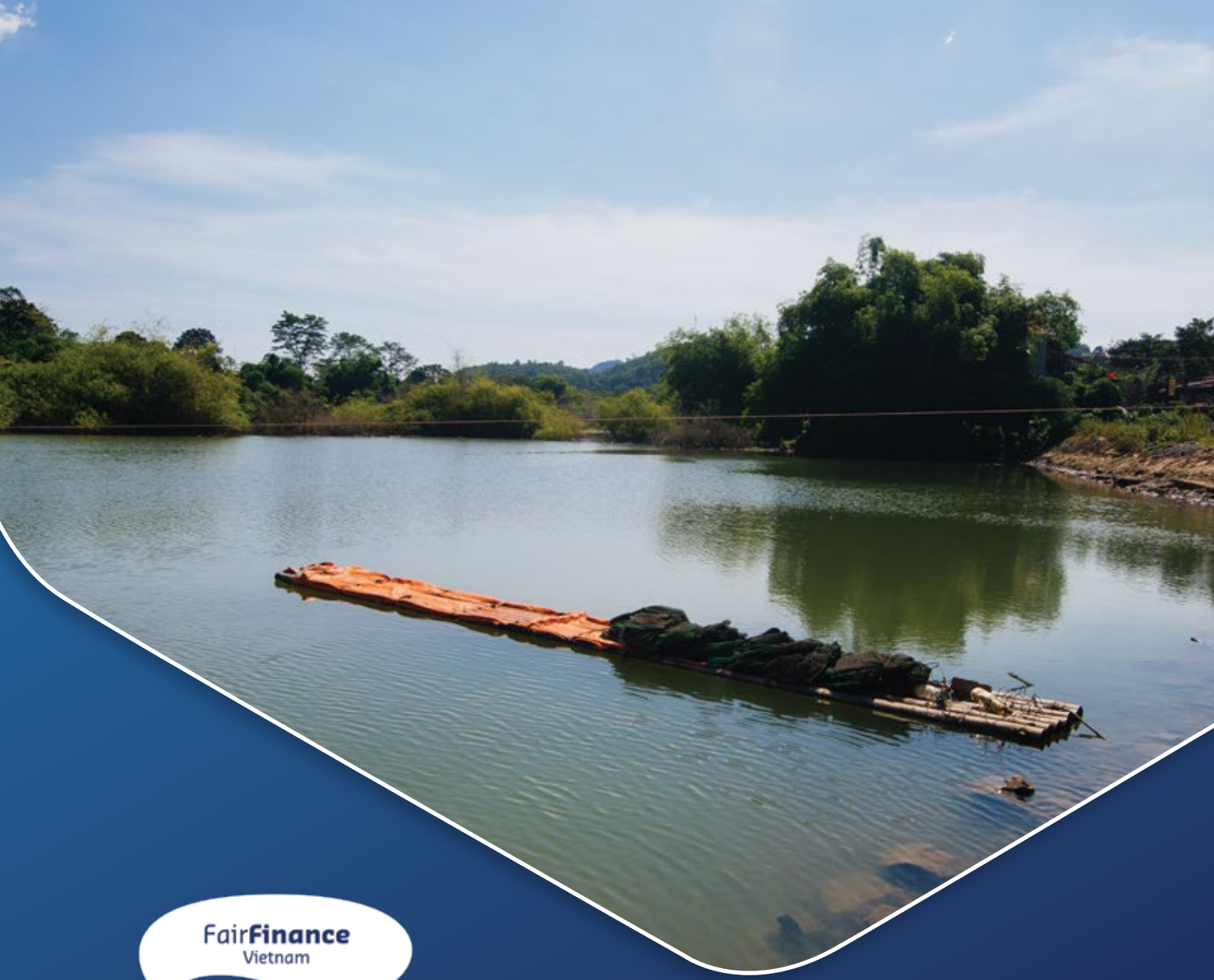

FairFinance Vietnam

RESEARCH REPORT

OVERVIEW OF STRANDED ASSETS RISK IN THE CONTEXT OF CLIMATE CHANGE

A case study of the power generation sector in Vietnam

Hanoi, July 2022

Sida

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CONTENTS

RESEARCH SUMMARY

The study on stranded assets in the context of climate change and its implications for Vietnam was developed with the aim of examining the relationships between climate change and stranded assets and the factors causing the risk of stranded assets. Thus, it aims to analyse the possibility of assets being stranded in the context of Vietnam - one of the countries most vulnerable to climate change.

Vietnam is often seen as one of the countries most vulnerable to climate change. The common patterns of climate change are increased temperatures; rising sea levels; and an increase in extreme weather events such as storms, heat waves, excessive rainfall, drought, etc. As reported by Espagne et al. (2021), many aspects of the Vietnamese economy, society, and healthcare system are feeling the impacts of climate change. For instance, climate change is expected to have a significant impact on Vietnam's energy system both in terms of electricity supply and demand. Increasing temperatures are likely to further increase electricity demand than is normally forecasted. That level of demand, together with the expected rate of economic growth, will put great pressure on the power generation sector in the long term. This increased demand for electricity leads to a corresponding increase in the supply of essential primary energy (due to an increase in the fuel input for power generation) as well as an increase in greenhouse gas emissions from power generation. Changes in rainfall and temperature can affect energy production, transmission and distribution systems, or infrastructure (World Bank, 2011; Ciscar & Dowling, 2014; Perera et al., 2020).

Over the past few years, the topic of "stranded assets"[1] related to environmental risks has received more and more attention. These risks include the physical risks of climate change as well as societal risks such as changes in consumer behaviour; and regulations, policies on climate change mitigation and adaptation. The main recent research trend in stranded assets has focused on the relationship between stranded assets and climate change. Since 2010, the concept of stranded assets has been associated

[1] In business, the term "stranded assets" refers to assets that are written down, devalued, or converted to liabilities sooner than originally planned.

with climate change when environmental policies and other policies on the green energy transition were introduced and implemented. The effects of climate change are believed to be the main driver of stranded assets (Rautner et al., 2016; Reddy and Anbumozhi, 2017).

Although this topic of stranded assets is considerably attracting interests among academia, governments, financial institutions, and corporations in many countries, there is still a few research in Vietnam.

The study on stranded assets in the context of climate change and its implications for Vietnam was developed with the aim of examining the relationships between climate change and stranded assets and the factors causing the risk of stranded assets. Thus, it aims to analyse the possibility of assets being stranded in the context of Vietnam - one of the countries most vulnerable to climate change. At the same time, the study also aims to provide a deeper understanding and current discussions on stranded assets, as well as to highlight the opportunities and challenges in Vietnam. The study is one of the efforts of the Fair Finance Vietnam (FFV) – coordinated by Oxfam in Vietnam. FFV aims to promote Environmental, Social, and Governance (ESG) commitments and practices in the financial sector towards sustainable finance. In doing so, it aims to contribute to achieving the Sustainable Development Goals (SDGs) and international environmental commitments.

The "***Overview of stranded asset risks in the context of climate change – The case of the power generation sector in Vietnam***" report is considered a fundamental study that paves the way for understanding the risks of stranded assets related to climate change in Vietnam. By studying secondary data and interviewing officials working in power enterprises, commercial banks, the Ministry of Finance, the State Bank of Vietnam, and the the National Financial Supervisory Commission, the report provides an overview of stranded assets and the causes of these assets in theory as well as in practice in Vietnam.

In the scope of this study, the term "stranded assets" refers to assets that are written down, devalued, or converted into liabilities earlier than expected due to changes related to environment and in the context of climate change.

The study shows that the risk of stranded assets related to the environment in the context of climate change exists in many sectors and industries of the Vietnamese economy. The impacts of climate change can cause both direct and indirect stranded asset risks.

Direct impacts include physical changes in the natural environment or in natural resources that pose a risk of stranded assets in many sectors and industries. For example, rising sea levels can affect the agriculture and transportation industries. Meanwhile, changes in rainfall can affect the hydropower and irrigation sectors.

Indirect impacts of climate change that cause stranded assets include changes in government regulations, technology, social norms or consumer behaviour, litigation, and statutory interpretation. Typically, the commitment of governments to net zero carbon emissions can affect economic sectors with large CO_2 emissions such as coal-fired power plants and manufacturers of vehicles running on gasoline, diesel, etc. These commitments are contributing to the rapid global energy transition from traditional fossil fuels to renewable energy. Vietnam is integrating into this trend. At the COP-26 conference, Prime Minister Pham Minh Chinh emphasised the goal of achieving net-zero emissions by 2050.

In general, Vietnam has perfected policies and regulations to respond to and mitigate the effects of climate change in many sectors and industries. This has included policies to encourage the development of renewable energy in response to climate change. However, the regulatory framework for dealing with stranded assets related to climate change remains to be considered. The risks of stranded assets related to climate change in the energy industry has received very little attention in Vietnam while this is a sector with a very large scale of assets. From a financial perspective, a legal framework to respond to and handle the risks of stranded assets related to climate change in commercial banks and other financial institutions is lacking. There are also no assessments or statistics on the scale and structure of outstanding loans for assets at risk of being stranded by climate change in Vietnam.

By analysing the case of power generation sector in Vietnam, the study has pointed out the risks of stranded assets when transitioning to fulfil Vietnam's pledges on net zero emission by 2050. Factors affecting stranded asset risk in the power generation sector range from internal (subjective) factors arising to external (objective) factors. Internal factors include fuel costs, technology, operating cost, and operating capacity. External factors include regulations on limiting pollution, fiscal policies on greenhouse gas emissions, the electricity market and competitiveness, and capital costs.

The study shows that coal-fired power plants are the most at-risk of becoming stranded assets. This situation is defined as a power plant in danger of loss, devaluation, or of falling into bankruptcy because it has to shut down early in order to meet the requirements for greenhouse gas emissions. The fact that coal-fired power plants are at risk of becoming stranded assets means that financial institutions, investors, and financers risk losing some of the capital invested in them. Meanwhile, most coal-fired power projects are implemented by state-owned enterprises with concessional loans. Therefore, Vietnam need consider policies to deal with the risk of stranded asset related to climate change in order to meet the 2050 net-zero emissions target. Also, we recommend that, Vietnam need a clear roadmap for the operation of coal-fired power plants in the coming period to meet commitments at the COP 26. Investment in new coal-fired power plants (if any) should consider low-emission technologies. Despite of that, modern coal-fired power plants with low carbon emissions will struggle to find financers. This is due to commitments to stop financing this sector in lending countries or higher borrowing costs and more difficult repayment terms in the short term.

Meanwhile, irreversible energy transition – a shift towards a cleaner energy - forces Vietnam to consider economic benefits and costs as well as the base load capacity for the national electricity grid. This is because one of the characteristics of renewable energy plants is an unstable power supply. Investing in renewable energy to replace coal-fired power requires a large amount of capital. Thus, mobilising capital for this purpose requires explicit and strategic calculations. While the transition will create new opportunities, sectors with high-emission products or activities will face significant impacts on demand, production costs, employment, and labour.

Concerning the risks of stranded assets related to climate change in general, and the power generation sector in Vietnam in particular - especially the coal-fired power - the report

proposes following policy recommendations:

Recommendations to the government

- Support research on the risks of stranded asset;
- Develop a voluntary carbon market;
- Price environmental externalities to rebalance incentives;
- Support low-carbon investment and consider support through PPP projects;
- Provide financial support to limit or stop the use of stranded assets.

Recommendations to financial institutions

- Expand green finance;
- Research and develop new financial instruments and products;
- Carefully review loans to coal-fired power projects;
- Develop hedging plans and strategies for existing coal-fired power projects.

Recommendations to power generation enterprises

- Closely monitor government commitments, the national Power Development Plan VIII, and greenhouse gas emissions plans in each period to decide on the most suitable investment in coal-fired power projects;
- Based on the assessment of electricity demand and commitments to support electricity use, develop a plan for operation of coal-fired power plants in accordance with the national strategy on greenhouse gas emissions;
- Have an investment plan for treatment technology to reduce greenhouse gas emissions.
- In the long-term, when considering investment projects for coal-fired power plants, take into account that the costs for environmental pollution will increase (costs such as carbon emission fees, environmental protection taxes, etc.).

Suggested following-up research topics

- Expand the topic of stranded assets caused by changes in the power generation sector, adding forecasts of total stranded assets of coal-fired power plants in 2050, costs to achieve zero emissions commitments, and the implications for prices and its impacts on vulnerable groups;
- Conduct in-depth studies on the risks of stranded assets in the industries that are vulnerable to climate change such as agriculture, irrigation, and tourism;
- Research alternatives or responses for stranded assets and impacts on businesses, the economy, and poverty when stranded assets occur.

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LIST OF ACRONYMS

AFD	French Development Agency
BAU	Business-as-usual
BOT	Build–operate–transfer
BP	British Petroleum
COP-26	The 26th United Nations Climate Change Conference
EPTC	Electric Power Trading Company
ESG	Environmental, Social and Governance
EVN	Vietnam Electricity
FIT	Feed-in-Tariffs
GDP	Gross domestic product
HDBank	Ho Chi Minh City Development Joint Stock Commercial Bank
IEA	International Energy Agency
IEVN	Institute of Energy
IFC	International Finance Corporation
INDC	Intended nationally determined contribution
IPP	Independent power producers
GHG	Greenhouse gas
LNG	Liquefied natural gas
LRMC	Long-run marginal cost
NDC	Nationally determined contribution
NPV	Net present value
NTP-RCC	National Target Program to Respond to Climate Change
ODA	Official development assistance
RCP	Representative Concentration Pathway
REDD+	Reducing Emissions from Deforestation and Forest Degradation

TPBank	Tien Phong Commercial Joint Stock Bank
SBV	The State Bank of Vietnam
VCB	Joint Stock Commercial Bank for Foreign Trade of Vietnam
VCGM	Vietnam Competitive Generation Market
VietinBank	Vietnam Joint Stock Commercial Bank for Industry and Trade
VPBank	Vietnam Prosperity Joint-Stock Commercial Bank

INTRODUCTION

At the international level, more and more governments, organizations, and businesses are making commitments and policies to reduce carbon emissions and to mitigate and adapt to climate and environmental change. The speech of Prime Minister Pham Minh Chinh at the COP-26 – the 2021 United Nations climate change conference also emphasised the goal of bringing net emissions to “zero” by 2050.

1. Research background

Vietnam is one of the countries most vulnerable to climate change. The common patterns of climate change are increased temperatures, rising sea levels, and an increase in the frequency of extreme weather events such as storms, heat waves, excessive rainfall, drought, etc. Climate change has strong impacts on the economies and societies of countries including Vietnam. According to the report of Espagne et al. (2021) the socio-economic impacts of climate change on Vietnam affect many aspects of the economy, society, and healthcare.

At the international level, more and more governments, organizations, and businesses are making commitments and policies to reduce carbon emissions and to mitigate and adapt to climate and environmental change. The speech of Prime Minister Pham Minh Chinh at the COP-26 – the 2021 United Nations climate change conference also emphasised the goal of bringing net emissions to "zero" by 2050. This shows that Vietnam cannot stay out of the global trend of energy transition from fossil fuels to renewable energy.

Over recent years, "stranded assets" caused by environmental risks have received more and more attention. These factors include the physical effects of climate change as well as societal and regulatory responses. This topic is increasingly attracting considerable interest among academia, governments, financial institutions, and corporations in many countries. However, there is still very little research on this issue in Vietnam. Given that Vietnam faces many challenges in terms of climate change, has many environmental risks, but still uses a lot of fossil fuel resources, this is indeed a gap in the literature. Stranded asset risks pose future challenges and opportunities that Vietnam may deal with.

In the current operations of commercial banks, lending and mortgaging of property is considered relatively safe and is a popular transaction when establishing a mortgage relationship. Banks are interested in choosing which assets will be used as collateral and whether it will be convenient to handle such assets in the event of a default. Recently, commercial banks have financed a series of fossil fuel power projects which are likely to be strongly impacted when cleaner energy technology is more developed.

The issue of stranded assets caused by environmental risks in the context of climate change will pose many challenges for both policymakers and commercial banks in Vietnam.

This report is a path-breaking initial study on the risks of stranded assets related to climate change in Vietnam. It aims to provide a deeper understanding and existing literature of the topic as well as highlight the opportunities and challenges emerged in Vietnam.

2. Objectives and research questions

The main objective of the study is to examine the effects of climate change on stranded assets and the factors affecting them. Since this is a relatively new topic in Vietnam, the report will also analyse and review a number of theories.

Based on literature review, the report will analyse the influencing factors on stranded assets in Vietnam in the context of climate change as well as Vietnam's policy framework. In order to have a deeper understanding of the current situation, the report focuses on the power generation sector with regards to the policy impact on the sector rather than the full range of physical and social effects of climate change.

The report will also give policy recommendations and suggest further research on stranded assets

in Vietnam in the context of climate change.

The main research questions in the report include:

1. What are stranded assets? What are factors causing them?

2. Climate change and stranded assets in the energy sector in Vietnam: What are the risks posed to stakeholders?

3. What does Vietnam need to do to deal with stranded assets caused by climate change?

As, the risks of stranded assets related to climate change are a relatively new topic, especially in Vietnam, this study does not expect to examine all related issues. We hope that there will continue to be more in-depth studies on this topic in the future.

3. Research methodology and structure of the report

3.1. Methodology

The research team approached the topic of stranded assets related to the impacts of climate change from the perspective of political economy. Since this is a new topic, the main method used is secondary literature research combined with in-depth interviews.

To point out the limitations in the analysed content, the research team conducted a synthesis of major studies from the past five years. To obtain the most relevant information as well as to verify and clarify the findings, the team interviewed managers from the public sector such as the Ministry of Finance, the State Bank of Vietnam, the Board of Supervisors, the National Financial Supervision Commission, and enterprises in the power generation sector.

3.2. Structure of the report

The report consists of three sections. The first reviews previous studies on stranded assets and the factors affecting them. The second analyses the impact of climate change on the Vietnamese economy and the risks of stranded assets in the power generation sector and points out the future challenges Vietnam may face. The final section provides policy recommendations and future research directions.

SECTION 1:

OVERVIEW OF STRANDED ASSETS

From the perspective of a risk manager, the concept of stranded assets is very important as economic loss could occur when stranded assets are converted into liabilities.

1.1. The concept of stranded property

The term "stranded assets" has existed since the beginning of business or investment activities. Throughout economic history, there are many examples of stranded assets. For example, in the early 1900s, as automobiles gradually became the preferred means of transportation, manufacturers of carriage whips and carriages had a hard time. Likewise, the advent of smartphones in the early 21st century has caused many other products such as calculators, alarm clocks, digital cameras, or physical newspapers to sink into oblivion. And this is, indeed, not a good thing for businesses manufacturing these products. From the examples above we can get an idea of what a stranded asset is.

As defined in the *Stranded Assets Project* by Caldecott et al. (2013), stranded assets are "*assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities*". This is a general definition of stranded assets, however, recently the term "stranded assets" has become widely used in an environmental context where assets are stranded due to environmental factors such as physical climate change or a change in society's attitude towards the environment.

In the energy industry, Carbon Tracker (2019) defines stranded assets as "*assets that at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return (i.e., meet the company's internal rate of return), as a result of changes associated with the transition to a low-carbon economy (lower than anticipated demand / prices).*"

From the perspective of a risk manager, the concept of stranded assets is very important as economic loss could occur when stranded assets are converted into liabilities. Thus, from the point of view of financial and accounting risk, stranded assets can be seen as obsolete or non-performing assets but must be recorded on the balance sheet as a loss of profit.

In the scope of this study, we use the term "stranded assets" to refer to assets that are written-down, devalued, or converted into liabilities sooner than expected due to the effects of environmental factors in the context of climate change.

1.2. Causes of stranded property

There are many causes or environmental factors that affect asset prices. In studies about the causes or risks made assets more prone to stranding, the primary causes are financial risk (Blumstain and Bushnell, 1994; Parker and Oczkowskyi, 2003; Gerasimchuk et al., 2013) and policy risks (Price and Krister, 1999; Babiker et al., 2000; Thomas, 2003). Financial risk occurs when the price of a product or demand for that product falls and makes it uneconomical to produce.

Meanwhile, policy risk occurs when a change in government environmental policy causes a certain group of assets to become stranded.

However, recent studies have shown that there are many other causes of stranded assets and these assets could be formed by a combination of risks. Risks other than financial risk and policy risk include technology risk (new technologies lead to old products and technologies becoming "stranded"); environmental risk (climate change causes assets to become "stranded"); or social

risk (social norms or consumer behaviour change) (Caldecott et al., 2013; Caldecott et al., 2016; Rautner et al., 2016; Gupta and Chu, 2018; Whitley et al., 2018). In Lloyd's report on stranded assets, the environmental risks that lead to stranded assets can be divided into two main groups: (i) Physical risks, including changes in the natural environment or changes in natural resources, and; (ii) social risks, including changes in government regulation, technology, social norms or consumer behaviour, or the statutory interpretation of litigation.

The mainstream research on stranded assets has focused on the relationship between stranding assets and climate change. Since 2010, **the concept of stranded assets has been associated with climate change when environmental policies, as well as policies on the energy transition, were introduced and implemented.** The effects of climate change are believed to be the main driver of stranded assets (Rautner et al., 2016; Reddy and Anbumozhi, 2017).

Studies of stranded assets in the energy industry using fossil fuels have received greater attention due to concerns about pollution and many countries' environmental policy changes from brown to green. Fossil-fuel-related businesses and countries with fossil-fuel-dependent economies will be affected by these changes (Van der Ploeg, 2016; Welsby et al., 2021).

SECTION 2:

CLIMATE CHANGE AND STRANDED ASSETS IN VIETNAM:

A CASE STUDY OF THE POWER GENERATION SECTOR

The indirect impacts of climate change that can cause stranded assets include changes in government regulation, technology, social norms or consumer behaviour, litigation, and statutory interpretation. A typical example is the commitment of governments to zero greenhouse gas (GHG) emissions that can affect sectors with large CO_2 emissions such as coal-fired power plants and the manufacturers of vehicles running on gasoline, oil, etc.

2.1. Overview of the impacts of climate change in Vietnam

Vietnam is often viewed as one of the countries most vulnerable to climate change. The common patterns of climate change are increased temperatures, rising sea levels, and an increase in the frequency of extreme weather events such as storms, heatwaves, heavy rainfall, drought, etc. The average annual temperature has risen across Vietnam with an average increase of about 0.89ºC from 1958 to 2018 (~0.15°C/decade). The past decade has seen the highest increase. During the same period, annual rainfall saw a slight increase with an average rise of about 5.5%. However, there was an opposite trend in specific areas. Furthermore, sea levels have also risen, with an average increase of 3.6 mm/year between 1993–2018, according to the Ministry of Natural Resources and Environment (2021).

Climate change has strong impacts on economy and society. According to Espagne et al. (2021) climate change has socio-economic impacts on sectors in Vietnam ranging from the economy to society and healthcare.

Society:

Infectious disease and mortality are two sensitive aspects of climate change. When studying the short-term effects of weather changes (temperature, precipitation, wind speed, heat waves, etc.) and the long-term effects of climate on infectious disease incidence in Vietnam, as well as the role of public health costs for adaptation and impact mitigation, Espagne et al. (2021) show how temperature and wind speed affect infectious diseases such as cholera, dengue fever, and flu. Climate change increases the direct and indirect costs associated with household healthcare. The report's estimates show that a 1% increase in infection rates results in a 0.049% decrease in average hourly wages. Meanwhile, adverse weather has a negative effect on the body's heat exchange, causing fatigue in labour and sports activities. Extreme weather increases the risk of stroke for the elderly and people with cardiovascular disease, and significantly increases influenza epidemics. Espagne et al. (2021) indicate that an extra day in a cold spell and heatwave is estimated to increase monthly mortality by 0.6% and 0.7%, respectively.

Economic:

The DARA International (2012) research report on vulnerability to climate change indicates that climate change can cost Vietnam about US$15 billion per year, or around 5% of GDP. If Vietnam does not have a timely response, the damage caused by climate change is estimated to reach 11% of GDP by 2030.

Espagne et al. (2021) estimate that annual cumulative direct economic loss is about 1.8% of GDP for a 1°C increase in temperature compared to pre-industrial (1851–1900) temperatures. These losses would rise to 4.5% of GDP for a 1.5°C increase in temperature, 6.7% for a 2°C increase, and up to 10.8% for a 3°C rise. By 2050, average macroeconomic and cross-sectoral losses could be about 30% larger than direct losses. In addition, the annual GDP loss due to hurricanes for the period 1993–2013 is estimated at 2.4%. In the event of uncertainty about the future impact of a storm combined with climate change scenarios, the minimum damage caused by a storm could equal this number. In addition, climate change will affect household income from agriculture. Indeed, the negative impact of weather shocks on poor households will be four times larger than the average.

Dasgupta et al. (2007) show that, if sea levels rise by 1 metre, 10.8 million people in the Mekong River Delta and the Red River Delta will be

affected, as will about 10.21% of GDP, 7.14% of agricultural land, 28.67% of wetlands, and 10.74% of urban areas.

Climate change impacts Vietnam's economy in many areas including agriculture, tourism, services, transport, energy, etc. The impact of climate change can, directly and indirectly, lead to stranded asset risks.

Direct impacts include changes in the natural environment or natural resources, and these can make assets prone to stranding in several industries. For example, a rise in sea levels can affect agriculture and transportation, to name just two. Meanwhile, changes in rainfall can affect hydropower, irrigation, and other sectors.

The indirect impacts of climate change that can cause stranded assets include changes in government regulation, technology, social norms or consumer behaviour, litigation, and statutory interpretation. A typical example is the commitment of governments to zero greenhouse gas (GHG) emissions that can affect sectors with large CO_2 emissions such as coal-fired power plants and the manufacturers of vehicles running on gasoline, oil, etc.

2.2. Policy framework regarding the response to climate change of Vietnam

2.2.1. Common Policy Framework

Since 2008, the Government of Vietnam has implemented the National Target Programme to Respond to Climate Change (NTP-RCC). One of its important elements is to develop and update climate change scenarios. Meanwhile, the National Strategy on Green Growth was approved in 2012. Its aim is to reduce GHG emissions and propose implementation solutions including the issuance of regulations related to the international carbon market. Then, in 2013, the Law on Natural Disaster Prevention and Control was promulgated to respond to natural disasters affecting the country, mainly phenomena caused by climate change. In addition, the Law on Environmental Protection 2014 and 2020 both contain provisions on climate change.

In the 2016-2020 period, the Government has approved the Target Programme to Respond to Climate Change and Green Growth in the 2016-2020 period; the National Programme on GHG Emission Reduction through Limiting Forest Loss and Degradation; the Conservation and Enhancement of Carbon Stocks and Sustainable Management of Forest Resources (REDD+) to 2030; and announced Vietnam's Intended Nationally Determined Contribution (INDC). Meanwhile, the Government's draft Decree on the mitigation of GHG emissions and the protection of the ozone layer is being finalised.

According to the Prime minister's Decision No. 1658/QD-TTg dated 1 October 2021 on the Approval of the National Strategy on Green Growth for the period 2021-2030, with a vision to 2050, green growth is an important way to realise sustainable development and reduce GHG emissions to archive a carbon-neutral economy in the long term.

2.2.2. Policy framework for sustainable finance

To adjust to the changing trends in economic development to be more environmental and social responsibilities, in recent years, the term "sustainable finance" has emerged as a strategic development direction in the banking sector. Sustainable finance refers to the process of considering environmental, social, and governance (ESG) factors when making investment decisions in the financial sector, leading to long-term investments in sustainable economic activities and projects[2].

[2] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainablefinance_en#:~:text=Sustainable%20finance%20refers%20to%20the,sustainable%20economic%20activities%20and%20projects

Bank development policy towards sustainability

The State Bank of Vietnam (SBV) has issued green banking development policies such as: The Action Plan of the Banking Sector (Decision No. 1552/QD-NHNN dated 6 August 2015); the Green Banking Development Project (Decision No. 1604/QD-NHNN); and credit programmes contributing to the efficient use of resources, creating livelihoods, improving living standards, solving environmental and social problems, prioritising the development of a number of industries and fields in the direction of in-depth investment, high technology, etc.

The state bank's Circular No. 39/2016/TT-NHNN has supplemented the regulation that credit institutions (CIs) can only grant credit when customers fully satisfy all legal regulations, including the Law on Environmental Protection. In 2017, the SBV issued Directive 01/2017/CT-NHNN which required strong implementation of the Action Plan of the Banking Sector until 2020.

In August 2018, SBV issued Decision No. 1604/QD-NHNN approving the Green Banking Development Project in Vietnam. This project sets out three specific objectives for the banking sector: (i) Gradually increase the proportion of credit for green sectors, (ii) Promote technology application and encourage environmentally-friendly habits for customers, and, (iii) By 2025, 100% of banks should carry out social and environmental risk assessments in credit granting activities and apply environmental standards to bank financing projects, while 60% of banks should have access to green capital and lend to green credit projects. The scheme also provides solutions and a roadmap for the implementation of these goals in the 2018 to 2025 period.

Other policies aiming to sustainably develop the banking industry include the Prime Minister's Decision No. 986/QD-TTg dated 8 August 2018 on a strategy for the development of the banking industry in Vietnam to 2025, orientation towards 2030, and the state bank's Decision No. 34/QD-NHNN promulgating the action programme to implement the Strategy on the Development of the Banking Industry in Vietnam to 2025, with orientation to 2030.

For the private sector, the Ministry of Finance's Circular 96/2020/TT-BTC of the Ministry of Finance guides information disclosure on the stock market and requires listed companies including banks and financial institutions to publish sustainability and ESG reports.

Credit policy towards sustainability

Sustainable credit, otherwise known as green credit, is one of the tools used to finance environmentally-friendly programmes, projects, and initiatives to encourage consumers and businesses to optimise, generate renewable energy, and care about environmental issues. In 2018, the SBV worked with the International Finance Corporation (IFC) to issue guidelines for credit institutions when granting credit to 10 sectors with the highest environmental and social risks. These sectors include agriculture, chemistry, infrastructure and energy, food and beverages, garment production, leather and textile products, oil, waste treatment and recycling, and mining and manufacturing of non-metallic mineral products.

The SBV was one of the earliest adopters of green credit policies. Before the Banking Sector Action Plan to implement the National Green Growth Strategy to 2020 was issued in mid-2015, the SBV issued Directive No. 03/CT-NHNN dated 24 March 2015 on promoting green credit growth and managing environmental and social risks in credit-granting activities. According to this Directive, credit institutions should focus on providing credit for projects and production and business plans that are environmentally and

socially friendly, supporting businesses to achieve green growth, promote green credit, and research and implement environmental and social risk management in the lending activities of credit institutions themselves.

The current policies regulating credit institutions are not yet specific for lending activities for investment and business projects that meet the requirements of green economic development. At the moment, the current policies only has general provisions on lending principles. The new credit policy only recommends measures to proactively develop green credit programmes and policies to gradually increase the proportion of green credit in the credit portfolio structure. The absence of specific regulations on green credit products is a huge barrier for organisations and individuals with capital demand for environmentally-sustainable projects.

Recently, the government of Vietnam has made efforts to issue specific regulations. The Law on Environmental Protection 2020 and the government's Decree 08/2022/ND-CP provide definitions of green bonds and green credits as well as roadmaps and incentive mechanisms to encourage green credit or green bonds. Accordingly, the Ministry of Natural Resources and Environment is primarily responsible for formulating and submitting to the Prime Minister for promulgation environmental criteria and certification for projects granted green credit or issuing green bonds before 31 December 2022. Currently, regulations on environmental criteria and certification for green credit and green bond issuance are being drafted. Earlier, in October 2021, the SBV prepared a draft Circular guiding the implementation of environmental risk management in the credit activities of financial institutions. The contents of this closely follow the provisions of the Law on Environmental Protection 2020.

Moreover, the key informant interviews show that **Vietnam's banking sector does not have yet a legal framework to respond to and handle the risk of stranded assets related to climate change. Currently, there are no public assessments or statistics on the scale and structure of outstanding loans for assets at risk of being stranded as a result of climate change in Vietnam.**

2.2.3. Policy framework for renewable energy

In addition to the protection-oriented incentives and environmental commitments mentioned above, the Vietnamese government has a series of regulations to encourage the development of renewable energy. According to the Prime minister's Decision No.11/2017/QD-TTg, organisations and individuals participating in the development of solar power projects are entitled to incentives in terms of investment capital, tax, and land.

In addition, EVN commits to buy electricity from solar and wind power projects at current prices and FIT (Feed-in-Tariffs) according to each period. For example, in 2019, the government issued the Prime Minister's Decision No.02/2019/QD-TTg and the Ministry of Finance's Circular No.05/2019/TT-BCT amending and supplementing several articles to encourage the development of rooftop solar power projects. According to this Circular, the electricity to be purchased by EVN for the rooftop solar power system will be US cents 9.35 /kWh. However, this FIT price expired on 30 June 2019 and, currently, there is no FIT price applied for this category.

In addition to solar, wind power is also entitled to incentives under the Prime Minister's Decision No. 37/2011/QD-TTg dated 29 June 2011 on the mechanism to support the development of wind power projects in Vietnam. This decision sets the price of wind power at 7.8 cents/kWh and, since this price was quite low, the number of wind power projects was limited. Later, the price of

wind power projects was limited. Later, the price of wind power increases according to the prime minister's Decision No. 39/2018/TTg dated 10 September 2018 on the mechanism to support the development of wind power projects in Vietnam. This set the price of wind power on land to US cents 8.5 /kWh (equal to VND 1,928 /kWh at the exchange rate of VND 22,683 /USD) and offshore to 9.8 US cents/kWh (equivalent to VND 2,223 /kWh at the above exchange rate). Wind power prices under this Decision are applied to partially or all grid-connected wind power plants with a commercial operation date before 1 November 2021 and this price will be applied for 20 years from the date of commercial operation.

It is worth noting that the purchase price of electricity with solar and wind power is much higher than the price of electricity from coal-fired power plants. According to the Ministry of Finance's Decision No. 354/QD-BCT dated 25 January 2018, the ceiling of the electricity-generation price bracket (excluding VAT, seaport costs, and shared infrastructure) applied for coal-fired power plants is regulated as follows (effective since 2018) (VND/kWh): Domestic coal-fired power (CS 2x300MW) is VND 1,597.22/kWh; imported coal-fired power (CS 1x600MW) is VND 1,536.76/kWh; and imported coal-fired power (CS 2x600MW) is VND 1,600.04/kWh. Therefore, there is a mechanism of cross-compensation for electricity from coal and hydroelectricity to wind and solar power. This is unlikely to last and an increase in retail electricity prices is inevitable as the share of wind and solar power increases in total generating capacity.

To avoid the risk of increasing electricity prices, the purchase price of wind and solar power is proposed to be reduced. For wind power, the Ministry of Industry and Trade proposes reducing the FIT price after 1 November 2021 as follows: For projects operating from November 2021 to the end of 2022, the applied purchase price is US cents 7.02 /kWh for terrestrial wind power (a fall of about 17% from the previous FIT price of US cents 8.5/kWh) and US cents 8.47 /kWh for offshore or nearshore wind power (a drop of about 13% compared to the previous FIT price of US cents 9.8 /kWh). Projects operating from 2023 onwards will apply prices of US cents 6.81 /kWh and US cents 8.21 /kWh, respectively.

FIT price cuts will affect investment in planned new wind power projects and create difficulties in attracting new investment. Wind power is on track to gain economies of scale and to reduce costs. However, with the proposed FIT pricing implemented, it will have a long-term impact, leading to higher energy prices at a time when energy demand is increasing. With a sharp price reduction without considering relevant challenges, Vietnam's wind power market may face a "boom-bust" cycle like countries in Europe and America.

In summary, the government has issued policies to encourage the development of renewable energy in response to climate change. However, they might not yet make significant and long-term changes. The main reason is the government must weigh the benefits and costs of switching to renewables against the economy as a whole. In addition, because one of the characteristics of renewable energy plants is an unstable electricity supply, there is still a need for thermal power plants to play the role of base load for the entire national electricity grid.

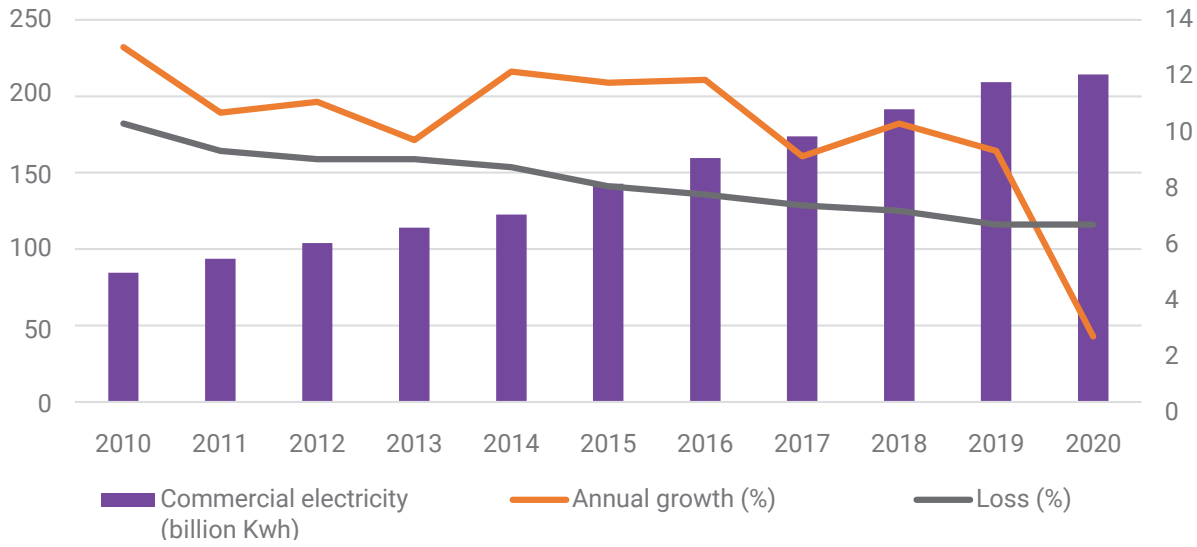
2.3. Stranded assets related to climate change: A case study of the power generation sector

2.3.1. Overview of the power generation sector in Vietnam

Current situation of the power generation sector in Vietnam

In terms of electricity demand, in recent years, electricity consumption in Vietnam has increased

Figure 2.1. Commercial electricity, growth rate and loss rate in the period 2010-2020



Source : EVN (2021) the draft Power Development Plan VIII – national electricity development in the period of 2021-2030 with a vision to 2045).

rapidly. In 2019, commercial electricity output reached 210.5 billion KWh. The average growth rate reached 10.5% a year for the whole period 2011-2019. The rate of electricity consumption decreased slightly in 2020 and 2021 due to the impact of Covid 19.

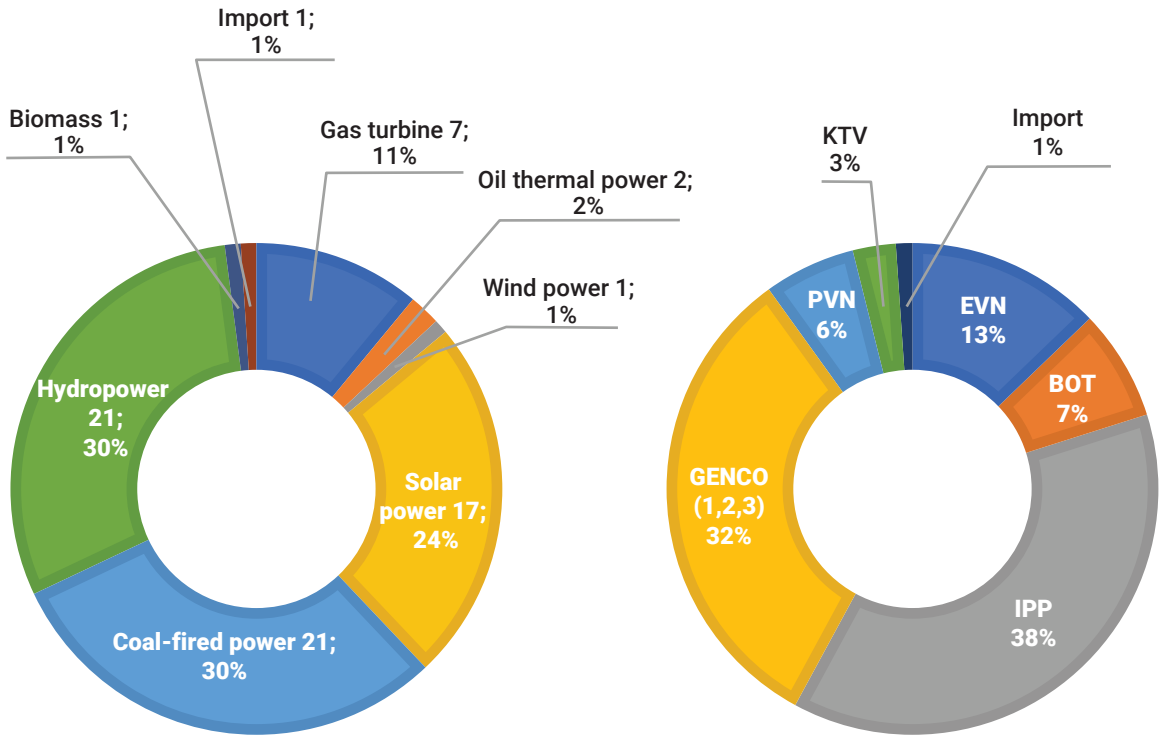
A strong rate of economic growth and rapid increased per capita income lead to a high demand for electricity. However, the efficiency of electricity use is still low. One indicator of efficient use of electricity is the magnitude of electricity per GDP. Figure 2.1 shows that the annual electricity intensity index tends to increase. This can partly be explained by changes in the energy use structure of households and businesses. The main reason is still the inefficient use of electricity in business and manufacturing industries.

The elasticity coefficient between electricity consumption and GDP growth tended to decrease slightly between 2001 and 2020. The elasticity coefficient for the 2001 - 2010 period is 2.17 times. This fell to 1.84 times in 2011- 2015 and again in 2016 - 2019 to 1.49 times. This shows that the trend of electricity use has changed positively.

However, electricity use is still inefficient. In 2017, Vietnam's electricity intensity per GDP was 996 kWh/USD 1,000 compared to China's 632, Indonesia's 221, and Singapore's 163. This shows that it is necessary to improve the efficiency of electricity use of the economy and especially to promote the process of economic restructuring towards green and sustainable growth.

On the power supply side, according to EVN estimates, by the end of 2020, Vietnam's power system would have a total capacity of about 69 GW (including hydroelectric plants imported from Laos and rooftop solar power plants). In addition, the Northern power system also imports electricity from China via transmission lines with a maximum capacity of about 700 MW. In the structure of national electricity capacity in 2020, coal-fired power accounted for about 30%, hydropower around 30%, solar power about 24%, and wind power around 1%. The maximum load capacity of the power system in 2020 was about 38.7 GW and the crude reserve ratio of the power system (except wind and solar) was 34.3%.

Figure 2.2. Capacity structure by source (GW; %) and by ownership in 2020 (%)



Source : EVN (2021)

In the 2011- 2015 period, the growth of power sources reached 13% a year. The fastest growth was seen in coal-fired power (27% a year, on average). Then, in the 2016 - 2020 period, the growth of power generation reached 12%, with growth in hydropower (5% a year, on average) and coal-fired power (10% a year, on average) decreasing significantly. Meanwhile, renewable energy has experienced a boom in installed capacity, now accounting for 26% of the total installed capacity of electricity.

Today, coal-fired power still plays a huge role in Vietnam's electricity supply. However, many plants use imported coal. Currently, those plants account for nearly a quarter of the coal power capacity in operation. For the coal power capacity under construction, this figure is expected to increase to 68%.[3] The increasing reliance on

[3] Global Energy Monitor, (2019). Global Coal Plant Tracker: https://globalenergymonitor.org/coal/global-coal-plant-tracker/

imports could impact upon the country's energy independence and security.

It is very noticeable that Vietnam is becoming a net importer of coal for energy needs. According to the Vietnam coal industry planning to 2020 with a vision to 2030 in the Prime Minister's Decision 403/QD-TTg, coal demand for thermal power was 64.1 million tons in 2020 and will be up to 131.1 million tons in 2030. However, also according to the above plan, domestic coal mining output is calculated to reach only 47-50 million tons in 2020 and 55-57 million tons in 2030. Domestic coal mining is not only used for coal-fired plants, but also for many other fields such as metallurgy, cement, fertilizer, and chemicals. These four groups are estimated to need 25.5 million tons of coal in 2030. Therefore, the total demand for coal production of the whole country in 2030 will be nearly 157 million tons, while the domestic mining capacity is only up to 57 million tons. As such, Vietnam faces the need to import up to 100 million tons of coal by 2030. A heavy reliance on imported coal will pose challenges as coal prices and supply are affected by a variety of factors.

Regarding the electricity market, Vietnam has reformed its power sector towards creating a more competitive market.[4] Before 2012, EVN monopolised the production, transmission, and distribution of electricity. The Electricity Law of 2004 initiated the restructuring of EVN to encourage private sector participation. With the establishment of the Vietnam Competitive Generation Market (VCGM) in 2012, power generation companies under EVN and the Independent Power Producers (IPP) started selling electricity to a single customer, the Electric Power Trading Company (EPTC). Then, in 2016, Vietnam started to pilot a wholesale electricity market (currently in operation). This allowed electricity producers to sell electricity to industrial customers on the spot market. As expected by the government, a fully competitive retail electricity market will be implemented by 2023, allowing consumers to choose their suppliers.

Vietnam's energy sector development plan

At the COP-26 conference in Glasgow (Scotland, UK), Vietnam and nearly 150 other countries committed to bringing net emissions to "zero" by 2050. Meanwhile, more than 100 countries joined the pledge to reduce global methane emissions by 2030; 140 countries signed the Glasgow Declaration of Leaders on Forests and Land Use; and 48 countries joined the Global Declaration on the transition of coal power to clean energy. Vietnam has committed to halting investments in new coal-fired power plants and phasing out coal-fired power by 2040. Vietnam has also pledged to cut GHG emissions by up to 30% by 2030.[5]

In the draft Power Development Plan VIII (April 2022), the total power source capacity by 2030 is expected to be about 146,000 MW (excluding rooftop solar power and cogeneration power sources). That is a fall of 35,000 MW compared to the plan submitted to the government a year ago. Meanwhile, the total installed power capacity in the national electricity system will increase to 217,596 MW in 2035 and reach about 401,556 MW in 2045.

[4] World Bank, (2016), Fourth Energy Sector Reform Building Policy Campaign: http://documents.worldbank.org/curated/en/539451470822913319/pdf/107674-PGID-P157722-Initial-ConceptBox396301B-PUBLIC-Disclosed-8-9-2016.pdf

[5] The 30% level is higher than the 27% commitment in Vietnam's Nationally Determined Contribution (NDC), 2020

Table 2.1. Proportion of capacity by power sources in the period 2025 - 2045

Target/Year	2025	2035	2045
Coal-fired power/biomass/ammonia	29.3	17.7	9.6
LNG, switching to LNG/hydrogen	11.1	7	3.8
Gas turbine using LNG, new hydrogen	3.6	14.8	8
Hydrogen-powered thermal power	0	3	7.2
Coal power, oil-fired gas turbines	0.6	0	0
Hydropower (including small hydropower)	27.2	15.9	9
Wind power on shore, near shore	13.8	12.6	14.3
Offshore wind power	0	8.5	17
Large-scale solar power	8.9	11.8	19.4
Biomass electricity, other renewable energy	1	1.5	1.3
Stored hydroelectricity, storage battery	0	3.6	7.5
Import	4.5	3.7	2.8

Source: the draft Power Development Plan VIII, latest draft April 2022, pending approval

Therefore, according to the plan, coal power will be lowered with the proportion gradually decreasing from 25.7% in 2030 to 9.6% in 2045. Coal power projects under construction will continue to be implemented (about 10,842 MW). However, cogeneration coal power sources (total capacity: 2,850 MW) will not be balanced into the planning and new coal power plants will not be developed. According to the plan, BOT coal power plants that have been assigned to foreign investors continue to be included in the planning to avoid litigation issues for the government. However, their implementation will be closely monitored and fuel conversion negotiated wherever possible. The draft of Power Development Plan VIII also encourages the development of offshore wind power, stored hydroelectricity, biomass power, battery storage, as well as direct solar power (self-sufficiency, on-site consumption) for production facilities.

Many coal-fired power plants nationwide have not been considered for development in the near future in areas such as Hai Phong, Quang Ninh, Long An, Bac Lieu, and Tan Phuoc. They have been replaced by other LNG sources.

However, to meet the commitments in the latest draft Power Development Plan VIII (April 2022), Vietnam will have to raise a large amount of investment capital due to the need to add more renewable energy to replace coal power sources that cause GHG emissions. Raising capital for investment in replacing old and expired coal power plants with low $C0_2$ emission modern

thermal power plants and renewable energy power plants is a big challenge for Vietnam.

According to EVN's calculations, the latter plan has a total investment of nearly USD 141.6 billion. In this, the power source is USD 127.45 billion and the transmission network is USD 14.14 billion. The total cost of operating the system by 2030 will be USD 317.24 billion.

Power Development Plan VIII aims to move towards a cleaner energy future for Vietnam. However, many challenges remain with the transformation of the energy sector.

2.3.2. Climate change and its impact on the energy industry in Vietnam

Climate change is expected to have a significant impact on Vietnam's energy system both in terms of electricity supply and demand. The results may vary depending on the forecasting models.

The forecast of the draft Power Development Plan VIII (IEVN, 2021) estimates that the demand for commercial electricity by 2045 will increase by 3.54 times compared to 2020 in the low scenario and up to more than 5 times for the high scenario. This forecast is based on the expected GDP growth rate, economic growth rate, electricity price, and the ability to save electricity. This scenario does not take into account changes in electricity demand due to climate change.

Table 2.2. Forecast of electricity demand nationwide to 2045

Year	2020	2025	2030	2035	2040	2045
Commercial Electricity (TWh)						
Low scenario	216.8	330.2	457.6	547.8	678.9	768.4
Base scenario	216.8	335.3	461.3	649.4	774.6	887.1
High scenario	216.8	346.6	530.5	734.7	932	1,089

Source: IEVN (2021) The draft Power Development Plan VIII

However, climate change with rising temperatures may further increase demand for electricity more than is normally forecast. Holding other uses constant, Espagne et al. (2021) find that each additional degree Celsius is estimated to increase household electricity consumption by 4.86% (95% confidence interval) and energy demand of businesses by 4.31% (95% confidence interval: 0.031–0.056). These effects, plus the expected economic growth rate of 5%-6% per year, will put great pressure on the power generation sector in the long term.

The research results of Espagne et al. (2021) show that electricity demand will increase significantly compared to the business-as-usual scenario caused by the increase in temperatures. Under scenarios RCP4.5 and RCP8.5, demand rises from 2.8% to 5.2% in 2050. This increased demand for electricity results in a corresponding soar in primary energy supply (due to an increase in the input fuel for power generation) from 1.3% to 2.4%. GHG emissions from power generation will also increase from 1.9% to 3.6% by 2050 under scenarios RCP4.5 and RCP8.5, respectively.

Espagne et al. (2021) suggest that if the current consumption pattern remains unchanged, residential electricity consumption will increase by more than 80% by 2050.

On the supply side, changes in precipitation and temperature can affect energy production, transmission systems, or infrastructure (World Bank, 2011; Ciscar & Dowling, 2014; Perera et al., 2020). Climate change affects thermal power plants as changes in air and water temperature will have an impact on their power generation efficiency. Higher air temperature will reduce the power generation efficiency of these plants while rising water temperatures can adversely affect the operation of their cooling systems.

Rising sea levels, changes in wind speed and cloud cover, as well as in the frequency and intensity of extreme weather events will have a direct impact on energy sector infrastructure. Irregular rainfall and runoff affect the ability to supply and regulate the electricity production plans of hydroelectric plants. They can also damage infrastructure such as power distribution networks, oil rigs, oil and gas transportation systems, and gas-fired power plants built along the coast. Meanwhile, the fossil fuel mining sector will be affected by climate change and extreme weather. Coal mining in Quang Ninh and the prospect of brown coal mining in the Red River Delta will become more difficult due to the increased possibility of loss caused by the increased frequency and intensity of storms and floods.

Oil and gas extraction operations outside the continental shelf and the refining and petrochemical industries must increase operating, maintenance, and repair costs for machinery and vehicles. It will be more difficult for the system to transport oil and gas from offshore rigs to petrochemical plants.

Some important regulations on climate change that will affect fuel and energy production demand and costs include: Fuel quality and performance standards; energy efficiency standards; air quality regulations; regulations on renewable energy; and standards and regulations related to emissions and applicable technology.

2.3.3. Stranded assets in the energy industry

Changing the economic structure in a greener direction and the commitments of the Vietnamese government at COP-26 will have a significant impact on the assets of the economy in general and the power sector in particular. Coal-fired power plants are most at risk of becoming stranded assets. This is defined as a plant that is in danger of being written-off, devalued, or falling into bankruptcy because it has to be closed early to meet GHG emissions targets. Simply put, a thermal power plant is stranded when its operating costs are greater than its revenue (given that emissions requirements are met)

Factors affecting stranded assets in the electricity industry in Vietnam

As mentioned, assets are stranded when they are no longer profitable as expected. From a financial perspective, the determination of the size of stranded assets is primarily influenced by the plant's costs and revenues. These factors affecting revenue and operating costs can be divided into (i) subjective factors (belonging to the enterprise), and (ii) objective factors (external to the enterprise).

+ Subjective factors

Subjective factors affecting the risk of stranded assets include:

(i) Fuel costs: Fuel costs include costs incurred by purchasing, transporting, and preparing coal. At present, most of Vietnam's thermal

power plants use imported bituminous coal, so if there is a big fluctuation in coal price, it will increase the operating costs of the plant.

(ii) Technology used by the plant (installed capacity of the unit, status of the unit, year of operation of the unit, type of combustion technology, type of coal, heat level, emission factor).

Different technologies can be used such as: Subcritical technology (imported coal or domestic coal), supercritical technology, and ultra-supercritical technology. Environmental control technologies are installed (for nitrous oxide, sulphur dioxide, and dust) and these, as well as the type of cooling technology, are also factors that affect the operating costs of the plant.

The efficiency of coal power plants depends on steam parameters. Most existing coal-fired power plants have subcritical, high, and medium-pressure steam parameters. Plants using coal-fired furnace technology currently have an efficiency of 38%-41%, only a few have lower efficiency due to their long operation such as Ninh Binh (23%) and Pha Lai 1 (30%). Some newly built plants have supercritical parameters such as Vinh Tan I, Vinh Tan IV, and Duyen Hai III. Most current coal-fired power plants have installed exhaust gas purification equipment to maintain emissions within permissible levels according to Vietnamese standards (such as electrostatic precipitators, SO_2 reduction, NO_x reduction, and continuous emission monitoring systems). However, there are still some old factories such as Pha Lai I, Ninh Binh that have not applied SO_2 reduction technology. Regarding the self-consumption of coal-fired power plants, newly operated plants such as Vung Ang I, Thai Binh I, Vinh Tan, and Duyen Hai Power Centers have a low self-use rate of about 8% while old plants have self-use rates from 10%-13%.

Thermal power plants built in previous period with outdated technology and high emissions will have to invest in additional waste gas treatment systems and upgrade their equipment, reduce environmental impacts and, at the same time, improve performance. This can increase costs and can lead to inefficient maintenance.

(iii) Operating and maintenance costs including fixed and variable costs

Fixed operating and maintenance costs depend on the boiler's combustion technology. The IEA report (2015) estimates USD 13 /kW for subcritical technology; USD 17 /kW for supercritical technology; USD 20 /kW for ultra-supercritical technology; USD 31 /kW for Integrated Coal Gasification Combined Cycle (IGCC); and USD 117 /kW for circulating fluidized bed combustion technology. Similarly, operating and maintenance costs vary depending on boiler combustion technology and unit capacity: USD 5.42/MW for subcritical technology; USD 4.34/MW for supercritical technology; USD 4.07/kW for ultra-supercritical technology; USD 31/kW for IGCC technology; and USD 7/MW for circulating fluidized bed combustion technology[6].

In addition, operating and maintenance costs must be taken into account in order to meet environmental protection requirements. This cost includes fixed operation and maintenance (USD/kW/year) and variable operation and maintenance (USD/MWh).

[6] Carbone Tracker Estimates (2019)

(iv) Extraction rate

A peculiarity of power plants is that their extraction capacity may be different from the designed capacity. The extraction capacity depends on the demand and power transmission capacity at each stage of development. High or low extraction rates affect the factory's revenue.

+ Objective factors

Objective factors affecting the operational efficiency of coal-fired power plants include:

(i) Government regulations to limit pollution

Changes in environmental and emission standards (dust, gas emissions, etc.) will increase operating costs and reduce the profits of coal-fired power plants. In order to reach the zero carbon target, the government will require the closure of coal-fired power plants that no longer meet environmental requirements. If so, the assets of these factories will become stranded assets. Environmental regulation affects the long-run marginal cost (LRMC) of a coal-fired power plant due to the additional costs of pollution remediation.

According to government regulations, thermal power plants need to meet environmental standards at the time of investment. However, environmental standards are also changing constantly. Currently, previously built thermal power plants have to upgrade technology to treat dust and waste discharged to the environment. Ministry of Finance's Circular No.57/2020/TT-BCT dated 31 December 2020 regulating methods of determining electricity generation prices and power purchase and sale contracts, permits the inclusion of upgrading dust and smoke treatment technology to electricity prices (following consultation with the Ministry of Industry and Trade and the Ministry of Finance).

(ii) Policy on taxes and fees related to GHG emissions

Changes in taxes or fees related to GHG emissions can increase the operating costs of coal-fired power plants. Moreover, if Vietnam applies the market for trading GHG emission certificates, it will also increase the operating costs of thermal power plants because most of these plants are net emitters of GHGs. Currently, Vietnam has not yet applied a carbon tax for thermal power plants. Only a number of thermal power plants using Official Development Assistance (ODA) loans have had to pay a fee to buy carbon certificates as committed when borrowing capital[7].

(iii) A competitive electricity trading market

Coal-fired power plants can derive revenue from sources within the market (e.g., the wholesale electricity market) and outside the market (e.g., ancillary services, power balance, and capacity market). Currently, the electricity market in Vietnam only stops at competitive wholesale electricity purchase. Therefore, if the market moves to competitive retail, coal-fired power plants will have some price advantages at the beginning. However, with increased operating costs, this advantage will soon disappear.

(iv) Cost of capital

The majority of investment capital for

[7] Results of interviews with managers of GENCO 1 power generation corporation

coal-fired power plants in Vietnam comes from loans. Therefore, the cost of borrowing has a large influence on the operating efficiency of factories. Because interest is an important component in the cost of electricity production, and the payback period and related costs are taken into account in the process of project planning, if a power plant has to stop operating before the committed period in the financed project, all stakeholders (financers and borrowers) will be affected. In fact, all BOT projects in the power generation sector have a commitment to the project's operating time. Therefore, it will not be easy if the government wants to stop BOT factories to reduce GHG emissions.

The role of loans for thermal power plants can be seen more clearly through the survey results with Hai Phong Thermal Power Joint Stock Company. The appendix shows both domestic and international financers to this company to construct Hai Phong 1 and Hai Phong 2 thermal power plants. Because these loans are preferential, the interest rate is quite low and the repayment period is long. Up to now, almost all loans have been paid off by Hai Phong Thermal Power Joint Stock Company. Therefore, the shutdown in 2030 (if any) does not affect the financers.

However, it should be noted that countries such as Japan[8] and those in the EU have announced that they will stop financing coal-fired power projects. Concessional loans with low interest rates for the energy sector in Vietnam are geared towards renewable energy. Therefore, Vietnam's coal-fired power projects will no longer be able to benefit from low capital costs as in the past. In other words, new coal-fired power plant projects will have to borrow capital at a higher cost and have a longer repayment period. This factor might cause the risk of stranded assets if a coal-fired power project is forced to stop operating before the scheduled time.

Meanwhile, renewable energy projects enjoy many incentives from both domestic and foreign financial institutions. From 2017, after the government issued Decisions on the mechanism to support the development of renewable energy projects, commercial banks has begun to develop credit policies for renewable energy projects. As of September 2020, 17 out of 35 domestic commercial banks have developed lending policies for renewable energy. Along with the implementation of credit policies for the renewable energy sector, a number of commercial banks also made commitments to support credit packages. For instance, VCB and the Japan Bank for International Cooperation signed a 14-year cooperation credit agreement of USD 200 million (equivalent to VND 4,600 billion) to finance renewable energy projects. Similarly, TPBank is cooperating with Bamboo Capital Group to sponsor VND 11,000 billion for renewable energy projects and HDBank has provided a credit package of VND 7,000 billion for clean energy projects. Likewise, VPBank has lent green credit worth USD 212.5 million (equivalent to VND 4,800 billion). One-third of this financial package will be for renewable energy. This shows that the attention and investment redirection of commercial banks has created a premise for the development of renewable energy, contributing to ensuring national energy security.

(v) Competition with other types of energy supply

[8] https://www.vietnamplus.vn/nhat-ban-dung-cap-oda-cho-cac-du-an-nhiet-dien-chay-than-o-nuoc-ngoai/688309.vnp

Until now, the cost of electricity generation from coal-fired power plants in Vietnam is still considered relatively cheap compared to other forms of electricity generation (mainly plants using old subcritical technology). The main reason is that Vietnam's regulations on the environment and GHG treatment are not as strict as other countries. If Vietnam applies a carbon price equivalent to the European emission trading system and implements air pollution regulations similar to those of developed countries, it is likely that coal-fired electricity generation will be much more expensive (Carbon Tracker, 2019). Moreover, some plants have been in operation for a long time and have almost finished depreciating.

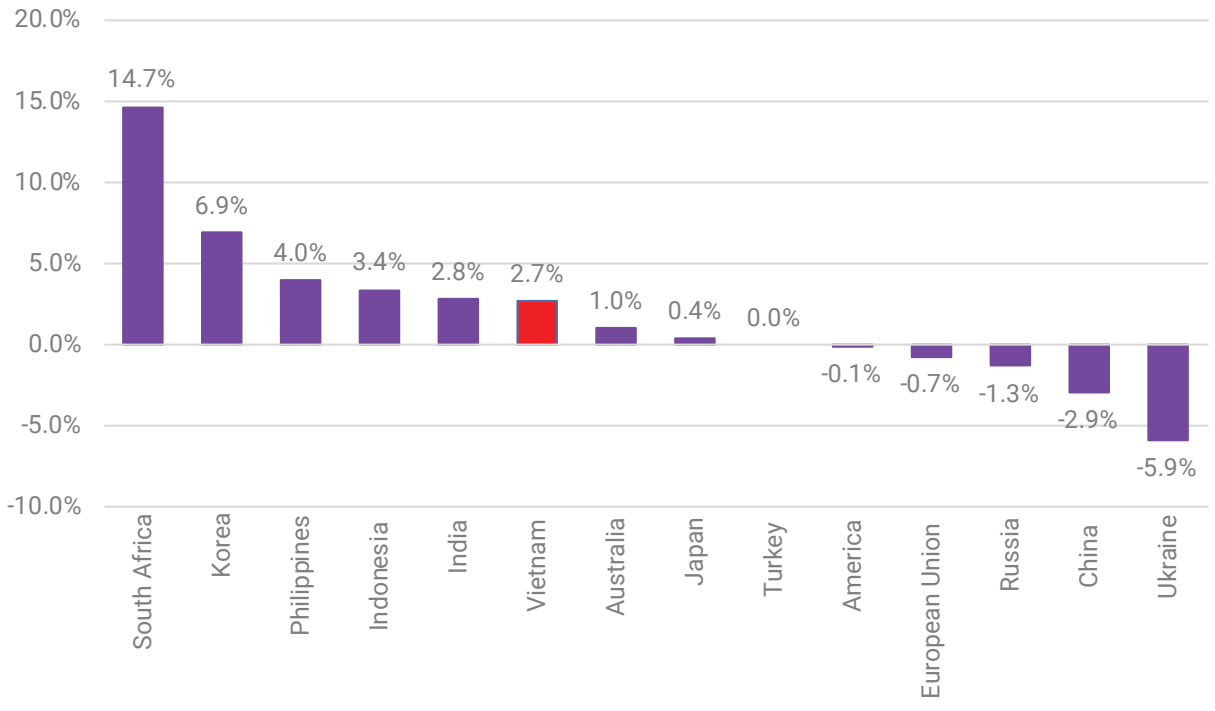
In the long term, along with technological progress and environmental requirements, the cost of generating electricity from wind and solar will gradually become more competitive with coal power.

The scale of stranded assets in the energy industry

McKensey (2022) reports that Vietnam is one of the countries strongly influenced by international commitments towards zero carbon. The main reason is that many coal-fired power plants in Vietnam have a shorter lifespan than those in developed countries.

Carbon Tracker (2019) uses the net cash flow

Figure 2.3. Risk of stranded assets due to coal power operation of countries, as of GDP in 2018



Source : Carbon Tracker - Here comes the Sun (and Wind), 2019

(NPV) comparison method to calculate the risk of asset entanglement with coal-fired power plants. According to this study, the risk of assets being stranded in the below 2°C scenario is defined as the difference between the Net Present Value (NPV) of cash flow in a below 2°C scenario (all coal-fired power plants phased out by 2040) and the NPV of cash flow in the business-as-usual scenario (including only those announced shutdowns stated in the normal scenario).

In Vietnam, the below 2°C scenario estimates the value of assets at risk of being stranded at USD 6.5 billion, equivalent to 2.7% of Vietnam's GDP in 2018. The risk of assets being stranded is the difference between the cash flows that companies can receive in the current Vietnamese electricity market and what they would receive in a less than 2°C scenario – when coal power phases out early to achieve the temperature target set out in the Paris Agreement on climate change.

However, Carbon Tracker's report did not account for out-of-the-ordinary changes that could affect coal electricity profitability such as commodity prices, environmental policy, market structure, and technology costs.

2.3.4. Risk of stranded assets: Case study of Quang Trach I Thermal Power Plant

To better examine the risks of stranded assets, we investigate further a specific case study at Quang Trach I Thermal Power Plant[9]. Quang Trach I Thermal Power Plant was approved by the Prime Minister in Decision No.428/QD-TTg dated 18 March 2016 on adjusting the National Power Development Master Plan for the period 2011-2020, with a vision to 2030 (Adjusted Power Development Master Plan VII).

The plant is located in Vinh Son village, Quang Dong commune, Quang Trach district, Quang Nam province. It includes two units with a total installed capacity of 1,200MW and commercial electricity output of about 7.8 billion kWh/year when connected to the national grid.

The project has a total investment of USD 1.86 billion. It aims to supplement the power supply, ensure national energy security, improve the safety and stability of the power grid system, increase the proportion of thermal power sources in the structure of the national power system, and overcome the system's dependence on hydroelectric power. Unit I of the plant is expected to be operational in June 2024.

Quang Trach I Thermal Power Plant uses ultra-supercritical technology USC with a direct-flow boiler and a direct injection coal-fired traditional steam condensate turbine with supercritical parameters: Main steam pressure of 26.9Mpa, main steam temperature of 600°C, and re-drying steam temperature of 610°C. This is the most advanced technology and the highest factory parameters found in Vietnam today and is used in many developed countries. In particular, the plant's coal conveyor, desulfurization, and dust removal systems all follow European standards. Therefore, the concentration of substances in the exhaust gas and wastewater treated before being discharged into the environment will meet environmental standards of the state and those of the World Bank. Regarding gas emissions, the plant will apply SO_x treatment using Sea-FGD technology. This method creates sulfate salts, which are readily available in seawater, thus, there will be no impact on the aquatic environment. Quang Trach I Thermal Power Plant uses imported bituminous coal with burn-out properties, so the residual carbon content in the ash and slag will be extremely low.

[9] This is project has quite complete information and is in the investment phase and will operate in the period 2025-2045.

Table 2.3. Expected business results in the first year (units: million VND)

No.	Criteria	CY1	Coal prices increase 18%
I	**Income**	**12,781,936**	**12,781,936**
1	Revenue from electricity sales	12,781,936	12,781,936
2	Other benefits obtained from the project (if any)		
3	Subsidy (if any)		
II	**Total cost**	**12,755,006**	**13,728,668**
1	Fixed operating and maintenance fees	1,077,994	1,077,994
2	Variable fees	5,611,885	6,585,547
2.1	Cost of main fuel (coal)	5,411,225	6,385,245.5
2.2	Fuel cost of oil DO	22,995	22,995
2.3	Cost of limestone auxiliary materials	0	0
2.4	Cost of auxiliary materials NH_3	36,041	36,041
2.5	Cost of water auxiliary materials	2,194	2,194
2.6	Other costs (regular maintenance and repair)	139,071	139,071
3	Fuel transportation fees	759,566	759,566
4	Fees for using infrastructure	337,982	337,982
5	Depreciation	2,463,637	2,463,637
6	Natural Resources Tax (N/A)		0
7	Interest expenses + fees	2,503,942	2,503,942
III	**Profit before tax**	**26,930**	**-946,732**

Based on the collected information[10], the study develops a scenario about the efficiency of the plant when it enters into operation.

In order to invest in thermal power plants, debt capital accounts for 70% of the total capital. The debt has an interest expense of 10% a year, with a grace period in the first four years of construction and interest payments in the first 10 years when the factory is put into operation. In the first year of operation, the main fuel cost of coal accounts for more than 96% of the total variable costs and

[10] For more detail, refer to Annex 1,2

makes up 52.7% of the total costs (excluding interest expenses and fees). Therefore, the cost of coal fuel accounts for a large proportion of the cost structure of the thermal power plant. The ratio of expenses (excluding interest and fees) to revenue is 80% and the ratio of coal fuel cost/revenue is 42.3%. Thus, a dollar of revenue generated must cover 0.8 dollars of expenses (not including interest) and 0.423 dollars of coal fuel cost. Currently, in the business plan of the power plant, the selling price of electricity remains unchanged and stable and the coal purchase price is estimated at VND 1,663,302/ton (equivalent to USD 74.2 /ton at the exchange rate of USD 1 = VND 22,400). This estimated coal price is much lower than the current global coal price.

If the price of coal increases by 18% and all other factors remain the same, the power plant's pre-tax profit will be negative. Since Quang Trach 1 Thermal Power Plant will use imported bitumen coal, if we calculated net profit using the current price of imported coal (the price of bituminous coal in February 2022 fluctuates around USD 240/ton)[11], the net profit of the project will be negative. If the price of coal doubles compared to one in the business plan (equivalent to USD 144/ton), the project's pre-tax profit in year 1 will be about VND -5,383,936 million (in the first year the project is exempt from CIT). Therefore, the first year's net operating cash flow of the project (profit after tax + depreciation) will be VND -2,900,000 million /year. Thus, if we use the market coal price, the project will not generate a positive cash flow. In other words, the factory is at risk of becoming a stranded asset. This is one of the reasons why Quang Trach 2 Thermal Power Plant was converted to use imported LNG.

The fact that the factory is at risk of becoming a stranded asset puts financer of the plant at risk of not recovering enough capital invested. The capital structure of the project shows that the capital source for the factory implementation is mainly from debt (70%). If the coal price is adjusted up, the cash flow of the plant will be negative, thereby making it difficult for the power plant to pay interest and principal to creditors. From an investor's perspective, they will face the risk of losing their capital.

[11] https://tradingeconomics.com/commodity/coal) accessed on 15/02/2022

SECTION 3:

CONCLUSIONS AND POLICY RECOMMENDATIONS

Vietnam faces great opportunities and challenges when trying to meet the goal of reducing GHG emissions to net-zero. Several policies need to be considered in the coming time to limit the negative impacts of climate change and reduce the risks of stranded assets related to climate change.

3.1. Conclusions

Vietnam is one of the countries most affected by climate change. Governments and companies are increasingly committing to climate action. Yet significant challenges stand in the way, not least the scale of economic transformation that a net-zero transition would entail and the difficulties of balancing the substantial short-term risks of poorly prepared or uncoordinated action with the longer-term risks of insufficient or delayed action.

The transition could result in a gain of about 200 million and a loss of about 185 million direct and indirect jobs globally by 2050. This includes demand for jobs in operations and in the construction of physical assets. Demand for jobs in the fossil fuel extraction and production and fossil-based power sectors could be reduced by about nine million and four million direct jobs, respectively, as a result of the transition. Meanwhile, demand for about eight million direct jobs would be created in renewable power, hydrogen, and biofuels by 2050. While important, the scale of workforce reallocation may be smaller than that of other trends including automation. Displaced workers will, nonetheless, need support, training, and re-skilling through the transition[12]. While the transition will create opportunities, high-emission product or activity sectors – generating about 20% of global GDP – will face significant impacts on demand, production costs, and employment.

This report shows that, in addition to the socio-economic effects in general, climate change can also cause property risk in many sectors. One of the industries that will be directly affected when Vietnam implements its COP-26 commitments is energy (including coal power generation enterprises and sponsoring financial institutions). The risks of stranded assets in the energy industry has received very little attention in Vietnam while this is a sector with a very large scale of assets. The interviews emphasise that Vietnam does not have its own policy to deal with the risks of stranded assets caused by environmental factors.

Therefore, although there are existing policies and regulatory frameworks related to climate change, Vietnam still needs specific action programmes in each sector/field and greater participation from businesses and citizens.

3.2. Policy recommendations

Governments and companies are increasingly committed to climate action. There are, however, significant challenges as the brown-to-green economic transition is a resource-intensive process. Stakeholders also face many difficulties in balancing short-term and long-term issues. Short-term risks are caused by poorly prepared or poorly coordinated actions. Meanwhile, long-term risks arise due to no specific action plan or delays in responding to the impacts of climate change.

Vietnam faces great opportunities and challenges when trying to meet the goal of reducing GHG emissions to net-zero. Several policies need to be considered in the coming time to limit the negative impacts of climate change and reduce the risks of stranded assets related to climate change.

[12] Mc Kensey (2022)

Recommendations for the government

- Support studies on the risks of stranded-asset risk related to climate change.

  The government should continue to support research related to climate change, including in-depth studies on finance, on asset risks related to environment across the economy. Interviews highlight that Vietnam has not really had specific policies to deal with the risks of stranded assets related to climate change.

  To have policies to deal with the risk of stranded assets, it is necessary to study each affected economic sector such as agriculture, transport, tourism, etc. In addition, it is also necessary to study the effects of climate change on poverty alleviation, inequality, and people's livelihoods.

- Developing a voluntary carbon market.

  Carbon credits can become an important vehicle for financing net-zero transformation as it encourages and complements companies' efforts to reduce the carbon footprint of their operations. Therefore, it is necessary to quickly finalise the carbon market development project.

- Pricing externally to the environment to rebalance incentives.

  The government could consider applying different levels of emission fees to encourage investment in emission-reduction projects. The government could also develop policies to encourage coal-fired power plants to invest in technology to reduce GHG emissions. Social costs due to negative externalities related to environmental protection and GHG emissions should also be fully accounted for when formulating power plant projects. This ensures fairness in the selection of future power projects.

- Support low-carbon investment and consider support through public-private partnership (PPP) projects.

  It is not always easy to mobilise capital for the transformation of the power supply model from brown to green. Therefore, supportive policies such as implementing loan guarantee commitments for coal-fired power plants converted to renewable energy could be applied. PPP projects are also a way to transition from brown to green energy.

- Financial support for limiting or preventing the use of stranded assets.

  The government could buy back old coal-fired power plants and then shut them down ahead of time. After that, the government could require owners to invest in low-emission energy projects. In this case, it is possible to mobilise multilateral or government funds to limit the risk of stranded assets. The government could also consider subsidising consumers, especially low-income households, if the transition to energy consumption yields higher net benefits.

Recommendations to financial institutions

- Scaling-up green finance.

  Many public and private financial institutions have committed to net-zero emissions and finance activities tied to the net-zero transition. More finance will be needed, even in the transition. This can come from both traditional finance and more specialised instruments such as green bonds or concessional credits for renewable energy or investment in technology to reduce GHG emissions.

- Research and develop new financial instruments and products.

  New financial products can help companies better handle the risks of stranded asset. Among the possible solutions is the

development of financial products that enable companies to transition from older high-emission assets and phase them out to move into low-emission assets. To support converted coal-fired power plants, the government could support the development of longer-term financial products, such as fixed-price power purchase agreements from low-emission plants.

- Carefully review loans and investment to coal-fired power plants.

  In order to avoid the risk of stranded assets leading to non-recovery of loans, financial institutions need to carefully consider financed projects in coal power not only in financial terms but also in terms of technical aspects such as: Commitments on technology used, GHG emissions, operation duration, input materials, etc and social and environmental aspects.

- Develop risk contingency plans with current coal-fired power projects.

  Facing the risks of stranded assets, financial institutions need to have a plan to prevent and handle risks in case coal-fired power plants are forced to stop operating before schedule.

Recommendations to power generation enterprises

Power generation enterprises need to closely monitor the government's policy commitments, Power Development Plan VIII, and GHG emission plans in each period to be able to choose the most suitable investment projects in thermal power.

Based on the assessment of electricity demand and commitments to support electricity use, power generation enterprises need to develop a plan in accordance with the national strategy on GHG emissions. At the same time, these enterprises also need to have an investment plan for treatment technology to reduce GHG emissions. Furthermore, in the long-term, when designing coal-fired power projects, it is necessary to take into account the increased costs related to environmental aspects (carbon emission fees, environmental protection taxes, etc.).

3.3. Potential research topics

- Expanded and in-depth research on the risk of stranded assets related to climate changes in the power generation sector.

It is necessary to add projections of the total stranded assets of coal-fired power plants in 2050, the costs to achieve the commitment to net-zero emissions, and its implications for prices and effects on vulnerable groups.

- In-depth studies on the risk of stranded assets in others industries that are vulnerable to climate change such as agriculture, irrigation, and tourism.

- Research alternatives or response methods, consequences, and impacts on businesses, the economy, and the poor when stranded assets occur.

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APPENDIX 1:

Loan sources and interest rates for plant investment of Hai Phong Thermal Power Joint Stock Company (as of the end of 2020)

Bank	Currency	Maturity	Annual interest
The Import-Export Bank of China (i)	USD	2021	5.78%
The Import-Export Bank of China (ii)	USD	2024	6.07%
Japan Bank for International Cooperation (iii)	JPY	2021	3.91%
Japan Bank for International Cooperation (iv)	JPY	2022	4.41%
VietinBank - Hoan Kiem Branch (v)	VND	2022	12 month VND deposit interest rate + 2.8%

APPENDIX 2:

INFORMATION ABOUT QUANG TRACH THERMAL POWER FACTORY

Table 1 : Parameters and operating modes of the factory

Category	Unit	Value
Project life	year	30
Depreciation period	year	15
Coal consumption rate with load at 85% (according to TT56)	kg/kWh	0.4400
Oil consumption rate	kg/kWh	0.0002
NH3 consumption	tons/year	3,146.00
Water consumption	m^3/year	2,437,500.00
Coal price	VND/ton	1,663,302
Oil prices	VND/ton	17,058,480
NH_3 price	VND/ton	11,570,500
Clean water price	VND/m^3	900

Table 2 : Electricity price

Electricity selling price (VND/kWh) without infrastructure usage price	1,596.94
Electricity selling price (VND/kWh) including infrastructure usage price	1,640.31
I. Power generation price in the base year	1,499.46
1. Average fixed price	640.95
2. Fixed cost of operation and maintenance. Base year	138.34
3. Base year variable price	720.17
II. Fuel transportation price base year	97.48
III. Price to use infrastructure	43.37

Table 3 : Capital structure

Criteria	Value
Equity ratio	30%
Loan ratio	70%
Local currency loan	VND 27,069,647 million
Borrowing interest rate in local currency	10%

Table 4 : Results of project financial analysis

NPV	VND 5,940,594 million
Payback period	17 years
Profitability Ratio (NPV/I)	12.96%

OXFAM

Oxfam is a global movement of people who are fighting inequality to end poverty and injustice. There are currently 21 member organizations working in 70 countries, who coordinate and lead this fight via the Oxfam International Secretariat.

Oxfam in Vietnam believes that a reduction in poverty, injustice, and inequality will occur through the interaction between active citizens, accountable states and responsible private sector and that it is fundamental to Vietnam's development.