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Preliminary 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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VIET economica nhquang&associates CARBON TRUST

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Project Manager: Ngo Thi To Nhien

Prepared by:

VIET SE	**MSc. Ngô Thị Tố Nhiên**	Project lead
	Assoc. Dr. Nguyễn Hồng Phương	Senior Power system consultant
	Dr. Trần Thái Trung	Senior Power system consultant
	Dr. Trương An Hà	Energy consultant
	MSc. Trần Hoàng Anh	Energy consultant
Economica	**Dr. Lê Duy Bình**	Senior Economist/ Financial consultant
	Dr. Nguyễn Mạnh Hùng	Senior Financial consultant
	Mr. Phạm Tiến Dũng	Senior Financial impact assessment consultant
	Ms. Đồng Thị Kiều Trang	Financial consultant
NHQuang	**MBA. Nguyễn Hưng Quang**	Social science / political sciences Senior consultant
	Ms. Nguyễn Ngọc Hà	Senior legal consultant
	Mr. Lưu Tuệ Đăng	Legal consultant
	Mr. Lê Gia Khánh	Legal consultant
Carbon Trust	**Mr. Mauricio Riveros**	Energy/Power System and Market consultant
	Ms. Xiying Tok	Electric Utilities, Transport, Real Estate, Green Finance consultant

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List of Acronyms

BESS	Battery Energy Storage System
BOT	Build – Operate – Transfer
CFB	Circulating fluidized bed
CFPP	Coal-fired Power Plant
CMSC	Commission for Management of State Capital
EIA	Environmental Impact Assessment
ETP	Energy Transition Partnership
ET	Energy Transition
ETM	Energy Transition Mechanism
EVN	Vietnam Electricity
(EVN)GENCO	EVN's Power Generation Corporation
GHG	Greenhouse Gases
IPP	Independent Power Producer
JETP	Just Energy Transition Partnership
MOIT	Ministry of Industry and Trade
NLDC	National Load Dispatch Centre
NZE	Net Zero Emissions
PDP8	Power Development Plan 8
PPA	Power Purchase Agreement
PVN	PetroVietnam or Vietnam Oil and Gas Group
SOE(s)	State-owned Enterprise(s)
VINACOMIN or TKV	Vietnam National Coal-Mineral Industries Holding Corporation Limited
B$	Billion US dollar
GWh	Giga Watt-hour
TWh	Tetra Watt-hour

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Executive Summary

The Commission for State Capital Management (CMSC) is currently managing the use and recovery of 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 play a central role in ensuring national energy security. Together, they still provided 58% of the total electricity output by 2021 and maintained their essential part in providing electricity for the country's socioeconomic development. Owning the majority of dispatchable sources (thermal and large hydropower plants), the SOEs also support the reliability of the power supply. It is crucial in circumstances where the state is still regulating the electricity price to ensure affordability and access to electricity for all, the target that aligns with the Sustainable Development Goal SDG 7 set by the United Nations.

At the landmark COP26, Vietnam has made strong climate protection commitments to the international community. Prime Minister Pham Minh Chinh affirmed that Vietnam - with international support on technology transfer, finance and capacity building - will aim 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, in which, the countries commit to promoting power generation from clean sources and transit the unabated coal power generation by 2040s.

The energy transition is inevitable to meet the goal of being independent from depleting fossil fuel sources and to protect our climate by the middle of this century. Scientific evidence has shown that accelerating clean, inclusive and just energy transitions is prequisited for implementing climate protection strategy in the long term. Following 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 highlighted the role of energy transition in achieving the NZE target. As the key stakeholders in Vietnam's energy sector, the three SOEs will be an important factor for the country in fulfilling the NZE commitment.

However, Vietnam is facing to a crisis of energy shortage, especially power generation. The price of coal and natural gas on the international market has reached a highly competitive record, pushing the country to challenges to maintain the electricity price stable and lower than the electricity production cost. During 2021-2022, 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. In that context, it is difficult for low-middle-income countries like Vietnam to compete with developed countries to buy fossil

fuels at market prices but are acceptable to the economy. The picture of the world energy market shows that ensuring energy security in the long term for Vietnam is a big challenge. The shock of electricity shortage due to high fuel prices, limited access to supply and the impact of extreme climate events occurring in 2023 is an important reminder of the need to ensure the stability, sustainability of the country and national energy system.

Moverover, CMSC and the three energy SOEs in Vietnam have drivers as well as challenges to plan and implement the effective and just energy transition toward the NZE target. CMSC has been paying high attention to supporting the SoEs to move towards sustainability, improving governance capacity, enhancing business efficiency, developping the emission reduction roadmap, and creating favorable conditions for promotion of the clean energy market. After indentifying the challenges as well as implementation requirements, CMSC cooperated with ETP to develop the technical assisstance. 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 summarised 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, focusing on power generation*** and not considering the other business activities such as oil, coal and gas exploitation, etc.

To meet TOR's requirements, the Consulting team have built several scenarios in overall approach and then more specifically for energy SoEs, then based on the techincal, financial and legal analysis to choose two (02) potential scenarios with the aim to select the most possible solution to meet SOEs' emissions reduction goals by 2050. The scenarios focus on the long-term emissions reduction of fossil-fuels-based power plants because they are large emitters and have risks in securing imported fuels.

The principles to develop scenarios upon are: Ensureing energy security → Affordability → Emissions reduction. The scenarios are based on 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 mobilised as follows:

- *Deep Decarbonisation 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 highlight that the principles for setting up the emission reduction scenario must firstly priority the national energy security, so the possibility for emission reductions applied for coal fired power plants could only realized when alternative sources of power generation such as renewable energies to ensure the supply demand balance and flexibility options are available.

Both simulation scenarios show that the CO_2 emission reduction potential of Vietnam's power system can meet the target stated in the updated NDC 2022. Accordingly, by 2030, the emission reduction potential of KB_DD is 251 $MtCO_2$ and KB_AR is 221 $MtCO_2$ (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 $MtCO_2$, meeting the target of the National Strategy on Climate Change.

The KB_DD scenario results show that the future CO_2 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 will reach their peak in 2026 and the largest emissions from power plants in 2025 as some 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 $MtCO_2$ (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 $MtCO_2$ (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 $MtCO_2$ (96% reduction compared to the no-action scenario).

The scenarios' simulation results show that it is necessary to add more renewable energy (RE) capacity to compensate for the reduced power output from SOEs' coal power plants. And 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 assessed SOEs' share in the electricity system by installed capacity and power output based on the current investment portfolio. The results show that, if SOEs do not invest more in clean energy in the next 7 years plus implements emission reductions according to the two scenarios mentioned above, SOE's share of electricity output in the total system output will 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.

In order to offset power output as well as revenue impact due to coal power cuts, it is recommended that corporations have a long-term investment strategy in developing 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***: it is possible to invest or participate in investing in upgrading infrastructure of the existing industry ports and new offshore wind power projects due to having 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:*** invest in new RE projects, storage batteries, consider the possibility of making use of land recovered after the mine closure. TKV can also explore biomass co-firing technology applied to some of its coal power plants.

Finacial implications

All the transition scenarios would have impacts on the three SOEs in terms of revenue and labour. Due to the decrease in coal power output, revenue from power generation of corporations will sharply drop if there are no additional new sources. SOEs will also have to cut their workforce in their coal power sector.

- **KB_DD**: the total revenue of the three corporations from 2022 to 2025 will decrease by a total of 72.4 trillion VND (3.0 bill USD) and then 744.1 trillion dong ($31 billion) from 2026 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 136.5 trillion dong ($5.7 billion) from 2026 to 2030. The number of workers affected in this scenario is 27.2 thousand jobs by 2050.

Of the three SOEs, EVN will be the most affected because it has a much larger power output from coal-fired power plants than TKV and PVN. EVN will also face the biggest job problem with about 19.7 thousand jobs lost by 2050. Therefore, solving the problem of redundant labor due to the transition should be one of the priorities of all three corporations. In which, it is necessary to consider financial to have a support package for employees who are laid off due to the implementation of transition scenarios. In addition, training and skills improvement programs should also be provided to prepare workers to find new jobs, at other establishments of corporations or at other companies.

Analysis of the financial health of the three SOEs shows that borrowing is necessary to finance and pay for the energy transition as it requires huge capital investment. This demand comes from investing in new clean energy sources to ensure revenue as well as the role of corporations in the power system and for a fair transition. The ability to use retained earnings to increase the equity of the three groups is limited because the return on equity of EVN, TKV and PVN is only at 6.0%, 9.7%, and 8.1% in 2021, plus a significant loss of $1.2 billion for EVN in 2022 and large fluctuations in the profits of TKV and PVN. Debt financing is a more feasible way for the three corporations to finance the energy transition. Debts can be in many forms, such as bank loans, loans through bond issuance, loans from donors, State credit, loans guaranteed by the Government or any other suitable form.

However, with the regulation that the debt-to-equity ratio in SOEs cannot exceed 3 times, the maximum amount of debt that EVN can borrow is $9.66 billion. This figure is $2.48 billion in the case of TKV and $43.81 billion in the case of PVN, respectively. Unless the equity of the three corporations increases, the total amount that the three corporations can take on additional debt is 55.9 B$ at current equity levels.

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 implemented based on 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 on aiming toward a Net-zero emission (NZE) target by 2050 has concretised Vietnam's commitment to climate protection. Being an emerging economy with greenhouse gas (GHG) emissions continuing to increase, strong actions are required in all sectors to achieve such an ambitious goal. Energy is a key sector to focus on since it accounts for the largest part of GHG emissions, occupying 65% of the total national emissions[(1)]. Since the power sector is still fossil fuel dependent (coal accounted for 32.5% of installed capacity and 46% of generation, while oil and gas accounted for 11.6% and 11%, respectively), it is crucial for Vietnam to speed up decarbonising the power sector toward the NZE target.

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

The Committee State Capital Management at Enterprises (CMSC) is 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, long-term development orientations need to take into account the factors of emissions reduction, better governance, efficient and sustainable business, and at the same time create conditions for 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:

[1] Bộ TNMT. 2020. Báo cáo Hai năm một lần lần thứ ba cho UNFCCC. https://unfccc.int/documents/273503.

- 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 conductive 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 realise the roadmap.

Deliverable 1 focuses on the general analysis of technical and financial conditions of the investment projects managed by the SOEs was handed over to ETP and CMSC in November 2022. This report is deliverable 2. This report consists of 8 chapters. Chapter 1 Introduction provided an overview of the assignment and expected outputs. Chapter 2 introduces the three energy SOEs in Vietnam, their role in the power sector, their drivers and challenges in developing energy transition roadmaps toward the national Net Zero Emissions target. Chapter 3 presents the methodology and inputs for technical analysis. Chapter 4 explains the technical modelling results of different scenarios for the SOEs to reduce their emissions from power production and the associated impacts on technical terms. Chapters 5 to 7 dive deeper into the financial, legal and

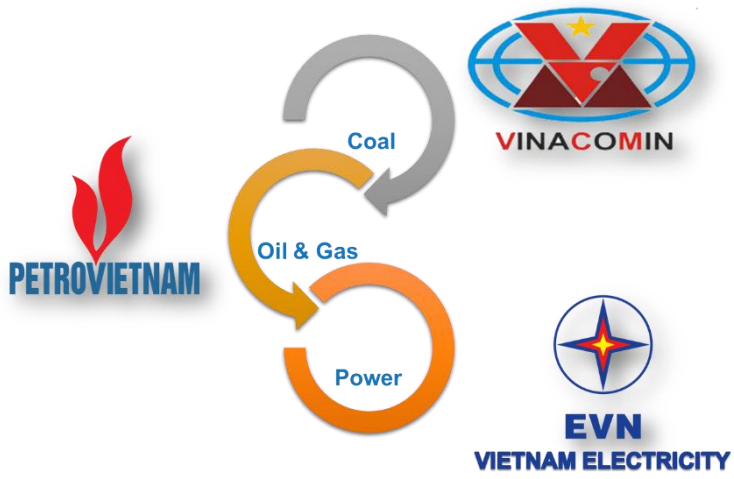
social implications for the SOEs as well as the international experiences in enabling a just transition. Finally, chapter 8 summarises the main findings and recommendations.

2. The role of SOEs in NZE goal

2.1. Energy SOEs in Vietnam

The Committee State Capital Management at Enterprises plays important role in ensuring the Governement role in capital management for energy and power sector. For power sector, CMSC is currently managing the state capital at Vietnam Electricity (EVN), Vietnam National Coal and Mineral Industries Group (VINACOMIN) and Vietnam Oil and Gas Group (PVN), three important SOEs in ensuring national energy security (see Figure 1).

Figure 1. Three energy SOEs in Vietnam



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 (GENCOs); the National Power Transmission Corporation (NPT) responsible for power transmission; and the 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. EVN owns the National Load Dispatch Center, which serves as the system and market operator (SMO). It also owns strategic power plants, including 8.6 GW multipurpose hydropower plants (see Figure 2) and the Electric Power Trading Company (EPTC). It is the majority shareholder of partially privatized power plants in the Vietnam Competitive Generation Market (VCGM).

- **Power Generation Corporations (GENCOs)** 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 under progress. GENCOs will continue participating in the competitive wholesale power market after their equitization.

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 Power[2]. PVN directly manages the power plants such as Thai Binh 2, Song Hau 1 and Long Phu 1.

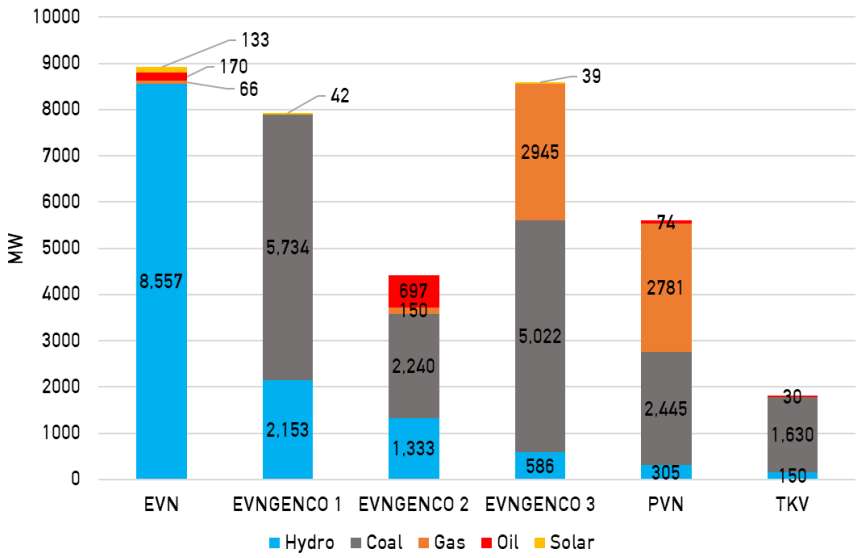
Vietnam National Coal-Mineral Industries Holding Corporation Limited (VINACOMIN or TKV) is a state-owned corporation established in 1994. TKV exercises the rights and obligations of owners of capital shares in subsidiaries and affiliated companies in proportion to its investment capital in these enterprises. 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 infrastructure 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 Janurary 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

[2] Tài liệu Hội nghị người đại diện Tập đoàn Dầu khí Việt Nam năm 2021, ban hành tháng 01 năm 2022

Power is mostly focusing on investment, construction, exploitation and operation of power plants.

Figure 2. Installed capacity by sources of SOEs in 2021



Source: VIETSE visualized based on data from EVN

Since the total emssions from power activities of the three SoEs was taking a high share as 69% of total national emissions (138 MtCO2) in 2021, their contributions will be the key factors involved in the energy transition towards achieving Vietnam's NZE target by 2050.

2.2. Energy SOEs' role in Vietnam's power sector

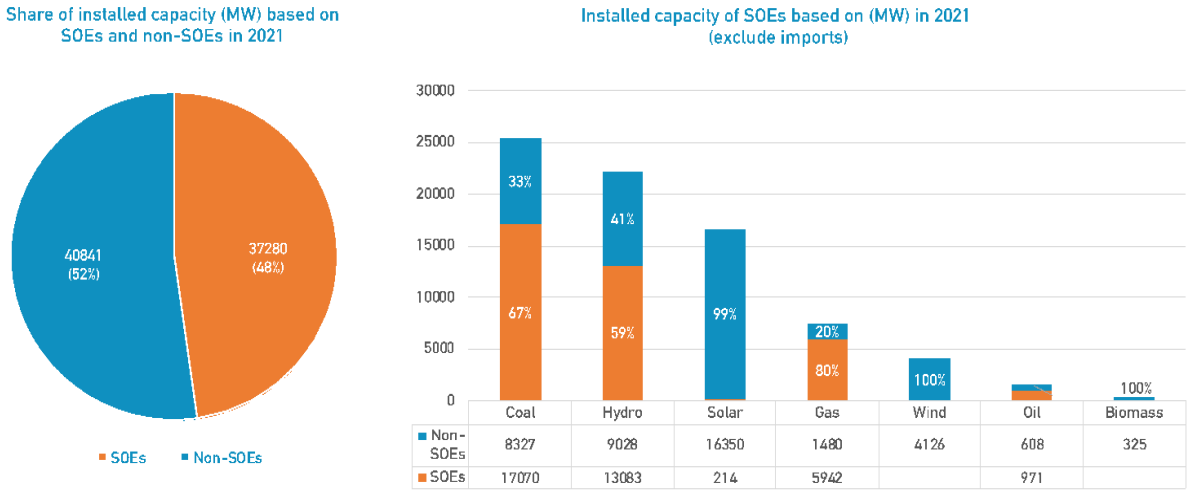
Before the renewable energy "booming" during 2019-2021, the three energy SOEs used to dominate power generation when they owned 69% of the total installed capacity at the end of 2018[3]. However, by the end of 2021, the share of SOEs in power capacity ownership sunk to 48%. It means more generation capacity is owned by the private sector than EVN, PVN and VINACOMIN combined. Figure 3 shows the comparison of the power mix between SOEs and non-SOEs. The three SOEs possess mostly conventional power plants like coal, gas and hydro, while the private sector owns the majority of renewable power plants (solar and wind).

However, the three SOEs still provided 58% of the total electricity output (Figure 4) because SOEs' plants are mostly hydro, coal and gas power, which have higher capacity factors than renewable energy plants. This means SOEs still maintain their essential role in providing electricity for the country's socioeconomic development. Owning these dispatchable sources, the SOEs also support the reliability of the power supply. It is crucial in circumstances where the state is still regulating

[3] EVN's Power system operation report 2018

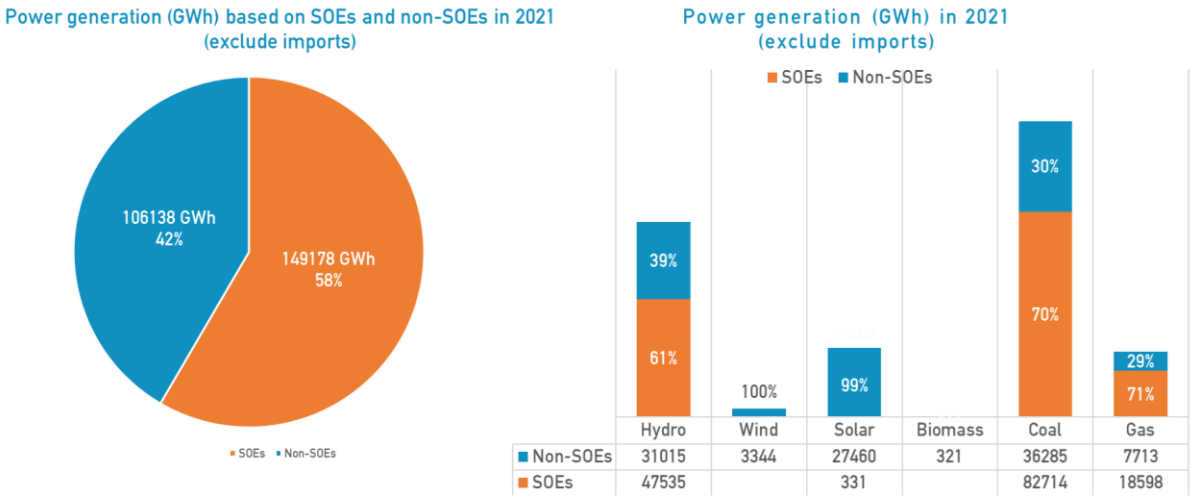
the electricity price to ensure affordability and access to electricity for all, the target that aligns with the Sustainable Development Goal SDG 7 set by the United Nations.

Figure 3. SOEs share in power system by installed capacity



Source: VIETSE visualized based on data from EVN

Figure 4. SOEs' share in power system by electricity output



Source: VIETSE visualized based on data from EVN

2.3. Drivers for SOEs to develop NZE strategy

Vietnam made strong climate protection commitments to the international community at the landmark COP26. In Glasgow, Prime Minister Pham Minh Chinh affirmed that with international support on technology transfer, finance and capacity building, Vietnam will aim to reach NZE by 2050. Vietnam is also one of the 47 signatories of the Global Coal to Clean Power Transition

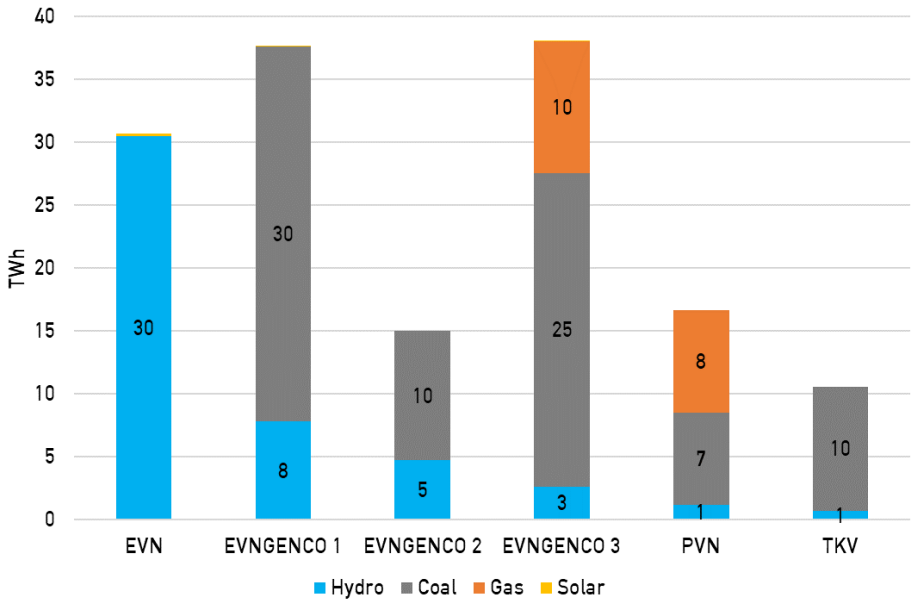
Statement[4]. The countries commit to promoting power generation from clean sources and transit the unabated coal power generation by 2040s.

To concretize the statement, the Government of Vietnam has issued several important Decisions, such as Decision 888/QD-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/QD-TTg dated 26/7/2022 approving the national strategy for climate change until 2050 (*Decision 896*).

The energy transition is inevitable to meet the climate neutrality target by mid-century. Scientific evidence has shown that accelerating clean and inclusive energy transitions is one of the key pillars to protecting the climate. Decision 888 and Decision 896 also highlighted the role of energy transition in achieving the NZE target. As the key stakeholders in Vietnam's energy sector, there is no doubt that the three SOEs will be an important factor for the country in fulfilling the NZE commitment.

The power sector is an important source of greenhouse gas emissions, to which SOEs are still the major contributors. Figure 5 shows that except for EVN, which owns the large strategic hydropower plants, EVN's GENCOs generation mix is fossil fuel heavy (accounted for 79%, 67% and 92% power output of GENCO 1, 2 and 3, respectively). While at PVN and VINACOMIN, the shares are 94% and 91%. Coal power generation is the sector for SOEs to focus on because it accounts for the majority share of the emissions from power generation of the SOEs (Figure 5).

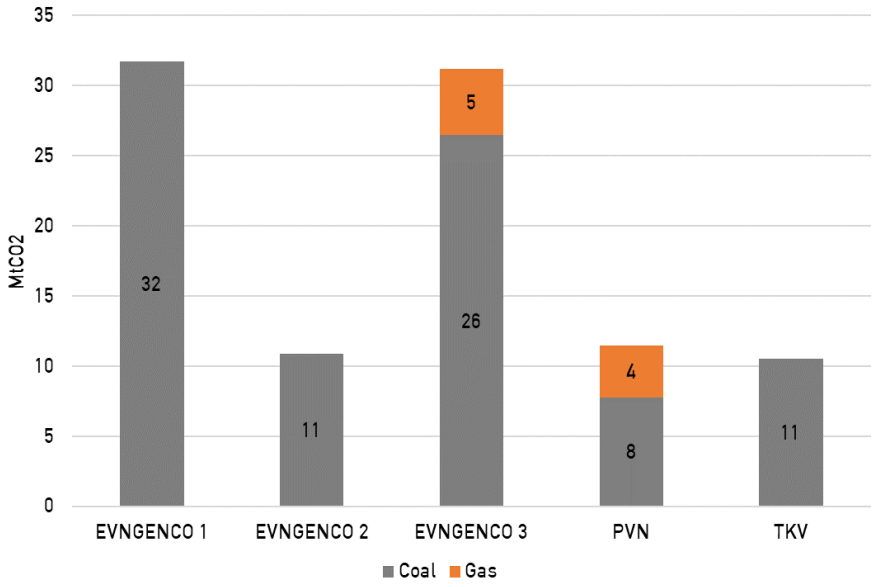
Figure 5. Power generation by sources of SOEs in 2021



Source: VIETSE visualized based on data from EVN

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

Figure 6. Estimated CO_2 emissions from power generation for SOEs in 2021



Source: VIETSE calculation

2.4. Challenges for SOEs to chart the energy transition

2.4.1. Institutional challenges

- EVN and PVN have identified energy transition (ET) as an important topic and are in the process of developing their ET strategies. PVN is currently working with two consulting firms on ET and emissions reduction, while EVN is sourcing for one. However, at the moment, their progress is still pending for the National Energy Master Plan and Power Development Plan to be approved for more specific orientation to base their ET strategies.

- PVN expressed their interest in diversifying their fields of business to include renewable energy investment. However, PVN needs to have approval from Politburo to be able to invest in Renewable energy in general and in offshore wind in particular.

- While waiting for the approval of PDP8, TKV has worked 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 pilot project for biomass cofiring at Cao Ngan Thermal Power Plant from 2028.

2.4.2. Technical challenges

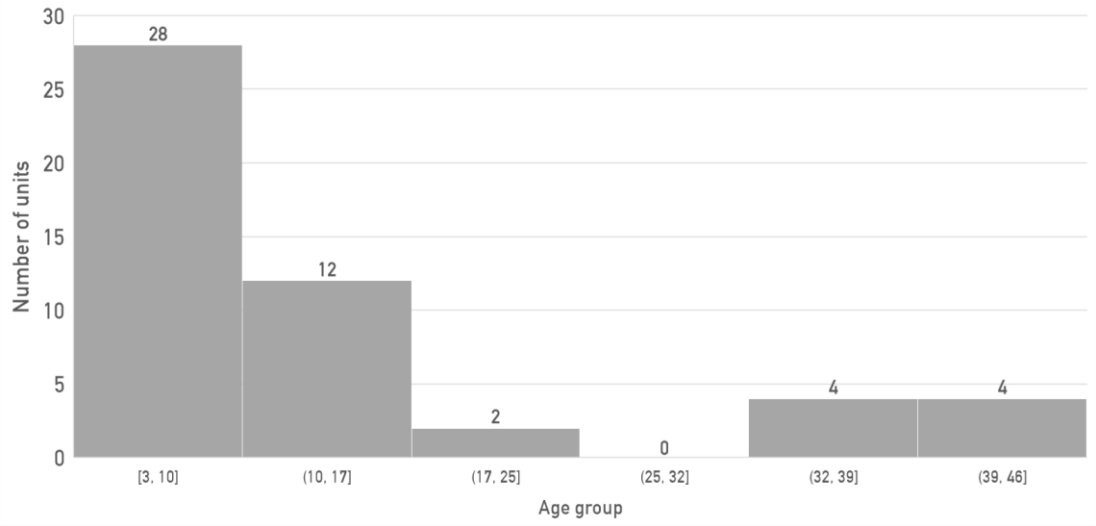
- The SOEs, especially EVN, are responsible for ensuring the energy security of the whole country. They have to balance the energy transition to cleaner and low-emissions sources

- SOEs owned 67% of coal power capacity. Except for a few old plants (such as Ninh Binh and Pha Lai), the majority of SOEs' coal fleet is quite young (Figure 7), making it harder to reduce their emissions by cutting down power generation or early retirement.

- During the meetings with the Consultants, SOEs mentioned the difficulties in project assessment and pre-feasibility planning for the fuel conversion solutions. They also expressed concerns that there are insufficient assessments on how the solutions can be realised.

- The readiness of mitigation technologies such as Carbon Capture, Usage and Storage (CCUS), green hydrogen production and application are still low in Vietnam and even in the international market.

Figure 7. Age distribution of existing coal power units of SOEs



Source: VIETSE visualized based on data from EVN

2.4.3. Financial challenges

- Finance sources for investment in new power sources and grid expansion will be challenging, due to the limited credibility and the lower average power selling price than the production cost (9.27%) that led to a large loss (in 2022 ~ 26,200 billion VND). These factors will push the power sector into a risky situation, especially when the power demand is continuing to increase for the next five years. Financing required for power development is estimated at 105 – 142 B$ for 2021-2030 and 325 – 483 USD for 2031 – 2050[5]. It is a real challenge for Vietnam's power sector to mobilize necessary finance, especially under the context of energy crisis resulting to a high volatility of fuel prices (coal, oil and gas),

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

economic downturn, the annual country's public debt (for 2021-2025) is allowed up to 60% of GDP[6] (2021: 43.1%).

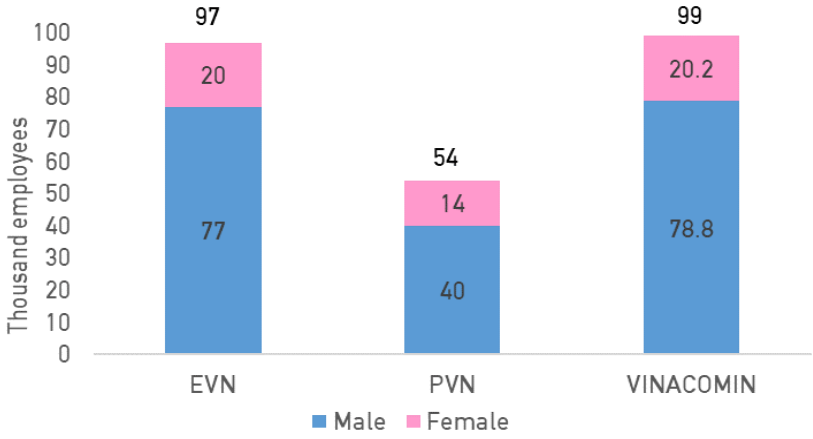
- EVN has stated in the meeting with the Consultant on 13th September 2022 that their biggest challenge for energy transition is the large investment costs while ensuring that electricity prices are in balance with affordability and approved by the Government. According to calculations, from 2025 to 2030, EVN needs to mobilize investment capital of up to 6 B$ annually for power source and grid projects in the condition that access to concessional loans is very limited[7].

2.4.4. Social challenges

- Ensuring social security for SOEs' ~250,000 employees (Figure 8) 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.

Figure 8. Labour in three energy SOEs in 2021



Source: VIETSE visualized based on [8]

[6] Resolution No. 23/2021/QH15 dated 28/7/2021.

[7] EVN: Cần vượt qua thách thức nào để đáp ứng nhu cầu chuyển dịch năng lượng?

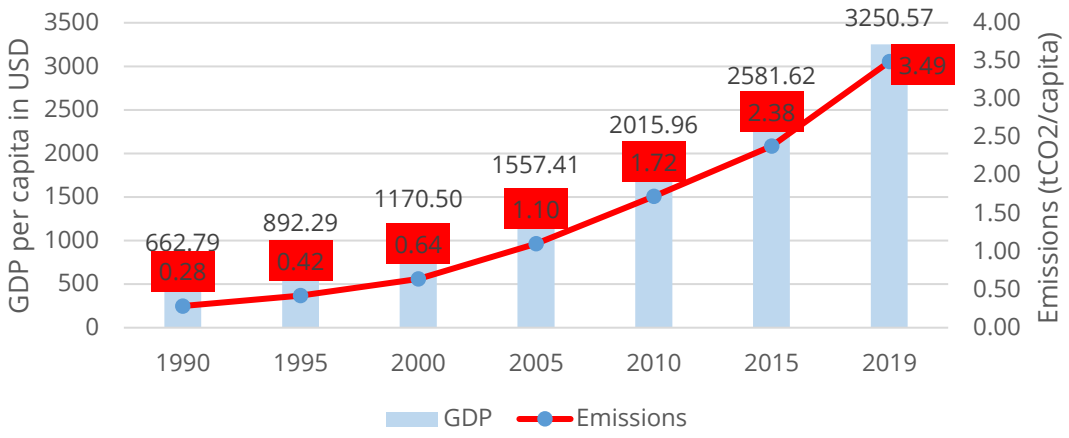
[8] https://www.evn.com/d6/news/Lao-dong-nu-cua-EVN-Tang-ca-luong-va-chat-0-12-29327.aspx
https://pvn.vn/chuyen-muc/doan-the/phu-nu-dau-khi-vung-/6f119208-fa824e2d-9a15-9542bc69abe9
http://www.vinacomin.vn/tintucvinacomin/tkv-tichcuc-cham-lodoi-songlao-dongnu-2020102016629325

3. Scenario design and methodology

3.1. CO_2 emission target and net zero pledges

In the last three decades, Vietnam has witnessed a fast-growing economy associated with increased GHG emissions (Figure 9). According to the latest National GHG inventory, the country's total emissions were 316 MtCO2e in 2016[9]. Since 2000, emissions from energy activities (including transport, industry and residential) have grown quickly, accounting for 65% of the total emissions by 2016. On the other hand, Vietnam is one of the most vulnerable countries to climate change. Realising the urgency of addressing the climate crisis, Vietnam has shown determination to join the global effort to meet Paris Agreement's 1.5°C target.

Figure 9. GDP and CO_2 emissions per capita of Vietnam



Source: VIETSE plotted based on the WB data

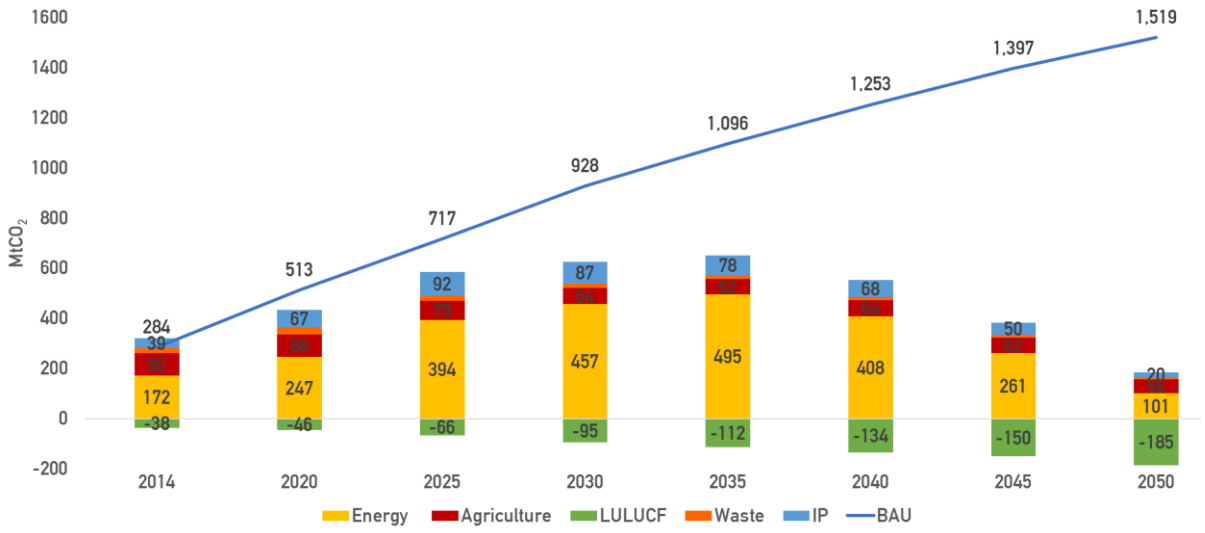
3.1.1. Net Zero Emissions (NZE) announcement

At COP26, Vietnam's Prime Minister announced the country's aim to reach "net zero" by 2050. Vietnam also signed the Global Coal to Clean Power Transition Statement and the Global Methane Pledge. This shows Vietnam's responsible, strong and ambitious commitment, in line with the general trend and supported by many countries.

[9] MONRE. (2020a). Vietnam Third biennial updated report to the United Nations Framework Convention on Climate Change. Ministry of Natural Resources and Environment. https://unfccc.int/sites/default/files/resource/Viet%20Nam_BUR3.pdf

After COP26, the Vietnamese Government has taken actions to implement the commitment. In July 2022, the Prime Minister approved the National Strategy on Climate Change, which charts the course to NZE by 2050 (Figure 10). Emissions are expected to peak in 2035, and Energy activities (including power, transport, industry, residential and services sectors) are the largest GHG emitters and will have to reduce 91.6% compared to BAU by 2050.

Figure 10. Net Zero Emissions scenario to 2050 in National Strategy on Climate change



Source: Technical report for National Strategy on Climate Change

3.1.2. Updated NDC 2022

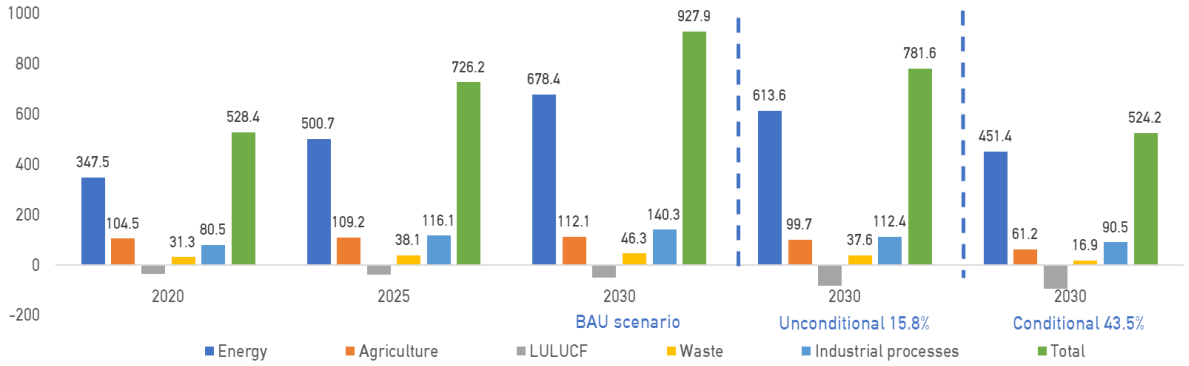
As a signatory of the Paris Agreement, Vietnam submitted its INDC in 2016 with an unconditional contribution of 8% and a conditional contribution of 25% compared to BAU. The NDC submitted in 2020 slightly raised the ambition to 9% with domestic resources and to 27% with international support. However, after COP26, the NDC has been 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 $MtCO_2eq$ (NDC 2020 is -9%).
- Conditional contribution: -43.5% GHG emissions by 2030 compared to BAU, equivalent to 403.7 $MtCO_2eq$ (NDC 2020 is -27%).

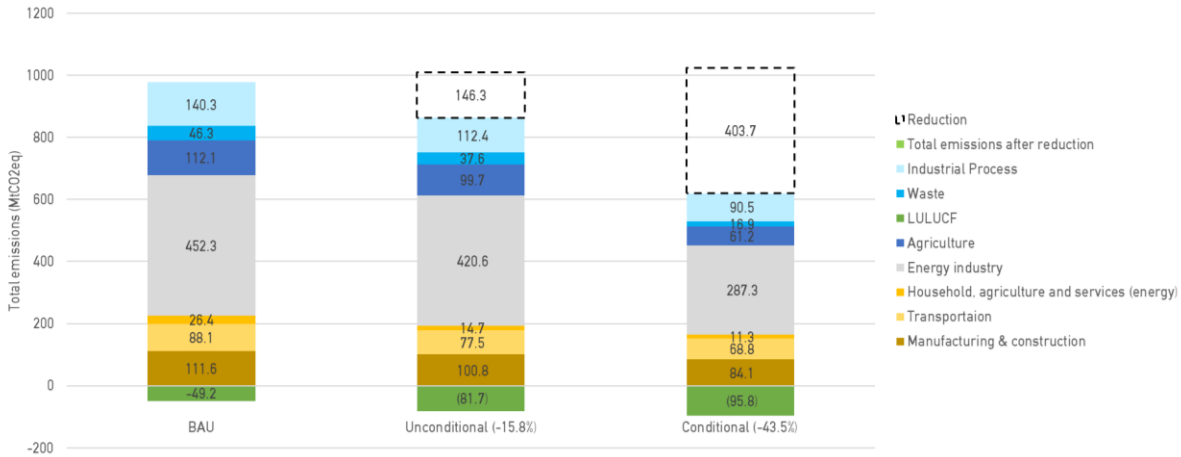
The BAU emissions in the updated NDC are the same BAU of the National Strategy on Climate Change. Sectoral emissions in the unconditional contribution and conditional contribution scenarios are presented in Figure 11. In 2030, the energy sector is expected to reduce emissions by 10% unconditionally and by 33% conditionally. The contributions are estimated by calculating the emissions reduction potential of each sector, in which the power sector's potential is estimated at 165 $MtCO_2$ with international support and 31.7 $MtCO_2$ without. Based on the emissions reduction potential, the remaining emissions in Conditional and Unconditional scenarios are broken down by sector, as presented in Figure 12.

Figure 11. GHG emissions – updated NDC November 2022



Source: Technical report for 2022 Vietnam NDC

Figure 12. Comparison of GHG emissions in NDC-2022's scenarios



Source: Technical report for 2022 Vietnam NDC

3.1.3. Just Energy Transition Partnership (JETP)

A Just Energy Transition Partnership (JETP) is an agreement in which developed countries provide financial support for developing countries to transition to green energy. The funding is in the form

of grants, concessional loans, investment, and risk-sharing instruments provided by the public and private sectors.

Vietnam JETP

After the negotiation process, a JETP was established between Vietnam and the IPG (EU, UK, US, Japan, Germany, France, Italy, Canada, Denmark and Norway) in December 2022[10]. JETP will mobilise 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:

- develop an ambitious and reliable long-term legal framework for the green transition of the economy;
- accelerate decarbonisation of the electricity system to peak emissions at 170 $MtCO_2$ in 2030 instead of 240 $MtCO_2$ 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);
- lead a just transition;
- educational, vocational training and re-skilling programs;
- define the role of the private sector and enable proactive participation in the transformation process;
- create opportunities for technological innovation and private investment to create green and decent jobs;
- negotiate the halting of investment in CFPP where appropriate;
- negotiate the closure of old, inefficient unabated coal-fired power plants to facilitate access to clean energy;
- develop renewable industry (RE hub, storage battery, RE equipment manufacturing, green hydrogen production, offshore wind platforms…)
- work towards the establishment of a centre of excellence for renewable energy in Vietnam

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

[10] Political Declaration on establishing the Just Energy Transition Partnership with Viet Nam.

3.2. Approach and scenarios narrative

As explained in Section 3.1.1 and following the instruction of the ToR, the roadmap toward NZE must covers emission reduction from all fossil fuels combustion for power generation, in which we focus more specifically on reducing emissions from the largest source – coal-fired power plants of SoEs. Therefore, the Consultant has developed the overall methodology to address this matter. The study implementation process, depicted in Figure 13, is divided into four steps as follows:

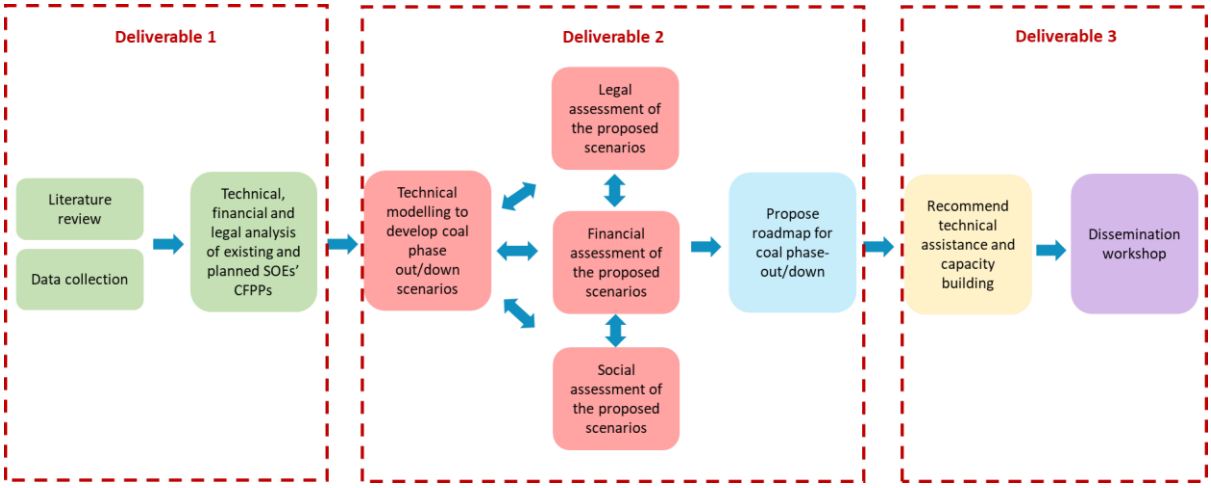
Step 1: Assess the current operating conditions of 403 power plants in the system (excluding the rooftop solar and small hydropower plants). Additionally, the Consultants conduct the assessment on financial, employment situation, and ownership structure of coal power plants in Vietnam. Review international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

Step 2: Conduct the technical modelling different alternative scenarios for emission reduction of 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 adjustment, if necessary, to derive a suitable solution.

Step 4: Synthesise and propose recommendations.

Figure 13. Overall methodology



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 on 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. The scenario description is presented in the Table 1.

Table 1. Scenario narratives

Scenario	Emission reduction roadmap for power sector
KB_AR	Demand: • 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 qnd 38% in 2050 compared with the PDP8. Supply: • 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: - 10% after 10 years of operation - 30% after 15 years of operation • Phase out CFPPs after 25 years of opeation. Emissions reductions: • Emission roadmap towards NZE 2050.
KB_DD	Demand: • 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 qnd 38% in 2050 compared with the PDP8. Supply: • 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:

- 30% after 10 years of operation
- 60% after 15 years of operation

- Phase out CFPPs after 20 years of opeation(*).

Emissions reductions:

- Deep decarbonization of the power sector to be in line with JETP declaration in 2030 and emission roadmap towards NZE 2050.

(*) The above emission reduction roadmaps are designed and inspired from the findings of international experience and research review[11]. The alternative scenarios on CFPPs decarbonization in Indonesia proposed that the CFPPs will operate no longer than 20 years.

3.3. Technical assessment approach

The method of data collection:

- Draft regulations and reports on the power sector have been published
- Working sessions with CMSC and SOEs
- Field trips at some of the factories of SOEs
- International research papers
- Legal documents

Built on the technical, financial and legal assessment findings, the Consultants have developed the scenario narratives for reducing emissions from SOEs' coal power generation, the largest source of CO2 emissions of SOEs. The narratives presented in Table 1 is based on the premise that the CFPPs will reduce and eventually cease the power generation from burning coal.

For each scenario, the technical assessment is conducted to find out the following:

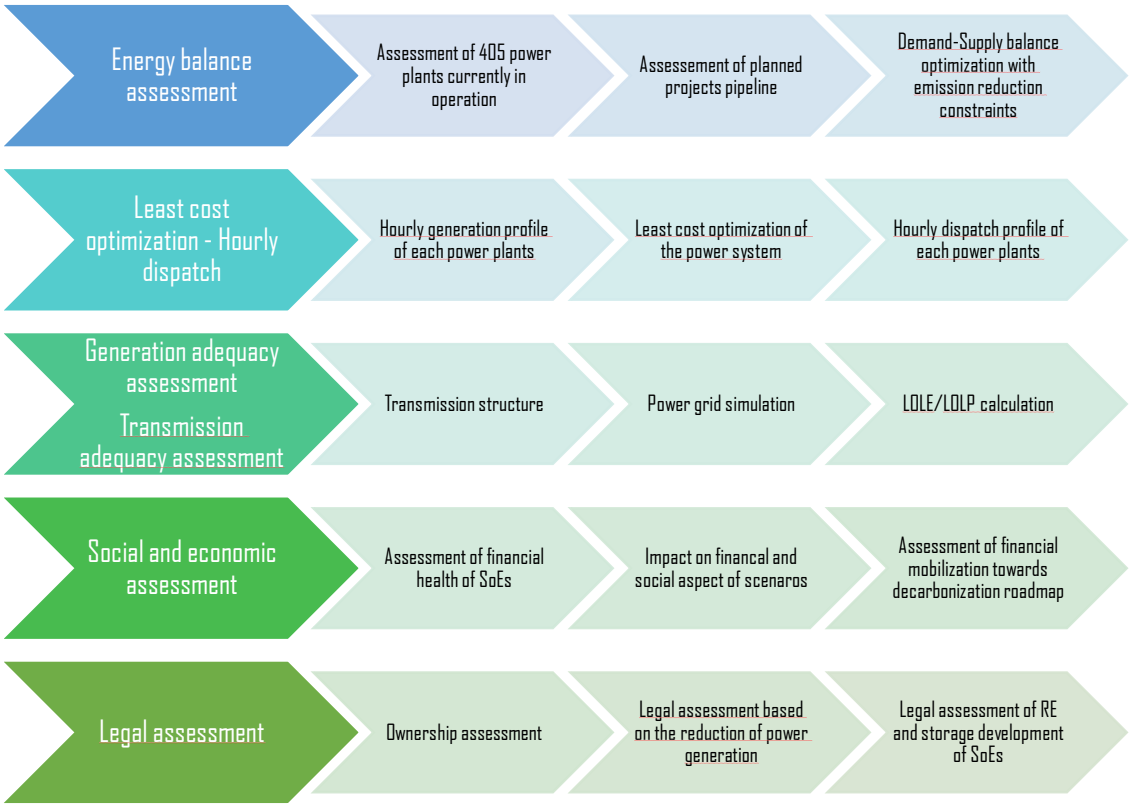
- How much of the power generation from coal is reduced?
- How much of the CO_2 emissions are reduced?
- How much renewable energy is needed to compensate for the reduced power outputs when coal generation is phased down/out?
- What is the security of each scenario's power supply to 2030, considering grid constraints?

The first three questions are addressed using a model built by the Consultants in LEAP. The energy balance has been modelled for the 2023 – 2050 period. The 2023 – 2030 has been simulated with a single year timestep while for 2031 – 2050 with 5 years timestep. The security of the power supply is conducted using Digsilent Power Factory software's Unit Commitment and Power Flow modules.

[11] 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

This study integrates a full model of Vietnam's power system in Digsilent/Powerfactory to assess the technical impact of developed scenarios on the security of supply for the whole system. This study investigates both generation adequacy and transmission adequacy of developed scenarios with the following calculation Unit Commitment and Power Flow modules.

Figure 14. Simulation flows for each decarbonization scenario



3.3.1. Generation adequacy assessment

Generation adequacy refers to the system's ability to meet the demand by calculating the LOLE/LOLP parameters. This is one of the most important parameters 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, especially RE sources, the generation characteristic curve for each type of generation (offshore wind power, onshore wind power, and solar power) has been developed in detail for the full simulation year. In addition, the operating parameters of conventional power plants (thermal and hydroelectricity) are not reported comprehensively and in detail. The random generation models developed for these generators will be based on the number of operating hours per year and estimated maintenance hours for each unit.

The generation adequacy is calculated based on random probabilities in a Monte-Carlo loop (10000 times). The LOLE/LOLP value will be calculated by running a Monte Carlo loop using onshore wind, offshore wind, and random solar models.

3.3.2. Transmission adequacy assessment

Based on hourly load demand profiles, economic dispatch could be run to yield the optimised power mix for developed scenarios. The Unit Commitment and Dispatch Optimization is run for the whole year of 2025 and 2030, equivalent to 8760-time steps. The DC-load-flow-based simulation is performed first to identify the optimal dispatch for each generation unit, considering only the cost constraints. Then, the AC-load-flow-based simulation is performed to redispatch all generation units to fulfil the network constraints (inter-regional capacity, voltage limits).

The tool optimises 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 checking the voltage level, loading of transformers and transmission lines, and inter-regional transmission capacity. Results of the most critical dispatch hours (or snapshots) are selected to show the grid operation and response of the transmission system with optimal results. If the system can operate adequately in critical snapshots, the grid can respond well to the remaining operation cases. The interesting snapshots are described in Table 2.

Table 2. Six critical snapshots for transmission adequacy assessment

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

3.4. Inputs and assumptions

On the basis of working sessions with EVN, TKV, and PVN and surveys at several factories of the three groups, a description of basic information and financial capacity about the plant will be made and presented with the substance as presented below. This provides the information required to serve as a basis for assessing the impact on the financial and economic aspects under the selected scenarios and determining the capital and investment needs 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 factos 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 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

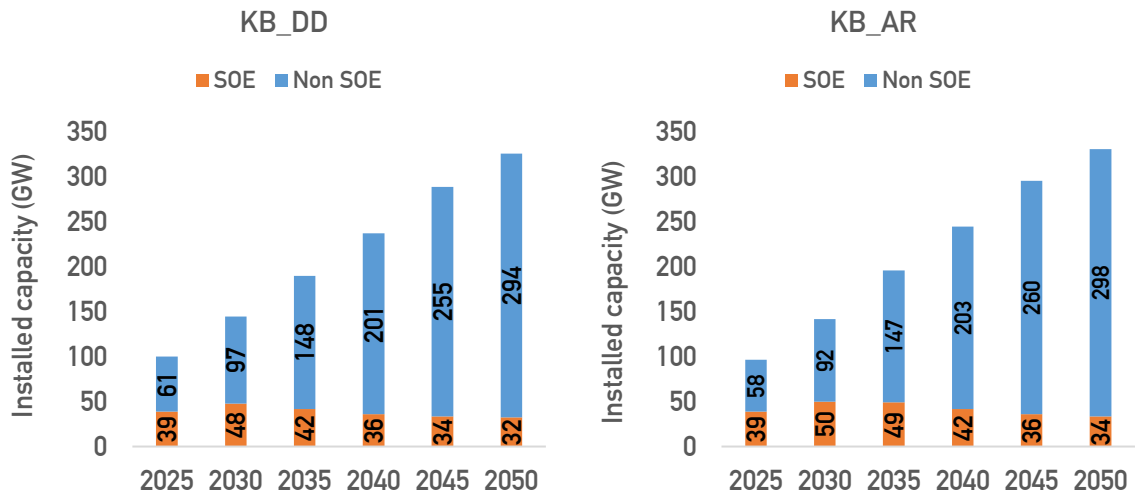
Source: Report on Emission Factor (EF) of Vietnam's electricity grid in 2020

4. Technical modelling results

4.1. Installed capacity

Figure 15 shows the share of installed capacity between SOEs and non-SOE under the current investment pipeline in the two scenarios. In such a circumstance, the share of SOEs in total installed capacity will shrink over time, and the dominant role will be taken by the non-SOEs actors. In KB_DD, non-SOEs will account for the higher share, and their dominance will continue to increase to 67% in 2030 and 90% in 2050. The KB_AR scenario shows a higher SOEs' capacity than KB_DD in 2030. This is because more coal capacity remained in KB_AR (17.9 GW compared to 16.7 GW) when CFPPs ceased operation after 25 years instead of 20 years as in KB_DD.

Figure 15. Share of SOEs by installed capacity

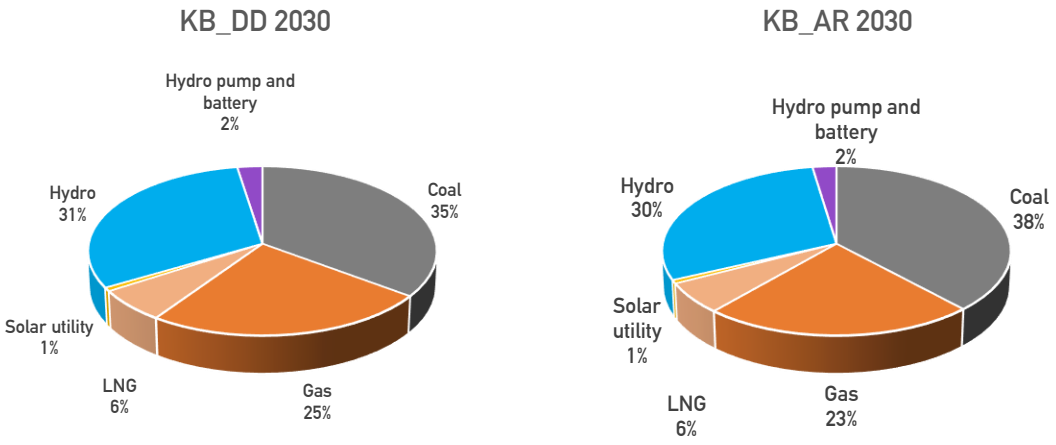


Source: VIETSE

Figure 15 provides a more detailed picture of 2030 with the installed capacity by source. When PVN and TKV do not make additional investments in RE, SOEs' power sources are mostly concentrated in conventional technologies. SOEs are in charge of many large power projects in the development pipeline:

- EVN: 1.4 GW coal Quang Trach 1, 3.6 GW gas O Mon III, O Mon IV, Dung Quat I, Dung Quat III, 1.5 GW LNG Quang Trach II, 1.9 GW hydropower extension
- PVN: 1.2 GW coal Long Phu 1, 1.5 GW gas Mien Trung I and II, 3 GW LNG Nhon Trach 3&4 and Quang Ninh 1 (invested by PV Power).
- TKV: 110 MW coal Na Duong 2

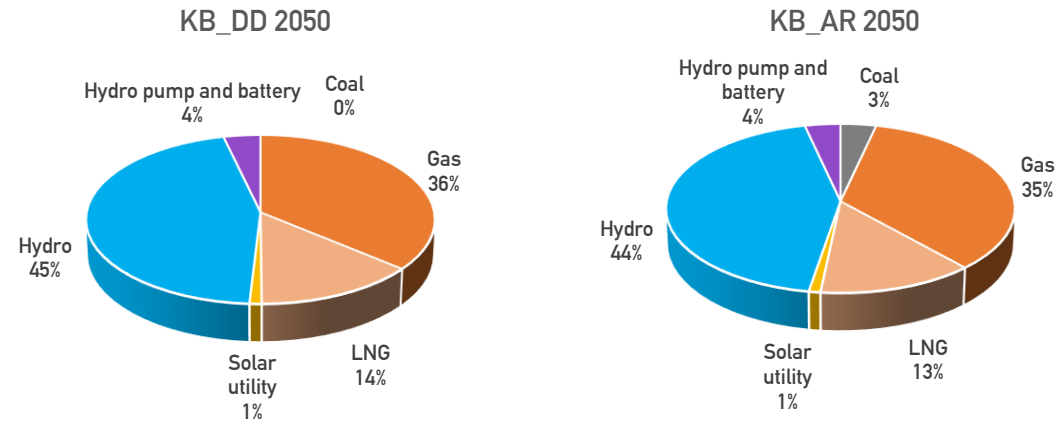
Figure 16. Installed capacity of SoEs by source in 2030



Source: VIETSE

Figure 17 provides the share of different sources by capacity in 2050. CFPPs are completely phased down in KB_DD, while in KB_AR, only Long Phu 1 CFPP (1.2 GW of PVN) is still being operated for five more years. Gas and hydropower are their two main power resources.

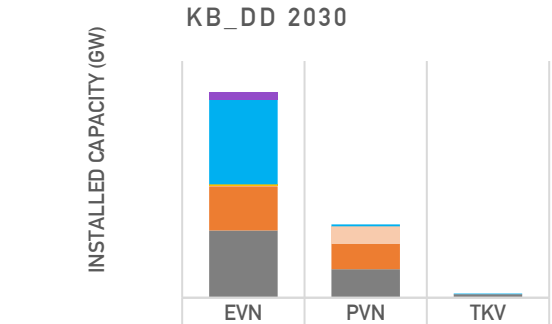
Figure 17. Installed capacity of SoEs in 2050



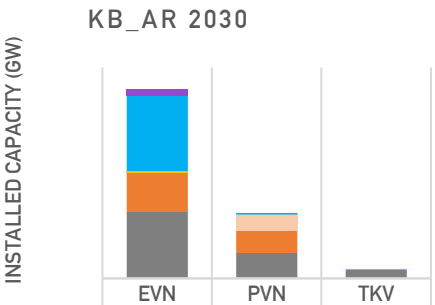
Source: VIETSE

The installed capacity of each SOE by 2030 is provided in Figure 18. In 2030, EVN will still have the highest installed capacity and continue to play the most important role in Vietnam's power sector among the three SOEs, followed by PVN with their gas and LNG portfolio. The installed capacity of TKV shrunk significantly in the KB_DD scenario, where many of their coal power plants (about 1 GW in total) will cease generating power after operating for 20 years and more. EVN also reduced their coal power capacity from 14 GW to 11.4 GW by 2030, while PVN increased theirs by 2.4 GW with new CFPPs Thai Binh 2 and Long Phu 1.

Figure 18. Installed capacity of each SOE



	EVN	PVN	TKV
Hydro pump and battery	1.2	-	-
Hydro	14.3	0.3	0.2
Solar utility	0.3	-	-
LNG	-	3.0	-
Gas	7.4	4.3	-
Coal	11.4	4.8	0.6



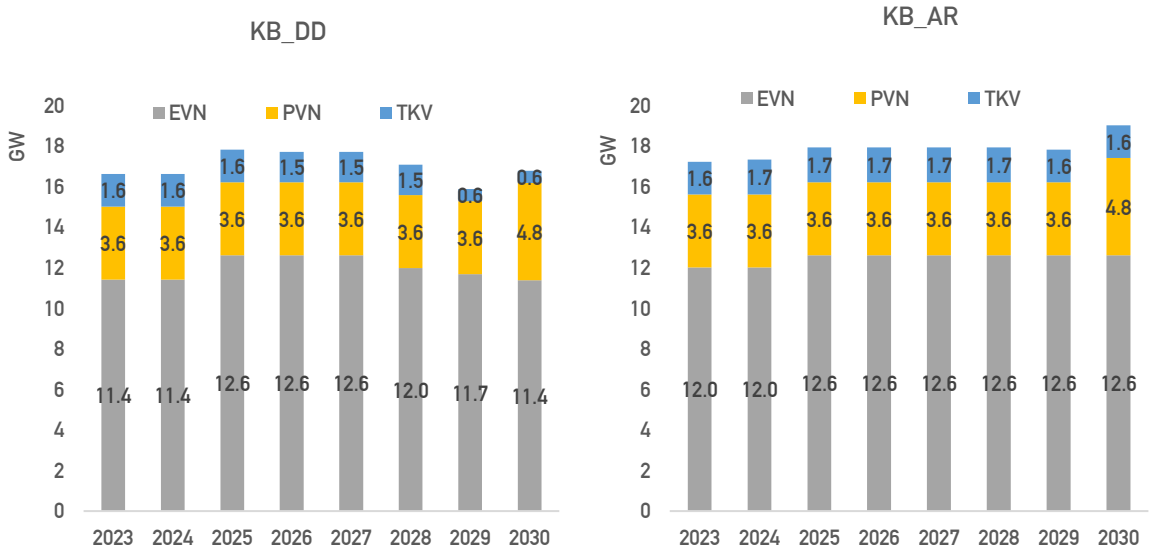
	EVN	PVN	TKV
Hydro pump and battery	1.2	-	-
Hydro	14.3	0.3	0.2
Solar utility	0.3	-	-
LNG	-	3.0	-
Gas	7.4	4.3	-
Coal	12.6	4.8	1.6

Source: VIETSE

At the SOEs level, a similar situation is observed in KB_AR compared to KB_DD, with non-SOE dominating the RE new investment under the current pipeline (Figure 18). EVN, PVN and TKV keep their pipeline within conventional power as in draft PDP8.

The coal capacity of each SoE is presented in Figure 19. The peak coal capacity of 3 SoE is observed by 2025 at 17.8 GW for KB_DD, while this peak is getting 19 GW by 2030 of KB_AR since the phase-down power plants are following a slower roadmap.

Figure 19. Coal capacity of 3 SOEs in the two scenarios



Source: VIETSE

4.2. Power generation

For power generation, with the current pipeline, the share of SOEs in total system output will be reduced dramatically, especially after 2030. In 2021, SOEs' share in power generation was 58%, but by 2030, it will be reduced to 38% and shrunk further to 10% by 2050 in the KB_DD scenario (Figure 20). Coal power generation from SOEs will be reduced by 29 TWh in 2025 and by 57.4 TWh in 2030.

This indicates the orientation of attracting more private-sector investment in power generation. However, it also shows that SOEs will no longer dominate the generation market. More private power sources mean more competition in the wholesale electricity market, driving the electricity price closer to the generation costs and being more volatile based on the inputs. This will be a challenge in case the state still wants to regulate the electricity tariff for end-users to ensure the socio-economic development goal.

In KB_AR, SOEs are also losing their dominant share in power generation (Figure 20). Their power generation shrinks when coal capacity is gradually retired after 25 years in service (-15.6 TWh by 2025 and -28.4 TWh by 2030) ***without additional new RE capacity invested*** by SOE.

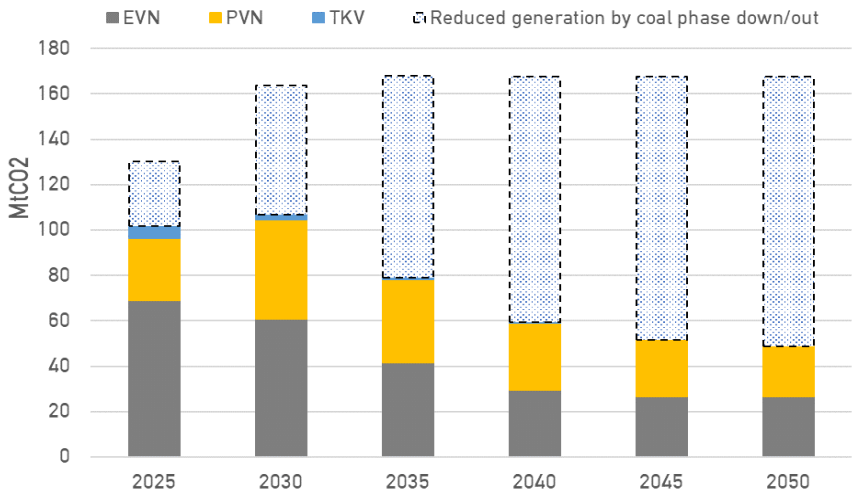
Figure 20. Share of SOEs' power generation

Source: VIETSE

4.3. Emissions

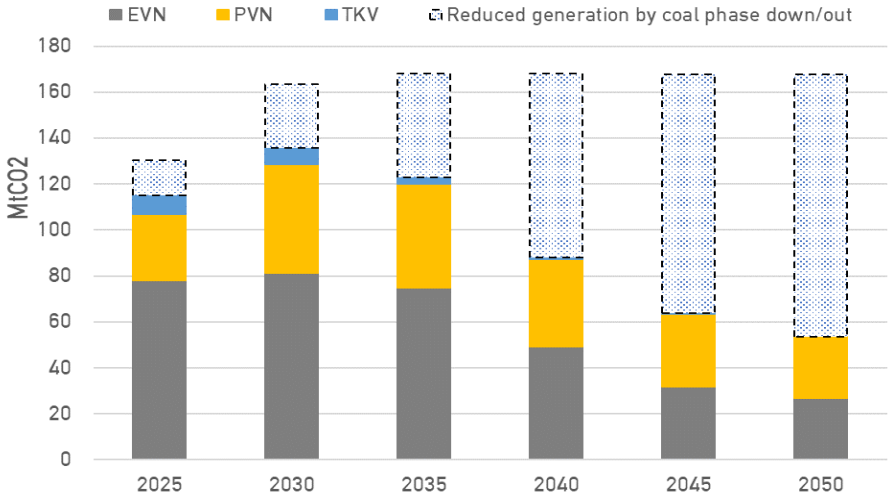
CO_2 emissions from three SOEs in power production activities (coal, gas and oil power plants) will be reduced in the future proportionally to the power generation from fossil fuels. Their emissions will peak in 2030 because of reducing and ceasing power generation from some coal power plants after 20 years of operation.

Figure 21. CO_2 emissions of SOEs in KB_DD



Source: VIETSE

Figure 22. CO_2 emissions of SOEs in KB_AR

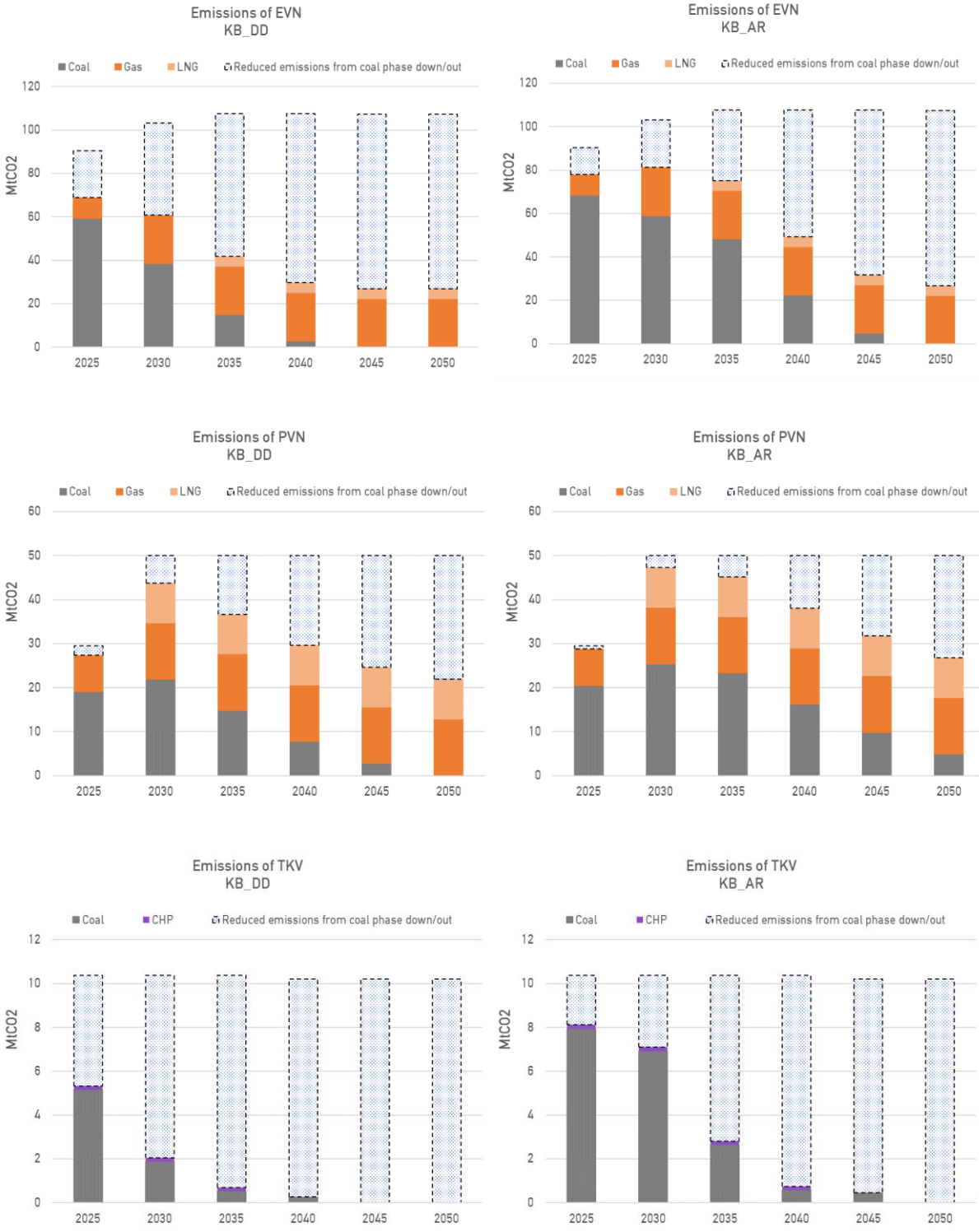


Source: VIETSE

In KB_AR, SOEs' emissions curve toward 2050 is less steep than in KB_DD. EVN continues to be the largest emitter among three SOEs until 2045 when PVN surpasses it.

EVN has the sharpest decrease in emissions from 2025 to 2050 as their share of old CFPPs is the largest among the three SOEs. Similarly, TKV also reduced their emissions significantly and will no longer emit CO_2 from power generation starting in 2045. PVN will peak their emissions in 2035 because they have a rich portfolio of gas and LNG projects, and their CFPPs are young and will still maintain the operation by 2030. Emissions of PVN will slowly decrease and will end up higher than EVN's emissions by 2040. Detailed CO_2 emissions by each SOE and by source from 2025 to 2050 are shown in Figure 23.

Figure 23. Detailed calculation of CO_2 emissions by each SOE

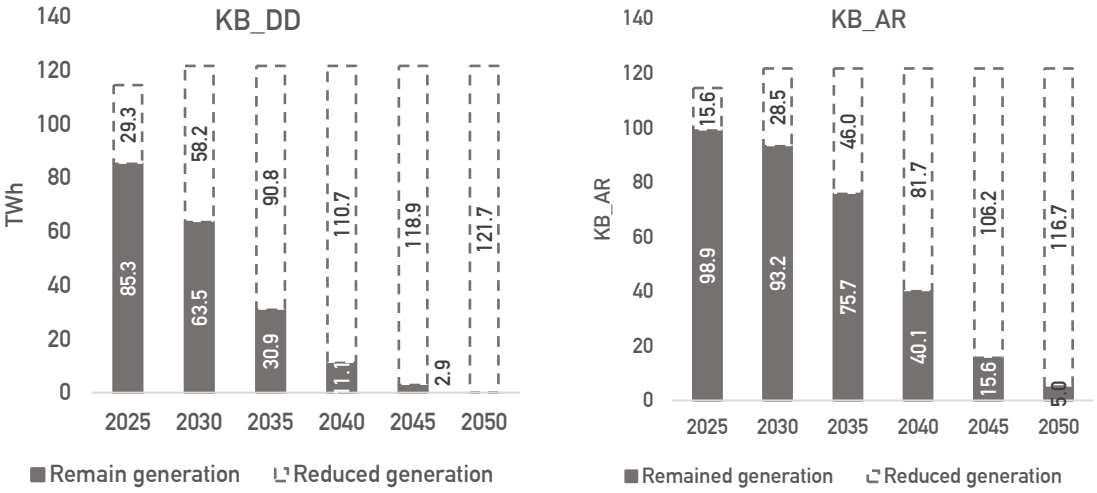


Source: VIETSE

4.4. Reduced coal power generation and its impacts

In the KB_DD scenario, coal power generation is set to be reduced steeply. Since SOEs own a large share of existing and planned coal fleets, they are also affected by the reduction of coal power output. Figure 24 shows the reduced coal power generation in the two scenarios where KB_DD has a more aggressive reduction compared to KB_AR.

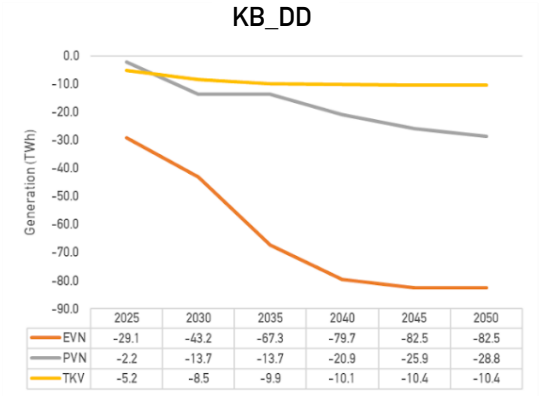
Figure 24. Coal power generation of SOEs



With the largest coal power capacity and many long-life plants, EVN will have the fastest coal power reduction rate in the period from 2030 - 2040, and the reduction is also the most, having the greatest impact on the system (Figure 25). TKV's plants also have a long average life, so they will also reduce output fastest in the period of 2030 - 2035. For PVN, the group currently has two plants: Vung Ang 1 (operating since 2013-2014) and Song Hau 1 (operating since 2020-2021). With the age of the plant still very young (Figure 26) and currently investing in two more coal power projects (Thai Binh 1 and Long Phu 1), PVN's coal power output will increase in the period of 2030 -2035, then it will decrease in the period 2035 - 2050.

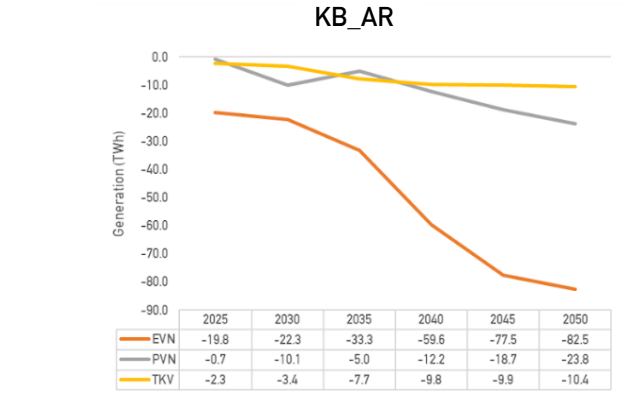
The power output from coal is reduced over time, and so is the amount of coal consumed by the power plants.

Figure 25. Reduced coal power generation in 3 SOEs



	2025	2030	2035	2040	2045	2050
EVN	-29.1	-43.2	-67.3	-79.7	-82.5	-82.5
PVN	-2.2	-13.7	-13.7	-20.9	-25.9	-28.8
TKV	-5.2	-8.5	-9.9	-10.1	-10.4	-10.4

% Reduction compared to SoE coal generation	32%	54%	75%	91%	98%	100%
% Reduction compared to total power demand	9%	11%	11%	11%	10%	9%



	2025	2030	2035	2040	2045	2050
EVN	-19.8	-22.3	-33.3	-59.6	-77.5	-82.5
PVN	-0.7	-10.1	-5.0	-12.2	-18.7	-23.8
TKV	-2.3	-3.4	-7.7	-9.8	-9.9	-10.4

% Reduction compared to SoE coal generation	20%	29%	38%	67%	87%	96%
% Reduction compared to total power demand	6%	6%	6%	8%	9%	9%

Figure 26. Coal capacity of SOEs by age group

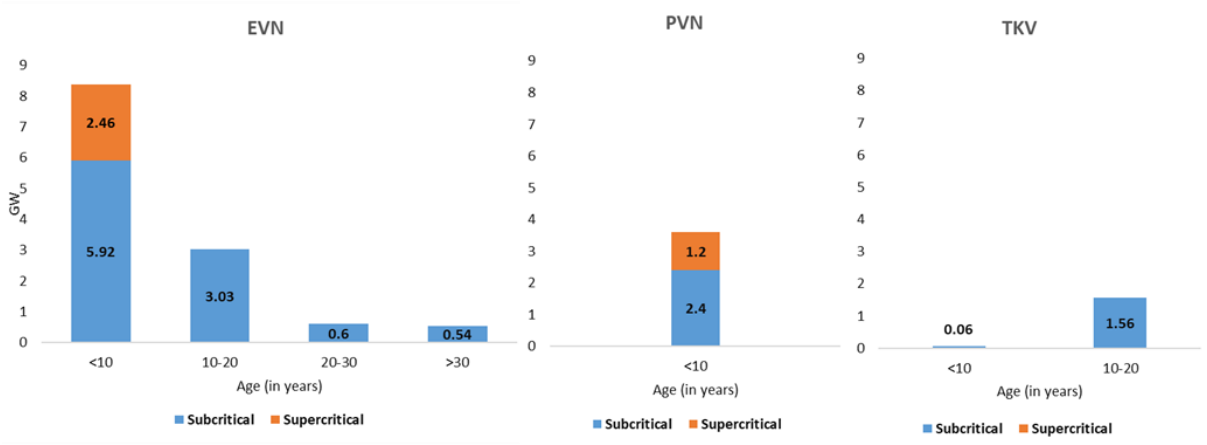
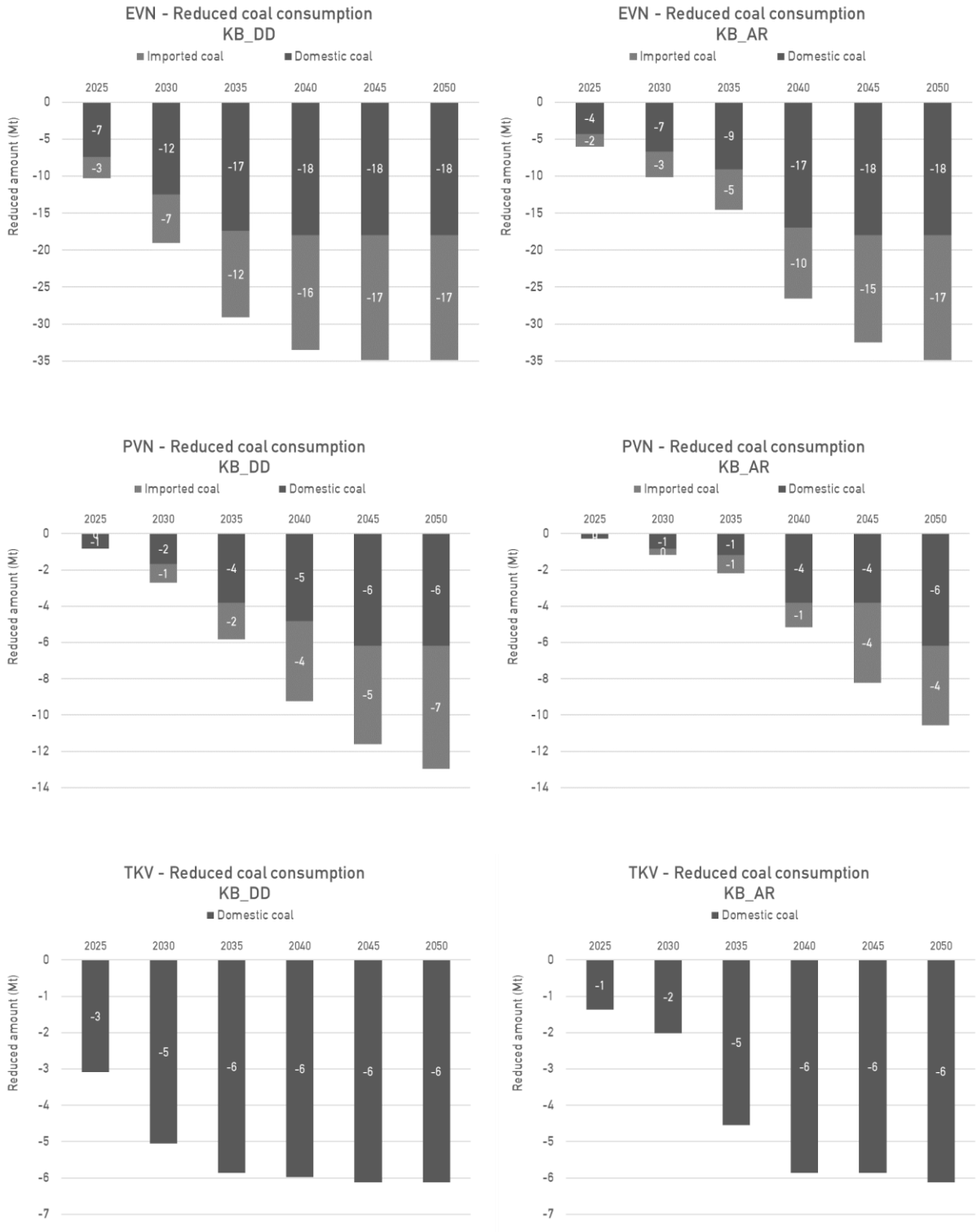


Figure 27. Reduced coal consumption in the three SOEs



Source: VIET's modelling results

Assumption: The CFPPs will operate with the same type of coal sources as of 2021 (Domestic, *Imported, Mixed). In the case of using a mixture of domestic and imported coal, the mixing rate (imported) is assumed at 40%*

Table 6. Roadmap for coal power reduction in KB_DD scenario

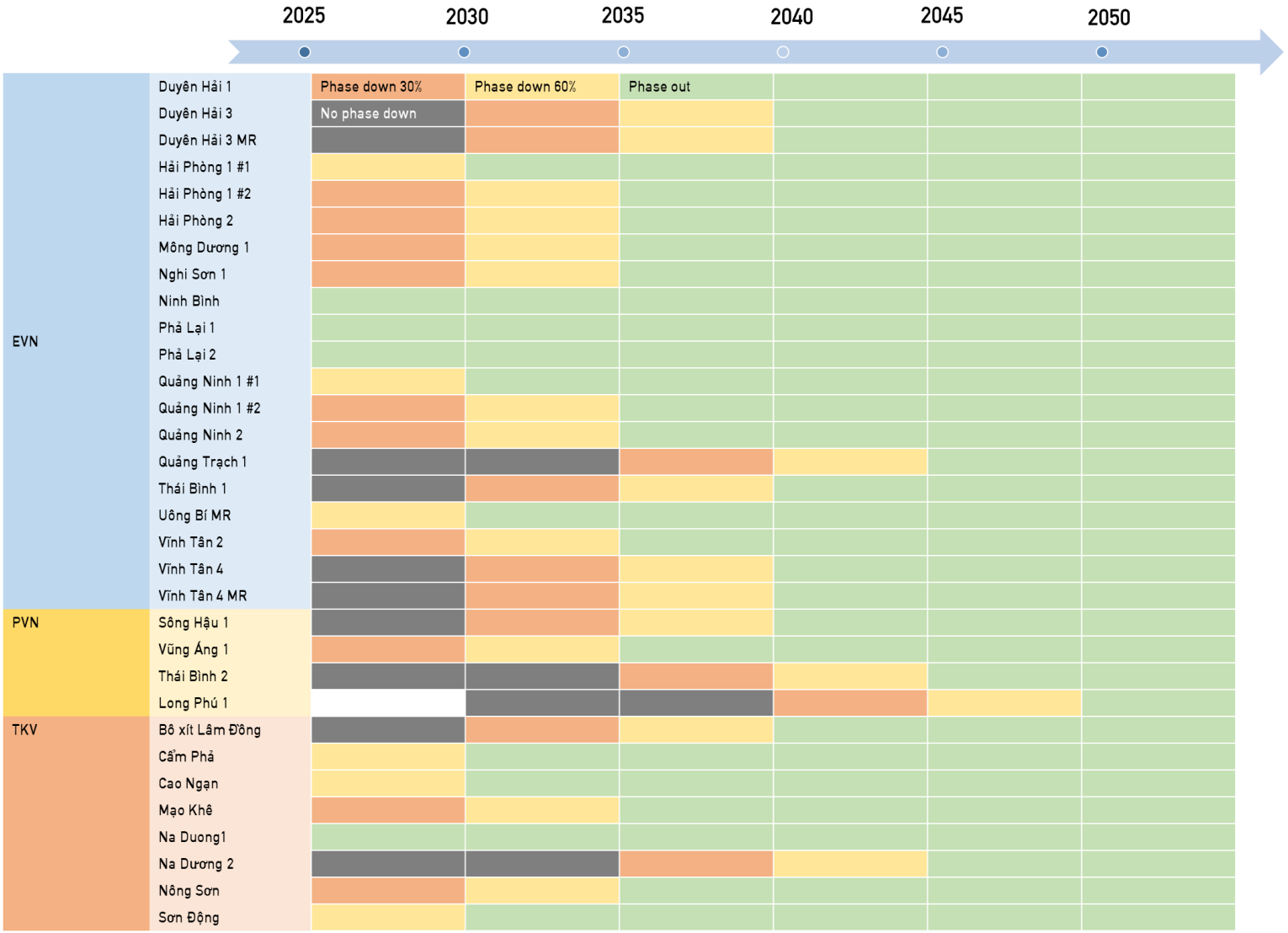
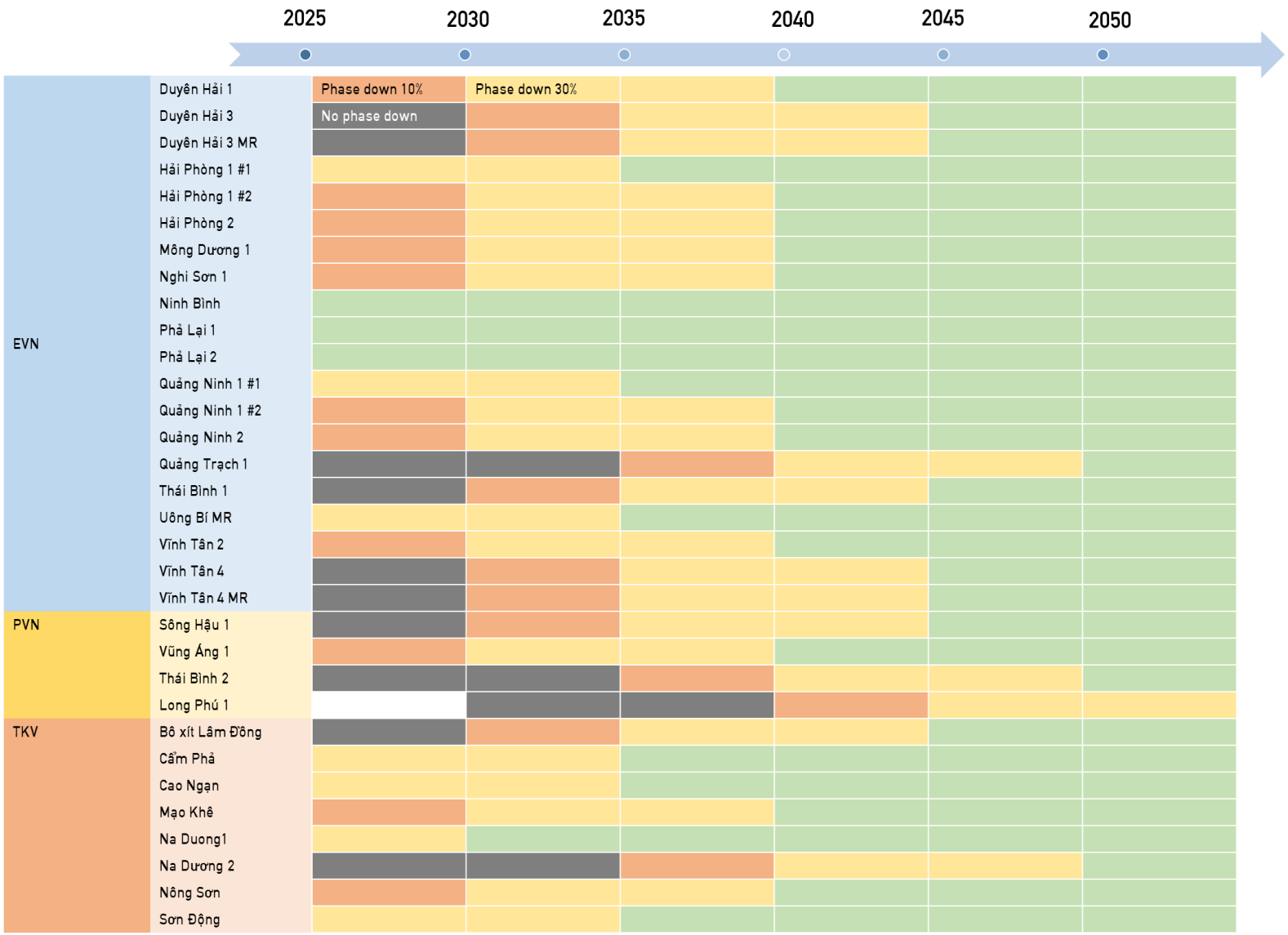


Table 7. Roadmap for coal power reduction in KB_AR scenario



4.5. Generation adequacy assessment

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 scenario, equivalent to the 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 fewer than 24 hours per year). Therefore, flexible sources need to be installed to meet the shortage. The results of LOLE/LOLP calculation for two scenarios with an additional Battery Energy Storage System (BESS) are presented in Table 5 and Table 6. The results show that the operation of BESS can significantly improve the LOLE/LOLP indices. For the year 2030, 7000 MW BESS is required for the KB_DD scenario and 6000 MW BESS for the KB_AR scenario to reduce the LOLE level to less than 24 hours per year.

Table 8. LOLE/LOLP value for KB_DD scenario in 2030.

Loss of Load Probability [%]				
Scenarios	**Average**	**Lower**	**Upper**	**LOLE [hr/yr]**
KB_DD_PHS&BESS_2700MW	0,0091	0,00754	0,01066	79,7
KB_DD_PHS&BESS_3000MW	0,0074	0,00599	0,00881	64,8
KB_DD_PHS&BESS_4000MW	0,0058	0,00455	0,00705	50,8
KB_DD_PHS&BESS_5000MW	0,0050	0,00383	0,00616	43,8
KB_DD_PHS&BESS_6000MW	0,0042	0,00314	0,00526	36,8
KB_DD_PHS&BESS_7000MW	0,0028	0,00193	0,00367	24,5
KB_DD_PHS&BESS_8000MW	0,0021	0,00135	0,00285	18,4

For the year 2025, since the hypothesis for the change in the generation mix is similar to 2030, the proposed scenario yields a similar LOLE/LOLP value, and around 3000 – 4000 MW BESS is needed to achieve a LOLE value of fewer than 24 hours per year.

Table 9. LOLE/LOLP value for KB_AR scenario in 2030

Loss of Load Probability [%]				
Scenarios	**Average**	**Lower**	**Upper**	**LOLE [hr/yr]**
KB_AR_PHS&BESS_2700MW	0,0067	0,00535	0,00804	58,7
KB_AR_PHS&BESS_3000MW	0,0058	0,00455	0,00705	50,8
KB_AR_PHS&BESS_4000MW	0,0050	0,00384	0,00616	43,8
KB_AR_PHS&BESS_5000MW	0,0032	0,00227	0,00413	28,0
KB_AR_PHS&BESS_6000MW	0,0026	0,00193	0,00367	22,8
KB_AR_PHS&BESS_7000MW	0,0022	0,00143	0,00297	19,3
KB_AR_PHS&BESS_8000MW	0,0017	0,00144	0,00186	14,5

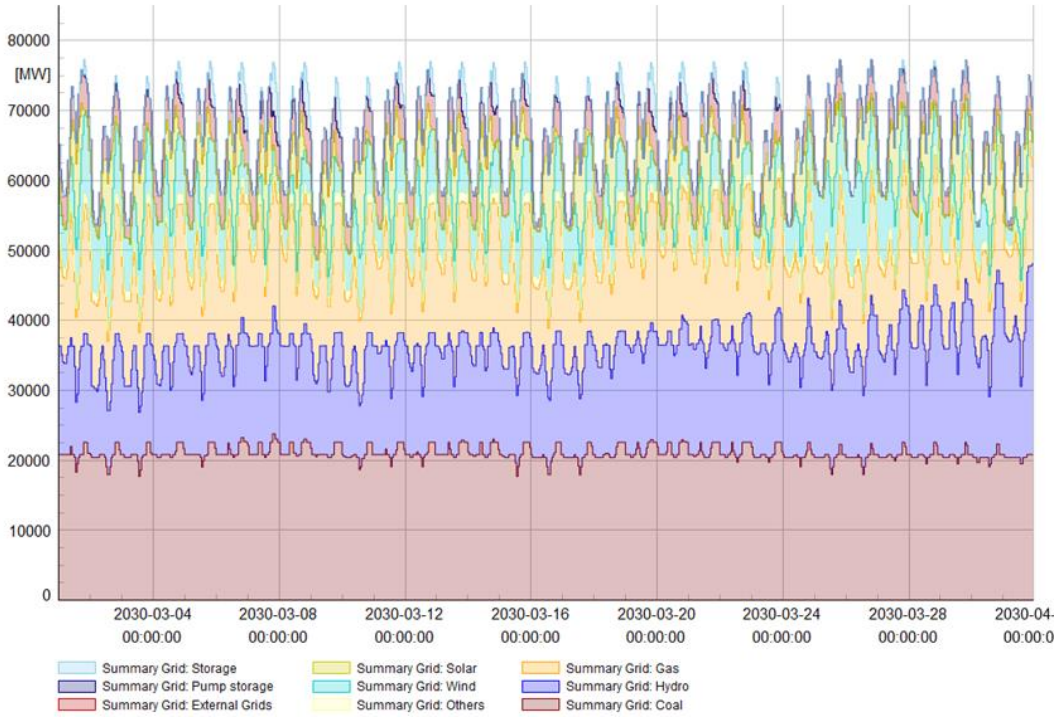
4.6. Transmission adequacy assessment

The KB_DD scenario has slight differences from the KB_AR scenario, with the capacity of coal power plants less than 2.14 GW. 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 results of the KB_DD scenario are summarised as follows:

March 2030 (dry season)

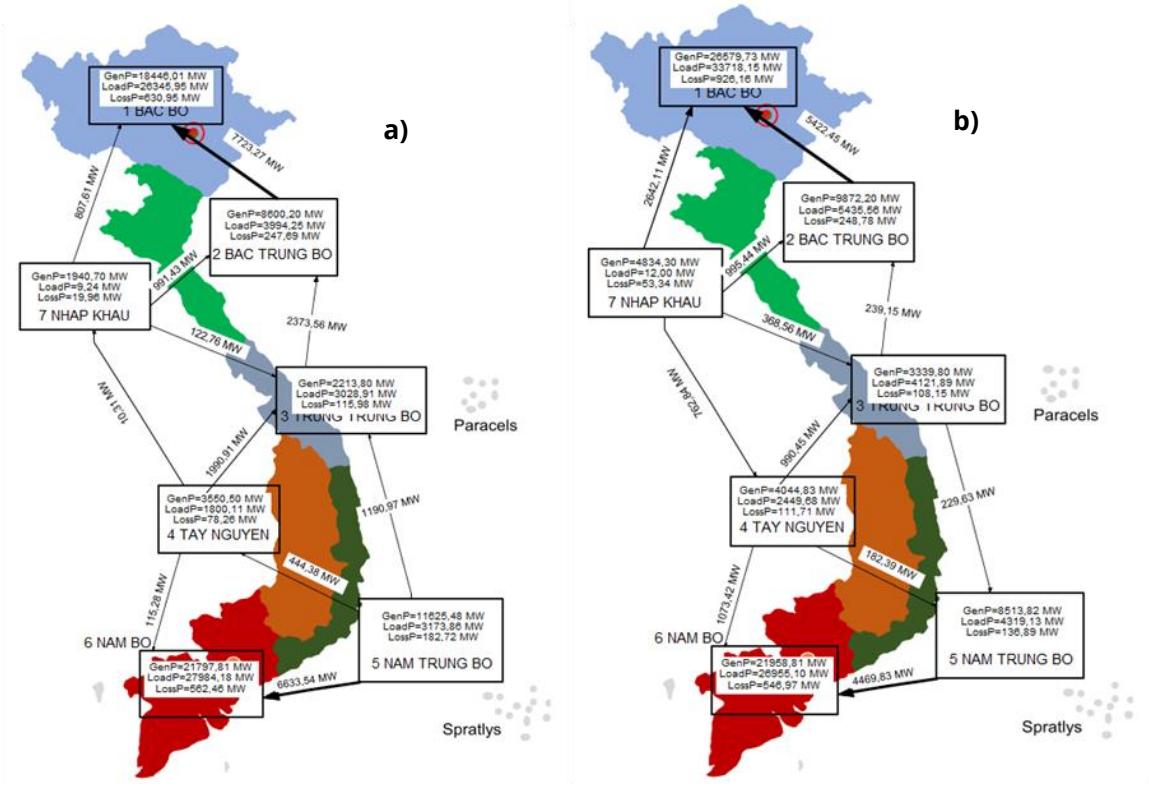
These results describe the operation of the power system during the dry season of the year. As shown in Figure 28, hydropower plants are limited in terms of generation capacity and are mainly used to cover peak loads. Meanwhile, thermal power plants (coal-fired, gas, LNG) are used to provide electricity for a certain part of the demand, and the remaining sources are mobilised depending on the fluctuation of RE sources, such as wind and solar power. The removal of coal-fired power, a huge amount of LNG and onshore wind, along with the lack of water for hydropower sources, lead to a high operation of BESS throughout the country, especially at the peak load demand at noon and in the evening.

Figure 28. Generation mix in March 2030



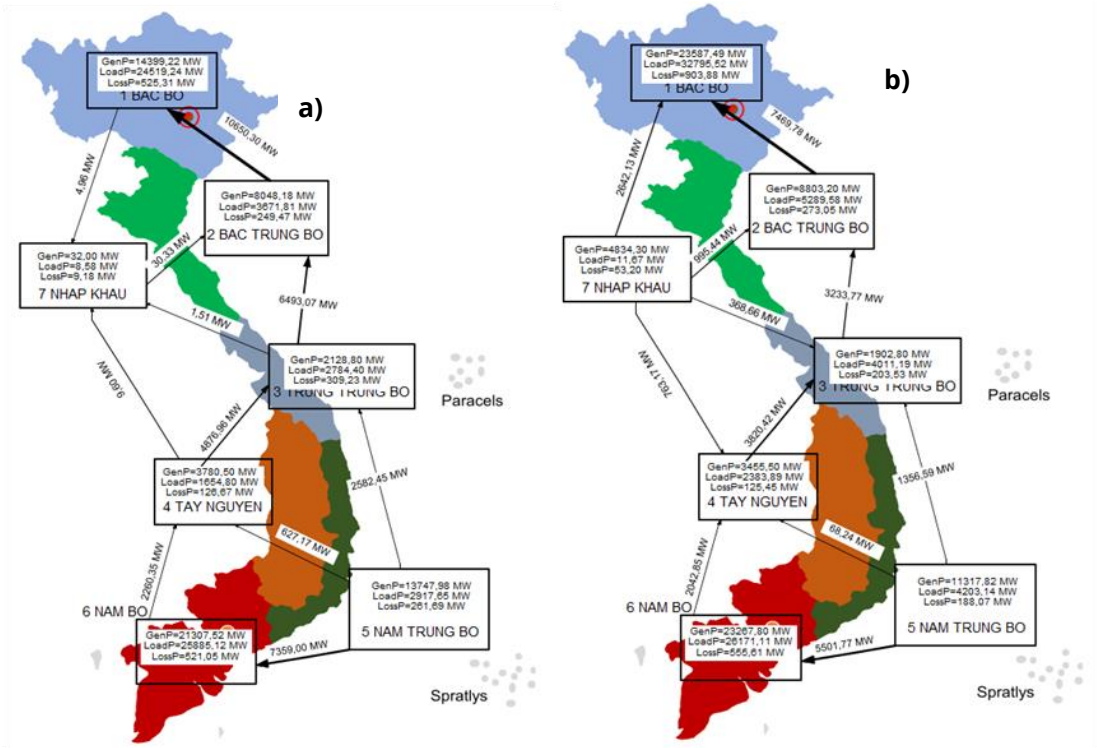
Source: VIETSE modelling

Figure 29. Inter-regional transmission on weekday March 2030: a) 14h, b) 19h



Source: VIETSE modelling

Figure 30. Inter-regional transmission on weekend of March 2030: a) 14h, b) 19h



Source: VIETSE modelling

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 (Figure 29). 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%).

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

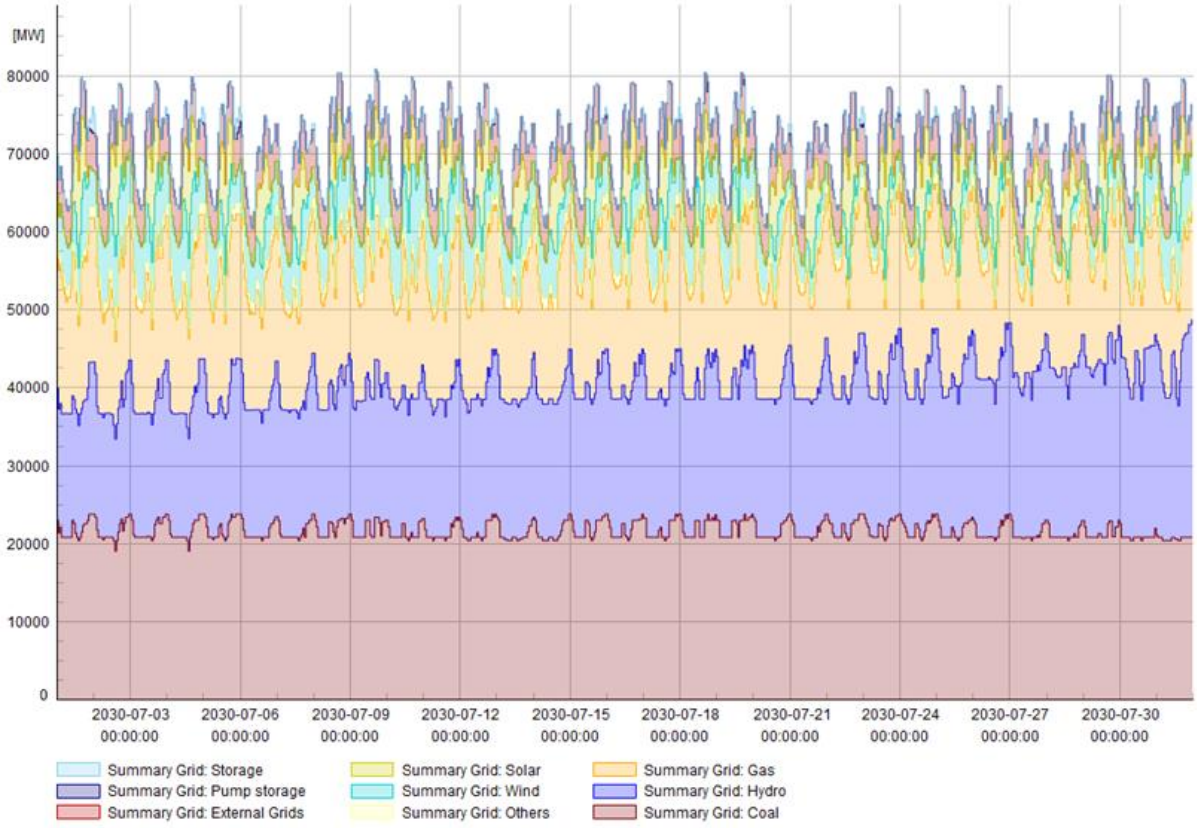
July 2030 (water season)

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 BESS 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 (Figure 31) and (Figure 32) (mainly concentrated in the North region due to having to receive a large amount of capacity from BESS), 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%).

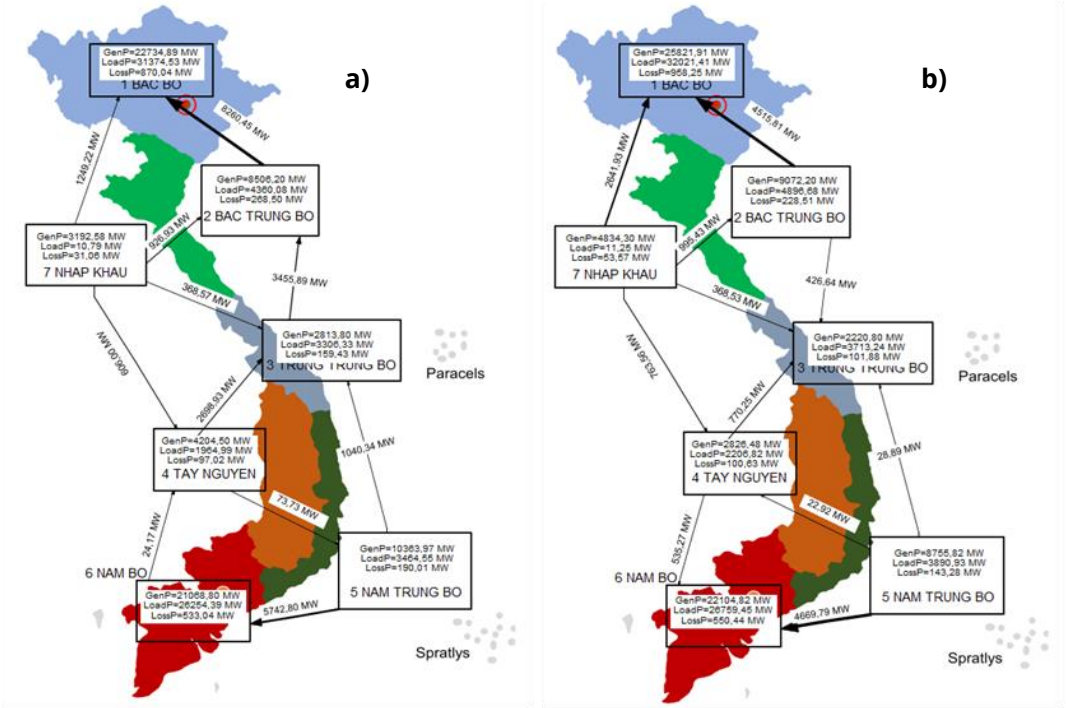
- Transformer stations: Tan Yen 220 kV (102%), Pho Noi 220 kV (92,6%), Ba Thien, Vung Ang (90,6%), Tay Ho (89,6%), Nho Quan 500 kV (89,5%), Pho Noi 500 kV (82,9%).

Figure 31. Generation mix in July 2030



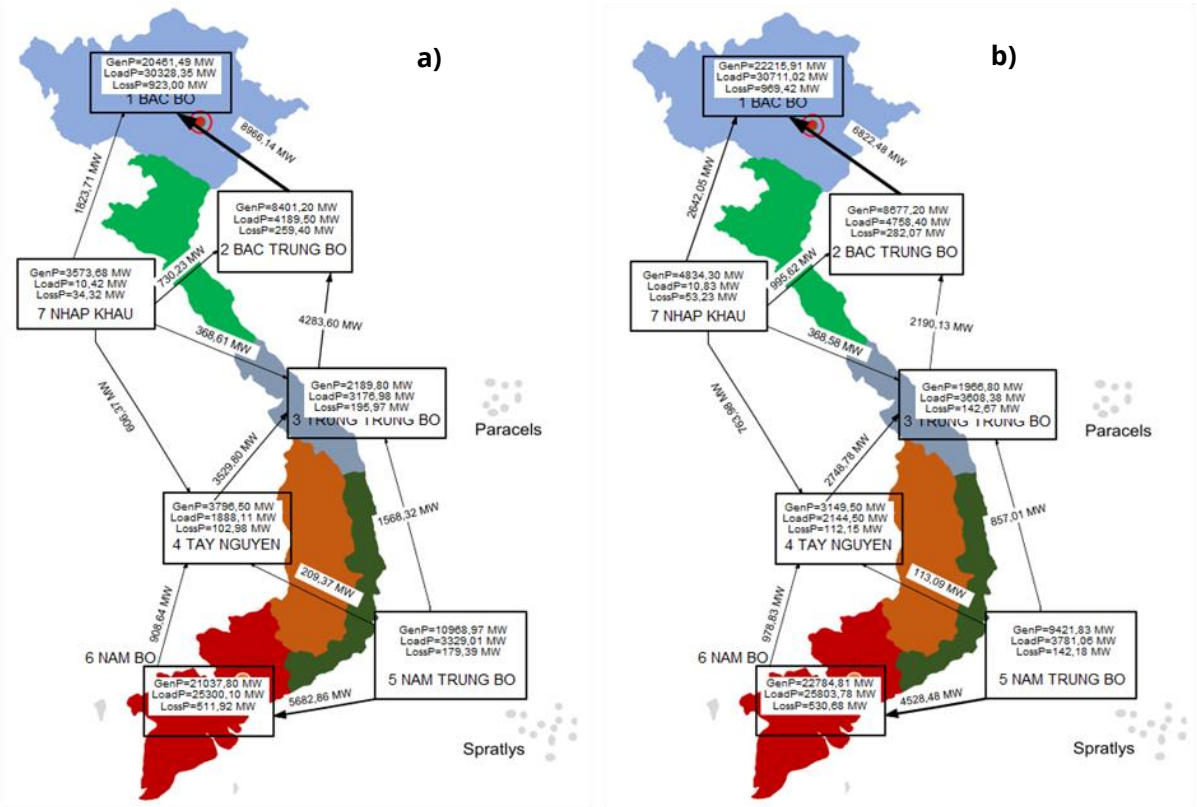
Source: VIETSE modelling

Figure 32. Inter-regional transmission on weekday July 2030: a) 14h, b) 19h



Source: VIETSE modelling

Figure 33. Inter-regional transmission on weekend of July 2030: a) 14h, b) 19h



Source: VIETSE modelling

December 2030 (water accumulating season)

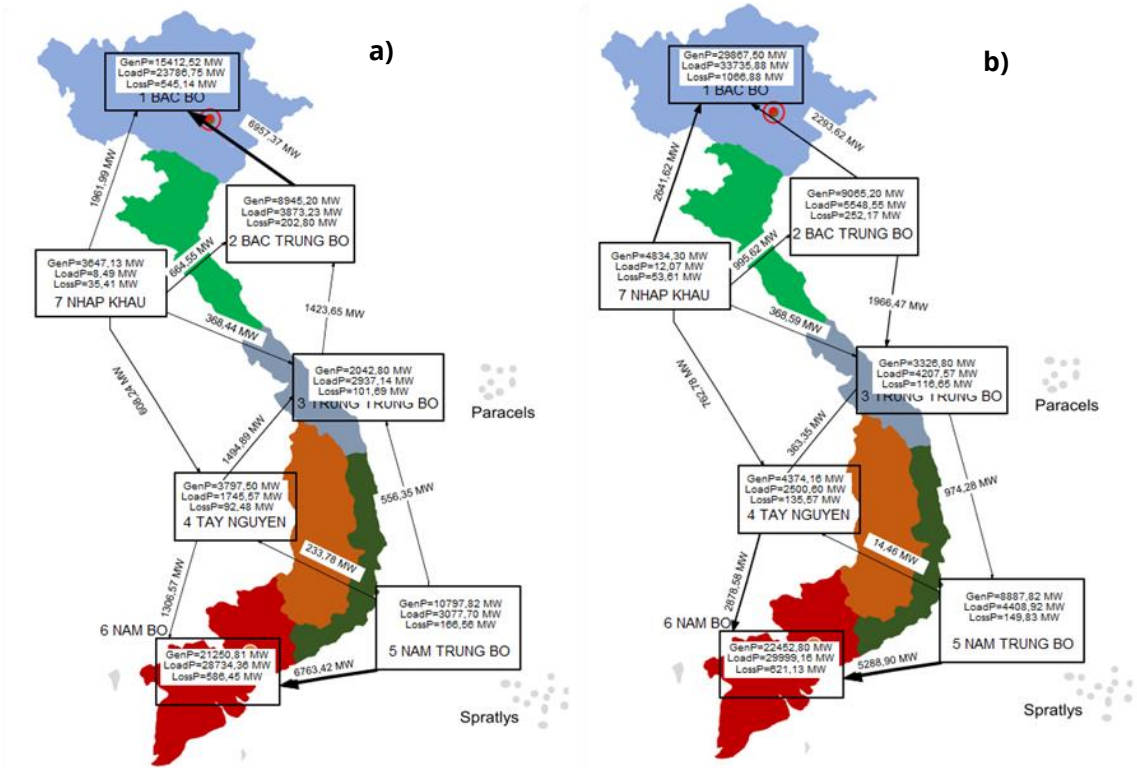
This scenario describes the process of operating the power system during the water storage season of the year. During this season, hydropower plants operate at a limited capacity to store water for the upcoming dry season and to support irrigation. The simulation results shown in the following figures show that the capacity from hydropower plants is only highly mobilised 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 (Figure 34). 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 mobilised 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.

Figure 34. Generation mix on December 2030

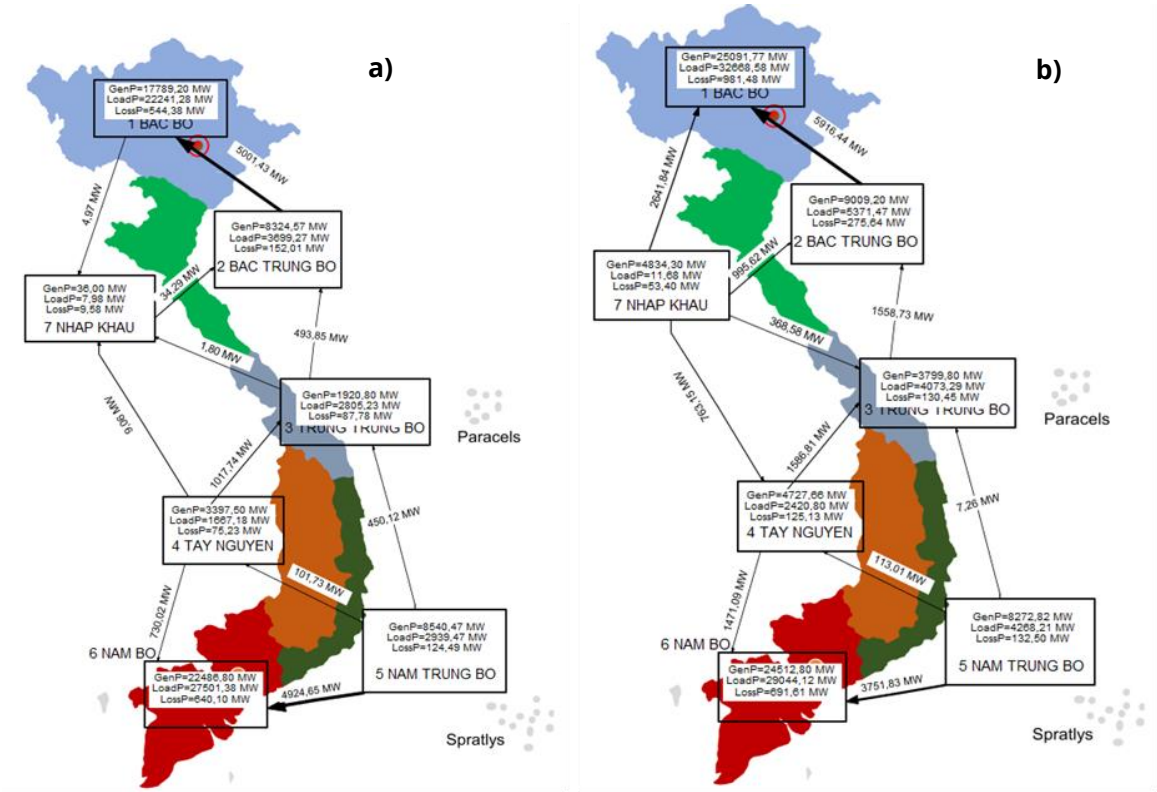
Source: VIETSE modelling

Figure 35. Inter-region transmission on weekday December 2030: a) 14h, b) 19h



Source: VIETSE modelling

Figure 36. Inter-region transmission on weekday December 2030: a) 14h, b) 19h



Source: VIETSE modelling

In summary, to ensure the security and reliability of supply in the two scenarios, additional flexibility sources (e.g., 6000 – 7000 MW BESS) are required. In addition, the grid infrastructure needs to be upgraded to absorb a large amount of generation from these sources, especially in the North region and the North–North Central inter-regional transmission interface.

Allocation of BESS capacity with 3 GW in the Northern region will be able to bring some of the following benefits:

- Balancing intra-regional capacity and reducing the inter-regional load from the North Central to the North.
- Support the operation of transport of renewable energy electricity generated from offshore wind power projects in the North Central region by 2030.
- With a roadmap to reduce and "early retire" some more thermal power plants, this will also be an opportunity to take advantage of the shift of more electrical assets to invest in BESS storage systems.

5. Financial implications for SOEs

5.1. Financial conditions of EVN, TKV and PVN

Among the three groups, EVN is a state-owned one-member limited liability company. The group's production and business activities as well as the revenue, are mainly related to the electricity sector. The main lines of business of Vietnam Electricity (EVN) include:

- Production, transmission, distribution and trading of electricity;
- commanding and operating the system of production, transmission, distribution and distribution of electricity in the national electricity system;
- Import and export of electricity; Investment and management of investment capital in power projects;
- Manage, operate, repair, maintain, overhaul, renovate and upgrade electrical, mechanical, control and automation equipment in the production line, transmission, and distribution of electricity, electrical works; electrical experiment;
- Project management consultancy, design survey consultancy, investment project formulation consultancy, bidding consultancy, cost estimation, verification and construction supervision consultancy, power source works, transmission line works and substation.

Meanwhile, Vietnam National Coal and Mineral Industries Group (TKV) has a lower proportion of revenue from power generation. TKV's production and business activities mainly include Mining and collecting hard coal; Mining; Producing, trading, preserving, transporting and using industrial explosives, ammonium nitrate and explosive precursors, chemicals and raw materials for the production of industrial explosives, destruction of industrial explosives; Generation, transmission and distribution of electricity; Processing and manufacturing industry; Professional secondary education, vocational training college, university and graduate training, educational support services; Activities of hospitals, clinics, activities of general, specialised and dental clinics, preventive medicine activities, operations of orthopaedic and rehabilitation facilities, activities of foster care and nursing facilities; and Import and export of products traded by the Group.

Vietnam Oil and Gas Group (PVN) has a lower share of the revenue from power generation. The group's activities include Searching, exploring, and exploiting oil and gas; the Gas industry; Petroleum processing; the Electricity and renewable energy industry; and High-quality Petroleum Technical Services.

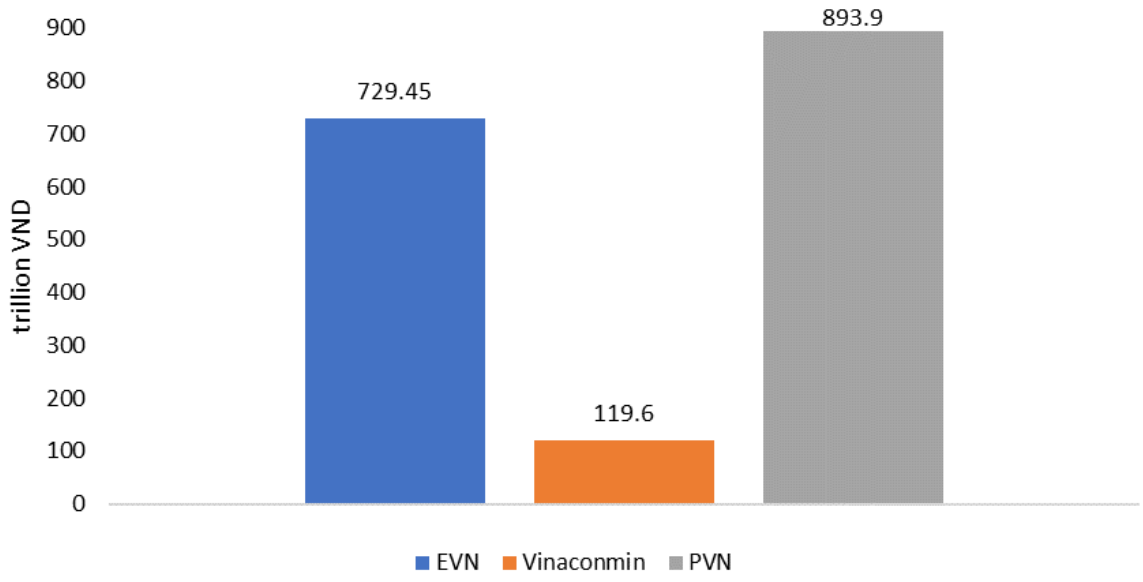
The following sections describe an overview of the financial position of the three corporations, with some analytical indicators, comparing the overall situation with the activities, production and

business of electricity in general and coal power in particular at the three corporations. The financial analysis of the Groups in this report is built based on data and information from financial statements, audit reports, and reports on production and business activities that the SOEs publicly disclose, its subsidiary companies and corporations, CMSC, Enterprise Development Agency (under the Ministry of Planning and Investment), several ministries and the mass media.

5.1.1. Assets

By the end of 2021, the total assets held by the three groups amounted to 1740 trillion VND (approximately 74.8 B$), accounting for 47.67% of the total assets of the state-owned enterprise sector[12].

Figure 37. Assets of EVN, TKV and PVN as of December 31, 2021



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

As of January 16, 2023, EVN has not released consolidated financial statements for 2021. Therefore, in this report, EVN's 2021 figures are estimated according to 2020 figures and will be updated when the consolidated audit report for the year 2021 is available. If estimated according to the data at the end of 2020, EVN's total assets in 2021 will reach about VND 729.45 trillion. Thus, the 2022 total assets of EVN decreased by approximately VND 8 trillion compared to 2020. TKV's total assets reached VND 119.6 trillion in 2021. This figure also decreases by 127.2 trillion VND

[12] 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 3650 trillion VND.

compared to 2020. Unlike EVN and TKV, PVN's total assets increased from VND 852.9 trillion in 2020 to VND 893.9 trillion in 2021.

5.1.2. Liabilities and equity

By the end of 2021, the equity of EVN, TKV, and PVN was VND 240.2 trillion, VND 44.8 trillion, and VND 486.3 trillion, respectively. The total equity of the three groups was VND 771.35 trillion (equivalent to 32.9 B$), equivalent to 43% of the total equity of the SOE sector [13].

In terms of equity to total capital ratio, PVN had the highest ratio at 54.0%, followed by EVN (37%) and TKV (33%). Thus, PVN and EVN have a better position regarding owner capital (equity).

Table 10. Total liabilities and equity, debts of EVN, TKV, and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN
Total liabilities and equity, in which:	Trillion VND	729.451	119.584	893.938
Debts	Trillion VND	489.256	74.787	407.595
Equity	Trillion VND	240.195	44.797	486.343
Loans/total liabilities and equity	%	67%	63%	46.0%
Equity/ total liabilities and equity	%	33%	37%	54.0%
Debt/Equity (D/E)	time	2.04	1.67	0.84

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

The total debts of EVN in 2021 were VND 489 trillion, while the figure for TKV was VND 74.8 trillion, and PVN was VND 408 trillion. Although having the lowest debt in absolute value, TKV's debt-to-total liability plus equity ratio was the highest at 67%. TKV has used financial leverage at a higher level. The ratio of debt to total liabilities plus equity of EVN was lower at 63%, and in PVN, it was

[13] 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 3740 trillion VND, up 2% compared to 2020. Owner's equity is 1790 trillion VND, up 3% compared to 2020. Total capital which is invested by the State in 826 enterprises is 1670 trillion VND, up 3% compared to 2020 (1500 trillion VND in enterprises in which State hold 100% of charter capital, and the rest 162,806 billion VND in enterprises which are partly owned by the State).

46%. Among the three corporations, PVN has the lowest debt ratio. PVN's D/E was only 0.84 times its equity. Meanwhile, TKV's debt was 2.04 times more than equity.

5.1.3. Liquidity

In 2021, the total revenue of EVN reached VND 351 trillion, TKV 114.4 trillion VND, and PVN 382 trillion VND.

Table 11. Short-term liquidity ratios of EVN, TKV, and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN
Short-term assets	Trillion VND	195.826	40.309	432.853
Short-term debt	Trillion VND	145.736	41.705	260.427
Short-term liquidity ratio	%	134.4%	96.7%	166.2%

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

In terms of short-term liquidity, PVN demonstrates its outstanding ability to ensure short-term liquidity with current assets 1.6 times higher than current liabilities. In the case of TKV, the short-term solvency ratio was only 96.7%. This shows that the group's current assets are insufficient to pay its short-term liabilities.

5.1.4. Revenue and costs

In 2021, the total revenue of EVN reached VND 351 trillion, TKV 114.4 trillion VND, and PVN 382 trillion VND. The total revenue of the three groups is VND 847.4 trillion, accounting for 40% of the total revenue of all SOEs in 2021[14].

Among the three groups, while revenue from electricity production, transmission, and trading accounted for a large proportion of EVN's total revenue, which was about 86% in 2021, the proportion of revenue from electricity sales accounted for 11.4% of TKV's total revenue and 5.8% of PVN's total revenue. If counting from coal power alone, revenue from coal power accounts for 10.3% of TKV's total revenue and 2.3% of PVN's total revenue. Although there is no exact figure from EVN, based on the ratio of coal production to the total commercial power output of EVN, it is estimated that revenue from coal power accounted for about 25.27% of EVN's total electricity

[14] 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 2120 trillion VND, 8% higher as compared to 2020.

sales. These figures show that EVN and TKV depend more on CFPPs to generate revenue. Energy transition initiatives and policies for CFPPs are likely to affect the total revenue of EVN and TKV more than PVN.

Table 12. Revenue of EVN, TKV, 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
Revenue from selling coal power	Trillion VND	-88.79	11.8	8.7
The proportion of revenue from electricity sales to total revenue	%	85.82%	11.4%	5.79%
The proportion of revenue from selling coal power to total revenue	%	25.27%	10.3%	2.3%

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

Table 13. Costs of EVN, TKV, and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN
Total cost, of which:	Trillion VND	385.6	109.1	331.3
Interest payment expenses	Trillion VND	-	2.6	1.5
The proportion of interest payments on total expenses	%	-%	2.4%	0.5%

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

Due to its level of debt, TKV's interest expense amounted to VND 2.6 trillion, accounting for 2.4% of total expenses. EVN's interest expense was not shown in the audit report out of the total of VND 23 trillion in financial expenses, which accounted for 6% of EVN's total cost of VND 385.6 trillion. PVN has the lowest interest expense of 1.5 trillion, accounting for a low proportion of this SOE's total expenses of VND 331.3 trillion.

The proportion of interest expense in the total cost of TKV and EVN is also one of the obstacles, forcing these corporations to consider carefully in their decisions to borrow more capital,

especially from sources with high-interest rates with less favourable conditions for energy transition projects and initiatives for CFPPs under the group.

5.1.5. Electricity production and trading

As an electricity group, EVN has the highest total electricity output. In 2021, the total electricity output of EVN was 233.670 GWh, TKV was 10,595 GWh, and PVN was 14,701 GWh.

Table 14. Production of EVN, TKV and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN[15]
Total electricity output, in which:	GWh	233,670	10,595	14,701
Power output from coal power	GWh	60,082	9,910	5,544
The share of electricity generation from coal power in total electricity production	%	25.7%	84.1%	37.7%

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

The share of electricity from coal power in the total electricity production of TKV was 84.1%, while that of EVN was 25.7%, and PVN was 37.7%. Thus, if only evaluated from the perspective of electricity production alone, the impact of energy transition in coal power generation on total electricity output and power production will be higher for TKV and EVN. In other words, the energy transition efforts at CFPPs will make a more considerable, faster difference to the group's overall power generation.

However, if evaluated in absolute numbers, the effort to shift the energy in coal power generation will be heavier for EVN Group because its coal power output is 118,068 GWh, much higher than the cases of TKV and PVN.

5.1.6. Business performance and profitability

In 2021, all three groups, EVN, TKV, and PVN, were profitable, with a profit of VND 5.8 trillion, VND 4.3 trillion, and VND 17.3 trillion, respectively.

[15] 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 15. Efficiency of production and business activities of SOEs (as of December 31, 2021)

Items	Unit	EVN	TKV	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: Audit reports, reports on production and business activities, and published reports of corporations.

With this profit, TKV has a return on equity (ROE) of 9.7%, much higher than EVN's 8.1% and PVN's 6%. If calculated on total assets, the return on total assets (ROA) of TKV also reached the highest level of 4.4% compared to 3.7% of PVN and 2% of EVN.

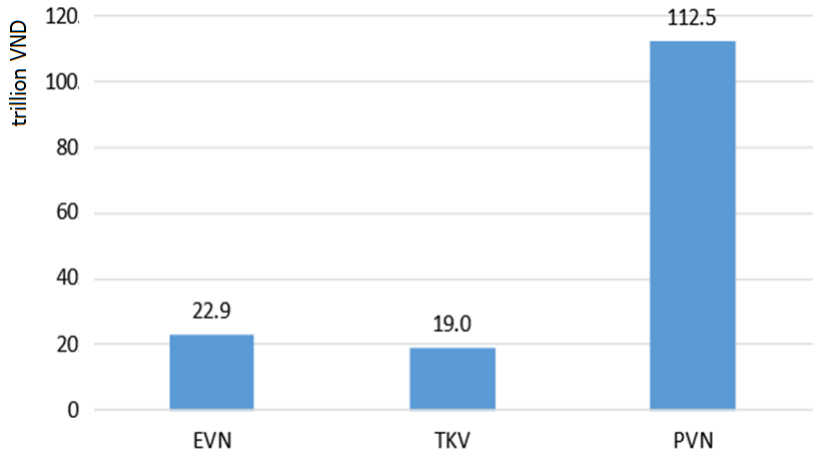
However, the profit of EVN has become negative in 2022. The SOE was reported to lose VND 29 trillion (1,2 B$) in 2022. The loss is expected to double to reach VND 64,9 trillion if the current (2.7 B$) electricity power tariff remains unchanged[16]. Meanwhile, the profit of TKV in 2022 nearly tripled to 8.1 trillion VND[17]. PVN also doubled its profit to 82 trillion VND [18]. The sharp increase in profit of the two SOEs is mostly thanks to the rise in commodity prices in international markets. This also shows the high volatility of the profitability of the three SOEs and their vulnerability to international market conditions.

5.1.7. Contribution to the State Budget

EVN, TKV, and PVN are consistently among the top 5 SOEs in terms of payment to the State budget. In the past three years, the payments to the State budget of these three SOEs accounted for nearly half of the total budget payments of state-owned enterprises. For example, in 2020, out of VND 202.6 trillion paid into the State Budget by all SOEs, the amount paid to the state budget by PVN was VND 55.6 trillion, EVN 22.5 trillion, and TKV VND 18.5 trillion. In 2021, it was estimated that the contribution of PVN would be 112.5 trillion VND (4.8 B$). EVN contributed 22.9 trillion VND (0.97 B$) and TKV contributed 19.0 trillion VND (0.8 B$)[19].

[16] https://moit.gov.vn/tin-tuc/bao-chi-voi-nguoi-dan/evn-lo-tai-chinh-u-am-lo-lich-su-trong-nam-2023.html
[17] https://www.vinacomin.vn/tin-tuc/tkv-cung-nhung-cong-trinh-phuc-loi-vi-cong-dong-202302061112081208.htm
[18] https://vov.vn/chinh-tri/thu-tuong-mong-pvn-thi-dua-lap-ky-luc-moi-trong-nam-2023-post995654.vov
[19] It should also be noted that, in the years 2020 and 2021, EVN has 5 times supported to reduce electricity prices and reduce electricity charges for businesses, people, and socio-economic organizations since the

Figure 38. State budget payment of EVN, TKV, and PVN by December 31, 2021



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

Despite the heavy loss in 2022, the contribution to the State Budget by EVN in the year remained at 25.5 trillion VND. Contribution to the State Budget by TKV increased to 21.35 trillion VND and PVN to 170 trillion VND[20].

5.1.8. Labour and Employment

As of 2021, EVN created jobs for 97,250 employees. TKV and PVN created 94,000 and 60,000 jobs, respectively. The total number of jobs created by the three corporations was 251,250, accounting for 22.69% of the total number of employees in the SOE sector [21].

The number of employees in CFPPs was 1,619 at TKV and 450 people at PVN, a very low number compared to the total number of employees at these two corporations. Although there is no exact number, this figure is much higher in the case of EVN based on the number of CFPPs owned by the SOE and on the amount of coal power output generated by EVN in its total electricity generation.

Covid-19 epidemic outbreak. The total amount of electricity price reduction and electricity price reduction is more than 16,950 billion VND.

20https://www.phapluatplus.vn/thuong-truong/vi-sao-evn-lo-dot-bien-toi-hon-31000-ty-dong-d187984.html, https://www.vinacomin.vn/tin-tuc/tkv-cung-nhung-cong-trinh-phuc-loi-vi-cong-dong-20230206111208208.htm, and https://vov.vn/chinh-tri/thu-tuong-mong-pvn-thi-dua-lap-ky-luc-moi-trong-nam-2023-post995654.vov

21 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 wholy 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

At the group level, energy transition initiatives and programs at CFPPs will affect EVN more than the cases of TKV and PVN. The requirements for supporting activities for employees to be trained with new skills and knowledge or find new jobs will be higher at EVN than in the other two groups.

Table 16. Employees of EVN, TKV, and PVN (as of December 31, 2021)

Items	Unit	EVN	TKV	PVN
Total labour, in which:	Person	97,250	94,000	60,000
labour, companies in CFPPs	Person	5,766	1,619	450
The average revenue per employee	Billion VND	4.21	1.22	6.37
The average profit per employee	Billion VND	0.16	0.06	0.86
The average income of employees	Million VND/month	-	12.97	-

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

On average, an employee at EVN generated 4.21 billion VND in revenue. This figure was 1.22 billion VND at TKV and 2.23 billion VND at PVN. The average profit per employee was 160 million VND, 60 million VND, and 860 million VND, respectively.

In 2021, the average income of employees of TKV was 12.97 million VND/month. This income level is lower than the average level of workers in the SOE sector across the country, of 14.21 million VND/month. There is no data on EVN and PVN employees' average income.

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

The immediate financial implications of the three transition scenarios to EVN, TKV and PVN can be measured in the fall of sales and employment as a result of the phasing down and phasing down of CFPPs.

5.2.1. Fall in sale

Due to the early retirement of CFPPs, the three SOEs will observe a fall in coal-fired power production. The accelerated KB_DD scenario will have the earliest impact on the production and, thus, the revenue of the three SOEs. Under this scenario, the total revenue of the three SOEs between 2022 and 2025 will fall a combined 3.0 B$ and then 31.0 B$ between 2046 and 2050. As for the KB_AR scenario, the fall in annual revenue will be less dramatic in the early years. For

instance, the decrease in revenue of the three SOEs will be only 1.6 B$ between 2025 and 2025 and 5.7 B$ between 2026 and 2030. Then, between 2045 and 2050, SOEs' total revenue would dramatically decrease by 28.7 B$.

Table 17. The combined decrease in revenue of EVN, TKV and PVN in the two scenarios

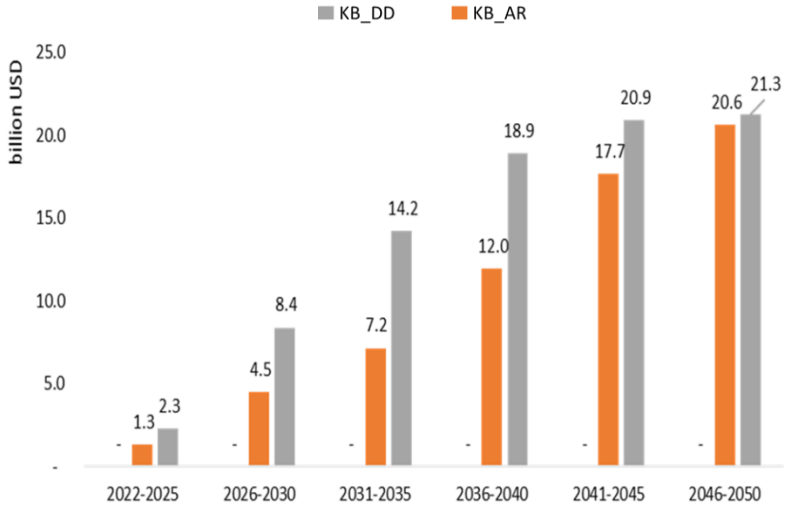
Unit: million USD

	2022-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	2022-2050
KB_DD	3.0	11.3	19.2	26.0	29.6	31.0	120.0
KB_AR	1.6	5.7	9.6	16.5	24.2	28.7	86.3

Source: *VIETSE, Economica Vietnam, NHQuang& Associates, and Carbon Trust (2022)*

Among the three SOEs, EVN will suffer the most significant fall due to its high level of coal-fired power production. Under the KB_DD scenario, EVN is expected to have a 2.3 B$ loss in revenue between 2022 and 2025 and 21.3 B$ between 2046 and 2050 (Figure 39). The decrease rate is slower in the KB_AR scenario but will reach the same level as the accelerated phase-out scenario between 2046 and 2050.

Figure 39. Decrease in EVN's revenue as a result of the phase-out/phase-down scenarios



Source: VIETSE, Economica Vietnam, NHQuang& Associates, and Carbon Trust (2022)

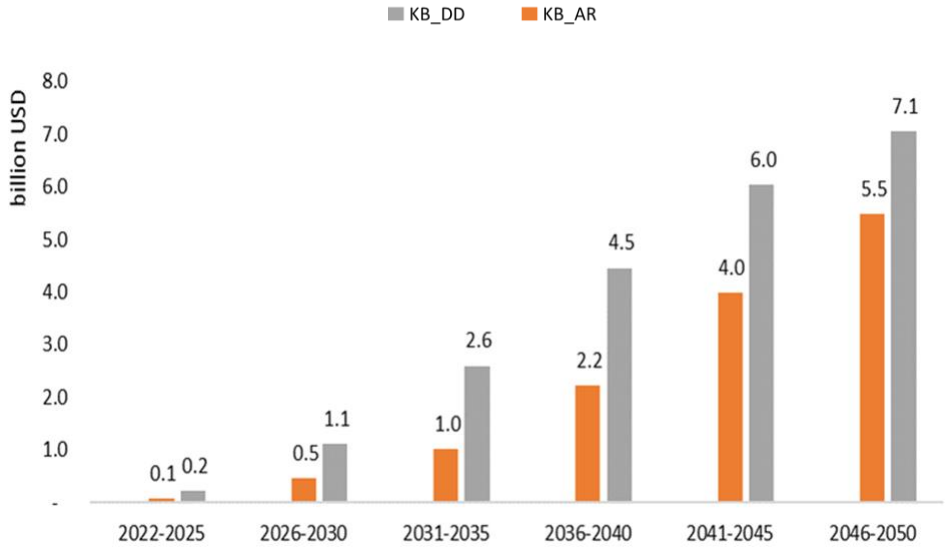
TKV will witness a fall of 0.5 B$ between 2022 and 2025 in the KB_DD scenario (Figure 40). If the SOE goes for the KB_AR scenario, it can delay the falling rate until 2040, when the two scenarios converge.

Figure 40. Decrease in TKV's revenue as a result of the phase-out/ phase-down scenarios

Source: *VIETSE, Economica Vietnam, NHQuang& Associates, and Carbon Trust (2022)*

PVN has a different pattern of decrease in revenue decrease for these scenarios. All scenarios seem to be able to delay the fall in revenue from coal-fired power for quite a long as between 2022 and 2025, the revenue of PVN only decreases by 0.1 B$ and 0.2 B$ under KB_AR and KB_DD scenarios, respectively. This is partly due to the fact that most of the CFPPs of PVN are new with young age equipment and facilities. However, from 2036, the revenue of PVN will significantly decrease.

Figure 41. Decrease in PVN's revenue as a result of the phase-out/ phase-down scenarios



Source: VIETSE, Economica Vietnam, NHQuang& Associates, and Carbon Trust (2022)

5.2.2. Reduction in employment

The transition plans will have an impact on the employment of the three SOEs. In phasing out and phasing down CFPPs, the three SOEs will have to reduce their workforce. If the accelerated KB_DD transition scenario is to be implemented, it is estimated that the three SOEs will lay off a total of 29,015 workers by 2050. The total number of workers to be made redundant under the transition pathway is 27,2 thousand people in the KB_AR scenario and 29 thousand in the KB_DD scenario between 2023-2050.

Under the NZE scenario, EVN will have to face this problem the most, with about 19,670 jobs to be lost by 2050. The number of jobs lost in the case of TKV and PVN is less than EVN, with TKV being faced with the issue earlier than PVN.

Addressing the issue of working being made redundant due to the transition plan should be one of the priorities for all three SOEs. Financial considerations should be taken into account to offer support packages to workers laid off due to the early retirement plan.

Besides training, upskilling programs should also be provided in order to prepare the workers to find new jobs, either at other facilities of the SOEs or in other companies.

Table 18. Job lost under the KB_AR and KB_DD scenarios

	2022-2025	2022-2030	2022-2035	2022-2040	2022-2045	2022-2050
KB_AR Scenario						
EVN	1,630	1,630	3,389	11,862	17,954	19,670
TKV	-	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 Scenario						
EVN	1,630	3,389	11,862	17,954	19,670	19,670
TKV	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 (2022)

5.3. Implications of the three SOEs' financial conditions to the scenario and the ability to mobilise funds to finance the transition

5.3.1. An increase in debt and borrowing is needed to finance the transition

The analysis in the above sections shows that both the KB_AR and KB_DD scenarios will have significant immediate impacts on the total revenue of the three SOEs. It is estimated that the three SOEs will have to forego a total revenue of 86.3 B$ in the KB_AR scenario and 120 B$ in the KB_DD scenario. The fall in sales will negatively impact the liquidity, solvency and profitability of the three SOEs. In addition, the three SOEs should address the employment issues when about 27.2 thousand and 29 thousand workers are laid off in the KB_AR and KB_DD scenarios, respectively.

Therefore, it is essential that the SOEs will need to be accompanied by measures to support the financial losses that they suffer. Such financial measures can be in the form of providing cash flow incentives to the three SOEs in pro rata with the reduction in coal-fueled production and revenue of the three SOEs or in the form of providing financing for the three SOEs to invest their green energy production 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 come either from the equity or the debts of the three SOEs. Given the fact that Return on Equity (ROE) or EVN, TKV and PVN are merely 6.0%, 9.7%, and 8.1% in 2021, the huge financial loss of 1.2 B$ by EVN in 2022 and the high volatility in TKV and PVN's profitability, the possibility of using retained earning to increase equity of the three SOEs is limited. Besides, it is unlikely that the three SOEs can launch IPO to mobilise more capital to increase their equity to finance their investment projects (including RE projects) since the three SOEs are all 100% owned by the State.

The more feasible way for the three SOEs to mobilize financing for projects to transition from coal-fired power to renewable energy is through borrowing and debts. The debts can be in various forms: bank loans, bond issuance, borrowing from donors, State credit, or borrowing with Government guarantee.

5.3.2. Borrowing ceiling of the three SOEs

However, there is a ceiling to how much the three SOEs can borrow. According to current prevailing regulations[22], the debt-to-equity ratio at SOEs cannot exceed 3.

[22] 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.

As such, given the current level of equity of the three SOEs, the maximum amount of debt that EVN can borrow further is 9.66 B$. The figures are respectively 2.48 B$ in the case of TKV and 43.81 B$ 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 55.9 B$.

Apart from other factors, such as the profitability of each single investment project, any transition scenario should take this ceiling into account to ensure the financial feasibility of the scenario. The transition scenario should be in line with the capacity of EVN, TKV and PVN to absorb the fall in sales and then its profit and its capacity to leverage funding to meet investment needs given its current indebtedness, its ability to service the new debts and the prevailing debt ceiling which is applicable to the three SOEs.

Table 19. Room for more debt and borrowing of the three SOEs as of 2021 (B$)

Items	Unit	EVN	TKV	PVN	Total
Debts	B$	20.39	3.12	16.98	40.48
Equity	B$	10.01	1.87	20.26	32.14
Debt/Equity (D/E)	time	2.04	1.67	0.84	-
Debt ceiling*	B$	30.02	5.60	60.79	96.42
Room for more debt or borrowing	B$	9.64	2.48	43.81	55.93

Source: *VIETSE, Economica Vietnam, NHQuang& Associates, and Carbon Trust (2022)*

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

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

Of the three SOEs, PVN has the strongest financial conditions. PVN has the largest assets and outperforms EVN and TKV in terms of financial ratios such as liquidity, debt-to-equity, ROA or contribution to the State Budget. In terms of productivity, a PVN employee also produces much higher average-per-employee revenue and profit than EVN and TKV.

Regarding debt to equity (D/E), the maximum D/E ratio applicable to the three SOEs is 3. From this respect, PVN has the largest room to increase debt to invest or support initiatives and projects for energy transition for CFPPs of the group and its subsidiaries. PVN's debt-to-equity ratio is 0.84 in

2021, while that of EVN and TKV are 2.04 and 1.67, respectively. Regarding D/E, EVN has the lowest ceiling to borrow more capital to finance its energy transition projects.

In terms of total debt to total equity and liabilities, EVN and TKV have more room to borrow for energy transition projects if they implement the transition scenarios. The total debt of EVN and TKV is 67% and 63% of total assets, respectively. EVN and TKV currently have used much higher financial leverage than PVN.

In terms of cost, total interest expenses over total costs of PVN is 0.5%, while that of TKV is 2.4%. This indicates that the more borrowing, the more burden will be on the costs of TKV. The burden is much less in the case of PVN.

From these financial indicators, PVN is in better shape financially compared to EVN and TKV. PVN is also better positioned to borrow more to finance energy transition projects. In this regard, the SOE is followed by TKV and then EVN.

6. Legal implications

6.1. Legal issues related to coal power reduction

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

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

The legal implications and risks can be generalised as follows:

6.1.1. Ownership

To implement the roadmap towards the NZE target in every scenario, SOEs directly or indirectly (through their subsidiaries/affiliates) hold, in whole or in part, the decision-making power on phasing out/phasing down the CFPPs. Resulted of the SOE's decisional impact on the CFPP owner companies, there are 04 models to be grouped:

(i) 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);

(ii) 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);

(iii) Model #3 **(CFPPs with 51% to less than 75% of state capital)**: including CFPPs with State capital from 51% to less than 75%); and

(iv) 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).

In any model, the CFPP owner companies' charters and internal regulations, which delegate the decision-making authority (Council's member, the GMS, or the BOD), should significantly impact the determination of SOEs' ability to influence CFPPs' phase-out/phase-down decision. When deciding to phase out/phase down CFPPs, related legal issues such as labour, contract, property handling, etc., shall be considered for approval or authorization based on the Company Charter, internal regulations and Law on Enterprises[23]. The decisions are not only based on the legal documents of the respective CFPP or its owner company but also based on legal documents of the owner/member/shareholder of the CFPP owner companies' company, total asset value of the CFPPs, and the total contract value over the total asset value of these companies.

Particularly, EVN has ownership in 16 CFPPs (09 of Model #1, 03 of Model #2, and 04 of Model #3), PVN holds majority shares in 04 CFPPs (including 03 of Model #1 and 01 of Model #2), and TKV holds its shares in 08 CFPPs (07 of Model #2 and 01 of Model #4).

6.1.2. Commercial input and output contracts

In order to implement a phase-down/out plan, two major legal consequences may occur to the Power Purchase Agreement (PPA) and coal supply contracts of the CFPPs, either contract amendment or contract termination.

(i) **PPA**: All PPAs have been executed in accordance with regulations on the standard form of PPA. The amendment or termination must be followed the guidance from regulation and notify relevant authorities, such as the Electricity Regulatory Authority of Vietnam (ERAV) or the Ministry of Industry and Trade (MOIT). So far, the sole contractual partner to the PPAs is EVN. Therefore, it will not cause a high risk in any phase down/out scenario except some CFPPs are assessed at high risk due to their high private capital ratio, i.e. Pha Lai 1 & 2, Vinh Tan 1, Ninh Binh.

- *Contract amendment*: in case of phase-down, a CFPP will reduce its volume of electricity supply to EVN, the CFPP or the SOEs can either choose the **(i)** procedures regulated in the PPA standard form and the **(ii)** statutory circumstances in the legislative documents, i.e., basic change of circumstances in Civil Code[24] in order to negotiate with EVN. It should be noted that the SOE should perform its obligation related to the authority, i.e., obtain approval, opinion, or report to the ERAV.
- *Contract termination*: in case of phase-out, the SOEs have to reach an agreement with EVN in this matter. If EVN agrees to the PPA termination, both parties will find a solution for terminating in accordance with the current regulations. Otherwise, the termination will be considered a unilaterally terminated PPA by the CFPP, and several conditions of each termination case must be met. The CFPP and/or the SOE who owns

[23] Law on Enterprises No. 59/2020/QH14 supplemented and amended on 2022
[24] Civil Code No. 91/2015/QH13

such CFPP must strictly follow the termination procedures' regulations. It should be noted that if the CFPP terminated the PPA due to a Force Majeure event, the CFPP and/or the SOE must prove they take appropriate measures to minimize the loss and impact, among other conditions of such event.

(ii) **Coal supply contract**: The interviews of selected CFPPs show that most coal supply contracts are frame contracts. The parties will have additional agreements on coal supply volume for certain periods. The amendment or termination of the coal supply contracts will be based on the agreement between the parties. It will not cause a high risk in any phase down/out in KB_DD and KB_AR scenarios except some CFPPs are assessed at high risk due to their high private capital ratio, i.e. Pha Lai 1 & 2, Vinh Tan 1, Ninh Binh. The majority of the CFPPs may have moderate risk in the KB_DD scenario since the SOEs may need to prepare more carefully in advance for their long-term coal supply contracts, i.e. **(i)** negotiating to reach an agreement of early contract termination with the coal supplier or **(ii)** assessing an external factor whether such external factor follows any case of legitimate early contract termination.

- *Contract amendment*: Similar to the PPA, in case of phase-down, a CFPP will reduce its volume of electricity supply to EVN. Consequently, the CFPP will reduce the volume of coal purchased for electricity production. For amending the coal supply contract, the CFPP should note at least two obligations: (i) notifying obligations and (ii) obligation to agree with the other party (coal supplier) on the contract amendment in writing. *In addition*, the SOE may request the other party to renegotiate the contract in a reasonable period in the case of a basic circumstance change. However, proving a basic circumstance change is a challenge since it must meet several conditions under Article 420 Civil Code.
- *Contract termination:* In case of termination of the coal supply contract due to phase out, the CFPP can consider applying either of four cases of early termination agreed in the contract (Force Majeure; decision of the state authorities requesting for termination; dissolved, bankrupt status or decision of the state authorities causing a party ceased for operation; contract breach). Otherwise, the SOE has to consider applying contract termination conditions according to the Civil Code.

6.1.3. Loan/capital arrangement

The result from desk research and in-depth interviews provides that most of the long-term loans between CFPP owner enterprises and domestic and foreign commercial banks are paid off and terminated. There are some other short- and medium-term loans which are being paid off by 2024. As the NZE 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 of these enterprises.

However, among the above-mentioned loans, some CPFFs owner companies may face some issues some issues relating to the ECA Loans when they consider decommissioning a CFPP, and to make prepayment of the loan if they have to implement the phase down plan having an effect on the existing ECA Loans. Some CFPP owner enterprises reflect that additional investment capital is required for converting the combustion technology of CFPPs. This report will provide and estimate some significant issues relating to the ECA Loans from the OECD which may require SOEs' attention before their implementation of the proposed transition.

6.1.4. Labour

Our field study shows that SOEs all have had internal labor regulations and collective labor agreements. Some employees' rights stipulated in their collective labor agreements are more favorable than those in the applicable laws during normal operation of CFPPs. There is no regulation relative to employees' interests in case of labor contract termination for reasons of organizational structure changes, changes in technology, or for other reasons originating from CFPP owner enterprises. The rights and interests of employees in all circumstances of workforce reduction under energy transition scenarios shall all comply with regulations of laws on labor.

Overview of the applicable laws on labor contract termination and labor transfer in CFPPs as follows:

- *In case of phase-down,* it is not considered a case to terminate labour contracts for economic reasons in accordance with the applicable labour laws[25]. CFPP owner companies will choose to maintain the number of employees or cut down on labour in one of the following options:
  (i) Terminate the labour contract at the end of the contract term[26].
  (ii) Reach an agreement with the employee on early termination of labour contracts[27].
  (iii) Unilaterally terminate the labour contract after having sought all remedies, but labour reduction is still a must as a result of business and production downsize at the request of competent state agencies[28].
- *In case of phase out ahead of schedule*, SOEs or CFPP owner companies could choose either of the two options mentioned above based on the authorization to make decisions on phasing down CFPPs as follows:
  (i) If one or all generation units phase out ahead of schedule, SOEs or CFPP owner companies can consider terminating labour contracts for reasons of "changing the organisational structure, reorganising labour. The procedures for labour contract termination will comply with Article 42 labour Code[29] and Decree 145/2020/ND-CP;

[25] Labor Code, Article 42, clause 2
[26] Labor Code, Article 34, clause 1
[27] Labor Code, Article 34, clause 3
[28] Labor Code, Article 36, Clause 1, point c
29 Labor Code No. 45/2019/QH14

(ii) SOEs or CFPP owner companies unilaterally terminate the labour contracts with employees early when having sought all remedies but are still forced to reduce the workplace as a result of production and business downsize at the request of the competent state agency[30].

In these two circumstances, CFPP owner enterprises shall be subject to follow Article 48 Labor Code. Similar to the case of phase down, when terminating labor contracts in these cases, CFPP owner enterprises need to formulate a plan for labor use and training the employees in addition to the interests to be paid to the employees so that the labor contracts are terminated under laws without causing many great social impacts.

In the suggested scenarios, CFPPs that will not phase down, or phase down gradually in the period from now to 2025 will have low legal risks. The longer duration the scenarios plan, the more time is given to CFPP owner enterprises to arrange capital sources and well prepare the human resources for cutting down or using employees untill the generation units phase out completely. Accordingly, when CFPPs have gradually reduced employees, the risk of labor dispute at such CFPPs will extremey low, and negative social impacts will be limited. KB_DD scenario is assessed to have much pressure in term of labor since it comprises several CFPPs of high and medium risk, which will be phased out in 2025, such has 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. Especially, some CFPPs are owned by independent joint stock companiess with major business from thermal power production such as Pha Lai, Ninh Binh, the possibility of employee reuse of such CFPPs is not high.

In the KB_DD and KB_AR scenario, Pha Lai 1, Pha Lai 2 CFPP will be phased out; Cam Pha, Quang Ninh 1, and Extended Uong Bi CFPP shall be subject to phase down in 2025 period. These CFPPs are all located in Quang Ninh Province. This may lead to negative social impacts in Quang Ninh. Any improper handling of procedures for labor contract termination will result in labor disputes.

It is only possible for CFPPs to transfer and reuse employees if such CFPPs are owned by SOEs (under Model 1) that have other business activities with relatively large quantity of employees. For some enterprises that only do business relying on electricity such as Pha Lai, Quang Ninh, Ninh Binh, it will be rather difficult in reusing labor, unless the CFPP owner enterprises have a plan to develop a renewable power plant (Refer to the analysis in Section 4.5.2 herein). Therefore, to minimize any risk, CFPP owner enterprises need to have plans for gradually reducing workforce and reasonable employee using plans.

In any scenario, phase out and phase down of coal-fired power production will result in the reduction of coal mining by VINACOMIN and subsidiaries with VINACOMIN's dominating capital (under Model #1 and #2). This will directly impact the use of labor in enterprises exploiting coal.

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

Therefore, it is suggested that VINACOMIN pays attention to making a plan for employee use and vocational training for employees of other exploitation entities. At the same time, VINACOMIN should also calculate the benefits to be paid to employees to ensure proper implementation of work hour reduction or labor contract termination, avoiding large impacts to the society in the areas where coal mines are located. The legal solutions for employees working at VINACOMIN's coal exploitation units are similar to the legal solutions analyzed herein for CFPPs.

6.1.5. Properties

In general, CFPP owner enterprises exercise their rights and obligations to their own properties based on the principles of the legislation, the corporate charters, internal regulations. In which, the principle of capital preservation and development should be deeply concerned in the implementation roadmap of any scenario.

In order to implement the roadmap towards NZE target in all three scenarios, some properties need to be liquidated, such as properties only serving the old coal fired power generation technology, and some properties need to be invested, built and purchased (properties serving the new coal fired power generation technologies, reducing pollution in accordance with legal regulations on environmental protection).

Scenarios need to be deployed flexibly for each CFPPs with different scale, capacity, and value. This flexibility, on the one hand, creates more favorable financial conditions for the CFPP owner enterprises when participating in the NZE target, on the other hand, will ensure the national energy security better.

Risk analysis shows that KB_DD will have many CFPPs at high-risk, except for Pha Lai 1, Ninh Binh, Thai Binh 2, Long Phu, Na Duong, Cao Ngan, and Nong Son, which have a medium or low level of risk due to the long service life of these turbines, the operating life is about to expire (as analyzed in the technical section). For the KB_AR, it is mainly medium and low risk as the turbine life will expire at the time of phasing down/out..

When calculating the phasing down plan for each CFPP, it is necessary to pay attention to the investment cost of the transmission grid system of EVN or CFPP that is subject to the phasing down plan. Although the cost of electricity transmission and distribution is not included in the costs of the PPA[31], if the CFPP has not reached the end of its economic life, the capacity of EVN's transmission system (the electricity buyer's) has not expired its amortization period. Thus, the reduction plan may affect the return of investment in the transmission system of EVN. Thus, the reduction plan may affect the return of investment in the transmission system of EVN. In the situation where the depreciation has not been exhausted, investment costs of EVN's transmission system may have to be compensated in accordance with the law and PPA.

[31] Circular 57/2020/TT-BCT, Model PPA Contract, Article 16

6.1.6. Industrial safety and environment

When starting phasing down and phasing out CFPPs, through the renovation, repair, dismantling CFPPs, CFPP owner enterprise must ensure the requirements for environmental protection in accordance with the provisions of the Law on Environmental Protection[32].

Compared to the KB_AR scenario, CFPPs which apply the KB_DD scenario may cause the lowest risk to the enviroment, this scenario is reasonable in terms of time with the goal of increasing the pressure on technical alternatives to reduce emissions, while supporting for the goal of environmental balance in the long time.

Related to the option of reducing power generation following the direction of irregular generation in case the turbines have reached the end of their life and low technology as analyzed in the technical section, CFPPs must strictly comply with the specified emission parameters at National Technical Regulation QCVN 22:2009/BTNMT to control emissions (QCVN 22:2009/BTNMT). Emissions must also comply with National Technical Regulation QCVN 05:2013/BTNMT on ensuring ambient air quality (QCVN 05:2013/BTNMT). In case CFPPs replaces FO oil with Diesel oil (DO oil), Biomass/ammonia as technical analysis, CFPPs needs to calculate the amount of SO2, CO2 and NOX gases to ensure compliance with the maximum allowable concentration on emissions in the thermal power industry in accordance with QCVN 22:2009/BTNMT.

Wastewater during operation should comply with the National Technical Regulation QCVN 40:2011/BTNMT on Industrial Wastewater (QCVN 40:2011/BTNMT) and the National Technical Regulation QCVN 14:2008/BTNMT on Domestic Wastewater (QCVN 14:2008/BTNMT).

For the plan to phase down, phase out CFPPs and dismantle the turbines, CFPP owner enterprise needs to comply with the provisions of the law on construction, occupational safety and health (OSH), environmental protection, and regulations in accordance with National Technical Regulation QCVN 18:2021/BXD on Safety in Construction. Within a period of at least 12 months before each construction work expires, the owner or the manager or the user of the construction work must report to the competent state authority on the expiry date of the construction work and the action plan for the expired construction work. If the demolished construction work contains combustible materials and substances and/or used for demolition, before and during the demolition, measures to ensure safety for fire and explosion prevention must be taken at Section 2.15.1.8 QCVN 18:2021/BXD on safety in construction, control of noise and vibration when phasing out CFPPs as prescribed in Section 2 and Section 3 of QCVN 26:2010/BTNMT and according to regulations Section 2.1 QCVN 27:2010/BTNMT.

In case it takes a long time to phase down or phase out CFPPs, the surrounding resident will be affected by the amount of ash, slag and other wastes released into the environment from the CFPP to settle complaints and lawsuits of people related to their living environment

Please refer to Annex 2 for risk analysis on industrial and environmental safety of each CFPP.

[32] Law on Environmental Protection No. 72/2020/QH14

6.2. Legal issues related to RE and storage development

The assessment of legal issues when the SOEs develop renewable energy (RE) and electricity storage or carbon storage in line with the roadmap towards the NZE goal is also considered under 06 legal issues analysed in the reduction of coal power generation section. Our general assessment is as follows:

6.2.1. Ownership

New investments for renewable energy as well as power storage and carbon storage at CFPP owner enterprises require the approval or authorization by the competent agency in accordance with their charter, internal regulations and the Law on Enterprises. Particularly, for PVN new investments in renewable energy may be deemed as investments beyond their main business areas and may be not permitted under regulations of the applicable laws[33]. 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[34]. Therefore, in considering power production transition from coal-fired sources to renewable energy sources, CFPP owner enterprises should address this issue. This also requests a specific written guideline by the Government for the enterprises that wish to make transition from coal-fired power production into production with renewable energy sources, including circumstances in which the SOEs invest in power projects with renewable energy sources, and SOEs transform their technology or their CFPP's production method from coal-fired sources to renewable energy sources.

6.2.2. Commercial input and output contract

If the CFPP owner enterprises turn to sell electricity generated from RE, they also need to amend the PPA or sign a new PPA with EVN. The PPA amendment is similar to that analyzed in the phase down/out scenario. However, the promulation of regime of electricity pricing from RE is the most important issue of the PPA amendment. This matter needs to be solved synchronously when the CFPP owner enterprises negotiate with EVN on contract amendments according to the approved phase down/out scenario.

6.2.3. Loan/Capital Arrangements

When the scenarios require that the CFPPs must be owned by the majority of the SOEs' capital for the period of 2025-2050, it is necessary for the SOEs to be allocated capital (added by loan

[33] Decree 91/2015/NĐ-CP investment of state capital in enterprises and management and use of capital and assets at enterprises, Article 21

[34] Viet Nam Finance, 2022, https://vietnamfinance.vn/lan-san-phat-trien-dien-gio-pvn-de-nghi-thao-go-vuong-mac-20180504224271221.htm.

agreements or state budget funding). As presented above, because the loans for the CFPPs, currently, are being tightened, these loans will belong to the green credit policies of the Government for the transformation from coal to renewable energy sources.

6.2.4. Labour

In case the CFPP owner enterprises plans to construct the RE plant, they can transfer and reuse the employees currently working in the CFPPs. These enterprises must agree with their employees on the employee transfer and reuse of employees and have plan to re-train the labor skills for the employee in accordance with the labor laws.

6.2.5. Properties

When investing in RE, electricity storage and carbon storage will create new assets for CFPPs in general and properties for SOEs in particular. For long-term invested properties that are equipment and machinery to generate electricity from RE sources, it must be approved by a competent authority as analyzed in the Ownership section.

For properties that are land use rights of CFPPs, the land use purpose will continue to be land for energy projects when switching to the purpose of generating electricity from RE sources and storing carbon. However, for cases where the land area has expired, procedures for extension must be carried out, unless the locality has a land use plan for other purposes.

6.2.6. Industrial safety and environment

The conversion and replacement of CFPPs with renewable energy power plants and investment in electricity and carbon storage are positive contributions to environmental protection and emission reduction. However, when implementing projects of generating electricity from renewable energy sources and storing electricity and storing carbon, a number of legal issues on environmental protection must also be paid attention, including:

- The construction renewable energy power plants must comply with the regulations on environmental impact assessment (EIA). Accordingly, investment projects to build renewable energy plants with an area from 100 hectares or projects that using land, land with water surface of nature reserves, natural heritage sites, biosphere reserves, wetlands important water resources, natural forests and protection forests (except for investment projects on construction of works in service of forest management and protection, nature and biodiversity conservation, forest fire prevention and fighting, and silviculture approved by competent authorities) or projects that use the marine area must make an EIA report.
- Implementing renewable energy projects must pay attention to solid waste and hazardous waste, especially solar power projects and electricity storage projects in accordance with the

law. Discarded solar panels (photovoltaic panels) are managed according to waste management regulations. Accordingly, the waste source owner is responsible for separating waste from solar panels (photovoltaic panels) according to the provisions of the National Technical Regulation (QCVN 07: 2009/BTNMT) on hazardous waste thresholds for appropriate management.

Compared to CFPPs, RE plants have fewer environmental issues. The process of dismantling CFPPs to convert their energy coal source to renewable energy may pose the same environmental issues as those analyzed above.

It should be noted that current TCVN system still lacks the standards related to: design requirements for small wind turbines, offshore wind turbines; design requirements for wind turbine components such as turbine blades, towers and foundations; methods for measuring and evaluating wind turbine performance; methods for controlling and monitoring wind power plants, especially the standards related to offshore wind power and electricity transmission from offshore to the onshore power system . The lack of standards and regulations of RE equipment and projects likely makes it difficult to procure and install equipment manufactured or procured from abroad in accordance with current standards and regulations of RE sector. This issue needs to be resolved soon because all SOEs have the ability and potential to develop RE sources, especially offshore wind power[35].

[35] 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

7. International experiences for a just transition

7.1. Ensuring the benefits of stakeholders in the coal transition

The coal asset transition will involve both the early retirement and repurposing of CFPPs. Given the complexity and multidimensional nature of the energy landscape, a wide range of factors must be considered when selecting CFPPs for transition. The whole system's impact of the coal transition, both at the plant level and national level must be understood and considered to provide stakeholders with certainty and confidence that a strategic transition perspective has been taken.

These considerations can be grouped under the following categories noted in Table 20, and further detailed below.

Table 20. Summary of factors that need to be taken into consideration when prioritising CFPPs

	Security	Economics & Policy	Social	Environment
National Level	• Reliance on coal to meet future electricity demand. • Deployment of alternative thermal and renewable generation. • Reliance on CFPPs for flexibility services. • Excess of installed capacity compared to peak demand.	• System operation rules. • Policies insulating CFPPs from market pressure, e.g. fossil fuel subsidies. • Policies encouraging coal transition e.g. carbon tax. • CFPP revenue mechanisms.	• Jobs and livelihoods. • Funding of a socially equitable transition. • Diverse engagement. • Communities. • Channels for social support. • Economic diversification of a region.	• Water scarcity in a region. • Air pollution.
Plant Level	• Flexibility provision by CFPP. • Utilisation. • Size. • Age.	• Utilisation. • Size. • Age.	• Utilisation. • Size. • Combustion technology.	• Combustion technology. • Type of coal burnt in CFPP. • Utilisation. • Size.

7.1.1. Security

National-level considerations:

- The relevance of coal generation to meet future electricity demand compared to renewable generation, i.e. the energy (MWh) produced by coal generation in the current and future generation mix.
- The relevance of coal generation for the security of supply, i.e. the installed capacity (MW) of CFPPs and their level of flexibility to respond to variances in demand.

Plant-level considerations:

- CFPPs with low- or medium utilisation should be prioritised for retirement as they will have a lower impact on the electricity network's security.
- Early retirement of plants that are too large compared to their grid may cause instability.
- Old CFPPs, typically 16 – 25 years, will likely have lower efficiency and therefore have a lower utilisation compared to equivalent but younger CFPPs operating under the same conditions.

7.1.2. Economics & Policy

National level considerations: The following factors will affect the pace of the coal transition in terms of creating a more conducive regulatory environment to phasing out coal:

- Carbon market/tax,
- Reallocating fossil fuel subsidies, creating fiscal space to invest in renewable generation
- Establishing the legal framework necessary for coal transition mechanisms
- National commitments to phasing out coal
- Providing limited-time financial incentives to drive investment in renewable generation

Plant-level considerations:

- The age, size and utilisation of a CFPP will affect its economic viability. Under the circumstance that a third party is acquiring a CFPP via a coal transition mechanism, more profitable plants would be prioritised for early retirement.
- CFPPs nearing the expiry of their PPA tenor should be prioritised for retirement compared to those with several years left in the tenor.
- The age and size of the CFPP also limit the potential repurposing options available and have a subsequent effect on the economics of closure. Younger plants are more suited for retrofitting to co-fire with alternative fuels as they are likely to operate more efficiently and have active PPAs. Older plants are better suited for replacement with renewable energy as they are likely to have lower performance and, therefore, less utilised than newer plants.

7.1.3. Social Considerations

National-level considerations:

- In addition to CFPP employees, indirect and informal jobs in the coal sector are also likely to be impacted. This can be mitigated by assessing alternative livelihood options and diversifying local economic activities.

- Significant investment will be required to create new income opportunities, stimulate job growth in coal regions and retrain former coal workers.

Plant-level considerations:

- Larger CFPPs with high utilisation are more likely to have a greater workforce than smaller CFPPs with low utilisation. This is because there are more generating units; therefore, more workers are required to operate and manage the site.
- Newer CFPPs are more likely to have more automated processes, requiring fewer workers. Prioritising CFPPs with a larger workforce will have a greater collective impact on a coal community.

7.1.4. Environmental Considerations

National-level considerations:

- CFPPs operating in water-scarce environments and regions with high levels of air pollution have significant environmental impacts; therefore, prioritising them for transition would lead to larger marginal benefits for the environment.

Plant-level considerations:

- The emission factors of CFPPs vary depending on their coal combustion technology, type of coal used, utilisation, age and size. All these factors should be considered when prioritising CFPPs.

Details on the review of international experiences with the specific example are provided in Annex 3.

7.2. Policy/economic/social Instruments used for coal transition

The development of instruments to accelerate the phase-down of coal is currently under development and has been prioritized by several global initiatives including the Coal Asset Transition Accelerator (CATA), among others. Key advancements to date to support the accelerated phase-down of coal and aid a just transition include:

- **World Economic Forum's Coal to Clean Decision Tree**[36]: The decision tree has been developed to support coal power plant owners, financiers and the government to assess the most beneficial repurposing strategies to lower a plant's emissions while maintaining energy generation capacity. The decision tree considers the following three outcomes – clean energy repurposing, upgrading with emission reduction technologies, and decommissioning – and prioritizes these in terms of their benefits to the energy system based on the operating conditions of the existing plant.

[36] World Economic Forum. Coal to Clean Decision Tree. https://initiatives.weforum.org/micee/ctr-toolkit

- **ADB's prioritisation framework for the early retirement of CFPPs via an Energy Transition Mechanism (ETM)[37]:** The framework was developed to identify coal plants best placed for retirement through an ETM, based on: (1) how early retirement could affect the local power grid's energy security; (2) the plant's economic viability, and; (3) how the plant's removal can contribute to emissions reduction. The framework can be used as a tool to support engagement and communication with governments and international stakeholders on early coal retirement using a retirement mechanism.

- **Alternative livelihoods plan:** Just transition principles go beyond consideration of the direct employees of plants facing closure but extend their application to the wider community, including indirect and informal workers, the families of workers, and the broader region. Several guidelines featuring international best practices on just transition strategies and alternative livelihood planning have been developed, though they must be tailored to the local context in terms of supporting displaced workers to access alternative jobs. Key pieces of literature highlighting such strategies include:

    - IISD (2018). Real People, Real Change: Strategies for just energy transitions
    - Agora Energiewende (2019). The German Coal Commission: A Roadmap for a Just Transition from Coal to Renewables
    - PWC (2007). People's Republic of China: Alternative Livelihood Options to Facilitate Coal Sector Restructuring

Examples of key instruments being implemented to support policy, economic and social priorities related to the coal phase-down are detailed below.

7.2.1. Instruments supporting policy objectives

The examples below detail the mechanisms that are being used to support the implementation of coal phase-down policies and regulations.

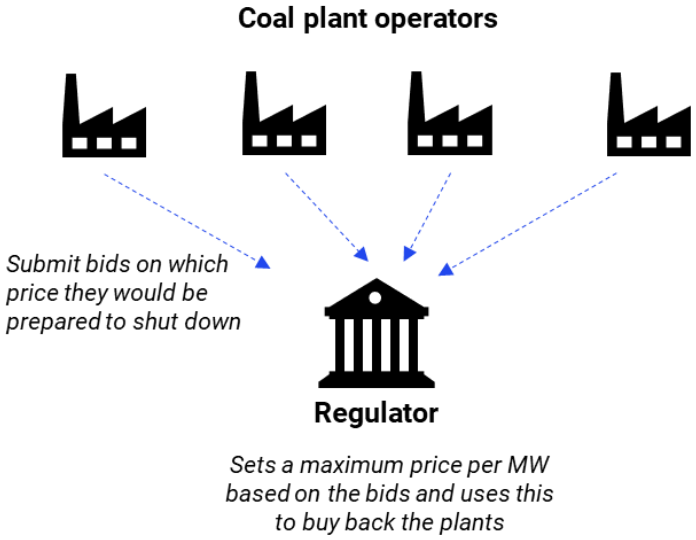
i. Reverse auctions

Overview: Pay-as-bid auctions are designed to compensate coal plant owners for decommissioning earlier than their current retirement dates. (Figure 42)

Description: Operators are asked to declare at which price they would be prepared to shut their plants, and the regulator sets a maximum price per MW accordingly. The ultimate price takes into account the bidder's offers and the CO2 emissions of the plants in question.

[37] ADB (2021). Opportunities to Accelerate Coal to Clean Power Transition in Selected Southeast Asian Developing Member Countries: Technical Assistance Consultant's Report. https://www.adb.org/projects/documents/reg-55024-001-tacr

Figure 42. Reverse auction instrument



Constraints:

- Require sufficient diffusion in coal plant ownership (e.g., enough coal plant owners, enough diffusion in market share) to be effective
- Require there to be sufficient incentives (e.g., political mandate, investor pressure, plants facing losses, sufficient auction budget size) and no significant barriers (e.g., long-term power purchase and fuel supply agreements) to participate as auctions are voluntary
- Verification of the performance needed to ensure payment of auction proceeds

Opportunities:

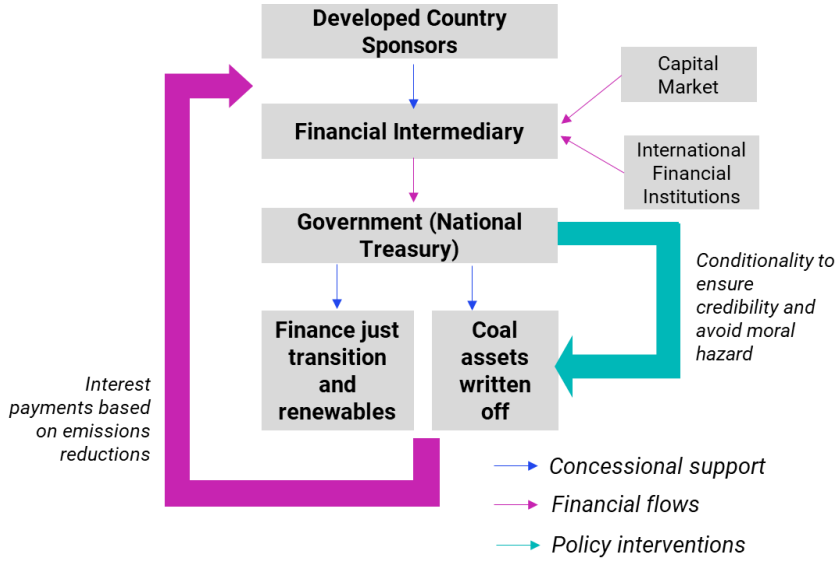
- If relevant data is not high-quality or easily available, auctions can be a useful tool to 'discover the price' of coal plants
- Can be useful to pair with clean energy auctions, especially when it would help scale clean deployment in-country

ii. Concessional debt

Overview: Public finance institutions or governments provide concessional (i.e., below-market) debt to sovereign governments or specific projects.

Description: In the case of South Africa, an international public fund grants a loan to refinance its national utility so that it can bear the cost of writing-off coal assets and fund the just transition. The interest payments on this loan are offered at concessionary rates proportional to the emissions reductions the country achieves.

Figure 43. Concessional debt instrument



This debt can be used to refinance and retire coal assets, build out new renewables, or increase institutional capacity to support a coal transition.

Constraints:

- Limited sources and amounts of public dollars
- Complex and often inaccessible system to disburse climate finance funding
- Local (technical and institutional) capacity to access climate finance can sometimes be lacking

Opportunities

- Useful when private investment is unavailable or insufficient to facilitate and/or initiate a transition by itself
- A suitable mechanism for commercial investors looking for initial public investment to enter a certain geography/market
- Flexibility in the use of proceeds is required to cover a range of possible transition activities

7.2.2. Instruments supporting economic objectives

The examples below detail the mechanisms that support market-based incentives and disincentives that incorporate the environmental costs and benefits of a coal phase-down.

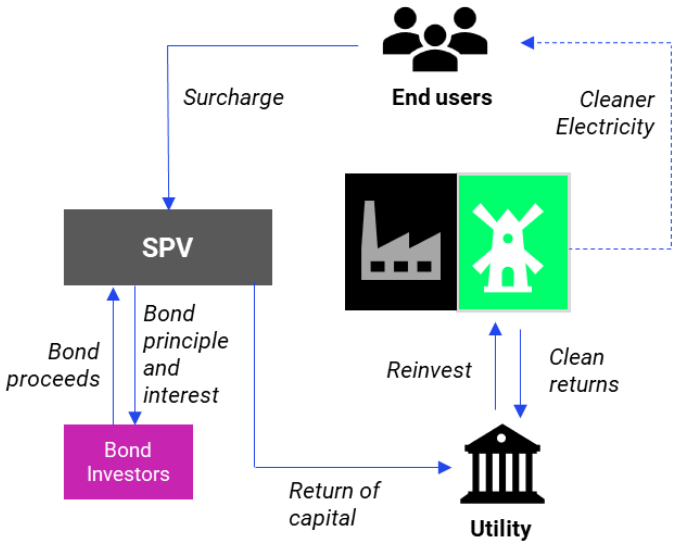
i. Ratepayer-backed securitisation

Overview: Utility raises low-cost debt, backed by repayment through current and future customers, to decommission existing assets.

Description: Once the utility issues a bond, the customers would pay the bondholders through a billing surcharge, but at a lower overall cost than paying the utility directly.

As high-carbon plants are retired by the utility, consumers benefit from lower electricity rates since the inefficient plants are no longer overseen by the utility, and the utilities can also use part of the savings to invest in clean energy replacement. Savings generated from lower costs of financing can also be used to support workers and communities.

Figure 44. Ratepayer-backed securitisation



Constraints:

- Requires enabling legislation to minimize costs of financing in its current form
- Requires liquid capital markets
- Can only be applied to utility-owned assets as debts are repaid through tariffs and ratepayers
- Legal framework must allow for the creation and use of some form of Special Purpose Vehicles

Opportunities

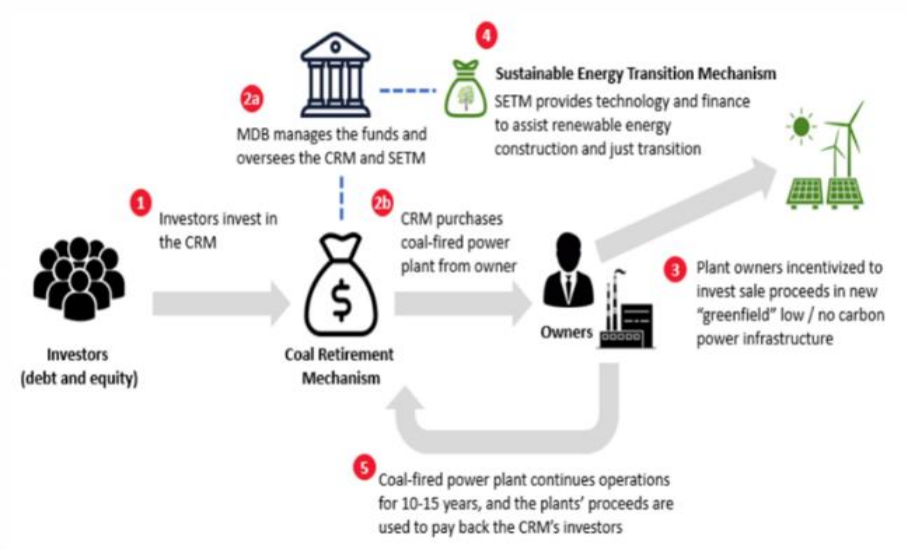
- Enabling legislation is seen to significantly reduce investment risk for bondholders

ii. Managed transition vehicle

Overview: Mobilise funds from the private and/or public sectors to support the buyout and retirement of high-carbon assets (Figure 45).

Description: ADB's Energy Transition Mechanism will be designed to secure blended finance to buy, operate, and retire coal assets ahead of schedule, support the development of renewable energy, and support worker transition.

Figure 45. Manage transition vehicle



Constraints:

- Transfer of coal plant ownership (and associated risk) requires accurate data on operational coal costs to accurately size and price transition vehicle
- Requires continued operation of coal assets until investors are repaid, limiting emissions reductions
- A structure that proposes to combine coal and renewables within its mechanism is a highly complex and an untested contracting structure may be challenging to standardize

Opportunities

- Useful when the utility/IPP owning the coal assets is heavily indebted and is unable to take on additional debt that may result from other coal transition mechanisms

7.2.3. Instruments supporting social objectives

The examples below detail the mechanisms that support the pathway towards a just transition related to a coal phase down.

i. EU Just Transition Mechanism

Overview: €29B policy package to support the impacts of the energy transition on workers and communities.

Description: The mechanism supports economic diversification in member states via grants, private-sector investment in low-carbon infrastructure and the just transition, and public-sector investments in low-carbon and social infrastructure.

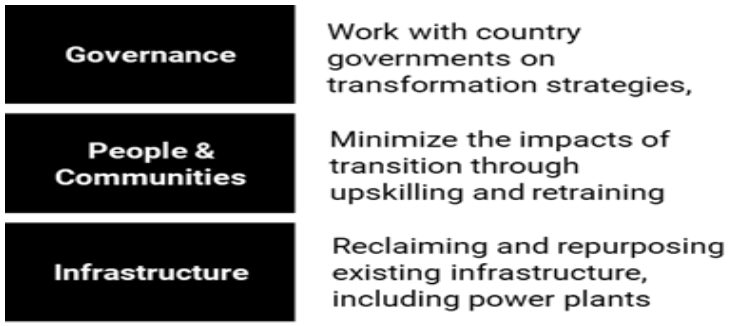
Constraints:

- For every €1 received from the Just Transition Fund, countries must match €1.5- €3 from their allocations under the European Regional Development Fund and the European Social Fund
- As with any program that has a dedicated source of funding, there are limits to replicability and scalability

Opportunities

- Particularly important to alleviate concerns about not enough resources being dedicated to the just transition of affected communities

ii. Climate Investment Funds – Accelerating Coal Transition (CIF ACT)



Overview: A 2.5 B$ global concessional finance initiative to support the impacts of the energy transition on workers and communities.

Description: Develops country-level strategies for the coal transition, provides direct transitional support to people and communities and reclaims and repurposes coal infrastructure.

Constraints:

- As with any program that has a dedicated source of funding, there are limits to replicability and scalability.

Opportunities

- Particularly important to alleviate concerns about not enough resources being dedicated to the just transition of affected communities.

7.3. Financial opportunities to support energy transition in Vietnam

7.3.1. Just Energy Transition Partnership

South Africa has signed the first JETP agreement in which the International Partnership Group has committed to raising 8.5 B$ over the next 3-5 years. This financing is seen as the starting point for a much larger funding program for South Africa to implement the just energy transition. One year after the signing, South Africa developed and announced a Five-Year Investment Plan (JET IP) in November 2022. This plan estimates the total required funding at 98.7 B$ for the period 2023-2027[38] with the main JET IP investments focusing on the following areas:

- ***Electricity (47.5 B$, 48%)***: Dismantling fossil fuel plants (repurposing the assets for clean technologies), strengthening and expanding the power grid, developing renewable energy, and supporting workers and local communities to transit away from coal.
- ***New energy vehicles (8.5 B$, 9%)***: Reducing emissions in the transportation sector and supporting the supply chain transition to sustainable green manufacturing.
- ***Green Hydrogen (21.3 B$, 21%)***: Planning and feasibility studies, including investments in ports to boost exports, employment, and GDP.
- ***Cross-cutting (21.5 B$, 22%)***: Invest in skills development and urban development.

An example of JETP mobilisation for emission reduction projects in the power generation sector in South Africa is the project "Decommissioning and repurposing Komati coal power plants".

The plant has a capacity of 1 GW, including 10 units owned by Eskom, which is a state-owned enterprise that plays a dominant role in electricity generation, transmission and distribution in South Africa. Eskom produces about 95% of electricity in South Africa, including 19 fossil fuel power plants (15 coal power plants and four gas power plants).

The Komati plant is located in Mpumalanga province, which produces 83% of coal in South Africa and is home to 12 out of 15 of Eskom's coal power plants. Komati's first unit was put into operation in 1961, and the last unit in 1966. Since 1988, some units started to stop operation and completely closed in 2008. Later, a number of units were put into operation again between 2009 and 2014. As of 2021, only one unit number 9 remains in operation and the technical life of the plant ends in September 2022[39].

[38] South Africa's Just Energy Transition Investment Plan 2023-2027.
[39] https://www.gem.wiki/Komati_power_station

The plan to decommission the Komati was proposed by Eskom at the end of October 2022 within the framework of JETP by turning the Komati coal power plant into a renewable energy centre (150 MW of solar power, 70 MW of wind power and 150 MW of wind power and storage). The project budget is $497 million (including a loan of $439.5 million from the World Bank; $47.5 million from CCEFCF; $10 million from ESMAP)[40]. The project includes three components[41]:

- ***Decommissioning of the Komati plants***: the estimated cost is about ***33.5 million USD***. It is possible to earn about 10 million USD from selling and recycling iron, steel and alloy.
- ***Reuse the plant to provide clean electricity***: an estimated cost of ***$416 million USD*** for solar, wind and battery solutions (approximately $410 million), applying new technology to improve the quality of electricity (three units will be installed with synchronous capacitor and flywheel).
- ***Provide opportunities for workers and communities:*** estimated cost of $***47.5 million USD*** to mitigate risks and ongoing socio-economic impacts of plant operations, including transition support for workers, employees, suppliers, community development and economic diversification, stakeholder engagement and community empowerment.

7.3.2. Energy Transition Mechanism

The Energy Transition Mechanism (ETM) was first proposed at the World Economic Forum in 2018 as a market-based model that can be replicated to support the transition from coal to clean energy[42]. This mechanism focuses on providing financial support to facilitate the "early retirement" of coal-fired power plants while ensuring socioeconomic factors while promoting investment in clean technologies (renewable energy, storage, electric vehicles, etc.). ADB's role helps catalyse public and private financing to support this equitable and sustainable transition for affected communities. Japan is the first partner that has committed $25 million in funding for the ETM. Private partners have also signed a Memorandum of Understanding to fund the mechanism, including the Rockefeller Foundation.

Technical and financial feasibility studies are being carried out in three countries, Indonesia, the Philippines and Vietnam, which have a high share of coal in the economy. According to the ADB, the “early retirement” of coal power plants will help reduce emissions while creating new investment demand in clean energy and reducing overall power generation costs in the long term.

The ETM Partnership Trust Fund has been established through which governments and international organisations provide highly concessional grants or financing packages. To date, the

[40]https://www.sanews.gov.za/south-africa/world-bank-approves-sa%E2%80%99s-497m-request-komati-power-plants-decommission-repurposing
[41] The World Bank Eskom Just Energy Transition Project (P177398)_ Project Information Document (PID)
[42]https://www.iges.or.jp/sites/default/files/inline-files/2_Tharakan_ETM%20Introductory%20Presentation%20External%20Feb%202022_IGES_Tharakan.pdf

Fund has received 25 million USD committed by the Japanese government and 30 million Euro from the German government. The Fund's budget is divided into two lines:

- Technical assistance: technical and financial analysis, grid development; just transition (skill development and livelihoods); policy and regulatory support, carbon finance, Measurement, Reporting and Verification (MRV).
- Concessional finance: exchange/trade coal power assets and clean energy assets at the plant level, exchange/trade in assets at the corporate level.

Two transaction models are proposed by ADB to accelerate the early retirement/reuse of coal power plants:

- ***Synthetic model (plant level):*** ETM invests capital (primary/secondary loan or mezzanine capital - with high flexibility and low cost) into the factory. The plant owner retains the same share of equity and operating responsibilities. The investment with the condition of the premature shutdown is committed through a contract between the owner and the plant with appropriate security measures. The loan from ETM will be used to pay existing creditors and the investor to compensate for economic losses due to shortening the plant's life. According to ADB, this model is most suitable for IPP plants with Power Purchase Agreements that international banks can accept.
- ***Portfolio model (corporate level):*** ETM provides financing to corporations that own multiple coal power plants and have new clean energy projects. The Group will ensure the construction of clean energy projects and the early retirement of coal power plants. CETM and the group will agree on targets, such as the plant selected for early retirement, the total coal power capacity to be retired up to a certain time, the amount of CO_2 emission reduction, etc. use this capital to close factories according to the schedule and invest in renewable energy projects as well as upgrade the power grid. Mechanisms (such as interest penalties) will be put in place to ensure the transition will take place.

Indonesia is the leading country in the research and application of the ETM mechanism. The Indonesian Ministry of Finance has established the National Platform for the Energy Transition Mechanism to mobilise financial resources and support from domestic and foreign partners. Indonesia and ADB have signed a Memorandum of Understanding on the premature decommissioning of the privately owned Cirebon-1 (660 MW) coal power plant. Details of the roadmap and terms will be further clarified by the stakeholders. The financing for this is estimated at 250-300 million USD.

National power group PLN has announced a plan to cut coal power with a roadmap for early retirement of 2-3 plants (~1 GW total) by 2030, about 9 GW in 2035 and 49 GW in 2050. Under the framework of JETP Indonesia, Climate Investment Funds (CIF) announced that it will provide Indonesia with a concessional loan of USD 500 million from CIF's Accelerating Coal Transition

program, part of which will be used to support the mechanism. ETM. This commitment stems from the Indonesian government's proposal in October 2022, which introduced a financial plan totalling 5.3 B$ to accelerate the "early retirement" of coal power plants, promoting equitable transition and reuse, scale up renewable energy and storage. In particular, the activities to support PLN close ahead of time ~1 GW of coal power is expected to require 1.55 B$.

8. Conclusions and Recommendations

Vietnam Electricity (EVN), Vietnam National Coal and Mineral Industries Group (TKV), and Vietnam Oil and Gas Group (PVN) are the three largest economic groups in Vietnam's energy sector. Together, they are providing stability and reliability for the power system and acting as government agents to provide affordable energy access for all. Under the urge to implement Vietnam's climate commitment, these SOEs are also the leading actors in driving the energy transition of Vietnam toward a low-carbon direction aligning with the Net Zero Emissions target by 2050.

In this report, two scenarios have been developed to evaluate the different decarbonisation pathways in SOEs, focusing on CFPPs, the largest emission source of SOEs' power generation activities. The following sections provide the recommendations for the energy transition in the three energy SOEs supporting the nation's NZE goal.

8.1. Technical aspect

To compensate for the reduced generation output and incomes from coal power, SOEs are recommended to invest in RE and storage capacity according to their strength, financial health and strategy for their future role in the power sector.

- **EVN:** to invest in the new floating solar capacity as they own many strategic hydropower reservoirs with an identified potential of more than 9 GW. As the most important SOE in the power sector, it is also recommended that EVN invest in new battery storage capacity to keep the enterprise's dominant role in ensuring power system security and stability.
- **PVN:** to invest in or take part in the investment of new offshore wind power capacity as they have excellent human resources and expertise in offshore engineering. PVN has a diverse set of subsidiaries specialising in different fields of offshore engineering. For example, PVN's PTSC is a leading offshore contractor in Vietnam with EPCIC (Engineering, procurement, construction, transportation and installation, and commission) capacity and already has some experience in the wind power sector as well as winning international tenders for offshore projects in other countries. PVN also has ports and supply bases for the assembly of oversize components, cargo handling, transportation and offshore support vessels.
- **TKV:** to invest in new RE capacity and battery storage, considering the possibility of utilising the land recovered from closed mines. TKV also can explore biomass co-firing technology at some selected coal-fired power plants.

8.2. Financial aspect

In the area of financing for the phasing down and phasing out of CFPP, each of the SOE (EVN, TKV and PVN) should take the following actions:

- On the basis of the scenario to be adopted, EVN, TKV and PVN will formulate a detailed plan and road map for phasing down and phasing out of its CFPPs.
- EVN, TKV and PVN will formulate the investment plan and financing mechanism for the implementation of such a transition plan and road map.
- EVN, TKV and PVN proceed with the approval of the roadmap and investment plan as the foundation for implementation (approval by the board of each of the SOE and then by the respective regulatory authority when necessary).
- EVN, TKV and PVN elaborate on concrete investment plans for concrete transition projects (e.g. for the phasing down and phasing out of initial CFPPs between now and 2025 and then 2026-2030) and present them to potential donors.
- EVN, TKV and PVN communicate and present the plans, roadmap (and specific proposal by each CFPP) to potential donors: JETP Secretariat (likely to be established in April 2023), ADB (early CFPP retirement programs), banks, etc.
- Engage the donors to finance and initiate the first projects (e.g. with financing under the JETP mechanism, or ADB Southeast Asia ETM Partnership, CIF), or with a donor (public or private, national or international).
- EVN, TKV and PVN to mobilize technical assistance from international agencies for support in all of the steps as investment preparation, investment, and post-investment.

8.3. Legal aspect

In order to achieve the goal of reducing coal power production, the Government needs to have a number of following solutions, but not limited to:

- Review several current legal documents with provisions related to the implementation of investment in the construction of CFPPs (such as the Circular 23/2015/TT-BCT regulating sequence, procedures for financing thermo-power plant project in the form of BOT contract) to consider amending and supplementing the same in order to **(i)** ensure conformity with the provisions of Power Development Plan VIII[43] on coal-fired power "*only continue projects mentioned under the amended VII Electricity Planning and under construction investment until 2030. Aim to make the transition to biomass and ammonia energy for power plants that have been operating for 20 years when market price is appropriate. Suspend operation of power plants which have lifetime exceeding 40 years if these plants cannot make the energy transition*"[44], "*coal-fired electricity is no longer present by 2050*" [45], **(ii)** meet international commitments on climate protection as a basis for the development and maintenance of CFPPs to ensure national energy security, **(iii)** adhere to the requirements of the Government's Resolution 140/NQ-CP of the Government on promulgating the Government's action plan to implement Resolution No. 55-NQ/TW dated February 11, 2020 of the Politburo on strategic orientations for national energy development of Vietnam Vietnam to 2030, with a vision to 2045 ("Resolution 140/NQ-CP"), such as: "Develop CFPPs at a reasonable level in the direction of prioritizing large-capacity and high-efficiency units, using advanced and modern technologies such as supercritical technology and above; ensure the full implementation of the law on ecological and environmental safety and protection[46].
- Develop and finalize more technical regulations, standards and technical guidelines for the use of ash and slag as ordinary industrial solid waste to ensure compliance with environmental issues treatment of residual ash and slag, promoting the CFPPs to use these wastes in many other industrial purposes. Currently, there are some technical regulations and standards on the use of ash and slag that are still being studied and developed by relevant ministries, i.e., **(i)** basic standards on the use of ash and slag from CFPPs in the construction of rural road surface foundations[47], **(ii)** the national standard TCVN on phosphorus slag for cement and concrete production[48].
- It is necessary to develop a mechanism of electricity purchase price that offsets 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....
- It is necessary to support SOEs to access preferential credit sources to be able to invest in investment projects, upgrade existing equipment of thermal power plants to be able to meet new requirements on environmental protection.

- Following the Power Development Plan VIII, consider promulgating legal documents that prescribe **(1)** specific (i) specific roadmap with clear deadline of coal power reduction for each CFPP, (ii) mechanism and procedures for CFPPs to reduce coal power generation, **(2)** cost compensation mechanism for CFPPs that are required to reduce coal power generation, **(3)** budget to implement the above reduction roadmap so that the SOEs have legal basis and clear roadmap and implementation measures.
- Study and consider promulgating mechanisms and policies on adjusting electricity prices appropriately, ensuring **(i)** meeting NZE targets and **(ii)** harmonizing the interests of the State, corporations, investors and consumers.

In oder to support SOEs in renewable energy development and energy storage, the Government needs to:

(i). Amend and supplement to Vietnam's Renewable Energy Development Strategy to 2030 with a vision to 2050 to be incompatible with Power Development Plan VIII[49].

(ii). Amend and supplement development strategy of the SOEs in renewable energy and energy storage development to successfully implement emission reduction scenarios. For PVN, the Government proposes to amend the Oil and Gas Industry Development Strategy so that PVN can invest in new energy fields such as renewable energy, especially offshore wind power and energy storage.

(iii). Develop technical standards and regulations (TCVN) of renewable energy projects such as wind power plants (wind turbine design requirements, method of measuring and evaluating wind turbine performance; ...)

(iv). Promulgate (i) a preferential mechanism to buy electricity from renewable energy sources of CFPPs turning to renewable energy sources for the CFPPs and SOEs' transition implementation, (ii) mechanism for developing electricity storage system, (iii) price mechanism for ancillary services when the national power system has a strong growth

[43] 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)

[44] Power Development Plan VIII, Article 1, Section III.1 (b).

[45] Power Development Plan VIII, Article 1, Section III.1 (b)

[46] Resolution 140, Government's action plan to implement Resolution No. 55-NQ/TW, Section II. 2 (a) stipulates the power source and grid

[47] 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

[48] 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

[49] 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 NMNĐ in the energy transition process. quantity in Vietnam

[50]Power Development Plan VIII, Article 1, Section II.2 (b): Extensively develop renewable energy sources for electricity production[51] Decree No. 131/2018/NĐ-CP, Article 4, clause 1

rate of renewable energy sources according to the objectives of the Power Development Plan VIII[50].

(v). Support the SOEs to access preferential credit through different institutions, especially the equity transfer mechanism (JETP) so that the SOEs can invest in renewable energy projects and energy storage.

CMSC needs to:

(1) Formulate and submit master plans for enterprises investment and development of the 03 SOEs[51] on the basis of **(i)** KB_AR, KB_DD scenario, **(ii)** Vietnam's renewable energy development strategy to 2030, vision to 2050 and plan to amend and supplement legal regulations, **(iii)** consolidation of difficulties of the SOEs and opinions/approvals of the competent authorities (such as the Politburo, the Government) in expanding the functions and business scope of the SOEs to implement the Vietnam's energy transition.

(2) Organize and collaborate with the Ministry of Planning and Investment, the Ministry of Finance, and relevant authorities in requesting the Prime Minister to make decisions on restructuring, ownership transfer in the SOEs if these matters arise during the implementation of KB_AR, KB_DD scenario[52];

(3) Organize and collaborate with the Ministry of Finance on requesting the Prime Minister to make decisions on the adjustment of charter capital of the in the SOEs if these matters arise during the implementation of KB_AR, KB_DD scenario[53];

(4) Organize and collaborate with the Ministry of Planning and Investment, the Ministry of Finance, and relevant authorities in requesting the Prime Minister to give approval for 05-year investment/development strategies or plans and business/production plans of the SOEs[54], in which these strategies or plans are formulated on the basis of **(i)** KB_AR, KB_DD scenario, **(ii)** Vietnam's renewable energy development strategy to 2030, vision to 2050 and plan to amend and supplement legal regulations, **(iii)** opinions/approvals of the competent authorities in reducing the coal power generation at the CFPPs and expanding the business scope of the SOEs in renewable energy, energy storage.

(5) Research and develop an internal manual on technical and economic assessment and propose risk reduction plans when implementing transition scenarios

[50]Power Development Plan VIII, Article 1, Section II.2 (b): Extensively develop renewable energy sources for electricity production[51] Decree No. 131/2018/NĐ-CP, Article 4, clause 1

[51] Decree No. 131/2018/NĐ-CP, Article 4, clause 1

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

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

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

8.3.1. Recommendations for each SOEs

EVN

- Review the tasks set forth for EVN to 2025 in the "Development Strategy of Electricity of Vietnam to 2030, with vision to 2045"[55] (referred to as "Strategy 538") to suit the suggested scenarios (KB_DD, KB_AR), especially the development orientations related to investment in new power plants assigned according to the plan, researching coal mixing solutions to improve plant operation efficiency. Then, based on the tasks reviewed, possibly propose the Prime Minister to promulgate a new strategy for EVN to conform to the selected scenario for emission reduction on the basis of amendments and supplements to Strategy 538.
- Pursuant to Resolution No. 140/NQ-CP of the Government on promulgation of the Government's Action program for implementation of Resolution No. 55-NQ/TW dated February 11, 2020 of the Politburo on the orientation of Viet Nam's national energy development strategy to 2030, with vision to 2045 ("Resolution 140"), EVN will study to propose the Government to formulate preferential mechanisms, policies and regulations to support the development of gas-fired thermal power since the Power Development Plan VIII stipulates that "Prioritize domestically available gas for generation" [56].
- At the capacity as an electricity buyer in PPAs, EVN needs to calculate the economic losses incurred to EVN for not using EVN's transmission system that has been invested to connect to CFPPs (not only including those studied in this Report) when CFPPs are subject to phase down/out according to the suggested scenarios. Based on the calculations of potential economic losses, EVN should develop public compensation plans in the proposal/request of CFPPs in implementing phase down/out if the time of phase down/out affects PPA's term. The calculation of economic losses will also help the State estimate the options to compensate for EVN's losses due to the implementation of emission reduction scenarios or to arrange for EVN to access preferential credit sources through KB_DD, KB_AR scenario.
- In this period, EVN should develop a plan for negotiating, discussing with the shareholders at the CFPPs of which EVN does not own 100% capital, such as Hai Phong, Vinh Tan 2, Quang Ninh, Pha Lai 1, Pha Lai 2, Ninh Binh, etc.
- EVN needs to request each CFPP or CFPP owner enterprise under EVN to specifically assess the legal risks (along with technical and economic assessments) and propose the solutions for risk minimization in implementing phase down/phase out or transition scenarios to develop the implementation plan from now onward. The plans should address the issues of owners' rights, benefits and risks of EVN when terminating or changing PPAs, labor use plans

[55] Decision No. 538/QĐ-TTg of Prime Minister on 01/04/2021 approving the Development Strategy of Vietnam Electricity to 2030, with a vision toward 2045.

[56] Power Development Plan VIII, Article 1, Section III.1 (a): **Gas-fired electricity:** Prioritize domestically available gas for generation. If domestic gas quantity is low, import additional natural gas or LNG. Develop projects utilizing LNG with matching LNG import infrastructures in appropriate scales and utilizing modern technology

according to the suggested scenarios, the solutions that need additional credit to implement the scenarios, the measures to terminate and modify coal purchase contracts and other long-term contracts, asset disposal options in the suggested scenarios and options for asset disposal and potential environmental impacts in each phase down/out scenario (KB_DD, KB_AR).

- Based on the risk assessments as provided in paragraph (v) herein, EVN will request the subsidiary CFPP or CFPP owner enterprise to pay attention to formulate plans relative to the suggested scenarios, which at least comprise the following:
  - Business plan of each CFPP upon phase down/out upon request of the suggested scenarios, develop the plan to discuss with other owners of each CFPP. For plants built on basis of joint venture contracts, investment capital contribution contracts ... it will be necessary to develop a plan to proactively notify partners in the course of contract amendment or early termination procedures with the basis of force majeure event regulations, basic change of circumstances.
  - Plans for procurement of input materials (such as coal) to change or terminate contracts for input material purchase. Similar to joint venture contracts, capital contribution contracts, EVN needs to proactively notify its partners so that circumstances of contract amendment or early termination can be applied.
  - Plan for the use of labor at each CFPP and the solution for transferring labor within the corporate to minimize social impacts as analyzed, with special note that the development of the plan must be in line with Strategy 538, such as reducing workforce, improving labor productivity, creating equitable learning and development opportunities for employees... When the phase down/out plans have been approved by competent authorities, labor issues will be handled in accordance with the law, minimizing possible strikes and collective labor disputes.
  - Plans for new investments, investment in upgrading and renovating CFPPs in this period are based on Strategy 538 to match the phase down/phase out scenarios, avoiding waste of the amount for investment or upgrade which are not depreciated in full. For circumstances of investment in new CFPPs, to ensure the power grid security, replacing CFPPs using old technology, it is requested to develop with priority for power generation units that are of large capacity, high productivity with advanced and modern technology such as ultra-super critical technology or better ones; assuring full implementation of legal provisions on econogical environment safety and environmental protection as requested by Resolution 140.
  - In the event that a CFPP is capable to transition to power production by renewable energy, storage, etc., it requires the preparation of the conditions stipulated by laws such as making EIA reports, extending investment licence (if any), extending land use period, and other requirements as well as conditions for environmental protection under laws.

PVN

- PVN needs to review its implementation of Resolution No. 41-NQ/TW of Vietnam's Politburo on the strategy for developing Vietnam's oil and gas industry to 2025 and vision to 2035 (Strategy 41) to be in compliance with the transition scenarios (KB_DD, KB_AR) and development conditions and active participation of PVN in the scenarios. At present, Strategy 41 restricts PVN to invest outside of its core sector, which limits PVN's capacity to implement energy transition scenarios. Therefore, a review of PVN's Strategy 41 implementation and a proposal for PVN's future development strategy are necessary, this will involve the determination of PVN's direction and role in the energy sector in order to supplement and amend Strategy 41.
- According to Resolution 140/NQ-CP, PVN studies and develops the mechanisms, policies and regulations to support the gas-fired thermal power development, ensure the gas-fired power development to be aligned with Vietnam's power system, especially paying attention to the coal fuel conversion technology at the current CFPPs. When developing gas-fired thermal power, PVN needs to prioritize the use of its available gas sources, focusing on using LNG to generate power.
- As a electricity seller in the PPAs, PVN needs to calculate its economic losses incurred by PVN when phasing down according to the proposed scenarios. Based on such possible economic losss calculations, PVN should develop a plan for accessing credit sources to support the energy transition. Economic loss calculations can help the State determine compensation for PVN's losses resulting from the implementation of GHG reduction scenarios, or arrange preferential credit sources for PVN in proposed scenarios i.e., KB_DD, KB_AR.
- During this period, PVN needs to develop a plan to negotiate and discuss with partners who jointly own the CFPPs where PVN does not hold 100% capital ratio, such as Vung Ang 1.
- Similar to EVN, PVN should require each CFPP or the CFPP owner enterprise where PVN contributes its capital (PV Power) to assess the legal risks in detail (along with technical and economic assessments), propose a plan to mitigate the risks when implementing the reduction or transition scenarios, to develop an implementation plan starting from this period onwards.
- Based on the risk assessments mentioned in paragraph (v) above, PVN either requires its CFPPs or the CFPP owner enterprise to develop a plan related to the scenarios, including at least the following:
    - Business plan of each CFPP when phasing down according to the scenarios, plan to discuss with other shareholders of Vung Ang 1 to implement the contract amendment or early termination procedures with the basis of force majeure event regulations, basic change of circumstances.
    - Plan to purchase input materials i.e., coal to amend or terminate the material purchase contracts. PVN needs to actively notify its partners as part of the procedure to amend or early terminate the input contracts.
    - Develop workforce planning at each CFPP and plan of corporate internal employee transfer to minimize social impacts as analyzed, such as reducing labor, improving labor productivity,

creating fair study and development opportunities for the employees. When the phase-down plans have been approved by the competent authorities, labor issues will be handled in accordance with the law, as lawful measures will be taken to limit strikes and collective labor disputes.

- The investment plan to upgrade and renovate CFPPs in this period should be aligned with the phase-down scenario, in order to avoid wasting investments and upgrading assets that have not yet fully depreciated.

- In case a CFPP is capable of converting to electricity generation by RE, energy storage, etc., it is necessary to prepare to meet the conditions prescribed by law such as making EIA report, extending the investment certificate (if any), renewing the land use term, and meeting other relevant environmental protection requirements and conditions.

Vinacomin

- VINACOMIN needs to propose detailed plan-based KB_DD, KB_AR scenario to finalize the Vietnam coal industry development strategy, which is currently being drafted and about to be promulgated.
- As a electricity seller in the PPAs, VINACOMIN needs to calculate its economic losses incurred by VINACOMIN when phasing down according to the proposed scenarios. Based on such possible economic losss calculations, VINACOMIN should develop a plan for accessing credit sources to support the energy transition. Economic loss calculations can help the State determine compensation for VINACOMIN's losses resulting from the implementation of GHG reduction scenarios or arrange preferential credit sources for PVN in proposed scenarios i.e., KB_DD, KB_AR.
- During this period, VINACOMIN needs to develop a plan to negotiate and discuss with partners who jointly own its CFPPs.
- Similar to EVN, VINACOMIN should require each CFPP or the CFPP owner enterprise where VINACOMIN contributes its capital to assess the legal risks in detail (along with technical and economic assessments), propose a plan to mitigate the risks when implementing the reduction or transition scenarios, to develop an implementation plan starting from this period onwards.
- Based on the risk assessments mentioned in paragraph (iv) above, VINACOMIN either requires its CFPPs or the CFPP owner enterprise to develop a plan related to the scenarios, including at least the following:
  - Business plan of each CFPP when phasing down according to the scenarios, plan to discuss with other shareholders since some CFPPs, where VINACOMIN contributes its capital, have several capital contributions, i.e. Vinh Tan 1 having foreign capital contribution, to implement the contract amendment or early termination procedures with the basis of force majeure event regulations, basic change of circumstances.

- Plan on coal mining to supply coal to VINACOMIN's CFPPs and other CFPPs in Vietnam according to the Government's coal power production reduction requirements and emission reduction scenarios.
- Develop workforce planning at each CFPP (due to change of coal use) and plan of corporate internal employee transfer to minimize social impacts as analyzed, such as reducing labor, improving labor productivity, creating fair study and development opportunities for the employees. When the phase-down plans have been approved by the competent authorities, labor issues will be handled in accordance with the law, as lawful measures will be taken to limit strikes and collective labor disputes.
- The investment plan to upgrade and renovate CFPPs in this period should be aligned with the phase-down scenario, in order to avoid wasting investments and upgrading assets that have not yet fully depreciated. In terms of investment in new CFPPs to ensure the grid security and replace outdated CFPP technology, priority should be given to the high-tech and modern power generation units that have large capacity and high efficiency, such as supercritical technology or better ones. It is also necessary to ensure full compliance with the laws on ecological and environmental safety and protection, as required by Resolution 140.
- In case a CFPP is capable of converting to electricity generation by RE, energy storage, etc., it is necessary to prepare to meet the conditions prescribed by law such as making EIA report, extending the investment certificate (if any), renewing the land use term, and meeting other relevant environmental protection requirements and conditions.

In medium term (2026 – 2030) and long term (2036 – 2050), the SOEs are recommended to implement the plans and tasks formulated in the 2023-2025 to ensure the successful implementation of the suggested scenarios.

Contact information:

Vietnam Initiative for Energy Transition (VIETSE)
Add: 7th Floor, Building 18 Ly Thuong Kiet, Hoan Kiem, Hanoi, Vietnam
Tel: 024.32045554
Email: info@vietse.vn
Website: https://vietse.vn

Economic Management Advisory., JSC (ECONOMICA)
Add: P805, Building 27 Tran Duy Hung, Cau Giay, Hanoi, Vietnam
Tel: 024.66722057
Email: contact@economica.vn
Website: https://www.economica.vn

NHQuang & Associates
Add: No. 23, Trung Hoa Nhan Chinh Villa Area, Thanh Xuan, Hanoi, Vietnam
Tel: 024.35376939
Email: contact@nhquang.com
Website: https://nhquang.com

Carbon Trust Singapore
Add: 63 Chulia Street, #14-01 OCBC Centre East Singapore 049514
Email: singapore@carbontrust.com
Website: https://www.carbontrust.com