.4.3. The design of coal transition mechanisms should consider the long-term context of national policy and market factors, which can vary the opportunities and limitations of deploying different financial instruments.

It is important to note that the feasibility of coal transition mechanisms ultimately rest on their fit with national policy and market contexts. For instance, one common transition approach is to refinance the obligation to provide returns to coal asset owners and investors – this can be achieved by strategies such as ringfencing revenues, de-risking through portfolio effects and guarantees, or reducing tenor. To deploy financial mechanisms in other contexts, it is imperative that local market conditions are well-considered: securitisation, for instance, likely cannot be applied directly in countries where local bond markets are under-developed and overseas bond markets are inaccessible⁹².

It is recommended that the Vietnam Government account for the financial status of key stakeholders such as utilities and IPPs when determining the appropriate mechanism for accelerating the coal transition. While tools like refinancing can free up capital for the utility to invest in low-carbon solutions and a just transition, its feasibility is dependent on the extent to which the coal plant is already leveraged. A utility that is already significantly leveraged is unlikely to be able to take on more overall debt through refinancing, even if refinancing could reduce its long-term debt-service coverage ratio. Furthermore, taking on additional debt through simple refinancing may also negatively impact other stakeholders, such as government and taxpayers, and may not be feasible if there are limitations on sovereign debt or contingent liabilities held by government⁹³.

⁹² RMI (2021). Financing the Coal Transition. [RMI_Financing_the_Coal_Transition_November_2021.pdf](#)

⁹³ RMI (2021). Financing the Coal Transition. [RMI_Financing_the_Coal_Transition_November_2021.pdf](#)

5.4.4. Monetizing the environmental, social and economic benefits of coal phase out can serve as a solution to reduce the cost burden associated with implementing coal transition mechanisms.

A coordinated transition mechanism can require substantial budget outlays often in a short period of time. Funding requirements span from income support packages for coal sector workers, expenses from regulatory reforms (including restructuring entities and their liabilities), environmental remediation and overall monitoring and reporting functions. One approach to generate a funding stream to support the retirement and repurposing of coal assets would be to identify the benefits of coal phase out that can be monetised. Direct benefits of coal phase out especially in the case where the plant is repurposed rather than decommissioned include land reutilisation, avoided pollutants, improved water quality, and transmission and interconnection benefits.

It is recommended that the Vietnam Government assess the monetary benefits associated with retiring or repurposing select coal plants, and the potential route to monetising these options to accelerate the pace of coal transition.



6

Recommendations

6.1. Recommended solutions

To ensure a clear and effective roadmap for SOEs in gradually achieving net-zero emissions by 2050, the Government should consider implementing the following actions:

- i. Conduct a comprehensive review of current legal documents related to investment in the construction of CFPPs. This review should assess the need for amendments and supplements to ensure compliance with Power Development Plan VIII⁹⁴, which focuses on the gradual reduction of CFPPs⁹⁵. Additionally, it should address national energy security and adhere to the requirements stated in Government Resolution 140/NQ-CP.
- ii. Develop additional technical regulations and guidelines for the proper utilization of ash and slag as ordinary industrial solid waste. These regulations should address environmental concerns and encourage CFPPs to explore other industrial applications for these by-products. For instance, establish basic standards for using ash and slag from CFPPs in constructing rural road surfaces⁹⁶, and introduce a national standard TCVN for utilizing phosphorus slag in cement and concrete production⁹⁷.
- iii. Develop electricity purchase price mechanisms that offset the cost of installing decarbonization equipment, carbon capture and storage (CCS) tools, burning other fuels to reduce pollution, such as biomass or converting technology from burning coal to other fuels with less pollution...
- iv. Provide support to State-Owned Enterprises (SOEs) to access preferential credit sources. This assistance will enable SOEs to invest in new projects and upgrade existing CFPP equipment to meet the new environmental protection requirements.
- v. In line with Power Development Plan VIII, consider issuing specific legal documents that outline: (1) a detailed roadmap with clear deadlines for reducing coal power generation at each CFPP, (2) mechanisms and procedures for CFPPs to implement coal power reduction measures, (3) a cost compensation mechanism for CFPPs required

⁹⁴ Decision No. 500/QĐ-TTg of Prime Minister dated 15/05/2023 approving the National Electricity Development Planning of the period of 2021 - 2030 and vision for 2050 (Power Development Plan VIII)

⁹⁵ Power Development Plan VIII, Article 1, Section III.1 (a)

⁹⁶ Industry and consumer magazine, Formulate and promulgate basic standards on the use of ash and slag, 2022 <http://www.congnghieptieudung.vn/xay-dung-ban-hanh-tieu-chuan-co-so-ve-su-dung-tro-xi-dt37997>

⁹⁷ Finance Magazine, Research and development of electric furnace phosphorus slag standards for cement and concrete, 2023, <https://tapchitaichinh.vn/nghien-cuu-xay-dung-tieu-chuan-xi-phot-pho-lo-dien-cho-xi-mang-va-be-tong.html>

to reduce coal power generation, and (4) a budget to support the implementation of the coal power reduction roadmap. Providing SOEs with a legal basis, clear roadmap, and necessary resources will facilitate their compliance.

- vi. Conduct a thorough study and consider implementing mechanisms and policies to appropriately adjust electricity prices. These adjustments should align with NZE targets and balance the interests of the State, corporations, investors, and consumers.

To foster the development of the renewable energy and storage sector and provide support to SOEs, the Government should consider implementing the following actions:

- i. Create favorable regulatory frameworks: Establish clear and comprehensive regulations that encourage the growth of the renewable energy and storage sector. Especially to Amend and update Vietnam's Renewable Energy Development Strategy to 2030, with a vision to 2050, to align it with Power Development Plan VIII⁹⁸. This will ensure consistency and coherence in the national energy development plans.
- ii. Revise and enhance the investment strategy of SOEs in renewable energy and ancillary services (incl. BESS, pump storage, ICE) to align with emission reduction goals. Specifically, the Vietnam Oil and Gas Group (PVN), amending the Oil and Gas Industry Development Strategy to allow PVN to invest in new energy sectors, including renewable energy, particularly offshore wind power and energy storage. This amendment would enable PVN to diversify its portfolio and actively participate in the transition toward sustainable and clean energy sources.
- iii. Develop technical standards and regulations, such as TCVN, specific to renewable energy projects. These standards should encompass various aspects related to wind power plant requirements, wind turbine design, spacing between turbines and wind farms, as well as methods for measuring and evaluating turbine performance.
- iv. Promulgate **(1)** preferential mechanism for purchasing electricity generated from renewable energy sources by CFPPs that are transitioning to cleaner energy sources. This mechanism would incentivize and facilitate the transition process for CFPPs, encouraging their shift towards renewable energy generation; **(2)** incentive mechanism for the development of electricity storage systems. This would involve implementing policies and regulations that promote the deployment and integration of energy storage technologies, ensuring efficient utilization and management of renewable energy resources; **(3)** price mechanism for ancillary services in the national power system, taking into account the strong growth rate of renewable energy sources as outlined in the objectives of Power Development Plan VIII. This mechanism would ensure a fair and sustainable pricing framework for ancillary services to support the reliable integration of renewable energy into the power grid⁹⁹.

⁹⁸ The amend and supplement should at least include **(i)** schedule to implement some activities of this Strategy (i.e., research and development of offshore wind power), **(ii)** expanding the targeted CFPPs of PVN that are invested in renewable energy and energy storage, **(iii)** supplementation of solution in the policy of "Financial support for the development and use of renewable energy" of the Strategy, and **(iv)** some contents of the Strategy also need to be adjusted in line with the Power Development Plan VIII in order to optimize the role of NMND in the energy transition process in Vietnam

⁹⁹ Power Development Plan VIII, Article 1, Section II.2 (b): Extensively develop renewable energy sources for electricity production

- v. Support the SOEs in accessing preferential credit options through various institutions, particularly through mechanisms like JETP. This will enable SOEs to invest in renewable energy projects and energy storage initiatives.

6.2. Recommendations for EVN

6.2.1. Technical recommendations

Based on the analysis results, our research team recommends the following actions for EVN:

Short-term and medium-term recommendations (2023 – 2030):

🔹 Increase operational efficiency of existing hydroelectric power plants:

Conduct research and consider implementing Decision Support System (DSS) to optimize the operation of inter-reservoir hydropower plants in real time. This system will maximize the power generation capacity of the plants while benefiting agriculture, the environment, and downstream communities by efficiently managing water resources. Increasing power generation from existing hydropower plants will contribute to compensating for the gradual reduction in coal power generation as part of the emission reduction roadmap. Additionally, it will enhance the flexibility of the power system when integrating renewable energy sources.

The power sector can optimize the use of existing hydropower resources and transition towards a more sustainable energy mix, reducing greenhouse gas emissions and ensuring a reliable and resilient power supply.

🔹 Enhance the efficiency of existing coal power plants and facilitate their transition to ancillary services:

Implement efficiency upgrades: Improving efficiency can lead to a reduction in fuel consumption (coal, oil) and emissions per unit of electricity produced. To achieve this for traditional technologies like Pulverized Coal-PC and Circulating Fluidized Bed-CFB, several solutions can be implemented, such as enhancing combustion efficiency, minimizing loss due to incomplete combustion, reducing heat loss, and utilizing heat from ash and slag... To enhance combustion efficiency, the incinerator can be upgraded with combustion equipment like nozzles, combustion chambers, and optimized aerodynamics in combustion to burn coal thoroughly and control slag accumulation in the furnace. Advanced material technology, design, and operation can also prolong the equipment life, contributing to increased operational flexibility of plants.

Transition to ancillary services: Encouraging coal power plants to shift towards providing ancillary services that support grid stability is a key step towards a successful transition. This involves utilizing their flexibility to regulate frequency, voltage, and reactive power to assist in integrating renewable energy sources and enhancing the reliability of the power system.

Altering this type of business model can be a complicated and demanding undertaking that necessitates meticulous planning, investment, and coordination among various stakeholders. Prior to implementation, it is crucial to identify the fundamental factors

that create a favorable foundation for this new business model, such as (i) Technical: CFPPs may need to invest in new technology and infrastructure to provide ancillary services, such as frequency regulation, voltage support, and reactive power control. Ensuring that the CFPPs can reliably and safely provide these services can require significant technical expertise and investment; (ii) Regulatory: Regulatory frameworks may need to be updated to account for the new business model and ensure that CFPPs are compensated appropriately for the ancillary services they provide. This may require coordination across multiple regulatory bodies and stakeholders; (iii) Market: The market for ancillary services can be complex and competitive, and CFPPs may need to compete with other types of generators and technologies to provide these services. This can require strategic planning and investment to ensure that CFPPs are competitive in the market; (iv) Financial: The transition to an ancillary services business model may require a significant upfront investment, and CFPPs may need to secure financing to fund this investment. Uncertainty around revenue streams and market dynamics can also pose financial risks and challenges.

▲ *A comprehensive evaluation of the "early retirement" mechanism for CFPPs:*

Several financial sources and mechanisms have been proposed to support the reduction of emissions through early decommissioning of coal power plants. Examples include the JETP program and the ETM Energy Transition Mechanism of the Asian Development Bank (ADB). The Komati Coal Power Plant Dismantling and Reusing Project in South Africa is an example of JETP financing, which is a \$497 million project financed through a \$439.5 million loan from the World Bank, a \$47.5 million concessional loan from Canada's CCEFCF, and \$10 million in grants from the ESMAP program. The funding will be used to (i) dismantle the Komati plant which has 10 units with a total capacity of 1 GW (cost \$33.5 million); (ii) invest in wind, solar and battery storage (cost \$410 million) and create employment and livelihood opportunities for workers and communities (cost \$47.5 million).

EVN owns a number of plants that have been operating for more than 30 years, such as Ninh Binh (100 MW operated since 1974), Pha Lai 1 (440 MW, operated since 1986), with low efficiency (13% and 24.17% respectively¹⁰⁰) compared to efficiency of new plants (over 30%). These power plants could consider the possibility of applying the above mechanisms and have a detailed assessment of the costs and impacts on the factory, workers, communities in the factory area, and the economic, environmental, and social benefits that can be obtained.

The early retirement mechanism for coal-fired power plants (CFPPs) can have both potential benefits and drawbacks.

▲ *Investment in renewable energy:*

Based on the scenario simulation, if the solution to fully compensating for the reduced coal power output with renewable energy is chosen, the required investment volume for EVN would be substantial. For instance, in the KB_DD, this volume would be:

¹⁰⁰ Consultation meeting in 10/2022



Reduction in carbon emissions: Early retirement of CFPPs can help to reduce carbon emissions and support the transition to a low-carbon energy system.

Improved air quality: CFPPs are a significant source of air pollution, and early retirement can help to improve air quality and public health.

Increased investment in renewable energy: Early retirement of CFPPs can create opportunities for investment in renewable energy sources and accelerate the transition to a more sustainable energy system.

Cost savings: Early retirement of older and less efficient CFPPs can result in cost savings for energy consumers and reduce the need for expensive maintenance and upgrades.

Job losses: Early retirement of CFPPs can lead to job losses in the coal industry and associated sectors, which can have significant social and economic impacts.

Energy security concerns: Early retirement of CFPPs can create energy security concerns if there is not enough replacement capacity or if there are disruptions in the supply of other energy sources.

Stranded assets: Early retirement of CFPPs can result in stranded assets and financial losses for energy companies if they are unable to recover the full value of their investments.

Regional economic impacts: Early retirement of CFPPs can have significant regional economic impacts, particularly in areas that are heavily dependent on the coal industry.

- 🌊 2023 – 2030: 4.3 GW of floating solar + 0.7 GW of ground-mounted solar + 2.3 GW of onshore wind + 6.6 GW of offshore wind.
- 🌊 2031 – 2050: 5.4 GW of floating solar + 2.9 GW of ground-mounted solar + 5.5 GW of onshore wind + 1.8 GW of offshore wind.

The investment required for the period 2024-2030 is estimated to be around 30 billion USD, and 24.1 billion USD for the period 2031-2050. This amounts to a total investment demand of over 5.4 times the room left for debt-borrowing of EVN, which is only 9.66 billion USD. Hence, financing this investment volume would be extremely challenging, especially for the period 2024-2030.

Therefore, EVN's investment roadmap should prioritize areas where it has a competitive advantage, such as floating solar power. As EVN owns several large-scale hydropower plants, particularly multi-purpose strategic hydropower plants, there is significant potential for developing floating solar power plants on hydroelectric reservoirs. The explanatory report of the draft Power Plan VIII has identified up to 77 GW of technical potential for floating solar power.

🌊 *Invest in upgrading and expanding the transmission grid to meet energy transition needs*

The simulation of two scenarios for the period of 2023-2030 indicates that the share of electricity production from variable renewable energy sources is projected to increase to 28% in KB_DD and 25% in KB_AR by 2030, which is more than one and a half times higher than the level of 16.2% in January 2023¹⁰¹. The modeling results suggest that to integrate variable renewable energy at these levels, additional infrastructure investments will be required to ensure the system's transmission response capacity.

¹⁰¹ <https://moit.gov.vn/tin-tuc/bao-chi-voi-nguoi-dan/tinh-hinh-hoat-dong-thang-1-2023-va-muc-tieu-nhiemvu-cong-tac-thang-2-2023-cua-evn.html>

To ensure the transmission response capacity of the system and integrate variable renewable energy at the projected levels, the following infrastructure investments will be needed: **(1)** Upgrading and expanding the transmission grid: This includes increasing the capacity of the existing transmission lines, constructing new transmission lines, and upgrading the grid's infrastructure to accommodate the increased electricity flow from variable renewable energy sources; **(2)** Energy storage facilities: Energy storage facilities such as batteries or pumped hydro storage can help to balance the intermittent output from variable renewable energy sources and ensure a stable supply of electricity to the grid; **(3)** Demand response systems: Demand response systems can help to manage the variable nature of renewable energy supply by adjusting electricity consumption in response to changes in supply; **(4)** Advanced control systems: Advanced control systems can help to manage the flow of electricity in the grid and maintain the stability and reliability of the system. Investments will be necessary to ensure that the transmission grid has the capacity and flexibility to integrate variable renewable energy sources and support the transition to a low-carbon energy system. The table below displays the priority investments required in the short-term:

No.	Name	Region	Recent capacity (MVA)	Proposed capacity	Note	Explanation
220 kV transmission lines						
1	Vung Ang 3 – Formosa	North Central	300 x 1	300 x 2	Build a second line	Build a second line to transmit electricity from local sources
2	Ba Queo – Dam Sen	South	200 x 2	300 x 2	Upgrade, build a new one	Increase capacity to receive local renewable energy
3	Gia Vien – Nho Quan	North	184.8 x 2	300 x 2	Upgrade	Increase capacity to receive local renewable energy
4	Hoa Binh – Xuan Mai	North	184.8 x 1	184,8 x 2	Build a second line	Build a second line to transmit electricity from local sources
5	Thanh Xuan – Tay Ha Noi	North	184.8 x 2	300 x 2	Upgrade	Increase capacity to receive local renewable energy
6	Phu Lam – Dam Sen	South	374 x 2	400 x 2	Upgrade	Increase capacity to receive local renewable energy

No.	Name	Region	Recent capacity (MVA)	Proposed capacity	Note	Explanation
220 kV substations						
1	Tan Yen	North	500	750	New construction	New construction, upgrading to receive offshore wind power and BESS.
2	Pho Noi	North	500	750	New construction	
3	Ba Thien	North	500	750	New construction	

Source: Simulation results of VIETSE

Invest in a storage system that provides ancillary services:

According to the PDP8, renewable energy will make up to 39% of the installed capacity in the power system by 2030 to achieve the net zero target by 2050. The PDP8 has also recognized the importance of having flexible assets in a high renewable energy power system. Various balancing solutions, such as pumped hydro storage, battery energy storage, and flexible gas based on ICE technology, can provide the needed flexibility. However, as analyzed earlier, it is not feasible to fully offset the reduced coal power generation with renewable energy in the medium term. Instead, EVN can invest in a energy storage system or internal combustion engines (ICE) to provide ancillary services to the system, creating an alternative revenue source to offset the declining revenue from coal power in emission reduction scenarios.

The modeling results indicate that the power system will require 6-7 GW of storage capacity by 2030 to integrate additional renewable energy capacity. EVN is currently investing in the 1.2 GW Bac Ai pump-hydro storage project, but there is still ample opportunity for investment in energy storage, given the declining cost of new storage technologies such as large-scale batteries and ICE systems. To establish an ancillary service market for the Vietnam power system, pricing mechanisms such as capacity payments, energy payments, frequency response payments, reserve payments, and congestion payments can be utilized. These mechanisms incentivize power plants or storage facilities to provide necessary services for maintaining the power system’s stability and reliability.

Long term (2031 – 2050):

Continuing to invest in upgrading the transmission and distribution infrastructure and implementing advanced solutions to ensure the stable and flexible operation of the power system, particularly in the context of a high variable renewable energy (RE) share

According to the two proposed scenarios, the period between 2031 and 2050 will witness a significant increase in renewable energy investment. The share of electricity production from RE, including hydropower, is projected to rise rapidly

from 52% in 2030 to 74% in 2050 in KB_DD and from 40% to 74% in KB_AR. Notably, the proportion of variable sources will increase from 24% in 2030 to 47% in 2050 in KB_DD, and from 12% in 2030 to 46% in 2050 in KB_AR.

As the proportion of renewable energy (RE) in the power system increases, the demand for investment in power grid infrastructure will also rise. This includes both consolidating and enhancing existing infrastructure, as well as researching and applying advanced technology solutions to improve the stable and flexible operation of the power system. One example of an advanced technology solution is virtual power plant technology, which can bring together small RE power plants on a digital platform to create a larger source capable of moderation and participation in the electricity market.

Other advanced technology solutions that could be applied to increase the stable and flexible operation of the power system include advanced demand response systems, smart grid technologies, predictive analytics and machine learning, and microgrid solutions. ESS can store excess energy produced during periods of low demand and supply it during periods of high demand, while demand response systems can adjust energy consumption in response to changes in supply and demand. Smart grid technologies can optimize the operation of the power system and improve grid stability, while predictive analytics and machine learning can be used to forecast energy demand and production. Microgrid solutions can provide localized power generation and storage solutions that can operate independently from the main grid, increasing the resilience and flexibility of the power system.

EVN can proactively improve the stable and flexible operation of the power system in the context of a high variable renewable energy share by implementing these advanced technology solutions. This can also help EVN to maintain its market position and generate revenue sources that align with the company's long-term business strategy.

6.2.2. Legal recommendations

In light of the ongoing energy transition, Vietnam's commitment to achieving net-zero emissions by 2050 at COP26, and the JETP declaration, EVN must reassess the tasks outlined in the "Development Strategy of Electricity of Vietnam to 2030, with vision to 2045" (also known as "Strategy 538"). This requires a comprehensive review and assessment of the current situation to develop a business strategy aligned with Power Plan 8 and the evolving trends in the global energy market.

It is essential to create concrete plans for the investment portfolio, services aimed at and potential to reduce emissions, as well as determining the number of carbon credits that can be obtained from hydropower and renewable energy plants. Understanding the capabilities of the business is crucial to developing a strategy that enhances its market position.

6.3. Recommendations for PVN

6.3.1. Technical recommendations

Short-term and medium-term (2023 – 2030):

- 🌊 *Invest in offshore wind power projects and develop its local supply chain:*

PVN can draw upon the experiences of major oil and gas corporations worldwide that have shifted and reoriented their business models to adapt to the energy transition context. Given its financial and technical capacity, PVN is well-positioned to invest and participate in offshore wind power projects, which often require significant investments and specialized offshore technical expertise in construction, operation, and maintenance. PVN can collaborate with reputable, experienced, and financially capable international partners to form consortia and develop offshore wind power projects in Vietnam

To enhance its capabilities in offshore wind power, PVN can leverage its existing offshore technology capabilities and those of its member companies. This can include investing in and developing local supply chains for offshore wind power, such as developing local manufacturing capabilities, establishing a regulatory framework, and fostering research and development.

Moreover, there are some basic capabilities that can be mobilized to improve efficiency. For example, PetroVietnam Technical Services Corporation (PTSC) is a leading offshore technology contractor in Vietnam with EPCIC capabilities and experience in wind power. PTSC has also won international bids for offshore projects in other countries and has a port and supply facility for assembling super-heavy components, cargo handling, shipping, and offshore support vessels. PTSC's port is considered one of the four ports with the best capacity for developing the supply chain for offshore wind power¹⁰².

Similarly, Petrovietnam Drilling and Well Service Corporation (PVD) has the capacity to execute and provide services for offshore projects. PVD can also provide personnel for offshore projects through its subsidiary, PVD Training, which specializes in training human resources in the oil and gas industry and provides safety and technical certificates for oil and gas activities at sea and international certificates.

Lastly, PetroVietnam Transportation Corporation (PVTrans) has the capability to provide maritime transport and logistics services. By leveraging the capabilities of these member companies, PVN can further enhance its capabilities in offshore wind power and contribute to the development of a sustainable and efficient supply chain for this industry.

- 🌊 One strategy to consider is integrating the offshore wind power supply chain with the green hydrogen production chain to provide energy to areas that are difficult to electrify.

Hydrogen is a crucial component of the carbon reduction process, and it has significant potential for building a low-emissions economy in Vietnam through the

¹⁰² MTBS, VIETSE. 2021. Requirements harbour and infrastructure OWE Vietnam.

production of green hydrogen from renewable energy sources. Based on analysis of international experience, the potential uses of green hydrogen in Vietnam's low emissions economy¹⁰³, which including:

- Green hydrogen can be utilized in various industries such as steel production and cement, and gradually replace gray hydrogen currently used in the oil refineries, fertilizer, and chemical industries.
- In transportation: using green hydrogen as a fuel for various models of transportation, including long-distance trucks, railways, sea transport and aviation
- Green hydrogen can also be used in the power sector as a flexible source of energy and for storage purposes
- Additionally, it can be produced for export.

Generating green hydrogen directly from offshore wind power is believed to be more cost-effective than relying entirely on grid electricity because it reduces transmission costs. By integrating the offshore wind power supply chain with green hydrogen production, a clean energy supply and production hub can be established. Green hydrogen produced from offshore wind power can be transported through existing gas pipelines when gas fields are depleted, or it can be exported directly

Long term (2031 – 2050):

- *Research and assess the possibility of implementing carbon capture, utilization, and storage (CCUS) technology in Vietnam*

PVN currently owns two operating CFPPs: Vung Ang 1 (1.2 GW COD in 2013) and Song Hau (1.2 GW COD in 2022). Thai Binh 2 Thermal Power Plant (1.2 GW) is about to be completed and the Long Phu Thermal Power Project (1.2 GW) is underway. Thus, PVN's power plants will have a late end of their economic life (Vung Ang 1 after 2043 and the others after 2050). PVN also operates 2.8 GW of gas power and plans to develop an additional 4.5 GW of gas and LNG power from now until 2035, which will also continue to produce emissions.

While CCUS technology is not currently considered economically viable in Vietnam before 2035, it may become a potential option in the long term for reducing emissions not only in the power sector but also in other industries with high carbon intensity that are difficult to decarbonize.

PVN has several advantages in researching and applying CCUS technology. With over 60 years of experience in oil and gas exploration, prospecting, and production, PVN has access to geological data related to fields, making it easier to assess storage potential. Since 2007, PVN has conducted a pre-feasibility study in collaboration with JX Japan¹⁰⁴ on a project to inject CO₂ into oil wells at the Rang Dong field to boost oil recovery. Additionally, PVN's subsidiary, VietsovPetro, has experience in CCUS technology from a pre-feasibility

¹⁰³ Vietnam Initiative for Energy Transition. 2023. Options for green hydrogen development in Vietnam. Vietnam Initiative for Energy Transition.

¹⁰⁴ Yohei Kawahara and Atsushi Hatakeyama. 2016. Offshore CO₂-EOR Pilot Project in Vietnam.

study conducted in 2005 with Mitsubishi Heavy Industry and Marubeni Corporation on a project to recover CO₂ from Phu My power plants to enhance oil recovery at the Bach Ho field¹⁰⁵. Although the project was not implemented due to economic inefficiency and a lack of support from the CDM mechanism, the research provided valuable insights into the design and implementation of CCUS technology in Vietnam.

6.3.2. Legal recommendations

After evaluating PVN's development strategy and investments, it is recommended that the relevant authorities consider revising and augmenting Resolution No. 41-NQ/TW to authorize PVN's involvement in marine energy development. This includes exploring new and renewable energy sources such as offshore wind power, green hydrogen, and energy storage.

6.4. Recommendations for TKV

6.4.1. Technical recommendations

Short-term and medium-term (2023 – 2030):

- *Conduct research and develop an actionable plan to implement co-firing technology integrating biomass with coal at specific power plants within the corporation*

TKV currently operates 7 power plants with a combined capacity of 1.6 GW. These plants utilize circulating fluidized bed (CFB) technology to generate power using low-quality coal sourced from TKV's mines. The CFB furnace offers more flexibility in terms of fuel usage compared to pulverized coal furnaces¹⁰⁶, making biomass co-firing a convenient option that requires minimal renovation. Additionally, CFB technology allows for higher biomass co-firing ratios.

One potential advantage of co-firing is the utilization of agricultural by-products that are otherwise discarded and burnt, contributing to air pollution. By incorporating these by-products into co-firing, we can find a sustainable solution to reduce air pollution.

However, when implementing this technology, we should consider the following aspects:

- Technical issues
 - The availability of biomass stocks is often scattered and seasonal, which can make it challenging to establish reliable supply chains for biomass co-firing.
 - The low block density of biomass can make it difficult to transport and store, resulting in increased costs for biomass co-firing.
 - Problems such as slag, scale, and equipment corrosion resulting from biomass co-firing can shorten equipment life and increase maintenance costs.
 - Safety issues (risk of explosion, self-ignition in the warehouse, etc.)

¹⁰⁵ <https://cdm.unfccc.int/methodologies/PAMethodologies/pnm/byref/NM0167>

¹⁰⁶ Frank Leuschke, Damian Goral, Heike Hünchen. 2018. Aspects of biomass co-firing for utility-sized CFB boilers, Copenhagen, Denmark.

To optimize biomass co-firing and reduce equipment damage, several measures can be taken, including using high-quality biomass with low alkali and chlorine content, optimizing combustion conditions to minimize the formation of slag and scale, using additives to reduce the risk of fouling, applying anti-corrosion coatings on equipment surfaces, cleaning equipment regularly to remove accumulated slag and scale, and implementing a comprehensive maintenance program to ensure equipment is regularly inspected and repaired as necessary.

Economic issues

- **Cost of biomass:** The cost of biomass can vary depending on its type, availability, and location, and in some cases, it may be more expensive than other fuel sources, such as coal or natural gas.
- **Supply risk:** competition for the use of biomass for other purposes, such as pellet production for export, animal feed, and litter, can limit its availability and increase its cost for use in biomass co-firing in CFB power plants.
- **Infrastructure and supply chain costs:** The infrastructure and supply chain for collecting, transporting, and storing biomass can be expensive to develop and maintain.
- **Retrofitting costs:** Retrofitting coal power plants to allow for biomass co-firing can be costly, particularly for older plants that may require significant upgrades.
- **Regulatory and policy support:** The economic viability of biomass co-firing can depend on regulatory and policy support, such as subsidies or tax incentives, which may not be available in all regions.
- **Market competition:** The use of biomass for other purposes, such as the production of pellets for export or animal feed, can result in increased competition for biomass and higher prices for biomass used for co-firing.
- **Revenue opportunities:** Biomass co-firing may provide revenue opportunities, such as carbon credits or renewable energy certificates, which can offset the costs of biomass.
- **International experience** has shown that the economic viability of biomass co-firing technology is dependent on supportive policies.

Long term (2031 – 2050):

It is advisable to conduct research on a national strategy to efficiently utilize assets from decommissioned coal-fired power plants and coal mines. This involves actively developing concrete action plans for their conversion into new renewable energy projects or for other economic purposes. Consider exploring potential strategies such as:

- **Identifying new renewable energy resources:** Conduct research to identify new renewable energy projects that can be developed using assets from decommissioned coal-fired power plants and coal mines. For example, converting a coal-fired power plant into a co-firing biomass or waste-to-energy facility, or developing a wind or solar farm on the land of a decommissioned coal mine.

- ▶ Repurposing assets for other economic purposes: Identifying other economic uses for decommissioned coal-fired power plants and coal mines. For example, converting a coal-fired power plant into an industrial park or a data center, or developing recreational facilities on the land of a decommissioned coal mine.
- ▶ Collaboration and partnerships: Working collaboratively with government, industry, and local communities to develop and implement strategies for the efficient use of assets from decommissioned coal-fired power plants and coal mines.
- ▶ Innovation and research: Researching and developing new technologies, such as carbon capture and storage or advanced energy storage, to make decommissioned coal-fired power plants and coal mines economically viable for new and renewable energy projects.
- ▶ Regulatory requirements: Ensuring compliance with regulatory requirements, such as environmental permits and zoning laws, when developing new renewable energy projects or other economic uses for decommissioned coal-fired power plants and coal mines.
- ▶ Economic viability: Ensuring that new renewable energy projects or other economic uses for decommissioned coal-fired power plants and coal mines are economically viable, including assessing the cost of conversion or repurposing, the availability and cost of alternative fuels, and the potential revenue from the new project or economic use.

Overall, a national strategy for the efficient use of assets from decommissioned coal-fired power plants and coal mines should consider a range of potential strategies and involve collaboration between government, industry, and local communities

6.4.2. Legal recommendations

VINACOMIN should ensure that their coal industry development strategy is both profitable and environmentally sustainable. This will help them to meet the growing demand for energy in Vietnam while also contributing to the country's efforts to reduce greenhouse gas emissions and mitigate climate change. To do that VINACOMIN should considering the following strategies:

- ▶ Diversifying their energy portfolio: VINACOMIN can consider diversifying their energy portfolio by investing in and developing new and renewable energy sources such as solar, wind, and biomass. This can help to reduce their dependence on coal while also contributing to the national goal of reducing greenhouse gas emissions.
- ▶ Implementing clean coal technologies: In the long term, considering the development of clean coal technologies like carbon capture and storage (CCS), VINACOMIN can explore options to reduce its carbon footprint. Implementing CCS can help mitigate emissions from coal-fired power plants, enabling VINACOMIN to benefit from the use of coal while promoting environmental sustainability.
- ▶ Improving energy efficiency: VINACOMIN can improve the energy efficiency of their operations by investing in new technologies and implementing best practices. This can help to reduce their energy consumption and operating costs while also reducing their carbon footprint.

- Engaging with stakeholders: VINACOMIN can engage with stakeholders such as local communities, and government agencies to understand their concerns and perspectives on the environmental impact of coal mining and power generation. This can help to build trust and support for VINACOMIN's operations and ensure that their development strategy is environmentally sustainable.
- Adopting sustainable mining practices: VINACOMIN can adopt sustainable mining practices such as reforestation, land restoration, and water management to minimize the environmental impact of their mining operations. This can also help to improve their social license to operate and reduce the risk of environmental liabilities.

6.5. Financial recommendations for three SoEs

In the area of financing for the NZE roadmap to 2050, each of the SOE (EVN, Vinacomin and PVN) should take the following actions:

- Each SOE should develop an investment plan and financing mechanism to support the smooth implementation of the transition plan and roadmap.
- Based on the chosen scenario, each SOE need to create a comprehensive plan and roadmap for their business operations, meticulously considering the phasing down and phasing out of CFPPs.
- Following the formulation of the roadmap and investment plan, each SOE should seek approval from the board. If necessary, they must also obtain approval from the respective regulatory authority.
- Subsequently, EVN, Vinacomin, and PVN must develop specific investment plans for concrete transition projects, such as the gradual phasing down and phasing out of initial CFPPs between 2025 and 2030. These plans should be presented to potential donors.
- It is crucial for EVN, Vinacomin, and PVN to communicate and present the comprehensive plans, roadmap, and specific proposals for each CFPP to potential donors, development banks, investment funds, the JETP Secretariat (likely to be established in April 2023), ADB (for early CFPP retirement programs), banks, and other relevant stakeholders.
- Engaging with donors is essential to secure financing and initiate the first projects. This could involve financing through mechanisms like JETP (Joint Energy Transition Program), ADB Southeast Asia ETM Partnership, CIF (Climate Investment Funds), or with support from a donor, whether public or private, national or international.
- Additionally, EVN, Vinacomin, and PVN should proactively seek technical assistance from international agencies to support them in all stages, from investment preparation to actual implementation and post-investment phases.



List of Technical Assistances

From the aforementioned findings, the Consultants have compiled a summary of the technical assistance requirements for CMSCs and SOEs to bolster and expedite the energy transition in the power sector, aligning with Vietnam's climate commitments.

Proposed Technical Support Activities

1. Offer comprehensive support in developing technical solutions for energy transition plans and roadmaps for each SOE. This will ensure a well-structured and effective approach to achieving the energy transition goals.
2. Provide valuable support in developing financial plans and investment strategies aligned with the energy transition roadmap of each SOE. This will lay a strong foundation for successful implementation.
3. Offer assistance in conducting energy audits for each coal-fired power plant and proposing solutions to enhance the operational efficiency of thermal power plants. These solutions may include optimizing combustion through coal particle size reduction after crushing, improving coal flow to the burner, implementing precise dosing systems to control combustion air flow, and monitoring emissions such as Oxygen and CO, among others.
4. Conduct thorough research and suggest solutions to enhance the operational flexibility of thermal power plants. For instance, exploring options like reducing minimum load, decreasing startup time, and improving speed load change capabilities can lead to improved efficiency.
5. Research and propose a comprehensive fuel conversion roadmap for thermal power plants, outlining the steps to transition towards more sustainable energy sources.
6. Investigate and propose technical solutions, mechanisms and policies for the application of carbon capture and storage systems, contributing to carbon emissions reduction efforts.
7. Provide technical assistance in developing a pilot pre-feasibility study for the early retirement mechanism of thermal power plants. This will help evaluate the feasibility and implications of such initiatives.
8. Assist in creating technical instructions, orders, and procedures for implementing self-consumption power plants, ensuring smooth implementation and adherence to guidelines.

9. Conduct in-depth research and propose technical methods for bidding and auctioning to select investors for transmission grid projects. This will help attract investment and facilitate grid development.
10. Study and suggest appropriate electricity price calculation methods for pump hydro power sources, solar power combined with BESS (Battery Energy Storage Systems), auxiliary services, fast frequency response services, and transmission services, promoting cost-efficiency and transparency.
11. Research and propose financial and technical solutions to support the development of Energy Storage Systems (ESS), contributing to improved energy storage capabilities.
12. Assess the potential impact of future climate policies (carbon market, carbon tax, etc.) on the financial situation of corporations, helping in risk assessment and planning for future challenges.
13. Evaluate the mechanism of prioritizing coal-fired power plant owners to invest in renewable energy, particularly in the North, to address the risk of power shortage in this region.
14. Conduct an in-depth study and propose solutions to develop human resources for the energy industry, specifically to effectively implement the Joint Energy Transition Program (JETP) and achieve Net Zero Emissions (NZE) commitments.
15. Design and implement a comprehensive training program to address human resources needs, including facilitating job transitions, thus ensuring a skilled workforce ready to embrace the energy transition challenges.

Proposed Financial Technical Assistance Activities

In the area of financing, the additional technical assistance to be provided should include the followings:

1. Provide assistance in formulating comprehensive plans and roadmaps for the transition from coal-fueled power to renewable energy (RE) in SOEs. This will ensure a well-structured and effective approach toward achieving the energy transition goals.
2. Offer valuable support in developing financing plans and investment strategies to facilitate the roadmap for transitioning from coal-fueled power to renewable energy (RE) in EVN, Vinacomin, and PVN. This will help ensure a smooth and successful transition process.
3. Provide exposure and training to EVN, Vinacomin, and PVN staff on international financing mechanisms that support the transition from coal-fueled power to green energy. Familiarize them with options like the KB_DD mechanism, ADB Southeast Asia ETM Partnership, CIF, and banks to enable informed decision-making.
4. Provide dedicated support in developing concrete proposals for financing projects under the approved CFPP transition plan of each SOE. This will strengthen the financial aspect of the transition and pave the way for successful implementation.

5. Assist in setting up financing agreements between the SOEs and donors. Establishing well-structured agreements is crucial for securing financial support and ensuring mutual benefits considering JETP declaration.
6. Set up a robust Monitoring and Evaluation (M&E) system to closely monitor the financial results of the implemented projects. This will provide valuable insights and aid in making informed decisions during the transition process.
7. Offer technical assistance for policy reforms to support the efforts of SOEs, especially CMSC and relevant ministries, in effectively transitioning from coal-fueled power to renewable energy. Adapting to policy changes is key to successful and compliant energy transition initiatives.
8. Offer technical support for regulatory reforms and policy decisions to enable SOEs to invest in renewable energy projects to replace lost production resulting from the phasing down and phasing out of CFPPs under the three scenarios, as well as to invest in energy reserve measures, among others.
9. Support communication efforts and facilitate the sharing of good experiences and best practices in financing the transition of CFPPs under the three SOEs with enterprises, companies, banks, donors, various agencies, regulators, and ministries in Vietnam, as well as in international forums.

Proposed Legal Technical Assistance Activities

CMSC needs to:

1. Formulate and submit comprehensive master plans for the investment and development of the three SOEs¹⁰⁷ taking into account various factors such as **(i)** KB_AR and KB_DD mechanisms, **(ii)** Vietnam's renewable energy development strategy up to 2030 and its vision for 2050, and plans to amend and supplement relevant legal regulations, and **(iii)** considerations of the challenges faced by the SOEs and the opinions/approvals of competent authorities (such as the Politburo and the Government) concerning the expansion of the SOEs' functions and business scope to align with Vietnam's energy transition goals.
2. Collaborate with the Ministry of Planning and Investment, the Ministry of Finance, and other relevant authorities to request the Prime Minister's decisions on any restructuring or ownership transfer matters that may arise during the implementation of the KB_AR, KB_DD scenarios for the SOEs¹⁰⁸;
3. Collaborate with the Ministry of Finance to request the Prime Minister's decisions on potential adjustments to the charter capital of the SOEs in case these matters arise during the implementation of the KB_AR, KB_DD scenarios¹⁰⁹;

¹⁰⁷ Decree No. 131/2018/NĐ-CP, Article 4, clause 1

¹⁰⁸ Decree No. 131/2018/NĐ-CP, Article 5, clause 2, point b

¹⁰⁹ Decree No. 131/2018/NĐ-CP, Article 5, clause 2, point c

4. Collaborate closely with the Ministry of Planning and Investment, the Ministry of Finance, and other relevant authorities to pursue the Prime Minister's approval for the 5-year investment/development strategies and business/production plans of the SOEs¹¹⁰. These plans should be meticulously crafted based on the KB_AR, KB_DD scenarios, carefully considering the opinions and approvals of competent authorities. It is of utmost importance to accentuate the significance of reducing coal power generation at the CFPPs and strategically expanding the SOEs' business scope into renewable energy and energy storage.
5. Conducting thorough research and formulating an internal manual for legal assessment. This proactive approach will equip the SOEs with a comprehensive understanding of the legal implications and potential challenges during the implementation of transition scenarios. Moreover, we urge the proposal of robust risk reduction plans to ensure a smooth and successful execution of the energy transition process. By employing our consulting insights in legal assessment and risk management, the SOEs can enhance their preparedness and pave the way for seamless progress.

The SOEs should prioritize conducting comprehensive research and reviewing legal regulations to effectively implement the coal power reduction targets based on the KB_DD, KB_AR scenarios. This will enable them to develop a well-structured plan for energy transition and coal power reduction. The research and review must specifically address the legal challenges faced by the SOEs during the energy transition process. Additionally, it should explore viable legal options for negotiating and reaching agreements with partners who co-own CFPPs, facilitating the reduction of coal power generation and ultimately achieving the desired energy transition objectives.

¹¹⁰ Decree No. 131/2018/NĐ-CP, Article 5, clause 2, point d

Annex

Annex 1: Report D3. Preliminary Report

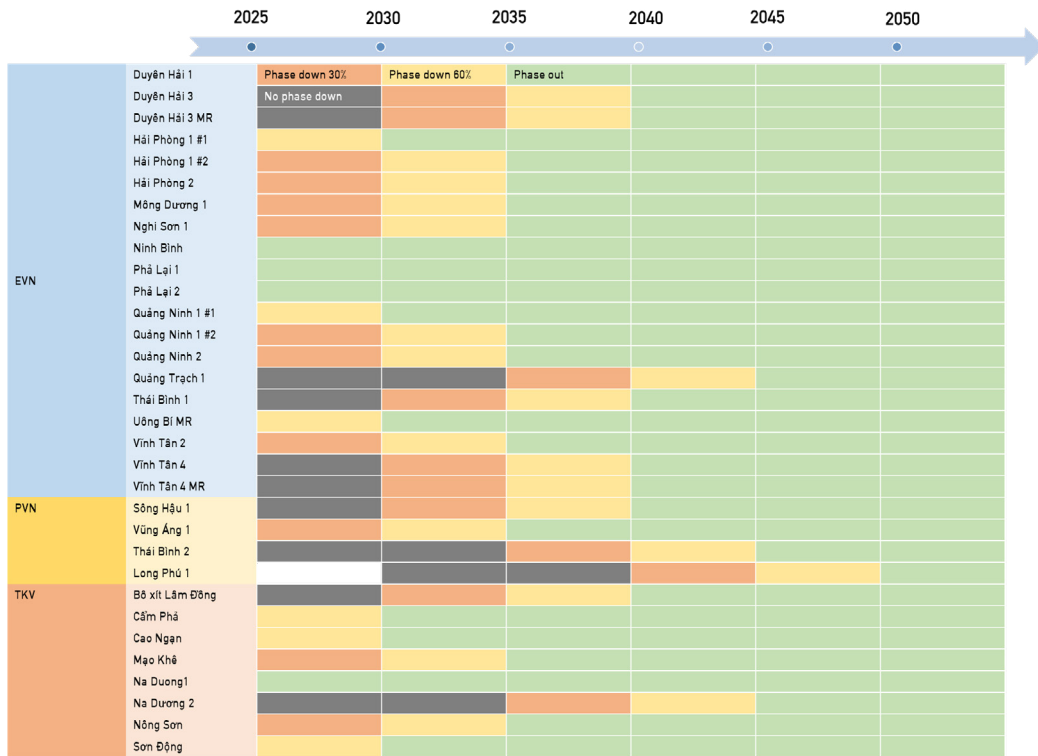
Annex 2: List of the coal fired power plants by age-groups

Area/Age (years)	40-50	30-40	20-30	10-20	<10
North	Ninh Binh (100 MW)	Pha Lai 1 (440 MW)	Pha Lai 2 (600 MW)	Quang Ninh 1 (600 MW)	Hai Duong (1200 MW)
				Cao Ngan (115 MW)	Quang Ninh 2 (600 MW)
				Cam Pha (670 MW)	Hai Phong 2 (600 MW)
				Na Duong 1 (110 MW)	Mao Khe (440 MW)
				Son Dong (220 MW)	Mong Duong 1 (1080 MW)
				Uong Bi MR (630 MW)	Mong Duong 2 (1200 MW)
				Hai Phong 1 (600 MW)	Nghi Son 1 (600 MW)
					Nghi Son 2 (1330 MW)
					Thang Long (620 MW)
					An Khanh (120 MW)
					Fomosa Ha Tinh (650 MW)
					Thai Binh 1 (600 MW)
					Thai Binh 2 (1200 MW)

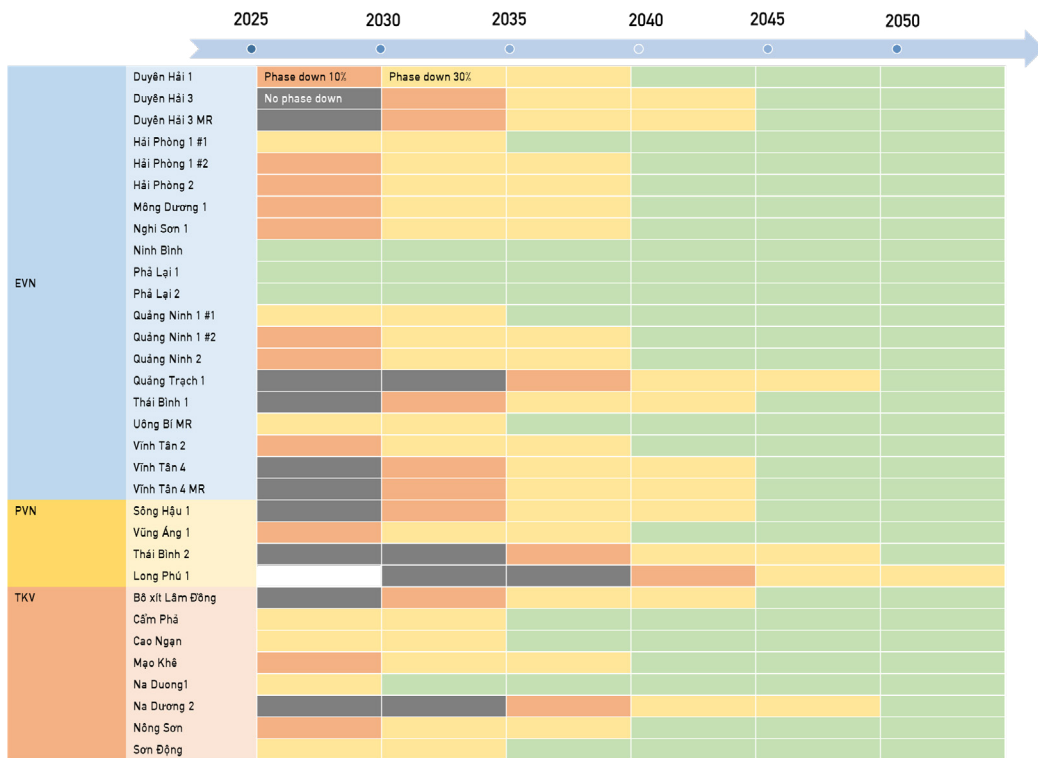


Area/Age (years)	40-50	30-40	20-30	10-20	<10
Centre					Vinh Tan 1 (1240 MW)
					Vinh Tan 2 (1200 MW)
					Vinh Tan 4 (1200 MW)
					Vinh Tan 4 MR (600 MW)
					Nong Son (30 MW)
					Vung Ang 1 (1200 MW)
South				Fomosa Dong Nai (450 MW)	Bauxit Lam Dong (30 MW)
				VEDAN Vietnam (72 MW)	Duyen Hai 3 MR (660 MW)
					Duyen Hai 3 (1200 MW)
					Duyen Hai 2 (1320 MW)
					Duyen Hai 1 (1200 MW)
					Song Hau 1 (1200 MW)

Annex 3: Roadmap for coal power reduction in KB_DD scenario



Annex 4: Roadmap for coal power reduction in KB_AR scenario





Source: Shutterstock



ENERGY
TRANSITION
PARTNERSHIP



UNOPS



COMMISSION FOR THE MANAGEMENT
OF STATE CAPITAL AT ENTERPRISES

FINAL REPORT

Roadmap for the Commission for
Management of State Capital toward
Net-Zero Emission in Energy State-Owned
Enterprises in Vietnam

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