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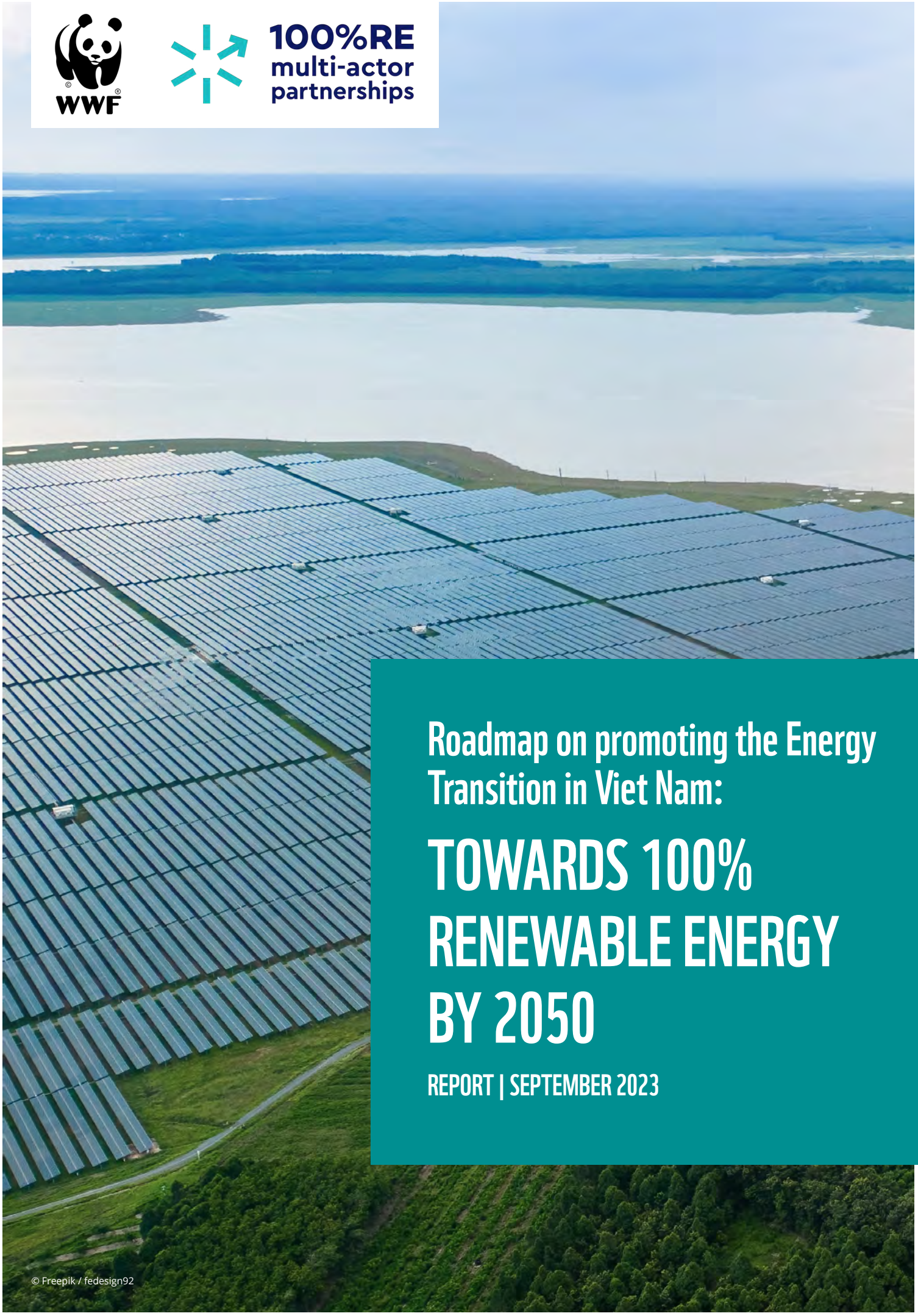
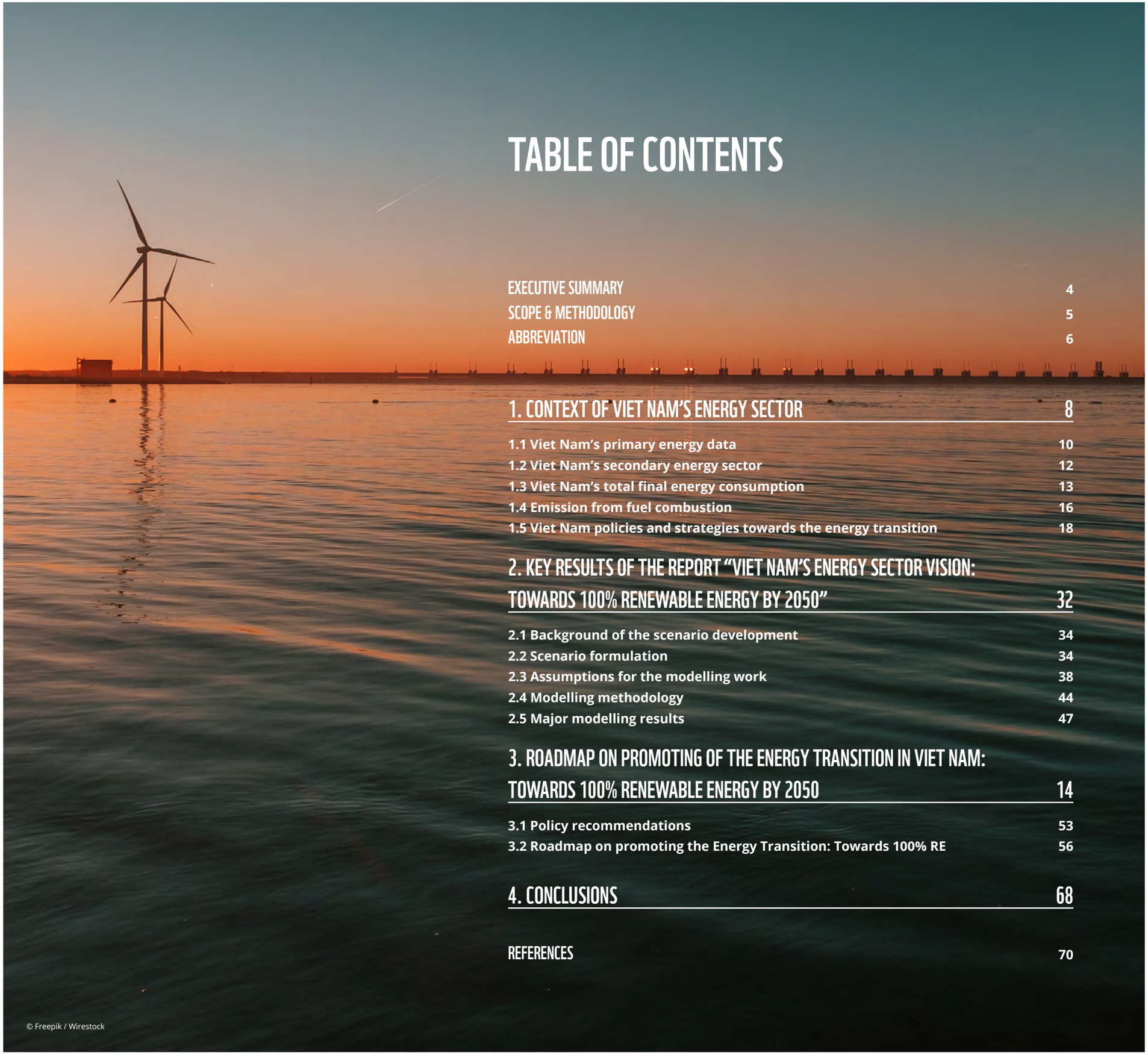
100%RE multi-actor partnerships



Roadmap on promoting the Energy Transition in Viet Nam:

TOWARDS 100% RENEWABLE ENERGY BY 2050

REPORT | SEPTEMBER 2023



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CONTRIBUTORS

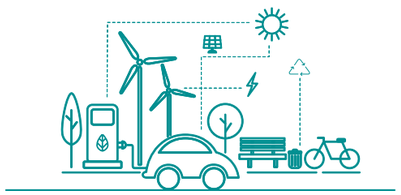
Editor in Chief & Technical Editor:
Assoc.Prof.PhD. Pham Hoang Luong

Editorial Team Primary Contributors:
Pham Thi Cam Nhung, Nguyen Thanh Trung, Pham Huong Mai, Nguyen Thai Binh, Nguyen Quoc Khanh, Nguyen Duc Tuyen, Kate Melville-Rea

The work would not have been possible without the tremendous help and engagement of Fentje Jacobsen, Corinne Kowalski, Sebastian Akermann, Anna Skowron, Lena Dente, Dr. Joachim Fünfgelt, Jaime Medina Fernandez.

PREFACE

The Multi-Actor Partnership for Implementing Nationally Determined Contributions (NDC) with 100% Renewable Energy for Everyone (100% RE MAP) has been implemented in 03 countries: Nepal, Viet Nam and Uganda, aiming to facilitate positive change and advance the transformation necessary to ensure economic and social development in line with the Paris Agreement's climate target of 1.5°C. In Viet Nam, the project has developed 02 important reports, including:



Report "Viet Nam's Energy Sector Vision: Towards 100% Renewable Energy by 2050", with 03 scenarios for the whole energy sector of Viet Nam: *BAU Scenario, 80% RE Scenario (80RE), and 100% RE Scenario (100RE)* by 2050. The report is based on the current power generation mix and energy plans and master plan of the Government, in order to build a feasible energy transition roadmap.

Report "Roadmap on promoting the Energy Transition in Viet Nam: Towards 100% Renewable Energy by 2050", includes an overview over existing policy frameworks, and identifies barriers and opportunities to accelerate RE deployment.

The report **"Viet Nam's Energy Sector Vision: Towards 100% Renewable Energy by 2050"** was developed and launched to all relevant stakeholders in March 2023 through diverse channels (workshops, trainings, website, etc). To promote and advocate for the key results of the Report, build a feasible energy transition roadmap towards 100% renewable energy by 2050, and contribute to NDC and Net-zero targets, the Project also developed a **Roadmap on promoting the Energy Transition in Viet Nam: Towards 100% Renewable Energy by 2050** based on results of the Scenarios Report.

These two reports have been developed in consultation with the technical working group, experts working in the energy sector, and other relevant stakeholders (representatives from Government, civil society, development partners, academia, private sector, etc.) in the Multi-Actor Partnership (MAP) Platform, to gather a wide range of perspectives and insights, ensuring these reports are well-informed and align with national policies and orientations in climate and energy-related works, as well as develop a pathway towards 100% RE future in Viet Nam.

SCOPE AND METHODOLOGY

The Roadmap to be developed would have five (05) steps as listed below:

Step 1	• Identification of the baseline policy issues/problems which are related to energy efficiency, renewable energy, and green growth development in Viet Nam;
Step 2	• Development of policy interventions and documents for the implementation of the technical 100% RE scenario by 2050 in Viet Nam;
Step 3	• Endorsement of official government on the policy interventions developed;
Step 4	• Implementation of the policy interventions endorsed;
Step 5	• Evaluation of the policy intervention impact.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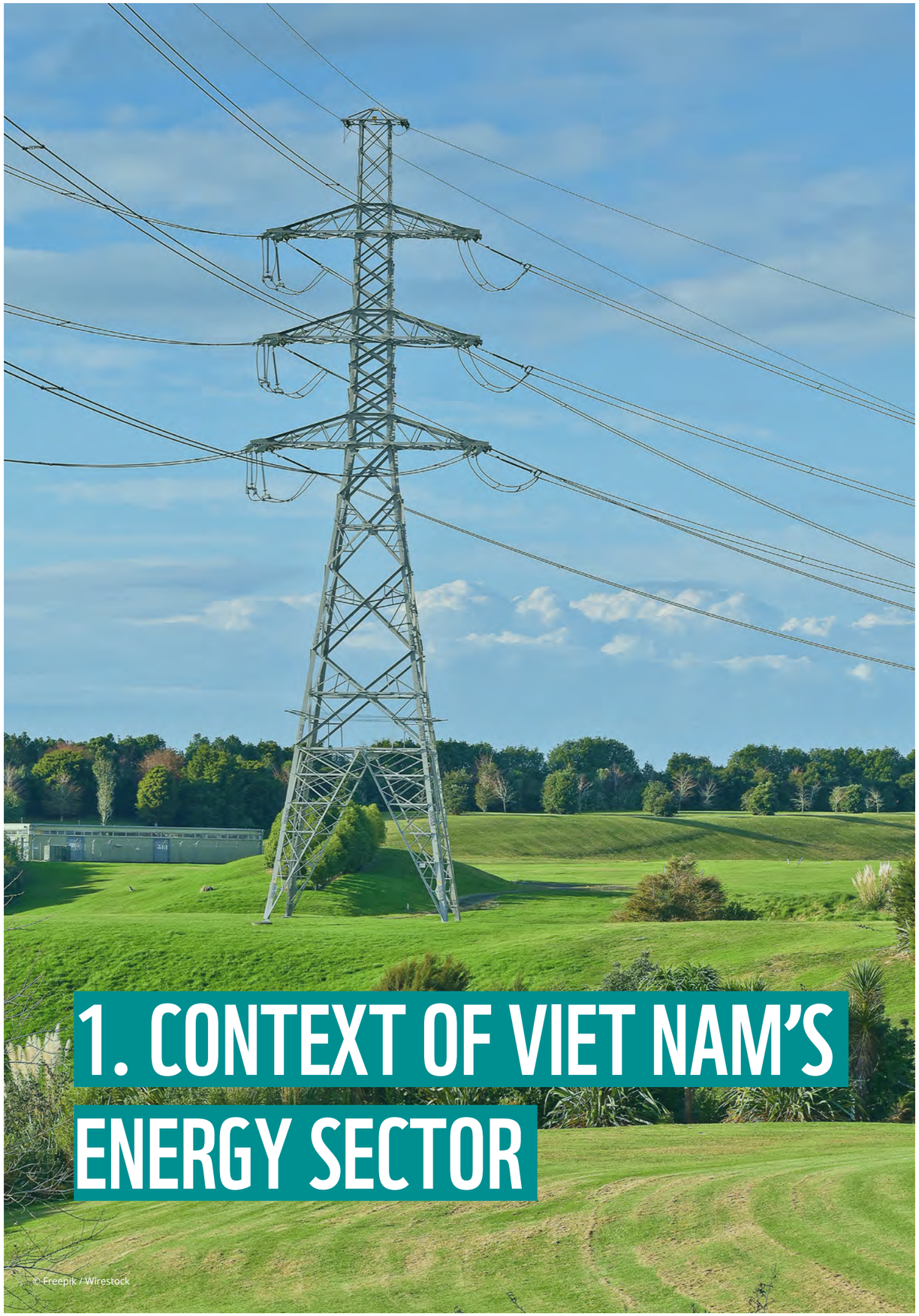
Within the scope of this report, the Project has considered and implemented the first two steps as mentioned above in close collaboration with relevant stakeholders.

ABBREVIATION

100% RE MAP	Project "Multi-Actor Partnership (MAP) for Implementing Nationally Determined Contributions with 100% Renewable Energy for everyone"
80RE Scenario	80% Renewable Energy Scenario
100RE Scenario	100% Renewable Energy Scenario
BAU Scenario	Business-as-usual Scenario
BESS	Battery Energy Storage System
BfdW	Brot für die Welt
BMZ	German Federal Ministry for Economic Cooperation and Development
CO_{2eq}	Carbon dioxide equivalent
EE	Energy Efficiency
EMP	Draft Energy Master Plan
EV	Electric vehicle
GDP	Gross Domestic Products
GJ	Gigajoule
GHG	Greenhouse Gas
GW	Gigawatt
ICE	Internal Combustion Engine
JETP	Just Energy Transition Partnership
KTOE	Kilotonne of Oil Equivalent
LCOE	Levelized Cost of Energy
LPG	Liquefied petroleum gas
MMTOE	Million metric tonnes of oil equivalent
NDC	Nationally Determined Contribution
p.a.	Per Annum
PDP8	Draft Viet Nam Power Development Plan VIII
RE	Renewable Energy
TOE	Tonne of Oil Equivalent
TFEC	Total Final Energy Consumption
TPES	Total Primary Energy Supply
UNFCCC	United Nations Framework Convention on Climate Change
VBCSD	Vietnam Business Council for Sustainable Development
VNEEP	Viet Nam – National Energy Efficiency Programme
VRE	Variable Renewable Energy
WFC	World Future Council
WWF - Viet Nam	World Wide Fund for Nature in Viet Nam



1. CONTEXT OF VIET NAM'S ENERGY SECTOR

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For the period 2010-2020, Viet Nam's energy system has developed to meet the energy demand of its economy with an increase in GDP (compared to the baseline of 2010) at 1.98 times, from 104.6 billion USD in 2010 to 206.6 billion USD in 2020. Viet Nam's population increased from 87.1 million people in 2010 to 97.6 million people by 2020 with the urban population structure increasing from 30.4% to 36.8%. During this period, GDP per capita at real prices increased from 1,201 USD in 2010 to about 2,117 USD in 2020. This was the stage of Viet Nam's development after joining the middle-income countries group in 2009. Viet Nam's energy demand was therefore driven by a number of factors such as manufacturing, population growth and urbanization, mechanization of transport, living standards, and increased access to energy. Table 1 shows major energy and economic indicators for the period 2010-2020.

FACTORS IMPACTING ON VIET NAM'S ENERGY DEMAND

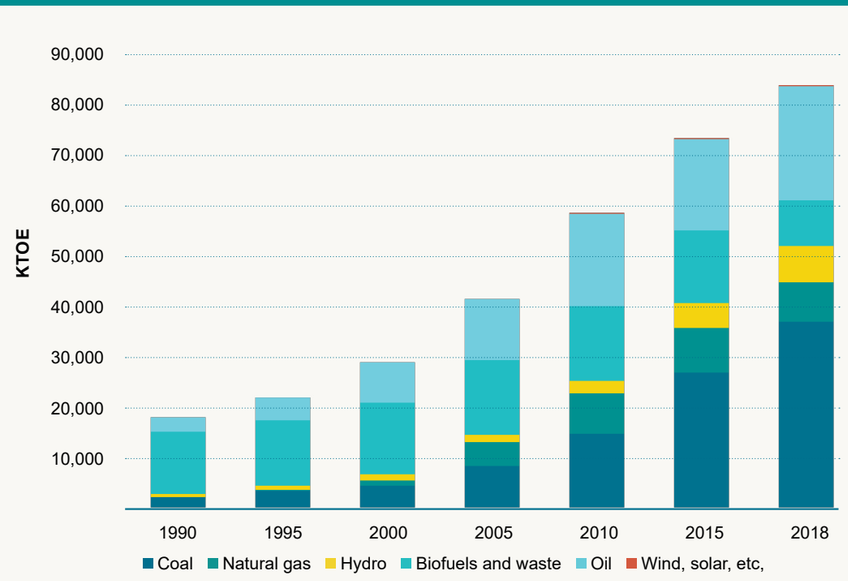
Table 1. Major energy economic indicators for the period 2010-2020 [1]

Indicator	Unit	2010	2015	2020	Increase 2020 vs 2010 (times)
GDP (2010 baseline)	Billion USD	104.60	115.92	206.61	1.98
Population	thousand	87,067	92,228	97,582	1.12
Urban population structure	%	30.39	33.48	36.82	1.21
GDP per capita	USD/capital	1,201.3	1,256.9	2,117.3	1.76
Total primary energy supply, TPES	thousand TOE	51,610	63,002	95,762	1.86
Total final energy consumption, TFEC	thousand TOE	39,831	47,561	66,014	1.66
TPEC/person	kgOE/person	457.5	515.7	676.5	1.48
TPEC/GDP	kgOE/1000USD	380,8	410,3	319,5	0,84
Electricity consumption/ person	kWh/person	972	1,548	2,229	2.29

1.1 VIET NAM'S PRIMARY ENERGY DATA

Some selected data on Viet Nam's Total Primary Energy Supply (TPES) for the period of 1990-2018, shown in Figure 1, have been used as a baseline in the development of "Viet Nam's Energy Sector Vision: Towards 100% Renewable Energy by 2050" report, with **03 scenarios** for Viet Nam's Energy Sector: Business-as-usual (BAU), 80% Renewable Energy (80RE), and 100% Renewable Energy (100RE) [2].

Figure 1. Viet Nam's Total Primary Energy Supply during 1990-2018



From Figure 1, it is seen that:

- The share of coal in TPES sharply increased (25% in 2010, 36% in 2015, and 44.0% in 2018). Such an increase in coal demand was mainly for electricity production;
- Supply of natural gas and oil in this period appeared quasi-stable. These two sources of fossil fuels accounted for 10% and 27% of TPES, respectively in 2018.

In 2020, Viet Nam's TPES was at 95,762 kilotonnes of oil equivalent (KTOE), an increase of 1.5% compared to 2019. This contrasts to a growth rate of 10.7% per annum (p.a) between 2016 and 2019. Thus, for the whole period of 2016-2020, the TPES growth rate was 8.7% p.a. on average. Coal had a relatively high growth rate, 17.1% p.a. over 2016 – 2020 which was followed by renewable energy (including biomass products and hydroelectricity) with an average growth rate of 0.8% p.a.. In terms of energy composition of TPES, coal share sharply increased from 35.9% in 2015 up to 52.0% in 2020. The COVID-19 pandemic caused a significant reduction in fuel demand, as well as a decrease in the share of oil and gas in the TPES to 24.4% and 8.2%, respectively.

In 2021, the TPES of Viet Nam was estimated to be 93.116 KTOE, a decreased of 5.3% compared to the previous year. This resulted in the annual TPES growth rate to reduce to 6.2% between 2016-2021 [1].

In 2021, TPES per capita was 947 kg oil equivalent (kgOE) which was lower than many other countries and regions (see Figure 2). However, the intensity of TPES per GDP was high, 281 kgOE/1000 USD, as seen in Figure 3.

Figure 2. TPES per capita (kgOE/person) for 2021 in some selected countries

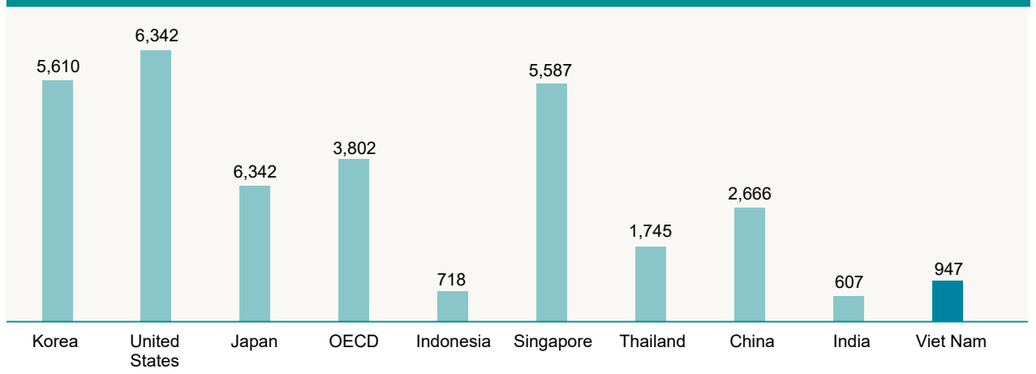
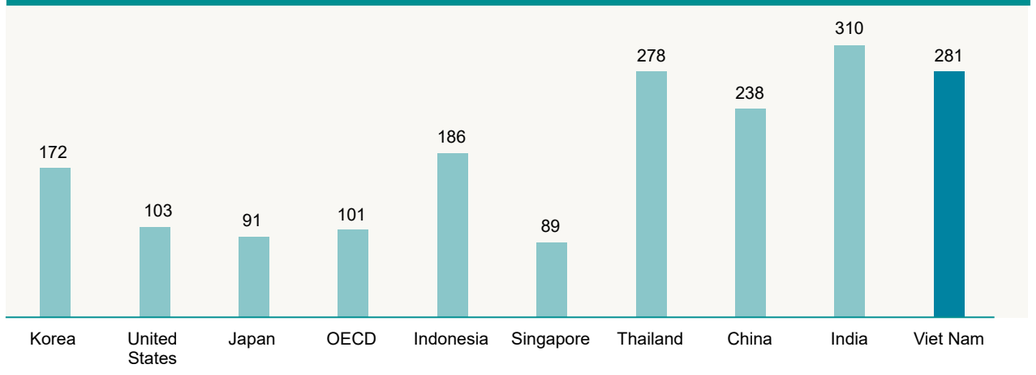


Figure 3. TPES per GDP (kgOE/1000 USD) for 2021 in some selected countries [4]

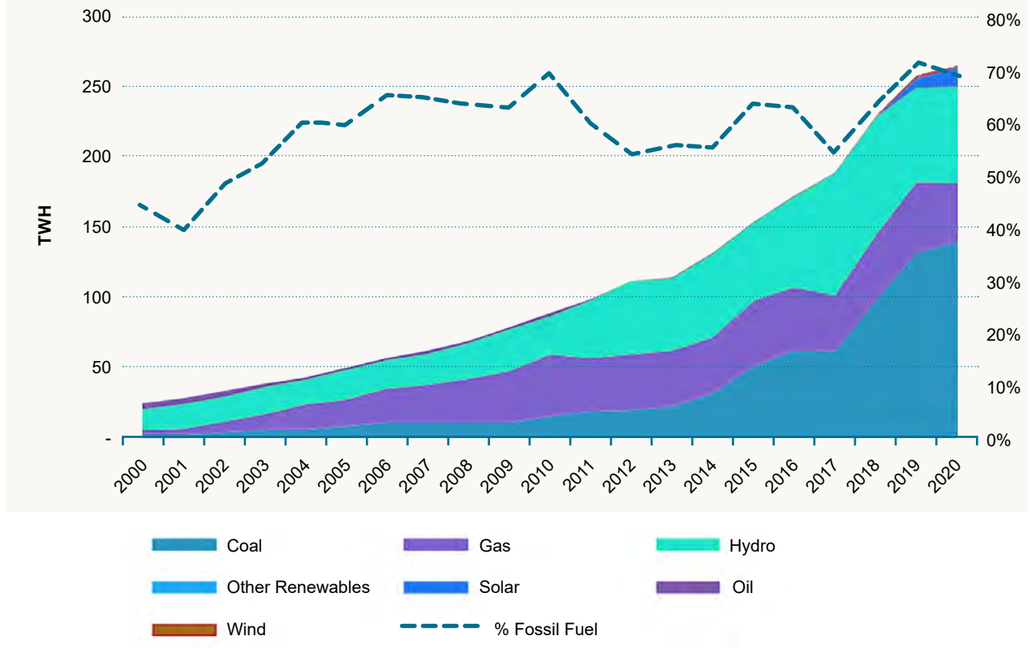


1.2
VIET NAM'S SECONDARY ENERGY SECTOR

Electricity and petroleum products from primary energy sources are considered as secondary energy of which electricity is the most significant. Figure 4 shows Viet Nam's power generation from both fossil fuels and renewable sources during 2000-2020 [2].

ELECTRICITY IS THE MOST SIGNIFICANT SECONDARY ENERGY

Figure 4 Viet Nam's Power Generation Mix during 2000-2020



From Figure 4, it is seen that:

- Power generation in Viet Nam was heavily dependent on fossil fuels, with coal playing the most significant role for the entire period of 2000-2020;
- From 2018 to 2020, there was a strong increase in electricity generation from renewable sources (mainly solar and wind). However, the share of renewable electricity in the nation's power generation mix still decreased (22.4% in 2015 down to 15.3% in 2020).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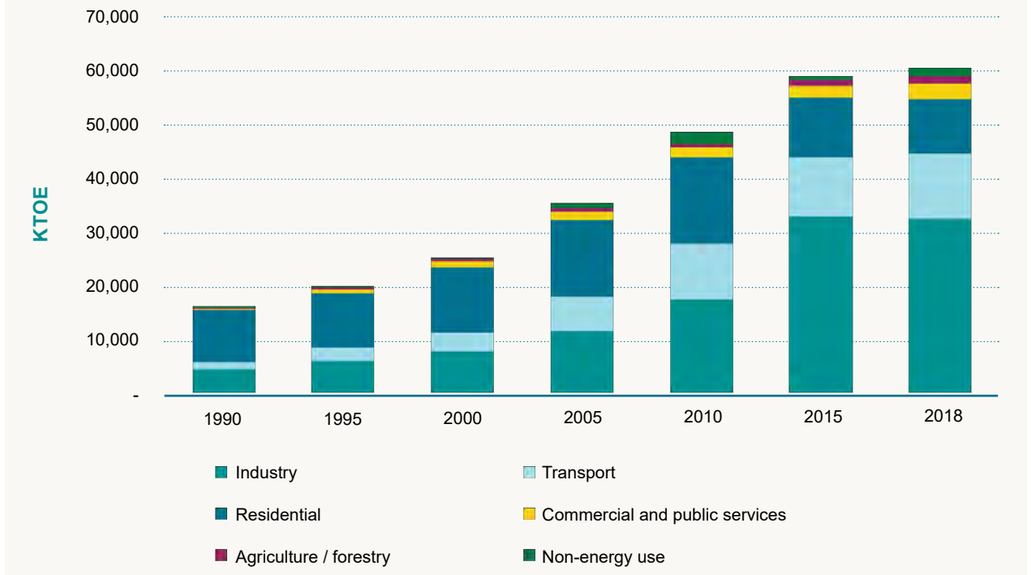
1.3
VIET NAM'S TOTAL FINAL ENERGY CONSUMPTION

TOTAL FINAL ENERGY CONSUMPTION

Transport sector	Industrial sector
20%	54%

Figure 5 shows the Total Final Energy Consumption (TFEC) for Viet Nam during 1990-2018. In 2018, the industrial sector consumed approximately 54% of the TFEC with a significant portion of this based on direct consumption of coal for heat provision in certain manufacturing processes such as steel and cement production. The transport sector used about 20% of the TFEC, becoming the next most heavily energy-consuming sector [2].

Figure 5. Viet Nam's Total Final Energy Consumption during 1990-2018



For the period of 2011-2019, the TFEC increased on average by 5,2%/p.a.

39.8 million TOE — 2011

For 2016-2020, the TFEC had a higher growth rate than that of 2011-2015 with an average annual growth of **6,8%/p.a.**

66.0 million TOE — 2020

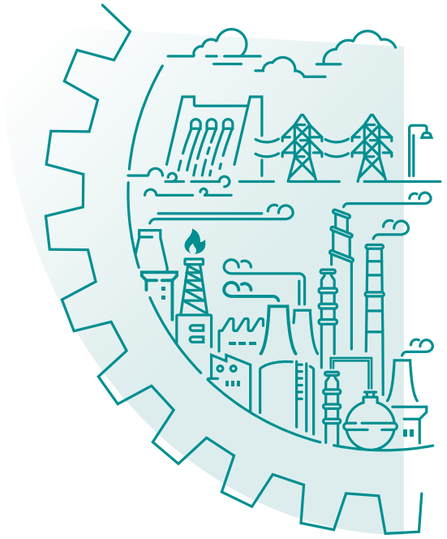
Among the fuels used,

coal had a very high growth rate in the period 2010-2020 with an average annual increase of **20,8%**

Electricity demand had an increase of **8,9%**/p.a.

Natural gas demand had an increase of **5,1%**/p.a.

In 2020, due to the impact of the Covid-19 pandemic, the demand for petroleum and gasoline decreased in comparison to 2019, resulting in an average rate of **3,2 %**/p.a. between 2011 and 2020 for those fuels.

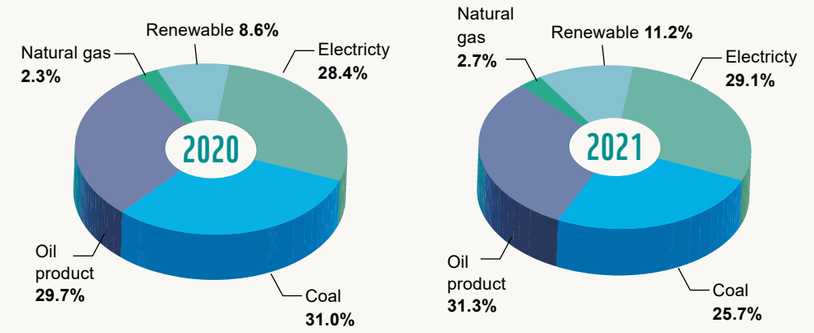


The share of coal in the TFEC increased sharply from 19% in 2010 to 31% by 2020. An increase in TFEC going towards electricity also increased, from 18.3% of the TFEC in 2010 to 28.4% in 2020. The share of petroleum and gasoline in the TFEC decreased during this period from 36.1% in 2010 down to 29.7% in 2020.

With reference to sector-wide energy consumption, industry used 47.5% and 53.1% of the TFEC in 2019 and 2020, respectively, reaching 35 million TOE for 2020. This is because, impacted by the Covid-19 pandemic, other economic sectors reduced their energy consumption. The most prominent drop was the transport sector, which decreased consumption share from 23.0% in 2019 to 18.9% in 2020. In 2020, the energy consumption in transport was about 12.4 million TOE which was equivalent to the baseline in 2016 [3].

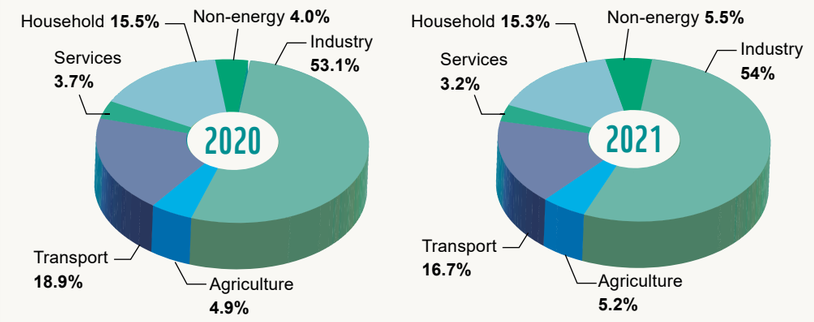
In 2021, the TFEC was estimated at 64.1 KTOE, slightly higher than the figure for 2020. Regarding the structure of energy consumption by fuel, Figure 6 shows that the share of coal decreased while the share of oil products increased [1].

Figure 6. Fuel-wide structure of TFEC for 2020 and 2021



Regarding the TFEC composition by sector, industry increased from 53.1% in 2020 to 54.9% in 2021 while the transport sector decreased from 18.9% in 2020 to 16.7% in 2021, as seen in Figure 7.

Figure 7. Sector-wide structure of TFEC for 2020 and 2021



1.4 EMISSIONS FROM FUEL COMBUSTION

In 2021, total emissions from fuel combustion were 252.4 million tonnes of CO_{2eq}, a decrease of 7.7% compared with 2020. In comparison with other countries and territories, Viet Nam's emissions per capita are quite low, whereas emissions over GDP remain high [1].

Figure 8. GHG emissions per capita in Viet Nam and selected countries for 2021

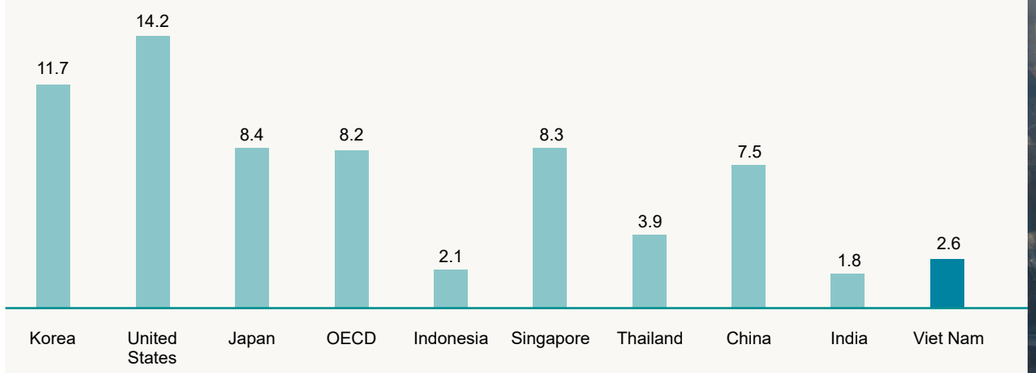
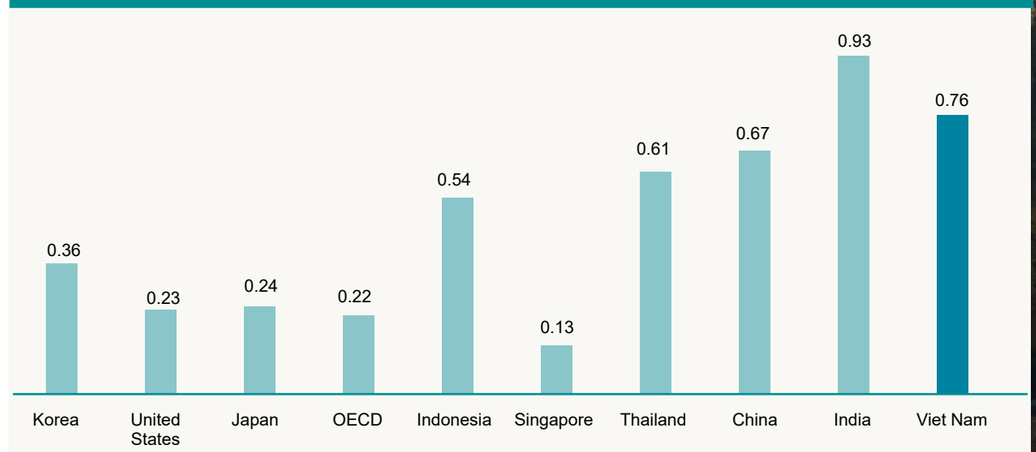


Figure 9. Emissions per 1000 USD GDP in Viet Nam and selected countries for 2021 (2015 USD value)



In conclusion, Viet Nam's energy development trends in 2016-2021 can be summarized as follows:

- The impact of the COVID-19 pandemic made TPES decrease and TFEC very slightly increase in 2021. Economic growth remained positive, leading to improvements in energy and emissions-to-GDP indexes;
- Although reducing in 2020, Viet Nam's dependence on imported energy remained high;
- Coal still played a key role in national energy supply and demand;
- The strong development of power generation from renewable energy resources such as wind and solar contributed to improving national energy security. However, the share of renewable electricity was still relatively modest;
- A massive shift from other forms of fuel to electricity improved the competitiveness and accessibility of electricity.

1.5 VIET NAM'S POLICIES AND STRATEGIES TOWARDS THE ENERGY TRANSITION

It is widely recognized that there are two main pillars for implementing Viet Nam's energy transition, namely:

(i)

Promoting energy efficiency (EE)

(ii)

Increasing the share of renewable energy in the nation's energy system

To understand current strategies, major legal documents related to Viet Nam's energy sector were summarized and are listed below.

1. **Viet Nam's Sustainable Development Goals for 2030**
2. **Viet Nam's Renewable Energy Development Strategy to 2030 with a Vision to 2050**
3. **Viet Nam - National Energy Efficiency Programme for the period of 2019-2030 (VNEEP3)**
4. **The orientation of Viet Nam's National Energy Development Strategy to 2030, with a vision to 2045**
5. **Viet Nam's National Green Growth Strategy for 2021-2030, vision towards 2050**
6. **Viet Nam National Climate Change Strategy towards 2050**
7. **Draft Viet Nam Power Development Plan for 2021-2030, with a vision to 2050**
8. **Draft Viet Nam Energy Master Plan for 2021-2030, with a vision to 2050**
9. **Just Energy Transition Partnership (JETP)**
10. **10 Strategic orientation for GHG emission reduction in the transport**

1.5.1

VIET NAM'S SUSTAINABLE DEVELOPMENT GOALS FOR 2030

The Sustainable Development Goals (SDGs) were established in 2015 by the United Nations General Assembly and offer 17 'global' goals for achieving a more sustainable future. Adapting to the local context, in 2015 Viet Nam has nationalized the 17 global SDG goals into 115 Viet Nam SDG (VSDGs) targets, of which targets for renewable energy and energy efficiency are as follow [4]:

For RE

To substantial-ly increase the share of RE in the total national consumption of primary energies, more specifically to reach 31% by 2020 and 32.3% by 2030 (Target 7.2);

For EE

To double the national rate of improvement in energy use efficiency by 2030: reduce the rate of power utilization by 10% compared to the baseline scenario (Target 7.3).

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1.5.2

VIET NAM'S RENEWABLE ENERGY DEVELOPMENT STRATEGY TO 2030 WITH A VISION TO 2050

This strategy has been approved in 2015, consisting of various targets for promoting RE in Viet Nam over 2020, 2030, and 2050 snapshots, in particular [5]:

Share of RE in total primary energy consumption to reach 31% by 2020, 32.3% by 2030, and 44% by 2050;

Share of RE in electricity generation from 38% in 2020, to 32% by 2030, and 43% in 2050;

Deployment of solar-water heating devices to households to reach 12% in 2020, 26% in 2030, and 50% by 2050;

Other targets for Biomass, Biogas, and Renewable fuel consumption include targets of 5% renewable fuels in the transport sector by 2020, 15% by 2030, and 25% by 2050;

Increase of domestically manufactured RE equipment from 30% in 2020 to 60% in 2030, and to 100% by 2050.

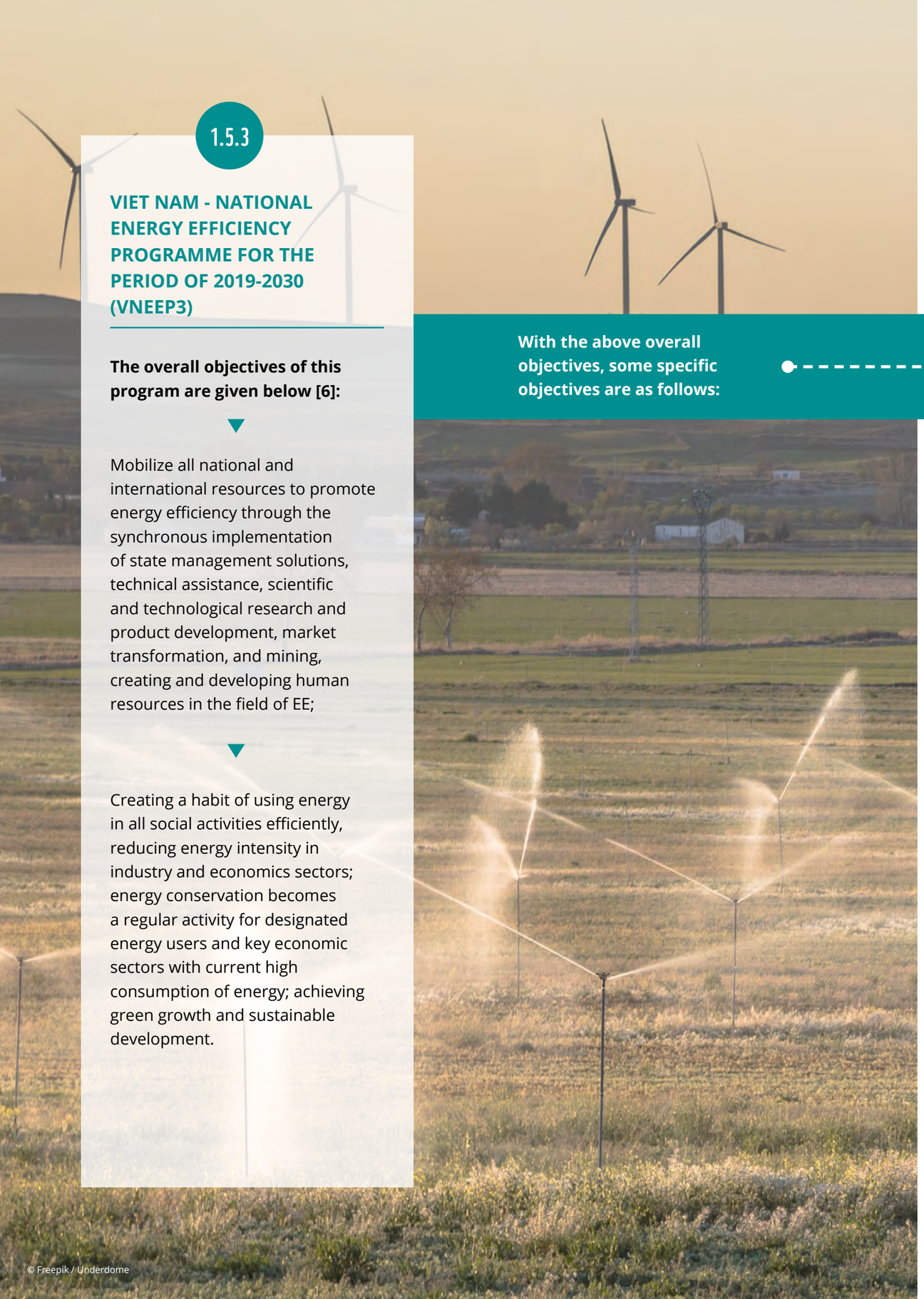
1.5.3

VIET NAM - NATIONAL ENERGY EFFICIENCY PROGRAMME FOR THE PERIOD OF 2019-2030 (VNEEP3)

The overall objectives of this program are given below [6]:

Mobilize all national and international resources to promote energy efficiency through the synchronous implementation of state management solutions, technical assistance, scientific and technological research and product development, market transformation, and mining, creating and developing human resources in the field of EE;

Creating a habit of using energy in all social activities efficiently, reducing energy intensity in industry and economics sectors; energy conservation becomes a regular activity for designated energy users and key economic sectors with current high consumption of energy; achieving green growth and sustainable development.



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With the above overall objectives, some specific objectives are as follows:

2019 - 2025

Saving 5 - 7% of total national energy consumption

Reduce power loss to below 6.5%;

Reduce average energy consumption in industries compared to the period of 2015-2018, in particular:
- Steel: 3 - 10%;
- Chemical: greater than 7%;
- Plastic: 18 - 22.5%;
- Cement: greater than 7.5%;
- Textile and garment: greater than 5%;
- Alcohol and beverage: 3 - 6.9%;
- Paper: 8 - 15.8%.

2025 - 2030

Saving 8 - 10 % of total national energy consumption

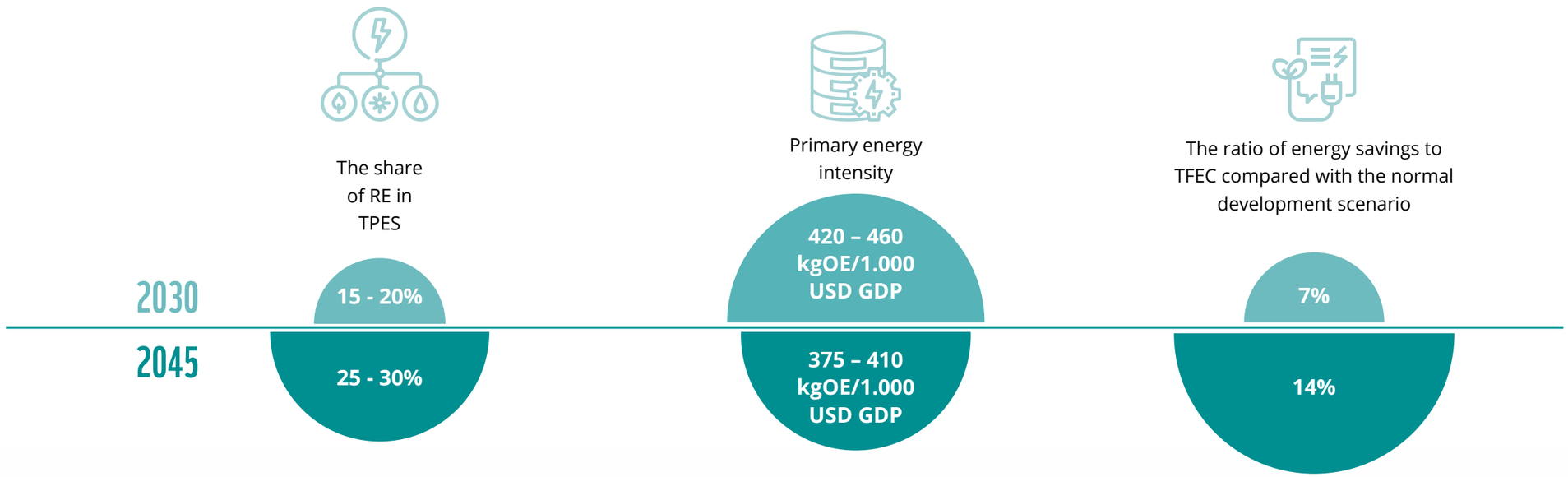
Reduce power loss to below 6,0%;

Reduce average energy consumption in industries compared to the period of 2015-2018, in particular:
- Steel: 5 - 16.5%;
- Chemical: greater than 10%;
- Plastic: 21.55 - 24.81%;
- Cement: greater than 10.89%;
- Textile and garment: greater than 6.8%;
- Alcohol and beverage: 4.6 - 8.44%;
- Paper: 9.9 - 18.48%.

1.5.4

THE ORIENTATION OF VIET NAM'S NATIONAL ENERGY DEVELOPMENT STRATEGY TO 2030, WITH A VISION TO 2045 (POLITBURO'S RESOLUTION 55-NQ/TW DATED 11TH FEBRUARY 2020)

Under this strategy orientation, the targets for RE and EE set forth as follow [7]:



By 2030

- Primary energy consumption per GDP in the period of 2021 – 2030 will be reduced from 1.0% to 1.5% annually;
- The share of RE in TPES reaches 15 – 20%;

By 2050

- Primary energy consumption per GDP in each 10-year period will be reduced from 1.0% annually;
- The share of RE in TPES reaches 25 – 30%.

1.5.5

VIET NAM'S NATIONAL GREEN GROWTH STRATEGY FOR 2021-2030, VISION TOWARDS 2050 (PRIME MINISTER'S DECISION 1658/QD-TTG DATED 1ST OCTOBER 2021)

Within this strategy, major targets are as follows [8]:

1.5.6

VIET NAM NATIONAL CLIMATE CHANGE STRATEGY TOWARDS 2050 (PRIME MINISTER'S DECISION 896/QD-TTG 2022 DATED 26TH JULY 2022)

This strategy has some objectives as listed [9]:

The greenhouse gas (GHG) emission reduction target of the energy sector are a 32.6% reduction compared to the Business as Usual (BAU) scenario, with total GHG emission not exceeding 457 million tCO_{2eq} by 2030, and 91.6% and 101 million tCO_{2eq} limit by 2050;

To meet the target, it is necessary to propose solutions adopting energy efficiency and clean energy technologies. In the power sector, proposed solutions include: developing small hydro power plants; expanding current large hydro power plants; increasing renewable energy power plants such as wind, concentrated solar, biomass, green hydrogen, green ammonia, wave energy, and tidal energy;

The share of electricity production from RE will be at least 33% in 2030, and 55% in 2050.

1.5.7

DRAFT VIET NAM POWER DEVELOPMENT PLAN FOR 2021-2030, WITH A VISION TO 2050 (NOVEMBER 2022 VERSION)

The Power Development Plan for 2021 – 2030, with a vision to 2050 (PDP8) aims to build an overall plan for the power sector in Viet Nam covering power sources and the transmission grid. The main results of PDP8 (November 2022 version) are presented in Table 1 [3].

Table 1. Main results of the Draft PDP8

	Baseline scenario	High scenario	High administration scenario
Total installed capacity (MW)	121,757 MW (2030) 368,461 MW (2050)	134.594 MW (2030) 498.108 MW (2050)	145.989 MW (2030) 501.608 MW (2050)
Renewable energy share in total electricity generation, (%)	11.6% (2030) 48.2% (2050)	20.7% (2030) 59.1% (2050)	27% (2030) 58.9% (2050)

1.5.8

DRAFT VIET NAM ENERGY MASTER PLAN FOR 2021-2030, WITH A VISION TO 2050 (DECEMBER 2022 VERSION)

The Energy Master Plan for 2021 -2030, with a vision to 2050 (EMP) aims to build an overall plan for the energy sector in Viet Nam covering oil, gas, coal, power, and renewable energy. The main results of the EMP are presented in Table 2 [10].

Table 2. Main results of the draft EMP

	Baseline scenario	High scenario
Total final energy consumption (MTOE)	103 MTOE (2030)	110 MTOE (2030)
	144 MTOE (2050)	177 MTOE (2050)
Total primary energy supply (MTOE)	160 MTOE (2030)	296 MTOE (2030)
	275 MTOE (2050)	315 MTOE (2050)
RE share in TPES (%)	17.4% (2030)	18.9% (2030)
	78.8% (2050)	79.1% (2050)

1.5.9

JUST ENERGY TRANSITION PARTNERSHIP (JETP)

The establishment of the Just Energy Transition Partnership (JETP) was announced on 14 December 2022. JETP is an agreement between Viet Nam and the International Partners Group (IPG) consisting of the European Union, USA, Italy, Canada, Japan, Norway, and Denmark. JETP will mobilize $15.5 billion of public and private finance over the next three to five years. The amount is made up of 7.75 billion USD in pledges, from the IPG in addition to the Asian Development Bank and the International Finance Corporation, and a commitment to facilitate a further 7.75 billion USD in investment from private financial institutions coordinated by the Glasgow Financial Alliance for Net Zero (GFANZ) which includes an initial set of 11 major financial institutions.

The JETP targets published on the European Commission's site are [11]:

- Bring forward the peaking date of GHG emissions in Viet Nam by five years from 2035 to 2030;
- Reduce peak annual power sector GHG emissions by up to 30 percent (from 240 megatons CO_{2eq} to 170 megatons CO_{2eq}) and bring forward the peaking date of GHG emissions in Viet Nam by five years from 2035 to 2030;
- Limit Viet Nam's peak coal capacity to 30.2 GW (down from a current planning figure of 37 GW;
- Accelerate the adoption of renewables so that it accounts for a minimum of 47% electricity generation by 2030 (up from the current planned generation share of 36%).

1.5.10

STRATEGIC ORIENTATION FOR GHG EMISSION REDUCTION IN THE TRANSPORT SECTOR (THE PRIME MINISTER'S DECISION NO. 876/QD-TTG DATED 22 JULY 2022)

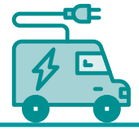
The overall objective for this strategic orientation is to develop a green transportation system towards net-zero GHG emissions by 2050. For this, two specific objectives are identified [12]:

By 2030

i. Promote energy efficiency in the transport sector;

ii. Speed up the transition to electric and green energy transportation within sub-sectors where technologically and institutionally feasible.

By 2050



i. Reasonably develop modes of transport;

ii. Strongly implement the transition of all means of transport, equipment and transport infrastructures with the use of electricity and green energy.

The roadmap on promoting green energy transition for the transportation sector in Viet Nam for 2022 – 2050 are formulated for roadways, railways, inland waterways, maritime shipping, aviation and urban traffic.

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In conclusion, policies and strategies in the development of energy sector in Viet Nam, which have been drafted and approved over the past 20 years, demonstrate strong efforts and commitments of the Government on promoting an energy transition pathway in line with the global trend, ensuring national energy security and exercising Viet Nam's climate change responsibility.

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2. KEY RESULTS OF THE REPORT "VIET NAM'S ENERGY SECTOR VISION: TOWARDS 100% RENEWABLE ENERGY BY 2050"

2.1 BACKGROUND OF THE SCENARIO DEVELOPMENT

CO_2 emissions from fossil fuel use are the main contributor to total GHG emissions and the global energy system accounts for approximately three-fifths of all anthropogenic GHG emissions. In order to achieve the Paris Agreement objectives, emissions need to reach net zero by no later than 2050. Therefore, complete decarbonization and a shift to 100% Renewable Energy (RE) sources across all sectors are needed.

Viet Nam's rapid economic growth is closely linked to the expansion of the energy sector, which has relied mostly on fossil fuel consumption that has severe environmental implications. To deal with such challenges, the government of Viet Nam has recently had a strong policy movement in promoting RE and EE.

Against this backdrop in Viet Nam, the project **Multi-Actor Partnership for Implementing Nationally Determined Contributions with 100% Renewable Energy for Everyone (100% RE MAP)**, under the financial support of the German Federal Ministry for Economic Cooperation and Development (BMZ), developed the report **"Viet Nam's Energy Sector Vision: Towards 100% Renewable Energy by 2050"**, with 03 scenarios for the whole energy sector of Viet Nam: **BAU Scenario, 80% RE Scenario (80RE), and 100% RE Scenario (100RE)** by 2050. The scenarios are based on the current power generation mix and energy plans and master plan of the Government. The aim of the report is that it equips decision-makers with science-based evidence and a roadmap to support a sustainable development pathway and 100% RE future.

2.2 SCENARIOS FORMULATION

Three (03) scenarios were developed which are listed below:

1

Business-As-Usual Scenario (BAU): taking the draft PDP8 (November 2022 version) and Resolution 55 into consideration. The BAU has been updated to reflect the higher level of renewable electricity resources.

2

80% Renewable Energy Scenario (80RE): supplied through the utilization of renewable energy by the year 2050. This scenario is to consider increased e-mobility and heating processes (e.g., electrification of residential, commercial, and industrial processes) and hydrogen production using surplus renewable electricity.

3

100% Renewable Energy Scenario (100RE): An advanced scenario is characterized by the ambition to achieve 100% RE by 2050 for electricity and the entire energy supply. This scenario has a clear focus on electrification, and increasing the production of hydrogen from surplus RE.

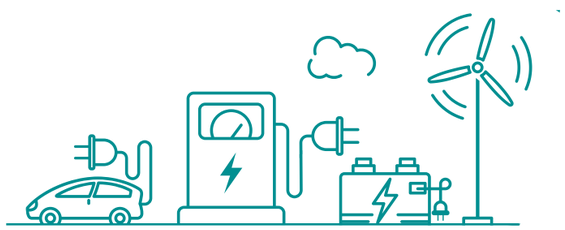
The modelling work considered five (05) main sectors which are, in order of decreasing energy consumption:

i) Industrial sector;
ii) Transport sector;
iii) Household sector;
iv) Commercial sector;
v) Agricultural sector;
vi) The power sector that supplies electricity to these five sectors.

A brief description and major features of each of the three selected scenarios are presented in Table 3.

Table 3. General description of the main features of each scenario

Aspect	Business as Usual	80% RE by 2050	100% RE by 2050
Description	Continuation of consumption in line with the preferred EMP scenario, Scenario A1.	Accelerated adoption of renewable energy options to reach 80% renewable energy by 2050 and allows for 20% of economy still based on fossil fuels. Economy growth per projections in EMP Scenario A1.	Higher acceleration of adoption of renewable energy options to reach 100% renewable energy (including conversion to renewable fuels) by 2050. Economy growth per projections in EMP Scenario A1.
Industry	Continuation of current trends in energy usage and sources. Includes achievement of VNEEP targets incorporated in EMP Scenario A1.	Accelerated adoption of electrification for heat. Higher share of renewable energy generation in the power system. Renewable fuels used for heat energy that is not electrified.	Higher acceleration of adoption of electrification for heat. Higher share of renewable energy generation in the power system. Renewable fuels used for heat energy that is not electrified.
Transport	Modest EV penetration.	Very high conversion to EVs or renewable fuels by 2050. EVs are powered by an increasing RE share in the power system. Fossil fuels remain in the sector.	100% conversion to renewables through EVs or renewable fuels by 2050. EVs are powered by an increasing RE share in the power system.
Household	Continuation of current trends in energy usage and sources in line with EMP Scenario A1.	Accelerated adoption of solar heating, electrification for heating, efficient electrified cooking and efficient lighting. Phasing out of LPG and biomass in cooking. Higher share of renewable energy generation in the power system.	Higher acceleration of adoption of solar heating, electrification for heating, efficient electrified cooking and efficient lighting. Phasing out of LPG and biomass in cooking. Higher share of renewable energy generation in the power system.
Commercial	Continuation of current trends in energy usage and sources in line with EMP Scenario A1.	Accelerated adoption of solar heating, electrification for heating and efficient lighting. Higher share of renewable energy generation in the power system.	Higher acceleration of adoption of solar heating, electrification for heating and efficient lighting. Higher share of renewable energy generation in the power system.
Agriculture, Forestry and Fishery	Continuation of current trends in energy usage and sources in line with EMP Scenario A1.	Accelerated adoption of renewable fuels. Higher share of renewable energy generation in the power system.	Higher acceleration of adoption of renewable fuels. Higher share of renewable energy generation in the power system.
Power sector	No new entrant coal from 2037. RE generation share in line with PDP8 base case outlook.	80% RE generation share by 2050. No new entrant coal from 2030. Additional transmission allowed to be built above the BAU transmission plan.	100% RE generation share by 2050. No new entrant coal or gas from 2026. Additional transmission allowed to be built above the BAU transmission plan.



2.3 ASSUMPTIONS FOR THE MODELLING WORK

The assumptions used for this consultancy work were based upon:

- ***Macroeconomic/socioeconomic outlooks (population, GDP, transport outlooks);***
- ***Technology cost assumptions (for building different technologies/infrastructure);***
- ***Energy efficiency (leveraging existing work);***
- ***Government-formulated scenarios/projections of the energy sector;***
- ***The government-determined policies/targets;***
- ***Formulation of baselines that are projected forward (using historical data or benchmarks).***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2.3.1. Key documents

Below are the main documents based upon which the modelling work was conducted.

- Viet Nam's Sustainable Development Goals to 2030;
- Viet Nam's Renewable Energy Development Strategy to 2030, with a vision to 2050;
- Viet Nam Nationally Determined Contribution (updated October 2022);
- Draft of Viet Nam Energy Master Plan (EMP) for the period 2021-2030 with a vision to 2050 (November 2022 version);
- Mekong Delta Master Plan for 2021-2030, with a vision to 2050;
- Viet Nam Technology Catalogue 2021;
- Viet Nam Energy Outlook Report 2019 and 2021;
- Draft of Viet Nam Power Development Plan for 2021-2030, with a vision to 2050 (November 2022 version).

2.3.2. Demand assumptions

The projected baseline electricity demand under the BAU Scenario was based on the EMP/PDP8 projection and grows from 240 TWh in 2020 to 922 TWh by 2050. This projection assumes continued growth in electricity demand driven by the growing economy, namely as a result of foreign direct investments in manufacturing and industrial sectors. The electricity demand assumptions in 80RE and 100RE Scenarios included additional demand from electrifying other economy-wide energy requirements in the BAU Scenario. This additional electrified energy consumption was apportioned across the North, Central, and South regions in accordance with the baseline electricity demand split over time. The added electricity demand was weighted towards the North and South regions, 45% and 44% respectively, in line with economic activity. Using these assumptions, projected demand in the 80RE and 100RE scenarios was calculated to increase from 240 TWh to 2092 TWh by 2050.

2.3.3. Fuel prices

The fuel price projection used in this work was based on the power sector modelling assumptions of the PDP8 (late 2021 version). A key feature of the projection was that fuel prices were assumed to increase over the projection horizon. The cost of renewable fuel, used as an alternative to electrification in the 80RE and 100RE Scenarios was assumed to be $26.4/GJ across the 2020-2050 horizon.

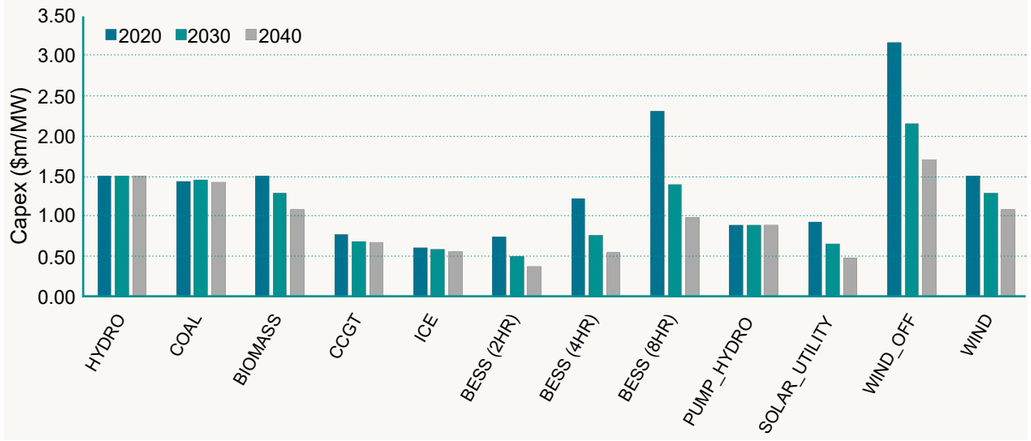
2.3.4. Sector-wide specific assumptions

2.3.4.1. The power sector

New entrant costs

Figure 10 plots the assumed new entrant costs for various new entrant options which were already used in the PDP8. The capital cost projection shows a significant decline in cost across renewable energy generation types and battery energy storage.

Figure 10. New entrant cost assumptions



Power generation from renewable energy resources

Utility-scale solar and wind (onshore) capacity developed in the BAU Scenario was consistent with the PDP8 Baseline scenario (November 2022 version). For high RE scenarios, additional renewable capacity was made available for development to meet the higher RE generation targets. In addition to utility-scale solar and onshore wind, biomass was assumed to run at a flat 65% capacity factor, offshore wind potential was based on the PDP8 resource quantities but with an assumed 45% capacity factor and only made available in the South-Central zone. Finally, rooftop PV was assumed to have 15% lower utilization than utility-scale solar.

Electricity Imports

Viet Nam currently has electricity imports from China (about 700 MW) and Laos (7.4 GW of hydroelectricity and 5 GW of wind and solar power). Additional expansions on imports were based on PDP8 which allows for up to 11 GW of total foreign electricity imports. Assumptions on imports were kept the same across all three scenarios.

2.3.4.2. The industry sector

Two (02) strategies were considered and proposed: i) Electrification and ii) Fuel switching to renewable fuels. The electrification of heat, where the electricity is supplied by renewable sources, increases RE share while switching to renewable fuel will convert the remaining portion of the heat that is not practical to electrify. To project the cost associated with converting process heat to renewable fuel, the study used the Levelized Cost of Heat (LCOH) for selected technologies earlier reported by the Australian Renewable Energy Agency (ARENA) in a study on Renewable Energy Options for Industrial Process Heat (2019). This value was based on biomass cost.

2.3.4.3. The transport sector

Table 4 presents the assumed percentage sales of road vehicles by type of fuel used for selected years of the 100 RE Scenario. Table 5 displays the assumed replacement rates for electricity or renewable fuel in non-road transport for the 100 RE Scenario.

Table 4. Road vehicle sales for the period of 2025-2050 (100RE Scenario)

100RE		2018	2025	2030	2040	2050
2 Wheelers	Electric	18.5%	5.0%	30.0%	80.0%	80.0%
Passenger Vehicles	Electric	0.5%	5.0%	30.0%	80.0%	80.0%
Light Comrnercial	Electric	0.5%	5.0%	30.0%	80.0%	80.0%
Heavy Comrnercial	Electric	0.5%	5.0%	30.0%	80.0%	80.0%
Buses	Electric	0.5%	5.0%	30.0%	80.0%	80.0%
2 Wheelers	Renewable fuel	0.0%	0.0%	10.0%	20.0%	20.0%
Passenger Vehicles	Renewable fuel	1.0%	1.0%	10.0%	20.0%	20.0%
Light Comrnercial	Renewable fuel	1.0%	1.0%	10.0%	20.0%	20.0%
Heavy Comrnercial	Renewable fuel	2.0%	2.0%	10.0%	20.0%	20.0%
Buses	Renewable fuel	2.0%	2.0%	10.0%	20.0%	20.0%
2 Wheelers	Gasonline	81.5%	95.0%	60.0%	0.0%	0.0%
Passenger Vehicles	Gasonline	98.5%	94.0%	60.0%	0.0%	0.0%
Light Comrnercial	Gasonline	49.3%	47.0%	30.0%	0.0%	0.0%
Heavy Comrnercial	Gasonline	0.0%	0.0%	0.0%	0.0%	0.0%
Buses	Gasonline	0.0%	0.0%	0.0%	0.0%	0.0%
2 Wheelers	Diesel	0.0%	0.0%	0.0%	0.0%	0.0%
Passenger Vehicles	Diesel	0.0%	0.0%	0.0%	0.0%	0.0%
Light Comrnercial	Diesel	49.3%	47.0%	30.0%	0.0%	0.0%
Heavy Comrnercial	Diesel	97.5%	93.0%	60.0%	0.0%	0.0%
Buses	Diesel	97.5%	93.0%	60.0%	0.0%	0.0%

Table 5. Replacement rates of non-road transport into electricity and renewable fuels (100RE Scenario)

Passenger transport replacement rates		100RE				
		2018	2025	2030	2040	2050
Rail	Electrification	0%	0%	0%	20%	50%
Inland waterways	Electrification	0%	0%	0%	20%	50%
Aviation transport	Electrification	0%	0%	0%	0%	0%
Rail	Convert to Renewable fuel	0%	0%	5%	30%	50%
Inland waterways	Convert to Renewable fuel	0%	0%	5%	20%	50%
Aviation transport	Convert to Renewable fuel	0%	0%	5%	50%	100%

Freight transport replacement rates		100RE				
		2018	2025	2030	2040	2050
Rail	Electrification	0%	0%	0%	20%	50%
Road	Electrification	0%	0%	0%	20%	50%
Inland waterways	Electrification	0%	0%	0%	20%	50%
Maritime transport	Electrification	0%	0%	0%	0%	0%
Aviation transport	Electrification	0%	0%	0%	0%	0%
Rail	Convert to Renewable fuel	0%	0%	5%	30%	50%
Road	Convert to Renewable fuel	0%	0%	5%	30%	50%
Inland waterways	Convert to Renewable fuel	0%	0%	5%	20%	50%
Maritime transport	Convert to Renewable fuel	0%	0%	5%	50%	100%
Aviation transport	Convert to Renewable fuel	0%	0%	5%	50%	100%

2.3.5. Energy efficiency

For the BAU Scenario, EE savings were the same as those incorporated in the EMP. For 80RE and 100RE Scenarios, further EE savings were assumed as given in Table 6.

Table 6. Energy Efficiency Assumptions

No.	Sector	EE Assumptions
1	Industrial	Assumes an additional 7% energy efficiency in the 80RE and 9% in100RE scenario over and above that assumed in the BAU by 2050
2	Transport	Electrified transport is more energy efficient than fossil fuel transport. No other energy efficiency measure are included in the modelling.
3	Household	Cooking: High Efficiency Electric Stove (90% EE) and Improved Biomass Stoves (30% EE) used in place of standard electric stove (60% EE) and conventional biomass stove (15% EE) Water heating: Solar water heaters with 85% EE
4	Commercial	50% improvement in EE of the lighting component of demand due to use of better lighting.

2.3.6. Externalities

Externalities analyzed in the modelling work included SO_2, NO_x, PM2.5, and CO_2 emissions associated with energy use across the economy to quantify the broader economic costs. Specific unit costs of the emission types were based on the assumptions used in the draft PDP8 and draft EMP, as given in Tables 7 and 8 respectively. A carbon cost of $40/tCO2 was used, based on World Bank Group data.

Table 7. Emission costs (US$/tonne)

Sector	CO_2	SO_2	NO_x	PM2.5
Industry and construction	40	2,000	5,000	6,000
Agriculture, forestry and fishing	40	3,000	6,000	17,000
Transportation	40	3,000	6,000	17,000
Commercial and other services	40	6,000	11,000	31,000
Households	40	6,000	11,000	31,000
Power	40	2,000	4,000	5,000

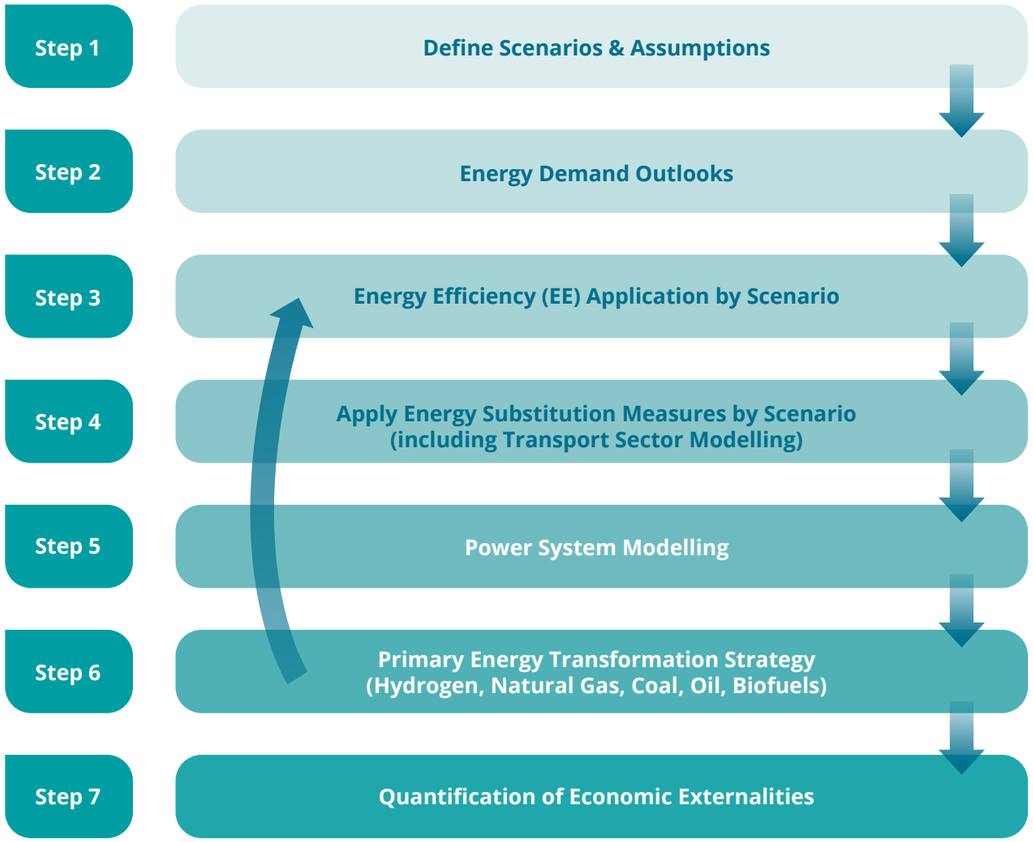
Table 8. Emission intensity

Emission intensity	CO_2 (t/mmbtu)	SO_2 (kg/MWh)	NO_x (kg/MWh)	PM2.5 (kg/MWh)
Coal	0.1031	4.04	1.68	0.16
Gasoline and other oil	0.0819	4.425	1	0
Gas	0.0592	0.165	2	0.05
Biomass and other	0	0.485	0.89	
RE	0	0	0	0

2.4 MODELLING METHODOLOGY

The methodology used to model each energy pathway (BAU, 80RE, 100RE) is detailed below in Figure 11. The economic and GHG emissions results from this systematic modelling were then used as the foundation for proposing policy options.

Figure 11. A flow-chart of the modelling work



- **Step 1**: Define scenarios and assumptions;
- **Step 2**: Develop energy consumption forecasts for each energy demand sector, i.e industry, agriculture, commercial, household and transport;
- **Step 3**: Model the application of energy efficiency measures in the agriculture, residential, commercial, and industry sectors and apply this to the demand outlooks determined in Step 2;
- **Step 4**: Determine energy substitution opportunities and measures to be applied to the energy demand outlooks;
- **Step 5**: Conduct power system modelling;
- **Step 6**: Conduct a primary energy sector transformation (energy transition) in order to make the necessary investments in the primary energy supply systems (for example, charging infrastructure and other infrastructure necessary to enable the transformation of traditional primary energy infrastructure to support renewable energy forms);
- **Step 7**: Assess and quantify the externalities.

For the transport sector, a modelling method was developed as illustrated in Figure 12 of which three steps involved are presented in Table 9.

Figure 12. A block diagram of transport sector modelling

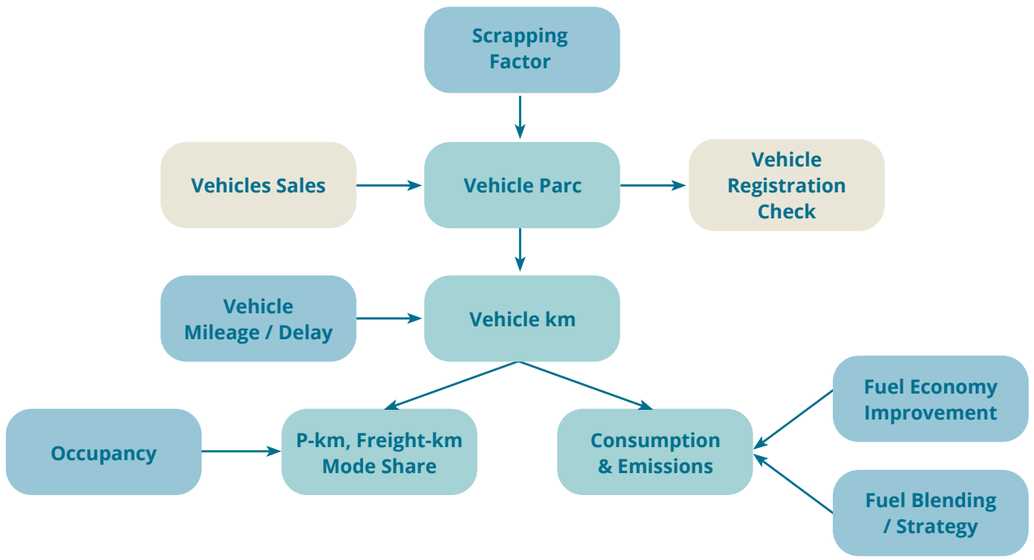


Table 9. Transport demand modelling methodology

Step	Passenger	Freight
Determination of overall transport requirements (kilometres) to 2050	• Based on person kilometres broken down into rail/road/inland waterways/ aviation; • Initial values (above) based on GSO data in 2018 then scaled in line with GDP growth (roughly 6% pa).	• Based on ton-kilometres broken down into rail/inland water ways/maritime/aviation; • To account for the impacts of COVID, 2022 estimate is based on the average of 2019 to 2021 historical data from the GSO. From 2023 forward it is assumed that growth returns to trend based on 2019 data grown by GDP. Initial values (above) based on GSO data in 2018 then scaled in line with GDP growth (roughly 6% pa).
Vehicle growth forecast and transport type switching (passenger)	• Road requirements category further divided into 2-wheelers, passenger vehicles, light/heavy commercial, buses, by vehicle numbers; • Assume scrapping factor based on vehicle life is applied to total vehicle stock at start of year; • Determine total replacement vehicles required for each year; • From the total replacements, assume a percentage of sales (profiled) is either electric, renewable fuel (equivalent), or fossil fuel based. Fossil fuel vehicle sales declines over time across all scenarios.	• Fuel consumption across the freight transport options assumed to change (electrified or renewable fuel) based on a profiled conversion and is dependent on costs and overall economy target; • Aviation and maritime assumed to transition to renewable fuels and not electrified.
Calculate energy consumption associated with each fuel and vehicle type	• Calculate the fuel consumption by vehicle type and by fuel based on the vehicle mileage; • Where applicable, apply energy efficiency improvements over time.	• Calculate the fuel consumption by vehicle type and by fuel based on the vehicle mileage; • Where applicable, apply energy efficiency improvements over time.

2.5 MAJOR MODELLING RESULTS

Detailed results of the modelling work for the entire period of 2020-2050 are provided elsewhere [1]. Table 8 shows the main findings for the BAU, 80RE and 100RE Scenarios for the year 2050.

Table 10. Summary metrics for three different scenarios in 2050

Metrics	BAU	80RE	100RE
TFEC (2050, mil. TOE)	244	229 (-6%)	223 (-8%)
TFEC (fossil fuel, 2050 share)	74%	21%	0%
TFEC (Renewable electricity, 2050 share)	19%	65%	78%
TFEC (Biomass, other and Renewable Fuel, 2050 share)	7%	14%	22%

Modeling results displayed in Table 10 show that in 2050, the BAU Scenario closely matches the expected energy outlook earlier addressed in the draft EMP (November 2022 version), while the 80RE and 100RE Scenarios correspond to more ambitious targets. In detail, for the 80RE Scenario, renewable electricity and biomass with other renewable fuels (simply defined as renewable fuels) account for 65% and 14% of the TFEC, respectively. The 100RE Scenario relies on renewable electricity generation for 78% of its energy consumption and renewable fuels for the remaining 22%.

2.5.1. Sector-wide energy data and its pattern of use for the year of 2050

2.5.1.1. Industrial Sector

Scenario **80RE**

The TFEC is estimated as 116.8 MMTOE of which renewable electricity, renewable fuels, and fossil fuels account for 90.2%, 1.4%, and 8.4%, respectively;

Scenario **100RE**

The TFEC will be 117.4 MMTOE of which renewable electricity accounts for 90.2% and the remaining 9.8% is from renewable fuels. Renewable fuels are expected to be used in select sub-sectors which are difficult to electrify (i.e., steel and cement industry);

2.5.1.2. Transport Sector

Scenario **80RE**

The TFEC will be approx. 54 MMTOE of which renewable electricity, renewable fuels, and fossil fuels account for 45%, 27%, and 28%, respectively;

Scenario **100RE**

The TFEC is estimated as 48 MMTOE of which renewable electricity covers approximately 51% of TFEC, and the remaining 49% is from renewable fuels. Renewable fuels are expected to be used in select activities which are hard to electrify (i.e., aviation transport);

2.5.1.3. Household Sector

Scenario **80RE**& **100RE**

The TFEC will be approx. 34.6 MMTOE of which renewable electricity and renewable fuels account for 76% and 24%, respectively;

2.5.1.4. Commercial Sector

Scenario **80RE**& **100RE**

The TFEC is estimated as 19.4 MMTOE of which renewable electricity and renewable fuels account for 76% and 24%, respectively;

2.5.1.5. Agricultural Sector

Scenario **80RE**& **100RE**

The TFEC is about 4.4 MMTOE of which renewable electricity and renewable fuels account for 76% and 24%, respectively;

2.5.1.6. Power Sector

▶ ***Capacity, generation mix and storage components:***

Scenario **80RE**

The total installed capacity is 1,100 GW of which renewable energy accounts for 80% and the remaining 20% is from fossil fuel sources (coal, fuel oil and gas). Energy storage capacity and throughput are estimated as approx. 130 GW and 740GWh, respectively;

Scenario **100RE**

The total installed capacity will be 1,350 GW of 100% of renewable energy. Energy storage capacity and throughput are estimated as approximately 200GW and 1050GWh, respectively;

▶ ***Fuel use and emissions:***

Additional transmission is required to achieve high RE shares by transporting renewable electricity from regions having higher renewable potential and resources.

Scenario **80RE**& **100RE**

The total installed transmission is approximately 150,000MW and 200,000MW, respectively, much higher compared to the BAU Scenario (approximately 8 times);

▶ ***Fuel use and emissions:***

Hydrogen is not featured in the transition to RE due to low efficiency and the assumed availability of solar and wind.

Scenario **80RE**

Total fossil fuel consumption is approximately 2,500 million MMBTU of which coal, gas, and biomass fuel account for 20%, 73% and 7%, respectively. The average emission intensity is approx. 18.5 tCO_{2eq}/MWh;

Scenario **100RE**

The total fuel consumption is estimated as approximately 180 million MMBTU from biomass only. The emission intensity is therefore zero (0) tCO_{2eq}/MWh;

2.5.2. System Costs and Levelized Cost of Electricity (LCOE)

The total system cost that includes annualized investment, fuel costs, variable, and fixed costs in line with different snapshot years for the three scenarios are presented in Figure 13.

From Figure 13, it is seen that in comparison to the BAU Scenario, costs are higher from 2040 onwards for both the 80RE and 100 RE Scenarios. The 100RE Scenario has higher costs than the 80RE Scenario to accommodate the additional RE to be built and supplied to the northern regions.

Figure 13. Comparison of Total System Cost of three scenarios for 2020-2050

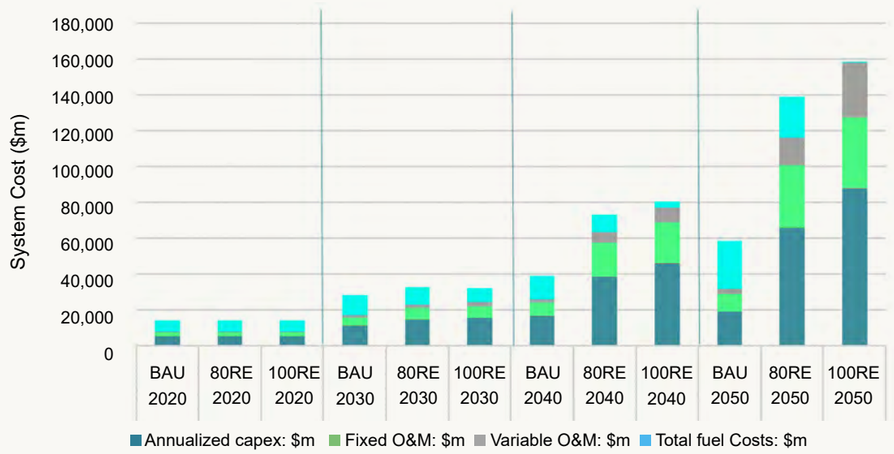
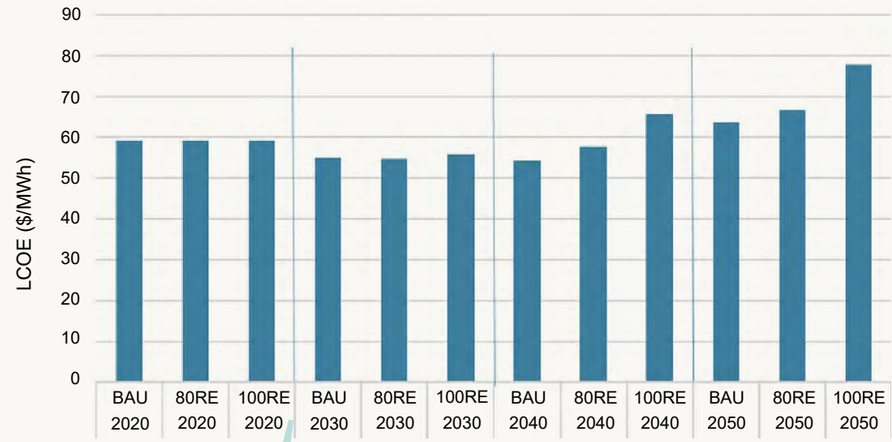
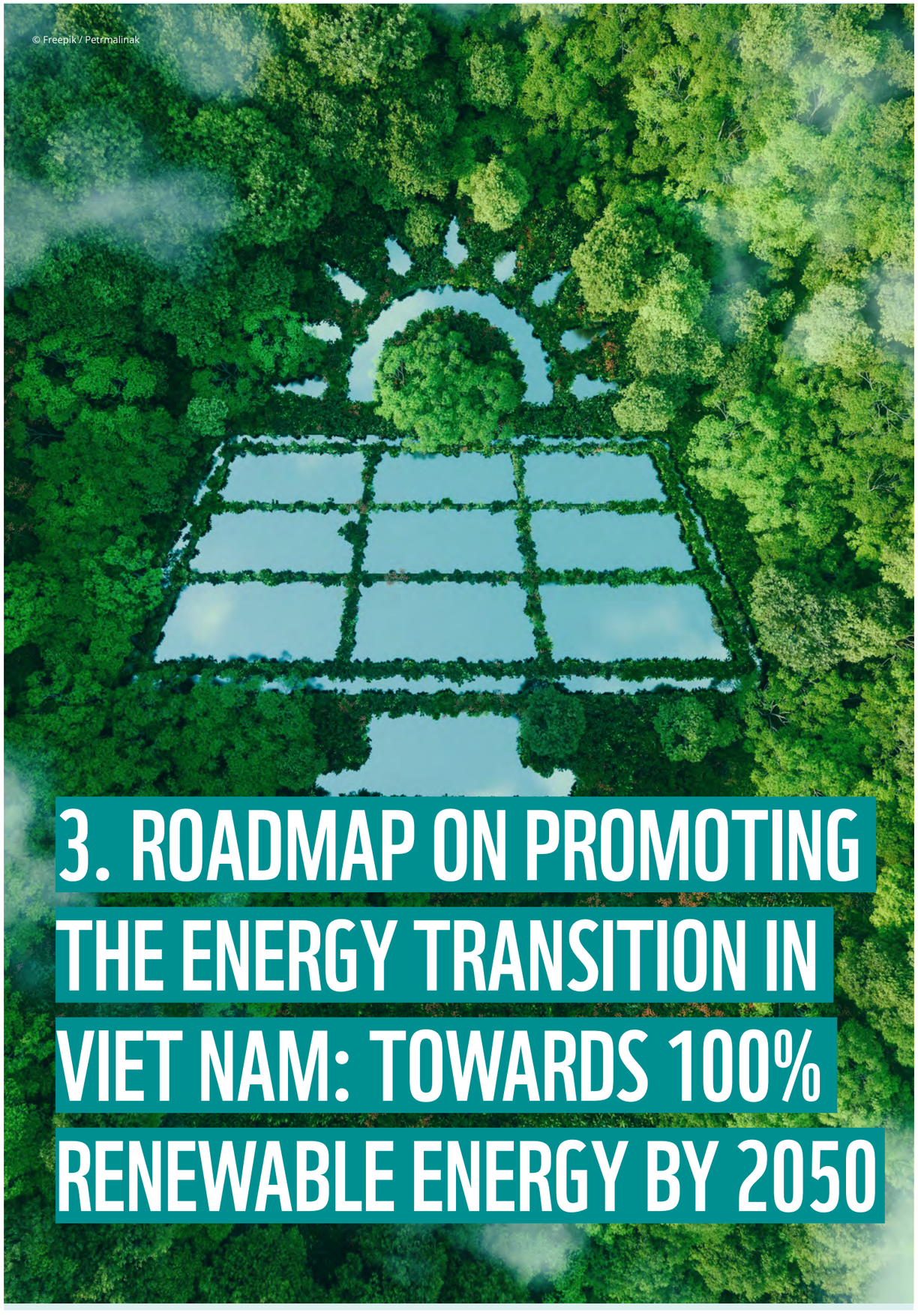


Figure 14 shows the levelized cost of electricity for the three scenarios with different snapshot years. For all scenarios, price trends downwards in the medium term followed by an increase in the LCOE in the long term. This increase is driven by higher fuel costs in the BAU Scenario, and higher renewables investments for the RE scenarios.

Hình 14. Chi phí điện quy dẫn (LCOE) đối với 03 kịch bản



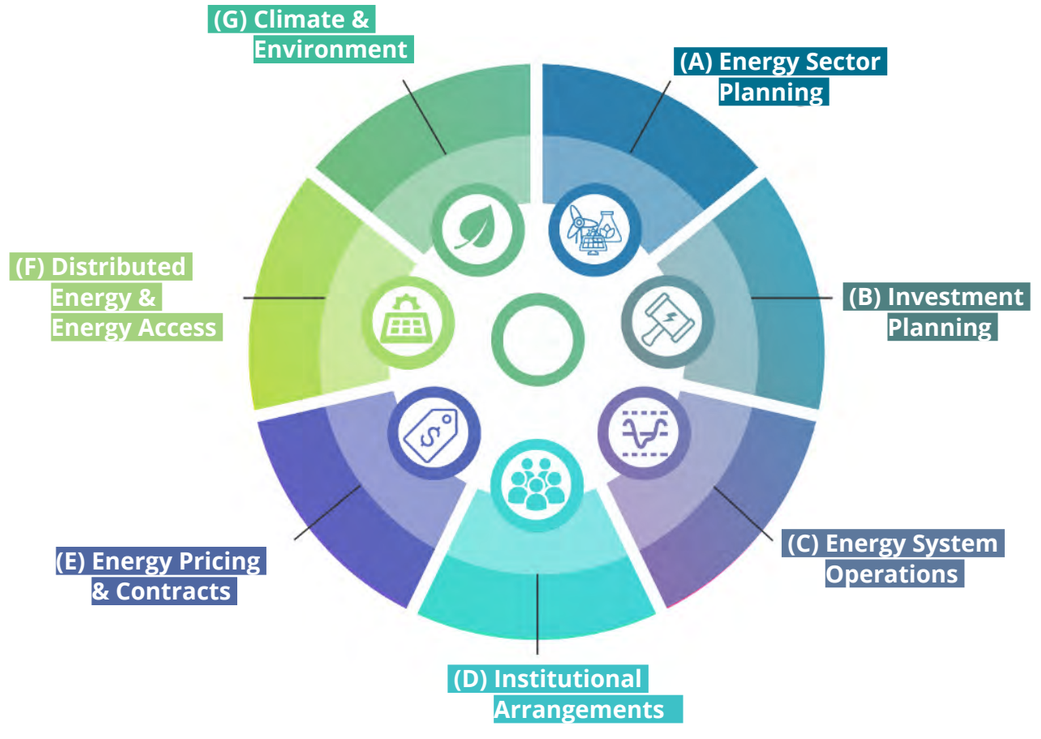


3. ROADMAP ON PROMOTING THE ENERGY TRANSITION IN VIET NAM: TOWARDS 100% RENEWABLE ENERGY BY 2050

3.1 POLICY RECOMMENDATIONS

Based on the results obtained from the modelling work, seven (07) overall policy recommendations were identified (Figure 15) to be formulated for approval by the Government.

Figure 15. Renewable energy policy framework for the energy sector



3.1.1. Energy sector planning

Electrification of the sectors based on expanding renewables is key to achieving high RE levels and the vision of 100% RE by 2050. In the high RE scenarios, electricity satisfies more than 50% of the energy consumed by 2040. By 2050 this rises to three-quarters of the energy consumed in the 100RE Scenario and nearly two-thirds in the 80RE scenario. This requires policies to integrate RE sources into the planning and operation of the power system including the grid which needs to develop to allow power from resource-rich areas to reach high-demand areas. Policies to encourage flexibility are needed by the power system. This includes encouraging demand-side flexibility, response to system needs (such as primary frequency response) and developing ancillary services markets. Higher levels of Energy Efficiency (EE) can be targeted through a mix of incentives, regulation, standardization of methods, better data collection, strengthening regulation, monitoring and enforcement, and capacity building.

3.1.2. Investment planning

Integrate resource mapping into overall planning requirements across networks, power system requirements, the environment, and public health. A more holistic approach to planning can improve outcomes for the entire economy. Offshore wind requires additional attention including in areas of surveying, evaluation and permitting. Use auctions, an approach that has already been used successfully in other jurisdictions.

3.1.3. Improving system operations for electricity

Upgrade the grid code, system operation and forecasting to enable the integration of RE in a robust power dispatch system without unduly constraining RE from being dispatched. Improve the underlying IT technologies to better integrate BESS and VRE into the power system. Modelling shows the growing share (and importance) of storage. Storage can play an important role in providing energy as well as system services to maintain system security and reliability.

3.1.4. Institutional arrangements

Strengthen governance including in areas of monitoring and reporting. Develop standards, methods and reporting systems for carbon accounting. Develop the workforce to support the achievement of the goals and policies.

3.1.5. Energy pricing and contracts

Reward flexibility and integrate distributed energy resources. Reward RE adoption through Green Certificates, RE generation quotas, and/or carbon trading. Incentives to increase RE capacity are important since the growing numbers of EVs will lead to growing electricity demand from the transport sector.

3.1.6. Transport sector

Encourage electrification and adoption of EVs through financial support for early adopters and provide the necessary infrastructure. Modelling shows that the majority of passenger transport and freight will shift to EVs and policies to encourage this shift are needed. Develop regulations to encourage EV owners to participate in the bidirectional network that will develop. Enforce the targets in the recently announced policy to phase out ICE.

3.1.7. Climate, health and environment

Develop an overarching planning framework that integrates climate policies, decarbonization strategies and achievement of NDC targets. These policies will improve health outcomes by reducing pollution and dependence on imported energy, thus accruing economic benefits to the economy.

3.2 ROADMAP ON PROMOTING THE ENERGY TRANSITION: TOWARDS 100% RE BY 2050

3.2.1. General

A policy is understood as a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions. A roadmap is known as a strategic plan that defines a goal or desired outcome and includes the major steps needed to reach it.

In general, there exist a variety of steps involved in the development of a Roadmap of which the major ones are listed below:

Policy anticipation and problem definition
Identifying problems that require government attention, deciding which issues deserve the most attention, and defining the nature of the problem;

Policy formulation
Definition of policy options in terms of means and possibilities to achieve policy objectives;

Policy impact assessment
Evaluation of the environmental, social and economic impacts of the different policy options in order to identify the one that maximizes benefits while minimising negative impacts;

Policy implementation
Actual application of what is prescribed by the selected policy option;

Policy evaluation
Assessment of the effectiveness of the policy.

To realize the 100RE Scenario, a proposed roadmap should be developed, including the following steps:

Step 1
Identification of the baseline policy issues/problems which are related to energy efficiency (EE), renewable energy (RE), and green growth development in Viet Nam;

Step 2
Development/formulation of policy interventions and documents for the implementation of the technical 100% RE scenario by 2050 in Viet Nam;

Step 3
Endorsement of official government on the policy interventions developed;

Step 4
Implementation of the policy interventions endorsed;

Step 5
Evaluation of the policy intervention impact.

Within the scope of current work, only the first two steps will be implemented in close collaboration with relevant stakeholders.

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3.2.2. Roadmap on promoting the Energy Transition: Towards 100% Renewable Energy

From the modelling work, to promote high renewable energy scenarios in the report "Viet Nam's Energy Sector Vision: Towards 100% RE by 2050", seven (07) overall policy recommendations were identified and recommended. However, as already seen in the comparison matrix in Chapter 2, in order to be able to develop the above recommendations on an appropriate and feasible timeline, it is necessary to identify and propose specific recommendations in the immediate period from now to 2030 to create momentum to implement the 100RE Scenario.

Specific recommendations towards the year of 2030 are proposed:

Recommendation 1
Integration of RE development into the power sector;

Recommendation 2
Electrification of the transport sector;

Recommendation 3
Off-shore wind development;

Recommendation 4
Integration of emissions reduction targets with Viet Nam's NDC goals.

In order to properly formulate such specific recommendations, there is a need for the development of a roadmap to detail the engineering and operational readiness steps required to implement the 100RE scenario. To do this, three main steps need to be carried out:

Step 1

Identify the preconditions that need to be satisfied to transition and operate at 100% RE. These can be considered as target objectives that the roadmap actions are designed to meet;

Step 2

For each precondition, assess current and emerging challenges associated with achieving the target objective. This includes issues at present, the near future, and future issues that are anticipated to emerge at 100RE penetrations;

Step 3

Based on the above, identify actions necessary to achieve the precondition, starting from today's state to the target objective.

A roadmap for each of the four recommendations are given below.

SPECIFIC RECOMMENDATION 1

INTEGRATION OF RE DEVELOPMENT INTO THE POWER SECTOR

The ability to maintain and strengthen the reliability and security of the power system is recognized as one of the preconditions based upon which some emerging challenges to the existing system are described in Table 11.

Table 11. Identified preconditions for integration of RE development into the power sector and associated challenges

Pre-condition	Current status and emerging challenges
Ability to maintain and strengthen the reliability and security of the power system	**Implementing the transmission expansion** ▸ Period 2016-2020: power transmission grid development completed only 70-90% of the revised PDP VII target due to difficulties in site clearance and lack of investment; ▸ In 2020, Trung Nam Group was the first private investor to develop a 500 kV super-high voltage power transmission line for a 450 MW solar project; **Operating the power system in the context of a high share of RE** ▸ In 2020, share of RE in Viet Nam's total power capacity was approx. 30% but RE's share in power generation was only 12% of the national power generation; ▸ RE curtailment was made due to the overload of the power transmission lines; **Developing energy storage system** ▸ No energy storage system in operation to date;

From the above challenges, actions to achieve identified precondition are recognized as listed in Table 12.

Table 12. Actions to achieve the identified precondition for integration of RE development into the power sector

Pre-condition	In progress	Actions proposed to commence soon
Ability to maintain and strengthen the reliability and security of the power system	MOIT's review of project portfolios related to investment in upgrading inter-regional and intra-regional power transmission lines for the period up to 2030;	▸ Revise/adjust Laws on Forests, Land, and Sea, resolutions and decrees related to land valuation, conversion of forest land, agricultural land to energy land; ▸ Adjust the Electricity Law to allow private RE investors to participate in the construction and development of the power transmission grid;
	EVN's implementation of Bac Ai hydro pumped storage project (300MW x 4 units) to meet the deadline for commercial operation (2029);	▸ To foster R&D in energy storage technology (Pumped hydropower storage and BESS); ▸ To formulate financial options for the promotion of energy storage systems and technology in Viet Nam;

The same approach is employed for the other 3 remaining specific recommendations as given in Tables 11 through 16.

SPECIFIC RECOMMENDATION 2

ELECTRIFICATION OF THE TRANSPORT SECTOR

Table 13. Identified preconditions for electrification of the transport sector and associated challenges

Pre-condition	Current status and emerging challenges
Ability to shift to electric vehicles for passenger transport	**Developing the infrastructure for EVs** ▸ In 2021, VinFast became the first private group in manufacturing and launching EVs in Viet Nam; ▸ The trend of using EVs in passenger transport has changed; **Formulating regulation for EV development in Viet Nam** ▸ Prime Minister's decision no. 876/QĐ-TTg dated 22nd July 2022 on action program in green energy transformation, reduction of carbon and methane emissions in the transport sector; ▸ Note from Ministry of Transport no. 3686/BGTVT-KHCN&MT dated 13th April 2023 to central cities and provinces about formulation and approval of specific plans and tasks for the implementation of Decision No. 876/QD-TTg;

Table 14. Actions to achieve the identified precondition for electrification of the transport sector

Pre-condition	In progress	Actions proposed to commence soon
Ability to shift to electric vehicles for passenger transport	MOT's reviewing action plans submitted by Thai Nguyen (no. 105/KH-UBND dated 30th May 2023), Quang Ngai (no. 139/KH-UBND dated 31st August 2022), Vinh Phuc (no. 157/KH-UBND) dated 24th May 2023) and other central cities & provinces;	▸ Formulate fiscal incentives for spurring the initial uptake of EV; ▸ Support EV charging infrastructure development through measures such as direct investment to install publicly accessible chargers;

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SPECIFIC RECOMMENDATION 3

OFF-SHORE WIND DEVELOPMENT

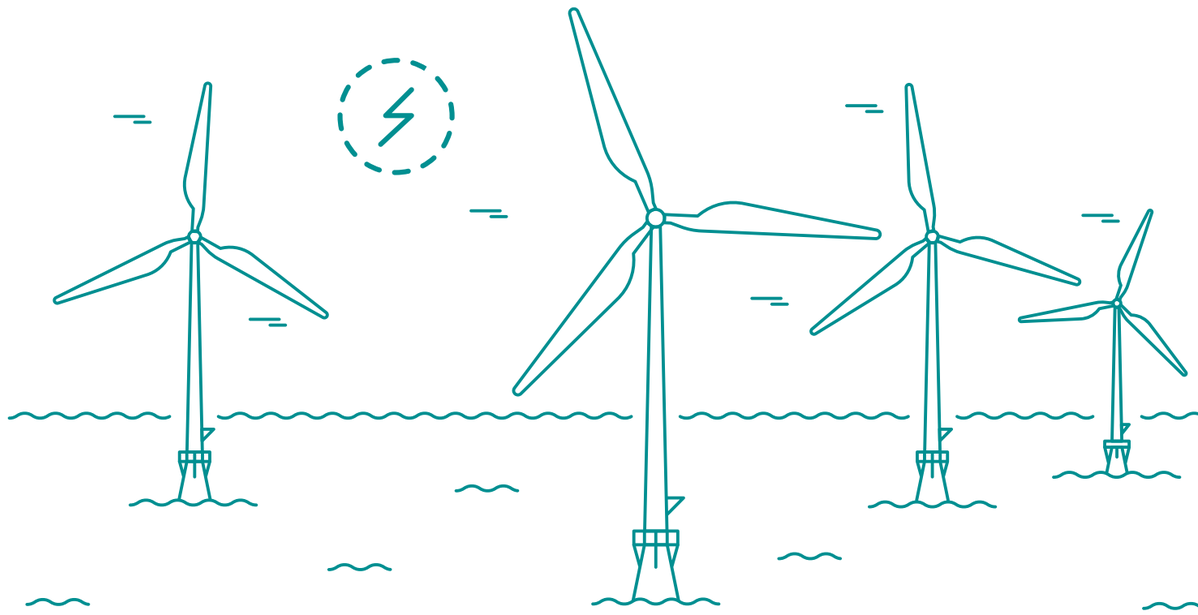
Offshore wind power development was identified as an important driving force in the orientations of Viet Nam's National Energy Development Strategy to 2030, with a vision to 2045 (Resolution No. 55/NQ-TW dated February 11th, 2020). The development of offshore wind has many opportunities as well as risks, so all development mechanisms and policies need a long-term vision to ensure the sustainable development of Viet Nam's offshore wind capacity.

Table 15. Identified preconditions for off-shore wind development

Pre-condition	Current status and emerging challenges
Ability to plan, tender and implement offshore wind projects in Viet Nam	**The development of Offshore Wind Power Planning in Viet Nam:** ▸ Offshore Wind Planning in Viet Nam should be in line with the National Marine Spatial Plan; ▸ Identify potential areas for wind power development; ▸ Ensure the utilisation of good energy sources, while reducing the impacts on marine ecosystems and avoiding conflicts with other marine economic sectors; ▸ To date, the National Marine Spatial Plan for the period of 2021-2030 has not yet been approved; **Designing/selecting rapid development or bidding mechanisms to kick-start the offshore wind in Viet Nam (7GW by 2030)** ▸ Rapid development mechanism: to choose a large-scale pilot project or apply a special set of mechanisms for a certain amount of capacity (3 - 4 GW) to develop projects in a shorter process. This mechanism helps support rapid implementation of projects to address policy barriers; achieve large enough deployment scale to reduce the cost of power generation; projects do not have to wait for the Marine Spatial Planning or bidding process to be developed and appraised. Main challenges: how to select good projects with capable developers; ▸ Bidding mechanism: has the advantage that the project development process is open, transparent, competitive and effective, but experience in most countries has shown that implementing the mechanism is really time-consuming; ▸ To date, no clear decision on tendering offshore wind has been made by the Ministries concerned;

Table 16. Actions to achieve the identified precondition for offshore wind development

Pre-condition	In progress	Actions proposed to commence soon
Ability to plan, tender and implement offshore wind projects in Viet Nam	▸ MONRE's review of the National Marine Spatial Plan; ▸ PDP8 was approved by the Prime Minister on 15th May 2023;	▸ The national marine spatial plan will be approved by the end of 2023, or early 2024; ▸ MOIT is to develop criteria for offshore wind investor selection (according to the provisions of Article 16 of Decree 25/2020/ND-CP);



SPECIFIC RECOMMENDATION 4

INTEGRATION OF EMISSIONS REDUCTION TARGETS WITH VIET NAM'S NDC GOALS

Table 17. Identified preconditions for the integration of emissions reduction targets with Viet Nam's NDC goals

Pre-condition	Current status and emerging challenges
Ability to synchronize emissions reduction targets with Viet Nam's NDC goals	**Formulating National Strategy on Climate Change:** ▸ Prime Minister's decision no. 896/QD-Ttg dated 26th July 2022 approving the National Strategy on Climate Change until 2050; **Developing action programs for the implementation of the National Strategy on Climate Change:** ▸ Viet Nam's NDC was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) on 8th November 2022; ▸ Prime Minister's decision no. 876/QĐ-TTg dated 22nd July 2022 on Action Program in the green energy transformation, reduction of carbon and methane emissions in the transport sector; ▸ MOIT Minister's decision no. 2756/QD-BCT dated 14th December 2022 promulgating the Action Plan in response to climate change and green growth for the Industry and Trade sector for the period to 2030 with a vision to 2050; ▸ MOT Minister's decision no. 70/QD-BGTVT dated 3rd February 2023 on approving the detailed plan for the implementation of the project to support the Ministry of Transport in the implementation of NDC within the framework of the project "Transport Initiative in NDC in Asian countries" in 2023;


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Table 18. Actions to achieve the identified precondition for the integration of emissions reduction targets within Viet Nam's NDC goals

Pre-condition	In progress	Actions proposed to commence soon
Ability to synchronize emissions reduction targets with Viet Nam's NDC goals	▸ MOIT's reviewing the National Master Plan for the period of 2021-2030, with a vision to 2050;	▸ Other relevant Ministries (MARD, MOC, etc.) to formulate their respective action plan/ program in line with Viet Nam's NDC goals; ▸ Action plans prepared by MOIT and MOT to be implemented as scheduled with expected results;

4. CONCLUSION

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The 100RE Scenario can only be achieved by successfully implementing two pillars:

1

Promoting energy efficiency measures

Energy efficiency has been recognized as low-hanging fruit and therefore a low-cost option in the nation's economy for the period of 2022-2030. Once the Viet Nam National Energy Efficiency Program for the period of 2019-2030 (VNEEP3) is accomplished, additional policies of further energy efficiency targets for the following years with strictly mandatory efficiency standards (or MEPS) should be developed.

Scaling-up of renewable energy into the entire national economy with electrification being a key

Adoption of renewable energy can be gradually taken up with a focus on offshore wind development that, together with solar and nearshore wind development, would be able to support the electrification of all the economic sectors of Viet Nam in the long run.

2

Finally, proper integration of climate change targets and power system requirement objectives in line with Viet Nam's NDCs is expected to create improved outcomes. For the implementation of such a series of actions, appropriate policies are necessary, of which specific policies for the intermediate period (2022-2030) have been put forth here.

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