Diagnostic Study on Net-Zero for The Energy Sector in Vietnam

Deliverable 1: Inception Report

By E4SMA

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1 Introduction

In November 2021, at COP26, Prime Minister Pham Minh Chinh announced strong commitments to tackle climate change, emphasising that with its own resources, along with the cooperation and support from the international community, Vietnam will develop and implement strong emissions reduction measures to achieve net-zero emissions by 2050. Moreover, Vietnam also joined the Global Methane Pledge supporting a goal of reducing methane emissions by 30% in 2030 compared to 2020 levels. Vietnam also supported the Global Coal to Clean Power Transition Statement and committed to ceasing the issuance of new permits and construction of new unabated coal-fired power generation projects.

Finding the optimal investments and combinations of resources to ensure energy security, decarbonization, and improved economic outcomes while ensuring a fair and just energy transition requires a dedicated and diverse analytical process. In this context, the proposed study aims to develop a deep-dive scenario assessment of Vietnam's energy sector transition towards net-zero emissions by 2050, considering the interrelations with major energy-consuming sectors such as transportation, manufacturing, and lighting.

The study will serve as a reference for the Government of Vietnam. It is expected to be relevant for the implementation of the Prime Minister's Decision 888/QD-TTg on tasks and solutions for COP26 commitment implementation. It is also expected to be relevant for the implementation of the National Energy Master Plan and for the Just Energy Transition Platform (JETP) program. In this context, the Department of Oil, Gas and Coal requested international support to complete and implement the Master Plan and inform about the Just Energy Transition. However, the study is not meant to overcome any Government's policy decisions. It will rather identify packages of solutions to support decision-making by the Government of Vietnam to achieve its COP26 commitment by 2050, relying on key transformations, optimal investments, and combinations of resources to support the energy transition.

This study will incorporate prior analyses conducted by ETP, World Bank, Denmark, and USAID and integrate closely with planning performed by the Government of Vietnam, the Government's agencies including (i) MOIT in charge of power planning and energy master plan; (ii) MONRE in charge of NDC, emission inventory and reduction measures; (iii) MOF and MPI for financial issues; (iv) CEC for political and national security in term of energy and (v) CMSC as the owner of major coal-fired power plants. The study will also benefit the engaged bilateral and multilateral partners.

The study is funded by the Southeast Asia Energy Transition Partnership (ETP), which brings together governments and philanthropies to work with partner countries in the region and support the transition towards modern energy systems\(^1\) that can simultaneously ensure economic growth, energy security, and environmental sustainability. ETP is initially focusing on Indonesia, the Philippines, and Vietnam, which are the countries in the region with the highest energy demand, a

\(^1\) « Energy systems » refers to all the energy commodities (not only electricity) and technologies that are needed for the economical and social activities.
substantial pipeline for fossil fuel-based projects, and a significant and cost-effective potential for renewable energy and energy efficiency.

2 Vietnam objectives towards net-zero target

The objective of this section is to provide a short overview of the main energy and climate policies of Vietnam. It provides valuable insights for assessing the pathways to net zero, including the challenges and opportunities associated with a Net-Zero target for the energy sector in the country.

The current Vietnam energy and climate policies towards net-zero targets for the energy sector include several major legal documents including Politburo’s resolution, and Decisions of the Prime Minister. Major legal documents shaping clean energy development in Vietnam are shown below:

2.1 Politburo’s Resolution 55-NQ/TW on the Orientation of Viet Nam’s National Energy Development Strategy to 2030 and outlook to 2045 (11/02/2020)²

Objectives

- To meet the domestic energy demand for the targets of the 10-year socio-economic development strategy 2021-2030; in which, primary energy will reach about 175 - 195 million TOE (tons of oil equivalent) by 2030, about 320 - 350 million TOE by 2045; the total capacity of power will reach about 125 - 130 GW by 2030, the electricity output will reach about 550 - 600 billion kWh by 2030.
- The share of renewable energy sources in the total primary energy supply will reach about 15-20% by 2030; 25 - 30% by 2045.
- Total final energy consumption will reach 105 - 115 million TOE by 2030, and 160 - 190 million TOE by 2045. Primary energy intensity will reach 420 - 460 kgOE/1,000 USD GDP by 2030, from 375 - 410 kgOE/1,000 USD GDP by 2045.
- Building a smart and efficient grid system for the region's connection; ensuring safety for power supply, meeting criteria N-1 for important load areas and N-2 for particularly important load areas. By 2030, the reliability of electricity supply will be in the top 4 of ASEAN’s leading countries, and the electricity access index will be in the top 3 of ASEAN's leading countries.
- Oil refinery capacity meets at least 70% of domestic demand; ensure the level of strategic petroleum reserve reaches at least 90 days of net import. The sufficient capacity to import liquefied natural gas (LNG) is about 8 billion cubic meters in 2030 and about 15 billion cubic meters in 2045.
- The ratio of energy savings to total final energy consumption compared with the normal development scenario will reach about 7% in 2030 and about 14% in 2045.

Reduce greenhouse gas emissions from energy activities compared to the normal development scenario by 15% by 2030, to 20% by 2045.

2.2 Prime Minister’s Decision 896/QD-TTg 2022 on National Climate Change Strategy through 2050 (26/07/2022)³

**Overall objective**
The overall objective of the strategy, set out in this decision, is to proactively and effectively adapt to climate change, reduce greenhouse gas emissions to net zero, and deal with vulnerabilities and risks caused by climate change. The strategy also aims to make active and responsible contributions to the international community in protecting the Earth’s climate, take advantage of opportunities from climate change response to transforming growth models, as well as improve the competitiveness of the economy.

**Objectives**
- The GHG emission reduction target of the energy sector is 32.6% compared to the Business as Usual (BAU) scenario, total GHG emission will not exceed 457 million tons CO₂eq in 2030; 91.6% and 101 million tons CO₂eq in 2050.
- To meet the target, proposed solutions include promoting energy efficiency and clean energy technologies. In the power sector, developing small hydro PP; expanding current large hydro PP; increasing renewable energy PP such as wind, concentrated solar PP, biomass, green hydrogen, green ammonia, wave energy, and tidal energy are the proposed solutions.
- The share of electricity production from renewable energy will be at least 33% in 2030, and 55% in 2050.

2.3 Prime Minister’s Decision 1658/QD-TTg on National Green Growth Strategy for 2021 -2030 period, with a vision 2050 (1/10/2021)⁴

**Overall objectives**
Accomplish green growth, thereby promoting the economic restructuring associated with innovation of growth model, to achieve economic prosperity, environmental sustainability, and social equality; strive towards the green and carbon-neutral economy and contribute to the achievement of the goal to reduce global warming.

**Objectives**


• By 2030, primary energy consumption per GDP in the period of 2021 - 2030 will be reduced from 1.0% - 1.5% annually, and the share of renewable energy in the total primary energy supply reaches 15 - 20%.
• By 2050, primary energy consumption per GDP in each 10-year period will be reduced from 1.0% annually, and the share of renewable energy in the total primary energy supply reaches 25 - 30%.
• By 2030, GHG emission intensity (GHG emissions per GDP) will be reduced by at least 15% compared to 2014.
• By 2050, GHG emission intensity (GHG emissions per GDP) will be reduced by at least 30% compared to 2014.

2.4 Draft Power Development Plan (December 2022)

The Power Development Plan for 2021-2030 with visions to 2050 (PDP8) aims to build an overall plan for the power sector in Vietnam covering power sources and transmission grid. It provides valuable insights and an appropriate starting point for assessing the pathways to net-zero.

In the context of Vietnam's commitment at COP 26, PDP8 has been redrafted to reflect the commitment. The draft PDP8 proposes three scenarios. The main results of the latest version of PDP8 (December 2022) for the three scenarios are presented in Table 2.1.

Table 2.1. Summary of main results in PDP8

<table>
<thead>
<tr>
<th>Overall description of the scenario</th>
<th>BASE SCENARIO</th>
<th>HIGH SCENARIO</th>
<th>HIGH ADMINISTRATION SCENARIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity demand forecast for base GDP growth rate</td>
<td>121,757 MW (2030)</td>
<td>134,594 MW (2030)</td>
<td>145,989 MW (2030)</td>
</tr>
<tr>
<td>Electricity demand forecast for high GDP growth rate</td>
<td>368,461 MW (2050)</td>
<td>498,108 MW (2050)</td>
<td>501,608 MW (2050)</td>
</tr>
<tr>
<td>Electricity demand forecast for high GDP growth rate and considering the risks in deployment of several large power plants</td>
<td>11.6% (2030)</td>
<td>20.7% (2030)</td>
<td>27% (2030)</td>
</tr>
<tr>
<td>48.2% (2050)</td>
<td>59.1% (2050)</td>
<td>58.9% (2050)</td>
<td></td>
</tr>
<tr>
<td>11.6% (2030)</td>
<td>20.7% (2030)</td>
<td>27% (2030)</td>
<td></td>
</tr>
<tr>
<td>48.2% (2050)</td>
<td>59.1% (2050)</td>
<td>58.9% (2050)</td>
<td></td>
</tr>
<tr>
<td>CO2 emission (Mt CO2eq)</td>
<td>259 Mt CO2eq (2035)</td>
<td>264 Mt CO2eq (2035)</td>
<td>239 Mt CO2eq (2035)</td>
</tr>
<tr>
<td>35 Mt CO2eq (2050)</td>
<td>34 Mt CO2eq (2050)</td>
<td>30 Mt CO2eq (2050)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Draft PDP8 submitted by MOIT to GOV for approval in December 2022 (available only in Vietnamese)

2.5 Energy Master Plan (December 2022)

The Energy Master Plan for 2021-2030 with visions to 2050 (EMP) aims to build an overall plan for the energy sector in Vietnam covering oil, gas, coal, power and renewable energy. The draft EMP
proposes two scenarios. The main results of the latest version of EMP (January 2023) are presented in Table 2.2.
Table 2.2. Summary of main results in EMP

<table>
<thead>
<tr>
<th>Overall description of the scenario</th>
<th>BASE SCENARIO</th>
<th>HIGH SCENARIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy demand forecast for base GDP growth rate</td>
<td>103 MTOE (2030)</td>
<td>110 MTOE (2030)</td>
</tr>
<tr>
<td>Total final energy consumption (MTOE)</td>
<td>144 MTOE (2050)</td>
<td>177 MTOE (2050)</td>
</tr>
<tr>
<td>Total primary energy supply (MTOE)</td>
<td>160 MTOE (2030)</td>
<td>296 MTOE (2030)</td>
</tr>
<tr>
<td>Renewable energy share in total primary energy supply (%)</td>
<td>17.4% (2030)</td>
<td>18.9% (2030)</td>
</tr>
<tr>
<td>CO2 emission</td>
<td>439 Mt CO2 eq (2030)</td>
<td>455 Mt CO2 eq (2030)</td>
</tr>
</tbody>
</table>

Source: Draft EMP submitted by MOIT to GOV for approval in December 2022.

2.6 Nationally Determined Contribution (October 2022)\(^5\)

In its Nationally Determined Contribution (NDC), emission reduction targets in the energy, agriculture, land-use, land-use change, and forestry (LULUCF), waste and industrial processes by 2030 compared to BAU are 15.8% in the unconditional contribution of Vietnam, and 43.5% in the conditional contribution.

The unconditional contribution will rely on the state budget, loan capital, investment of domestic and foreign enterprises, contribution, and investment of the people. The conditional contribution will be effective if adequate and appropriate resources are received from international financing through grants, concessional portions of loans, financial resources, technology, and capacity building under bilateral and multilateral international cooperation mechanisms, especially under the UNFCCC and the Paris Agreement.

In the energy sector, the emission reduction by 2030 compared to BAU is 7% in unconditional contribution and 24.4% in conditional contribution. There is no target for 2050 in the NDC.

2.7 Political Declaration on establishing the Just Energy Transition Partnership with Vietnam (JETP)\(^6\)

One of the targets of the Political Declaration on establishing the Just Energy Transition Partnership with Vietnam (JETP) is reducing the volume of emissions from the electricity sector. JETP will support Vietnam to accelerate the decarbonisation of its electricity system from the current net-zero planning peak of 240 MtCO2e by 2035 with international support (down from 280 MtCO2e before COP26) towards reaching a peak of no more than 170 MtCO2e emissions from electricity generation by 2030.

\(^5\) Vietnam NDC 2022 | UNFCCC
\(^6\) Political Declaration on establishing the JETP with Viet Nam (europa.eu)
JETP will work with Vietnam and investors to reduce Vietnam's project pipeline for coal-fired generation, currently standing at a planned capacity peak of 37 GW, towards a peak of 30.2 GW. The other support is increasing electricity generated from renewable energy, from the current planned figure of 36% to at least 47%.

2.8 Summary of the emission targets

The different emissions targets are summarized in Table 2.3. The National Climate Change Strategy (NCCS) is the most recent official target for achieving Net-zero emissions by 2050 in Vietnam. NDCs are also aligned with the NCCS with targets only by 2050. The two draft plans PDP8 and EMP are also aligned with the NCCS with targets for the power and energy sectors. The recent Vietnam's JETP agreement requires more ambitious targets for the power sector with an earlier emission peak by 2030, lower coal-fired capacity, and higher shares of renewable power.

Table 2.3. Major targets for GHG emission reduction in Vietnam

<table>
<thead>
<tr>
<th>No</th>
<th>Document</th>
<th>Emission</th>
</tr>
</thead>
</table>
| 1  | National Strategy for Climate Change | Reduction compared to BAU:  
- 32.6% (2030)  
- 91.6% (2050)  
Emission: do not exceed  
- 457 Mt CO2eq (2030)  
- 101 Mt CO2eq (2050). |
| 2  | National Green Growth Strategy   | Reducing GHG emission intensity (GHG emissions per GDP) by:  
- at least 15% compared to 2014 (2030)  
- at least 30% compared to 2014 (2050) |
| 3  | Nationally determined contribution | Reduction compared to BAU:  
- 7% in unconditional contribution (2030)  
- 24.4% in conditional contribution (2030). |
| 4  | PDP8                            | Emissions (base, power sector):  
- 259 Mt CO2eq (peak in 2035)  
- 151 Mt CO2eq (2045)  
- 35 Mt CO2eq (2050). |
| 5  | Energy Master Plan               | Emissions:  
- 439-455 Mt CO2eq (2030)  
- 98-101 Mt CO2eq (2050) |
| 6  | Vietnam's JETP agreement         | Emission peak of no more than 170 Mt CO2eq by 2050  
(emissions from electricity generation) |

2.9 Opportunities and challenges

The Net Zero Target represents several opportunities and challenges for Vietnam.

The opportunities often considered are the following ones.
• Transformation of the energy sector to meet international commitments.
• Development of governmental policies to promote green growth and circular economy development.
• Reducing energy dependence and therefore reinforcing energy security.
• International interest in the energy market.
• Ability to access new and green technology, and carbon financial instruments in the international context.
• Chances to join the global energy value chain.

The challenges to overcome, which can also be a source of opportunities, are the following ones:
• Need to ensure energy security and energy supply to meet the rapid socio-economic development.
• Risk of stranded assets.
• Decline in domestic traditional primary energy resources.
• Impact of global geopolitics and conflicts on energy supply and prices.
• Large investment requirements for decarbonizing the energy sector, including still immature and non-commercial technologies,
• Labour transformation for the domestic fossil energy supply sub-sectors.

3 Review of past and ongoing studies

Several studies have already been conducted to inform about a lower CO2 energy outlook of Vietnam. The analysed scenarios are presented below, as a basis of useful information for the new ongoing study, in terms of data inputs, assumptions for scenario definition, and benchmark for result analysis. Moreover, gaps have been identified that deserve special consideration in the new study of the future Vietnamese energy landscape.

The review is split into two parts. First, four significant reports from VIET SE & RMI (2022), USAID (2021), EREA & DEA (2022), and World Bank Group (2022) are reviewed. Second, a shorter overview is given of the national studies from McKinsey & Company (2022), Tan, Harrison, & Howells (2022a), Tan, Harrison, & Howells (2022b), and IES Intelligent Energy Systems & WWF (2022), and the regional studies from Phoumin, Kimura, & Arima (2021) and Wärtsilä (2022).

3.1 VIET SE & RMI: Review and Gap Analysis of the Existing Abatement Scenarios for Vietnam 7

ETP completed a review and gap analysis of existing coal abatement scenarios for Vietnam which assesses the potential emission reduction in the power sector in Vietnam. The study was conducted under the Rapid Response Facility of COP26.

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The study covers the period 2020 to 2045. GAMS models were used for evaluating installed capacities, and for creating hourly production profiles which were then evaluated using the DigSILENT model to identify any possible grid congestion issues.

The study includes four main scenarios, which all have the same assumptions on the demand side, where the demand and the elasticity per GDP from the draft PDP8 from September 2021 was followed:

- A **Business-As-Usual** scenario (BAU), following the planned coal development from the draft PDP8 from November 2021. Coal capacities are increased to 2035 and stay constant thereafter, domestic gas capacity stays constant after 2030, liquified natural gas (LNG) increases throughout the modelled years, and renewable energy steadily increases after 2030.
- A **Blue** scenario, where no new coal capacities are considered after 2030. The lack of capacity is compensated by LNG and offshore wind. Offshore wind capacity is increased by 5 GW compared to the BAU scenario. Additional LNG is included to replace the coal capacity in BAU. The efficiency of hydropower plant operation has been increased by 10%.
- A **Green** scenario, where the restriction of no new coal after 2030 is included and the capacity is compensated by renewable energy. As opposed to the BAU and Blue scenarios, more coal capacity is assumed to be phased out by 2030, namely Ninh Binh, Pha Lai 1, and Pha Lai 2. Domestic gas capacities are assumed to be constant from 2030 and no new LNG capacity is allowed. The capacities of solar, onshore, and offshore wind are growing rapidly. Last, the hydropower efficiency is increased as in the Blue scenario.
- A **Cyan** scenario, mixing the blue and green scenarios allows for some LNG capacity but adds a lot of green energy capacities. The phase-out of the existing coal plants, the restrictions on domestic gas, and the increased efficiency of hydropower as in the Green scenario are included. Solar and wind additions dominate the system but the growth in wind energy is slower than in the Green scenario, which is then compensated by LNG.

The Blue, Green, and Cyan scenarios have also been combined with energy efficiency (EE) measures to create a total of seven scenarios. The EE scenarios include lower electricity demands in the future years with reductions of 4% in 2025, 10% in 2030, and up to 16% in 2045 compared to the baseline.

The authors conclude that energy efficiency is a promising way to decrease the need for capacity installations and leads to higher job creation. LNG capacity installations can help the sector in the mid-term but add to the risk of stranded assets in the longer term. The authors further suggest increasing flexibility in the power system to allow for better integration of renewable energy. The flexibility could come from decision support systems for hydropower, and an overall update of the power system infrastructure, e.g., sub-station automation systems, and battery storage, amongst others. The authors suggest the development of the ASEAN power market to allow for flexible trading between the countries in the region and for better utilisation of the generated renewable power.
Overall perspective: The study constitutes a very useful reference providing relevant background information on data and pathways toward a more sustainable future. However, the proposed scenarios do not show sufficient reductions in CO2 emissions to reach Net Zero by 2050. Moreover, the study focuses on the power system, and it does not provide a full energy sector perspective, where mitigation pathways would consider actions in end-use sectors.


The Vietnam Country Climate and Development Report (CCDR) is the first in a series of country-level diagnostics by the World Bank Group under its 2021-2025 Climate Action Plan. The report examines adaptation and mitigation challenges in Vietnam and provides recommendations to policymakers to allow them to prioritise possible actions. The study is a key reference study.

The report includes two pathways from 2022: a Resilient Pathway, covering adaptation measures to cope with climate change and continuing to 2050, and a Decarbonising Pathway, covering mitigation measures to go towards net zero, which ends in 2040. The analyses are based on World Bank's computable general equilibrium (CGE) model, MANAGE (Mitigation, Adaptation, and New Technologies Applied General Equilibrium), and for the Decarbonising Pathway, also World Bank's internal Electricity Planning Model (EPM) has been used to run two scenarios for the power sector.

The Decarbonising pathways include three main scenarios:

- A **Baseline scenario** (both pathways), with a baseline growth path of the economy and where climate change impacts are ignored.
- A **Net Zero Pathway scenario** (Decarbonising Pathway) where an 80% reduction of GHG emissions by 2040 compared to the baseline scenario is included.
- A **Net Zero Pathway with supporting reforms scenario** (Decarbonising Pathway), building on the net zero Pathway and including further measures: reduced air pollution, competitiveness gains from climate policies (price advantage in markets that adopt border carbon adjustments, attraction of foreign direct investment), energy efficiency gains of 5% in industry and services, improved labour mobility across sectors, low crowding out of other investments.

For the EPM, the two scenarios that are compared are:

- A **Currently Proposed Policy** scenario, which follows the targets from the draft PDP8 report from October 2021, in which a significant increase in renewable energy capacity is included as well as a lower increase in coal power capacity than the current plans.
- An **Accelerated Decarbonisation** scenario, that is in line with Vietnam's goal of phasing out coal in the 2040s and that reduces power sector emissions in 2040 by 80% compared to the Currently Proposed Policy scenario.

The report concludes that if the net zero pathway is implemented together with the supporting reforms, the GDP can be increased by 1.7% in 2030 and 3.3% in 2040, and the net zero pathway would pay for itself. A net zero pathway would also increase employment with up to 1 million jobs in 2040.

**Overall perspective:** The study is considered a key one in Vietnam, and it constitutes a useful benchmark of further analyses. The combination of a CGE model with a power system model constitutes a relevant framework to assess both the economy-wide impacts and the impacts on the power system of different scenarios. However, it does not allow a detailed analysis of the technological transformations needed in the end-use sectors. Furthermore, the analysis stops in 2040, not capturing challenges related to the decade 2040-2050, where net emissions need to reach zero.

### 3.3 EREA & DEA – Vietnam Energy Outlook Report 2021

The Vietnam Energy Outlook Report (EOR) is a biennial report published by the Vietnamese Electricity and Renewable Energy Authority (EREA) and the Danish Energy Agency (DEA) to provide mid- and long-term perspectives on the development of the Vietnamese energy sector as input to stakeholders.

The 2021 version has been published in May 2022 and evaluates a series of five scenarios of the energy sector towards 2050. The analyses have been performed with the energy system model, TIMES-VN, which covers all sectors, and a power sector model, Balmorel. The two models are linked in a simple way by feeding model results from TIMES to Balmorel and for some of the scenarios also feeding results back into TIMES from Balmorel. The PSS/E model has been used for exploring the implications of the power system for snapshot years.

The scenarios analysed in the report are:

- **A Baseline scenario**, where the existing policies and contracted commissioning of new plants have been included. The committed capacities in the power sector follow the draft PDP8 (March 2022) until 2026 and include no new coal from 2035. A CO₂-emission pathway has been included, which includes reductions in emissions of 15% in 2030 and 20% in 2040 compared to a business-as-usual scenario.

- **A Green Power** scenario, where a higher share of renewables in the power sector has been added (38% in 2030 and 75% in 2050). The RE share in primary energy, the CO₂-emission pathway, the committed power capacities and the restriction on new coal capacities from 2035 follow the Baseline scenario.

- **A Green Transport** scenario, in which higher shares of electrification of the land-based transport (cars, buses, trucks, trains, motorbikes) have been included. A modal shift towards collective transportation modes, especially from motorbike to metro, and no new gasoline

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motorbikes from 2030 have also been included. Last, more renewable energy has been included in the power sector to cover the increase in electricity demand from transport with green electricity.

- An **Air Pollution** scenario, which includes costs of air pollution from NOx, SO2, and PM2.5 in the optimisation. The costs depend on sectors and the unit costs have been projected for the future following population growth.
- A **Pathway to Net Zero** scenario, in which a carbon budget of 11.2 bn t CO2 has been included for the period 2020 to 2050. The emissions are assumed to peak in 2035 and go to zero in 2050 as announced by the Prime Minister during the COP26.

The authors conclude that to reach net zero emissions by 2050 at least costs, fossil fuels should be substituted by renewable electricity, biofuels, or electro-fuels (e-fuels) produced with renewable electricity. The analysis shows that a huge build-out of transmission is necessary and that storage is not necessary for the decarbonised sector before and after 2030. Energy efficiency is expected to play a large role for decarbonisation, and the study shows that non-compliance with low energy efficiency measures increases sector costs by 5%. Further, while decarbonisation of the energy sector comes at a higher cost, air pollution will be significantly reduced (87% compared to the baseline scenario). It is concluded that emissions should peak no later than 2035 to stay within the carbon emission budget while avoiding excessive costs that would happen if emissions peak later. Interestingly, reaching net zero will make Vietnam almost independent of fuel import by 2050, enhancing energy security and reducing the costs of imports.

> Overall perspective: Although the EOR includes a net-zero scenario, the models were not able to reduce the emissions to zero in 2050, especially because of the difficulty to decarbonise the end-use sectors. This indicates that the modelling of the end-use sectors must be fine-tuned, including more decarbonisation options. This is key to any new study aiming at informing decision-makers about Net zero pathways.

### 3.4 USAID - Technical Report: Analysis of Peak Coal in Vietnam long-term power development planning scenarios

The report is developed through the United States Agency for International Development (USAID) Vietnam Low Emission Energy Program II (V-LEEP II), where the focus is to help the Government of Vietnam continue its transition to a clean, secure, and market-based energy sector. The report provides a detailed look into the implications for when and how coal-based generation would peak in Vietnam and builds on a previously published report from USAID.

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The scenarios in the report are generated using the PLEXOS-tool, which is a power system model. The analysis covers the period 2020-2045.

The scenarios analysed in the report are the following ones:

- **A Business-as-Usual** scenario, including no new policies and without externality costs. The scenario is similar\(^{12}\) to the S0A scenario from the draft Power Development Plan 8 (PDP-8) version 3 (dPDP-8 v3) from February 2021.
- **A Base case** scenario, including the renewable energy targets from the Vietnam Renewable Energy Development Strategy for the period up to 2030 with a vision to 2050\(^{13}\) and including a base externality cost of US$4/ton CO2. The scenario is similar to the S1B scenario from dPDP-8 v3 and includes targets of 32% RE in 2030 and 43% in 2050.
- **A High RE Target** scenario, where a more ambitious RE target has been applied together with the base externality costs. The target increases to 38% in 2030 and 50% in 2050 and is similar to the S3B scenario from dPDP-8 v3.
- **A No New Coal** scenario, where the current RE targets are implemented including the base externality costs as in the base case but further adding a restriction of no new coal-fired plants after 2030.
- Two **Carbon Price Sensitivity** scenarios, where two trajectories of CO\(_2\)-prices were tested, from US$4/ton CO2 in 2020 to respectively US$30/ton CO2 in 2030 (flat thereafter) and US$100/ton CO2 in 2025 (flat thereafter).
- **A Low RE cost** scenario, which combines a lower investment cost of solar, wind and batteries, and differentiated financing costs as represented by the Weighted Average Cost of Capital (WACC) for coal-fired power plants (12%), gas (9%), wind power (9%) and solar power (8.5%) where all the other technologies have a WACC of 10%. The lower WACC would correspond to lower perceived risks from financial institutions in investing in these technologies.
- **A Coal & Gas Delay + Low RE cost** scenario, which includes a delay of coal and domestic gas plants from the 2020s to early 2030s, a lower investment cost of solar, wind, and batteries. Solar capacities of 16.5 GW that were installed at the end of 2020 have also been included in this scenario.

As the report was published before the COP26 meeting, the commitment to achieving net zero emissions in 2050 is not reflected in the analyses. The report concludes that net zero emissions will not occur before 2060 in the power sector with the mentioned scenarios, which are therefore not in line with the recent commitments. The authors also highlight the need for adding net zero scenarios including new technology options in the model as CCS and direct air capture. They also suggest a better understanding of the feasibility of coal alternatives, including significant RE capacity and potential early retirements of coal units, while maintaining Vietnam's grid security, flexibility, and resilience, and considering the risks of stranded assets.

\(^{12}\) The assumptions for the modelling in the USAID report are not fully exactly the same as the draft PDP-8 Version 3 but they are very close.

\(^{13}\) Decision no. 2068/QD-TTg, November 2015
Overall perspective: The study uses only a power sector model, which includes an exogenously defined development of the end-use sectors. Given the high share of overall CO2 emissions emitted from these sectors, especially transport and industry, and the projected growth of end-use sector demands in the future as a result of wealth's increase, it is crucial to include a more detailed representation of the end-use sectors in order to capture transformations required for a Net Zero pathway. Furthermore, the study analyses scenarios that are not in line with a Net Zero pathway, and covers the period 2020-2045, not capturing challenges related to the milestone year 2050, where GHG emissions are needed to reach net zero.

3.5 Other studies

The four national analysis reports from McKinsey & Company (2022)\textsuperscript{14}, Tan, Harrison, & Howells (2022)\textsuperscript{15}, and IES Intelligent Energy Systems & WWF (2022)\textsuperscript{16} all come with different scenarios, and they all provide a net zero pathway scenario. All the studies show that decisions on coal phase-out must be taken soon to avoid stranded assets in the longer run. They all find significant increases in wind and solar capacities, and all show that action must be taken also on energy efficiency implementation. Last, all studies show that storages are necessary for the transition.

In McKinsey & Company (2022) and IES Intelligent Energy Systems & WWF (2022), all sectors have been modelled, and the studies clearly demonstrate that all sectors must contribute and change radically in order to meet the net zero goal. Moreover, in McKinsey & Company (2022), the reduction to zero emissions in 2050 is obtained by relying massively on negative emissions from land use, land-use change, and forestry (LULUCF) of approx. 90 MtCO\textsubscript{2}eq by 2050 compared to close to 0 MtCO\textsubscript{2}eq in 2020, compensating for the remaining emissions. The need for carbon capture and storage technology is also emphasized, applied either to thermal generation (for peak management until long-duration energy storage develops further) or bioenergy power plants (resulting in negative emissions).

The two studies by Phoumin, Kimura, & Arima (2021)\textsuperscript{17} and Wartsila (2022)\textsuperscript{18} focus on the region of Southeast Asia. Phoumin, Kimura, & Arima (2021) includes all the ASEAN countries\textsuperscript{19} and analyses


\textsuperscript{19} Brunei Darussalem, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand and Vietnam
four alternative policy scenarios covering higher energy efficiency, more efficient power generation, higher renewable targets, nuclear power plants, and one scenario with emission reduction targets in 2050 of 80% compared to BAU. Wärtsilä (2022) focuses on Vietnam, Indonesia, and the Philippines but model each of the countries individually. They include three emission reduction scenarios of which one is a net zero scenario by 2050 or 2060 depending on the countries’ plans.

The studies agree that the need for adding renewable energy capacities is huge. This entails large investments in electricity grids and the inclusion of flexible engines and energy storage alternatives. While the study by Phoumin, Kimura, & Arima (2021) does not reach net zero, Wärtsilä, (2022) shows that net zero is possible and that renewable energy technologies will be able to meet the rising demand in the region at lower costs than legacy fossil fuel base load. Wärtsilä (2022) also argues that policy interventions are necessary to incentivise renewables and flexible assets and that inflexible plants should be phased out.

3.6 Synthesis

Past studies highlight the raising interest and the commitment of Vietnam into a cleaner energy transition. Each analysed study brings elements of novelty which help to shed light into the key challenges associated with the energy system transformations foreseen by the energy transition and by the latest policies and plans. The remaining gaps towards a clean energy transition are also evidenced. The goal of the new study is to explore the solutions to fulfil those gaps.

The following synthesis can be drawn:

- The VIET SE & RMI study focused on a series of power system decarbonization patterns up to 2045, which point to the right direct direction, but are not sufficient to reach the Net Zero target by 2050.
- The World Bank Group study is considered as a key one in Vietnam, and it constitutes a useful benchmark of further analyses. Its modelling approach allows the assessment of the economy-wide impacts and the impacts on the power system of different scenarios. However, it does not provide a detailed analysis of the technological transformations needed in the end-use sectors, and the analysis stops at 2040, not capturing challenges related to the decade 2040-2050, where net emissions need to reach zero.
- The EREA & DEA study includes a net-zero scenario for the Vietnamese energy system, although the models employed in the analysis were not able to reduce the emissions to zero in 2050.
- The USAID study focuses primarily on the power sector, and the evolution of end-use sectors are exogenously estimated. Furthermore, the study analyses scenarios that are not in line with a Net Zero pathway, since they cover the period 2020-2045 and do not capture the challenges related to the period just before 2050, which will be critical.

The new study will have a focus horizon up to 2050, in line with the most recent commitments of reaching net-zero emissions by 2050, aiming to capture not only the short-to-medium expected energy sector transformations, but also the longer-term solutions. Furthermore, our analysis will
provide a strategic view about investment needs in the different sectors of the energy system, not solely focussing on the energy supply – e.g., the electricity generation and fuel supply – but also on end-use sectors where energy savings and changes in energy usage paradigm are critical to the net-zero emission target. The study will cover a large number of energy sources, either fossil or renewable; it will analyse the future role of electricity – e.g. through electrification of key end-use sectors – and other emerging energy vectors, such as hydrogen, ammonia and other synthetic fuels. The analysis will also cover the policy dimension, by considering key national and international commitments in the analysed scenario – the main one will be related to the Net Zero target – and aiming to identify the possible gaps between the current legislation and the long-term perspectives.

4 Proposed assessment framework

4.1 Overview of existing energy/power modelling tools available in Vietnam

Several bottom-up models of the Vietnamese energy sector have been developed and adopted to analyse challenges and transformations in the energy sector. Some of them cover the entire energy sector, with different levels of details and different types of analytical frameworks (optimisation, accounting, simulation) – i.e., TIMES, LEAP, EFFECT, and the Global Calculator. Others focus on specific components of the energy sector, such as the power sector – i.e., Balmorel and PLEXOS – or the transmission grid – i.e., PSS/E, DlgSILENT/Power Factory. Their key characteristics are summarized in table 4.1. Annex 2 provides further details of these different models.

In addition, Computable General Equilibrium (CGE) models, such as MANAGE model (Mitigation, Adaptation, and New Technologies Applied General Equilibrium) used by the World Bank, assess climate transition with a different perspective, examining the adaptation and mitigation challenges by representing capital/labour/energy substitution in the economy and determining how economic agents react to changes in the economy (e.g., prices, income, taxes, labour, etc.). Another modelling exercise is ongoing, supported by the French Development Agency (AFD), aiming at the “Macro/energy modelization of a Net Zero strategy in Viet Nam”. No details were obtained yet.
Table 4.1. Main bottom-up models of the energy sector of Vietnam

<table>
<thead>
<tr>
<th>Methodology</th>
<th>TIMES-Vietnam</th>
<th>BALMOREL</th>
<th>PLEXOS</th>
<th>GLOBAL CALCULATOR</th>
<th>LEAP</th>
<th>EFFECT</th>
<th>Electricity Planning Model</th>
<th>PSS/E</th>
<th>DigSILENT/Power Factory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modelling</td>
<td>Optimisation</td>
<td>Optimisation</td>
<td>Simulation</td>
<td>Simulation</td>
<td>Optimisation</td>
<td>Optimisation</td>
<td>Optimisation, Simulation</td>
<td>Simulation</td>
<td></td>
</tr>
<tr>
<td>Data requirements</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium / Low</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Geographical coverage</td>
<td>Single region, with 3 sub-regions for specific power sector variables</td>
<td>7 sub-regions</td>
<td>6 sub-regions</td>
<td>Single region</td>
<td>Single region</td>
<td>Single region</td>
<td>Single region</td>
<td>7 sub-regions</td>
<td>6 regions and 19 sub-regions</td>
</tr>
<tr>
<td>Technology detail</td>
<td>High (all energy sectors)</td>
<td>High (power sector)</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Temporal resolution</td>
<td>20 time slices or more</td>
<td>336 time slices per year</td>
<td>Hourly</td>
<td>Yearly</td>
<td>Yearly</td>
<td>Yearly</td>
<td>Yearly</td>
<td>Hourly</td>
<td>Hourly</td>
</tr>
<tr>
<td>Emissions</td>
<td>CO₂, NO₂, PM₁₅, SO₂</td>
<td>CO₂, NO₂, PM₁₅, SO₂</td>
<td>CO₂</td>
<td>CO₂</td>
<td>CO₂</td>
<td>CO₂</td>
<td>CO₂</td>
<td>CO₂</td>
<td>-</td>
</tr>
<tr>
<td>Carbon taxes, incentives, pledges</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Typical applications</td>
<td>Capacity expansion planning, Unit commitment.</td>
<td>Capacity expansion planning, Unit commitment, Market analysis; Operational modelling; Portfolio optimisation.</td>
<td>Long term scenario exploration at varying of key factors such lifestyle, technology, etc.</td>
<td>Long term energy planning; Technology roadmaps.</td>
<td>Long term energy planning, Marginal abatement cost curves.</td>
<td>Capacity Expansion Planning.</td>
<td>Transmission planning; Power flow analysis.</td>
<td>Transmission planning; Power flow analysis.</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Main selling points</td>
<td>Technology explicit; Cost-optimal pathways; Powerful solvers; Full energy system; Large user base.</td>
<td>Hourly resolution; Technology explicit; Cost-optimal pathways; Powerful solvers.</td>
<td>Hourly resolution; Technology explicit; Cost-optimal pathways; Powerful solvers; Large user base.</td>
<td>Powerful engagement tool; Easy to develop and use.</td>
<td>Limited data requirement; Large user base; Suitable for exploration of multiple scenarios.</td>
<td>Technology explicit; Optimised pathways; Technology explicit.</td>
<td>Powerful representation of transmission and load flows</td>
<td>Powerful representation of transmission and load flows</td>
<td></td>
</tr>
<tr>
<td>Main limitations</td>
<td>Limited temporal resolution; Data intensive.</td>
<td>Limited representation of energy sectors other that power.</td>
<td>Limited representation of energy sectors other that power; Cost of licensing.</td>
<td>Limited technology representation; Costs/Expenditures not assessed.</td>
<td>Simulated pathways; ex-post evaluation of costs.</td>
<td>Small user base; Data intensive.</td>
<td>Limited representation of energy sectors other that power.</td>
<td>Limited representation of energy sectors other that networks; Cost of licensing.</td>
<td>Limited representation of energy sectors other that networks; Cost of licensing.</td>
</tr>
</tbody>
</table>

22. [https://dec.usaid.gov/dec/content/Detail-Presto.aspx?vID=47&ctID=ODVhZjk4NWQ1M2YyMj00YjRmTkxNjktZTcxMjM2NDBmY2Uy&rID=NTgxNTIw](https://dec.usaid.gov/dec/content/Detail-Presto.aspx?vID=47&ctID=ODVhZjk4NWQ1M2YyMj00YjRmTkxNjktZTcxMjM2NDBmY2Uy&rID=NTgxNTIw)
4.2 The proposed modelling framework

The proposed technical approach relies on the development of a set of quantitative analyses employing a techno-economic model, TIMES-Vietnam. This option was motivated by several factors. First, TIMES-based models are extensively used across many countries for assessing various climate and energy policy issues. In recent years, a key focus of the use of TIMES-models has been informing the policymakers of different countries about the feasible options for decarbonising their energy systems. This is becoming increasingly important as countries look to strengthen their Nationally Determined Contributions (NDCs) under the UNFCCC process and to submit long-term low-emission development strategies. Some examples of countries using TIMES models for this type of analysis are Russia, Italy, the UK, South Africa, India, and China, as part of the international Deep Decarbonisation Pathway Project (DDPP).  

The relevance of the use of TIMES models to inform decisions about climate strategies relies on the intrinsic characteristics of the models, well-suited to the questions raised by policymakers.

- **Technology detailed pathways**: The technology explicit nature of the model allows specific options to be explored in different sectors. This is important for policymakers who want to better understand the role of specific technologies and energy commodities and develop appropriate policies to accelerate the deployment of these technologies and commodities.

- **Integrated sector perspective**: TIMES models cover all sectors of the economy, from supply to end-use sectors. This sector coverage allows us to assess contributions and interactions between energy sectors (e.g., impacts on the electricity generation of further electrification in end-use sectors), to take into consideration the competition between fuels and technical solutions, and to estimate investments and other economic impacts on the entire energy system.

- **Multidimensional metrics**: The model provides information on economic, technology, and environmental metrics, all of which are important for policy deliberation and design.

- **Comprehensiveness of policies**: TIMES models can assess the impacts of a wide range of policy instruments, covering taxes & levies (e.g. carbon taxes), incentives (e.g. on specific renewable technologies), or climate pledges. The instruments can be specific to technologies, energy commodities, and sectors or apply to the whole economy.

- **Flexibility and user-friendly adjustments of data**: Assumptions (technology costs, demand growth, resource availability) can be easily varied, allowing for scenario-based exploration of energy systems under different conditions.

- **Well-proved modelling approach**: TIMES models have been built in many countries and regions, and therefore provide a tried-and-tested approach and an active research community for support and knowledge sharing.

25 DDPP website, [https://ddpinitiative.org/](https://ddpinitiative.org/)
In the case of Vietnam, a TIMES-Vietnam model has already been successfully employed in several studies for Vietnam, with the aegis/engagement of key policy stakeholders and key energy sector players. TIMES-Vietnam was initially developed under the World Bank-funded project “Getting Vietnam on a Low-Carbon Energy Path to Achieve NDC Target” (DWG, 2018\textsuperscript{26}). Furthermore, the TIMES-Vietnam model has been adapted to support scenario analysis underpinning the Vietnam Energy Outlook Report 2021\textsuperscript{27}

### 4.3 TIMES-Vietnam

The TIMES-Vietnam model is a TIMES\textsuperscript{28} partial equilibrium model of the Vietnamese energy system. It portrays the full energy system, from fuel extraction and trading to fuel processing and transport, electricity generation, and all final energy demands on a sectoral basis, with a high level of technical details. The model generates scenarios for the evolution of the energy system based on different assumptions around the evolution of demands, and future technology costs, and it measures energy system costs and all greenhouse gases (GHGs) associated with the scenario. It can be used to explore the evolution of the entire energy system of Vietnam over a time horizon that can be extended or shortened depending on the analysis needs.

TIMES-Vietnam models the energy system with a Reference Energy System (RES). Figure 4.1 shows a simplified RES of the Vietnamese energy system for illustration.

- The RES is a network description of energy flows with a description of all technologies that are involved (or potentially involved) in the production, transformation, and use of various energy forms to satisfy energy demand services required by economic activities\textsuperscript{29}.
- Those energy services are, for example, passenger kilometres in passenger transportation, tonnes of cement produced by the industrial sectors, useful energy requirements for air conditioning in buildings, etc.
- Demand devices and technologies (cars, trains, air-conditioners, industrial processes, etc.) transform various energy carriers into useful demands.
- Both storable energy carriers, like gasoline, and diesel fuels, and non-storable energy forms, like electricity and heat are generated and can be produced from primary energy forms obtained from energy resources technologies.

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\textsuperscript{26} https://www.decisionwaregroup.com/assets/wb-pmr_vietnam_ndc-final-report_03282020-clean.pdf  
\textsuperscript{27} https://ens.dk/sites/ens.dk/files/Globalcooperation/vietnam_energy_outlook_report_2021_english.pdf  
\textsuperscript{28} TIMES (an acronym for The Integrated MARKAL-EFOM System) is an economic model generator for local, national, or multi-regional energy systems, which provides a technology-rich basis for estimating energy dynamics over a long-term, multi-period time horizon. This tool is developed and maintained by the ETSAP community, one of the longest-running Technology Collaboration Programme of the International Energy Agency. For more details: https://iea-etsap.org/. See also annex 3 for more information.  
\textsuperscript{29} Energy services mean for example useful energy requirements for air conditioning in buildings, passenger kilometres in passenger transportation, tonnes of cement produced by the industrial sectors, etc.
Figure 4.1. Simplified RES of the Vietnamese energy system.

Note: Boxes represent sectors (which are further disaggregated into sub-sectors and sets of technologies), and arrows represent key flows of diverse energy carriers (including fossil fuels, electricity, heat, biomass, biofuels, hydrogen, etc.). Emissions by each technology are also estimated.

TIMES-Vietnam includes seven sectors, divided into two supply-side and five demand sectors:

- Transformation (or supply) sectors:
  - Upstream (UPS): Contains domestic resources, fuel trading, refineries, other key transformations including biofuel and hydrogen production and delivery, etc.
  - Power sector (PWR): Electricity and heat generation – both centralized and distributed – and transmissions and distribution grids.

- Demand sectors:
  - Residential (RSD).
  - Services (SRV).
  - Industry (IND).
  - Transport (TRA).
  - Agriculture (AGR).

The model used for this assignment is an improved offspring of the previous applications of TIMES-Vietnam, in part reshaped and improved to better capture key critical elements regarding energy transition towards net zero (e.g., CCS, Power-to-X), updated data, and specificity of the Vietnamese energy context (e.g., differentiated renewable potentials across regions), more detailed transportation and industry sectors. Data collected under task 2 (assumption book and scenario) and stakeholder dialogue will aim to ensure alignment between the modelling key assumptions and the latest policy context.
4.4 Capacities of the proposed modelling framework

Direct outcomes of TIMES-Vietnam

The TIMES modelling framework provides a quantitative basis for an exhaustive analysis of key implications and challenges related to the transition to net-zero of the Vietnamese energy sector. The modelling analysis quantifies different technical, environmental, and economic key performance indicators (KPIs) useful for policymakers.

Direct outcomes of TIMES-models cover cost and expenditures, energy supply and production, power sector, end-use sector, and emissions. Annex 4 provides a summary (non-exhaustive) of these KPIs directly estimated by the TIMES model.

Based on these direct outcomes provided by TIMES-Vietnam, a common set of “transition indicators” will be established to map the required transformations of the energy sector to reach Net Zero target, to understand their consequences, and to facilitate future monitoring of the energy policies. This approach is inspired by the common sets of indicators proposed by the European Commission (EC) to monitor progress towards the energy union objectives through a set of specific indicators\(^{30}\) organized in 5 dimensions\(^{31}\). This approach aims to ease communication with non-technical stakeholders and facilitate comparison and benchmarking with other regions and similar analyses.

Our proposal consists in developing two different levels of transition indicators:

- Tier 1 indicators cover higher-level dynamics, at the scale of the overall economy or of a specific sector, easily comparable with other national and international studies.
- Tier 2 indicators include a more granular technological assessment of net-zero transition implications.

The proposed indicators (Table 4.2) will be discussed and fine-tuned with stakeholders during the kick-off workshop so that it represents well the priorities of the country. Moreover, the most relevant indicators for high-level policymaking, adapted to Vietnam, will be selected based on the discussions with stakeholders.

\(^{30}\) https://energy.ec.europa.eu/system/files/2021-02/swd-energy-union-key-indicators_en_0.pdf
Table 4.2. The proposed Transition Indicators

<table>
<thead>
<tr>
<th>Dimension 1. Decarbonization</th>
<th>Dimension 2. Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>● GHG emissions reductions (total and by sector)</td>
<td>● Primary energy consumption</td>
</tr>
<tr>
<td>● Gap between GHG emissions projections and existing policy goals</td>
<td>● Final energy consumption</td>
</tr>
<tr>
<td>● GHG intensity by sector</td>
<td>● Final energy intensity in industry</td>
</tr>
<tr>
<td>● Emissions per capita</td>
<td>● Final energy consumption in residential sector</td>
</tr>
<tr>
<td>● Renewable energy share (in supply and in final energy use)</td>
<td>● Final energy consumption in transport</td>
</tr>
<tr>
<td>● GHG removals</td>
<td>● Final energy intensity in services sector</td>
</tr>
<tr>
<td>● Optional: reduction of other pollutants</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension 3. Energy security</th>
<th>Dimension 4. Internal energy market</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Net import dependency - total</td>
<td>● Level of electrification in end-use sectors</td>
</tr>
<tr>
<td>● Net import dependency - natural gas</td>
<td>● Level of renewable and e-fuels (e.g., hydrogen) in use in end-use sectors</td>
</tr>
<tr>
<td>● Net import dependency - crude oil and LNG</td>
<td>● Technology adoption rates for key mitigation technologies</td>
</tr>
<tr>
<td>● Net import dependency – coal</td>
<td></td>
</tr>
<tr>
<td>● Net import dependency – biomass</td>
<td></td>
</tr>
<tr>
<td>● Energy diversity</td>
<td></td>
</tr>
<tr>
<td>● Electricity interconnection capacity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension 5. Financial and socio-economic feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Energy prices</td>
</tr>
<tr>
<td>● Investments expenditures by type</td>
</tr>
<tr>
<td>● Energy system cost breakout</td>
</tr>
<tr>
<td>● Job implications for the energy sector</td>
</tr>
</tbody>
</table>
Indirect outcomes of the assessment

TIMES-Vietnam outputs will also drive further assessments and considerations about socio-economic implications like employment, central to the acceptability of a just transition, stranded assets, grid reliability, and possibly other priority areas which may emerge from stakeholder engagement.

On these dimensions, the consultants will make use of the modelling outcomes as starting point and apply the latest scientific and policy approaches to explore these areas and monitor progresses and milestones. For example, in the case of job creation and loss, the Employment Factor Approach appears a relevant methodological approach, as outlined by Ram et al.\textsuperscript{32} to assess impacts on ‘fuels' jobs (fuel jobs are defined as jobs from coal, oil, biomass, waste incineration, and gas generation sectors) – and in van de Ven et al.\textsuperscript{33}, where burdens between investment portfolios of green recovery packages and green jobs have been analysed. Detailed methodology and outcome of these assessments will be reported under Deliverable 3 - Mid-term Report: “Assessment of the Energy Sector in Vietnam.

4.5 Visualization of the results

The consultants will develop a set of catchy dashboard visualization, aiming to make accessible to stakeholders the key tier indicators results and highlight key messages. These visualizations will also serve as starting point for figures to be used in the final project report. High-level views for policymakers may also be prepared to select Tier 1 & 2 indicators of most interest. The following figure shows some examples of possible synthesis visualizations, as developed in previous projects.

![Visualization Examples](image)

Figure 4.2. Example of results visualization

4.6 Availability of data and data collection

The net zero analysis of the Vietnamese energy sector will rely on an already existing modelling tool, the TIMES-Vietnam model. This model has been developed through internationally funded projects and maintained with updated data over the past few years (see previous sections for more details). This will be used as a starting point, and the consultants aim to further update, improve and customise the tool in order to ensure that the most relevant and up-to-date set of exogenous data and assumptions are considered in the analysis.
For the study to be fully relevant, it will be important to reach a consensus with core stakeholders on key data assumptions such as macroeconomic assumptions, policy measures, and technology perspectives. For this purpose, the consultants will provide, during the Kick-Off Workshop, an overview of the most-relevant data assumptions for the analysis, along with, when possible, some initial sets of information and data sources, based on previously collected data sources already included in the TIMES-Vietnam model and/or most relevant national and international datasets (e.g., from the review prepared by ETP in 2022, from the International Energy Agency, IRENA, the Danish Energy Agency, European Commission, etc.).

Synergies with other donors and ongoing projects may also be explored, for example, in the area of techno-economic characterization of technologies, where work from the Danish Energy Agency on technology catalogues is currently underway.

Following the workshop, the consultants will share a well-structured template to facilitate the validation of assumptions and data by the stakeholders. The distribution will be under the leadership of MOIT. Whether required, further discussion and clarification will be continued during the Mini-Workshops planned in April (see table 5.3)..

The following data typically required:

1. **International fossil fuel price projections:**
   a. These are used primarily to characterise future fossil fuel importations.
   b. Ideally projections in use/adopted by relevant Ministries are to be used, including, when available, details about different prices across sectors or even specific plants. When not available, international assessments (for example from the IEA World Energy Outlook 2022[^1] and/or assumptions adopted in recent relevant studies (e.g., the review prepared by ETP and the Vietnam Energy Outlook Report) can be used as a source of data.

2. **Socio-economic and service demand drivers:**
   a. The analysis is driven by a set of underpinning socio-economic drivers which guide exogenous assumptions about future energy service demands, such evolution of useful energy in buildings, passenger and tonne kilometres in transport sectors, key goods productions in key industry sectors (e.g., tonnes of cement produced), etc.
   b. Typical drivers often used for these projections are Gross Domestic Product (GDP), GDP/capita, population, sectoral Gross Value Added (GVA), etc. When specific data sources are not available, international sources (for example using data from the UN, World Bank, and Shared Socioeconomic Pathways Database (SSP) by IIASA) and/or assumptions adopted in recent relevant studies (e.g.,[^2]) can be used.

3. **Existing plans and policies:**

[^1]: [https://www.iea.org/reports/world-energy-outlook-2022](https://www.iea.org/reports/world-energy-outlook-2022)
a. The study will aim to reflect the set of most relevant short-term plans (e.g. under construction facilities) and more relevant foreseen transformation trends in the energy sector. This includes plans on electricity generation expansion; new supply infrastructures such as new LNG terminals, pipelines, or interconnections; new (energy intensive) industrial districts; etc.
b. Source data will be based on insights from local stakeholders and key official documents from the Government. A relevant example is the Power Development Plan 8 (PDP 8), currently under development (advanced draft released in December 2022).

4. Technical potentials and localization for renewables and other sources:
   a. The modelling study will identify the cost-optimal mix of fossil, renewable, and other fuels needed to deliver the transition to NZE. At this scope, the characterization of regional technical potentials of key renewable energy sources (e.g., wind, solar, hydro, advanced biomass, biofuels, etc.) needs to be quantified. Similar estimates shall be also quantified for GHG removals potentials (e.g. in salt aquifers, depleted oil/gas fields, etc.).
b. Source of this type of information can be either i) specific national estimates (e.g., from detailed analyses and studies), and ii) international resource assessments (e.g. from Irena, Shell, etc.).

5. Techno-economic assumptions for key mitigation technologies:
   a. The NZE study will provide a technology-rich assessment of the Vietnamese energy transition. In order to deliver that, assumptions on economics (costs) and technical characteristics (efficiencies, capacity factors, etc.) of a large set of technology options – either commercially available or in the early development stage – have to be made.
b. The TIMES-Vietnam model already includes several technology options, basing characterization on specific national sources (e.g., Vietnamese technology catalogues) or alternatively international data sources (e.g., IEA, IRENA, EC, US EPA datasets). Any data source emerging from stakeholder consultation will be considered and, when relevant, included in the model.

6. Characterization of key energy-intensive sectors:
   a. TIMES-Vietnam has the capability of representing key energy-intensive sectors in industry and its key mitigation options. To correctly capture so it requires a detailed characterization of the Vietnamese context and a review of the applicable abatement technologies (i.e., based on the type of plants, location, and other possible constraints).
b. TIMES-Vietnam currently includes some details relative to key energy-intensive sectors (e.g., Cement sector). However, these are mainly based on international data
sources\textsuperscript{36}, which in some cases may not completely fit well with the local context. Local statistics and data sources which may arise from stakeholder engagement may be a key added value for the analysis.

A final summary of all key assumptions for the study, once finalized, will be detailed in Deliverable 2 – Interim report.

4.7 Scenario and sensitivity analyses

The definition of the NZE scenario narrative to be explored, along with the set of sensitivity explorations, will be carried out in close coordination with ETP and local stakeholders. The preliminary discussion will start during the kick-off workshop and continue in the following exchanges. Discussions will consider:

i. Key scenario levers: e.g., GHG trajectories, specific policies, and measures (technology subsidies, energy efficiency, etc.), exclusion or priority of some technology options, etc.

ii. Internal/external influencing factors: e.g., international price outlooks, GDP growth, cooling demands, resource and technology costs, etc.

iii. Constraints to be considered during the analysis: e.g., energy security requirements, under development plans, etc.

Based on the main discussion points raised during scenario discussion and initial findings from preliminary model runs, the consultants will identify the most relevant elements of uncertainty which may significantly affect the capability of Vietnam to achieve its Net Zero goal. These elements will form the basis for the exploration of a set of sensitivity scenarios. Sensitivity scenarios may explore some assumptions about levers, internal/external influencing factors, and other constraints. Conducting sensitivity analysis around these dimensions analysis will be enriched with insights taking into consideration not just costs-benefits, but also resilience to a variety of possible futures.

The narrative of the scenario and the proposed sensitivity analyses will be detailed in Deliverable 2 – Interim report.

5 Stakeholder outreach

5.1 Mapping of the main stakeholders and their expected engagement in the study

Key governmental stakeholders of the energy sector include\textsuperscript{37}:

- The Central Economic Commission (CEC) for political and national security in term of energy.

\textsuperscript{36} For example, from the World Steel Association for the Iron & Steel sector, the USGS for the Cement and key industrial sectors, the International Energy Agency with its sectorial briefs, from other existing global modelling applications, etc. A more detailed data source summary is reported in Annex 6.

\textsuperscript{37} More detailed description in Annex 5.
• The Ministry of Industry and Trade (MOIT), more particularly the Oil, Gas and Coal Department, in charge of power planning and energy master plan; MOIT also manages the Electricity and Renewable Energy Authority (EREA) and the Electricity Regulatory Authority of Viet Nam (ERAV).
• The Ministry of Natural Resources and Environment (MONRE) in charge of climate action plans and emission inventory; the department of climate change is in charge of JETP.
• The Ministry of Finance (MOF) and the Ministry of Planning and Investment (MPI), for financial issues.
• The Committee for Management of State Capital at Enterprises (CMSC) as the owner of major coal-fired power plants.
• The Ministry of Transport (MOT), as the agency in charge of one of the biggest energy-consuming sectors.
• Vietnam Electricity (EVN), as a state-owned corporation leading the power sector, owing several power generation and transmission corporations, amongst others.
• PetroVietnam (PVN), as a state-owned corporation leading the oil and gas sectors (exploration and production to storage, processing, transportation, distribution, and services).

Table 5.1 identifies the “core stakeholders”.

International and national commercial banks and investors, bilateral and multilateral donors, development partners, think tanks and academics, and civil society constitute other stakeholders to engage. Their participation was initially envisioned in the final workshop. However, several of them also attended the Kick-Off Workshop since the scope of the KO Workshop was extended compared to the initial proposal. More details are provided in Annex 1.

These stakeholders are important for the effective implementation of the Net-Zero Scenario, which will require investments, technical assistance, and a large ownership of the proposed changes by all actors in all sectors of the economy. Amongst them (not exhaustive): the Hanoi University of Science and Technology (HUST), the Vietnam Petroleum Institute (VPI), the Institute of Energy (IEVN), the PetroVietNam University (PVU), the Electric Power University (EPU), the Vietnam Energy Association, the Vietnam Trade and Industry Review in Ho Chi Minh City (under MOIT), the World and VietNam Report under the Ministry of Foreign Affairs, the Centre for Strategic Energy and Resources (CSER). The relevant stakeholders to participate in the final workshop will be selected later during the study, in the light of the challenges identified in the Net-Zero scenario.

Several development partners share experience and interest in emission reduction strategies in the energy sector. Amongst them, are the ones who carried out past studies about the topics (see section 3 of the report), such as the World Bank, the Danish Energy Agency (DEA), and USAID. Some other modelling exercises are ongoing, such as the preparation of the Energy Outlook Report EOR 2023 by DEA, or the Macro/energy modelization of a Net Zero strategy in Vietnam by the French Development Agency (AFD). Specific coordination activities with DEA are proposed in the Implementation Framework (section 6 of the report).
Other recent initiatives are of interest to the study. Amongst them, the EU – Viet Nam Sustainable Energy Transition Facility (2022-2027) was recently established to support the EU – Vietnam Sustainable Energy Transition Programme (SETP) and more in general, the energy sector in Vietnam in the Net-Zero context. The Facility provides high-level demand-driven technical assistance and capacity development, more particularly to MOIT. It also supports the activities of the Vietnam Energy Partnership Group (VEPG). In addition, a Just Energy Transition Partnership (JETP) has been established in Vietnam with the mobilization of $15.5 billion of public and private finance over the next 3 to 5 years to support the realisation of the Net Zero target.
Table 5.1. Key stakeholders

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Main roles in relation to the assignment</th>
<th>Kick-Off Workshop (yes/no)</th>
<th>Final Workshop (yes/no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre Economic Commission (CEC)</td>
<td>In charge of political and national security in term of energy – Important role for sector integration and effect of net zero targets on the socio-economic development</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ministry of Industry and Trade (MOIT) - Oil and Coal Department</td>
<td>In charge of power planning and energy master plan – important expected role in commenting the net zero pathways and policies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Electricity and Renewable Energy Authority (EREA) under MOIT</td>
<td>Performs advisory functions and assists MOIT in relation to electricity, new energy, and renewable energy.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Electricity Regulatory Authority of Vietnam (ERAV) under MOIT</td>
<td>Monitors the operation of the power sector (power supply security, price mechanisms, grants operating licenses, standards)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ministry of Natural Resources and Environment (MONRE) - Department of Climate Change</td>
<td>In charge of NDC, emission inventory and reduction measures</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ministry of Finance (MOF)</td>
<td>In charge of financial issues</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ministry of Planning and Investment (MPI)</td>
<td>In charge of financial issues – Interest in investment policies, green finance</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ministry of Transportation (MOT)</td>
<td>In charge of one of the biggest energy-consuming sector</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Commission for the Management of State Capital at Enterprises (CMSC) - Energy Department</td>
<td>Owner of major coal-fired power plants – Important role in coal phase-out strategies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

38 The Kick-Off Workshop, initial planned to be limited to 15 persons, was extended up to more than 30 persons, with a larger representation of stakeholders, more particularly Development Partners. More details in annex 1.
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Main roles in relation to the assignment</th>
<th>Kick-Off Workshop (yes/no)</th>
<th>Final Workshop (yes/no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PetroVietnam (PVN) - Power and Renewable Energy Department</td>
<td>Responsible for all oil and gas resources in Vietnam</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Vietnam Electricity (EVN) - Electricity Market Department</td>
<td>Vertically integrated, state-owned corporation responsible for Vietnam's power subsector</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Power Generation Corporation 1 (Genco 1)</td>
<td>Playing an extremely important role in the country's socio-economic development and national security</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Power Generation Corporation 2 (Genco 2)</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Power Generation Corporation 3 (Genco 3)</td>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Vietnam National Coal and Mineral Industries Group (TKV)</td>
<td>Playing an important role in coal and mineral mining, and power generation</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
VIETSE, NH Quang and VNEEC will also be invited by ETP to the Kick-Off Workshop. Their contribution as partners of ETP, would be complementary to inputs provided by policy makers.

5.2 Communication and engagement

**Communication and engagement objectives**

Tailored communication activities will support all four phases of the project, ensuring maximum visibility, accessibility, and impact of the project, as well as engagement of the core stakeholders. They will also ensure that the project addresses the needs of the government and are in line with the regulations.

The objectives of the communication and engagement activities will be to:

- Inform about the project and make the outcomes developed through the project available to the different target audiences.
- Engage core stakeholders during the project implementation, invite them to workshops, and receive support, inputs, and feedback from them, more particularly related to data availability/collection, key policy assumptions, legal framework, and socio-economic impacts.
- Enhance project results exploitation potential and maximise impacts of the project.

**Communication and engagement activities**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Main roles in relation to the assignment</th>
<th>Kick-Off Workshop (yes/no)</th>
<th>Final Workshop (yes/no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIETSE, NH Quang and VNEEC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2. Project Workshops

**PROJECT WORKSHOPS**

Project workshops will come as a major channel to support the objectives. They will help to spread the project information to the stakeholders, facilitate valuable feedback from them, and provide ground for discussion and brainstorming. Two workshops will be held: Kick-off and Final workshops.

**Action Plan – Kickoff workshop**

The kick-off workshop targets technical/operational stakeholders (15 participants, including project team members). It was extended to more than 30 persons.

The objectives of the workshop are:

a) To inform key stakeholders of the energy sector of Vietnam about the study.

b) To guarantee that the study is well-aligned with the realities and priorities of stakeholders.

c) To establish a collaborative working framework.
Date of the Kick-Off workshop: 28 February 2023.
The minutes of the kick-off workshop are available in annex 1.

**Action Plan – Final workshop**
The final workshop targets both technical stakeholders and high-level stakeholders (35 participants). Initially planned for 35 participants, it is proposed to extend the final workshop to 60 persons given the interest of stakeholders in the study.

The objective of the workshop is to present and discuss the final report and its main outcomes, more particularly:
- the assessment of the Energy Sector of Vietnam;
- the characteristics of the Net-Zero for the Energy Sector of Vietnam;
- the policy and technical recommendations needed to support the net-zero emission of the energy sector.

Proposed date of the Final workshop: first week of October 2023.

The date must be fixed at least 3 weeks before the Workshop in order to facilitate the preparation and ensure the availability of the stakeholders.

**Expected Outcomes**

Kick-Off
- Engagement of stakeholders in the following steps of the study
- Better understanding of the realities and priorities of stakeholders
- First feedback about data and scenario assumptions

Final Workshop
- Dissemination of the results
- Mobilisation of the stakeholders to explore the implementation of the Net-Zero Scenario.
- Identification of possible further analysis needs.

**Key KPIs**

- 4 non-technical summaries to summarize the 4 deliverables.
- 2 workshops.
- 15 participants in the Kick-Off, including 5 stakeholders (extended to 35 participants and 11 stakeholders).
- 35 participants in the Final Workshop, including 10-15 stakeholders (extended to 60 participants).
- A total of at least 5 presentations per Workshop.

**Table 5.3. Dialogue with stakeholders**

**DIALOGUE WITH STAKEHOLDERS**
The dialogue with key stakeholders will contribute to inform them about progresses of the project, gather their inputs and feedbacks on initial results and reinforce the ownership of the study.

It will include:
- Mini-workshops with stakeholders focussing on Data/Assumptions, and about initial Outcomes of the NZE scenarios.
- Progress meetings with MOIT, the beneficiary of the Study.
- Presentation of the study to other audience, such as VEPG.

**Action Plan**

**Mini-workshops with stakeholders** (MOIT, VPN, EVN, GENCO2, CMSC, TKV, donors). The objective is to get inputs from the stakeholders at the two critical stages of the study: data/assumptions (deliverable 2), and outcomes (deliverable 3). The mini-workshops will be short and focussed on key questions. Two mini-workshops are envisioned at each of these two stages, because the number of participants is limited 15 persons per mini-workshop; as to ease communication and fluidity of the contributions.

The Local Project Leader will steer the discussion, with the support of the international team. VIETSTAR will provide support by dealing with the logistics of the
mini-workshops (e.g. invitation, room renting, translation, etc.). The International consultants will attend these meetings virtually.

A brief summary of each mini-workshop series follows.

- **Mini-workshops "Data and Assumption". Objective: discuss/validate data and scenarios.**
  Before these mini-workshops, most important data and assumptions to be used in the NZE diagnostic study will be shared with stakeholders, under the leadership/approval of MOIT. The active support of MOIT will be critical for this stage.
  Date: End of April, before Deliverable 2.

- **Mini-workshops “NZE scenario”. Objective: discuss initial outcomes of the NZE scenario and the recommendations about the required technological transformations and policies.**
  Date: End of June – beginning of July, between Deliverable 3 and Pre-final Report (Deliverable 4).

**Progress meetings with MOIT:** Monthly progress meetings will be held with MOIT from March to October. They will be short (around 2 hours). They will allow a close follow-up of the activities of the study with the principal beneficiary, the MOIT. The Local Project Lead will participate in these progress meetings. It is expected that MOIT identifies the persons who will be in charge of these meetings.

**Technical meetings with the Danish Energy Agency** (see more details in the Implementation Framework of section 6): On a bi-monthly basis, held virtually. These meetings will be held by the international consultants.

**Presentation of the study to other audience,** such as VEPG. The Local Project Lead will attend up to three events organized by other entities and present the Diagnostic Study. The events will be proposed by UNOPS-ETP and MOIT.

For the stakeholders far away, VietStar will exchange information and invite them to workshops via email.

| Expected Outcomes | - Contribution of stakeholders to data and scenarios, in order to reinforce the validity and ownership of the Scenario assessment.  
| | - Improvement of the analysis of the Net Zero Emission Scenario, based on the feedback received from stakeholders about initial results.  
| | - Better ownership of the study by the stakeholders, and networking between them.  
| | - Reflection about policies needed to implement the Net-Zero scenario.  
| Key KPIs | - 4 mini-workshops with stakeholders.  
| | - 8 progress meetings with MOIT.  
| | - Presentations of the Study in up to 3 events, such as VEPG working groups.  
| | - Up to 3 bilateral meetings with DEA.  

### 5.3 Dissemination objectives and activities

**Dissemination objectives**
Broad dissemination actions will be undertaken to promote project objectives, activities, and findings in a clear, intelligible, and non-technical way. The dissemination strategy will pursue the following objectives:

- Raise awareness and ensure maximum visibility of the project’s key facts, objectives, activities, and findings among target audiences.
- Announce and promote the workshops, contributing to upgrading attendance and engagement potential.
- Support the communication objectives.

**Dissemination target audience**

E4SMA & VIETSTAR will strive for disseminating project information to reach main stakeholders (government; energy organizations, corporations/groups; and academic, international organizations, and media).

**Dissemination Activities**

To achieve the mentioned goals, E4SMA & VIETSTAR will produce and use a set of modern dissemination tools and channels described below.
**Table 5.4. Website**

**WEBSITE**
The public project information will be published on ETP's website. The Consultant team will provide the required material (text / posts).

<table>
<thead>
<tr>
<th>Action Plan</th>
<th>- The relevant and public project reports, press releases, and publications will be provided to ETP for publication on the UNOPS-ETP website after each workshop and after Deliverables 2, 3, and 4).</th>
</tr>
</thead>
</table>
| Expected Outcomes | - Information of the specialized audience about the ongoing study.  
- Creation of awareness about the NZE and the required changes in the energy sector (technologies, policies) |
| Key KPIs | - An updated section of the ETP website about Vietnam  
- Material for 5 posts is provided to UNOPS-ETP. |

**Table 5.5. Publications**

**PUBLICATIONS**
Tailored publications will be released in the second part of the study, once results from the NZE scenario are available (after Deliverable 3), showcasing project outputs. Those publications will be based on the results of the activities, including but not limited to short articles, always approved by UNOPS-ETP.

<table>
<thead>
<tr>
<th>Action Plan</th>
<th>- Write and release short articles in electronic journals or magazines (such as Vietnam Energy, Vietnam Trade and Industry Review, Vietnam Economic News) after getting approval by UNOPS-ETP.</th>
</tr>
</thead>
</table>
| Expected Outcomes | - Information of the specialized audience about the ongoing study.  
- Creation of awareness about the NZE and the required changes in the energy sector (technologies, policies) |
| Key KPIs | - 10 posts on electronic journals or magazines |

**Table 5.6. Social Media**

**SOCIAL MEDIA**
Social Media activities will strengthen the project presence in Vietnam Media and help to increase the project impact as widely as possible in Vietnam.

| Action Plan | **LinkedIn/Twitter/Facebook pages** will be created with the name “Diagnoastic Study on Net-Zero for The Energy Sector in Vietnam” and serve as a platform for dissemination of the public project outputs.  
One concise social media post will be published after kick-off workshop (March), final workshop (October) and after Deliverables 2 (beginning May), 3 (end June), and 4 (mid-August). They will provide a brief summary of the events (in the case of the workshops), outcomes, impacts, and upcoming plans. The optimal post requirements, such as word count and visual aids, for each platform, will be defined at a later stage. The contents will be approved by UNOPS-ETP. |
| Expected Outcomes | - Information of the specialized and wider audience about the ongoing study and about the Net Zero Emission scenario. |
| Key KPIs | - 5 posts on LinkedIn  
- 5 posts on Twitter  
- 5 posts on Facebook  
- Similar posts could be published on ETP’s channels (optional) |

**Table 5.7. Press Release**
6 Implementation framework

The purpose of the assignment is to deliver a model-based scenario assessment of Vietnam energy sector transition towards net-zero emissions by 2050. The proposed work will contribute to scaling up policy dialogue and strategic engagement on net-zero energy transition, by developing and reaching a consensus on the cost-effective of long-term low carbon development pathways, highlighting i) likely technological developments, ii) impacts of policies to implement the identified cost-effective low-carbon mitigation options, iii) total costs and financing needs to achieve the low carbon targets.

6.1 Updated timeline and deliverables

No change is expected in the overall work plan (Figure 6.1), deliverables, and timeline Figure 6.2), except the date of the Kick-Off Workshop, now fixed to 28/02. A complementary timeline of the Dissemination and Communication plan is provided (Figure 6.3), emphasizing the outreach strategy and the role of stakeholders in all phases of the project.
The objective of **TASK 1 (Inception Phase)** is the establishment of i) an effective project management, timeline, and organisation; ii) the setup of clear and effective communication, and iii) the selection of the most viable/relevant modelling methodology for accomplishing the assignment objectives. This Inception report constitutes **Deliverable 1**, due by 10/02/2023. Comments from ETP are expected by 15/02/2023 at the latest in order to have sufficient time for translation before the Workshop.

The Kick-Off Workshop will be held during this phase. It is a key step to orientate well the study. Its objectives are i) to inform key stakeholders of the energy sector of Vietnam about the study, ii) to guarantee that the study is well-aligned with the realities and priorities of stakeholders, iii) to establish a collaborative working framework. First ideas about assumptions, data, and narrative of the NZE will be discussed during the Kick-Off Workshop.

The objective of **TASK 2 (Assumption Book and Scenario Definition)** is to design/improve the Vietnamese energy model structure and to build the narrative of the NZE scenario and its sensitivities, considering the available data and the priorities identified by stakeholders. Critical data, KPIs and assumptions of the NZE scenario will be shared and validated with stakeholders under the leadership of MOIT and during mini-workshops held before the finalisation of Deliverable 2. Critical KPIs, data, and scenario assumptions will be described in **Deliverable 2 (Interim Report)** due by 05/05/2023.

The objective of **TASK 3 (Scenario Modelling)** is to model the NZE scenario and produce the results based on the proposed modelling approach and taking into consideration critical KPIs, data, and scenario assumptions defined in the previous phases of the study. Sensitivity analyses will also be carried out, based on the key parameters which could critically influence the results of the NZE scenario, identified during scenario building and during the preliminary model runs. The main results of the modelling assessment will be presented in **Deliverable 3 (Assessment report of the**
**Energy Sector in Vietnam** by 23/06/2023. Mini-workshops with stakeholders will be held at the end of June, beginning of July to discuss the initial outcomes of the NZE scenario and the recommendations about the required technological transformations and policies. This discussion will contribute to prepare Deliverable 4.

The objective of **TASK 4 (Net-zero for Energy Sector of Vietnam)** is to formulate recommendations about the technological transformation of the energy sector and identify the policies required to realize the net-zero energy transition, based on the outcomes of the modelling exercise and along with other any relevant technical paper and other modelling activities for Vietnam. A pre-final report will be produced by 21/07/2023 for review and validation by ETP and MOIT. Comments are expected by 01/09/2023. **Deliverable 4 (Final Report “Net-zero for the Energy Sector in Vietnam)**, integrating comments by ETP/MOIT and translated into Vietnamese, will be available by 24/09/2023 and disseminated during the Final Workshop, planned at the beginning of October. The date of the Final Workshops must be fixed at least 3 weeks before the Workshop is held, to facilitate their preparation and ensure the availability of the stakeholders.
Figure 6.2. Updated Gantt Chart (overall project)

Figure 6.3. Gantt Chart of the Communication and Dissemination Plan

43
<table>
<thead>
<tr>
<th>Legend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Inception Report</td>
</tr>
<tr>
<td>D2</td>
<td>Interim Report &quot;Data and Assumption&quot;</td>
</tr>
<tr>
<td>D4</td>
<td>Final Report after UNOPS-ETP and MOIT approval/review</td>
</tr>
<tr>
<td>KO</td>
<td>Kick Off Workshop</td>
</tr>
<tr>
<td>FW</td>
<td>Final Workshop</td>
</tr>
<tr>
<td>EE</td>
<td>Email Exchange</td>
</tr>
<tr>
<td>MW</td>
<td>Mini-Workshops</td>
</tr>
<tr>
<td>Web</td>
<td>Website (UNOPS-ETP)</td>
</tr>
<tr>
<td>Pub</td>
<td>Publications (e-news)</td>
</tr>
<tr>
<td>SM</td>
<td>Social Media (Twitter, Facebook, LinkedIn)</td>
</tr>
<tr>
<td>PR</td>
<td>Press Releases</td>
</tr>
</tbody>
</table>
6.2 Coordination with ongoing projects in Vietnam

Danish-Vietnamese Energy Partnership Programme (Danish Energy Agency)

E4SMA is currently involved in ongoing projects in the framework of the Danish-Vietnamese Energy Partnership Programme (DEPP), coordinated by the Danish Energy Agency (DEA) and with EREA as a partner in Vietnam, with a focus in building capacity for long-term energy planning. In this framework, starting from 2017, DEA supported Vietnam in i) the preparation and publication of the Vietnam Energy Outlook Report (a new release of this report is planned for the end of 2023); ii) the delivery of supporting analyses to inform key Vietnamese policy documents (e.g. Power Development Plan 8, Energy Master Plan, etc.); iii) the periodic development of the Technology Energy Catalogues for the Vietnamese context (the 2023 version will be presented in draft form during a deep dive workshop with relevant stakeholders in March, with final publication is expected in June 2023); iv) the maintenance and improvement of a series of national modelling tools, such the TIMES-Vietnam (originally developed in a World Bank project), the Balmorel and the PSS/E models; and v) capacity building activities on model usage.

The ETP study and DEA projects have a different focus, although sharing some similarities related to long-term scenario analysis. However, close collaboration/communication in certain areas may allow for:

- the optimisation of resources,
- an increased visibility of the project and involvement of local stakeholders and experts,
- the maximisation of benefits for the Beneficiary institutions.

In this regard, the proposal of the Consultants is to:

- Hold monthly meetings with ETP and DEA to discuss the progress of the two projects, highlighting aspects of common interest, possible overlaps, and risks.
- Prepare short keynotes on aspects of common interest.
- Invite DEA experts to the Kick-off and final workshops as observers or to make a presentation on the ongoing activities and how these could support the NZE road map.
- Discuss together data availability, and the role of key technologies and exchange data and assumptions when possible. For example, this assignment could take advantage of the work done by DEA on the technology side (with the preparation of Technology Catalogues) and previous high-level studies on how to achieve the NZE target. On the other end, the DEA might be interested in better understanding the approach used to deliver the ETP study, the underpinning assumptions, and the results of stakeholder engagement.
- Involve DEA members in the formalisation and the review of preliminary NZE scenario results.

Other
The Consultants were informed about a Macro/energy modelization of a Net Zero strategy in Vietnam by the French Development Agency (AFD). More details are not available yet. The Consultants are willing to contact AFD after an agreement with ETP.

Liaising the current study with other recent initiatives in Vietnam, such as the EU – Viet Nam Sustainable Energy Transition Facility (2022-2027) and the Just Energy Transition Partnership (JETP), may be strategically sound, given the common overall objectives and beneficiaries. The Consultants are available to exchange about those strategies with ETP.

6.3 Results-based monitoring and evaluation (M&E) framework with gender-disaggregated data

The study directly and indirectly tackles Strategic Outcome 1 (Strengthened Enabling Policy Environment) and Strategic Outcome 4 (Knowledge and Awareness Building) proposed by ETP.

As regards **Strategic Outcome 1 (Strengthened Enabling Policy Environment)**, the outcomes of the study will contribute to better-informed decisions by national stakeholders, more particularly MOIT, about renewable and energy efficiency planning and policies (Result 1.1.). More particularly, the study will provide one Net Scenario Emission scenario and up to 5 sensitivity analyses. It would be unrealistic to expect that the study alone will directly contribute to the implementation of new policies and plans, given its short time horizon and scope. However, the outcomes of the study will certainly feed the longer-term activities of ETP in Vietnam as well as other initiatives now ongoing in Vietnam (EU Viet Nam Sustainable Energy Transition Facility, JETP) on the Net Zero Emission outlook of Vietnam.

As regards **Strategic Outcome 4 (Knowledge and Awareness Building)**: the outcomes of the study will contribute to several indicators of this outcome (Table 6.1).

As regards gender, the modelling exercise of the NZE scenario will not collect/use/produce any gender or sex-disaggregated data and narratives. This level of details cannot be reflected in the energy model. A possibility is to tackle it when discussing about policies, this will remain at a general level.
Table 6.1. Contribution of the study to Strategic Outcomes 1 and 4 of ETP

<table>
<thead>
<tr>
<th>ETP Indicator</th>
<th>KPIs of the project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic Outcome 1.</strong> Strengthened Enabling Policy Environment</td>
<td>Transversal and indirect contribution - 1 Zero Emission Scenario - Up to 5 sensitivity analyses</td>
</tr>
<tr>
<td><strong>Result:</strong> Short-Term Outcome (By 2025)</td>
<td></td>
</tr>
<tr>
<td><strong>Strategic Outcome 4.</strong> Knowledge and Awareness Building</td>
<td>IN 4.1-01 - No. of studies, research, new evidence gathered and published, for raising awareness, improving the knowledge base, driving decisions, and dissemination - 4 reports, supported by non-technical summaries</td>
</tr>
<tr>
<td><strong>Result:</strong> Short-Term Outcome (By 2025)</td>
<td></td>
</tr>
<tr>
<td><strong>Description:</strong> 4.1. Stakeholders (relevant Government entities, public sector companies, financial institutions, Private entities, Academia, and Consumers) involved in the RE/EE value chain, are knowledgeable and better informed to advance the energy transition agenda</td>
<td>IN 4.1-02 - No. of training, knowledge sharing events, and/or awareness workshops organized at national and regional levels to build institutional capacity and knowledge networks - 2 workshops (up to 10 stakeholders, initially planned for 15 and 35 persons respectively, extended to 30 and 60 persons respectively) - 4 mini-workshops with national stakeholders - 8 progress meetings with MOIT (monthly, from March to October) - Presentations of the Study in up to 3 events. - Up to 3 bilateral meetings with one international stakeholder (DEA)</td>
</tr>
<tr>
<td></td>
<td>IN 4.1-04 - No. of articles, press releases on social media, and mass-media, for outreach - Up to 20 posts on the ETP website, electric journals/magazines, and social media (LinkedIn/Twitter/Facebook) - 10 articles (e-journals) - 1 press release</td>
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ANNEXES

Annex 1. Minutes of the Kick-Off Workshop

Diagnostic Study on Net-Zero for the Energy Sector in Vietnam

Kick-Off Workshop Meeting

Minutes

DATE 28 February 2023
VENUE Fortuna Hotel Hanoi,
6B Lang Hạ, Ba Đình, Hà Nội, Việt Nam
OBJECTIVE To inform key stakeholders of the energy sector of Vietnam about the study. To guarantee that the study is well-aligned with realities and priorities of stakeholders. To establish a collaborative working framework.

AGENDA

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speakers</th>
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<tbody>
<tr>
<td>9h00-9h20</td>
<td>Welcome and objective of the workshop. Presentation (tour de table)</td>
<td>MS. PHAM THU HANG, CEO OF VIETSTAR</td>
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<tr>
<td>9h20-9h30</td>
<td>Welcome Remarks</td>
<td>MS. SIRPA JARVENPA, ETP FUND DIRECTOR</td>
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<tr>
<td>9h30-9h40</td>
<td>Welcome Remarks</td>
<td>MS. NGÔ THUY QUỲNH, DEPUTY DIRECTOR OF OIL, GAS AND COAL DEPARTMENT</td>
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<td>9h40-10h00</td>
<td>Overview of the energy sector – focus on challenges and opportunities of the Net-Zero target in Vietnam.</td>
<td>MOIT (Oil, Gas and Coal Department)</td>
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<tr>
<td>10h00-10h30</td>
<td>Presentation of the Diagnostic Study on Net Zero: approach and scenario.</td>
<td>MR. MAURIZIO GARGIULO, E4SMA</td>
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<td>10h30-10h50</td>
<td>Coffee/Tea Break</td>
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<td>1</td>
<td>Ministry of Industry and Trade (MOIT)</td>
<td>Ms</td>
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<td>Mr.</td>
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<td>3</td>
<td>Singapore Embassy in Vietnam</td>
<td>Mr.</td>
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<td>4</td>
<td>Delegation of the European Union to Vietnam</td>
<td>Mr.</td>
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<td>Ms.</td>
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<td>6</td>
<td>Danish-Vietnamese Energy Partnership Program</td>
<td>Ms</td>
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<td>7</td>
<td></td>
<td>Mr.</td>
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<td>8</td>
<td>World Bank</td>
<td>Mr.</td>
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<td>9</td>
<td>Embassy of United Kingdom in Vietnam</td>
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<td>10</td>
<td>Agence Francaise de Développement (AFD) French Development Agency</td>
<td>Mr.</td>
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<tr>
<td>11</td>
<td>Vietnam Oil and Gas Group (PVN)</td>
<td>Mr.</td>
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<td>Ms.</td>
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<td>15</td>
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<td>16</td>
<td>Vietnam Electricity (EVN)</td>
<td>Ms.</td>
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<td>18</td>
<td>Power Generation Corporation 2 (GENCO2)</td>
<td>Mr.</td>
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<td>19</td>
<td>Power Generation Corporation 3 (GENCO 3)</td>
<td>Mr.</td>
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<td>20</td>
<td>Mr. Trần Hà Anh Vũ</td>
<td>Technique and Production Department</td>
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<td>21</td>
<td>Energy Transition Partnership (ETP)</td>
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<td>Energy Transition Partnership (ETP)</td>
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<td>Ms</td>
<td>Trương An Hà</td>
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<td>E4SMA</td>
<td>Mr.</td>
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<td>E4SMA</td>
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<td>30</td>
<td>Vietstar Training and Consulting JSC</td>
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<td>31</td>
<td>Vietstar Training and Consulting JSC</td>
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<td>Institute of Energy</td>
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<td>33</td>
<td>Institute of Energy</td>
<td>Mr.</td>
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<td>34</td>
<td>Electric Power University</td>
<td>Ms.</td>
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<td>35</td>
<td>Hanoi University of Science and Technology</td>
<td>Ms.</td>
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OVERVIEW OF THE PRESENTATIONS

Overview of Vietnam energy sector - focusing on challenges and opportunities of the Net-Zero target in Vietnam

By representative of Oil, Gas and Coal Department (MOIT)

- Vietnam energy sector has been developed for decades, contributing to the social-economic development of the country. Total final energy consumption increased from 39.8 MTOE in 2010 to 66.0 MTOE in 2020.
- EMP (PDP-8) has been developed and being finalized with the goal of ensuring energy security, prioritizing the full and efficient utilization and usage of new and renewable sources, and contributing to implementation of Vietnam's commitment to Net-zero emissions by 2050.
- "Green" hydrogen is expected to play an essential role in decarbonization of future energy sector.
- Challenges to achieve Net-zero: large capital, technology readiness and incomplete legal framework.
- Opportunities: green growth, mobilization of private investment and participation of global energy chain values.
Approach and Scenario of the Diagnostic Study on Net Zero
By Mr. Maurizio Gargiulo, E4SMA

- Objective: Deliver a diagnostic study on net-zero for the energy sector in Vietnam
- Project plan: 4 tasks (Inception phase, Assumption book and scenario definition, Scenario modelling, Net zero for energy sector of Vietnam)
- Methodology approach: Development of a set of quantitative analyses employing a techno-economic model representing the entire economy: TIMES-Vietnam
- Direct outcomes of TIMES-models cover, amongst other: cost and expenditures, energy supply and production power sector, end-use sector, emissions.
- Several sensitivity studies

Role of stakeholders
By Ms. Pham Thu Hang, CEO of Vietstar

- Central Economic Commission (CEC) for political and national security in term of energy
- Ministry of Industry and Trade (MOIT), is in charge of power planning and energy master plan
- Ministry of Natural Resources and Environment (MONRE) in charge of climate action plans and emission inventory.
- Ministry of Finance (MOF) and Ministry of Planning and Investment (MPI) for financial issues
- Committee for Management of State Capital at Enterprises (CMSC) as the owner of major coal-fired power plants
- Committee for Management of State Capital at Enterprises (CMSC) as the owner of major coal-fired power plants
- Vietnam National Coal And Mineral Industries Holding Corporation Limited (Vinacomin), a national industrial corporation of Vietnam, focusing on coal and mineral mining, power generation and trading, construction materials and chemicals production and trading, etc.
- Vietnam Electricity (EVN), as a state-owned corporation leading the power sector, owing several power generation and transmission corporations, amongst others
- PetroVietnam (PVN), as a state-owned corporation leading the oil and gas sectors (exploration and production to storage, processing, transportation, distribution, and services).

KEY POINTS SHARED BY PARTICIPANTS

Mr Bùi Minh Tiền – Member of Board of Directors, Vietnam Oil and Gas Group (PVN)
- PVN operates in 5 fields: exploitation, processing, transportation and distribution, investment in power plant construction, oil and gas engineering
- PVN's activities are directly related to emissions and energy development trends.
- PVN will invest in future energy for sustainable development.
- So, they are interested in the study and open to exchange and support the study. PVN will actively support for the project’s success.
- He emphasised the important role of communication to policy makers and business leaders => should focus much on communication efforts.
- He expressed his strong support to the project. PVN will actively support to make the project successful.

Another representative from PVN
- Vietnam Oil and Gas Group has many related activities to a roadmap to achieve netzero: Energy saving, CCS, CCUS solutions
- Energy transition have certain difficulties: Energy saving only reaches 10% CO2 emission reduction
- How does each energy corporation have a roadmap to achieve netzero for its activities?

Mr. H.E. Jaya Ratnam, Singapore Ambassador to Vietnam
- To get net-zero, also pay attention to regional cooperation, especially energy cooperation between Vietnam and Singapore.
- Regional power grid issue: investment.
- Also, it is needed to optimize domestic resources for Net-zero.
- Information from Net-zero Study plays an extremely important role, which will influence the decision-making activities of policy makers as well as energy businesses.
- The bilateral partnership between Vietnam and Singapore has achieved significant progress and activities in recent years. Singapore businesses are also very interested in the transformation steps of Vietnam towards in the Net-zero roadmap.

Mr. Phan Minh Tuân, Head of International Relation Department, Vietnam Electricity (EVN)
- Need to consider Vietnam National Coal and Mineral Industries Group – Vinacomin a key stakeholder, and need to engage CMSC.
- EVN owns the units operating the national power system. Energy transition directly relates to the operation of the national power system operators. EVN pays much attention to net-zero despite only accounting for 30% power generation capacity. Net-zero emission is in daily discussion of energy sector, MOIT, PVN, EVN, Vinacomin.
- How to make transition to coal-fired power, biomas power; big challenges for the coal-fired power plants (those are more than 20 years old) when power demand increase high. He expected, by 2050, electricity demand may be 4 times higher than the current rate.
- Energy transition accompanies with increased OPEX and CAPEX because power price has not increased for many years. He said power price should have increased when input price go up. So, it is necessary for the power price related suggestions to meet energy transition.
- It is needed to enhance transmission and distribution.
- He questioned about whether Vietnam should restart nuclear power because now it has trained experts for previous incompleted projects. It will waste effort if consider about it too late.
- Challenges for Vietnam to get Netzero: large population with high growth rate, small area
- It is crucial to have a clear roadmap to net-zero.

Mr. Lê Quóc Vũ, Deputy General Director of Power Generation Corporation 2
- Wish consulting firms to suggest new technologies for energy transition
- He suggested developing tide energy in the South of Vietnam
- Vietnam should be ready in policies because state-owned enterprises wasted much time and lost opportunities due to complicated mechanisms.

Ms. Maryse Labriet, International expert, E4SMA
- Project team periodically work with MOIT and relevant stakeholders: both online and in person meetings are planned during the study.
- Project team will share data and assumptions in April to get validation, and first results of scenario analysis in July about potential technologies and transformations to reach Net Zero, sensitivity analysis focusing on some priorities identified by stakeholders.
- Final workshop will present recommendations and project outcomes.
- Operational and technical meetings are very important.

Mr. Maurizio Gargiulo, International expert, E4SMA
- For other impacts like air pollution, employment, etc., we will evaluate possible approaches and which areas could possibly be included directly and/or analysed indirectly.

Mr. Nguyễn Ngọc Hưng, Local Expert, Institute of Energy
It is a big challenge to study and plan for the energy transition to meet net zero 2050, but it will be a turning point for energy sector.

Difficulties of supply:
- Thermal power: energy price issues, financial mobilisation, stranded asset.
- Biomass energy: plays an important role in decarbonization; difficulties in land use
- Renewable energy: wind and solar is invested; challenges in transmission capacity and cutting capacity; focusing mainly on the central and southern regions, so it is needed to develop rapidly in the north.
- Hydrogen and hydrogen fuel: no policy yet; plays an important role in decarbonization in industry and transportation.
Difficulties of demand:

- Industry: replacing and converting fuel from coal to biomass energy.
- Difficulties in accessing to finance: it is hard to prove the effectiveness of energy projects.
- Future technology needs to be shared transparently.
- Buildings: Vietnam’s strong development orientation on urbanization accompanies the electrification in buildings (100% electricity usage); upgrade labelling; use building code, green building and net zero buildings.
- Transportation: 99% of fuel used in transportation is gasoline and oil products; switch to electric vehicles => change infrastructure and load curve.

Carbon capture, use and storage: CO2 can be used in the production of building materials, chemicals. Reducing emissions from the energy sector to 100 million tons of carbon => balance with absorption. By 2030, firmly established.

EU Delegation

- Reach green agreements in all economic sectors in dialogues with other countries.
- Collect enough data to run the model, pay attention to exogenous factors: pollution impacts on human health, impacts on people, employment, health care...
- Peripheral costs are quite significant when evaluating benefits – costs.

(Ms Dương from EU Delegation)

- The study is important, support cooperation.
- Suggest to share the study with the Vietnam Energy partner group. (website).

Ms. Ngô Thuỷ Quỳnh, Deputy Director of Oil, Gas and Coal Department, MOIT

- Many issues/topics for the study, need to identify netzero-related problems.
- Data is important.
- The oil, gas and coal departments play a connecting role to the stakeholders.
- Need international experience sharing.
- Need to enhance communication.

ETP

- Fast action and response
- Assumption and discussion by stakeholders is critical to success
- Agree with the Ambassador of Singapore, the connection is not only within the country but also between countries; Indonesia has a research development center; Emerging Tidal Energy is popular in Singapore.
- ETP has research activities to ensure the market operates equally and competitively.
- EVN mentioned transmission and distribution; ETP Refers to transmission technology.
- Regarding the collaboration between project actors, ETP is open and supportive.

**NEXT STEPS**
- Further consultations of stakeholders about data/assumptions (end April) and outcomes of the NZE modelling (July).
- Final Workshop in October.
Annex 2. Mapping of the existing energy/power modelling tools available in Vietnam other than TIMES-Vietnam

**LEAP Vietnam:**
LEAP is a widely used software tool for energy policy analysis and climate change mitigation assessment, developed by the Stockholm Environment Institute (Source 1). The latter is an integrated, scenario-based modelling tool developed with the aim of tracking energy consumption, production, and resource extraction in all sectors of a given economy. In terms of emissions, the tool accounts for both energy sector and non-energy sector greenhouse gas (GHG) emission sources and sinks. Furthermore, also employs a least-cost capacity expansion and dispatch methodology based on the use of linear programming-based optimisation frameworks (Source 2). LEAP's application is particularly wide between developing countries undertaking integrated resource planning and greenhouse gas mitigation assessments.

In order to prepare GHG reduction commitments for the 21st United Nations Framework Convention on Climate Change Conference in Paris in 2015, LEAP was selected as modelling tool to determine the possible GHG emission reduction potential in the energy sector and its contribution to the Intended Nationally Determined Contributions (INDCs) for Vietnam (Source 3). Mitigation scenarios were designed based on the potentials of RE sources and EE technologies under the assumption that additional action plans or policies are developed. To develop GHG mitigation scenarios for LEAP Vietnam, the following methodology has been followed in the proposed order. First, a set up the options/list of mitigation technologies. Here, technologies considered include EE, RE, and fuel substitutions. Secondly, a framework for the energy sector has been created. Finally, during the evaluation phase, costs, benefits, and GHG mitigation potential have been computed and assessed.

Sources:
1) [https://leap.sei.org/help/Optimization/OptimizationIntroduction.htm](https://leap.sei.org/help/Optimization/OptimizationIntroduction.htm)
2) [https://leap.sei.org](https://leap.sei.org)

**Energy Forecasting Framework and Emissions Consensus Tool (EFFECT):**
EFFECT is an Excel-based, inventory-style tool with simple built-in optimisation functionality that mainly focuses on forecasting greenhouse gas emissions (GHG) from a range of scenarios (Source 1). The model consists of five modules that coincide with the main sectors investigated: power generation, land transport, household electricity consumption, non-residential, and industry. The model was initially developed by the World Bank with the aim to evaluate and compare different development scenarios in specific areas (sectors) where important mitigation impacts could be achieved. EFFECT has since been used in eleven countries, including Brazil, Poland, Georgia, Macedonia, Nigeria, and Vietnam.

EFFECT forecasts GHG emissions for given development scenarios or policy choices. In addition to forecasting GHG Emissions, EFFECT enables consensus building among disparate government
departments, and forecasts energy balances and amounts of energy-generating assets in a country or sector. EFFECT also produces results for individual sectors such as road transport, agriculture, power, industry, household, and non-residential sectors. As the name suggests, reaching a consensus among local stakeholders on the assumptions and data used to construct the scenarios is a major part of the modelling process.

EFFECT has been used in Vietnam to assess the energy end use in transport, industry, residential, and commercial, and power generation sectors on two separate occasions so far (2013 and 2016) (Source 2). Starting from a reference scenario, a low-carbon scenario assessing options to achieve the same or better development progress than in the “reference scenario” but with lower greenhouse gas (GHG) emissions has been constructed.

Sources:
2) https://openknowledge.worldbank.org/handle/10986/23522

**Balmorel Vietnam:**
Balmorel is a fairly used least-cost dispatch methodology. The Balmorel investment power system model optimises the generation, transmission, and consumption of electricity and heat by finding an energy balance for the system at each given timestep (Source 1). In terms of technical detail, all generation plants and the interconnected transmission grid of the system under investigation are well represented. Hence, both the existing power system and future investment options are represented in Balmorel. An additional feature of the model is that it allows for investments in different new renewable and non-renewable generation units as well as in new interconnector capacity (Source 2). Finally, in terms of temporal resolution, the model can be run on hourly time steps to allow for adequate analysis of the integration of the variable renewable energy (RE) in the power system.

Balmorel Vietnam contains data on the existing interconnected power system in Vietnam. In the model, Vietnam is subdivided into six transmission regions each having an individual hourly electricity consumption. In Balmorel Vietnam, electricity balances are given on a regional basis with seven lines connecting the above-mentioned six transmission regions. Accordingly, an electricity balance must be satisfied for each of the six regions while leaving the opportunity open for inter-regional electricity with each other. In addition, four transmission lines connect China, Laos, and Cambodia to the Vietnamese grid. In the model, import from these neighbouring countries is allowed with fixed profiles.

Sources:

**PLEXOS Vietnam:**
PLEXOS is a simulation software designed for electric power, gas, heat, and water market analysis (Source 1). It is commonly used as an integrated power system optimisation model to simulate different planning horizons. It is a powerful tool for system operators, regulators, and planners as well as utilities, traders, consultants, and manufacturers. Also, PLEXOS employs a least-cost dispatch methodology by taking into account operational and generation constraints, such as capacities and ramp rates of generators, transmission constraints, such as transmission line-specific power flow limits, and uncertainties.

The PLEXOS Vietnam model developed as part of the United States Agency for International Development (USAID) Vietnam Low Emissions Energy program (V-LEEP) has two levels of detail: a regional and a more detailed intra-regional level. In the first level, the model is evaluated without considering transmission lines within the regions. On the other hand, at the intra-regional level, detailed characteristics of transmission lines in each region are considered. While the first level, including only the interconnection between the six identified Vietnamese regions, allows for a quick assessment, it does not include details on local congestion while optimising the dispatch. More information on the specific model and assumptions underlying it can be found in the final report by USAID called “Final Report: Assessment of Revised Power Development Plan 7 by using Production Cost Model with PLEXOS” (Source 1).

Sources:
1) https://pdf.usaid.gov/pdf_docs/PA00XGQK.pdf

Electricity Planning Model (EPM):
Electricity Planning Model (EPM) is an optimisation tool owned by the World Bank which simulates the current electricity generation sector situation and provides demand projections between 2020 and 2040 (based on economic growth and declining income elasticity with aggressive energy efficiency assumptions).

The EPM is a multi-year mixed-integer programming model for capacity and dispatch analysis. The EPM considers chronological load curves for representative days for each year, solar/wind hourly profile for these days, spinning reserve requirements, and hydropower energy constraints. It is a least-cost optimisation model with inputs capturing renewable resource availability, hourly demand profile and forecast, and the technical and cost parameters of infrastructure including plants and power lines. The model displays the optimal investment plan by simulating the economic dispatch in the given period. It also provides utilization rates of plants and power lines, energy trade between zones (countries), and system-wide carbon emissions. The model selected generation resources (which compete on a level playing field with optimistic cost reduction projections assumed) on a least-cost basis.

Sources:
   https://openknowledge.worldbank.org/handle/10986/37966
**PSS/e Vietnam:**

PSS/e is a Siemens-owned software tool aimed at simulating electrical power system networks (Source 1a). With PSS/e power system engineers can simulate and optimise operational features of the power system as well as perform power system planning. Its main functions in grid planning are load flow, short circuit calculation, P-V curve and Q-V curve analysis, and dynamic stability simulation. An added functionality coming from using the simulation tool is that N-1, and N-2 grid criteria can be checked to assess where violations occur.

The PSS/e model is widely applied in Vietnam for both short and long-term grid planning and operation optimisation. For the Vietnam Energy Outlook 2021, a detailed PSS/e model of the power grid has been used to test grid-related assumptions in the Balmorel power system analyses (PSS/e, Source 1b). Here, the Vietnamese transmission system has been subdivided into 7 geographical regions. Based on the Vietnamese Power Development Planning (PDP8) this model includes a representation of the 500kV and 220kV national power grids for the years 2020 and 2030 with representations of around 600 nodes and 1200 branches of lines for the system in 2030. Hereby, the model includes all power plants, loads, transformers, shunts, facts, and branches of lines.

Sources:

   b. [https://zenodo.org/record/6606382#.Y-EODHbMIPY](https://zenodo.org/record/6606382#.Y-EODHbMIPY)
2) [https://ens.dk/sites/ens.dk/files/Globalcooperation/grid_modelling_of_the_vietnamese_power_system.pdf](https://ens.dk/sites/ens.dk/files/Globalcooperation/grid_modelling_of_the_vietnamese_power_system.pdf)

**DigSILENT/Power Factory:**

DigSILENT/Powerfactory is a transmission system model used for electrical power simulation, planning, and development. The main modules include load flow analysis, short circuit analysis, and optimal power flow.

Again, as for the PSS/e Vietnam model, starting from a base year grid configuration based on the PDP8, the DigSILENT/Powerfactory Vietnam model includes a list of power plants with respective locations according to a generation type classification, the yearly peak loads and load profiles by geographical region, the 500 kV, and 220 kV transmission lines, and finally the respective substations (DigSILENT/Power Factory, Source 1).

Sources:

1) REVIEW AND GAP ANALYSIS OF THE EXISTING ABATEMENT SCENARIOS FOR VIET NAM: D.3. FINAL REPORT
Global Calculator for Vietnam 2050:

The Global Calculator (GC) is an engineering model of stocks and flows which combines all sectors of the global economy into a single system dynamics model (Source 1). This is accomplished by deriving interconnecting variables between the different sectors over time. Hence, it allows for simulations of system dynamics at a global scale. Compared to the previously introduced models, the GC is not an econometric or profit-optimisation model. In fact, the user decisions and model manipulations replace the optimisation functionality of the model. User interaction with the tool plays a major role as the user firstly defines/sets levels of core activities and then chooses the solutions that enable those activities. For example, the user sets a level of the distance travelled and then sets the transport solutions that enable this specific activity.

The Ministry of Industry and Trade of Vietnam (MoIT) in collaboration with the British Embassy Hanoi have jointly launched an updated version of the 2050 Calculator energy and emissions model for Vietnam in 2015 (Source 2). The updated version reflects the prevailing policies, and ongoing efforts in energy supply and demand, and proposes reference scenarios on energy production and consumption and greenhouse gas emissions up to 2050. Furthermore, detailed information for 14 industries, and the energy and transport sectors are included. Here, compared to the previous version, information on the energy sources for socio-economic development towards climate change mitigation has been updated.

Sources:
1) https://reader.elsevier.com/reader/sd/pii/S2211467X2030047X?token=8BCBB5296BFA74C43D67C23AC5B910A45E5467C92E2059F6EB4D6584B0064F27023672E7A8AD7346CB184B519A7E4C2&originRegion=eu-west-1&originCreation=20230123082902
Annex 3. What is TIMES?

TIMES is a modelling framework developed to explore and assess how energy systems may change over time, particularly in response to different policies e.g. climate or renewable energy targets, and drivers of energy demand e.g. economic growth. It is a partial equilibrium model, so balances supply and demand within the energy system, finding the least-cost solution for an energy system that meets future demand for energy services, such as space heating and cooling, mobility, and industrial production output.

A key feature of the model is that it is constructed from the technology level up, meaning that many of the system components e.g. refineries, vehicles, and power stations, can be represented, including their performance and costs. However, the advantage of TIMES is that it can assess the role of these many different components within an interconnected system, exploring trade-offs, and dependencies, and providing a consistent assessment of the system as a whole. TIMES is also known as an E3 model, meaning that it provides metrics on the physical energy system (technology capacity, system operation, energy use totals), on the economics of the system (investment requirements, energy costs), and on the environmental impacts (GHGs).

The model is widely used around the world, in over 70 countries (see Figure), both by the policy community and for academic research. The Energy Technology Systems Analysis Programme (ETSAP), a technology collaboration programme of the International Energy Agency (IEA), ensures the development of the TIMES code, provides training, supports the network of users, and facilitates joint working.39

Figure A2. The global extent of TIMES model users and contracting parties.

Contracting party countries include model users but are differentiated as being official members (and funders) of ETSAP.

39 A user forum for TIMES modellers can be found at http://iea-etsap.org/forum/index.php
Annex 4. List of relevant KPI estimated directly by TIMES (not exhaustive)

<table>
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<th>Area</th>
<th>Results (KPIs)</th>
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<tr>
<td>Costs and Expenditures</td>
<td>Total discounted system cost (Objective Function)</td>
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<td>All system expenditures summary table</td>
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<td>Annualized Investment expenditures by type</td>
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<td>Fixed and variable O&amp;M and delivery expenditures by type</td>
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<td>Fuel costs by sector</td>
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<td>LumpSum Investments by type</td>
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<td>Investment expenditures by sector</td>
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<td>Energy (marginal) prices, as well as emissions when constrained</td>
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<td>Electricity (marginal) price by timeslice</td>
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<td>Energy Supply and Production</td>
<td>Energy production by fuel type</td>
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<td>Resource supply by source (domestic/ imports)</td>
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<td>Imports by type</td>
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<td>Exports by type</td>
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<td>Total GHG emissions</td>
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<td>GHG Emissions by sector and sub-sector</td>
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<td>Others</td>
<td>Advanced CO₂ abatement technologies</td>
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Annex 5. Mapping of governmental stakeholders

Central Economic Committee
Central Economic Committee (CEC) is the advisory body of the Communist Party of Vietnam's Central Committee, directly and often the Politburo and the Secretariat in building orientations and perfecting the economic institutional framework, planning major and important socio-economic policies and measures. CEC, therefore, have the responsibility for proposing policies and guidelines for energy sector development. CEC is the main advisory body for Politburo's Resolution No. 55-NQ/TW. Consequently, CEC shall take charge and cooperate with relevant regulatory bodies in regularly supervising, inspecting, and expediting the implementation of this Resolution; and periodically submit preliminary and summary reports on such implementation to the Politburo and Secretariat of the Communist Party.

Ministry of Industry and Trade
Ministry of Industry and Trade is a governmental agency in charge of performing the state management of industry and trade, including the following energy subsectors: electricity, coal, oil and gas, and new and renewable energy. MOIT is in charge of building Power Development Plan, and Energy Master Plan. MOIT's tasks in Decision 896/QD-TTg 2022 are as follows:

- Review, amend and supplement specialized laws, strategies, master plans, and sector plans in line with the objectives of climate change adaptation and reduction of greenhouse gas emissions; develop and implement a plan to reduce greenhouse gas emissions in all fields according to the roadmap to achieve net emissions of "zero" by 2050.
- Completing regulations, processes, and technical guidelines on greenhouse gas inventory, the system of "measure, report, appraise" GHG emission reduction activities at the sectoral and facilities level.
- Organize GHG inventory at the sector level and prepare reports for national GHG inventory in accordance with the law.
- Develop national standards and regulations on emission reduction and inventory of greenhouse gases; technical standards and regulations related to the fields in line to achieve "zero" net emissions by 2050.

Ministry of Natural Resources and Environment
Ministry of Natural Resources and Environment (MONRE) is a governmental agency performing the function of state management in the fields of land; water resources; mineral resources and geology; environment; meteorology and hydrology; climate change; survey and mapping; integrated management and protection of natural resources and environment of seas and islands; remote sensing; state management of public services in the fields of the Ministry's management. MONRE is the major governmental agency for building the National climate change with quantified targets for different sectors towards net-zero emission by 2050. MONRE, therefore, is responsible for guiding the integration of the climate change targets into the development strategies and plans of the energy sector. MONRE, therefore, takes prime responsibility for implementing the National climate change strategies. Cooperating between ministries and local in order to meet the target NetZero emission in 2050 as regulated in Decision No. 896/QD-TTg 2022.
Ministry of Finance

Ministry of Finance (MOF) is a governmental agency which has the function of implementing state management in finance (including: state budget, tax, fees and other revenues of the state budget, national reserve, State financial funds, financial investment, corporate finance; cooperative finance and collective economy; public property as prescribed by law); customs; accounting; independent auditing; insurance; prices; securities; insurance; financial and other services under the Ministry's state management; conducting the ownership rights to the State’s investment capital in enterprises according to regulations of the Law. MOF, therefore, plays important role in allocating budget for the energy development. Towards to net-zero emission target, MOF's tasks in Decision 896/QD-TTg 2022 are:

- The prime responsibility for, and coordination with relevant ministries, and agencies in reviewing, adjusting, and submitting to competent authorities for approval policies on finance and investment, and supporting and creating favorable conditions for the implementation of the strategy.
- Pursuant to the law, balance and allocate state budget and recurrent expenditures for the implementation of the Strategy.

Ministry of Planning and Investment

Ministry of Planning and Investment (MPI) is a governmental agency performing functions of state management over planning, development investment, and statistics, including the provision of general advice on strategies, master plans, plans for national socio-economic development and public investment; on mechanism and policies for economic management; on domestic investment, foreign investment into Vietnam and Vietnam's investment abroad; economic zones; on official development assistance (ODA) source, preferential loans, and foreign non-governmental aids; on bidding; on development of enterprises, collective economy, and cooperative sector; on statistics; performs the state management over public services in sectors, fields under its state management as prescribed by laws. , MPI play important role in reviewing, and building investment policies and mechanism for the energy sector. Towards to net-zero emission target, MOF's tasks in Decision 896/QD-TTg 2022 are:

- Prime responsibilities and cooperation with ministries in reviewing and updating the national strategies and plans.
- Reviewing the investment policy and mechanism.
- Facilitate for development of green finance.

Ministry of Transport

Ministry of Transport (MOT) is an agency of the Government, performing the function of state management of transportation by road, railway, inland waterway, maritime and civil aviation nationwide. The transport sector is one of the biggest energy consumers, thus, the strategies in transport have a close relationship with the energy supply strategies. The cooperation between MOT and other ministries brings lower-cost solutions for reaching emission targets. MOT's tasks in Decision 896/QD-TTg 2022 are:

- Review, amend and supplement specialized laws, strategies, master plans, and sector plans in line with the objectives of climate change adaptation and reduction of greenhouse gas emissions; develop and implement a plan to reduce greenhouse gas emissions in all fields according to the roadmap to achieve net emissions of "zero" by 2050.
- Completing regulations, processes, and technical guidelines on greenhouse gas inventory, the system of “measure, report, appraise” GHG emission reduction activities at the sectoral and facilities level.
- Organize GHG inventory at the sector level and prepare reports for national GHG inventory in accordance with the law.
- Develop national standards and regulations on emission reduction and inventory of greenhouse gases; technical standards and regulations related to the fields in line to achieve “zero” net emissions by 2050.

Commission for the Management of State Capital
Commission for the management of state capital at enterprises (CMSC) was established organization under the Government. Politburo’s Resolution No. 12-NQ/TW dated 03 June 2017 has directed to establish a specialized agency to represent state capital at SOEs and state shareholding and capital contribution at enterprises. CMSC and enterprises of which CMSC represents the owner shall manage and use state capital in conformity with national strategies, plans, and policies for the development of industries approved by competent authorities. In the energy sector, CMSC represents state capital at cooperations namely Vietnam national Petroleum Group (Petrolimex), Electricity of Vietnam (EVN), Vietnam Oil and Gas Group (PVN); Vietnam Coal and Mineral Industries Group (TKV). Due to the actions of CMSC, many difficulties of projects have been removed, especially some large and important projects that have been delayed for many years.

CMSC has the responsibility of submitting project proposals to Prime Minister for approval. CMSC need to submit to Prime Minister for approval of investment policy in case the level of approval is Prime Minister or National Assembly. For investment decisions, CMSC will direct and inspect the construction authorities in charge of economic-technical reports, and construction design.
Annex 6. Review of main available international data sources on energy intensive industrial sector

Current status characterization

<table>
<thead>
<tr>
<th>Sector</th>
<th>Database and Sources</th>
<th>Quality of the data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron and Steel</td>
<td>World Steel Association, Midrex, US Geological Survey, World Energy Balance (IEA)</td>
<td>● Good data quality about the production, the capacity and the share of the different process routes for the main producer countries.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● For DR technology is available also the age of the plants.</td>
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<tr>
<td></td>
<td></td>
<td>● The world energy balance provides the consumption of the sector per country</td>
</tr>
<tr>
<td>Cement</td>
<td>Global Cement and Concrete Association (GCCA), US Geological Survey, IEA website</td>
<td>● GCCA provides an exhaustive database with production data, clinker to cement ratio, mineral consumption, energy consumption for main world geographical areas and for specific countries.</td>
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<tr>
<td></td>
<td></td>
<td>● USGS provides data for the top 13 countries for cement production and an aggregation for the other countries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● IEA website provides the specific energy (fuel and electricity) consumption for 10 selected countries and for aggregated world geographical area</td>
</tr>
<tr>
<td>Ammonia</td>
<td>US Geological Survey 2022</td>
<td>● USGS provides data production for the top 23 countries for ammonia and an aggregation for the other countries</td>
</tr>
<tr>
<td>Other Industries</td>
<td>World Energy Balances</td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Sector</th>
<th>Database and Sources</th>
<th>Technologies</th>
</tr>
</thead>
</table>
| Iron and Steel      | Energy Technology Perspectives Model (IEA), JRC-EU-TIMES, PRIMES Europe, Danish Energy Agency Technology Catalogue | ● Blast furnace - basic oxygen furnace, Direct reduced iron and electric arc furnace Steel from scrap and electric arc furnace, Smelting reduction and BOF, BF-BOF with CCS, BF with top-gas recovery and BOF with CCS, DRI-EAF with CCS, Hlsarna-BOF, Hlsarna-BOF with CCS  
● Hydrogen direct reduction and EAF. Ulcored with CCS, Ulcolysis, Ulcowin |
| Clinker, cement     |                                                                                      | ● Dry process, Wet process/Not Efficient Process, Dry process with post-combustion CCS, Dry process with oxy-fuel combustion.                            
● Cement blending, Alkali-activated cement binders, Belite cement |
| Chemicals           |                                                                                      | ● Ammonia: NG Steam reforming, Naphta partial oxidation, coal gasification, Electrolysis, NG Steam reforming with CCS, Biomass GSF                           
● Methanol - NG Steam reforming, LPG partial oxidation, coal gasification, electrolysis, biomass gasification  
● HVC - Ethane Steam Cracking (SC), Naphta SC, Gas Oil SC, LPG SC, Propane Dehydrogenation, Napthta catalytic cracking, Methanol to olefins, Bioethanol Dehydration |