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VIETNAM

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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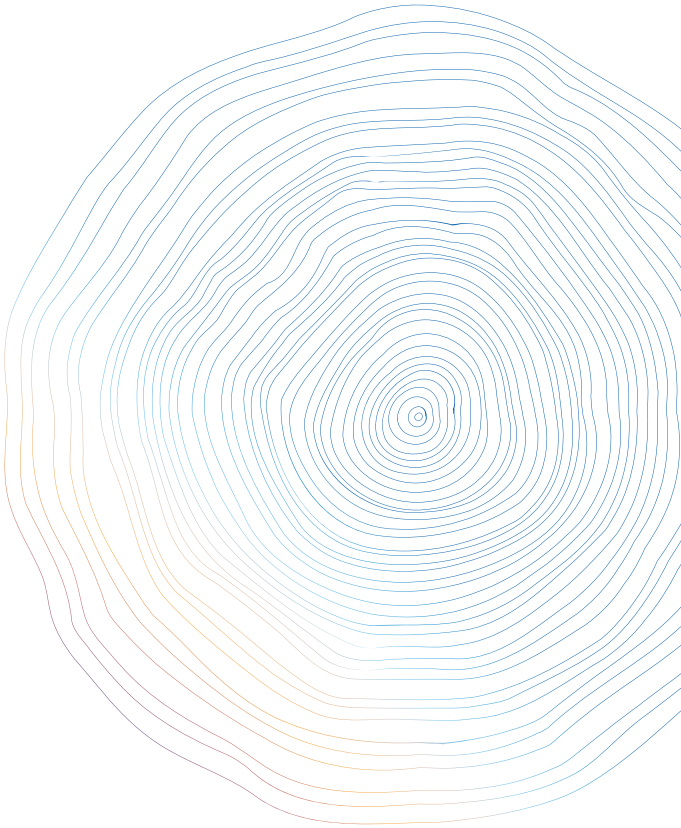

VIETNAM

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Acknowledgments

This Country Climate and Development Report (CCDR) is a collaborative effort of the World Bank, IFC, and MIGA, produced by a core team led by Muthukumara Mani (Lead Environmental Economist), Jacques Morisset (Lead Economist and Program Leader) and Dinesh Aryal (Senior Environmental Specialist). The key section contributors include Rahul Kitchlu, Shigeyuki Sakaki, Hardwick Tchale, Matthew Wai-Poi, Richard Olowo, Sean Bradley, Jose Antonio Cuesta Leiva, Dorsati Madani, Nga Thi Nguyen, Phuong Hoang Ai Nguyen, Taisei Matsuki, Thu Thi Le Nguyen, Bryce Ramsey Quillin, Darryl James Dong, Ketut Ariadi Kusuma, Vicky Chemutai, Maryla Maliszewska, Hang Thu Vu, Ha Thu Nguyen, Eugeniu Croitor, Mizushi Satoh, Rohan Bhargava, S. Vaideeswaran, and Gaurav Trivedi.

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List of Acronyms

1M5R	One Must Five Reduction
ADS	Accelerated decarbonization scenario
ASEAN	Association of Southeast Asian Nations
AWD	Alternate wetting and drying
BAU	Business-as-usual
BRT	Bus rapid transit
CBAM	Carbon Border Adjustment Mechanism
CCDR	Country Climate Development Report
CEA	Country Environmental Analysis
CGE	Computable general equilibrium
CNG	Compressed natural gas
CO2	Carbon dioxide
COP26	26th meeting of the Parties to the UNFCCC
COVID-19	Coronavirus disease 2019
CPS	Currently proposed policy scenario
EIPs	Eco-industrial parks
EPT	Environmental Protection Tax (EPT)
ESCOs	Energy Services Companies
ESG	Environmental-social-governance
EV	Electric vehicle
EVN	Vietnam National Electricity Utility
FIT	Feed-in tariff
GDP	Gross Domestic Product
GHG	Greenhouse gas
GIDD	Global Income Distribution Dynamic Model
HVDC	High-voltage direct current
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
ILO	International Labor Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IWT	Inland waterway transport
LEP	Law on Environmental Protection

MANAGE	Mitigation, Adaptation, and New Technologies Applied General Equilibrium
MIGA	Multilateral Investment Guarantee Agency
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
NAAQS	National Ambient Air Quality Standard
NDC	Nationally Determined Contribution
ND-GAIN	Notre Dame Global Adaption Initiative
NPV	Net present value
NTMs	Non-tariff measures
NZP	Net-Zero Pathway
ODA	Official development assistance
OECD	Organization for Economic Co-operation and Development
PDP	Power Development Planning
PFES	Payment for Forest Environment Services
PM	Particulate Matter
PPP	Public private partnership
RCP	Representative concentration pathways
REDD	Reducing Emissions from Deforestation and Forest Degradation
RNZP	Resilient and a Net-Zero Development Pathway
SBV	State Bank of Vietnam
SEDS	Socio-Economic Development Strategy
SME	Small and medium enterprises
SOE	Stated-owned enterprises
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
VCCI	Vietnam Chamber of Commerce and Industry
VGGS	Vietnam Green Growth Strategy
WBG	World Bank Group
WHO	World Health Organization

INTRODUCTION

Like most countries in the world, Vietnam is increasingly seeing its development affected by climate change. With a coastline of 3,260 kilometers that includes major cities and production sites, Vietnam is highly exposed to sea-level rise. Climate change impacts on the Vietnamese economy and national welfare are already significant—about 3.2 percent of gross domestic product (GDP) in 2020—and they are expected to escalate rapidly even if greater efforts are made to mitigate future climate change around the world.

Vietnam has historically had very low greenhouse gas (GHG) emissions, but over the past two decades, it has seen some of the fastest emissions growth rates in the world. From 2000 to 2015, as GDP per capita increased from $390 to $2,000, per capita emissions more than quadrupled. Vietnam's GHG emissions are associated with toxic air pollution in many of its cities today, with implications for health and labor productivity. At the UN Climate Change Conference in Glasgow in November 2021 (COP26), the Prime Minister made several commitments, including an ambitious target of reducing emissions to net zero by 2050. Vietnam's increased attention to climate change and the environment reflects the growing economic costs of resource depletion and climate impacts, which have already started to harm trade and investment—two key drivers of the nation's robust growth and job creation in recent decades.

Vietnam now faces critical questions about how to respond to climate change: How intensively should it work to adapt to previous and predicted damages caused by climate change, given the uncertainty of global mitigation efforts? How much will it cost to reduce GHG emissions? How can the private sector be mobilized to help achieve Vietnam's climate goals? Are there trade-offs between adaptation and mitigation investments? Are there trade-offs between economic growth, poverty reduction, and climate action, and how can they be managed? Which sectors and regions should be prioritized? What are the distributional implications of a low-carbon, climate-resilient growth path?

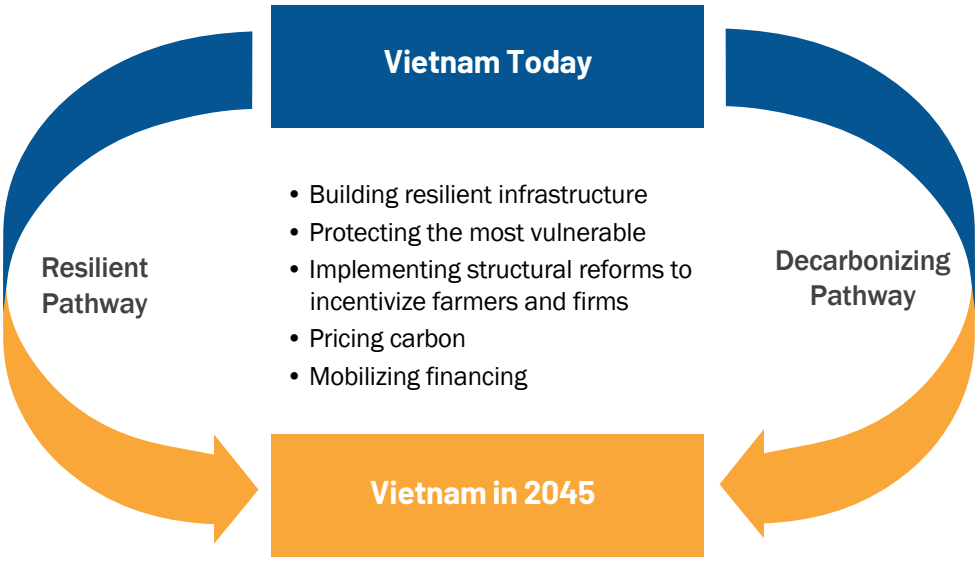
The Vietnam Country and Climate Development Report (CCDR) investigates these questions. One of the first in a series of country-level diagnostics produced by the World Bank Group (WBG) under its 2021–2025 Climate Change Action Plan, the CCDR examines the adaptation and mitigation challenges faced by Vietnam. It pays special attention to policy trade-offs and provides recommendations to help policy makers prioritize among a range of options, recognizing uncertainties about future climate change impacts and the availability of technology and financing. The CCDR relies on data and quantitative tools to inform the analysis and prioritization process.

The CCDR proposes that Vietnam should embrace a new development paradigm by incorporating two critical pathways that will help it balance development goals with growing climate risks (Figure 1):

- **Adapting to Climate Change – the Resilient Pathway:** The high level of vulnerability of Vietnam's infrastructure, productivity, and social capital to climate risks will limit the country's ability to achieve long-term development goals and require adaptation measures.[1] Extreme events such as storms and floods, compounded by the degradation of ecosystem services due to the loss of mangroves or wetlands, have already put multiple billions of dollars of the country's assets at risk. Strategic locations (e.g., the Mekong Delta and Ho Chi Minh City or HCMC) and economic activities (e.g., rice farming and industrial parks) are exposed to rising temperatures, shifting rainfall patterns, and saltwater intrusion. Increasing climate resilience is therefore vital to future development. In this CCDR, the resilient pathway implies adaptation to climate risks but also the ability to acquire new capabilities and perhaps emerge stronger from climate shocks.

- **Mitigating Climate Change – the Decarbonizing Pathway:** Although Vietnam only contributes about 0.8 percent of global GHG emissions, mitigation measures are in the national self-interest. Measures that reduce GHG emissions would also abate severe air pollution in the main urban centers, which the World Health Organization (WHO) estimates to cause about 60,000 deaths annually, imposing large economic costs through health and productivity losses. Moreover, multinational companies and consumers in Vietnam's main export markets are shifting toward a low-carbon economy. To remain competitive, Vietnam will need to decarbonize its energy sector and take actions in the agriculture, transport, and manufacturing sectors.

Figure 1: A new development paradigm for Vietnam



Source: World Bank.

1 The term climate risk here and in the rest of the report encompasses many manifestations of climate change, such as temperature increases, changing precipitation patterns, sea-level rise, and increases in the frequency and intensity of extreme events.

For each of these pathways, the CCDR identifies actions that are particularly urgent, most likely to create synergies between development and environmental objectives and impose the smallest burdens on the poor. The underlying argument is that actions will be more acceptable, increasing their chance of being implemented rapidly, if there is a sense of urgency associated with them and if they contribute to the country's objectives of rapid development, inclusion, and financial stability. In this way, the CCDR aims to stimulate policy discussions on how Vietnam can reconcile its development and climate objectives, in both the short and longer terms.

The CCDR does not address all the key climate-related challenges faced by Vietnam. For example, one key understudied area has been how, through its negative effects on health and education, climate change hinders human capital formation, especially for poor households that do not have the resources needed to adapt. Further work is also needed to better understand how the domestic labor market may adjust to expected technology shifts in high-emitting sectors (energy, transport, and agriculture), as well as the new opportunities that may emerge from higher demand for low-carbon products by industries and consumers. Likewise, more attention should be paid to how climate change is affecting water security (how much and how good), water management, and the blue economy, in particular the compounding effects of climate change and poor planning on fisheries and aquaculture, coastal ecosystems, ports, and coastal infrastructure. These are just a few examples that highlight the need for a continued examination of climate issues in Vietnam beyond the CCDR.

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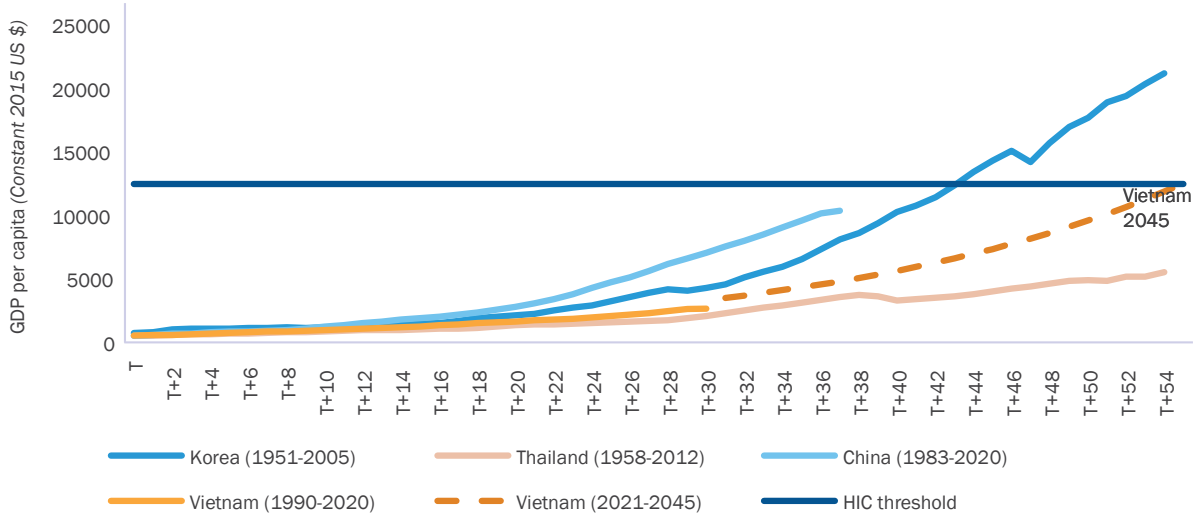
Vietnam's Development Model and Climate Challenges

1. Vietnam's Development Model and Climate Challenges

1.1. Vietnam is at a crossroads

After more than two decades of steady growth, Vietnam has set an ambitious goal of reaching high income status by 2045. However, for Vietnam to reach high-income status (defined as per capita income of $12,695), it will need to exceed its historical growth rates achieved during the 1990-2020 period. In comparison, Korea, which had the same per capita income in 1951 as Vietnam did in 1990, took 42 years to reach high-income status (see Figure 2).

Figure 2: Reaching high-income status in 2045 will require faster growth for Vietnam



Source: World Bank, based on World Development Indicators data.
Note: Time-T corresponds to the year when each country reported the same GDP per capita as Vietnam had in 1990.

To achieve high-income status, the country's latest Socio-Economic Development Strategy (SEDS) emphasizes the need to accumulate more productive, physical, and human capital – and to use it more efficiently – in order to generate the productivity gains needed to replicate the South Korean economic success.[2] The SEDS also recognizes that economic growth to date has consumed Vietnam's natural capital at an unsustainable rate, so that it is being depleted.[3]

A major recognition in the latest SEDS is that the country's economic transformation will greatly depend on better management of natural capital. Like most low-income countries, Vietnam has relied heavily on its natural resources for economic growth, using its extensive stocks of agricultural, forest, and mineral

2 For more details, see Ministry of Investment and Planning, *Vietnam Socio-Economic Development Strategy: 2021–2030*, February 2021. See also World Bank Group. 2020. "Vibrant Vietnam: Forging the Foundation of a High-Income Economy." Country Economic Memorandum. Hanoi: World Bank. http://hdl.handle.net/10986/33831. The recent Systematic Country Diagnostic update provides a series of reforms that should help generate this shift toward more economic efficiency during and in the aftermath of the COVID-19 pandemic. See World Bank. 2021. "How Will Vietnam Blossom? Reforming Institutions for Effective Implementation." Systematic Country Diagnostic. Washington, DC: World Bank. http://hdl.handle.net/10986/36797.

3 The natural capital being depleted includes forests, water, fish stocks, minerals, biodiversity, land, and other assets.

resources to drive development over the past two decades. The estimated value of Vietnam's stock of natural capital accounted for about one-third of its wealth during 1990–2014, compared with 10 percent in East Asia and 17 percent in upper-middle-income countries. Such a reliance explains to a large extent the rapid degradation of the country's net genuine savings from a peak of 25 percent in early 2000s to around 10 percent by 2019. The deterioration of existing natural capital has been further exacerbated by insufficient maintenance and increasing climate risks.[4] Looking forward, Vietnam will need to shift from an arguably wasteful approach to economic expansion—as producers often use more land, water, wood, energy, and other resources per unit of output than in other countries—to a development model that manages natural capital more sustainably.

1.2. Climate change impacts are eroding Vietnam's productive capital

Vietnam is among the world's very vulnerable countries, ranked 127 out of 182 by the Notre Dame Global Adaptation Initiative (ND-GAIN), and 13th highest among 180 countries by the Germanwatch Global Climate Risk Index for 2000–19. It is also ill-prepared to cope with extreme events, hotter temperatures, and rising sea levels (ranked 91 of 192 by the ND-GAIN Readiness Index,[5] [6]

- Assuming a similar rate of increase in average temperatures for Vietnam, by 2080-90 temperatures could be higher on average by 1-3.4 degrees Celsius, relative to the 1986-2005 baseline, with a larger amplitude in maximum and minimum temperatures.

- The rise in extreme heat is likely to amplify the impacts on human health, livelihoods, and ecosystems.

- Modeling results show considerable uncertainty around two important issues for Vietnam: future precipitation trends, and trends in the intensity of extreme events.

- Vietnam's low-lying coastal and river delta regions have very high vulnerability to sea-level rise. Without effective adaptation measures, six-to-12 million people could be affected by coastal flooding by 2070–2100, depending on the global emissions pathway.

- Climate change is exacerbating the already substantial risks posed by river floods; by 2035–2044, several million more people could be affected by extreme floods every year.

As the climate changes, it is increasingly disrupting Vietnam's economy, and the costs are already starting to undermine growth. Initial calculations from the recent Country Environmental Analysis (CEA) suggest that Vietnam lost $10 billion in 2020, or 3.2 percent of its GDP, to climate change impacts (Figure 3).[7] The magnitude of these damages, which are projected to increase rapidly, emphasizes the increasing need for Vietnam to adapt to the risks from a changing climate, While Vietnam's vulnerability to climate change stems from the accumulated stock of GHG in the atmosphere and the slow response by the largest polluters to reduce their GHG emissions, it is exacerbated by poor planning and unsustainable management of natural resources in Vietnam. A case in point is the Mekong Delta where continued sand mining compounds the effect of sea level rise on erosion of the coastline and riverbanks.

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4 For a fuller discussion on wasteful growth, see World Bank Group, 2020, "Vibrant Vietnam."

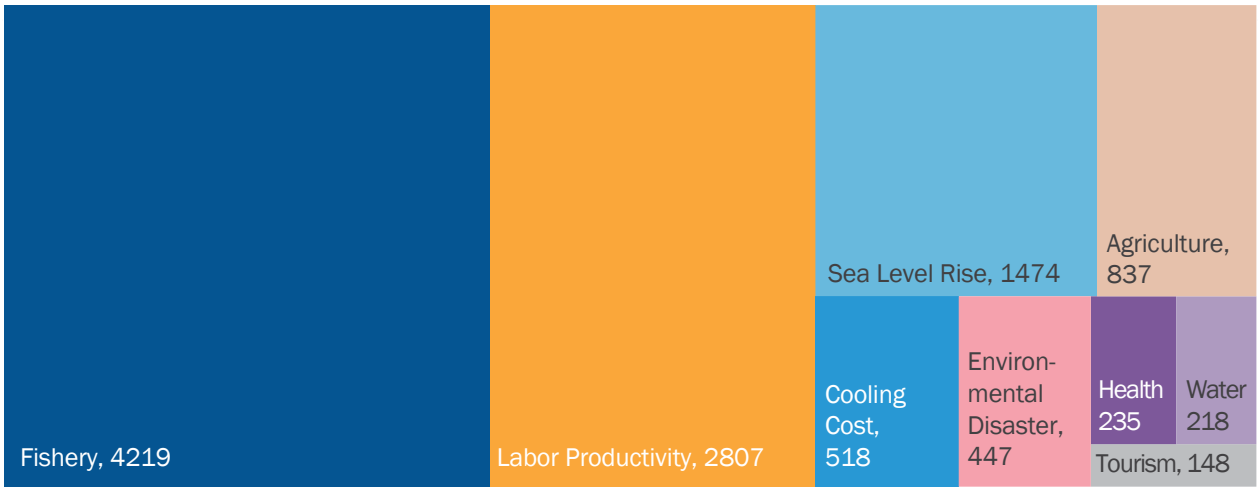
5 For a summary of Vietnam's key climate and development data, see Annex 1.

6 For more details, see World Bank Group, and Asian Development Bank. 2021. "Climate Risk Country Profile: Vietnam." Washington, DC, and Manila: World Bank. https://openknowledge.worldbank.org/handle/10986/36367. For details on ND-GAIN, see https://gain.nd.edu/. For details on the German Watch Global Climate Risk Index 2021, see https://www.germanwatch.org/en/19777.

7 See World Bank. 2021 (unpublished). "Accelerating Clean, Green, and Climate-Resilient Growth." Vietnam Country Environmental Analysis.

Climate change is not only negatively affecting strategic sectors, such as fisheries and agriculture, but also slowing labor productivity growth, increasing cooling costs due to higher temperatures, and harming human health. The exact costs are uncertain, but Vietnam's economic performance is not well captured in national economic statistics, which often fail to account for the loss of natural and physical assets. What Vietnam needs today is a Green, Resilient and Inclusive D evelopment (GRID) model.[8]

Figure 3: Estimated costs of climate change in 2020 ($ million)



Source: World Bank, 2021.[9]

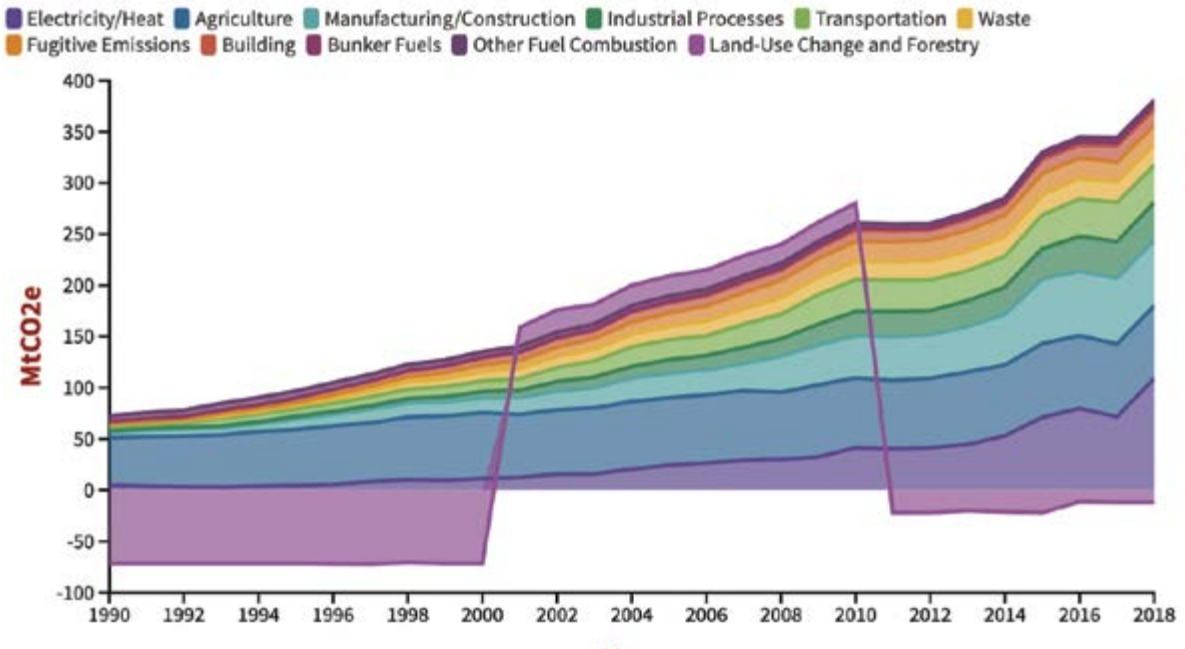
1.3. Rising emissions are causing damages

The country's rapid economic growth, urbanization, and industrialization over the last 30 years have been powered by a coal-dependent energy supply that creates significant GHG emissions (Figure 4). Emission levels have increased substantially over the last decade, and Vietnam has locked its power sector into high-emissions technologies for the next decade. In 2020, energy accounted for about 65 percent of the country's GHG emissions.[10] Agriculture was the second-largest emitter, at about 19 percent, followed by transport, industry, and waste. More than a third of Vietnam's GHG emissions are non-CO_2 gases—most notably methane, but also nitrogen dioxide—that have powerful near-term warming effects and are also air pollutants, though CO_2 emissions from energy use are growing much faster.

Vietnam has one of the most GHG-intensive economies in East Asia (measured as emissions per unit of output) in Asia, similar to Indonesia's, but much higher than China's or the Philippines'. In absolute terms, Vietnam's GHG emissions—364 million tonnes[11] of carbon dioxide equivalent (Mt CO_2e) in 2018— amount to no more than 0.8 percent of global emissions, on par with Malaysia, Thailand, France, and the United Kingdom. GHG emissions per capita were 3.81 tonnes CO_2e in 2018, up from 0.79 tonnes in 2000, but still relatively low by regional and global standards (see Table 1 and Figure 5).

8 For more details on GRID, see https://thedocs.worldbank.org/en/doc/9385bfef1c330ed6ed972dd9e70d0fb7-0200022021/green-resilient-and-inclusive-development-grid.
9 World Bank, 2021, "Accelerating Clean, Green, and Climate-Resilient Growth."
10 Climate Watch. 2020. "GHG Emissions." Washington, DC: World Resources Institute. https://www.climatewatchdata.org/ghg-emissions.
11 Throughout this text, the word "tonnes" is used to denote metric tons.

Figure 4: Rising GHG emissions



Source: World Bank, based on data from Climate Watch, 2020.[12]

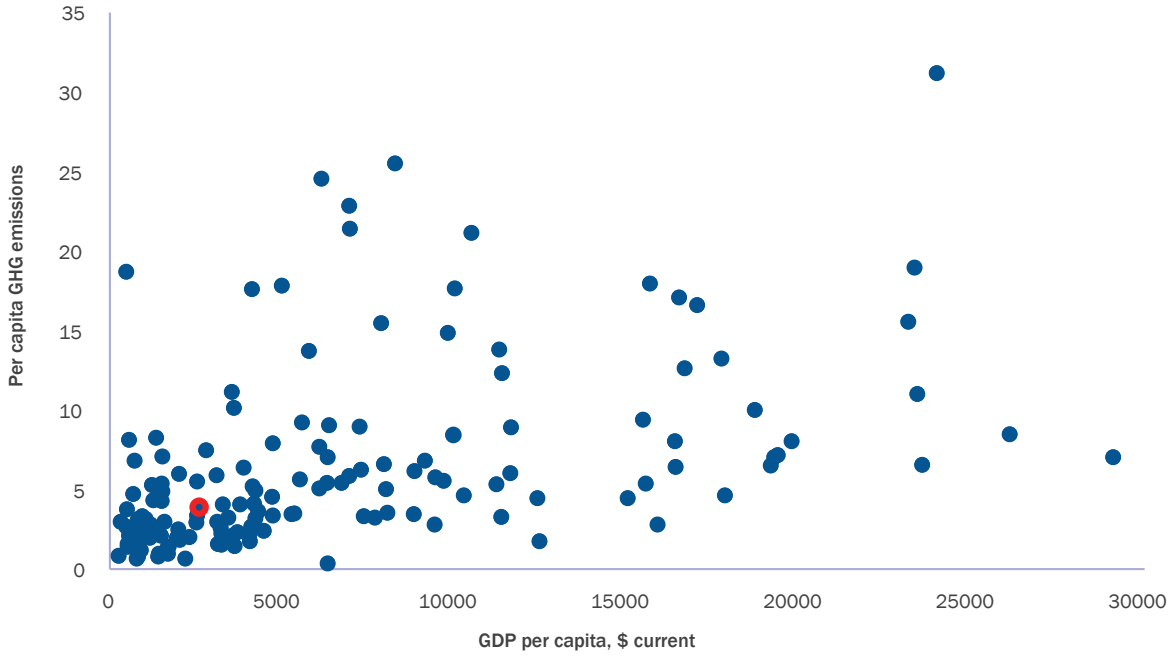
Table 1. Cross-Country Emission Overview

Country	Emissions per capita (tCO_2e per capita)	Carbon intensity (tCO_2e/million $GDP)	Total emissions ($MtCO_2e$)	% of global emissions
United States	17.7	281.5	5,794.3	12.0%
Mongolia	17.5	4,250.9	55.7	0.1%
Malaysia	12.3	1,081.9	388.1	0.8%
OECD	10.8	266.6	14,081.8	29.8%
Germany	9.4	195.9	776.61	1.6%
China	8.4	842.5	11,705.1	23.9%
Papua New Guinea	7.5	2,658.3	64.1	0.1%
United Kingdom	6.6	154.2	441.1	0.9%
Indonesia	6.4	1,634.8	1703.9	3.6%
Thailand	6.2	851.4	431.2	0.9%
Lao PDR	5.5	2,151.6	38.6	0.1%
France	5.4	129.6	361.4	0.7%
Timor-Leste	5.3	4,271.0	6.7	0.0%
Myanmar	4.3	3,040.9	231.6	0.5%
Cambodia	4.3	2,814.1	69.2	0.1%
Vietnam	3.8	1,486.2	364.4	0.8%
Philippines	2.2	677.0	234.8	0.5%

Source: Climate Watch

12 Climate Watch. 2020. "GHG Emissions." Washington, DC: World Resources Institute. https://www.climatewatchdata.org/ghg-emissions.

Figure 5: Per Capita GHG Emissions (tonnes/capita) (Vietnam in Red)



Source: ClimateWatch.

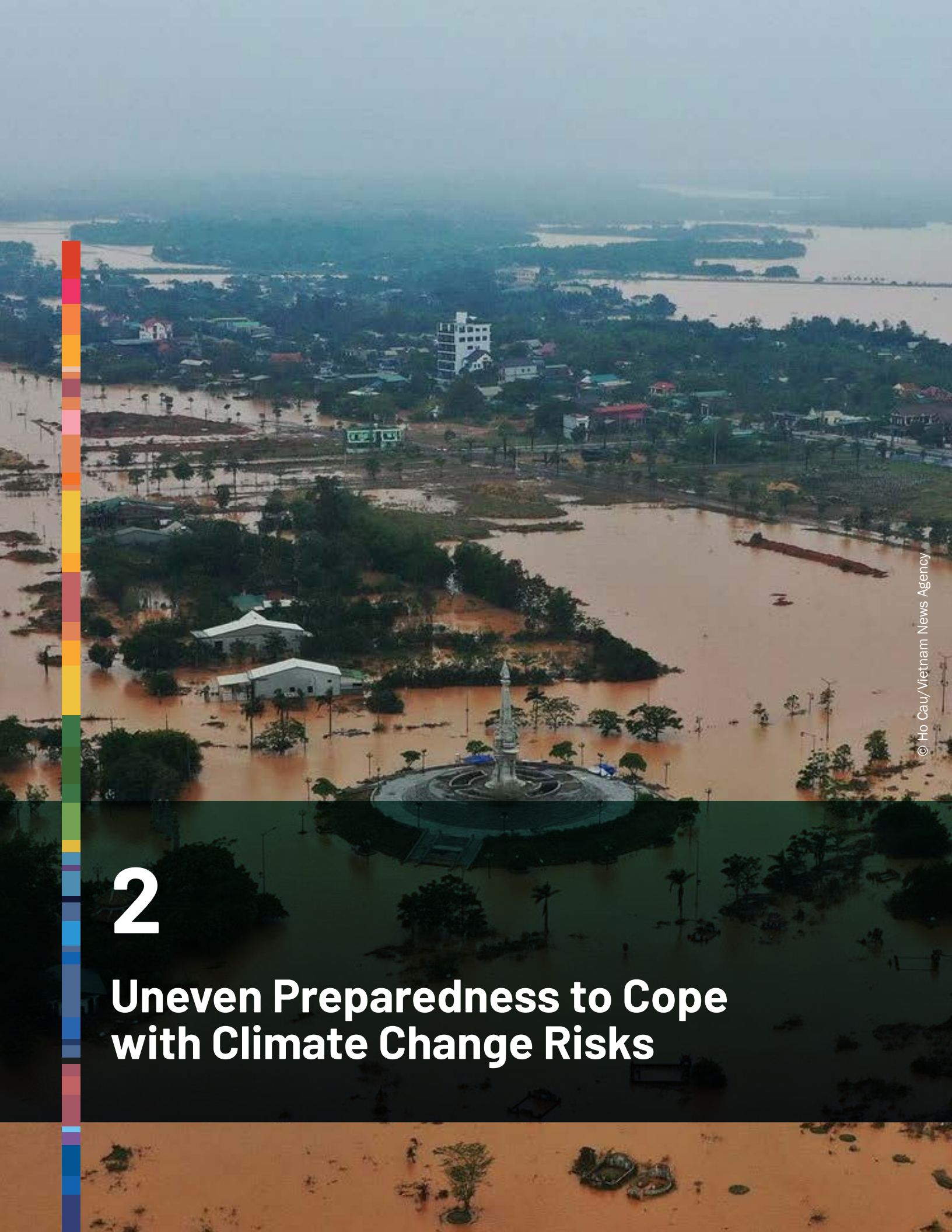
The rapid increase in GHG emissions over the last two decades has been correlated with significant air pollution, especially in the large cities, and considerable health and productivity costs. The average annual concentration of particulate matter has been consistently four to five times higher than the World Health Organization (WHO) safety threshold of 10 micrograms of $PM_{2.5}$ particles per cubic meter of air volume (µg/m3), according to data derived from satellite observations[13] and averaged for the entire country. These national estimates mask very high seasonal and geographic concentrations in major urban areas such as Hanoi and the northern regions. The WHO, using a standard well-accepted methodology, estimated in 2016 that more than 60,000 premature deaths per year in Vietnam are linked to air pollution.[14] The Global Alliance on Health and Pollution put that number at over 50,000 in 2019.[15] The CEA estimates the economic costs of air pollution to have equaled one percent of GDP in 2020, based on the monetary costs associated with increased morbidity and labor productivity losses.[16]

13 Satellite-based estimates are useful, as they cover large areas, and can be supplemented with extensive ground-based monitors.

14 The causes of death include heart disease, stroke, lung cancer, chronic obstructive pulmonary disease, and pneumonia. See World Health Organization. 2018. "More than 60,000 Deaths in Viet Nam Each Year Linked to Air Pollution." Press release, May 2. https://www.who.int/vietnam/news/detail/02-05-2018-more-than-60-000-deaths-in-viet-nam-each-year-linked-to-air-pollution.

15 https://gahp.net/wp-content/uploads/2019/12/PollutionandHealthMetrics-final-12_18_2019.pdf.

16 World Bank, 2021 (unpublished). "Accelerating Clean, Green, and Climate-Resilient Growth." Vietnam Country Environmental Analysis. Washington, DC: World Bank. These costs are based on the loss of output and constitute a market cost-based estimate. Two alternative approaches are to use the value of a statistical life (VSL) or the willingness to pay (WTP) to reduce the risk of death, which is a measure of the welfare loss associated with mortality. Using the latter, the economic cost would amount to around 3.9 percent of GDP.



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2

Uneven Preparedness to Cope with Climate Change Risks

2. Uneven Preparedness to Cope with Climate Change Risks

2.1. Strong government commitment has led to revised strategies

The Prime Minister demonstrated the country's strong commitments to reforms at COP26, when he declared that Vietnam would reach net-zero GHG emissions by 2050. He declared that "climate change response and the restoration of nature must become the highest priority in all development decisions," and called for fairness and justice in the global response to climate change.[17] Also at COP26, Vietnam joined more than 100 countries in pledges to halt deforestation by 2030 and to slash methane emissions by 30 percent from 2020 levels in the same period.[18] Vietnam has further committed to ending all investment in new coal power generation, scaling up deployment of renewable energy, and phasing out coal power by the 2040s. These commitments go beyond those included in the Nationally Determined Contribution (NDC) update submitted in 2020 under the United Nations Framework Convention on Climate Change (UNFCCC).

Building on the recent SEDS for the period 2021–2030, the government has already started to revamp its plans and corresponding legal framework. A new Vietnam Green Growth Strategy (VGGS) prepared by the Ministry of Planning and Investment (MPI) was adopted in October 2021, while an updated NDC implementation support program is being led by the Ministry of Natural Resources and Environment (MONRE). In addition, the amended Law on Environmental Protection (LEP) adopted in 2020 represented the most significant modernization of Vietnam's environmental legislation since 1993 and has climate change as its main focus. The draft Power Development Plan VIII (PDP8) reinforces the centrality of prioritizing renewable energy sources.

These efforts are paving the way for further actions, but three challenges require immediate attention:

- Vietnam's climate strategies need to be rebalanced to include strong policies and investments for adaptation as well as mitigation. The new strategies now emphasize mitigation, but as a highly vulnerable country, Vietnam also needs to invest significantly in building resilience given the serious impact of climate change on growth. The imbalance between mitigation and adaptation is most visible in the VGGS, which introduces several energy intensity targets (nationwide and sectoral), but no equally specific targets in terms of adaptation - even though the strategy recognizes the importance of resilient agriculture, transport, and cities.
- All the new strategies and Vietnam's NDC need to be updated to reflect recent commitments, including those made at COP26. For example, the net-zero carbon emission target has yet to be factored into any national or sectoral strategies (including the energy sector's PDP8).
- Greater consistency is needed across key climate policy documents. The new commitments and strategies, prepared by different ministries, set targets and priorities in inconsistent ways, complicating the vision and potentially hindering implementation. For example, the NDC defines the mitigation target as a reduction in GHG emissions relative to a business-as-usual (BAU) scenario, while the VGGS targets the carbon intensity of GDP. These indicators are related, but different: for examples, whether the latter achieves absolute emission reductions depends on the rate of GDP growth.

17 See Chinh, P.M. 2021. "Remarks by H.E. Mr. Pham Minh Chinh, Prime Minister of the S.R. of Viet Nam, at the 26th United Nations Climate Change Conference of the Parties (Glasgow, 1 November 2021)." Glasgow: United Nations Framework Convention on Climate Change. https://unfccc.int/documents/308938.

18 See the Glasgow Leaders' Declaration on Forests and Land Use: https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/ and the Global Methane Pledge: https://www.globalmethanepledge.org.

The new strategies have yet to be translated into significant changes in Vietnam's fiscal policy. For example, some progress has been made toward the development of carbon pricing instruments, but such instruments are not yet implemented at scale. The existing carbon tax — the Environmental Protection Tax (EPT) — is around $0.50 per tCO2e on coal, $77.60 per tCO2e on gasoline, and $32.90 per tCO2e on diesel, lower than most countries and too low to incentivize large-scale decarbonization. However, the authorities have demonstrated a strong interest in using quantity-based caps in a trading system (under preparation with WBG support) and have started to shift subsidies from petroleum to renewable sources of energy, which contributed to a private investment boom in solar energy in 2020.[19] On the expenditure front, a recent analysis of six key ministries found climate-related spending varied annually from 2016 to 2020, but held relatively steady, ranging from 26 to 38 percent of the ministries' combined budgets.[20] About 25 percent of public capital expenditures were fully or partially directed to adaptation, mainly in irrigation and transport projects. Though promising, the figures should be interpreted with caution, because there is no accepted methodology to capture them in the budget. There are also well-known inefficiencies in public investment management, and maintenance is typically underfunded in Vietnam.[21] Green public procurement is also just in its infancy, as existing legal and institutional frameworks need to be aligned with international best practices.

2.2. The private sector's uneven level of preparedness

The private sector will need to make substantial investments to adapt to climate change, which is already impacting many businesses. About $300 billion of assets held by the commercial and industrial sector are vulnerable to climate-related disasters.[22] Many firms are already reporting climate change impacts that significantly affect their income, mainly from extreme weather events that disrupt operations, but also from reduced labor productivity and other problems (Figure 6).[23] A 2020 analysis found climate-related damages were occurring annually and could amount to as much as 70–80 percent of the total revenue of some small and mid-size enterprises (SMEs).[24]

The most vulnerable sectors to climate change are extractives, manufacturing, agriculture, wholesale and retail, and hotels/accommodation. In addition, many firms have substantial long-term investments in high-emission production methods, which puts them at risk of losing competitiveness in increasingly clean export markets. Yet businesses lack the resources to adapt to climate change and to invest in cleaner technologies. This will require a greater engagement of the financial sector to ensure that private savings can be mobilized into cleaner and more resilient investments.

19 Analysis drawn from the World Bank's Review of Energy Subsidies in Vietnam, completed in June 2018 (unpublished).

20 MPI and UNDP. 2022. "Climate Public Expenditure and Investment Review of Viet Nam." Hanoi: Ministry of Planning and Investment and United Nations Development Programme.

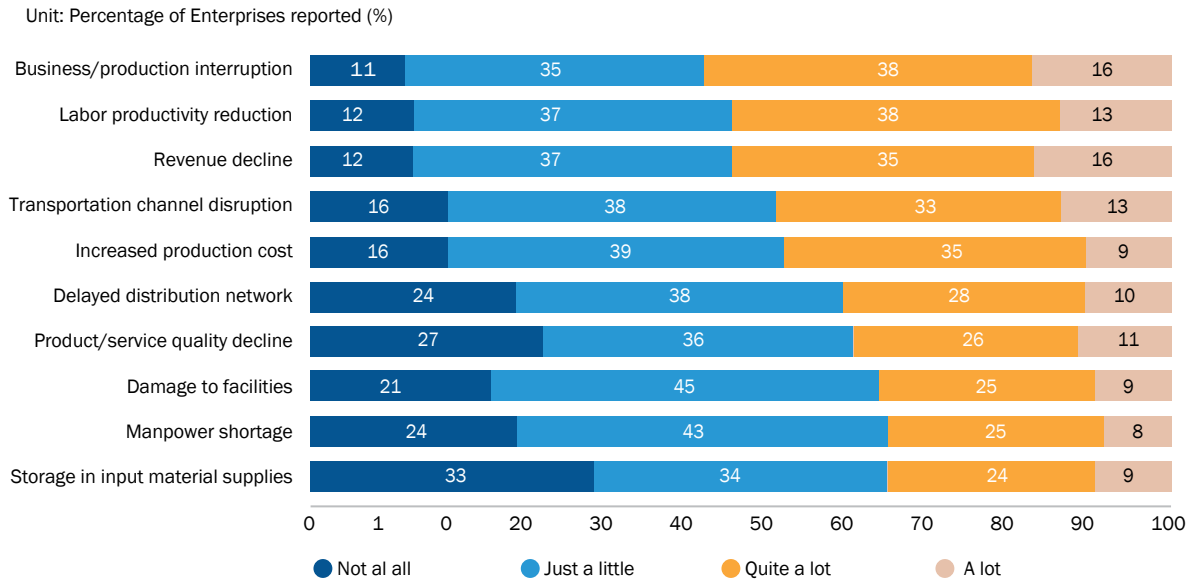
21 For a review of key issues with public investment management in Vietnam, see World Bank. 2018. "Public Investment Management in Vietnam: Assessment and Reform Priorities for Overcoming the Bottlenecks." Public Investment Review. Washington, DC: World Bank. http://hdl.handle.net/10986/31762.

22 Source: World Bank's 2017 catastrophe risk assessment for Vietnam (unpublished).

23 VCCI. 2020. "Adapting to Succeed: Assessing the Impact of Climate Change on Vietnamese Businesses." Hanoi: Vietnam Chamber of Commerce and Industry with UPS and The Asia Foundation. https://pcivietnam.vn/en/publications/assessing-the-impact-of-climate-change-on-vietnamese-businesses-ct181.

24 MONRE. 2020. "Private Sector Engagement in National Adaptation Plan Development and Implementation in Vietnam." Hanoi: Department of Climate Change, Ministry of Natural Resources and Environment. https://napglobalnetwork.org/resource/private-sector-engagement-in-national-adaptation-plan-development-and-implementation-in-vietnam/.

Figure 6: Climate change impacts and disaster risks observed by businesses (2019)



Note: The figure summarizes the responses of more than 10,000 Vietnamese- and foreign-owned businesses to a 2019 survey described as "the largest, most comprehensive enterprise survey ever conducted in Vietnam from the perspective of businesses on climate change."
Source: Reproduced from Figure 3.3 in VCCI, 2020.[25]

State-owned enterprise (SOE) reform will be important to encourage greater private sector investment in green technologies and business practices. In Vietnam, SOEs still dominate many of the country's most carbon-intensive industrial sectors, particularly coal, chemicals, fertilizers, electricity, and freight transport (Figure 7), crowding out private investment. As part of its mitigation strategy, the government could condition its near-term support for SOEs on actions that accelerate decarbonization, enhance climate resilience, and otherwise reduce climate-related risks. Over the medium to long term, reforming SOEs and opening the market to greater private sector participation in the economy is essential to achieving much of the climate agenda as many of the new technologies are easily accessed by private firms, including foreign ones.[26] Putting Vietnam on a green growth path will require mobilizing massive amounts of private capital, which will not happen in sectors dominated by SOEs without fostering further competition now and in the future.

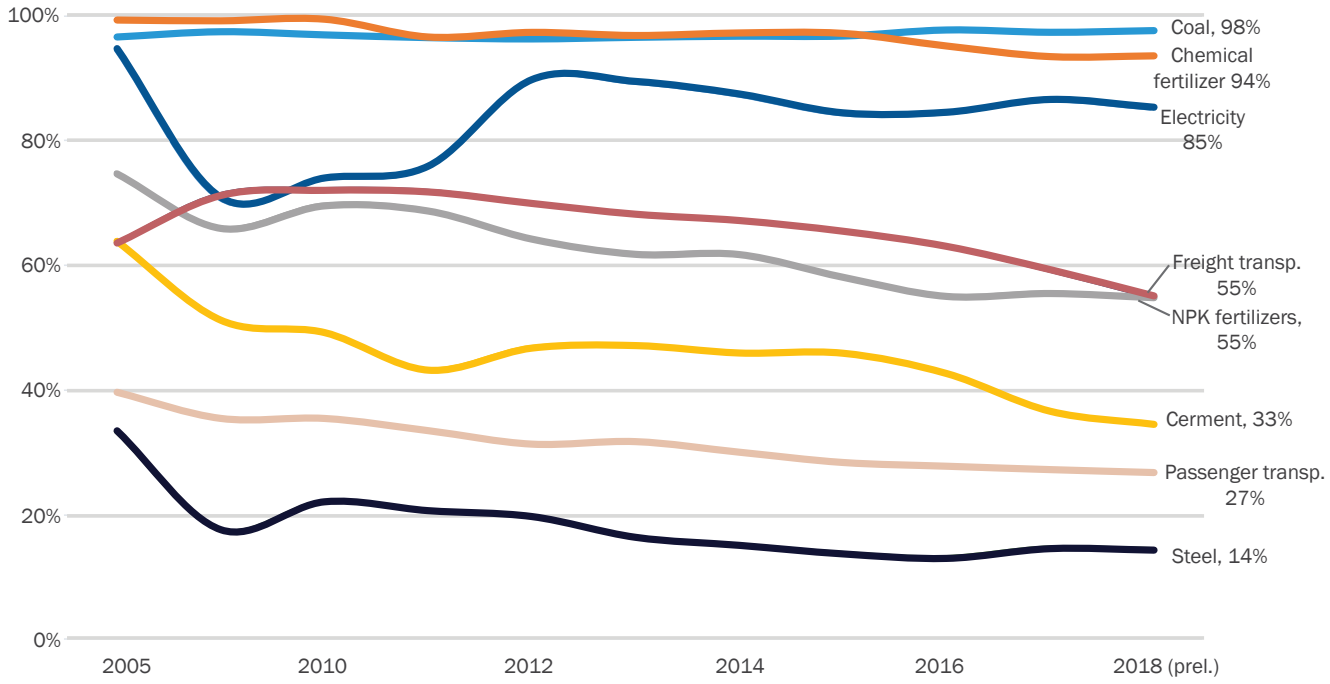
The financial sector, which will be key to ensuring that capital can flow to climate investments, is also vulnerable to climate change in two ways. First, there is physical risk, as extreme weather events can disrupt business operations and damage the property and infrastructure of financial institutions and their customers. Rising temperatures, rising sea levels, and precipitation changes will require additional investments and adaptation by households, firms, and governments that may increase their credit risk. Second, financial institutions may face risks through their high-emitting clients who could suffer market losses and be exposed to legal challenges.

There has been no systematic and comprehensive assessment of the climate risks faced by the financial sector in Vietnam. Several indicators suggest that physical risks for many financial institutions in Vietnam are already high and expected to grow. For example, about 55 percent of total loans extended by banks in Vietnam went to businesses and people in climate-vulnerable regions, including the Southeast provinces,

25 VCCI, 2020, "Adapting to Succeed."
26 For a fuller discussion of competition in Vietnam, see World Bank, 2021, "How Will Vietnam Blossom?"

the Mekong Delta, and coastal provinces.[27] The deterioration of customers' collateral and revenue streams would lead to an increase in delinquent loans to weaken the banks.

Figure 7: Evolution of SOEs' share of output in Vietnam's carbon-intensive industrial sectors (%)



Source: Coste et al., 2020.[28]
Note: Computed, with data from the General Statistics Office, based on output in tonnes, except electricity (kWh), freight (million tonnes per kilometer) and passenger transport (million person-kilometers).

Similarly, the risks for banks have not been evaluated. The government should consider assessing climate-related risks on the banking sector and other parts of the financial system including stress testing, as recommended by international standard setting bodies such as the International Association for Insurance Supervisors (IAIS) or Financial Supervisory Board (FSB). Such assessment will require quality data and robust analytics—which, in turn, can inform green finance policies.

27 Analysis by FiinResearch, using data from provinces' statistics offices.
28 Coste, A., H.Dudu, and A.D. Feige. 2020. "Macroeconomic Impacts of Climate Change and Mitigation Policies in Vietnam: Supporting Systematic Action to Implement Vietnam's NDC." Washington, DC: World Bank.

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3

Adapting to Climate Change - The Resilient Pathway

3. Adapting to Climate Change – The Resilient Pathway

3.1. Building a climate-resilient economy will not be cheap

Even if the world acts swiftly to address climate change, Vietnam faces major impacts from climate change. To assess the potential economic losses associated with climate change, the CCDR used two complementary models. The first is a computable general equilibrium (CGE) model of the Vietnamese economy that aims to capture the impacts of two of the main manifestations of climate change—higher and more variable temperatures, and sea-level rise—on future economic growth (Box 1). The second is a probabilistic catastrophe model to estimate the economic impacts associated with extreme events such as typhoons.

The CGE model, built for the Vietnamese economy, was run against two global representative concentration pathways (RCPs) developed by the Intergovernmental Panel on Climate Change (IPCC)—RCP 2.6 and RCP 4.5—that roughly correspond to global mean temperature increases of less than 2°C and 2–3°C by 2100 (details of RCPs and the key results can be found in Annex 3). The main result is that the costs of climate impacts could reach 9.9 percent of GDP under RCP 2.6, and 12.4 percent of GDP under RCP 4.5 (Figure 8). The most serious damages would be to the infrastructure stock (about 42 percent of total economic losses by 2050), followed by fisheries (20 percent), and labor productivity (13 percent). Increased cooling needs would also impose large costs (13 percent). Economic losses in agriculture could be twice as large as in manufacturing. By 2050, under RCP 4.5, the fiscal deficit could increase by about 1.3 percent of GDP, mainly through the projected decline in public revenue, while the current account deficit could widen by 0.5 percent of GDP due to lower exports.

Box 1. A brief description of the CGE model and basic assumptions

The World Bank's Mitigation, Adaptation, and New Technologies Applied General Equilibrium (MANAGE) Model is used for this study. MANAGE is a (recursive) dynamic CGE model designed to focus on energy, emissions, and climate change. In addition to the standard features of a CGE model, MANAGE includes a detailed energy specification that allows for capital/labor/energy substitution in production, substitution between fuels by producers, and a multi-output, multi-input production structure.

The MANAGE model relies on behavioral assumptions that determine how economic agents react to changes in the economy (e.g., prices, income, taxes, etc.) under well-defined constraints based on the availability of resources. Markets are assumed to be flexible so that prices can adjust to balance supply and demand. MANAGE is a dynamic model that broadly follows a neo-classical growth specification. Labor supply is exogenous, but accumulation of the capital stock capital derives from savings/investment decisions.

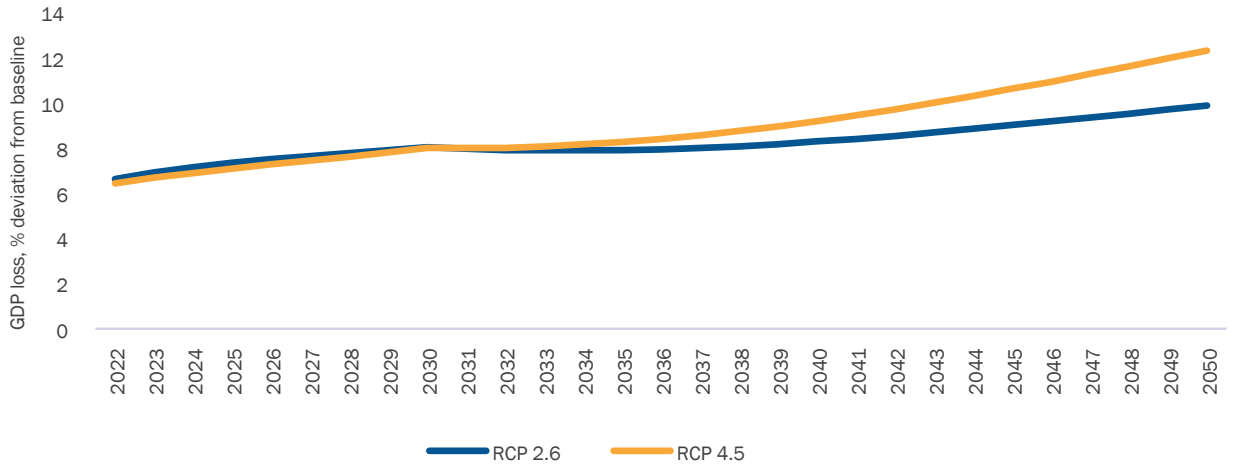
Climate change impacts are simulated by identifying the relevant economic variables, and imposing changes in model parameters. In this way, the model generates two sets of results: a baseline growth path for the economy, in which climate change impacts are ignored, and an alternative scenario, in which climate change impacts are simulated.

The key assumptions are as follows. The climate change costs are estimated by attaching economic values to physical damages. The impacts are taken for the most recent period for which data are available (2020 in most cases). Quantitative estimates of how the level of damages would change under different climate change scenarios are based on findings in the literature.

The estimated climate change costs are introduced into the model by considering the impacts of increased temperatures, changes in precipitation patterns and higher sea levels on: (i) total factor productivity of the affected sectors; (ii) damage or destruction of physical capital; (iii) lower labor productivity through poorer health; (iv) agriculture damages manifested through poorer soil nutrition and crop loss; (v) cooling costs in the form of higher electricity demand by households.

The probabilistic catastrophe model was used to estimate the economic impacts associated with climate extreme climate events (tropical storms and typhoons).[29] On average, Vietnam has incurred direct losses to private and public assets of about $2.4 billion per year -- or 0.8 percent of GDP -- due to extreme climate events. In the next 50 years, Vietnam has a 40 percent chance of experiencing an economic loss from climate catastrophes exceeding 2.4 percent of GDP and a 20 percent chance of experiencing a loss exceeding three percent of GDP.

Figure 8: Estimated economic impacts of higher and more variable temperatures and precipitation patterns, rising sea levels—loss of GDP



Source: World Bank, based on the CGE model adapted for Vietnam.
Note: RCP2.6 and RCP 4.5 are two climate trajectories envisioned by the IPCC, based on projected GHG concentrations.

The combination of the two forecasting models indicates that climate change impacts could cost Vietnam a total of 12–14.5 percent of GDP or cumulative costs of $400–$523 billion, by 2050. Higher and more variable temperature and precipitations as well as rising sea levels will gradually destroy physical, productive, and human assets. These costs will rise from about six percent of GDP in 2022 to 9.8 (RCP2.6) or 12.3 percent of GDP (RCP4.5) in 2050 (Figure 8). At the same time, the costs of climate catastrophes could average around an additional two percent per year.[30]

Reducing those damages will require significant investments by both the private and public sectors. Quantifying the necessary investments is difficult, as it entails identification and costing of adaptation measures not only across different economic sectors, but also in specific geographic areas. This CCDR uses three complementary methodologies to provide an estimate of the costs of upgrading private assets, of retrofitting and upgrading infrastructure and of reducing vulnerabilities (as zero-climate risk does not exist):

- A methodology developed by World Bank economists provides a proxy, estimating the overall annual financing need for upgrading the country's assets at about three percent of their value.[31] With

29 Source: World Bank Vietnam Catastrophe Risk Assessment, Summary Report, 2017.
30 The CEA estimates (presented in Section 1) are for 2020 and include impacts of temperature increases, precipitation changes and sea level rise. The figures quoted in this CCDR here begin in 2022 and are derived from the MANAGE model which includes damage functions from the CEA estimates plus costs of extreme events from catastrophe modeling.
31 Hallegatte S. et al, 2017, Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters: Climate Change and Development:, Washington D.C., World Bank.

the total value of commercial and industrial assets that are vulnerable to climate change risks assessed at around $300 billion in Vietnam, the cumulative cost of making them more resilient to climate change would amount to $228 billion over the period 2022–2050.

- Additional costs would arise from the need to upgrade and retrofit public infrastructure, as well as necessary new investments required to increase climate adaptation. The International Monetary Fund (IMF) has estimated those annual costs at three-to-four percent of GDP over the period 2021–2025. That can be extrapolated to a cumulative $228–$266 billion up to 2050. The latter is likely an underestimate, since it may not reflect additional adaptation costs in the agricultural sector related to increased salinization and droughts.[32]
- The estimated cost to reduce vulnerabilities through early warning systems and post- disaster programs could be around 0.3–0.7 percent of GDP per year, based on a recent World Bank assessment, or approximately $22–53 billion from 2022 to 2050.[33]

Overall, Vietnam's total incremental financing needs to for upgrading the country's assets, retrofitting and upgrading existing public infrastructure, and financing social assistance could reach $342–$411 billion over the period 2022–2050 in net present value, or about 4.5–5.4 percent of GDP per year (Table 2). This estimate was obtained by considering the difference between the financing needs noted above, and existing adaptation related expenditures. These represent estimated investments in today's value using a discount rate of 6 percent as per the World Bank guidelines for economic analysis. Social discount rates are normally used to put a present value on costs and benefits that will occur later. In the context of climate change policy making, they are considered very important for working out how much today's society should invest to limit the impacts of climate change in the future (for more information on discount rates, please refer to Annex 3C). While there is no estimate of current private spending available, the recent Climate Public Expenditure and Investment Review estimates the level of climate-related capital spending toward resilience at about 25 percent of the government investment budget, or 1.5 percent of GDP.[34] The current level of public funding for disaster programs is around 0.3 percent of GDP.

Table 2. Estimates of incremental financing needs for adaption measures, 2022–2050

	Average per year (% of GDP)	Accumulated value ($ billion in NPV terms)
Incremental financing needs	4.5–5.4	342.3 –410.7
Total financing needs	6.3–7.2	479.2–547.6
Investment needs for resilient private assets	3.0	228.2
New and retrofitting investments for resilient infrastructure	3.0–3.5	228.2–266.2
Financial support to affected people and businesses	0.3–0.7	22.8–53.2
Existing financing	1.8	136.9

Note: NPV is net present value; all those amounts reflect a 6 percent discount rate.

32 Dabla-Norris, E., J. Daniel, M. Nozaki, C. Alonso, V. Balasundharam, M. Bellon, C. Chen, D. Corvino, and J. Kilpatrick. 2021. "Fiscal Policies to Address Climate Change in Asia and the Pacific." Departmental Paper No 2021/007. Washington, DC: International Monetary Fund. https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2021/03/24/Fiscal-Policies-to-Address-Climate-Change-in-Asia-and-the-Pacific-Opportunities-and-49896.

33 Fiscal Policy and Climate Change, background paper for the CCDR, January 2022.a

34 MPI and UNDP, 2022, "Climate Public Expenditure and Investment Review of Viet Nam."

The Resilient Pathway will therefore will require substantial financing to protect the country's assets and infrastructure as well as vulnerable people against climate shocks. Given the "public goods" nature of these investments, much of this funding would have to be financed through mobilizing tax revenues or borrowing, both of which will significantly impact current or future taxpayers.

The timing of costs and benefits poses an additional challenge for policy makers. In the first decade, the costs associated with building resilience will be higher than the gains. This means that leaving those investments to the market, which tends to focus on near-term profits, may fail to generate the necessary upfront investments in adaptation, especially if there are financial constraints. Another market failure is that individuals are likely to invest less than is required from a collective perspective, because private benefits are lower than social benefits. For example, individual farmers may not deem it cost-effective to invest in water-saving irrigation system—even if the farming community as a whole need to use water more efficiently to avoid running out during droughts. Instead, there is an incentive for individual farmers to wait for others to make the necessary investments, and then enjoy the benefits. Government intervention is needed to address these market failures, recognizing that climate adaptation is at least partly a public and a global good.

3.2. Improving resource allocation is key

The government can adopt structural reforms to reduce the costs of adaptation measures. Many of these reforms will be needed for the country to achieve its aspiration of reaching high-income status by 2045. Top priorities include adopting rules and regulations to ensure competition between big and small firms, between foreign and domestic investors, and between state-owned and private enterprises as building a resilient economy will require a vibrant and dynamic private sector. New investments from existing and new firms should be encouraged by promoting information on climate risks and available instruments to address them, lowering barriers to entry, and using the right pricing signals. On the public sector front, there is a need to improve public investment management and increase coordinated action across provinces to enable the emergence of economies of scale in the design, implementation, and resourcing of infrastructure projects. Horizontal coordination at both the central and local levels is necessary to ensure alignment of annual budget planning with medium-term investment planning, and of recurrent expenditure (for operation and maintenance) with capital expenditure.

These structural measures could be complemented by more targeted actions on climate-related investments, including:

- Conducting periodic risk assessments of public assets and contingent liabilities owned by both the central and provincial governments and developing the use of markets and insurance instruments.
- Improving the efficiency of climate resilient public investment by (a) introducing performance indicators for the allocation of fiscal transfers from the central to provincial governments, which are responsible for about 70 percent of all public investments; (b) systematically tagging and monitoring those expenditures in the budgets of the central and local governments; and (c) evaluating projects by using a social welfare-equivalent discount rate (in contrast to a market-based discount rate) to enhance rapid interventions.
- Adopting public procurement procedures such as construction standards or land-use regulations that explicitly account for climate risks (including for SOEs).
- Adjusting the public-private partnership (PPP) legal framework to create incentives for greater private sector participation in climate resilient-infrastructure projects by allowing risk-sharing on investments in new technologies and innovative business practices.

- Considering tax incentives to stimulate private operators to spend on improving the resilience of their own assets or to expand their investments for the well-being of the community through corporate social responsibility measures.

In addition to these fiscal cross-cutting measures, the government could use financial sector policies to stimulate more and better climate-resilient investments from both the public and private sectors. These measures are further detailed in Chapter 5.

3.3. Protecting vulnerable assets and improving disaster risk management

To adapt to climate change, there will be a need to prioritize the policy responses and investments in the most vulnerable sectors and locations. These include agriculture, transport, and the trade/industry sectors, and the Mekong Delta region. Since climate risks disproportionally affect the poor, specific pro-poor remedial actions are also necessary.

3.3.1. Resilient agriculture and forestry

Climate change poses an increasingly severe threat to Vietnam's agriculture, forestry, and fisheries. Rising temperatures are likely to shorten plant growth cycles in the North, and severe water shortages could lead to significant reductions in annual yields. The most productive agricultural area of the country, the Mekong Delta, faces growing threats from sea-level rise and associated saltwater intrusion, which could render the production of some crops impossible.

Agricultural losses due to climate change in Vietnam are projected to reach 5.6–6.2 percent by 2030 and 7.6–10.6 percent by 2050, depending on the climate scenario. The overall loss of output in agriculture is estimated for a given year relative to what it would be without climate change in that year. Based on an analysis by the International Food Policy Research Institute (IFPRI),[35] losses are estimated under three emissions trajectories: RCP 2.6, RCP 4.5, and RCP 8.5.[36] For the period around 2030, the losses are 5.6 percent (RCP 2.6), six percent (RCP 4.5) and 6.2 percent (RCP 8.5). For the period around 2050, the losses are 7.6 percent (RCP 2.6), 7.9 percent (RCP 4.5) and 10.6 percent (RCP 8.5). Notably, without climate change, Vietnam's overall agricultural output would be projected to increase by 25 percent from 2010 to 2030, and by 36 percent by 2050. Climate change impacts would thus deprive Vietnam of a large share of its agricultural productivity gains. Reduced crop yields could also lead to higher food prices, with particular impacts on low-income people.

The forest sector contributes significantly to the country's economy. Vietnam was one of the first countries in the world, and the first in Asia, to institute a system of payments for forest environmental services (PFES). Since 2008, its PFES program has paid out nearly $400 million to farmers and communities helping to prevent deforestation and forest degradation. In addition, the forest provides a myriad of goods and services that support local livelihoods and the economy. Given the topography of the country, forests play a particularly critical role in watershed and coastal protection.

Besides employment and timber and non-timber products, forests provide a range of environmental services involving water resources, biodiversity, and climate protection. Forests are a means for delivering adaptation measures, and well-planned and protected coastal forests can deliver adaptation and economic benefits. Through the hydrological cycle, forests help protect watersheds and their vegetation, water flows, and soils, and store vast amounts of genetic information. Mangrove forests are particularly important

35 For details on the calculation, see World Bank, 2021, "Accelerating Clean, Green, and Climate-Resilient Growth." The costs were computed based on the welfare concept of costs and using a market value-based concept.
36 RCP 8.5 represents a "high emission" or "worst-case" scenario.

in protecting coastlines by reducing exposure to flooding and erosion. They are also some of the most carbon-rich forests in the tropics, contributing to climate change mitigation.[37] Conversely, when forests and mangroves are burned, their climate adaptation benefits are lost, with substantial amounts of carbon are released into the atmosphere.

Despite great economic progress and decreasing deforestation rates, the forest sector in Vietnam faces challenges from competing land uses, overexploitation of resources, and insufficient capacity for forest governance and management. As a result, deforestation and forest degradation rates continue in parts of the country, such as the Central Highlands. Although the forest cover continues to increase, that is mostly due to the expansion of forest plantations and to the way the term "forests" is officially defined (it includes palm and bamboo plantations, for instance). Meanwhile, the quality of natural forests continues to deteriorate.

Changing temperature and precipitation patterns and increasing concentrations of atmospheric CO2 are likely to have significant impacts on both natural and degraded forests. Forest fires, insect outbreaks, wind damage, and other extreme events are expected to impose substantial economic costs on the forest sector. Climate change has a negative impact on the poorest forest-dependent communities, which lack adaptive capacity because of poverty, marginalization, and geographic isolation. Improving forest management and expanding tree cover will deliver a range of livelihood and environmental benefits that help people and ecosystems adapt to climate change.

Recommendations

There is need to prioritize and promote adaptation to increase farmers' resilience to climate change. Key adaptation strategies with economic and other co-benefits include:

- **Repurpose agricultural subsidies on inputs (mainly on the use of water and fertilizers) to support the adoption of resilient agriculture production practices:**[38] Expenditure realignment is required to increase public spending on research and development of drought-resistant and salt-tolerant crop varieties and other innovations to boost productivity. Subsidies can be redirected from water and fertilizers into training, local infrastructure, and services to help farmers switch to improved seeds/breeds and adopt practices that bring climate benefits while maintaining or increasing productivity. Increasing the share of public expenditure for operations and maintenance of irrigation and flood-control infrastructure can ensure their durability and reduce the frequency and cost of rehabilitation. The focus of these adaptation measures should be on the most productive agricultural landscapes, particularly coastal low-lying areas such as the Mekong Delta, which are particularly vulnerable to the effects of climate change.[39]
- **Rehabilitate and upgrade and make irrigation infrastructure and make it more resilient to climate change to reduce system losses and expand irrigation infrastructure in selected areas**: Rainfed agriculture is highly vulnerable to droughts and increasingly unreliable precipitation, and floods and salinization can create problems for irrigation systems. Along with making irrigation systems more climate-resilient, it is important to establish last-mile connections between irrigation infrastructure

37 Donato, D.C., J.B. Kauffman, D. Murdiyarso, S. Kurnianto, M. Stidham, and M. Kanninen. 2011. "Mangroves among the Most Carbon-Rich Forests in the Tropics." Nature Geoscience 4 (5): 293–97. doi:10.1038/ngeo1123.

38 The ASEAN Climate Resilience Network has produced a series of briefing papers on climate-smart land use practices that build resilience and often also reduce GHG emissions, tailored specifically to Southeast Asia: https://asean-crn.org/climate-smart-land-use-practice-insight-brief-series/.

39 For a detailed discussion of future climate change impacts on Vietnam's main agricultural areas, including implications for migration, but also near-term adaptation priorities, see Clement, V., K.K. Rigaud, A. de Sherbinin, B. Jones, S. Adamo, J. Schewe, N. Sadiq, and E. Shabahat. 2021. "Groundswell Part 2: Acting on Internal Climate Migration." Washington, DC: World Bank. http://hdl.handle.net/10986/36248.

and low-income farmers' land, and to provide some irrigation for vulnerable rainfed smallholders. Initial baseline costs for such investments are estimated at up to $2 billion to 2030.

- **Adopt ecological redlining to curb the expansion of agriculture into forested areas:** Agricultural expansion continues to be the main direct cause of forest loss in Vietnam, with construction of rural infrastructure, in particular roads, also contributing. Agricultural expansion at the expense of forests is often the result of poor planning or fiscal policy privileging food production over the protection of ecosystem services. To curb further expansion of agriculture into forested areas, it is necessary to ensure that intensification occurs with more sustainable production, as well as protection and sustainable management of forests. China has successfully developed its system of "ecological conservation redlines" that contribute to the reversing of ecological degradation and biodiversity loss, as well as to climate change mitigation and adaptation.
- **Support large-scale investments in agriculture by strengthening cooperative farm models and facilitate the entry of big operators:** In Vietnam, small farms remain an important part of the sector, but many are constrained in their capacity to invest in climate adaptation. Capacity-building of farmer organizations (cooperatives) is needed so they can be more commercially oriented and transact effectively with large entities. This is also an opportunity to promote climate-smart agriculture (CSA) practices among farmers. Small farmers would also benefit from the adoption of enabling policy and institutional frameworks to promote the digital transformation of the sector (to promote efficiencies in payments and logistics). This is an area in which Vietnam currently lags many of its peers.[40] Improved weather risk forecasting and early warning systems are also crucial.
- **Improve access to finance for smallholder agriculture by removing caps on bank lending and allowing warehouse receipts and crops as collateral:** Providers of financial services for the agriculture sector are subject to significant public policy intervention. For example, commercial banks cannot not lend to agricultural activities at a rate higher than the cap imposed by the State Bank of Vietnam (about six-to-6.5 percent). Allowing farmers to use warehouse receipts and crops as collateral would allow small farmers to secure loans to upgrade their operations. Removing many of these restrictions would allow capital to flow more freely into the sector.
- **Invest in afforestation and reforestation, with a focus on mangroves:** Vietnam joined more than 100 countries at COP26 in pledging to stop and reverse forest loss and degradation by 2030.[41] After a string of deadly typhoons in late 2020, Vietnam's Prime Minister also called for the country to plant 1 billion trees nationwide by 2025 to reduce the risk of landslides and flooding. More broadly, managing and expanding tree cover could deliver a range of livelihood and environmental benefits that help people and ecosystems adapt to climate change.

3.3.2. Resilient infrastructure

Flooding and subsequent landslides are the main hazards threatening Vietnam's transport and energy infrastructure and services. Although regional vulnerability varies depending on the type of hazard, the risk is particularly high in disaster hotspots that include vulnerable regions along the coast, in the northern mountains, and in the Mekong Delta (Figure 9). Under a high-emission scenario, events that used to occur once in 1,000 years could start occurring in five-year cycles.

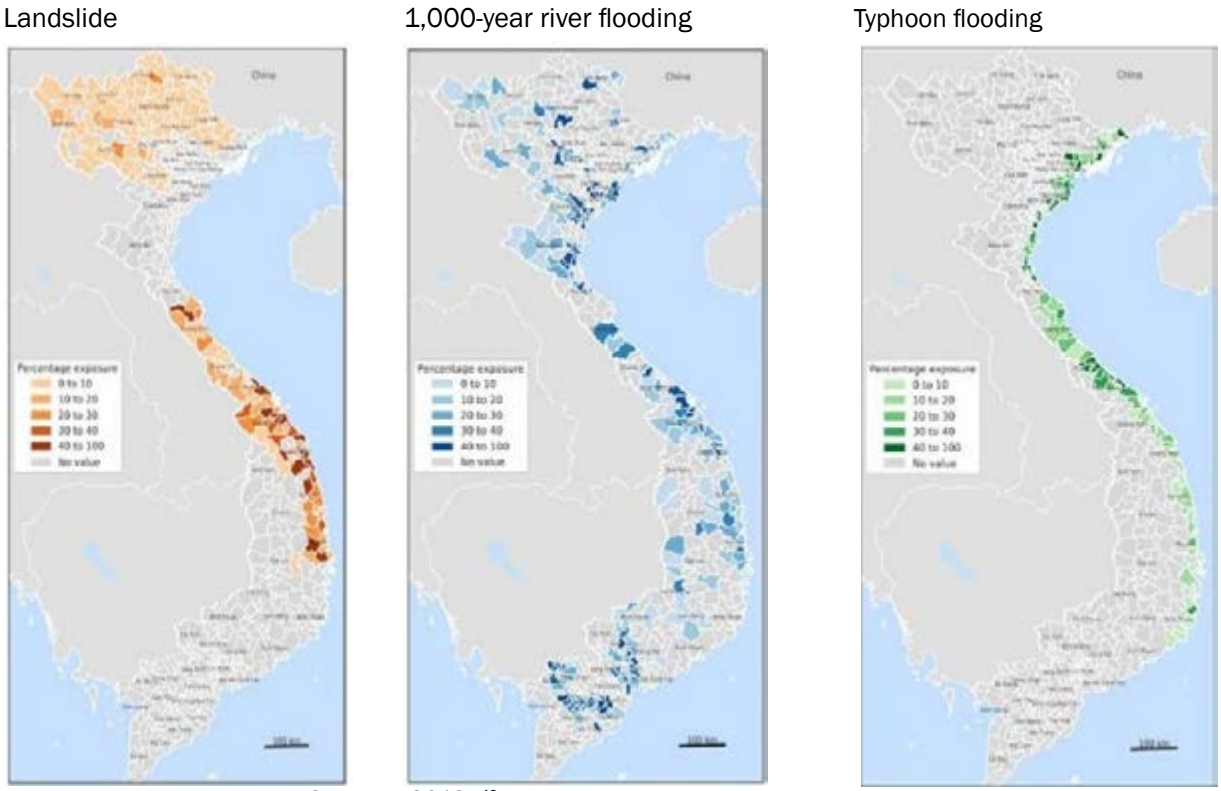
Climate change will put strains on all types of physical infrastructure in Vietnam. Hazard scenarios show road failure due to river flooding will increase by at least 40 percent by 2030. Similarly, the country's largest maritime port, in HCMC, is projected to be about five times more prone to frequent flooding in the future.

40 World Bank and Government of Vietnam. 2019. "Digital Government and Open Data Readiness Assessment." Washington, DC: World Bank. http://hdl.handle.net/10986/32547.

41 See the Glasgow Leaders' Declaration on Forests and Land Use: https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/.

Repairing damage to the power grid from extreme weather events, meanwhile, already takes up to two percent of the power sector's capital expenditures, and those costs are only expected to rise.[42] At the same time, higher temperatures and extreme heat will increase cooling needs and thus electricity demand, which translates into higher peak power generation needs. Weather extremes around the world can also impact global fossil fuel markets, with implications for Vietnam's energy security, as it relies heavily on imported fossil fuels.

Figure 9: Extreme hazard susceptibility exposure of national-scale roads in Vietnam



Source: World Bank analysis (Oh et al., 2019).[43]

Damage to physical infrastructure has negative local impacts as well as cascading macroeconomic impacts on the national economy. Damage to the interconnected power grid can generate prolonged outages and reduced system reliability that can affect manufacturing and trade. Mountainous regions where many poor ethnic minority communities are concentrated rely on a few critical road links and power lines, so the loss of infrastructure connectivity due to climate events could leave them isolated for months. Damage to national level networks could have major macroeconomic impacts. An analysis of road links found that the unavailability of a single link on National Highway 1A could cause $1.9 million per day in economic losses just from the need to reroute freight flows, not including damage to the infrastructure. Imbalances in supply and demand, as observed during the pandemic, can also be costly. Under worst-case scenarios, some 68,000 to 106,000 tonnes of maritime cargo flow per day could be affected by extreme flooding at the major maritime port of Hai Phong and the city of Can Tho, greatly jeopardizing Vietnam's international trade. Similarly, some 25,000 to 55,000 tons of cargo flows per day on inland waterways could be affected under worst-case climate scenarios.[44]

42 World Bank estimates based on data from Vietnam Electricity annual reports for 2019 and 2020.

43 Oh, J.E., X. Espinet Alegre, R. Pant, E.E. Koks, T. Russell, R. Schoenmakers, and J.W. Hall. 2019. "Addressing Climate Change in Transport: Volume 2: Pathway to Resilient Transport." Vietnam Transport Knowledge Series. Hanoi: World Bank. http://hdl.handle.net/10986/32412.

44 Oh et al., 2019. "Addressing Climate Change in Transport."

Recommendations

- **Upgrade road and power assets to climate-resilient design standards:** Upgrading a typical national highway on a flat terrain to very high standards cost around $1.5 million per kilometer. While such upgrading could be costly, a cost-benefit analysis shows that upgrading 20 national highway sections to climate-resilient standards, which would require about $153 million in new investment, would yield $651 million to $3.66 billion in benefits over 35 years.[45] In addition, integrating different transport networks—roads, maritime, inland waterways, and railways—would enable the overall transport network to function better and to be more resilient to disasters. Shifting just 10 percent of road freight to other modes could reduce the economic impacts from climate extreme events by 20–25 percent. Different networks are often exposed to different hazards; for instance, waterway and domestic maritime transport is known to be much less affected by flooding than road transport. It also has little exposure to landslide risks. On the other hand, ports are exposed to climate risks and if poorly planned, may themselves aggravate climate change-linked damages, in particular coastal erosion.
- **Introduce a life-cycle asset management approach for infrastructure:** Vietnam currently allocates well below 20 percent of its transport expenditure to maintenance, far less than peer countries such as Indonesia and Malaysia.[46] The life-cycle asset management approach is a globally recognized good practice to sustain the level of service of infrastructure while minimizing the overall budget spent on the creation and maintenance of the asset. The approach is especially critical for Vietnam, which has major network expansion needs and faces significant climate risks to such assets. A substantial proportion of the needed finance can be mobilized from the private sector via management contracts or PPPs in which the government retains control over the assets but transfers the day-to-day management and business operations to the private sector. More detailed guidance on Decree 35 (March 2021) and the new PPP Investment Law (Law 64 of 2020) can increase private investment in contestable sectors, including transport (road, railways, ports, maritime, and aviation) as well as electricity transmission connectivity and infrastructure. Updating the technical and operating standards of transport and energy sectors to adapt to climate risks and improve resilience, including designing the assets to better withstand extreme weather events and adding redundancy, where possible, will be crucial. A systematic risk review is necessary, followed by the incorporation of such standards into sectoral plans for investments (e.g., retrofitting of vulnerable roads, power plants, and backbone grid infrastructure).

3.3.3. Resilient trade and manufacturing

Vietnam's competitiveness in global markets — the country's trademark — is at risk from climate change. Two of Vietnam's largest export sectors, manufacturing, and agriculture are concentrated in coastal lowlands and deltas that are extremely vulnerable to the impacts of climate change (Box 2).

The vulnerability of the trade/manufacturing sector is particularly apparent in cases of critical industrial parks. A recent WBG report showed that 34 percent of the country's industrial zones (127 of 372) are in coastal provinces at risk of flooding.[47] In the HCMC agglomeration and in Binh Duong and Dong Nai, where many industrial zones are concentrated, flood-prone areas within the city may increase from 23 percent to 35 percent by 2050.

45 Oh et al., 2019. "Addressing Climate Change in Transport."

46 World Bank and Government of Vietnam. 2017. "Vietnam Public Expenditure Review: Fiscal Policies towards Sustainability, Efficiency, and Equity." Washington, DC: World Bank. http://hdl.handle.net/10986/28610.

47 Braese, J., S.A. De Vries Robbe, and J. Rentschler. 2020. "Coastal Development between Opportunity and Disaster Risk: A Multisectoral Risk Assessment for Vietnam." Policy Research Working Paper No. 9352. Washington, DC: World Bank. http://hdl.handle.net/10986/34284.

Trade could also be negatively affected by climate change impacts on physical infrastructure. Maritime shipping, which accounts for about 80 percent of global trade by volume and more than 70 percent of global trade by value, could be disrupted by climate change. In particular, more frequent and severe storms, heavy precipitation, and sea-level rise could cause more frequent port closures, affect the speed of passage, necessitate the use of alternative shipping routes or other safety measures, and increase the maintenance costs for ships and ports.

Box 2. Assessing exporting firms' vulnerability to flooding or tropical storms

Using the balance sheet data collected from 700,000 firms in Vietnam, an International Finance Corporation (IFC)/World Bank team assessed the companies' vulnerability to climate shock. The methodology employed a microeconomic and corporate finance approach to analyze the impact of exogenous shocks on the firms' key financial indicators, including liquidity, capital structure, profitability, and the (un)availability of cash buffers to withstand external shocks. This approach made it possible to quantify the firms' debt at risk, from which a relationship could be established to understand employment at risk and government tax revenue at risk.

Manufacturing and agriculture — the two main exported products — were among the most financially vulnerable sectors. The main risk for manufacturing was from the impact on jobs and insufficient liquidity to sustain a big shock. For the agriculture sector, the main challenge was the number of farms affected, rather than the financial risks to individual establishments. Among non-tradable sectors, real estate, construction, and education emerged as the most vulnerable.

Recommendations

- **Strengthen and enforce policies and regulations for industry resilience, including in industrial parks:** This should include guidelines on (i) infrastructure solutions that minimize physical damage and disruption of services critical to industries; (ii) financial mechanisms available before, during, and after disasters to secure financial protection of firms and channel investment in resilient infrastructure; and (iii) measures that encourage investment in and implementation of digital technologies to improve data quality, offer predictive analytics, enhance monitoring and communication, and provide real-time information.
- **Model and plan alternative locations and trading channels for the most climate-vulnerable industries:** Companies should systematically assess the vulnerability of their trading environments to floods, droughts, and storms, paying particular attention to areas that have a limited ability to anticipate and adapt to climate change. For example, the most vulnerable will be places where there is limited capacity to respond, and where local ecosystems are fragile.

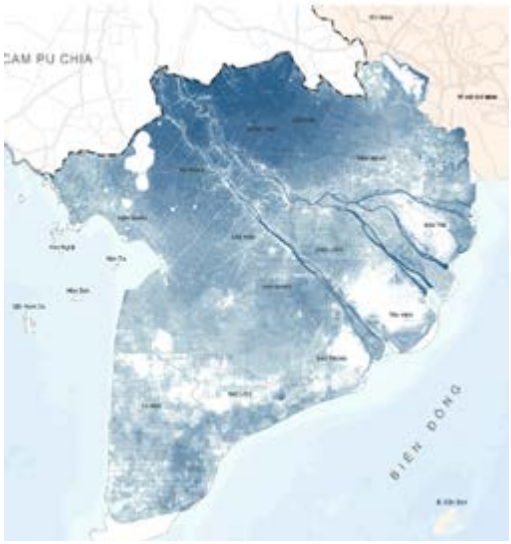
3.3.4. Resilient Mekong Delta

The Mekong Delta contributes 50 percent of the country's rice production and 95 percent of rice exports, 65 percent of aquaculture production and 60 percent of exported fish, 70 percent of fruit production, and a third of Vietnam's agricultural GDP. The early economic success of the region has, however, come at a huge cost. Rice intensification and the necessary massive water regulation infrastructure systems have exhausted the delta's natural systems and created a whole host of issues including: increased inundation in the downstream provinces in the flood season and increased salinization in the coastal provinces in the dry season; declining fishery resources; degradation of surface water quality; overexploitation and pollution of groundwater resource; land subsidence induced by excessive groundwater extraction, sand mining in waterways and reduced sedimentation due to impoundment in dams higher up in the water basin; environmental and ecosystem degradation including loss of the coastal mangrove belt; loss of Delta culture and out-migration.

All available evidence suggests that, the Mekong Delta is at great risk from climate change. If sea levels rose by 75–100 centimeters relative to 1980–1999 levels, almost half of the delta area would be inundated. A meter of sea-level rise would inundate 79 percent of the total area of Ca Mau province and 76 percent of Kien Giang province (Figure 10).[48] Without adaptation measures, around 45 percent of the Mekong Delta area will be affected by salinity, at an economic cost of about $17 billion by 2030.

Figure 10: The Mekong Delta is highly exposed to sea-level rise

Projections for Flooded Land at High Tide in 2050 in Mekong Region



Source: Kulp and Strauss, 2019

Over recent decades, the frequency and intensity of disasters such as flooding, drought, coastal and riverbank erosion, and salinization have increased significantly. These have caused human and property losses, damaged socioeconomic and cultural infrastructure, and negatively impacted living conditions (as evidenced by the fast and accelerating out-migration from the Delta region).

In 2017, the Prime Minister issued the resolution on "Sustainable and Climate-Resilient Development of the Mekong Delta of Vietnam" (Resolution No. 120/NQ-CP) that could be considered the most important and transformative political initiative movement towards an integrated and adaptive approach to delta management. It particularly focused on (i) establishing ecological subregions and developing land use plans in accordance with natural characteristics; (ii) developing an integrated master plan to guide socioeconomic development of the whole region; (iii) building an economic structure based on aquaculture-horticulture-agriculture, green industries, and eco-tourism; (iv) ensuring regional coordination and connectivity; and (v) identifying breakthrough mechanisms and policies to attract non-budget capital resources, especially from the private sector. In February 2022, the first regional masterplan was approved for the Mekong Delta building the way toward investment planning and implementation.

Recommendations

- **Implement and enforce conservatory measures.** The list includes curtailing sandmining and groundwater extraction that cause land subsidence, which is currently a more significant factor of inundation of the Delta than sea-level rise; widening the adoption of farming practices that are better adapted to increasing salinization (e.g., mixed rice and shrimp farming); increasing freshwater flow and aquifer recharge to offset saltwater intrusion; and protecting and restoring mangroves that protect the land against storms and produce ecological and livelihoods benefits.
- **Implement, with urgency, a coordinated regional investment program in the Mekong Delta:** The Regional Coordination Council (RCC) could play this role, but it does not yet have the mandate to prioritize or implement these investments. Investments could include, but not be limited to, restoration of wetlands to manage flood and droughts; dikes, wave breakers, and mangrove belts to protect from sea-level rise; and alternative livelihoods investments for those affected by salinity intrusion.

48 These estimates (Kulp and Strauss, 2019), are based on a new approach called CoastalDEM, that was used to correct for possible errors in a satellite-based approach that calculates land elevations based partly on the height of trees, and where dense fauna conceal the actual level of the land. However, there are other studies that show that the Mekong Delta will be under sea-level only in another 80 years.

- **Correct the deficit in public investment that has built up in recent years in the Mekong Delta:** One way is to introduce special provisions in the Public Investment Law to allow streamlining of approvals. In addition, funds should be made available to prepare project proposals, and the approval processes (such as contracting consultants to prepare the Project Investment Policy/Pre-Feasibility Studies/Feasibility Studies) should be streamlined. Such actions would help minimize delays in preparation and subsequent approval and implementation of investments.
- **Adopt innovative instruments that can help further mobilize additional resources.** These include risk sharing instruments such as guarantees in which public money is blended with private capital through a risk sharing mechanisms; green banking and green loans that make financing available for projects that are considered to contribute to climate-resilient development; and green bonds in which proceeds will be exclusively applied to finance or refinance eligible projects that contribute to adapting to climate change.

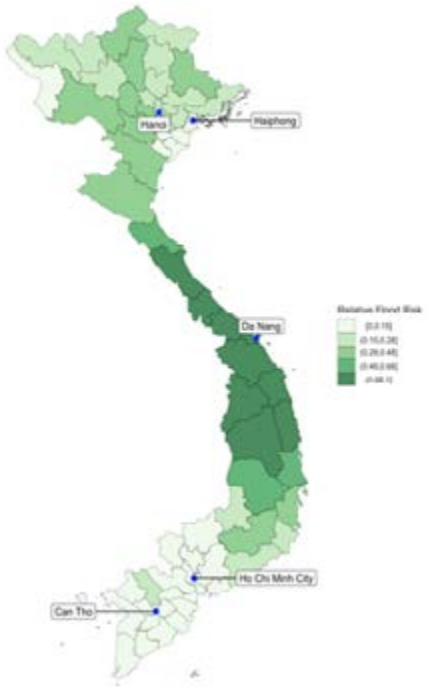
3.3.5. Resilient shores and cities

Vietnam's 300 coastal cities are low-lying and frequently affected by natural disasters such as storms, floods, droughts, and saltwater intrusion. The World Bank estimated in 2020 that 11.8 million people in Vietnam are directly exposed to intense flood risks, and more than 35 percent of coastal settlements are on eroding coastlines.[49]

In the agriculture sector, $1 billion worth of GDP and 1.5 million workers are directly exposed to intense flood risks. Aquaculture alone has 1.1 million tonnes of production at risk of flooding per year, accounting for almost $1 billion in exports. Tourism is also at high risk, with 42 percent of hotels located near eroding beaches. Vietnam's large industrial sector has developed in high-risk areas, with half of industrial zones directly exposed to intense flood risks (Figure 11).

The costs of climate-induced disasters are climbing rapidly, taking an increasing toll on human life, assets, and livelihoods, as well as on valuable ecological systems. The expansion of urban areas to accommodate growing populations has reduced green space and increased the extent of impermeable surfaces, which are prone to flooding and put high pressure on water resource management in Vietnam's cities. Secondary cities in the North and South-Central Coast Regions have experienced some of Vietnam's highest urban growth rates since 2012.[50] An approach to urban development that incorporates sustainable, climate-resilient measures such as strengthening the infrastructure systems and public services will provide a safe and healthy environment for the cities' economic development and enhance the resilience of their residents.

Figure 11: Flood risks in coastal regions



Source: World Bank.

49 Rentschler, J., S. de Vries Robbé, J. Braese, D.H. Nguyen, M. van Ledden, and B. Pozueta Mayo. 2020. "Resilient Shores: Vietnam's Coastal Development Between Opportunity and Disaster Risk." Washington, DC: World Bank. http://hdl.handle.net/10986/34639.

50 . World Bank (2020). Vietnam: Urbanization Review. Shifting the GEAR: Putting Vietnam's Urbanization onto an Efficient, Inclusive, and Resilient pathway.

Land markets are powerful tools for driving new construction in a way that efficiently meets population needs. However, land markets often fail to fully internalize climate change and natural hazards. As a result, development often occurs in risky areas, especially when developers do not carry the cost of future climate change impacts.

Recommendations

- **Develop an integrated coastal resilience investment program for the main urban centers and connecting infrastructure:** Risk-informed zoning and spatial planning is vital to ensure that economic growth in coastal zones does not irreversibly lock in unsafe development. This should be based on the best available risk information. To ensure that lifeline infrastructure systems can deliver their essential services, an integrated coastal resilience investment program should be developed by integrating risk information into the planning, design, and maintenance stages of all infrastructure investments. Upgrades should start in the most exposed and under-protected areas, and existing safety standards should be reviewed and updated.
- **Develop a systematic approach to using nature-based solutions:** To harness the protective function and economic contribution of ecosystems (including mangroves and sand dunes), a systematic approach to their rehabilitation, conservation, monitoring, and management is essential. Relevant policy, regulatory, and legal frameworks must be strengthened, and lessons from past initiatives should be consolidated to inform technical guidelines and future programs.
- **Restrict new developments, including in buffer zones, by strengthening and enforcing land use regulations**: Regulations are also needed to avoid unchecked urban development that leaves too little porous green space, further increasing runoff and flood risks. In addition, risk-sensitive land use and urbanization plans must be enforced through construction norms and building regulations. The quality of construction and the role played by building regulations are key determinants of climate resilience.

3.3.6. Caring for the most vulnerable people

Without rapid and inclusive adaptation responses, climate change impacts on low-income people could drive an additional 400,000 to 1 million into extreme poverty by 2030.[51] This would be a significant setback after Vietnam's marked reduction in poverty over the past few decades. The WBG's latest poverty assessment study finds that about 10 percent of Vietnamese households are vulnerable to falling into poverty due to exposure to a climate-related event.[52] This vulnerability varies by types of climate risks, social cohesion, and poverty rates across regions. For example, poor households in the Northern Midlands and Mountain areas are most exposed to precipitation and temperature variations, while those in the North Central, Central Coastal, and Mekong Delta regions are most exposed to sea-level rise. In general, poor households have less resilience to such shocks and fewer coping strategies. Ethnic minorities are far more exposed and vulnerable to climate impacts than the rest of the population. Climate change is threatening livelihoods and productivity, affecting health and nutrition outcomes, and impacting learning and educational attainment (Box 3).

Vietnam's government has developed strategies to ensure that when disasters occur, the most vulnerable people can cope and then recover quickly, without devastating long-term consequences. Data and early

51 Hallegatte, S., M. Bangalore, L. Bonzanigo, M. Fay, T. Kane, U. Narloch, J. Rozenberg, D, Treguer and A. Vogt-Schilb. 2016. *Shock Waves: Managing the Impacts of Climate Change on Poverty.* Climate Change and Development Series. Washington, DC: World Bank.

52 The economic security line in Vietnam is $5.50 per person per day in 2011 purchasing power parity (PPP) terms. Washington, DC: World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099945004182217194/P17626100f8c0005d0b7270db2c28481e36.
The economic security line in Vietnam is $5.50 per person per day in 2011 purchasing power parity (PPP) terms.

warning systems are already operational, but they could be improved through better coordination and communication across agencies. The most vulnerable segments of the population should be targeted when establishing policies and frameworks and communications protocols for emergency preparedness.

Box 3. Building resilient human capital

For Vietnam, further investing in human capital should be an utmost priority, because climate change is already affecting human capital outcomes, and human capital plays a major role in adaptation and resilience.

Climate change is threatening livelihoods and productivity, affecting health and nutrition outcomes, and impacting learning and educational attainment. There is clear evidence that heat, and pollution increase the likelihood of illnesses (especially vector-borne diseases) in children and adults, and directly impede learning and productivity. For instance, a recent modeling exercise found that a day in a heat wave may increase mortality by 0.7 percent. In addition, recent analyses indicate that diseases transmitted from animals to humans, such as COVID-19, may occur more frequently due to climate change. Heat and droughts affect crop production, consumption, and nutrition, leading to inadequate cognitive development early in life that depresses the entire earnings trajectory of an individual. While potential effects on health have been modeled, there is an urgent need to conduct similar exercises with leaning outcomes.

Concurrently, the efficiency of adaptation measures will be increased if citizens have a good understanding of the consequences of inaction. A better educated and informed population is more likely to adapt its behavior and to upgrade its buildings and other assets. It will also further support the government priorities in collective infrastructure.

Financial inclusion, such as access to emergency borrowing, and social protection are essential ways to help firms and people recover from climate shocks. In Vietnam, the government introduced a comprehensive post-disaster social assistance program as early as 2007, which was revised in 2021. An important, but underdeveloped, instrument in Vietnam is the development of insurance markets. Between 2011 and 2013, an experimental agricultural insurance program was implemented on a limited scale in 20 provinces, but the results were mixed due to the lack of awareness by farmers and inadequate monitoring tools. In general, domestic disaster or weather insurance markets can be effective channels for reducing climate risks. The Turkish Catastrophe Insurance Pool and the Mongolian Livestock Insurance Pool are good examples of PPPs that have substantially increased insurance penetration at the local level, including among the poorest households.

Drawing on international experience, to scale up their support to vulnerable groups, Vietnam recently launched the Adaptive Social Protection system, piloting it in Can Tho and Tra Vinh provinces. The system will allow local governments to measure the cost of delivering the necessary funding while helping ensure that funds are spent efficiently and transparently. Once impacted households are identified, the system is expected to deliver payments to recipients as quickly and conveniently as possible. The system will also provide support to modernize the payment process by linking beneficiaries with the payment provider to open accounts and channel the support directly to recipients' accounts. If successful, those pilots should be extended to other provinces.

Persistent climate risks are likely to drive millions of people to migrate within Vietnam, with implications for the economy's long-term structural transformation and spatial development. Recent analytical work by the World Bank has emphasized that changes in temperature and precipitation patterns, as well as sea-level

rise — have been the key drivers of mobility in Vietnam and worldwide (Box 4).[53] The higher frequency of natural disasters and extreme climate events can also push people to move away from the most vulnerable regions.

Box 4. Climate-induced migration in Vietnam

Climate change could significantly increase internal migration in Vietnam, especially to urban areas. Depending on the trajectory of climate change and socioeconomic development, 25–33 percent of all internal migrants in Vietnam by 2050 could be climate migrants.

Hanoi and the Red River Delta are projected to be the largest hotspots for climate in-migration by 2050; there are also smaller in-migration hotspots in the coastal central region, including Bin Dinh, Quang Ngai, and Quang Tri provinces. These areas are projected to see improvements in water availability to 2050 and, on average, in crop productivity. Sea-level rise impacts in the Red River Delta are expected to be largely confined to the mouth of the river, with better conditions prevailing further inland.

The largest climate out-migration hotspots by 2050 are projected to be the Mekong Delta and around HCMC. Sea-level rise augmented by storm surge is the main driver of migration from the Mekong Delta, as the low-elevation coastal zone is already subject to inundation and associated impacts. HCMC and its environs are projected to see declines in water availability. High population densities in both climate in- and out-migration hotspots that are highly vulnerable to sea-level rise and storm surge will require strong proactive adaptation measures and planning. While people with some resources can use mobility as an adaptation strategy, the poorest, most marginalized, and most vulnerable may not be able to move, and thus may be forced to stay in situations of extreme impoverishment and exposure to severe climate hazards.

Source: Clement et al., 2021.

Evidence also suggests that ethnic minorities are far more vulnerable to climate impacts than the rest of the population.[54] Ethnic minorities in Vietnam are substantially poorer, more marginalized, and more vulnerable to climate change than the country's ethnic majority, the Kinh. Minority groups often inhabit marginal and fragile ecosystems that are most threatened by a wide range of climate change impacts, including extreme weather events such as cyclones and hailstorms, prolonged droughts, desertification, and sea-level rise. Understanding such vulnerabilities is critical to supporting holistic policy making.

Recommendations

- **Implement a modernized, scaled-up, and adaptive social safety net program:** It is important to issue guidelines to improve the coordination of early warning systems and communication across various agencies and provinces. The revised post-disaster social assistance program can also be implemented more efficiently. In addition, the government can use its own resources to support domestic insurance markets and reach households and businesses with insurance products to realize the policy goal of expanding the population's financial resilience to disasters.

- **Invest in information technology and other digital technologies to improve weather risk forecasting and early warning systems:** While Vietnam's early warning systems are relatively effective, coordination is often weak, and funding and the allocation of responsibilities are not always well-defined in advance. Key areas that need attention include (i) improving and modernizing the

53 Clement et al., 2021, "Groundswell Part 2."

54 See, for example, P. McElwee, *Ethnic Minorities and Climate Change in Vietnam: Impacts, Vulnerabilities, and Adaptation Strategies*, December 2021.

early warning systems, and (ii) explicitly addressing the needs of different user groups in a robust communication system that translates climate risk data into actionable information.

- **Prioritize investments in infrastructure and social services in areas that will be impacted by climate migration:** Early coordinated action may be needed to prepare agricultural areas for climate change impacts, including low-lying areas in the Mekong and Red River Deltas facing sea-level rise and storm surge, as well as the Central Highlands and mountainous Northeast and Northwest. Major coastal urban centers will also require climate-resilient planning, but they have differentiated needs. Hanoi, which could see climate in-migration even as flooding and exposure to tropical cyclones continue to increase, may need to address growing strains on urban infrastructure and key economic activities. HCMC, meanwhile, will need to balance climate out-migration with broader population growth trends and strengthen investments in adaptive capacity.

4

Mitigating Climate Change – The Decarbonizing Pathway

4. Mitigating Climate Change – The Decarbonizing Pathway

4.1. Bold commitments call for bold actions

Vietnam aspires to become a high-income economy by 2045, while it has at the same time committed to achieving net-zero emissions by 2050. Aggressive strategies will therefore be required in the main emitting sectors (energy, transport, agriculture, and industries), combined with carbon pricing to incentivize behavioral changes in businesses and households. They will need to be accompanied by measures that will reduce local air pollution, improve labor mobility, and bolster Vietnam's competitiveness in a decarbonizing world. Efficiency improvements and foreign assistance, in turn, can help ensure major investments in mitigation are not made at the expense of other equally important productive investments.

A net-zero pathway (NZP) developed for the CCDR shows Vietnam will need to make significant investments in its main emitting sectors: energy, transport, agriculture, and industry/trade. This pathway is one of the possible combinations that Vietnam could envision to reach its target as, for example, it could use more pricing instruments and less new investments than considered in this report. Drawing on the sectoral analyses presented in the next sections, it shows that the energy transition should be the backbone of the country's program and that many investment decisions will have to be frontloaded to be the most cost-effective. The total cost of necessary investments is estimated at about $81.3 billion in net present value terms between 2022 and 2040 (Table 3). Over 80 percent would be to support the energy transition, and with the remainder, for agriculture, transport, and industry. Those investments alone would reduce GHG emissions by nine percent in 2030 and 21 percent in 2040 relative to a BAU scenario. However, that is far short of what is required to achieve net zero by 2050.

Sectoral investments will need to be supported by carbon pricing (as a tax or through regulations creating an emission trading system) to incentivize businesses and households to shift their behaviors toward low-emitting activities.[55] Several options were analyzed for an economywide carbon tax. The most modest option would start at about $12 per tCO_2e in 2022, which is the weighted average of the EPT rate on coal, diesel, and gasoline, and ramp up to $40 per tCO_2e by 2040. The two other options are to ramp up to $90 or to $120 per tCO_2e by 2040 (from the same starting point). The $90 option appears sufficient to generate the necessary changes in emitting activities. Combined with sectoral investments, the $90 tax would reduce emissions by 42.8 percent relative to the BAU scenario by 2030, and 73.6 percent by 2040. The reduction would mainly be driven by the gradual increase in the carbon tax, technology shifts in manufacturing/trade, and the transition of the energy sector away from coal. The power sector would make the greatest contributions to GHG emission reductions, followed by manufacturing, transport, and agriculture.

Pursuing the net-zero pathway could slow GDP growth. The CGE model shows that under the NZP, Vietnam's GDP would be 0.6 percent lower in 2030 and 2.2 percent lower in 2040 than in the BAU scenario (a description of main assumptions and key results can be found in Annex 3). While Vietnam would be able to reduce its GHG emissions, doing its part to address the global climate crisis, the cumulative impact on the economy between 2022 and 2040 would be a loss of about $135 billion, reflecting reduced outputs and investment costs (Table 3). The net impacts on the energy and industrial sectors would be especially large — a cumulative $102 billion and $167 billion, respectively—while other sectors combined would gain $165 billion.[56]

55 Parry, I. 2019. "Putting a Price on Pollution: Carbon-Pricing Strategies Could Hold the Key to Meeting the World's Climate Stabilization Goals." Finance and Development, December 2019. https://www.imf.org/external/pubs/ft/fandd/2019/12/the-case-for-carbon-taxation-and-putting-a-price-on-pollution-parry.htm.

56 It is important to stress that these estimates reflect the high costs of the transition to clean technologies. Although the model did not look beyond 2040, many studies have shown that in the longer term, the economics would be much more favorable.

Table 3. Investment needs and output gains under the Net-Zero Pathway

$ billion in NPV terms

	2022–2030	2031–2040	2022–2040
NZP			
Investment needs	31.8	49.5	81.3
Output gains	-7.6	-46.0	-53.7
Net economic impact	-39.4	-95.5	-134.9
NZP with supporting reforms			
Investment needs	31.8	49.5	81.3
Output gains	11.3	68.7	80.1
Net economic impact	-20.5	19.3	-1.3

Notes: All amounts are discounted using a 6 percent discount rate. The investment needs are estimated on the basis of the sectoral analysis in the energy, transport, agriculture, and industry/trade sectors. The output gains are the accumulated variations in GDP derived from the CGE model for each scenario.

4.2. Smart policies to align decarbonization and development objectives

With the right mix of policies and strategies, Vietnam can leverage its decarbonization efforts to advance development objectives, so that achieving net-zero emissions does not reduce GDP growth. These policies are important to generate a (net) welfare gains as illustrated in Table 3, with the net economic impact of the NZP with reforms is evaluated to be almost neutral on GDP over the period 2022-2040 (a small loss of $1.3 billion).

This positive outcome will not happen automatically but will require proactive measures from the government. While some of the measures are closely associated with the climate agenda (such as the health benefits of a reduction in air pollution or energy efficiency gains), others will be necessary for the country to achieve its development ambitions regardless of its climate objectives (including efficiency in public spending and furthering of labor market mobility). The main policies are the following:

Prioritizing actions to reduce air pollution: Several key measures to reduce GHG emissions, such as shifting away from coal power, reducing traffic congestion, reducing transport emissions, and improving farming and livestock practices, can also significantly reduce air pollution. That, in turn, can improve human health and labor productivity.[57] This expected co-benefit was considered in the CGE model by assuming that a one percent decrease in air pollution augments labor productivity by 0.3 percent.[58] As shown in Table 4, that would result in GDP being 0.8 percent higher in the NZP in 2030 than in the BAU scenario. In 2040, GDP would still be lower than in the BAU scenario, but only by one percent, instead of 2.2 percent. Prioritizing actions in areas with severe air pollution, such as around Hanoi, can heighten the economic benefits of decarbonization (see Box 5).

57 OECD. 2016. *The Economic Consequences of Outdoor Air Pollution*. Paris: Organisation for Economic Co-operation and Development. doi:10.1787/9789264257474-en.

58 Fu, S., V.B. Viard, and P. Zhang. 2021. "Air Pollution and Manufacturing Firm Productivity: Nationwide Estimates for China." *The Economic Journal* 131 (640): 3241–73. doi:10.1093/ej/ueab033.

Box 5. Hanoi air pollution: How targeted action can maximize co-benefits

The main local benefit for Vietnam from mitigation is reducing air pollution, which is particularly concentrated in Hanoi and its neighboring provinces. The current air quality situation necessitates urgent action to reduce levels of pollution and the population's exposure to harmful $PM_{2.5}$ concentrations. The measured annual mean concentrations are clearly above the national ambient air quality standard (NAAQS) of 25 µg/m³ and exceed the global guideline value of the World Health Organization (10 µg/m³) by a wide margin.

$PM_{2.5}$ in Hanoi originates from both local and regional sources. A recent World Bank analysis identified the main ones: (i) nearly 35 percent comes from industry, including large power and industrial plants around Hanoi; (ii) about 25 percent comes from transport; (iii) 20 percent involves ammonia emissions from livestock and from fertilizer use; (iv) 10 percent is produced by the residential sector (primarily cooking with biomass); and (v) about 7 percent comes from the open burning of agricultural waste.

$PM_{2.5}$ concentrations are projected to continue to increase, mainly due to the planned expansion of coal capacity without strengthening air pollution regulations. According to government plans, 10 new coal-fired power plants will be put into operation in the Northern region by 2030. Agricultural pollution also is expected to grow because of increased production and a lack of policies targeting ammonia emissions.

Effective improvements to Hanoi's air quality will require urgent actions, in close coordination with neighboring provinces. Priorities should include reducing reliance on coal—for example, by repurposing the 100 MV plant in Ninh Binh; incentivizing farmers to use fewer polluting inputs and burn less waste; improving public transportation systems; and applying tougher standards on motor vehicle emissions.

Source: World Bank, 2021, "The Source of Air Pollution in Hanoi Agglomeration, unpublished.

- **Boosting international competitiveness:** By decarbonizing its economy, Vietnam could improve its competitiveness on international markets. In markets that adopt border carbon adjustments, as the European Union is planning, low-carbon goods have a price advantage. Decarbonization will also help retain and attract foreign direct investment (FDI), as many multinationals have their own commitments to reach net-zero emissions, driven to a great extent by consumer demand. In Vietnam, about 85 percent of exports are produced by foreign-owned companies. If, by expanding its low-carbon production, Vietnam could increase its exports by 20 percent (relative to a BAU scenario) over the period 2022–2040, its GDP would be 0.9 percent higher in 2030 and decline less (by only 0.6 percent) in 2040.
- **Improving energy efficiency:** Vietnam has been working to increase energy efficiency and that commitment has already been accounted for in the BAU scenario. However, there are several additional measures that can further reduce demand for energy—which, in turn, can reduce the cost of scaling up clean energy (see section 4.3.1). One key option is to adopt energy-saving materials and equipment in production processes, as called for in the National Energy Efficiency Program. Based on the government's revised targets, the CGE model assumes that energy efficiency in industrial and services production would gradually increase and reach five percent (without major investment costs) by 2040.[59] If that can be achieved, the impact of the NZP on GDP would be positive, with an increase of 0.5 percent by 2030 and 0.2 percent by 2040.

59 Ministry of Industry and Trade. 2018. "Vietnam – National Energy Efficiency Program 2019–2030." Hanoi: Socialist Republic of Vietnam. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/598851561961183317/Vietnam-National-Energy-Efficiency-Program-2019-2030.

- **Improving domestic labor market mobility:** Implementing the NZP would result in significant changes in the economy, with some industries growing and others shrinking. For the workers' sake, and to meet the needs of growing industries, it is crucial that workers be able to move smoothly into new jobs. This will require coordination as well as job training (see section 4.4.3). The CGE model assumes, as is standard in the literature, that workers will move within sectors—for instance, from coal power to solar power—as there are fewer constraints to overcome than when moving across sectors. If all the frictions in the labor market can be eliminated, which might be feasible in the long run, GDP would be only 0.2 percent lower in 2030 and 2040 than in the BAU scenario.
- **Reducing the impact on other investments:** By default, the NZP assumes that the massive new investments in the energy, transport, agriculture, and industrial sectors will replace other investments that would occur in the BAU scenario. To some extent, that is as it should be: for instance, investing in renewable energy instead of fossil fuels. However, necessary, and productive investments could also be "crowded out," and this is reflected in the lower GDP projections. This effect can be reduced by adopting measures to make the management of public and private investments more efficient, so that more investments can be realized with the same resources. New investment could also be partly funded by additional foreign assistance. If the crowding out is reduced by about 70 percent, GDP would still be lower in the NZP than in the BAU scenario, but only by 0.5 percent in 2030 and 0.9 percent in 2040.

As shown in Table 4, by implementing the NZP together with all these supporting measures, Vietnam could reduce GHG emissions by more than 70 percent in 2040 relative to the BAU scenario, while increasing GDP by 1.7 percent in 2030 and 3.3 percent in 2040. The cumulative output gain for 2022–2040 relative to the BAU scenario would be $80 billion — which, as noted above and shown in Table 3, means that the NZP would effectively pay for itself. While the energy and agriculture sectors would still see output reductions, transport, industries, and other sectors (mainly services) would enjoy gains. Resources would be allocated better, and workers would shift from high- to low-emitting sectors, with limited crowding out of other productive investments. Further gains in manufacturing would be generated by improved competitiveness and labor productivity increases.

Table 4. How key supporting policies would affect the impact of the NZP on GHG emissions and GDP

Percent change from baseline

	% change in GHG emissions		% change in GDP	
	2030	2040	2030	2040
NZP without reforms	-42.8	-73.6	-0.6	-2.2
NZP with reduced air pollution	-42.2	-73.4	0.8	-1.0
NPZ with competitiveness gains	-42.7	-71.8	0.9	-0.6
NZP with energy efficiency gains	-41.9	-72.1	0.5	0.2
NZP with improved labor mobility	-43.0	-71.8	-0.2	-0.2
NZP with low crowding out of other investments	-43.1	-73.5	-0.5	-0.9
NZP with all supporting measures	-40.2	-71.9	1.7	3.3

Source: Authors' calculations based on the CGE model built for the CCDR.
Note: The slightly smaller scale of projected GHG emission reductions when supporting measures are included is partly—though not entirely—a function of the higher GDP achieved, as in an economy that is not yet fully decarbonized, increasing GDP will increase emissions, at least modestly.

4.3. Sectoral Transitions

The rest of this chapter examines in detail the implications of decarbonization in the four key sectors that are major contributors of emissions: energy, transport, agriculture and forestry, and trade and manufacturing. It assesses the broader micro-economic and socio-economic implications of these potential transitions.

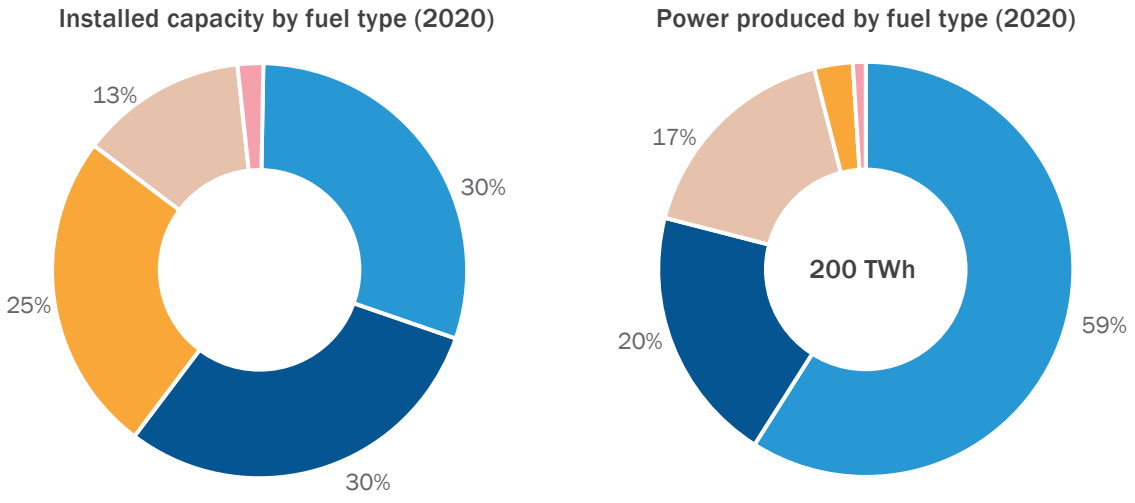
4.3.1. Decarbonizing energy

Vietnam's electrification program has been a global success story for its ability to increase the rate of electricity access from 14 percent in 1993 to 99 percent in 2020. As electricity demand grew at a double-digit rate, the installed capacity of the power sector increased nearly 14-fold—from five GW in 2000 to 68 GW in 2020 (Figure 12)—under national policies that focused on service delivery at the grassroots level executed by Vietnam Electricity (EVN), a vertically integrated SOE.

However, the installed capacity of coal power plants quadrupled in a decade (from five GW in 2010 to 20 GW in 2020), making the power sector the largest source of GHG emissions in Vietnam. In 2020, coal power accounted for about 30 percent of installed capacity and 59 percent of electricity generation. The grid emission factor, estimated at 0.9 tCO_2e per MWh of electricity in 2020, is high by global standards. The power sector accounted for 70 percent of the 88 million tonnes of coal consumed by Vietnam in 2020 (about 1 percent of global consumption).

Electricity demand is expected to continue to grow by six-to-seven percent per year, driven by improved living standards and the emergence of new demand sources, such as digitalization and electric mobility. At this rate, the supply of electricity would need to double every 10 years to meet the demand for base load and peak load of power, as well as to maintain sufficient system reserve margins. To respond to this growth, the Revised Seventh Power Development Plan (PDP7) approved in 2016, proposed to continue reliance on coal-based power generation, with installed capacity of coal-based power plants more than tripling from 20 GW in 2020 to 63 GW in 2030.

Figure 12: Vietnam's power sector is highly reliant on coal



Source: World Bank, based on data from MOIT and EVN.

At COP26, Vietnam signed the "Global Coal to Clean Power Transition Statement," which aims to phase out coal power generation by the 2040s as part of an effort to achieve net zero emissions by 2050.[60] Meeting these targets would require adjustments to current sectoral expansion plans. The government is now preparing the Eighth Power Development Plan (PDP8), which is considered the currently proposed policy scenario (CPS) in this CCDR. Draft PDP8 (of October 2021) would significantly increase renewable energy capacity, from the previously planned 17 GW, to a new target of 36 GW (Figure 13). The scale of the expansion of coal power capacity would be reduced, to a new target of 38 GW by 2030—but that would still represent a near-doubling from installed capacity in 2020 of 20 GW and this growth would largely rely on imported coal.

To inform the discussion on clean energy transition pathways, an exploratory decarbonization analysis was performed by the World Bank to identify policy priorities to accelerate decarbonization of the power sector in Vietnam relative to the CPS.[61] An accelerated decarbonization scenario (ADS), in line with Vietnam's target to phase out coal in the 2040s, would reduce power sector emissions in 2040 by about 80 percent relative to the CPS (see Figure 13). Although that is a significant reduction, additional measures would be required to achieve economywide net zero emissions by 2050 (Box 6). The modeling carried out by the World Bank did not include carbon capture and other emission removal technologies. Whether and how to decarbonize power generation by possibly as early as 2040 will depend on breakthroughs in technologies and associated cost reductions. Positive externalities such as lower air pollution and environmental damages can be expected in the ADS.

Box 6. Ten technical highlights of the Accelerated Decarbonization Scenario

i. The installed capacity of coal power plants peaks in 2025 (following completion of projects under construction), and coal usage is gradually phased out, so only a small footprint remains by 2040.

ii. Power sector-related emissions peak in 2030 and are below 2020 levels by 2040.

iii. The share of fossil fuels is less than 10 percent of the generation capacity in 2040.

iv. Renewable energy technologies (e.g., solar, on-shore, off-shore wind) dominates the power system accounting for as much as 90 percent of all installed capacity.

v. The analysis underscores the importance of overcoming the challenges of intermittency and reliability created by the large-scale deployment of renewable energy in the power system. This has implications both for base load power and for managing peak load.

vi. Significant capacity of energy storage systems (e.g., batteries, pumped hydropower), should technological advancements in energy storage systems allow for it, would need to be added.

vii. The capacity and flexibility of the power grid would need to be significantly increased.

viii. Power system modeling should be carried out periodically to update investment decisions. As new technologies become commercially viable at scale, their role in the lower-carbon pathways would be further enhanced.

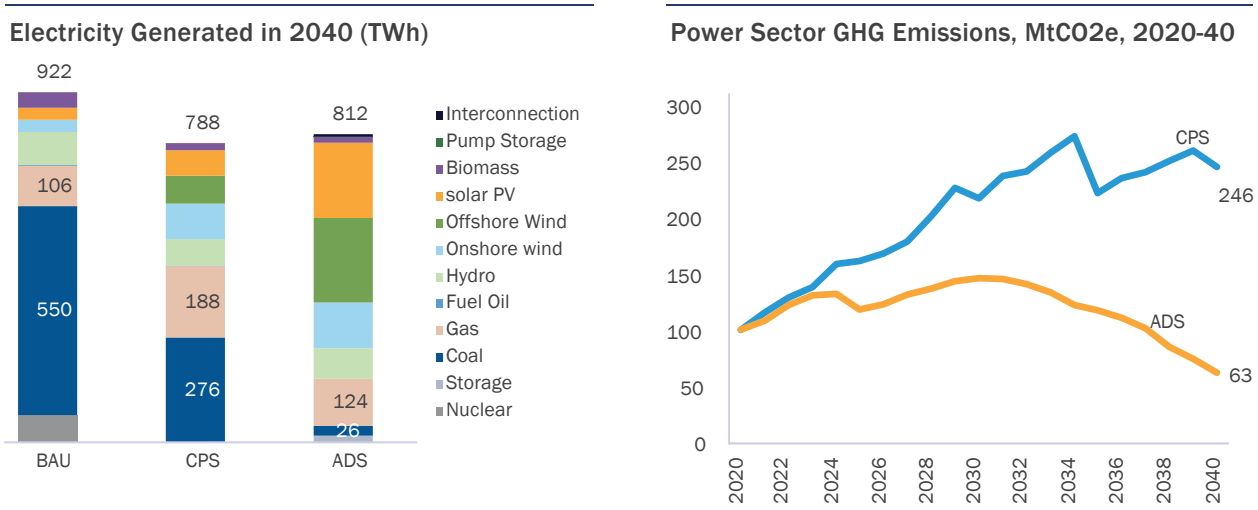
ix. Natural gas can play a role as a transition fuel. Based on current analysis, natural gas features in the generation mix under all scenarios in 2040, until other clean technologies become more cost-efficient.

x. Unbalanced implementation or mismatch of timing of required clean energy investments (for instance, inadequate scale-up of renewable energy or grid capacity to compensate for a corresponding reduction in coal capacity) could create energy security concerns and a risk of retreating to coal.

60 See https://ukcop26.org/global-coal-to-clean-power-transition-statement.

61 The Electricity Planning Model (EPM), an in-house power system planning model that includes capacity expansion and unit dispatch, was used to understand the implications of different levels of emissions reductions on the capacity and generation mix given assumptions about demand growth and available technologies. The work should not be interpreted as a forecast, but as a projection of the scale and speed of necessary interventions.

Figure 13: Comparison of electricity sources and GHG emission between CPS and ADS



Source: World Bank, based on power sector modeling.

The ADS highlights decarbonization opportunities due to rapid reduction in the cost of clean energy alternatives (solar, wind, and energy storage) and the savings from lower fuel costs. It also emphasizes that lower-carbon scenarios require additional and higher upfront investment costs (Table 5). This is due to the higher total system cost associated with additional complementary capital investments needed to overcome the challenges related to integration of renewables (energy storage, grid upgrades, backup generation). The total system costs are estimated at $65 billion between 2022 and 2040, i.e., a 56 percent change between the CPS and ADS. Taking into account the fuel cost savings, the net investment needs are estimated at $33 billion, or a 13 percent change. On the other hand, the ADS would reduce local environmental costs by an estimated $14 billion. The large financing needs of the energy transition calls for accelerated reforms of the investment climate (for increased private sector participation and complementary public investment), as well as mobilization of concessional financing resources.

Changing investment dynamics and higher system costs could impact the consumer price of electricity. Maintaining affordability would be an important political economy consideration. The levelized cost of electricity would be 26 percent higher in the ADS relative to the CPS by the year 2040, and 16 percent higher on average between 2020 and 2040. As discussed in section 4.4, there are options to mitigate these risks and distributional impacts of these price increases. For instance, using the revenue collected from carbon tax, cross-subsidizing electricity tariffs for poor consumers and mobilizing concessional financing can help keep electricity prices in the ADS at par with those in the CPS. The final impact on electricity prices will also depend on the prices of inputs such as coal and other fuels that are partly imported by Vietnam. A case in point is the recent oil price hike because of the Ukraine crises (Box 7)

Table 5. Investment Needs and Economic Costs: Accelerated Decarbonization Scenario, 2022–2040

NPV, deviation between CPS (baseline) and ADS

	$ billion	Change
Capital costs for new generation and storage	+44	+52%
Coal	-19	- 72%
Gas	-8	- 42%
Solar	+21	+ 429%
Wind (onshore)	+8	+ 55%
Wind (offshore)	+39	+ 402%
Hydropower and other renewables	~0	+ 4%
Storage (batteries and pumped hydropower)	+3	N/A
Grid network expansion and upgradation costs	+13	+52%
Variable operational and maintenance costs	+2	+40%
Fixed operational and maintenance costs	+6	+12%
Total system costs	+65	56%
Minus fuel costs savings	-32	-31%
Net total system costs	+33	+13%
Local environmental damage costs	-14	-40%
Global environmental damage costs	-40	-37%

Source: World Bank staff analysis based on power sector modeling.

Box 7: Impact of the war in Ukraine on Vietnam's energy sector

The ongoing conflict has impacted fossil-fuel supply chains, and the global oil and gas prices are at a ten-year high level. Countries with direct energy trading relationships (mainly within Europe) are urgently seeking alternative sources and the short-term price volatility is expected to continue. However, the longer-term outlook remains uncertain. Historically, fuel shocks have led to producers increasing and diversifying supplies, or consumers adjusting demand patterns (efficiency, alternative sources). In the current context, it remains early to predict the degree to which the conflict will have a sustained impact on long-term energy prices.

Vietnam, as a net energy importer, will be increasingly vulnerable to external energy commodity shocks. The transportation fuel prices have seen an increase in the past months, moderated by the petroleum price stabilization fund (which now holds a negative balance, as of April 2022). Within the power sector, while coal imports have not been impacted much, thus far, the planned expansion of fossil-fuel based power generation capacity, especially the imported gas-to-power market, could face increased risks.

Some mitigation measures for Vietnam would be: (i) use power sector planning tool - PDP8 - as a dynamic investment decision platform, such that it can adapt to changing nature of fuel prices. (ii) prioritize development of domestic clean energy resources such as offshore wind, and (iii) move towards technology-neutral competitive procurement of power projects.

The required investment to achieve net-zero emissions will need to be funded by a combination of cost-reflective electricity tariffs, carbon pricing, and borrowing. The shift from coal to renewables will also have an impact on the labor market - eliminating existing jobs and creating new ones. The increased demand for raw materials for clean energy would require new supply chains from extraction to manufacturing, which may place additional pressure on ecologically sensitive locations and on vulnerable communities. Strategic assessment of impacts, costs, and benefits of developing these metals is necessary to ensure a more secure supply chain and confidence in investments, as well as to prevent harm. Effective multi-stakeholder assessment and engagement should be undertaken to ensure that a "just transition" is carried out by making smart decisions about re-purposing resources, providing safety nets, and crowding in investments to promote revitalization.

With limited domestic resources, Vietnam is increasingly reliant on imported coal for power production. Vietnam currently imports about 55 million tons of coal, annually (2022 estimate) and the remainder (about 40 million tons) is domestically supplied. Around 72 percent of the coal consumed nationally is now used for power production. Phasing out the use of coal under the ADS can reduce Vietnam's vulnerability to fossil fuel supply chain disruptions and energy commodity price shocks. Under ADS, 1.1 GW of coal plants are retired upon reaching their technical lifetimes while an additional 18 GW are retired early at an economic cost of US$12 billion. However, these early retirements will deliver economic benefits through avoided local and global environmental damage costs.

However, phasing out coal would require careful consideration of the existing fleet and a just transition for the people, communities, and businesses that rely on the coal industry. About 75 percent of the coal power plants are owned by SOEs and the rest are owned by the private sector. The average age of SOE-owned coal power plants is 11 years, while the average of those owned by the private sector is five years. The government would need to assess and prepare new contractual mechanisms for these relatively young assets, which hold long term power supply contracts, to transition away from coal. Decarbonizing the energy sector would also require management of impacts on workers and communities and ensuring good environmental stewardship of lands and infrastructure assets.

The coal transition, however, will produce asymmetric impacts, creating losers and winners. This will entail some trade-offs, not only win-wins necessitating political economy considerations of such a transition. There will be a need to improve the governance processes leading to coal mine and thermal power plant closures for the decarbonization pathway. For example, most of the domestically produced coal (over 90 percent) is currently mined in the northern areas of the country (proximity of the Red, Da, and Ca river deltas, and particularly in the Quang Ninh Province) (Figure 14), which tend to be economically weaker than rest of the country. These coal producing regions could face difficult circumstances as coal mines and thermal power plants incur losses and the future for workers and their communities becomes uncertain. Geographic isolation of most coal mines means that the loss of the main regional employer can reduce overall employment potential. The narrow economic base of a coal dependent region could expose the fragility of the economy, in terms of its job creation potential. Disparity of wages between coal mining and alternative professions could be an obstacle to re-employing former coal miners. Indirect job losses from subsidiary businesses accentuate the labor challenge and may be more at risk if not considered as beneficiaries of temporary income support or labor programs.

Figure 14: Vietnam's domestic coal production is concentrated in the northern areas of the country

Source: World Bank based on government information

Recommendations

- **Facilitate rapid renewable energy deployment (in particular, offshore wind) by improving the regulatory framework, including transparent and competitive procurement procedures (auctions) to encourage private sector participation:** Vietnam has witnessed a period of rapid expansion of solar and onshore wind energy in the past few years through premium pricing offered under a feed-in tariff (FIT) policy.[62] This has put it among the top 10 countries in terms of installed solar capacity as of 2020 (16.5 GW).[63] But the FIT policy is now starting to impede the energy transition by making renewable energy projects costlier than fossil-fuel projects and is leading to grid instability and curtailment. At the same time, the government's recent pledge to achieve net-zero emissions by 2050 has substantially increased the scale of the required capacity for renewable energy. FIT should be replaced by a transparent, predictable, and coordinated auction-based scheme for procurement of energy projects, starting with solar, onshore wind, and offshore wind (for which domestic resources are amongst the best in the world), and then extending it to other technologies.
- **Finalize PDP8 to align with COP26 net-zero commitments and implement identified investments:** Improving the regulatory framework to attract investments includes fully implementing the Public Private Partnership Law of 2020 with provisions for consolidated review and approval, and mobilization of government support where necessary (e.g., through guarantees backed by a strong contingent liability management approach). There is a need for bankable power purchase agreements (PPAs) so that cheaper international capital can be attracted to the sector. There are additional opportunities for the private sector to participate in the clean energy transition in the medium-term: green bonds issued by sector utilities (SOEs), equitization and recycling of existing

62 A feed-in tariff (FIT) policy is designed to accelerate investments in renewable energy technologies. The objective is to offer cost-based compensation to renewable energy producers, providing price certainty and long-term contracts to incentivize investments in renewable energy.

63 IRENA. 2021. "Renewable Capacity Statistics 2021." Abu Dhabi: International Renewable Energy Agency. https://www.irena.org/publications/2021/March/Renewable-Capacity-Statistics-2021.

sector assets, selected transmission and distribution investments (for instance, lines connecting private power plants to the grid network), as well as the energy efficiency market.

- **Invest in the power grid's capacity and flexibility to absorb additional renewable energy:** Increased investments are needed to upgrade the capacity of the transmission and distribution networks and to introduce modern technologies designed for improved variable renewable energy integration. There is a need to increase public (SOE) investments to upgrade the capacity of the power transmission and distribution networks and to introduce modern technologies designed for improved variable renewable energy integration This includes energy storage systems, power system automation tools, load dispatch management capabilities, smart grid technologies, expanded use of grid digitalization, telecommunication equipment upgrades, and systems based on high-voltage direct current (HVDC). Vietnam also needs a regulatory framework for energy storage systems (such as batteries and pumped hydropower), which is necessary to develop ancillary services as well (voltage and frequency management, peak shaving).
- **Accelerate implementation of energy efficiency plans including effective pricing policies:** Despite being among the leaders in the region in supply side energy efficiency, Vietnam remains an outlier when it comes to demand-side efficiency. There are several steps that Vietnam should take to improve end-use efficiency and reduce the burden on supply expansion. Vietnam should update building codes and efficiency standards and issue comprehensive technical specifications for lighting and cooling devices, consumer appliances, and industrial equipment, supported by monitoring and enforcement. Vietnam should offer incentives for investments in efficiency improvement, as well as implement measures to enhance access to finance (e.g., capacity building of local banks as well as preferential credit and taxation schemes) and technology and build capacity for the private sector led Energy Services Companies (ESCOs).
- **Reform of electricity tariffs**: Electricity tariff reforms are needed not only to send the right price signals to consumers to moderate energy consumption but also to ensure that revenue requirements are based on the full cost of supply, thereby warranting the financial viability of the power sector. While fossil fuel subsidies for the power sector have been largely eliminated, designing cross-subsidies across consumer categories can address poverty and affordability concerns. EVN is the primary off taker in the power sector and maintaining its creditworthiness is at the heart of the sector's financial viability. It is important that the roadmap of reforms for the energy sector is implemented based on the long-term goals of improved market competition and sector performance.
- **Use power system planning as a dynamic investment decision tool that incorporates new technologies (and their evolving costs) as well as externalities of fossil fuels:** Identification of an appropriate power generation mix should be based on principles of least-cost power supply and strengthening of the sector's financial viability within the context of the long-term policy target of reducing emissions by eventually phasing out the use of unabated fossil fuels, starting with coal. Power sector planning should be a continuous process that periodically, perhaps even annually, examines the changes in market conditions - demand, costs, technological progress - while increasingly factoring in (currently uncaptured) local and global externalities. This approach can avoid a potential long-term carbon lock-in that is not aligned with policy goals while also shielding the economy from import reliance and price volatility of fossil fuels. Revision and timely approval of the draft PDP8 is necessary to set the power sector on the pathway for achieving net-zero emissions by 2050.
- **Develop natural gas to power as a transition fuel, factoring in the risk of long-term carbon lock-in, by implementing the necessary upstream reforms and investing in selected strategic projects:** Phasing out the use of coal in two decades will be challenging. Natural gas is a lower-carbon fuel frequently used to replace coal, to provide flexible dispatch and backup capability for integration of renewables, and to meet peak load demand. Given limited domestic gas resources, Vietnam's

gas supply will rely on imported liquified natural gas (LNG). LNG, as a new market segment, will require upstream policy reforms, including transparent procedures for gas procurement. Updating the regulatory framework with health, safety, and environmental standards is needed together with a policy for pass-through of gas price fluctuations. Power system planning can be used to assess the viability of carbon capture and storage and other technologies to complement LNG to power. Strict criteria for selectivity should be developed for investing in only those receiving ports, processing, transporting, storing, and power generating facilities that are optimally required and to identify where public investment support may be justified. Currently, Vietnam has not identified specific plans for development of nuclear power plants (draft PDP8 version of April 2022). However, the government is keeping open the possibility of developing the technology in the future. The government is also encouraging further research and development of feasibility studies for an honest assessment.

4.3.2. Decarbonizing transport

The transport sector is a major consumer of energy, with increasing numbers of road vehicles causing serious congestion and air pollution in cities, affecting the well-being of millions of people. In the BAU scenario, these problems will continue to get worse as the transport sector grows:[64]

- GHG emissions from transport will grow by 6–7 percent per year to 2030, reaching nearly 90 $MtCO_2e$, equivalent about 80 percent of Vietnam's 2018 power sector emissions.[65]
- Mobility demand and motorization will rise rapidly, with passenger-kilometers increasing by an average of 5.9 percent per year to 2030, and freight tonne-kilometers, by 6.9 percent per year.
- Road transport will continue to dominate, accounting for 80.2 percent of the sector's emissions, with trucks dominating in freight transport and motorbikes dominating in passenger transport.
- The modal share of public transport will remain persistently low, owing to the low level of network development, the dominance of motorbikes, and the increasing share of car use.
- The sector will continue to depend heavily on imported fuels, tripling 2014 levels to reach 11.7 million tonnes of gasoline and 14.8 million tonnes of diesel by 2030.
- Road congestion and air pollution problems will become more acute in most Vietnamese cities.
- The energy efficiency and logistical efficiency of the transport sector will remain relatively low.

Decarbonizing the transport sector will require the systematic implementation of "Avoid-Shift-Improve" principles across the sector. "*Avoid*" measures reduce the distances traveled by motorized transport, such as through more compact and mixed-use urban development. "*Shift*" actions will enable and incentivize the shift from higher-emitting to lower-emission transport modes—for instance, by making it safer to walk, or enhancing bus service. "*Improve*" actions will reduce emissions per unit of distance traveled—for instance, by improving fuel efficiency or switching to electric vehicles.

The most aggressive mitigation scenario modeled for this CCDR would reduce transport emissions by 20 percent by 2030 relative to BAU (Figure 15),[66] through the following actions:

- Shift freight transport from road to waterborne transport by further promoting inland waterway transport (IWT) and coastal shipping for freight transport.

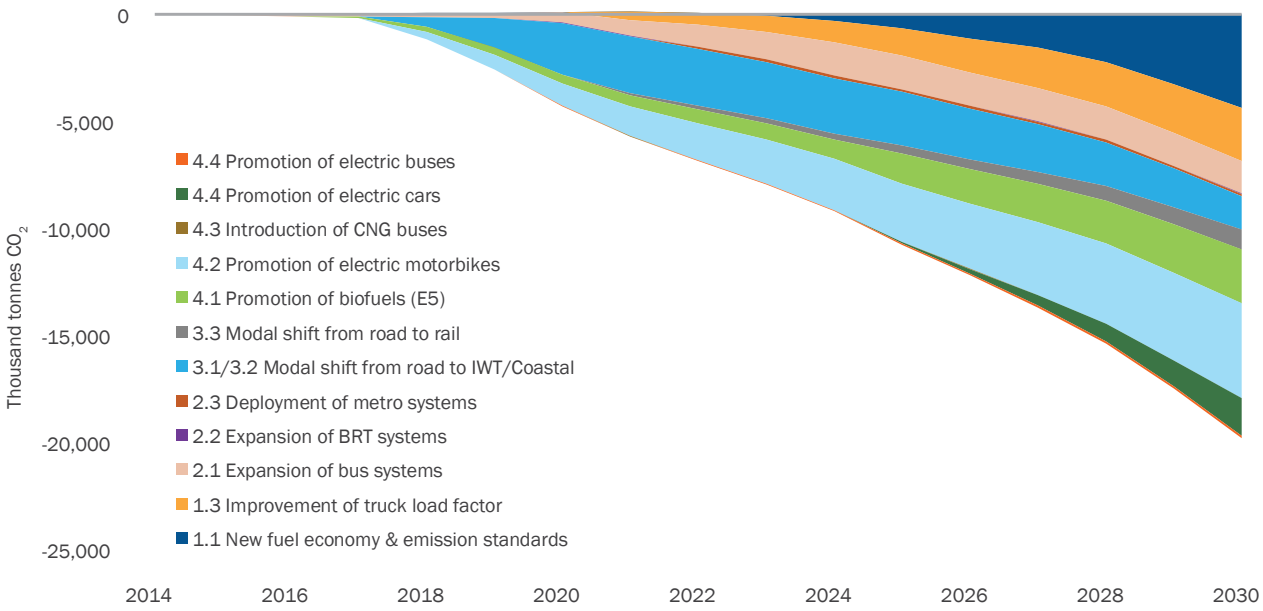
64 Oh, J.E., M. Cordeiro, J.A. Rogers, K. Nguyen, D. Bongardt, L.T. Dang, and V.A. Tuan. 2019. "Addressing Climate Change in Transport: Volume 1: Pathway to Low-Carbon Transport." Vietnam Transport Knowledge Series. Hanoi: World Bank. http://hdl.handle.net/10986/32411.

65 See Our World in Data: https://ourworldindata.org/co2/country/vietnam.

66 Oh et al., 2019, "Addressing Climate Change in Transport."

- Shift urban passenger transport from personal vehicles to public transport systems by developing a network of metro, bus rapid transit (BRT), and regular buses.
- Improve the energy efficiency of motorized vehicles through applying higher fuel efficiency and emission standards for all types of automobiles, promoting electric vehicles, and promoting cleaner fuels, such as biofuels and compressed natural gas (CNG).

Figure 15: Reduction in CO2 emissions by 2030 in mitigation scenario, compared with BAU



Source: World Bank. 2019

Recommendations

- **Introduce vehicle fuel economy standards for new internal combustion engine vehicles:** Between 2016 and 2020, ownership of motorbikes and passenger cars grew by 138 percent and 177 percent, respectively.[67] Motorbikes make up 93.3 percent of motorized vehicles in Vietnam, the largest share among the Association of Southeast Asian Nations (ASEAN) Member States. ASEAN has promoted the adoption of fuel economy standards for light-duty vehicles in all markets, aiming to reduce average fuel consumption by 26 percent between 2015 and 2025.[68] Vietnam could set a standard of four liters per 100 kilometers in 2025, including for private trucks and buses, which is equivalent to an annual emission reduction rate of 6.6 percent.[69] This step also would yield critical co-benefits, reducing local air pollution and fiscal expenditure on fuel imports.
- **Facilitate a modal shift from road transport of freight to waterborne transport systems by scaling up investments and supporting policies:** Key measures could include: (i) substantially increasing the budget allocation for capital investment and maintenance for IWT/coastal shipping, including

67 Data from the Vietnam Register, 2020.
68 ASEAN Secretariat. 2019. "ASEAN Fuel Economy Roadmap for the Transport Sector 2018–2025: With Focus on Light-Duty Vehicles." ASEAN Secretariat. https://asean.org/storage/2019/03/ASEAN-Fuel-Economy-Roadmap-FINAL.pdf.
69 Zang, Z. 2021. "Global Best Practices on Vehicle Fuel Efficiency Standards." Presentation by the International Council on Clean Transportation at the launch of the NDC Transport Initiative for Asia launch, March 15. https://changing-transport.org/wp-content/uploads/6.-210312-NDC-TIA-kick-off-Vietnam_ICCT.pdf.

for waterways suitable for large barges; (ii) promoting access roads connected to road networks for container traffic on barges on the IWT networks, starting with IWT ports and channels along the Hanoi–Hai Phong route and the Can Tho–HCMC route, which account for 15 percent and five percent, respectively, of overall intercity freight flows in Vietnam; (iii) promoting domestic coastal shipping services on the Hai Phong–HCMC route, shifting freight traffic from National Highway 1 and National Highway 5 and shifting about 25 percent of existing bulk cargos on roads between regions around Hanoi and HCMC to coastal shipping; (iv) creating an enabling policy environment for the modernization of IWT/coastal shipping ecosystem (vessels, ports, logistic centers, operations) with private sector participation; and (v) lowering taxes on specific fuels used by barges.[70]

- **Make public transport more attractive and private vehicle use less attractive:** Public transport has a mode share of only nine percent in HCMC and 15 percent in Hanoi, compared with 30 percent in Yangon and 66 percent in Singapore.[71] Unlike its peer cities, HCMC still has no rail-based public transit, though the first line is near completion and a second is being built. Vietnam needs to substantially upgrade public transport networks by investing in metro lines (starting by completing several pending projects in Hanoi and HCMC) and BRT, using electric buses when feasible. It also needs to scale up bus services, promoting compressed natural gas as fuel to reduce air pollution, and improve first- and last-mile solutions, such as shared e-bikes and scooters, and safe sidewalks. Public transport can be promoted further by offering free or discounted bus, rail, or public transportation passes. At the same time, appropriate fees for using personal vehicle use can be instituted through parking regulations and congestion zoning schemes. Vietnam can address resource constraints by examining non-farebox revenue generation through land development, as is commonly done in Hong Kong and Japan, as well as PPP mechanisms to utilize private sector expertise and resources in the accelerated development and sustainable operation of public transport.
- **Support a transition to electric vehicles through standards, incentives, and investments in public charging stations and electric bus pilots:** Electric mobility is in its infancy in Vietnam, but it has strong momentum. Electric vehicle (EV) sales in Vietnam grew from just 1,579 in 2010 to about 1.9 million in 2020, or seven percent of private vehicle sales, primarily driven by sales in e-motorbikes and e-bicycles. In the near term, scaling up the e-mobility transition would require setting realistic, yet ambitious, targets for EV development, followed with technical, safety, and environmental standards and test protocols for EVs, batteries and charging infrastructure. Fiscal and non-fiscal incentives are needed to further promote market demand and supply for EVs, including relief from high import tariffs for EV models and components. It is also important to establish visible and accessible EV charging infrastructure/battery swapping stations at high-traffic parking areas and destinations, and to fund electric bus pilot programs in cities.
- **Develop a clear policy framework for the private sector to play a major role in the decarbonization of transport:** Specifically, the government needs to issue a legal framework for transitioning to electric vehicles, with clear targets and plans supported by a combination of regulations and fiscal incentives covering the supply side (manufacturing), demand side (purchase and usage), infrastructure, and financing. The participation of the private sector also needs to expand to areas managed by the public sector, such as development, financing, operation, and maintenance of metros.

70 Lam, Y.Y., K. Sriram, and N. Khera. 2019. "Strengthening Vietnam's Trucking Sector: Towards Lower Logistics Costs and Greenhouse Gas Emissions." Vietnam Transport Knowledge Series. Washington, DC: World Bank Group. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/165301554201962827/Strengthening-Vietnam-s-Trucking-Sector-Towards-Lower-Logistics-Costs-and-Greenhouse-Gas-Emissions.

71 Hee, L., S. Sunn, C. Chow, D. Hoh, and L. Lewis. 2017. "Urban Mobility: 10 Cities Leading the Way in Asia Pacific." Singapore: Centre for Livable Cities and Urban Land Institute. https://www.clc.gov.sg/research-publications/publications/books/view/urban-mobility-10-cities-leading-the-way-in-asia-pacific.

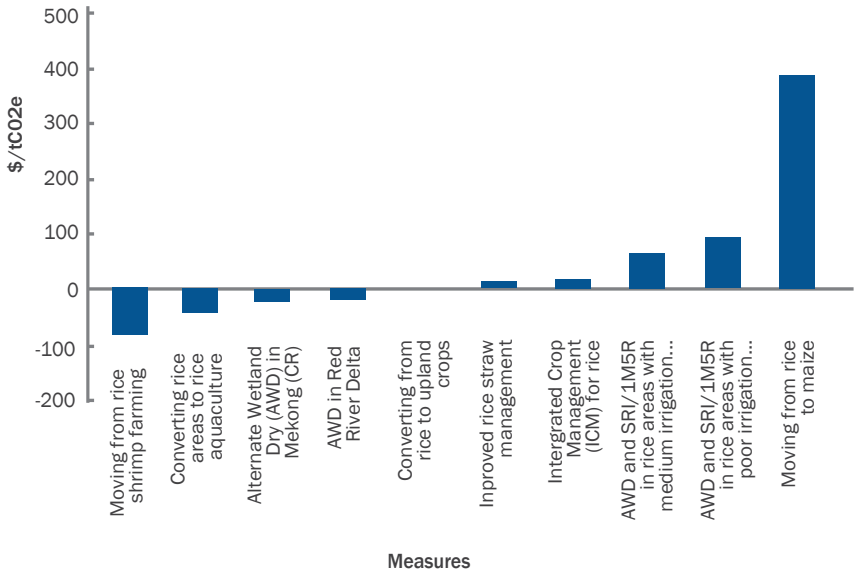
4.3.3. Decarbonizing agriculture

The agriculture sector is the second-largest contributor of GHG emissions in Vietnam, at about 19 percent of total emissions in 2020. Rice production accounts for about 48 percent of those emissions, followed by enteric fermentation in livestock production (15.3 percent), synthetic fertilizer application (12.9 percent), and manure management (9.5 percent). A unique feature of the sector's GHG emissions is that more than 70 percent are methane and nitrous oxide, not carbon dioxide (CO_2). Methane and nitrous oxide both have far shorter atmospheric lifetimes than CO_2, but they are also many times more potent, so reducing them would have a rapid and powerful impact in reducing near-term warming.[72]

Mitigation options for agriculture, applied at the farm level to reduce emissions from rice, other crops, and livestock, vary in terms of potential impact and cost per ton reduced (Figures 16 and 17). The combination of potential emissions reduction and cost is summarized in the cost per tonne abated, also referred to as the cost-effectiveness of the measure. The real challenge in the agriculture sector is to ensure that mitigation measures can combine with other investments to ensure growing and robust livelihoods for farmers. Unless these measures can provide for a viable exit from poverty and sustainable livelihoods for farmers, measures to reduce emissions in the sector are likely to fail in the medium term.

The NZP decarbonization strategy for the agricultural sector is anchored in three key measures: (i) reducing fertilizer and pesticide use by 14 percent to decrease the emissions intensity of crop production; (ii) changes in cattle feed, herd health, and breeding practices to achieve a 14 percent emissions reduction per unit in livestock; and (iii) a 50 percent increase in subsidies for forest services (relative to BAU) to stimulate reforestation and increase carbon sinks. These measures will require significant new investment by both the private and public sector, estimated at about $15.6 billion over the period 2022–2040.

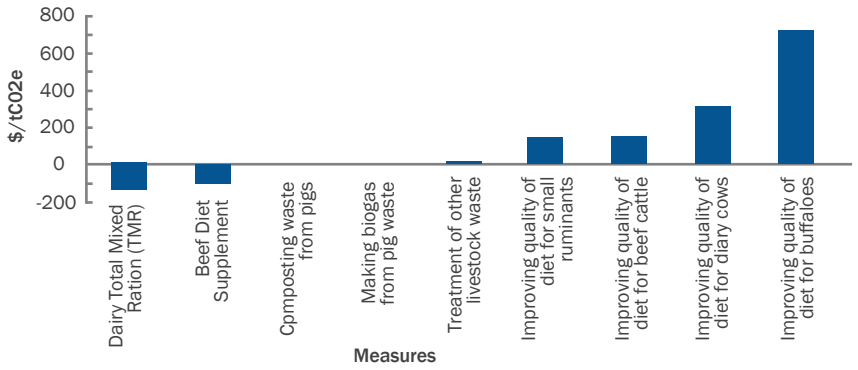
Figure 16: Cost-effective measures to reduce GHG emissions from rice production



Source: World Bank Staff estimates.

72 For an overview of short-lived climate pollutants, see this primer by the Climate and Clean Air Coalition, of which Vietnam is a member: https://www.ccacoalition.org/en/content/short-lived-climate-pollutants-slcps.

Figure 17: Cost-effective measures to reduce GHG emissions from livestock



Source: World Bank Staff estimates.

Recommendations

- **Repurpose public expenditure in agriculture to support the adoption of lower-emitting crop varieties and production technologies:** The Organization for Economic Co-operation and Development (OECD) has found that most agricultural support measures provided to farmers and other agricultural actors are environmentally harmful.[73] Vietnam has yet to make agricultural support conditional on environmental objectives, and it imposes no tariffs for water use in irrigation that would discourage inefficient extraction. To promote sustainable agriculture that is climate-resilient and low-emitting, Vietnam will need to strengthen institutions at both the central and provincial levels, leverage private sector financing, and promote market incentives — including helping farmers and actors along the agri-food system to access carbon financing. Important investments will be needed in climate-smart value chain infrastructure, water and energy saving technologies as well as digital technologies to promote efficiencies in the production, processing and distribution of food and other agricultural products.
- **Invest in and scale up the use of low-carbon technologies in rice production such as alternate wetting and drying (AWD):** Emerging technologies and techniques can provide efficiencies in water use and other inputs that translate into reduced production costs and higher net profits for farmers and other value chain actors. Instead of burning agricultural residues in the field, rice straw could be used for co-firing in coal power plants, which could reduce GHG emissions by three percent.[74] Initial estimates using the International Rice Research Institute's investment model suggest that investing $1.4 billion to implement AWD and related techniques could reduce emissions from rice production by 6.8 $MtCO_2e$ relative to BAU by 2030.[75] Similarly, an evaluation of a recent pilot program using

73 OECD. 2021. *Agricultural Policy Monitoring and Evaluation 2021: Addressing the Challenges Facing Food Systems.* Agricultural Policy Monitoring and Evaluation. Paris: Organisation for Economic Co-operation and Development. doi:10.1787/2d810e01-en.

74 Truong, A.H., and M. Ha-Duong. 2018. "Impact of Co-Firing Straw for Power Generation to Air Quality: A Case Study in Two Coal Power Plants in Vietnam." *IOP Conference Series: Earth and Environmental Science* 159 (June): 012034. doi:10.1088/1755-1315/159/1/012034.

75 The field trials conducted by the International Rice Research Institute (IRRI) in the Mekong Delta found that the average net benefit of applying AWD (coupled with 1M5R) was estimated at 27.53 million VND per ha, compared to normal rice production practice (no-AWD) assuming the coverage of 1.9 million hectares in the MKD by 2030. Economic benefits projected to 2030—assuming consistent application of this practice—were estimated at 52,960 billion VND ($2.3 billion) per year by 2030, an addition of 8,540 billion VND ($371.36 million) compared with conventional rice production. This is due to increased revenue of $287.57 million and reduced costs of $83.79 million (in terms of land preparation, sowing seed, irrigation water, labor). The potential GHG emission reduction was estimated at 10.97 $MtCO_2e$ per year by 2030.

digital sensors to promote water-use efficiency in rice production showed farmers saved up to 47 percent of water compared with continuously flooded irrigation, and up to 20 percent compared with manually managed AWD.

- **Scale up investment in carbon sinks to achieve net-zero targets:** The value of ecosystem services provided by primary tropical forests in Vietnam is estimated at $2,077 per hectare per year, on average. Climate regulation services that include carbon sequestration are estimated at $381 per hectare. Measures to reduce emissions from land use, land-use change, and forestry are relatively low-cost compared with those in the industry, transportation, and energy sectors. Some measures, such as reforestation, forest conservation, and sustainable soil management, are considered win-win solutions, with broad climate, ecological, and development benefits. In addition, activities in conservation, protection and sustainable management of existing forest areas can potentially benefit from carbon payments under Reducing Emissions from Deforestation and Forest Degradation (REDD+) programs.

4.3.4. Decarbonizing trade and investing in new technologies

Given the relatively large carbon footprint of international trade activities in Vietnam, technological shifts toward low-emitting activities will be required to achieve the net-zero target. These shifts could be partly induced by the introduction of a carbon tax (either domestically or in main destination markets), but also by changes in behaviors of multinational companies (representing close to 85 percent of Vietnam exports) that are becoming increasing committed to a low-carbon transition.

Vietnam has started to decarbonize its trade (Box 7). In 2020, Vietnam was the third largest exporter of environmental goods—products that contribute to climate and environmental goals—in Southeast Asia, with exports valued at $6.5 billion, and the second largest importer, at $12.9 billion.[76] Vietnam's annual average growth of environmental goods exports was 48 percent from 2000 to 2020, and 22 percent for imports, which is the second highest in the region, after Cambodia. Vietnam's trade in environmental products mostly has involved renewable energy products, but there are opportunities to expand such trade by reducing non-tariff barriers on environmental goods and services.

Box 8. Vietnam' shift toward environmental goods exports and emerging opportunities

Vietnam's trade in environmental products mostly has involved renewable energy. Solar cells and heliostats exports showed exceptional annual growth rates from 2010 to 2020— of 81.6 percent and 71.2 percent, respectively—highlighting the change in the structure of Vietnam's export basket. Such economic transformation and the emergence of new sectors are likely to create new and more sustainable jobs in a sector that will continue to grow as the world rapidly shifts to more climate-friendly trade, production, and consumption. The solar photovoltaic (PV) cell sector is a niche that is often embedded in complex value chains. Therefore, access to inputs is critical to maintain a sustainable growth rate in the coming years.

Vietnam is already a major player in solar equipment but can position itself in wind-related technologies and electrical equipment. However, policies enacted by trading partners (importers) may affect this trade, so market diversification would be recommended. Opportunities also exist in growing markets, such as the African Continental Free Trade Area.

76 World Bank. 2022. "No Time to Waste: The Challenges and Opportunities of Cleaner Trade for Vietnam." Hanoi: World Bank. http://hdl.handle.net/10986/36819.

The CCDR analysis shows the impact of the EU Green Deal's carbon border adjustment mechanism (CBAM) may be limited initially for Vietnam,[77] but other countries are likely to introduce similar mechanisms with expanded reach as consumer demand shifts toward cleaner products and firms implement changes in their production processes to remain competitive in a low-carbon future. For example, Apple Inc. is transitioning its entire supply chain to 100 percent clean energy.[78] FoxConn, one of Apple's major suppliers, which has recently moved its assembly lines to Vietnam, will be subject to Apple's environmental-social-governance (ESG) and decarbonization requirements. In the garment industry, Nike is implementing an initiative to reduce Scope 1 and Scope 2 emissions by 65 percent and Scope 3 emissions by 30 percent, and to increase renewable energy use across its entire supply chain. More than 100 Nike suppliers in Vietnam will be affected.

Recommendations

- **Facilitate imports of clean technologies by cutting non-tariff measures applied on environmental goods and services:** Vietnam imposes a low (0.33 percent) average tariff on environmental goods, but several non-tariff measures (NTMs) continue to hamper trade flows. Considering that Vietnam's simple average applied tariff rate for all products was 12 percent in 2020, environmental goods face almost a zero tariff. However, tariffs on environmentally preferable products are high, at eight percent, so there is potential for tariff reduction in this area. By contrast, Vietnam imposed 199 NTMs on 54 environmental products in 2020. Renewable energy products face the largest number of NTMs, followed by waste management and monitoring equipment. For example, solar cells are required to meet labeling, inspection, and conformity assessments when imported to Vietnam. However, all imported products are subject to such requirements, so it is safe to say that environmental goods are hardly treated differently from other products.

- **Decarbonize the trade sector through policies and direct financial support for startups and emerging green businesses,** capacity building through training programs, tax incentives, and the enforcement of stronger regulations. The costs of such programs will need to be assessed, as well as their implementation through a close coordination between the public and private sectors. Under the new environmental protection law, businesses will be required to actively employ technologies to control pollution and will be subject to recycling or monetary compensation obligations for certain products and packaging. These regulations are designed to support Vietnam's emission reduction ambitions and encourage renewable energy projects.

- **Reduce the carbon intensity of trade by improving traceability along value chains and upgrading eco-industrial parks (EIPs):** Consumers in Vietnam's major export markets—such as the United States and the EU — increasingly demand more environmentally friendly goods and cleaner production processes, and many foreign-owned firms are part of values chains in which the central corporations have committed to greener practices. If Vietnam does not shift to clean energy sources, the country will become less attractive to these companies. Transforming industrial parks into EIPs would also reduce emissions and help meet the country's net-zero emissions target. In Turkey, for example, turning industrial parks into EIPs is expected to lead to a 20 percent reduction in emissions while sustaining competitiveness.[79]

77 The EU CBAM will cover only direct emissions of a small number of products under Scope 1, which account for less than 4 percent of Vietnam's exports to the EU. Further details are provided in the CCDR background note on trade.

78 Apple, Inc. 2020. "Apple, In. – Climate Change 2020." Responses to CDP questionnaire. https://www.apple.com/environment/pdf/Apple_CDP-Climate-Change-Questionnaire_2020.pdf.

79 See description of the Turkey Organized Industrial Zones Project: https://projects.worldbank.org/en/projects-operations/project-detail/P171645.

- **Design targeted support programs for small and medium enterprises (SMEs) and startups investing in low-carbon technologies:** While the government has made some progress, radical changes are needed to unleash private investments to meet medium-to long-term climate goals, especially from SMEs. Many green opportunities are small in scale and would require the loosening of several bottlenecks that have frequently prevented private sector participation, including capacity building and skills development, access to knowledge and finance, and streamlined administrative procedures. Clarifying the role of SOEs would be necessary, especially in infrastructure, as they can be competitors or strategic partners of private investors through PPPs. The government could incentivize the private sector—from farms to firms—by direct interventions to provide subsidies, concessional loans, tax breaks, or guarantees or through stringent standards and measures that would change relative prices in favor of investments in green technologies. Indirect interventions would be mainly through financial market interventions, with the aim to de-risk private investments using new capital market instruments and insurance schemes.

4.4. Ensuring a just transition: Addressing impacts on low-income people and workers

The decarbonizing pathway is expected to affect people's well-being through its impacts on the economic growth trajectory, GDP composition, and relative prices. This influence will differ across households, depending on their resources and consumption patterns. To capture these distributional impacts, the CGE model was linked to a macro-micro simulation modeling approach based on household welfare distribution and characteristics drawn from the 2016 Vietnam Household Living Standards Survey.[80] The results of the analysis are presented in three parts: long-term impacts of the NZP on poverty and inequality; short-term adjustments in households' consumption behaviors that might occur due to changes in relative prices; and shifts in the labor market.

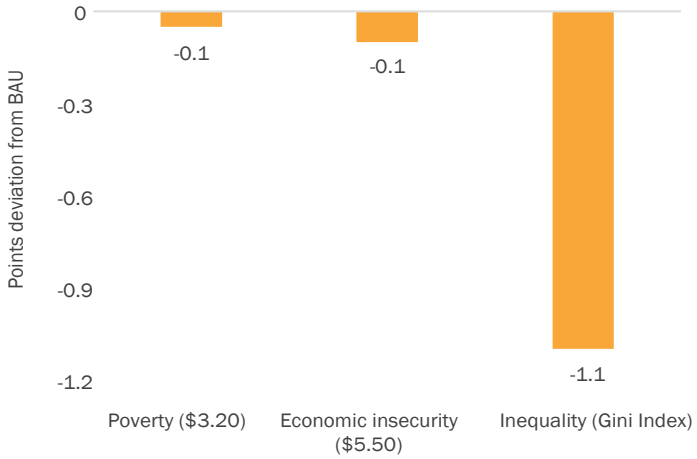
While the long-term impact of the decarbonizing pathway on poverty and inequality appears to be relatively limited, the transition costs could be substantial for poor consumers and unskilled workers. To protect affected groups, the government will need to provide safety nets and facilitate the adjustment of the labor market through measures such as reskilling and retraining programs and early-retirement benefits. The costs of these measures, albeit difficult to estimate, could amount to 0.7 percent of GDP per year, or $33 billion from 2022 to 2040, which would raise the total cost of the NZP.

4.4.1. Marginal impacts on poverty and inequality in the long term

Overall, the NZP has almost no impact on poverty and economic insecurity levels if households can adjust their consumption patterns to changes in relative prices, which is a fair assumption for the long term. Both the levels of extreme poverty (under the $3.20 per day line) and economic insecurity (under the $5.50 per day line) would remain about the same as in the BAU scenario, reflecting the fact that a large share of the poor today live-in remote areas and would not be very affected by decarbonization efforts (Figure 18). Inequality (as measured by the Gini Index) would slightly increase relative to BAU by 2040.

80 The microsimulation model is the Global Income Distribution Dynamic model (GIDD), adapted to the climate change MANAGE CGE. Details are provided in the CCDR background note "Climate Change, Adaptation, Mitigation and Distributional Impacts in Vietnam."

Figure 18: Impact of NZP on poverty, economic security, and inequality (in deviation from BAU) by 2040



Source: World Bank.

The most penalized households under the NZP are likely to be younger, less educated, and members of an ethnic minority and/or living in a rural area:[81]

- *Age of head of household*: A 50-year-old head of household is 10 percent less likely to become economically insecure than a 40-year-old.
- *Education level*: Heads of household who have completed lower secondary education are 12 percent less likely to become economically insecure than those who have less education.
- *Ethnic minority:* A Kinh household is 37 percent less likely to be penalized than an ethnic minority household.
- *Rural/urban:* An urban household is 10 percent less likely than a rural one to fall into poverty.

4.4.2. Adjustment costs during the NZP transition

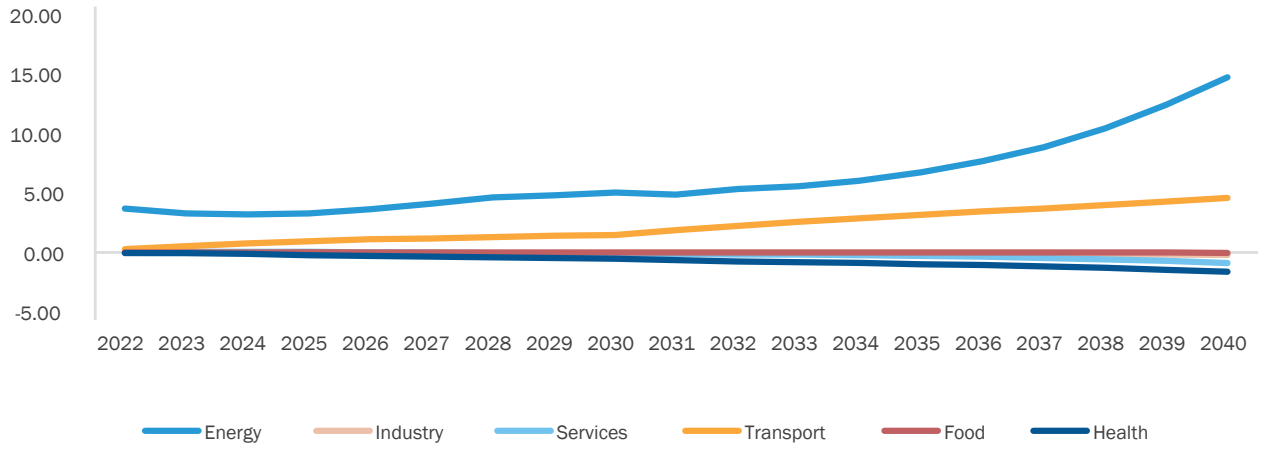
In the near term, people will need to adjust their consumption patterns to the new low-carbon economy, as energy and transport prices will rise, mainly due to the carbon tax. The CGE model shows most other prices would remain roughly the same (Figure 19). Households may have difficulties adjusting if they have rigid consumption habits, if their options are limited, or due to financial constraints.

The projected increase in energy prices ranges from 3.5 percent in 2022 to almost 15 percent in 2040.[82] Information from the 2018 household survey showed that poorer households devote more of their expenditures to energy than the overall average, which means an increase in energy prices will disproportionally impact the impoverished. For example, a 10 percent increase in energy prices will lead to an increase in the poverty and conomic insecurity rates by, respectively, 0.5 and 1.3 percentage points.

81 Preliminary results indicate that the NZP would have no impact on gender equality.

82 This is lower than the estimated impact derived from the partial analysis of the power sector (up by 26 percent by 2040) because it accounts for cross-sectoral effects and the use of a broad-based carbon tax as a key source of financing for the transition.

Figure 19: Price index by commodity group, 2022–2040 (% deviation from BAU)



Source: World Bank, based on the CGE model for Vietnam.

Recommendations

- **Manage the near-term regressive impacts of the carbon tax by providing support to the consumers who are most affected by the increases in energy and transport fuel prices:** The government could earmark part of the revenue from the carbon tax to subsidize electricity prices for poor households (as Sweden and Germany have done), provide free or lower-cost public transportation, or reduce other taxes to help offset the impact of the carbon tax on households and businesses. Some of this would require Vietnam to amend its existing regulations, as earmarking of the EPT is currently not authorized.
- **Enhance the social protection system to protect the most vulnerable households during the transition:** To ensure a just transition, Vietnam may need to strengthen safety net programs to protect households that are at high risk of falling back into poverty. This includes those who are expected to lose their employment or at least part of their income because of transition. Stronger social protection systems will also play a crucial role in supporting people whose livelihoods are disrupted by climate change impacts, and thus can help build resilience.

4.4.3. Expected changes in the labor market

The NZP is expected to boost employment by 726,000 jobs in 2030 and by close to 1 million jobs in 2040. This positive result on jobs is similar to what has been found in the literature on how the shift from high- to low-emitting sectors helps generate a higher demand for labor than in a BAU scenario.[83] Although the figures are relatively small (equivalent to about 60,000 new jobs per year), they mask significant movements across and within sectors (Figure 20):[84]

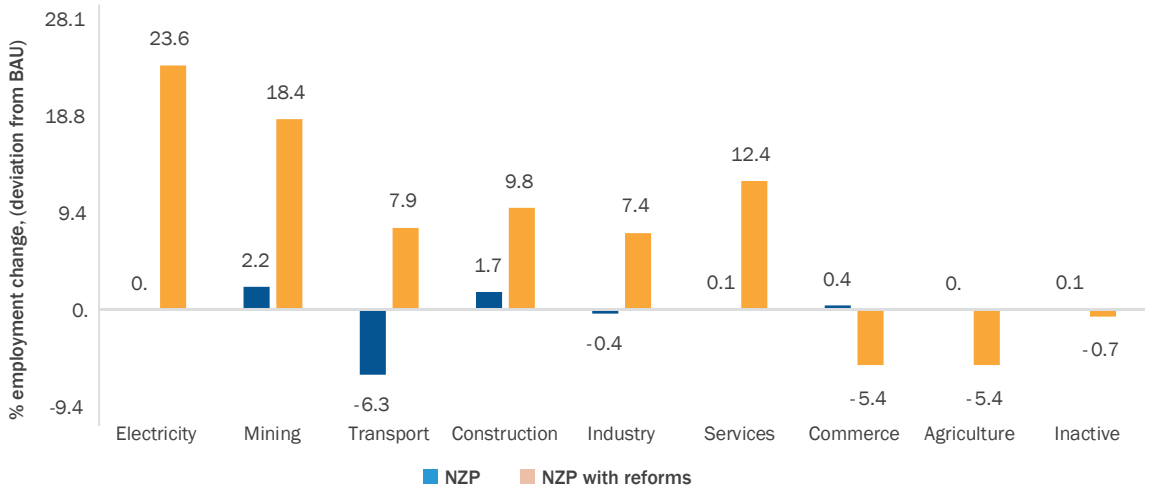
- Jobs will be created in construction and mining and, to some extent, in services and commerce, with some unemployed people returning to work. The neutral impact in the electricity sector is partly due to opposite effects (a decline in carbon-intensive sub-sectors and an increase in renewables).

83 See, for example, Fankhauser, Samuel & Sehlleier, Friedel & Stern, Nicholas. (2008). *Climate change, innovation and jobs. Climate Policy*, Earthscan ISSN. 80513.

84 Globally, the International Labour Organization (ILO) estimates that moving to a renewables-dominated energy sector will generate around nearly 25 million jobs, with the largest growth in construction, the manufacture of electric machinery, and the mining of copper ores. However, over 6 million jobs will be shed, mostly in "dirty" industries such as petroleum extraction and refining, coal mining, and the generation of electricity from coal.

- Some jobs in high-emitting sectors will be eliminated without direct replacements, as particular processing methods or resources are banned or discouraged, especially in energy-intensive and polluting industries. The largest drop in employment would be in the transport sector, as the development of public transit will replace drivers of taxis and motorbikes. Coal mining, which currently employs about 75,000 people, will shed large numbers of jobs.[85] Other jobs at risk are in coal-fired power plants and highly intensive energy industries (cement, chemicals). Those jobs will be replaced by new jobs in renewable industries.[86] The gain in the non-coal mining sector is the result of the higher demand for minerals and metals that will be needed to produce cleaner sources of energy.

Figure 20: Changes in employment per sector in 2040



Source: World Bank Staff estimates.

A key condition for success with a decarbonizing strategy will be flexibility in the labor market, which will require measures to enhance workers' ability to move across sectors. Full labor market flexibility would magnify the positive impacts of the NZP on the composition of the labor force, as the movement of workers across sectors contributes to a better allocation of resources. Conversely, if displaced workers cannot move quickly into new jobs, the welfare impacts of the transition would be more severe, and growth in renewable energy and other low-carbon sectors might be impaired. Employment will increase in most sectors, except for commerce and agriculture. There will be less employment in the agricultural sector because the transition from farm to non-farm employment will be accelerated by adoption of more capital-intensive technologies, especially in rice production.

To be mobile, workers will need the right skills to take advantage of the decarbonization transition. The stock of qualified workers in Vietnam's labor force is low, and the number of students registering in relevant post-secondary programs is currently insufficient to fill this gap. At the current pace, it would take 25 years for Vietnam to catch up with Thailand. Given the rapid pace of change, and the uncertainties that remain about what future jobs will require, it is important for the government to collaborate with the private sector to identify and anticipate what skills are most in demand. The main lessons from international experience on reskilling or retraining programs are summarized in Box 8.

85 However, Vietnam's domestic coal reserves are nearing depletion, so—although the jobs modeling exercise did not take this into account—in reality, even without decarbonization, most coal mining jobs in Vietnam would likely disappear after 2030.

86 Ongoing work is being carried out by the World Bank on the impact of climate change on the labor market in Vietnam, but the key findings were not available in time to be included in this CCDR.

Box 9. Lessons from international experience on reskilling or retraining programs

While designing an effective reskilling or retraining program is complex, a review of the international experience points out the following lessons:

- Short-time training within a short period after displacement may be a viable strategy to keep individuals in the labor market by transitioning to new jobs.
- There must be a prior understanding of the skills requirement and needs of workers before conducting training. This will make the training program relevant to the current requirements of displaced workers.
- There must be a synergistic partnership between the government and the private sector to leverage each of their strengths to mobilize resources to help workers.

One important factor is the timing and intensity of retraining programs. The sooner workers are retrained after retrenchment, the higher the impact of the training program is, in terms of future wages and re-employment. In addition, the shorter and more intensive the retraining program, the greater the impact on workers in transitioning to new occupations. Early interventions for displaced workers include career advice based on existing and potential skills.

Existing studies emphasize the need for a screening or skills assessment stage prior to any retraining program to maximize its impact. At a minimum, program designers should gather information about the general characteristics of each displaced worker—for instance, skill level, occupation, education, age, and gender. This will ensure the suitability of the training program to the individual, and the core contents of the program should be understood with the existing competence of the individual.

Another important aspect is the synergy and partnership between the government and private sector in providing the retraining program. This will ensure that the program will be market-oriented and cost-effectively delivered, without compromising on quality. One mechanism is to provide vouchers for training, as was done through the Workforce Innovation and Opportunity Act in the United States. These vouchers allow individuals to choose their preferred training provider, whose past program performance is published in "report cards" that the individual can assess. In addition, governments can leverage existing available grants, aids, and loans to provide quality retraining programs.

Source: CCDR background note "Climate Change, Adaptation, Mitigation and Distributional Impacts in Vietnam."

Recommendations

- **Design a comprehensive national skills development program to improve labor productivity and correct skill mismatch in clean/green industries by reforming educational and vocational training programs:** World Economic Forum indicators show that the Vietnamese market is relatively flexible in terms of regulations and practices (ranked 60th out of 138 countries), emphasizing that the main constraint will be in the limited skills of the labor force. A large share of the new job opportunities will be in tasks and economic activities requiring skill sets not readily available in Vietnam today. In agriculture, in addition to soil scientists, technical experts will be needed to help farmers store more carbon in their soil, along with communicators who will market climate-friendly foods to the public. In the energy sector, new jobs will be related to energy storage, energy management, and energy efficiency, while in the transportation sector, the electrification of cars and decarbonization of shipping will create new demand for workers. A rapid survey conducted in early 2022 revealed that less than one percent of university students were following "green skills" programs, with most

of them at undergraduate levels.[87] The number of master's degrees and doctorates in green skills decreased during the period 2016–2021.

- **Develop labor market programs to support workers exiting the labor market involuntarily (compensation, information, reskilling):** Although the adjustment is expected to be gradual over time and concentrated in a few sectors (coal mining, coal power, and to some extent, textile, and rice production), those job losses are likely to be visible politically and socially. Beyond the reskilling and retraining programs discussed above, the government will need to develop specific assistance programs and effective communication campaigns, perhaps using part of the revenue from the carbon tax to fund them.
- **Carefully weigh options for how to best allocate the revenue collected from the carbon tax**: As the discussion in this section has highlighted, ensuring a just transition will require several measures to support affected households and workers, which carry costs that could be covered by carbon tax revenue. However, carbon tax revenue is also needed to finance crucial major investments in clean technologies. To illustrate the trade-offs involved and the implications for the country's growth trajectory, the NZP was run with the assumption that about 30 percent of carbon tax revenue is allocated to social programs supporting the transition. In that case, GDP in 2040 would be about 0.5 percent lower than in the NZP in which all the revenues are invested in the decarbonization transition. However, if such an allocation were made as part of the full package of supporting measures discussed in section 4.2, the GDP in 2040 would still be higher than in the BAU scenario—just modestly less so.

87 The survey was conducted by the World Bank in higher education institutions. Green skills were narrowly defined as environmental protection.

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5

Mobilizing Finance

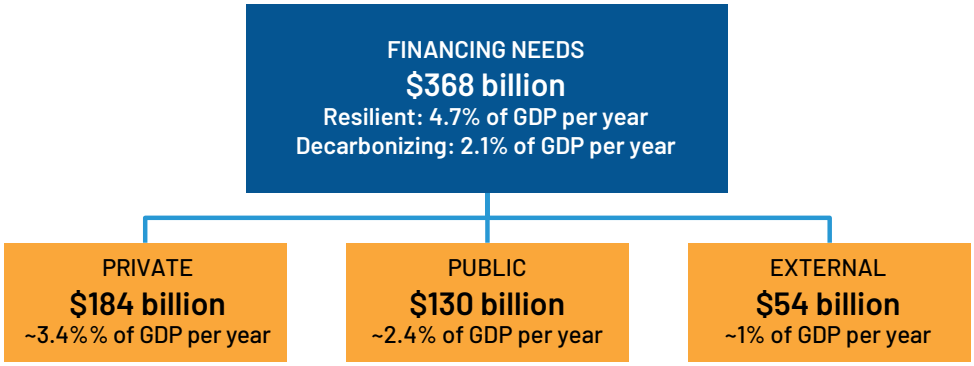
5. Mobilizing Finance

Pursuing a combined resilient and net-zero development pathway (RNZP) is likely to require additional investments of about 6.8 percent of GDP per year, or a cumulative $368 billion through 2040. As explained in Chapter 3, investments in resilience alone would cost around $254 billion from 2022 to 2040 in order to enable adaptation to past and future climate change.[88] The decarbonizing pathway to meet international commitments will require another $114 billion through 2040, including $81 billion in investments and $33 billion for social programs.[89] These estimates are first orders of magnitude and should be interpreted with caution, due to uncertainties about the future evolution of technologies and other parameters, including the magnitude of climate projections, business and household behaviors, and government policies.

At least three potential avenues exist for filling these finance needs, as shown in Figure 21. The approach that is taken here is that public financing is something that can be mobilized relatively quickly given the government's current fiscal policy stance. But government commitments can and should be bolstered by the engagement and tangible actions of the domestic private sector and through external finance, public and private. It is not affordable for Vietnam to finance all its adaption and mitigation measures without a contribution from external sources. The following actions will be needed:

- Forcefully encourage private investment, both in new technologies and in more resilient infrastructure. To this end, greening the financial sector needs to be prioritized as it was only equivalent to about 0.2 percent of GDP in 2020. This will imply mobilizing green credit by banks, developing market-based instruments such as green equities and green bonds, and applying de-risking tools (e.g., insurance) and new ways to share the burden of risk between the public and private sector to encourage investment amid high levels of uncertainty.
- Increase public funding by raising additional revenue through a carbon tax and/or by borrowing in domestic and external markets, within the limit required to avoid future debt distress for the government.
- Garner more revenue from international financial sources, including institutional investors and multilateral and bilateral donors, and tap into FDI and inward remittances

Figure 21: Financing needs and potential sources of funding, 2022–2040



Note: NPV discounted at 6 percent.

88 In Chapter 3, the costs were estimated for the period 2022-2050. They are presented up to 2040 in this chapter to make them consistent with the period covered by the decarbonizing pathway.

89 These additional investments may have implications for long-term employment, inflation, exchange rate, current account balances, etc. But these areas require additional analysis and are outside the scope of the CCDR.

5.1. The private sector will be pivotal

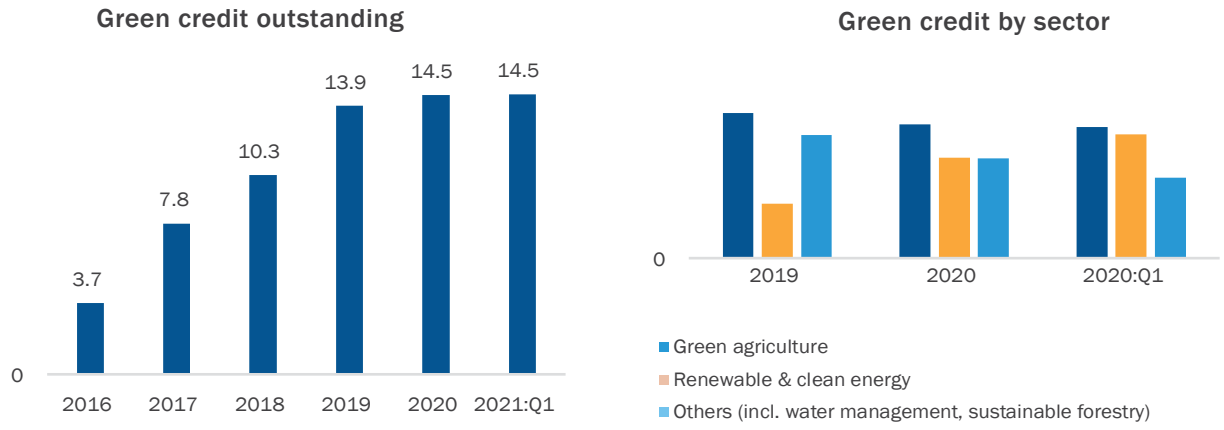
The private sector will not necessarily need to save more revenue, but instead will need to allocate a quarter of its current savings (3.4 percent of GDP per year) toward resilient and low-carbon investments. Overall, the Vietnamese private sector's capacity to save is one of the highest in the world, reaching around 20 percent of GDP over the past few years. Self-preservation will be a source of motivation for businesses and property owners to directly invest their retained earnings in climate change-related activities. Yet, with 80 percent of private savings directed to the banking sector, the private sector's capacity to invest will largely depend on the behavior of the banks and their willingness to finance climate-related projects.

Green finance is still in its infancy in Vietnam. While the State Bank of Vietnam (SBV) in 2018 approved a program on green bank development and an action plan to realize Vietnam's sustainable development goals by 2030, climate financing was only about five percent of total financing provided by Vietnamese banks (or about 0.2 percent of GDP) in 2020. Domestic financial institutions are in the early stages of their understanding of green bonds and other capital market instruments. This implies that there is significant potential to increase green finance and use the financial sector as a lever to help reallocate capital to more sustainable investments. Building on the SBV guidance on sectors that qualify for green loans, green credit has almost quintupled since 2015, increasing 2.5 times faster than the average credit growth during this period (Figure 22). The main beneficiaries have been agriculture, renewable energy, sustainable water management, and sustainable forestry.

The lack of internal procedures for and expertise on green finance assessment is a key challenge for many banks. Of 85 credit institutions reporting to the SBV, 72 lack a dedicated business unit for green finance, and 74 lack a specific procedure on green credit appraisal. Other credit institutions have substantial challenges to develop green finance expertise and integrate the green finance procedures into their existing operations.

Another bottleneck has been the mismatch between the short terms of most deposits and the longer terms typically required by green projects. This mismatch increases the funding liquidity risks for commercial banks, undermining their risk appetite and motivation to finance green projects. Financial institutions also need clearer information about the requirements for incorporating environmental and social risk assessment into credit underwriting policies and operations.

Figure 22: Private climate and green outstanding loans from 2016 to 2021 ($ billion)



Sources: FiinResearch and SBV.

Public policy must play a role in helping the financial sector move past these barriers and develop a strong green financial lending market. The bottlenecks must be tackled through a combination of regulatory reforms and incentives to both credit providers and borrowers. The SBV has issued a framework on greening the banking sector[90] to promote green finance and encourage all credit institutions to incorporate environmental and social risks into their credit decision-making processes. However, further initiatives and improvements are needed to increase green financial flows:

- Vietnam should adopt international best practices to identify green projects, helping banks to track their green credit growth consistently and transparently against their targets, and to apply eligibility criteria to a relatively broad range of sectors or projects.
- The government can incentivize green credit supply by providing long-term seed funding to supplement banks' finances for green projects. Borrowers for climate change projects should be supported through grants, tax rebates, subsidized interest rates, and comprehensive knowledge.

Vietnam also needs to deepen capital markets and further develop the green bond market to address climate change and finance growth more generally. With the international emergence of new sustainable finance products and the increasing focus on the transition of heavy industries to lower carbon footprints, market participants are often looking for strong transaction benchmarks to build confidence and unlock potential businesses. Vietnam can benefit from this trend, attracting green capital to develop an effective, resilient, and credible transition pathway. Potential policy actions to grow the green bond market could include incentives such as tax exemptions for the coupon of green bonds and the building of capacity for green bond verifiers to decrease issuance costs.

There is also substantial scope for leveraging blended finance. Blended finance has emerged as a valuable tool for de-risking climate-related investments, especially in developing countries. It is important for Vietnam to make the most of this tool to maximize financing from other sources. The optimal approach may be to blend concessional financing with commercial financing to ensure that investments are deemed feasible from a private sector perspective.[91]

5.2. Public financing should act as a catalyst

The government could contribute to the financing of the resilience and decarbonizing pathways by collecting more taxes and borrowing more domestically. While a menu of taxes or tariff surcharges could be considered to help finance public investment in climate-related areas, the main fiscal instrument will be carbon pricing. For example, introducing the carbon tax modeled in the NZP would mobilize close to $80 billion over the period 2022–2040, or an average of 1.5 percent of GDP per year.

Concurrently, the authorities could borrow on the domestic financial markets. About one-to-1.3 percent of GDP per year could be mobilized, under current market conditions, without endangering public debt and fiscal sustainability over time, according to a debt sustainability analysis carried out jointly with the

90 Decision on the green bank development in Vietnam (No 1604/QD-NHNN) in 2018; Directive on promoting green credit growth and ES risk management in 2015 (No 03/CTNHNN); and Decision on issuance of Action Plan of the banking sector to implement the National Strategy on Green growth toward 2020 (No 1552/QD-NHNN), Sustainable Banking Network Brief, May 2021.

91 World Bank Group. 2018. "Vietnam: Maximizing Finance for Development in the Energy Sector." Washington, DC: World Bank. doi:10.1596/31246.

IMF.[92] Considerable savings could also be achieved by enhanced fiscal efficiency measures including improvements in the allocation and the financial management of public investments. While some fiscal space is still available, care will need to be taken to avoid crowding out private investments. The public sector's role remains central to cover the early costs of the resilient and decarbonizing pathways and to reduce the risks to private investors.

5.3. International climate finance and FDI are both crucial

Although Vietnam can mobilize domestic public financing and shift part of its domestic private savings toward its climate agenda, external resources will also be critical to meet its climate goals. Otherwise, the domestic financing effort might be detrimental to other social and economic needs, and negatively affect the country's quest to achieve high-income status by 2045. Beyond affordability, it is also a matter of common but differentiated responsibility as the country is to a large extent a victim of damages caused by the GHG emissions already generated by other countries. The external finance could be from both public or private sources, The public sources could include multilateral and bilateral concessional or non-concessional financing while the private sources could be from FDI or institutional impact investors.

The Paris Agreement and the recent Glasgow Agreement have generated a major collective boost of climate finance to support green recovery packages and investment needs to deliver on NDCs, but the magnitude and availability of these funds remain uncertain, both globally, and specifically for Vietnam. Official development assistance (ODA) to Vietnam has fallen sharply from $4.2 billion in 2014 to $1.0 billion in 2019 since the country graduated from the highly concessional programs of the World Bank and the Asian Development Bank in 2017 and 2018. The government does not anticipate a major increase in ODA in its macroeconomic and fiscal projections, which include an average of about $4 billion in ODA over the period 2021–2025. This amount is considerably more than what has been programmed in recent years.

Another channel for international funding could be through the presence of multinational companies and potential new foreign investments. According to Vietnam's Government Statistics Office, the country hosts more than 220,000 foreign-owned firms, including major companies that have corporate environmental and social responsibilities to decarbonize their value chains and protect assets vulnerable to climate change. The government could consider using incentives (such as tax relief, subsidies, or streamlined procedures) to direct these funds toward climate mitigation or adaptation activities. One consideration would be to substitute the existing tax holidays for FDI, costing around 1.5 percent of GDP in revenue loss, with tax credits for climate-related investments or green technology transfers realized by both local and foreign firms. Such incentives have proved relatively effective in other emerging and industrial countries.[93]

Remittances contribute significantly to the Vietnamese economy, reaching 6.3 percent of GDP in 2020, or more than 10 times the (net) flow of ODA. The government could launch a promotional campaign to encourage the use of these funds for climate-related projects, including the potential use of subsidies to leverage further participation.

92 This estimate is based on the macroeconomic and fiscal projections derived from the net-zero emission pathway in the CGE model. It assumes that the government will follow the same debt strategy as in the recent years—in particular, that about 80 percent of public borrowing will occur in domestic financial markets. Global market assumptions (terms-of-trade, interest rates, etc.) have been determined by the IMF. At this stage, this debt module does not feed back into the CGE model, while in reality it should impact on the country's macroeconomic trajectory. This assumption should be relaxed in future research.

93 World Bank, 2021, Vietnam tax policies: Issues and Recommendations for Reforms, unpublished.

Vietnam will require external financial assistance to cover the funding gap and provide immediate concessional resources. To the extent that many of the benefits associated with climate change adaptation and mitigation measures accrue to future generations, part of the cost of borrowing should be delayed to the future. The international community should help provide these long-term financing instruments (such as concessional debt with long grace period), as many investments will have to be frontloaded before their costs will become even higher for the country (for instance, to build resilience to floods and other urgent climate risks).

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6

Conclusions and Recommendations

6. Conclusions and Recommendations

6.1. Prioritization is key

This CCDR comes at a critical time for informing major climate strategies currently being considered or implemented by the government. It uses multiple analytical and diagnostic tools to identify options for both the public and private sectors to enhance synergies between building climate resilience, achieving Vietnam's net-zero emissions pledge, and advancing socioeconomic development—and to reduce trade-offs. Drawing on the analysis presented throughout this report, six building blocks for the government emerge that will be critical to Vietnam's development in coming decades:

- **Building resilience:** The high level of vulnerability of Vietnam's infrastructure, productivity, and social capital will negatively affect national welfare and its ability to achieve long-term development goals. Climate-related disasters such as storms and flooding, compounded by the degradation of ecosystems such as mangroves and wetlands and their services, already put multiple billions of dollars of the country's assets at risk on an annual basis. Strategic locations such as the Mekong Delta and HCMC and key economic activities, such as rice production and industrial production for export, face escalating impacts from rising temperatures, variable and often extreme precipitation, and sea-level rise and salinity intrusion.
- **Decarbonizing growth:** Although Vietnam is not a major contributor to global GHG emissions, it still has several reasons to decarbonize, beyond contributing to global goals. Fossil fuel use is driving a rapid rise in air pollution levels in the country's main urban centers, which is causing tens of thousands of deaths annually and imposing large economic costs in terms of health and productivity losses. In addition, the deep value chains that underpin much of Vietnam's economy are at risk from changing global production and consumption patterns. Maintaining the country's competitiveness will thus require a more aggressive strategy in the energy sector than considered by the government in its NDC, combined with actions in the agriculture and transport sectors—the second- and third-largest carbon emitters.
- **Ensuring a just, "people first" transition:** Both climate risks and policy responses are likely to disproportionately impact the poor, so measures are needed to ensure a just transition. Workers will need support shifting quickly from high-emitting to low-emitting activities. Fairness and good opportunities in the new low-carbon, climate-resilient economy are also key for economic, social, and political cohesion. Furthermore, it is important to recognize the additional costs that households could face in the near term, especially for energy and transport. Targeted interventions and pricing strategies will be needed to protect vulnerable segments of the population. Given the high costs of the transition, trade-offs may need to be made.
- **Mobilizing financing:** Mitigation and adaptation strategies will require massive funding, with more than $250 billion likely needed for resilience-building alone up to 2040. New instruments (carbon tax, green bonds) and partnerships (private sector, global community) will be required for meeting mitigation objectives, along with greening fiscal and financial policies (transfers, procurement, loans).
- **Unleashing the private sector:** The private sector should play a key role in climate action, including through setting science-based targets to reduce emissions within operations and value chains and compensating for residual emissions through buying carbon credits. The government can take numerous actions to support, incentivize, or partner with the private sector on mitigation and adaptation initiatives. Greening the economy will help create new productive jobs and trade opportunities (renewable energies, equipment for electric vehicles, and so on). Policy measures

are needed to facilitate technology transfers (reducing non-tariff barriers, skill development), and improve the business environment (financing, ease of doing business).

- **Getting institutions and incentives right:** Mitigation and adaptation policies are partially about changing individual and collective behaviors, which will require leadership, coordination, and effective incentives. There is a need to align the institutional framework so that fragmentation is reduced across sectors and between the central and subnational governments. Participatory processes should be strengthened through data-sharing and partnerships with the private sector and civil society.

Without addressing these six building blocks, it will be difficult for Vietnam to achieve green, resilient, and inclusive economic development it needs. However, selectivity will also be required to manage the costs associated with all the actions unless the country can mobilize substantial amounts of external financing upfront.

Table 6 summarizes prioritization framework that was used to select key areas of intervention. It organizes actions according to their levels of urgency and impact. Urgency is broken down into two levels -- actions that are urgent, and other interventions that can be delayed due to lack of political will or financing or may become more affordable in the future given the expected decline in the cost of green technologies. These two levels of urgency are further separated according to the level of impact expected from interventions high and medium. The key rationale of this urgency-impact matrix is that actions will be more acceptable, increasing their chance to be implemented rapidly, if there is a sense of urgency associated with them and if they contribute to the country's objectives of rapid growth, inclusion, and financial stability.

Table 6. Prioritization criteria

		Impact	
		High Action that has immediate impact and facilitates the achievement of other development objectives	**Medium** Action with impacts that will are realized over several decades
Urgency	High Delay in action increases the cost of achieving the same end point	Actions that cannot be postponed and will produce a high and immediate impact (quick wins)	Actions that may need long-term planning and mobilization of political capital and financing
	Medium Delay in action does not increase the cost of achieving the same end point	Actions that require time to conceive and implement but may deliver high impact	Actions that require time to conceive and implement with uncertain impacts

The results of this selectivity exercise are summarized in Annex 4. This report presents the five-priority policy packages that require the most immediate attention by government and most urgent public and private investments to achieve adaptation and mitigation goals.

- ***Priority Package #1: A coordinated regional program for the Mekong Delta.***[94] This program should focus on stemming land subsidence and saltwater intrusion by curtailing sandmining and groundwater extraction, adapting farming practices, increasing freshwater flow and aquifer recharge, and restoring mangroves. Existing physical assets should also be retrofitted to become less vulnerable to inundation, while the Land Law, including on land use planning, should be amended to prevent further encroachment on natural vegetation cover. Moreover, new developments should account for climate risks through systematic environmental assessments. All the above measures will require strengthening the Regional Coordination Council and correcting the deficit in public investment of the recent past. They will also involve revising existing transfers from the central to local governments, while encouraging the use of specific instruments, such as green bonds, to finance new projects.
- ***Priority Package #2: An integrated coastal resilience investment program for main urban centers and connecting infrastructure.*** Central coastal areas are prone to extreme weather events, highlighting the need to upgrade road and power assets to climate-resilient design standards. Building the resilience of coastal areas will also depend on effective land-use planning and investments in afforestation. Special emphasis should be on strengthening and enforcing policies and regulations for industry resilience, including in industrial parks, and envisioning relocation when necessary. Cities should invest more in digital technologies for improving weather-risk management and early warning systems. In addition, since it is impossible to eliminate all risks, expanding the use of insurance and risk-hedging instruments should be priorities.
- ***Priority Package #3: A targeted air pollution reduction program in the Hanoi airshed to reach the WHO interim target by 2030 and enhance labor productivity gains.*** Data from the World Air Quality Report indicates that air pollution in the capital city already exceeded the WHO 2.5 guideline by at least five times for half of the year from 2018 to 2021.[95] $PM_{2.5}$ concentrations are predicted to increase, given the absence of adequate air pollution regulations and the planned expansion of coal capacity. According to government plans, 10 new coal-fired power plants will be put in operation in the Northern region by 2030. Agricultural pollution is also expected to grow in the absence of policies targeting agricultural residue burning and fertilizer use. Effective improvements in Hanoi's air quality will require urgent actions in close coordination with neighboring provinces. Priorities should include reducing the reliance on coal—for example, by repurposing the 100 MW plant in Ninh Binh. Other measures will have to be put in place to incentivize farmers to use fewer polluting inputs and burn less waste, improve public transportation systems, and apply tougher standards on motor vehicle emissions.
- ***Priority Package #4: Acceleration of the clean energy transition.*** The energy sector accounts for about 60 percent of the country's GHG emissions, and the government is currently working to align investments in the power sector with its COP26 net-zero commitment. This is an immediate task, given the lead time for implementing energy sector investments. Renewable energy deployment (in particular, offshore wind) could be accelerated by improving the regulatory framework, including transparent and competitive procurement procedures (auctions), to encourage private sector participation. Bankable power purchase agreements aligned with international standards can mobilize much-needed private investment in the sector. Ensuring investments in the capacity of the power grid, which can provide flexibility to absorb additional renewable energy will be important. Accelerating implementation of energy efficiency plans — including through effective pricing policies such as a carbon tax or an emissions trading system — is also a priority. In addition, encouraging low-carbon energy sources by monitoring the carbon footprint of large private companies, including

94 The CCDR focuses on interventions under the responsibility of Vietnam, but strong coordination will be required with other riparian countries of the Mekong River Basin to ensure a proper flow of the river and reduce impoundment of sediment by river dams in the upper river basin.

95 IQ*Air*, 2021: World Quality report.

along their value chains, will be vital. Many companies have already committed to their own net-zero targets. The government could link support to state-owned enterprises with actions that accelerate low-carbon energy consumption.

- ***Priority Package #5: A new social contract to protect the most vulnerable people.*** Climate change tends to disproportionally affect poorer households in vulnerable areas or those less prepared to cope with the consequences. Some of the mitigation actions proposed above could also have a regressive impact, such as through the broadening of carbon tax or the greater inability of unskilled workers to secure a new job during the transition to cleaner technologies. As part of the government's program, implementing a modern, scaled-up adaptive social safety net can improve the effectiveness of post-disaster assistance. The priority should be to protect the most vulnerable segments of the population against price increases in transport and energy that will result from the energy transition and the use of carbon pricing instruments. This could be achieved by transferring part of the carbon tax revenue to social programs. Investment will also be needed in skills development programs to support workers exiting the labor market involuntarily. Beyond this, a comprehensive national skills program should be developed to correct skills mismatches in green industries by reforming educational training. Protecting the most vulnerable must be underpinned by advance information and citizen participation in public debates about the adaptation and mitigation measures envisaged nationally and locally.

These policy packages will maximize adaptation and mitigation benefits. They are also in line with the government's recent bold climate commitments made at COP26. The order in which the packages are presented is not coincidental as the first two packages emphasize the top priority for Vietnam to adapt to climate change. The focus on reducing the level of air pollution in Hanoi is justified as it will optimize the local benefits of decarbonization on people's health and productivity – a key factor also for neutralizing the negative impact on GDP growth, while accelerating clean energy transition. The package focused on vulnerable people should not only be a building block of any climate agenda, but also help create more productive jobs.

These priority packages will require not only upfront financing but also several policy and structural reforms. The bulk of financing will be directed to climate-resilient actions in the Mekong and coastal areas – in the range of $30-40 billion between 2022 and 2030 – by extrapolating from the estimates presented in Chapter 3. The reduction of air pollution in Hanoi will require decommissioning one existing coal-power supply plant and making an aggressive push toward renewables together with support programs to incentivize farmers to shift towards new technologies. The cost of the energy transition is estimated at $15 billion up to 2030 in Chapter 4. The cost of the package relating to social transfers to vulnerable people could reach $3 billion per year. These packages also include policy reforms that will not necessitate financing but will require political willingness as they will produce differentiated impacts on people and businesses. This could arise not only from the extension of carbon pricing but also the reform in the Land law, the revision of government transfers toward the most climate vulnerable provinces or the enforcement of buffer zones.

6.2. Ways forward

As Vietnam seeks to achieve high-income status by 2045, it needs to deal decisively with climate change. An important conclusion of the CCDR is the need for immediate actions to mitigate and adapt to climate change, or in other words build climate resilience and decarbonize – through the implementation of five priority policy packages. Like often in economic and development policy, climate action will be taken in a context of incomplete information and large irreducible uncertainties. Analytical work can help, but many uncertainties will only be resolved as the country implements its climate policies, carefully monitors their impacts and results, and learns from its successes and failures. There is no dearth of strategies and action

plans in the country, but what seems to be missing is the need to progress from "what to do" to "how to do it." The CCDR takes a step in this direction, identifying clear priorities that now need to be implemented.

There are real political economy risks associated with the policies and investments proposed in the Resilient and Decarbonizing Pathways. Some of the proposed actions will produce asymmetric impacts, creating losers and winners. These actions will entail some trade-offs, not only win-wins. For example, the broadening of the carbon tax will help reduce GHG emissions and is expected to generate benefits for the most of the population through labor productivity gains, a shift towards more labor-intensive industries, and improved competitiveness on international markets. Yet, it will also negatively affect some segments of the local economy, including workers and businesses (and SOEs) in high-emitting sectors and poor households that cannot cope with higher electricity tariffs. Another example is that many of the climate-resilient interventions will require a national or a regional approach, which will curtail the independence of decision-making by provincial authorities regarding public investments and implementation processes (as they are today responsible for 70 percent of the investment budget). To large extent these political economy challenges explain why Vietnam has missed key opportunities for climate action in the past—and, as a result, also missed its declared targets.[96] Indeed, Vietnam is arguably more dependent on fossil fuels and more vulnerable to climate change today than it was a decade ago. Many of these problems are also rooted in the weaknesses of the institutional framework surrounding the climate change agenda in Vietnam. Fortunately, there are a number of actions that the government and its partners can take to facilitate adoption and reduce resistance, ranging from information-sharing to specific support and compensation for affected parties.

The existing institutional framework suffers from an absence of a clear anchor in the government as parallel strategies and plans, which may not be in full alignment, are today developed by several ministries. Changes in governance are also needed, such as more efficient coordination mechanisms across provinces to facilitate adaptation investments in climate-vulnerable regions. The existing fiscal decentralization rules, by decoupling spending and revenue responsibilities in the provinces, limit incentives for provinces to invest in infrastructure. Market signals may also be confusing as subsidized natural resource prices often encourage more exploitation rather than sound management, while laws and regulations are not always enforced. Together, these shortcomings will complicate decision-making and implementation of the desired adaptation and mitigation measures. Several institutional reforms are needed, including:

- **Establishing a solid institutional anchor** (such as the Climate Change Committee chaired by Prime Minister) to secure strong leadership and coordination for climate action and coordinate actions within the government, including between MONRE and MPI, as well as strategic ministries such as Finance, Agriculture and Rural Development, Transport, and Energy, and between the national and provincial governments. A priority should be to establish an institutional mechanism that will help coordinate regional initiatives, such as building resilience in the 13 provinces of the Mekong Delta region, or decarbonizing Hanoi and its agglomeration.
- **Streamlining administrative processes and procedures** to accelerate decisions and approval processes through (i) clear allocation of responsibilities within the government (including between the national and provincial levels); (ii) elimination of duplications across and within ministries (for example, the early warning system for climate disasters); (iii) use of digital tools and shared platforms to minimize human interactions and improved monitoring; (iv) adoption of methodologies that will help adjust public investment management and procurement to climate change risks (such as risk assessment, tagging climate spending in budget systems, criteria for public contracts); and (v) development of a credible pipeline of investments.

96 World Bank, 2021, "Systematic Country Diagnostic Update: How will Vietnam Blossom? Reforming institutions for effective implementation".

- **Using market-based or relative pricing instruments** to incentivize behavior changes in the private sector (such as through carbon pricing) and within the public administration at the national and provincial levels (such as through the introduction of performance-based incentives in fiscal transfers to provinces and SOEs to motivate their interest in resilience-building and decarbonization).
- **Enforcing rules and regulations** to enhance motivation, trust, and fairness – for example, by strengthening and modernizing inspections and controls, as well as enacting credible sanctions for trespassers, including for high polluters, and the misusers of land or abusers in protected areas.
- **Increasing participation** to secure accountability and transparency by strengthening open-data and e-government initiatives (including improved statistics such as the development of System of Economic and Environmental Accounts); better communicating the sense of urgency associated with climate change, including through education; and increasing engagement by civil society and the private sector in the country's climate decision-making processes.

Annexes

Annex 1. Vietnam Key Climate and Development Data

	Unit	#	Year	#	Year	#	Year	Source
CURRENT MACROECONOMIC CONTEXT								
GDP per capita (annual growth rate)	%	5.1	1990	7.5	2005	2.9	2020	WDI
Labor productivity (annual growth rate)	%	-	1990	-	2005	6.9	2020	OECD
Informal economic output	% of GDP	23.0	1990	15.2	2005	11.6	2018	WBG
Average unemployment	% labor	1.8	1991	2.1	2005	2.2	2020	WDI
Current account balance	% of GDP	-	1990	-0.9	2005	-5.5	2020	WDI
Fossil fuel pre-tax subsidies	$/capita	0.9	2015	5.1	2017	2.8	2019	CCDRDB
Coal export level	Mst (million short tons)	2,910	1990	15,138	2005	982	2020	EIA
Oil export level	Mb/d	53.0	1990	361.0	2005	67.0	2020	EIA
CLIMATE CHANGE MITIGATION								
GHG Emissions								
Emissions per capita	tCO_2e/capita	0.3	1990	1.1	2005	3.8	2018	Climatewatch
Total GHG emissions, incl. LUCF	$MtCO_2e$	1.17	1990	207.64	2005	364.43	2018	Climatewatch
Agriculture	$MtCO_2e$	46.34	1990	65.9	2005	70.99	2018	Climatewatch
Building	$MtCO_2e$	1.97	1990	9.88	2005	15.79	2018	Climatewatch
Electricity/heat	$MtCO_2e$	4.88	1990	24.28	2005	109.13	2018	Climatewatch
Fugitive emissions	$MtCO_2e$	0.66	1990	12.85	2005	18.66	2018	Climatewatch
Industrial processes	$MtCO_2e$	1.06	1990	13.15	2005	37.13	2018	Climatewatch
Manufacturing/ construction	$MtCO_2e$	5.66	1990	24.06	2005	63.91	2018	Climatewatch
Other fuel combustion	$MtCO_2e$	5.35	1990	4.96	2005	4.21	2018	Climatewatch
Transportation	$MtCO_2e$	4.17	1990	19.36	2005	36.32	2018	Climatewatch
Waste	$MtCO_2e$	2.46	1990	13.5	2005	20.4	2018	Climatewatch
Land Use Change and Forestry	$MtCO_2e$	-71.38	1990	19.69	2005	-12.09	2018	Climatewatch
Emission scenario – BAU	$MtCO_2e$	528.4	2020	726.2	2025	927.9	2030	VN NDC
NDC target – 9% below BAU (unconditional)	$MtCO_2e$	-	-	673	2025	844	2030	VN NDC
NDC target – 27% below BAU (conditional)	$MtCO_2e$	-	-	-	-	677	2030	VN NDC
Energy Consumption and the Power Sector								
Per capita electricity consumption	kWh	128	1990	613	2005	2745	2020	Our World in Data
Total electricity consumption	TWh	8.68	1990	51.36	2005	267.18	2020	Our World in Data
Energy from renewables	%	80.34	1990	87.69	2005	84.78	2020	Our World in Data
Energy from fossil fuels	%	19.66	1990	12.31	2005	15.22	2020	Our World in Data

	Unit	#	Year	#	Year	#	Year	Source
Energy intensity per unit of GDP	kWh	0.94	1990	1.33	2005	1.5	2016	Our World in Data
Energy intensity level of primary energy	MJ/$2011 PPP GDP	7.55	1990	6.02	2005	5.95	2015	CCDRDB
Electricity generation – coal	TJ	93,058	1990	371,918	2006	1,560,577	2018	IEA
Electricity generation – natural gas	TJ	113	1990	214,433	2006	348,091	2018	IEA
Electricity generation – oil	TJ	113, 489	1990	490, 421	2006	884, 442	2018	IEA
Electricity generation – biofuels and waste	TJ	522, 123	1990	618, 246	2006	345, 922	2018	IEA
Electricity generation – hydropower	TJ	19, 328	1990	73, 469	2006	238, 021	2018	IEA
Electricity generation – renewables (excluding hydropower)	GWh	0	1990	65	2006	181	2015	CCDRDB
Population – financial access	%	21.37	2011	30.95	2014	30.80	2017	GFI
Government effectiveness	Percentile rank	40.00	2000	47.06	2005	61.54	2020	WGI
Political stability	Percentile rank	62.96	2000	62.14	2005	44.81	2020	WGI

a Account at a financial institution or with mobile-money provider (ages 15+); b Percentile rank [0 to 100], higher values = better outcomes.
c services include Agriculture and Fisheries; d Poverty headcount ratio at $5.50 a day (2011 PPP); e drinking water defined as "least basic"; f Projection from SSP2-4.5 Ensemble; g Level of spending in protection that minimizes the cost of flooding (prevent expenditure + damages)

Annex 2. Background Papers

This CCDR builds on several existing studies, from the World Bank Group or other academic, research, or development institutions, as well as many government reports. In addition, several background papers were commissioned that include:

1. Mekong Delta: Critical Role in Vietnam's Economy and the Challenges of Climate and Development, January 2022.
2. Overview of Vietnam's Legal and Policy Framework on Climate Change, January 2022.
3. Institutional Capacity Relevant to Climate Change, January 2022
4. Climate Change and Agriculture in Vietnam, January 2022
5. Financial Policy and Climate Change, January 2022
6. Trade and Climate Change-Vietnam Country Study January 2022
7. Transport Sector Decarbonization and Building Resilience in Vietnam, January 2022
8. Climatic and Environmental Risks and Social Sustainability in Vietnam: A Joint Spatial Analysis, January 2022
9. Fiscal Policy and Climate Change, January 2022
10. Energy Sector Decarbonization Note, January 2022
11. Climate Change, Adaptation, Mitigation and Distributional Impacts in Vietnam, January 2022.
12. Macroeconomic Impacts of Climate Change and Mitigation Policies in Vietnam, September 2020 (to be updated).
13. Climate Change Public Expenditure and Institutional Review, September 2021.
14. Government's Contingent Liabilities from Natural Disasters, September 2021.
15. Supporting Systematic Action to Implement Vietnam's NDC: Review of Adaptation and Mitigation Priorities, Feb 2022.
16. Sustainable and Resilient Futures for Bien Hoa City (draft), Jan 2022.
17. Sustainable and Resilient Futures for Ho Chi Minh City (draft), Jan 2022.

Annex 3. Methodology, Modelling Results, and Data Issues

A. Global climate scenarios and CGE estimates of damages

Global climate scenarios: Assumptions and outcomes

CMIP5/6 Scenario and key Assumptions	Bad Climate Surprises (pessimistic case)	Intermediate Climate Outcomes (intermediate case)	Limited Warming (optimistic case)
Scenarios	CMIP5: RCP8.5 CMIP6: SSP3-7.0	CMIP5: RCP4.5 CMIP6: SSP2-4.5	CMIP5: RCP2.6 CMIP6: SSP1-1.9
Climate policies	Low achievement of current climate commitments	Achievement of current climate commitments and 2030 targets	High global ambition and achievement in decarbonization and sequestration
Climate response	High climate sensitivity; Possible amplification through reduction in natural carbon sinks	Medium climate sensitivity	Low climate sensitivity
Level of global warming	Average global temperature rises around 4 °C by 2100	Average global temperature rises by 2–3 °C in 2100	Average global temperature rises by less than 2 °C in 2100
Other factors	• Sea-level rise exceeds 100 cm in 2100 • Net increase in intensity of major storms • CO2 fertilization is limited by other factors and crop yield losses are in the higher range • Tipping points in major ecosystems	• Average global sea-level rise in 2100 is 50 cm • CO2 fertilization translates into limited crop yield losses (and benefits in some regions) • Some resilience of major ecosystems	• Average global sea-level rise in 2100 is 30 cm • CO2 fertilization translates into limited crop yield losses (and benefits in some regions) • Good resilience of major ecosystems

Source: World Bank analysis.

Key damages and macroeconomic results from CGE model

	Baseline				RCP 2.6				RCP 4.5			
	2022	2030	2040	2050	2022	2030	2040	2050	2022	2030	2040	2050
					Deviation from Baseline (Percent)*				Deviation from Baseline (Percent)*			
Average Growth, % (1)												
Real GDP	7.29	5.45	4.41	4.24	-0.23	-0.35	-0.08	-0.03	-0.18	-0.39	-0.19	-0.15
Real GDP per capita	6.35	4.73	3.88	3.88	-0.23	-0.35	-0.08	-0.03	-0.18	-0.39	-0.19	-0.15
Per Capita Income and Consumption												
Real GDP Per Capita (Constant 2020 USD)*	3,329	5,162	7,588	11,095	-2.81	-6.39	-7.49	-7.95	-2.59	-6.19	-8.02	-9.47
nsumption Per Capita (Constant 2020 USD)*	2,150	3,305	4,871	7,111	-2.93	-7.60	-8.91	-9.39	-2.74	-7.37	-9.45	-11.02
Real Expenditure Shares in Real GDP												
Private Consumption (% of GDP)	64.59	64.03	64.19	64.09	-0.13	-0.93	-0.95	-0.83	-0.14	-0.91	-0.97	-0.92
Government Consumption (% of GDP)	6.23	6.23	6.23	6.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Private Investment (% of GDP)	16.72	18.30	18.96	19.50	-0.36	-0.05	-0.08	-0.17	-0.33	-0.04	-0.12	-0.23
Government Investment (% of GDP)	6.82	6.38	5.99	5.74	0.20	0.44	0.48	0.50	0.18	0.42	0.52	0.60
Net exports (% of GDP)	3.42	3.71	3.79	3.88	-0.01	0.19	0.22	0.19	0.00	0.19	0.22	0.22
Sectoral Shares in GDP												
Agriculture	13.10	10.84	9.29	8.15	-1.28	-2.17	-2.22	-2.30	-1.29	-2.18	-2.20	-2.24
Industry	63.90	65.40	66.33	66.97	1.52	2.67	2.52	2.41	1.53	2.68	2.51	2.38
Services	22.99	23.77	24.37	24.87	-0.25	-0.50	-0.30	-0.12	-0.24	-0.50	-0.31	-0.14
Exteral Balance												
Current Account Balance (% of GDP)	-0.54	-0.50	-0.47	-0.45	-0.01	-0.04	-0.04	-0.04	-0.01	-0.04	-0.04	-0.05
Fiscal Aggregates												
Fiscal revenue (% of GDP)	27.70	27.68	27.07	26.80	-0.15	0.27	0.56	0.61	-0.15	0.26	0.55	0.65
Fiscal expenditure (% of GDP)	20.47	20.44	20.16	20.03	-0.06	-0.01	0.12	0.16	-0.06	-0.02	0.11	0.17
- o/w Interest payments (% of GDP)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Budget deficit (% of GDP)	0.37	0.89	1.00	1.14	-0.31	-0.17	-0.10	-0.11	-0.31	-0.16	-0.12	-0.17
Public debt (% of GDP)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
- o/w External Public Debt (% of GDP)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Emissions												
Emissions (milions of tons C02)*	436	691	1,106	1,695	-4.18	-15.90	-16.95	-12.36	-3.86	-15.57	-18.99	-18.08
Emissions per unit of ouput (tons C02)*	60.0	57.5	58.7	59.0	-1.42	-10.16	-10.22	-4.80	-1.30	-10.00	-11.93	-9.51
Damages												
Total (% of GDP)	NA	NA	NA	NA	6.46	8.14	7.80	7.36	6.26	8.08	8.72	9.36
-o/w Agriculture (% of GDP)	NA	NA	NA	NA	2.53	3.85	2.93	2.25	2.53	3.84	2.95	2.31
-o/w Heat (% of GDP)	NA	NA	NA	NA	1.48	1.46	1.55	1.56	1.35	1.46	2.23	2.92
-o/w Flooding (% of GDP)	NA	NA	NA	NA	2.37	2.73	3.22	3.47	2.31	2.68	3.42	4.00
Memorandum Items												
Population (Millions)	99	106	113	118	-	-	-	-	-	-	-	-
Working Age Population (Millions)	68	70	71	72	-	-	-	-	-	-	-	-

** Deviations from baseline are expressed as percent of baseline level for Real GDP Per Capita, Emissions, and Carbon Price. For all other variables deviations from baseline are expressed as percentage points of GDP in the corresponding scenario.*

B. CGE model basic assumptions for the NZP and main macroeconomic results

- Energy transition: Aggressive decarbonization scenario includes 80 percent GHG emissions by 2040 with existing energy capital stock declining by 25 percent because of stranded assets.
- Transport transition: Most aggressive scenario in the transport transition includes (i) 50 percent of refined petroleum products in vehicles replaced by electricity substitutes by 2040 and (ii) five percent energy efficiency savings in transport sector by 2040.
- Agriculture transition: Most aggressive scenario in the agriculture transition includes (i) 14 percent reduction in emissions per unit livestock; (ii) 14 percent reduction in fertilizer and pesticides used by substituting with other inputs.
- Land use, land-use change, and forestry (LULUCF): Gradual increase in subsidies to forest services sector, reaching up to 50 percent in 2040.
- Industry/services technological change: 95 percent reduction in industrial processes and product use (IPPU) emission coefficients in waste and fugitive emissions, and 50 percent reduction for cement with $300 cost per tonne of C02 avoided.
- Carbon pricing: Gradual increase from $1 to $24.60 per tonne equivalent between 2020 and 2030 and then to $90 per tonne by 2040.
- Co-benefits: De-link labor productivity impacts of PM2.5 pollution by assuming a 0.3 elasticity between air pollution reduction and increase in labor productivity.
- Full labor market flexibility within sectors but not mobility across sectors. This assumption is relaxed by assuming full flexibility,
- No demand efficiency gains. This assumption is relaxed by assuming a five percent reduction in the demand for energy.
- Necessary investments in priority sectors for net zero transition fully crowd out investments in other sectors. This assumption is relaxed by assuming a low crowding-out effect as the result of additional financing available.
- Carbon tax revenue is made available for the private sector for investment in clean energy and therefore adds to the capital stock in the next period.
- Total investment needs equal to $81.3 billion (NPV) in line with the needs identified in the sectoral transition models and the needed technological change in industry/services.

Key emission and macroeconomic results from the CGE

	Baseline			Net Zero			Netzero with reforms		
	2022	2030	2040	2022	2030	2040	2022	2030	2040
				Deviation from Baseline (Percent)*			Deviation from Baseline		
Average Growth, % (1)									
Real GDP	7.29	5.45	4.41	0.03	-0.08	-0.26	1.25	0.12	0.21
Real GDP per capita	6.35	4.73	3.88	0.03	-0.08	-0.26	1.24	0.12	0.21
Per Capita Income and Consumption									
Real GDP Per Capita (Constant 2020 USD)*	3,329	5,162	7,588	0.03	-0.67	-2.32	-0.29	0.95	2.90
Real Household Consumption Per Capita (Constant 2020 USD)*	2,149	3,300	4,873	-0.03	-0.96	-3.12	-0.80	1.02	2.99
Real Expenditure Shares in Real GDP									
Private Consumption (% of GDP)	64.54	63.93	64.22	-0.03	-0.19	-0.53	-0.33	0.04	0.06
Government Consumption (% of GDP)	6.23	6.23	6.23	0.00	0.00	0.00	0.00	0.00	0.00
Private Investment (% of GDP)	16.76	18.38	18.97	-0.01	0.05	0.15	0.27	0.03	0.07
Government Investment (% of GDP)	6.82	6.38	5.99	0.00	0.04	0.14	0.15	0.06	0.20
Net exports (% of GDP)	3.43	3.73	3.74	-0.01	-0.06	0.02	-0.16	-0.27	-0.50
Sectoral Shares in GDP									
Agriculture	13.51	11.97	10.80	0.01	0.10	0.22	-0.38	-0.91	-1.02
Industry	63.54	64.37	65.13	-0.01	-0.18	-0.32	0.37	0.48	-0.04
Services	22.94	23.65	24.07	0.00	0.08	0.10	0.02	0.44	1.06
Exteral Balance									
Current Account Balance (% of GDP)	-0.54	-0.50	-0.47	-0.01	-0.01	-0.01	-0.01	0.09	0.32
Fiscal Aggregates									
Fiscal revenue (% of GDP)	27.74	27.74	27.08	-0.18	1.10	1.93	-0.22	0.86	1.84
Fiscal expenditure (% of GDP)	20.51	20.51	20.19	-0.08	0.54	0.93	-0.11	0.41	0.92
- o/w Interest payments (% of GDP)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Budget deficit (% of GDP)	0.39	0.91	1.01	-0.25	0.33	0.64	-0.33	0.16	0.53
Public debt (% of GDP)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
- o/w External Public Debt (% of GDP)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Emissions									
Emissions (milions of tons C02)*	440	725	1,123.3	-6.39	-42.89	-73.65	-6.91	-41.53	-70.08
Emissions per unit of ouput (tons C02)*	60.6	60.3	59.6	-6.41	-42.51	-73.03	-6.64	-42.09	-70.92
Damages									
Total (% of GDP)	NA	NA	NA	NA	NA	NA	NA	NA	NA
-o/w Agriculture (% of GDP)	NA	NA	NA	NA	NA	NA	NA	NA	NA
-o/w Heat (% of GDP)									
-o/w Flooding (% of GDP)									
Memorandum Items									
Population (Millions)	99	106	113	-	-	-	-	-	-
Working Age Population (Millions)	68	70	71	-	-	-	-	-	-

* *Deviations from baseline are expressed as percent of baseline level for Real GDP Per Capita, Emissions, and Carbon Price. For all other variables deviations from baseline are expressed as percentage points of GDP in the corresponding scenario.*

C. Use of discount rates

The CCDR uses a discount rate of six percent as per the World Bank guidelines for economic analysis. Social discount rates (SDRs) are normally used to put a present value on costs and benefits that will occur later. In the context of climate change policy making, they are considered very important for working out how much today's society should invest to limit the impacts of climate change in the future. In other words, they calculate how much safeguarding against future carbon emissions is worth to us now, weighing up the benefits future generations would experience against the costs that today's society would have to bear.

The use of a high discount rate implies that people put less weight on the future and, therefore, that less investment is needed now to guard against future costs. The use of a low discount rate supports the view that we should act now to protect future generations from climate change impacts. In other words, more importance is given to future generations' well-being in cost–benefit analyses. The Table below illustrates how use of the different discount rates could alter the present value of future mitigation and adaptation investments derived in the CCDR.

		US$ billion, 2022-2040		
	% Of GDP	Undiscounted	2% Discount Rate	6% Discount rate
Financing Needs				
Resilient and net-zero development pathway	6.8	701	562	368
Resilient Pathway	4.7	483	387	254
-- Private assets and public infrastructure	4.2	431	346	227
-- Social assistance (disaster preparedness and relief)	0.5	52	41	27
Decarbonizing Pathway	2.1	218	175	114
-- Sector transitions (energy, transport, agriculture, industry)	1.5	156	125	81
-- Social assistance (training, safety-net etc.)	0.6	62	50	33
Sources of Funding	6.8	701	563	368
-- Private	3.4	351	282	184
-- Public	2.4	248	199	130
-- External	1.0	102	82	54
Memo				
GDP		10,381.56	8331.12	5,450.32

Economists often disagree on which discount rate to use. Higher rates lead to lower present values, and when the benefits are low, mitigation does not seem worth the cost. Often, the discount rate the economists choose makes the difference between acting and doing nothing. Lord Nicholas Stern used an exceptionally low discount rate, which explained his recommendations for urgency of action. Other economists, such as

William Nordhaus, have preferred a higher discount rate, rendering unnecessary the need for such a massive upfront investment unnecessary. There is also an increasing support for the view that discounting may have a less important role in cost–benefit analysis of climate change than once thought. This is because, as highlighted by the Harvard economist Martin Weitzmann, in the case of catastrophic climate change, the severe consequences would override the effect of any discounting.

D. Data discrepancies

It is possible that in some cases there may be discrepancies between what is reported by the country and what is being reported in publicly available databases. In the case of Vietnam, this discrepancy arose in the context of agricultural emissions. The estimate of agriculture sector emissions as reported in the NDC, 104.5 $MtCO_2e$, was found to be significantly higher than what is calculated by the World Resources Institute (WRI) and the UN Food and Agriculture Organization (FAO).

Information Source	Estimated emissions (MtCO2e)
Government of Vietnam / updated NDC (2020)	104.5
Draft Background Paper (2020)	104.5
FAO (2019)	72.74
Climate Watch (WRI) (2018)	71
Climate Transparency (2018)	61

Further investigation of the issue indicated that the 104.5 $MtCO_2e$ reported in the NDC was a BAU projection for 2020 using the 2014 actual emission level (89.8 $MtCO_2e$, which is the same as the FAO agricultural emission level for Vietnam for 2014).

The 2020 projection for Vietnam was developed according to the Department of Science and Technology of MARD, based on the medium economic development scenario with assumptions on all parameters that affect emissions in agriculture including activity levels and production of rice, livestock, other crops, forest, and forest land use for the period 2020–2030. It followed the procedures for the estimation of the National GHG Inventory while considering all the relevant factors such as Activity Definition (AD), Emission Factors (EF) and Global Warming Potential (GWP), which seem to be well-aligned with the IPCC Guidelines (2006) for the estimation of the National GHG Inventory.

Annex 4. Impact–Urgency Priority Matrix

		Impact	
Urgency		High	Medium
	RESILIENT PATHWAY		
	High	Implement, with urgency, a coordinated regional investment program in the Mekong Delta. Develop an integrated coastal resilience investment program for main urban centers and connecting infrastructure. Rehabilitate or upgrade irrigation infrastructure. Invest in afforestation and reforestation, with a focus on mangroves. Implement a modernized, scaled-up adaptive social safety net program. Restrict overly risky new development, including in buffer zones, by amending the land law. Upgrade road and power assets to higher climate-resilient design standards.	Correct the deficit in public investment that has built up in recent years in the Mekong Delta. Repurpose agricultural subsidies on inputs (water, fertilizer, etc.) towards adoption of resilient agriculture production practices. Invest in digital technologies for improving weather risk forecasting and early warning systems. Adopt ecological redlining to curb the expansion of agriculture into forested areas.
	Medium	Strengthen and enforce policies and regulations for industry resilience, including in industrial parks. Expand the use of insurance and risk-hedging instruments Improve access to finance for smallholder agriculture by removing caps on bank lending and permitting warehouse receipts and crops to serve as collateral. Mandate the use of climate risk assessments for all public investment decisions. Develop systematic approach to using nature-based solutions	Support large-scale investments in agriculture by strengthening cooperative farm models and facilitating the entry of big operators. Promote PPPs in research and development for resilient and smart agricultural technologies. Introduce a life-cycle asset management approach for infrastructure. Invest in biosecurity measures (protection from pests, viruses, etc.) for effective prevention of spread of livestock diseases. Prioritize investments in infrastructure and social services in areas that will be impacted by climate migration. Model and plan alternative locations and trading channels for most climate vulnerable industries.

		DECARBONIZING PATHWAY	
Urgency	High	Reduce air pollution in the Hanoi airshed by targeting critical sources to reach the WHO interim target by 2030. Finalize PDP8 to align with COP26 net-zero commitments and implement identified investments. Facilitate renewable energy deployment (in particular, offshore wind) by improving the regulatory framework, including transparent and competitive procurement procedures (auctions) to encourage private sector participation. Accelerate implementation of energy efficiency plans, including through effective pricing policies. Reform electricity tariffs both for moderating energy use and to improve financial viability of the power sector. Fast-track use of carbon tax (ETS), while protecting the most vulnerable segments of the population against price increases in transport and energy. Introduce vehicle fuel economy standards for new internal combustion engine vehicles. Reduce the carbon intensity of trade through traceability of carbon use along value chains and eco-industrial park upgrades.	Use power system planning as a dynamic investment decision tool. Invest in power grid's capacity and flexibility to absorb additional renewable energy. Support transitioning to electric vehicles through standards, incentives, and investments in public charging stations and buses. Facilitate the imports of clean technologies by cutting non-tariff measures applied on environmental goods and services. Invest in and scale up the use of low carbon technologies in rice production.

Urgency	Medium	Make public transport more attractive and private vehicle use less attractive. Invest in skills development programs to support workers exiting the labor market involuntarily (compensation, information, reskilling). Design targeted support programs for SMEs and startups investing in low-carbon technologies. Facilitate modal shift from road freight (trucks, etc.) to waterborne transport systems by scaling up investments and supporting policies. Decarbonize the trade sector through policies and direct financial support for startups and emerging green businesses. Enhance the social protection system to protect the most vulnerable households during the transition.	Repurpose public expenditure in agriculture to support the adoption of less GHG-emitting crop varieties and production technologies. Reduce livestock emissions through guidelines on improved diets and waste management practices. Develop a clear policy framework for the private sector to play a major role in the decarbonization of transport. Develop natural gas as needed to serve as a transitional fuel. Scale up investments in carbon sinks to achieve net-zero target.

Urgency	CROSS-CUTTING ACTIONS		
	High	Harmonize various existing climate strategies (NDC, VGG) and their implementation by strengthening the mandate of the Prime Minister's National Climate Change Committee. Establish new institutional frameworks for implementing regional and national climate programs (Mekong Delta, HCMC, Hanoi agglomeration). Create a climate fund with potential international private and public funders of Vietnam's COP26 commitments. Link government support to SOEs with actions that accelerate the transition to decarbonization, enhance climate resilience, and reduce climate-related risks. Establish a green taxonomy to scale up sustainable investments and apply eligibility criteria for green credit.	Monitor the implementation of the recently SBV-adopted framework for greening of the banking sector. Develop and implement a nationwide climate communication strategy, including dissemination in schools, to increase public awareness. Issue the required secondary regulations to implement PPPs in key climate-related infrastructure sectors. Accelerate the equitization program of SOEs operating in key climate related sectors. Create a level playing field for the private investors by removing barriers to entry and promoting market competition in climate-related sectors.
	Medium	Activate green bond markets through the creation of standardized criteria and the provision of tax exemptions for the coupon of green bonds. Develop a comprehensive national skills program to correct skill mismatches in clean/green industries by reforming educational/vocational training programs. Initiate labor market programs to support workers exiting the labor market involuntarily (compensation, information, reskilling).	Enhance the tracking of climate-related expenditure in both central and provincial budgets. Integrate climate risks into the Public Procurement Law, in line with international best practices. Develop a system of economic and environmental accounts as well as of a modern MRV system for various sectors. Align medium-term public expenditure and debt strategy with financing for the national climate change action plans. Implement a green training program for financial institutions. Mobilize international concessional finance and domestic finance to leverage and complement banking finance for green capital investments. Allow foreign financial institutions to register mortgages over immovable assets in a streamlined and transparent structure to mobilize capital for climate investments.