
Carbon pricing in Vietnam: Options for adoption

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Abstract

This paper investigates options for carbon price adoption in Vietnam, with a focus on model designs capable of meeting the country's updated Nationally Determined Contribution (NDC). We employ an ex-ante policy evaluation across environmental, economic, social, and political dimensions, drawing on interviews with key stakeholders. A multi-criteria analysis is also pursued to provide an overall comparison across policy options. The findings indicate that a relatively low but increasing carbon price could play an important role in steering Vietnam toward meeting its emission reduction targets. A carbon tax has the advantage of simplicity, while an emissions trading scheme would likely be politically easier to introduce. If an emissions trading scheme is established, permit auctioning would be preferable to free allocations on account of revenue benefits and relative simplicity. A key risk is that an overgenerous cap would be set, which would undermine environmental impact.

Keywords: carbon pricing, climate policy, emissions trading scheme, greenhouse gas emission, green growth, Vietnam

JEL codes: O13, O38, Q48, Q54, Q58

Abbreviations¹

¹ ASEAN, Association of Southeast Asian Nations; ETS, emissions trading scheme; EU, European Union; GHG, greenhouse gas; Kt, kilotons; LULUCF, land use, land use change and forestry; MRV, monitoring, reporting, and verification; NDC, Nationally Determined Contribution; NMVOC, non-methane volatile organic compounds; tCO₂, ton of CO₂; TSP, total suspended particles; VND, Vietnamese dong.

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transdisciplinary research project is a \$10m investment between 2019 and 2023 that aims to help transform the way Australia trades with the world. It comprises five interrelated projects: Renewable Electricity Systems, Hydrogen Fuels, Energy Policy and Governance in the Asia-Pacific, Renewable Refining of Metal Ores, and Indigenous Community Engagement. The Grand Challenge's goals include developing zero-carbon export industries, creating new paradigms in benefit-sharing, and developing technologies, policies and approaches which can be applied in the Asia-Pacific and beyond.

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1. Introduction

Reducing greenhouse gas (GHG) emissions is a matter of national interest for Vietnam, one of the most vulnerable countries to global climate change. Serious local air pollution, particularly in large cities, has also increased the case for emission reduction policies. In November 2020, Vietnam's National Assembly passed a revised Law on Environmental Protection that will take effect on 1 January 2022 and that legalizes the establishment of an emissions trading scheme (ETS) for greenhouse gases (Do, 2020a). Details of any ETS have yet to be determined and there is still a path ahead before a scheme will be ready to launch.²

Carbon pricing is a policy instrument that puts a price on carbon dioxide (CO₂) and other GHGs such as methane (CH₄) and nitrous oxide (N₂O). The idea follows the theory of externality pricing pioneered by Pigou (1920) and is in line with the “polluter pays principle” (Timilsina, 2018). By internalizing externalities associated with GHG emissions, carbon pricing can facilitate cost-effective abatement and promote low-carbon innovation (Aldy and Stavins, 2012). If introduced early in the development process, emission pricing can help countries to avoid the high emissions trajectories experienced by developed countries (Burke, 2014). Empirical evidence indicates that countries with carbon prices on average have annual CO₂ emission growth rates about two percentage points lower than countries without a carbon price (Best et al., 2020). A key channel is faster substitution from emissions-intensive energy sources towards low-emission sources such as solar and wind (Best and Burke, 2018, 2020).

The two main forms of carbon pricing are a carbon tax and an emissions trading scheme (ETS) (Harris and Roach, 2018). A carbon tax is a levy on GHG emissions from covered sectors. For the energy sector, this is typically in the form of a levy on fossil fuels in proportion to the quantity of emissions flowing from their use. An ETS involves issuing permits for GHG emissions and allowing their trade among emitters. The permits could be auctioned or freely allocated, or a combination. Both approaches can facilitate low-cost emissions reductions across covered sectors by encouraging equalization of marginal abatement costs. The main difference is that a carbon tax sets the emission price while an ETS sets the total emission quantity. The instruments can be applied at a subnational, national, or international scale and

² As of 8/2021, the proposed timeframe for an ETS is that the preparation, including establishment of GHG inventories and monitoring, reporting, and verification (MRV) systems will be conducted over 2022–2026. The ETS would then roll out in 2027, although this is a tentative schedule. A draft government decree on an ETS is due to be issued in late 2021 (Government of Vietnam, 2021). The revised Law (Article 136) also expands the coverage of an environmental tax to include pollutants as opposed to only products and services. A carbon tax could thus be deemed to have become legally possible, although is not referred to directly in the Law.

to either a specific sector or on a broader basis (Timilsina, 2018). Hybrid forms of carbon pricing that involve both price and quantity controls also exist.

Carbon pricing has gained increasing popularity worldwide. As of August 2021, 64 carbon pricing initiatives had been implemented or scheduled for implementation worldwide (World Bank, 2021). 31 are ETSs and 33 are carbon taxes. Except for the European Union (EU) ETS, these schemes have been at the national and sub-national levels. Carbon pricing initiatives currently cover about 12 GtCO₂ or one-fifth of global GHG emissions. Carbon pricing has been adopted in several developing countries, including China, South Africa, and Kazakhstan. In 2019 the average price across all CO₂ emissions, including emissions that face a price of zero, was about US\$2 per tCO₂ (Parry, 2019).

Carbon pricing has been gaining recent momentum in Asia. Japan applied a carbon tax in 2012, set at US\$2.7 per tCO₂ (World Bank, 2021). South Korea introduced an ETS in 2015, with its permit price sitting at about US\$18 per tCO₂ in September 2020 (International Carbon Action Partnership, 2020). Singapore introduced a carbon tax of about US\$3.5 per tCO₂ in 2019. China started a national ETS in July 2021 after a series of sub-national pilots (Zhu et al., 2020). Kazakhstan's ETS was introduced in 2013, covering the power sector, heating, and some industrial emitters. Subnational ETSs have been introduced in Japan (Tokyo and Saitama), and in 2021 Indonesia commenced a pilot ETS for its power sector. Quasi-carbon pricing programs include India's charge of about US\$1 per ton of coal since 2010 and Thailand's voluntary emission reduction program since 2013 (Partnership for Market Readiness, 2020).

There are relatively few studies on the options for and potential impacts of carbon pricing in Vietnam. Michaelowa (2018) analyzed barriers to a carbon tax and options for introduction, although did not explore linkages between tax levels and Vietnam's GHG reduction targets. Nong et al. (2020) presented static computational general equilibrium modelling to assess potential environmental and economic impacts of an ETS, but used scenarios that differ from Vietnam's Nationally Determined Contribution (NDC) and did not analyze social and political aspects. Coxhead et al. (2013)'s analysis of potential distributional impacts of a carbon tax employed relatively outdated data. Vietnam's Partnership for Market Readiness Project (2020) modelled scenarios involving a carbon tax of US\$10–30 per tCO₂ for fossil fuels and an ETS for the energy sector, but did not go into the feasibility of carbon pricing and only partly analyzed scenarios under Vietnam's NDC. A lack of information is an important constraint in ongoing carbon pricing discussions in Vietnam.

This paper is the first to investigate carbon pricing options in the Vietnamese context using both quantitative and qualitative analyses. We apply an *ex-ante* policy evaluation across environmental, economic, and social dimensions (de Ridder et al., 2007; Podhora et al., 2013; European Commission, 2020). The result of Best et al. (2020) that a €1 per tCO₂ of carbon price (in 2012 prices) on average reduces the annual emission growth rate by 0.3 percentage points is used to estimate the carbon price level that would be required to meet Vietnam's targeted emissions reductions under its updated NDC. Potential revenues from carbon pricing, effects on energy prices, and effects on non-GHG emissions will be estimated.

The modelling simulation is complemented by desk research and interviews with 15 Vietnamese experts from government agencies, academia, industry, and non-governmental organizations (Dorband et al., 2020; Dyarto and Setyawan, 2020). The information is used as an input to a broad multi-criteria analysis of carbon pricing options (Kumar et al., 2017) and to inform the discussion throughout the paper. Three policy options are investigated: a carbon tax; an ETS for the energy sector with permit auctions; and an ETS for the energy sector with free allowances. Voluntary emission reduction mechanisms are outside the scope of the study.

The paper is structured as follows. Section 2 reviews Vietnam's GHG emissions and related issues. Section 3 discusses methods. Section 4 introduces carbon pricing options. Section 5 assesses impacts of the options. Section 6 presents option ranking results. Section 7 concludes and discusses policy implications.

2. Vietnam's GHG emissions and related issues

2.1 GHG emissions

Vietnam's GHG emissions have been increasing quickly. The main contributor to the country's emissions is fossil fuel combustion, which accounted for about 60% of greenhouse gas emissions in 2014 (Government of Vietnam, 2019).³ CO₂ emissions from fossil fuel combustion reached 285.9 million tCO₂ in 2019 (BP, 2020). As of 2018, the electricity sector accounted for 48% of Vietnam's CO₂ emissions from fossil fuel combustion, industry for 28%, transport 16%, the residential sector 4%, the commercial sector 3%, and agriculture 1% (International Energy Agency, 2020a). In 2019 Vietnam was the world's 22nd largest CO₂ emitter from fuel combustion and the 3rd largest in the Association of Southeast Asian Nations (ASEAN), behind Indonesia (632 million tCO₂) and Thailand (302 million tCO₂). The average

³ Other contributors were industrial processes (14%), agriculture (32%), land use, land use change and forestry (LULUCF) (-13%), and waste (7%).

annual growth rate of Vietnam’s CO₂ emissions from fuel combustion over 2009–2019 was 10.8%, the fastest in ASEAN (BP, 2020). However, per capita CO₂ emissions from fuel combustion remained relatively low, at only 3.0 tons in 2019, below Thailand (4.3), Malaysia (7.7), and Singapore (38.4) (BP, 2020; World Bank, 2020a).

Table 1 presents Kaya (1989) decompositions of CO₂ emissions from fuel combustion. In 2017 the energy intensity of Vietnam’s economy (E/G) was 5.7 MJ per year-2010 US\$, above the world average of 5.2 or the energy intensities of Thailand (5.3), Malaysia (4.3), Indonesia (3.5), Singapore (3.3), or the Philippines (3.1). This reflects the high level of energy use associated with Vietnam’s industrialization and its heavy reliance on coal (typically used in processes with low thermal efficiency, such as the production of coal-fired power). It is also related to the fact that Vietnam’s GDP per capita remains quite low, as the energy intensity of the economy tends to decline as economies develop (Csereklyei et al., 2016). There are many opportunities for Vietnam to improve the efficiency of its energy use.

Table 1. Kaya identity decomposition for selected ASEAN countries, 2017

Variable:	CO ₂ emissions	Population	GDP per capita	Energy intensity of economy	CO ₂ intensity of energy
Abbreviation:	C	P	G/P	E/G	C/E
Unit:	million tons	million people	thousand year-2010 US\$ per person	MJ per year-2010 US\$	tons per GJ
Indonesia	496	264	11.0	3.5	0.049
Philippines	126	105	7.4	3.1	0.052
Vietnam	191	96	6.0	5.7	0.058
Thailand	244	69	16.0	5.3	0.042
Malaysia	211	32	26.3	4.3	0.059
Singapore	47	6	84.0	3.3	0.031
World	32,840	7,519	15.1	5.2	0.056

Note: Countries are sorted by population. CO₂ emissions are from fuel combustion. GDP is in purchasing power parity terms. $C = P * (G/P) * (E/G) * (C/E)$. Source: International Energy Agency (2020b).

Table 1 also shows that Vietnam has a high CO₂ intensity of energy (C/E). In 2017, this was 0.058 tons per GJ, while that of the Philippines was 0.051, Indonesia 0.049, Thailand 0.042, and Singapore 0.031. This primarily reflects heavy reliance on coal.

Vietnam has a tentative target of reducing the carbon intensity per unit of GDP (C/G) by 15% by 2030 relative to 2014 (Vietnam Ministry of Planning and Investment, 2021). For the energy sector, our focus in this paper, the trend in C/G has generally been increasing, although with year-to-year variation (Figure 1). A slight decline was recorded in 2020, a year in which the COVID-19 pandemic hit and additional solar power entered the grid.

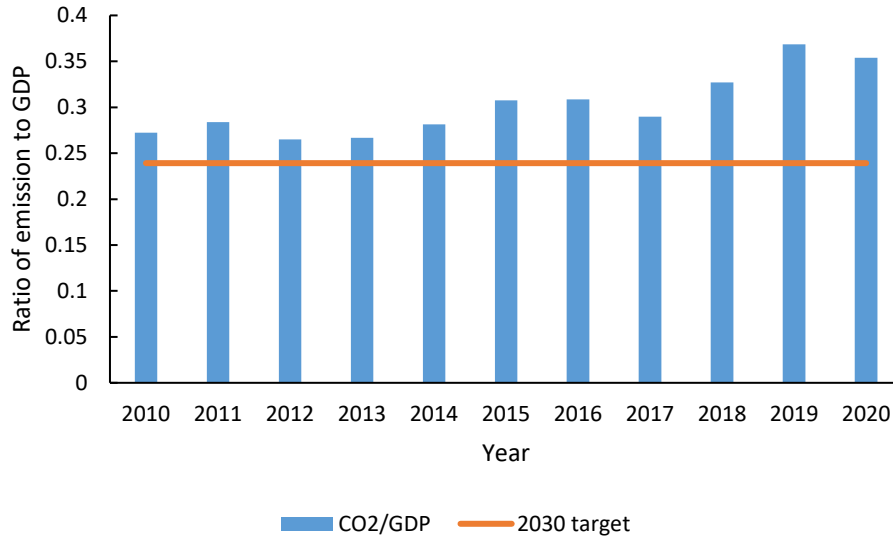


Figure 1. Vietnam’s emission intensity (energy sector) per unit of national GDP, 2010–2020

Note: Emissions are from fuel combustion and GDP is in purchasing power parity terms (constant 2017 international \$). The unit is tCO₂/thousand \$. The displayed target assumes that the emissions intensity target for the energy sector is the same as that for the entire economy. Sources: BP (2021); World Bank (2020a).

Vietnam had ASEAN’s fastest growth in coal consumption over 2009–2019, at an average rate of 16% per annum (BP, 2020). Emissions from coal equaled 150 million tCO₂ in 2018, accounting for about 66% of Vietnam’s total CO₂ emissions from fuel combustion (International Energy Agency, 2020a). Coal has become the largest contributor to the electricity mix for reasons including local coal endowments; efforts to keep the price of domestic coal below international market prices; subsidies for coal infrastructure; and lax environmental regulations (Do et al., 2020).

In 2016, the government expected that in 2030 coal and natural gas would account for 43% and 15% of electricity generation capacity respectively (Government of Vietnam, 2016). In the draft Power Development Plan 8 released in February 2021, the share of coal in electricity generation capacity in 2030 is now foreseen to be only 27% and the share of gas 21% (Vietnam Energy Institute, 2021). With large opportunities in solar and wind and also rapid ongoing adoption, Vietnam is likely to continue to experience an evolution in its expectations regarding the future composition of its electricity mix (EREA and DEA, 2019; International Renewable Energy Agency, 2019; Teske et al., 2019).

2.2 Climate change and local air pollution

Vietnam is highly vulnerable to impacts of climate change. Its average temperature increased by 0.6°C over 1958–2014, and in the absence of serious global mitigation efforts is projected to increase by 3–4°C by 2100 relative to the 1986–2005 level (Government of Vietnam, 2019).

Extreme weather events have intensified and become more frequent, with monsoonal flooding in the north and droughts in the south. Typhoons are causing severe damage. The sea level rose by up to 5.6 mm/year at Phu Quy monitoring station over 1993–2014, with a potential increase of up to 73 cm by 2100 in what is thought to be an upper-bound scenario. This, together with subsidence due to ground water extraction (Ingebritsen and Galloway, 2014), poses risks of inundation of the Red River Delta, the Mekong River Delta, and coastal areas, potentially leading to the displacement of millions of Vietnamese people. Kompas et al. (2018) estimated that the current global emission trajectory may cost Vietnam 0.8% of annual GDP by 2027, 1.6% by 2037, and 8% by 2100.

Combustion of fossil fuels also contributes to local air pollution.⁴ Vietnam was the 2nd-most air-polluted country in ASEAN in 2019, behind Indonesia. Hanoi was also among the top-10 most polluted capitals across 85 countries in 2019, with conditions worse than Beijing and Bangkok (IQAir, 2019). Exceeding the World Health Organization guidelines on outdoor air pollution is estimated to reduce life expectancy in Vietnam by about a year and cost the country about 5% of annual GDP (World Bank and Institute for Health Metrics and Evaluation, 2016; Energy Policy Institute at the University of Chicago, 2019). There were about 50,000 deaths related to air pollution in Vietnam in 2017 (Fuller et al., 2019).

2.3 Policy responses

The Government of Vietnam has issued various policies and regulations to address GHG emissions and climate change. These include the Central Committee of the Party's Resolution No. 24-NQ/TW in 2013 on a Pro-active Response to Climate Change (Vietnam Communist Party's Central Committee, 2013), the Law on Environmental Protection (Vietnam National Assembly, 2020), the National Climate Change Strategy (Government of Vietnam, 2011), and the National Green Growth Strategy (Government of Vietnam, 2012). In 2016, Vietnam signed the Paris Agreement on Climate Change and developed a National Action Plan on Implementing the Paris Agreement (Government of Vietnam, 2019). The Law on Energy Efficiency and Conservation 2010 and the Renewable Energy Development Strategy 2015 reinforce Vietnam's GHG emission reduction measures (EREA and DEA, 2019).

In 2020, Vietnam adjusted its NDC to commit to reduce GHG emissions by 9% or 27% in 2030 relative to business as usual (BAU) without and with international assistance, respectively

⁴ Other causes include residential biomass cooking, agricultural waste burning, construction, and ammoniac emissions from livestock farming and fertilizer applications (Amann et al., 2019).

(Government of Vietnam, 2020). However, the BAU trajectories associated with these targets involve a large increase in emissions.⁵ Under business-as-usual, Vietnam’s total annual GHG emissions are projected to increase from 528.4 million tCO₂e in 2020 to 927.9 million tCO₂e in 2030 (Government of Vietnam, 2020).

For the energy sector, Vietnam’s updated NDC targets are for emission reductions of 5.5% (unconditional) and 11.2% (conditional) relative to BAU – smaller proportional reductions relative to what is targeted for the economy as a whole. Because these targets are relative to BAU, absolute energy-sector emissions are also still likely to increase. Indeed, if no revisions are made to BAU emissions over coming years, Vietnam’s unconditional commitment is in effect to limit annual emissions from the energy sector to an 80% increase above the 2020 level. The BAU assumes that the average annual growth rate of GHG emissions from the energy sector is about 7% over the period 2020–2030 (Government of Vietnam, 2020).

In recent years Vietnam participated in a “Partnership for Market Readiness” project supported by the World Bank to study the potential introduction of market-based instruments to reduce GHG emissions. A GHG registry and a monitoring, reporting, and verification (MRV) system for the energy sector are being developed (Partnership for Market Readiness, 2020). Vietnam has also recently experienced a boom in installations of solar photovoltaic panels, with about 16.5GW of installed capacity by the end of 2020. This has been heavily incentivized by a generous feed-in tariff (Do and Burke, 2021).

Despite some positive steps, Vietnam’s climate policy framework remains thin and the country’s climate change mitigation targets remain unambitious. Vietnam’s GHG reduction commitments against BAU are less ambitious than for example those of Indonesia, which has committed to reduce GHGs by 29% and 41% by 2030 relative to BAU in unconditional and conditional scenarios respectively (Overland et al., 2021). Thailand’s targets are 20% and 25% below BAU by 2030. Vietnam has also yet to join the group of nations to pledge to achieve absolute emissions reductions or a net-zero emission economy.

Vietnam’s planned increases in emissions over coming years poses risks to the country’s socioeconomic development given the costs of air pollution and climate change. The country also risks emission lock-in given that fossil fuel infrastructure can be used for multiple decades. Vietnam may need to enhance its commitments to climate change mitigation to reap maximum

⁵ Vietnam’s BAU emissions for 2030 were increased by 140.5 million tCO₂e in the updated NDC in 2020. This is almost fully due to the inclusion of emissions from industrial processes for the first time.

benefits from free trade agreements such as the EU-Vietnam Free Trade Agreement (Climate Action Tracker, 2020).⁶ Exports may also face the risk of carbon border levies (Do, 2020b).

To date, regulations have been used as the main instrument for GHG emission reductions in Vietnam. Examples include vehicle emission standards, regulations for landfill gas management, a biofuel blending mandate, and energy efficiency and renewable energy targets (EREA and DEA, 2019). Ministries and provincial governments have been required to develop sectoral and provincial GHG emission reduction plans that set performance- and technology-based regulations to contribute to achieving the national emission reduction targets.

As a policy tool, emission regulations typically fail to provide adequate incentives for technological innovation (Harris and Roach, 2018); once industries have met the regulations, they do not have a strong incentive to further improve their performance. Regulations also tend to be cost-ineffective in that they often impose rigid requirements on emitters regardless of their abatement costs. The inability to generate public revenues also makes regulations a less attractive approach than the market-based instruments considered in this paper.

3. Methods

The paper uses an *ex-ante* assessment framework (de Ridder et al., 2007; Podhora et al., 2013) to evaluate three carbon pricing options for Vietnam: a carbon tax, an ETS for the energy sector with permit auctions, and an ETS for the energy sector with free allowances. These alternatives have been actively considered by the Government of Vietnam.

First, we analyze likely economic and environmental impacts of these options. We employ a simple reduced-form emission projection method using recent estimates of the effectiveness of emissions pricing from Best et al. (2020), who found for an international sample that an additional €1 per tCO₂ of carbon price (in 2012 prices) on average reduces the annual emission growth rate by 0.3 percentage points. This is a simpler approach than estimating effects of a carbon price on fuel prices and then fuel use (Stretton, 2020).

Inputs to our modeling include the GHG emission level in 2020; an assumed BAU emission growth rate for 2021–2030; Vietnam’s emission reduction targets for the energy sector; the Best et al. (2020) estimates of the effect of a carbon price on emissions; and an assumed 10% per annum real growth rate in the carbon price (as will be discussed further in section 5). The modelling outputs include the initial carbon price required to achieve the NDC; revenues

⁶ The World Bank (2020b) estimated that the EU-Vietnam Free Trade Agreement could increase Vietnam’s GDP and exports by 2.4% and 12% by 2030, respectively.

generated from carbon pricing (excluding the value added tax of 10% on the carbon price); changes in downstream energy prices; and changes in non-GHG pollutant emissions.

Our focus is the energy sector. Specifically, we use data on CO₂ emissions from fuel combustion from BP (2021). This dataset also provides data on fossil fuel use by fuel and has the advantage of being up-to-date, although it does not exactly align with domestic data on GHG emissions in the energy sector. The simulation assumes that other climate change and environmental policies are held constant. The results are approximate and indicative.

In calculating implications for individual energy prices and for local pollution emissions, we use an approach that uses Singapore National Environment Agency (2020) methods for calculating GHG emissions from the combustion of specific fossil fuels (Appendix A) and non-GHG pollutant emission factors from the European Environment Agency (2019) (Appendix B). Secondary data were also drawn from published and unpublished sources in English and Vietnamese. Statistical sources include BP, the International Energy Agency, World Bank, and Vietnamese government reports. The overall steps for the simulation method are outlined in Appendix C.

Our paper also uses information from semi-structured interviews to gain insights into expected impacts of carbon pricing models. 15 Vietnamese policy experts were interviewed from: government agencies (4), academia (4), industry (4), and nongovernmental organizations (3) (Dorband et al., 2020; Dyarto and Setyawan, 2020). The interviewees were randomly selected from a list of about 100 experts administered by the Ministry of Natural Resources and Environment. Interviews were conducted in Vietnamese during September 2020–January 2021. Interviewees were asked about their expectations regarding the economic, environmental, and social impacts of carbon pricing. Questions were also asked on political viability and administrative feasibility (Appendix D). The personal and institutional details of interviewees remain confidential.

Several measures were taken to control for potential hypothetical biases of interview responses. The questionnaire was sent to respondents several days before the interviews to give them time to think about the issue (Do and Bennett, 2010). An introduction of carbon pricing options was included in the questionnaire to familiarize respondents with the topic. The questionnaire also included a reminder about the hypothetical nature of the options and urged the respondents to think carefully before answering (Cummings and Taylor, 1999). Only points mentioned by

over 50% of the respondents and supported by secondary sources including grey literature and news articles were brought forward for further analysis (Dorband et al., 2020).

The simulation and expert consultation were complemented by desk research. A summary of the overall impact assessment framework is presented in Table 2.

Table 2. Framework for impact assessment of carbon pricing

Assessment method	Impact assessment				
	Economic impacts	Environmental Effectiveness	Social impacts	Administrative feasibility	Political viability
Simulations	x	x			
Expert interviews	x	x	x	x	x
Desk research	x	x	x	x	x

Finally, we used the information gained from the interviews and other methods to rank the options in a multi-criteria analysis (Kumar et al., 2017). The adopted criteria are economic impacts, environmental effectiveness, social impacts, administrative feasibility, and political viability (European Commission, 2020; Klenert et al., 2018; Richter and Mundaca, 2015). Definitions of these concepts are as follows:

- *Economic impacts*: The extent to which the proposed policy improves economic welfare via measures such as public revenue generation.
- *Environmental effectiveness*: The extent to which intended objectives of emission reductions are met.
- *Social impacts*: The extent to which the proposed policy improves social harmony.
- *Political viability*: The extent to which the proposed policy is accepted by policymakers, businesses, and the community.
- *Administrative feasibility*: The extent to which operational procedures are easily developed and implemented.

Each of the assessed criteria received scores of one (1) for a positive evaluation, minus one (–1) for a negative evaluation, and zero (0) for a neutral evaluation. The scores were summed, with the total able to range from minus five (–5) to plus five (5). The preferred option is identified by the highest score. We then shared the results with the experts via follow-up emails and asked their views. They were given the options of “agree”, “disagree”, and “unsure”. The consultations ensured policy relevance of the research.

4. Carbon pricing options examined in this study

4.1 Option 1: Carbon tax for fossil fuels

Under this option, a carbon tax would be applied to coal, liquid fuels, and natural gas. To facilitate low-cost collection, the tax could be applied upstream (Stretton, 2020), meaning at about 150 coal mining companies, petroleum extraction sites, natural gas extraction sites, plus import terminals. Such a tax could be introduced by revising the tax rates under the current environmental protection tax (Michaelowa, 2018).⁷ Under this tax, anthracite (hard coal) and liquid fuel (motor gasoline) are already taxed at VND30,000 (US\$1.29) per ton and VND4,000 (US\$0.17) per liter respectively. The tax rate for diesel oil is VND2,000 (US\$0.09) per liter. Tax rates are not currently a function of the carbon contents of the fuels, and natural gas is not currently subject to the environmental protection tax.

4.2 Option 2: ETS for the energy sector

Like a carbon tax, an ETS could be applied upstream, focusing on about 150 coal, oil, and gas producers plus importers. Based on projected emissions levels and the reduction targets, an emission cap could be determined, setting the total emission limit over each period. The emitters could trade their permits or bank them for future use.

Coverage beyond the energy sector would help to lower abatement costs (Nong et al., 2020). However, poor systems for emissions MRV in some sectors make this infeasible at this stage (Wang et al., 2018). As in other countries, Vietnam's emissions MRV systems are particularly underdeveloped for agricultural and land-sector emitters. To minimize transaction costs (Wang et al., 2018), carbon pricing is thus initially recommended to focus on fossil fuels. In future phases, emitters from the waste, cement, and other sectors could be incorporated into the scheme if MRV systems allow.

There are two key possible approaches that will be examined:

- *Option 2a*: Emission permits could be sold via auctions.
- *Option 2b*: Emission permits could be distributed to individual emitters based on some combination of past emissions, past output, and/or performance standards.

⁷ An alternative is for the carbon tax to be introduced via a new law.

5. Impact assessments

5.1 Initial carbon price level and revenue effects

Our simulation model suggests that a carbon tax of about VND43,068 (US\$1.85) per tCO₂ on fossil fuels starting from 2022 and increasing at a real rate of 10% per year has the potential to reduce year-2030 emissions from fossil fuel combustion by about 5.5% relative to BAU (Table 3). This would be consistent with achieving Vietnam’s unconditional NDC target for the energy sector. The tax could generate about US\$10.9 billion of revenue over 2022–2030 (in year-2022 prices), thus making an important contribution to the state budget, which would benefit from additional funds in the post COVID-19 setting. A tax rate that starts at VND89,861 (US\$3.86) per tCO₂ and increases at a real 10% per annum is estimated to reduce emissions by about 11.2% relative to BAU in 2030, in line with the conditional NDC target for the energy sector (Figure 2). This could generate cumulative revenue of about US\$21.9 billion by 2030 in year-2022 prices.

The interviewees generally believe that a carbon price that starts at a low level and increases at about 10% per year would be feasible provided that communication on carbon pricing is conducted effectively. The issue of political acceptability is further discussed in section 5.6. A slower real rate of increase would mean that a higher initial price is required to achieve the same mitigation effect.

Table 3. Estimated impact of a carbon tax on GHG emissions and public revenues, Vietnam

	Carbon tax rate (US\$/tCO ₂ , 2022 dollars), starting from 2022, increasing by 10% per year in real terms	
	1.85	3.86
GHG emission reduction relative to BAU in 2030 (%)	5.5	11.2
Aggregate revenues by 2030 (US\$ billion)	10.9	21.9

Note: Emissions are from fuel combustion. Assumptions: the BAU emission growth rate is 7% per annum over 2021–2030, and a carbon price of €1 (in 2012 terms) per tCO₂ reduces the annual emission growth rate by 0.3 percentage points (Best et al., 2020). Exchange rate: €1=US\$1.13. Carbon tax revenue is aggregated over 2022–2030 and excludes revenues from value added tax. An estimated average inflation rate of 1% per annum over 2012–2022 was used to convert euros from 2012 to 2022 terms (IMF, 2020). Year-2022 prices are used. Data are from BP (2021).

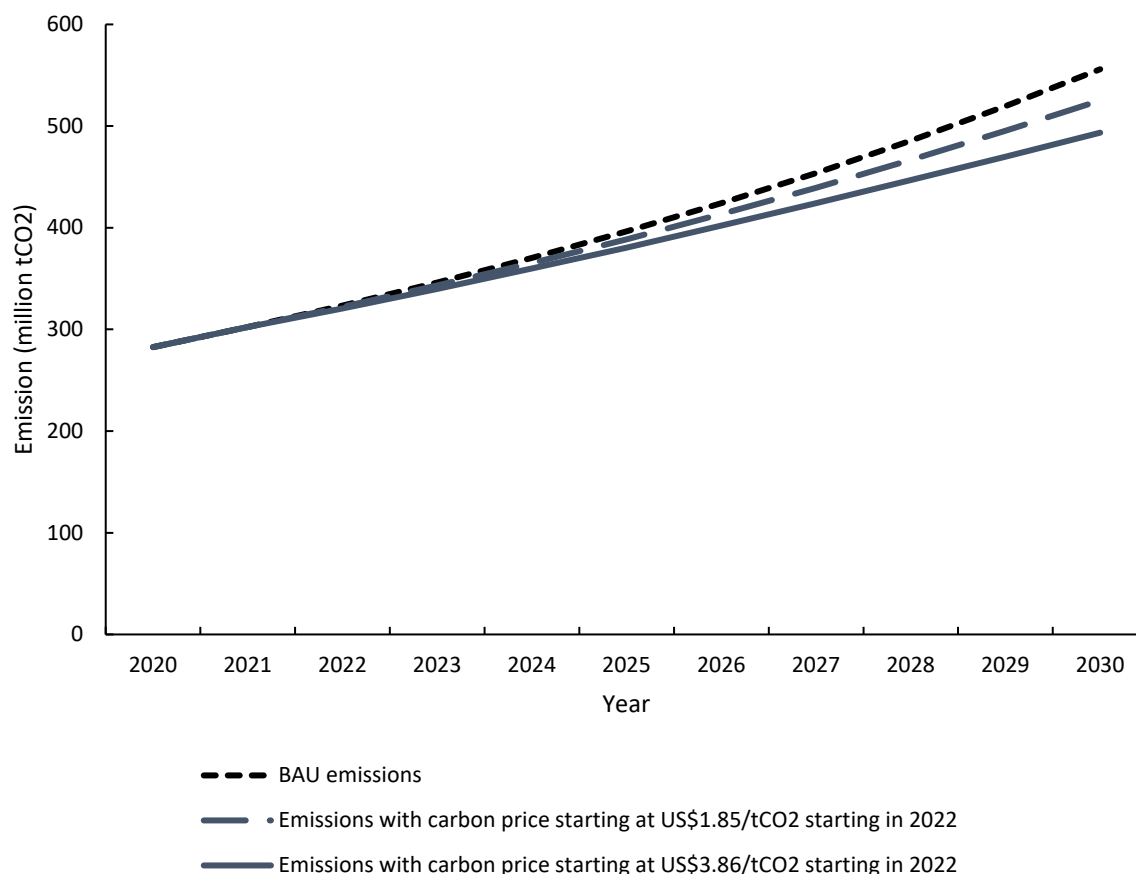


Figure 2. Projected CO₂ emissions from fuel combustion with and without a carbon price.

Note: The carbon price is assumed to increase at 10% per annum in real terms. The BAU pathway uses a 7% per annum growth rate as under Vietnam's updated NDC. Emissions coverage is that of BP (2021). Energy-sector emissions under Vietnam's updated NDC are measured more broadly, including all greenhouse gas emissions in the energy sector.

5.2 Other economic effects

5.2.1 Effects on energy prices

Applying a carbon tax of only US\$1.85 per tCO₂ would have relatively insignificant initial implications for fuel prices (Table 4). The tax on anthracite coal would increase by about VND111,750 (US\$4.9) per ton (about a 3.3% increase in the after-tax price), motor gasoline by VND100 (US\$0.004) per liter (0.7% increase in after-tax price), and diesel oil by VND116 (US\$0.005) per liter (a 1% increase in after-tax price) in the year of scheme implementation. The approach would involve a new tax on natural gas of about VND116,081 (US\$4.9) per ton. This means about a 0.4% increase in the after-tax natural gas price in the initial year. These estimates assume 100% incidence for consumers and may be an overestimate given that some incidence may be borne by producers (Wang and Zhou, 2017). Effects would increase over time as the real carbon price increases.

Table 4. Estimated impact of a carbon tax of US\$1.85 per tCO₂ on after-tax fuel prices

	Calculation unit	Current environmental tax rate (in USD)	Current environmental tax rate (in VND)	New carbon tax rate (in USD)	New carbon tax rate (in VND)	% change in after-tax price due to carbon tax
Anthracite	ton	1.29	30,000	4.879	113,596	3.3
Lignite	ton	0.64	15,000	2.234	52,013	1.8
Bituminous coal	ton	0.64	15,000	4.538	105,655	3.3
Brown coal	ton	0.64	15,000	3.752	85,939	3.4
Aviation gasoline	liter	0.13	3,000	0.004	101	0.1
Diesel oil	liter	0.09	2,000	0.005	116	1.0
Kerosene	liter	0.04	1,000	0.005	110	1.1
Lubricants	liter	0.09	2,000	0.006	146	0.2
Motor gasoline	liter	0.17	4,000	0.004	100	0.7
Residual fuel oil	liter	0.09	2,000	0.006	134	1.2
Natural gas	ton	0.00	0	4.905	116,081	0.4

Note: Assumed exchange rate US\$1=VND23,280. Fuel prices were as of 7/2020. The current environmental tax was for 2020. Data from Vietnam National Assembly (2018); Singapore National Environment Agency (2020); local sources.

The required carbon tax to achieve the same emission reduction percentages as Vietnam's unconditional NDC is unlikely to significantly affect electricity tariffs. It is estimated that a tax of US\$1.85 per tCO₂ would place upward pressure on electricity generation costs of about 1% in the initial year. This is due to the increases of 3.3%, 1%, and 0.4% in the downstream prices of anthracite, diesel oil, and natural gas mentioned above (Table 4). The assumptions are that fuel costs account for 59% of the electricity generation costs (GreenID, 2021) and that the shares of coal, natural gas, and diesel oil in the electricity mix are 51%, 15%, and 0.5% respectively as in 2018 (BP, 2021). As electricity generation costs account for about 80% of retail electricity tariffs in Vietnam (Electricity Regulatory Authority of Vietnam, 2021), the carbon tax would result in only about a 0.8% increase in retail electricity tariffs in the initial year if cost-price pass through were to occur.

The effect on electricity generation costs is small relative to the usual fluctuations of electricity generation costs due to changes in fuel costs. For example, the Australian Newcastle steam coal price increased by about 7% over the twelve months from December 2019, from US\$64 to US\$68.7 per ton (International Energy Agency, 2021a). During the same period, the Asian spot natural gas price increased by 100%, while the world average diesel oil price decreased by 18%, from US\$1.1 per liter to US\$0.9 per liter (International Energy Agency, 2021b,2021c). These types of fuel price changes would result in about a 20% increase in electricity generation costs or a 16% increase in retail tariffs in Vietnam if price pass-through existed. Relatively

insignificant impacts of carbon pricing on final energy prices have also been found in previous studies (Audinet et al., 2016; Michaelowa, 2018; Neeffjes, 2018).

The effect of a carbon price on energy prices and emissions is expected to be roughly the same under a carbon tax or ETS (Best et al, 2020). Thus, on an *ex-post* basis, the carbon price determined in the ETS would be the same as the required tax to achieve the same emissions level.

5.2.2 Macroeconomic impacts

Economic impacts were the interviewees' top concern, an introduction of a low carbon price was generally believed to be unlikely to cause significant negative impacts on Vietnam's economy. This is supported by empirical evidence that carbon taxes have not had a negative effect on GDP growth in Europe, even at rates of over \$20 per tCO₂ (Metcalf and Stock, 2020). Earlier simulation modelling for Vietnam indicated that carbon pricing that aims at an 8% emission reduction relative to BAU in 2030 may reduce fuel expenditure by 6.9%, with no significant negative impact on the economy as a whole (Vietnam's Partnership for Market Readiness Project, 2020). The shares of coal, oil, and natural gas rents in Vietnam's GDP were only 0.4%, 1.6%, and 0.6% respectively as of 2018, so fossil fuel extraction is not a large share of the economy (World Bank, 2020a).

Carbon pricing is unlikely to affect business competitiveness and investment. Most Vietnamese firms could cope with gradual increases in energy costs of 5–10% per year and offset those through energy savings and price pass-through (Neeffjes, 2018). The increase in energy prices due to carbon pricing is unlikely to substantially hinder foreign investors, as they tend to be more concerned about issues such as infrastructure availability and the stability of electricity supply (Neeffjes, 2018). Carbon pricing will generate revenue that could be used to boost Vietnam's competitiveness via infrastructure and other investments.

A question arises about emissions-intensive, trade-exposed industries such as steel manufacturing (Narassimhan et al., 2017). To protect their competitiveness, one option in an ETS is for some emission allowances to be freely allocated to enterprises in such industries. In the case of a carbon tax, the industries could be exempt from the tax until certain threshold level of emissions (Pezzey and Jotzo, 2013). However, many of Vietnam's trading partners will already have a carbon price and/or emission regulations in place, including China, the EU, Japan, and South Korea. Given that Vietnam's carbon price is likely to be low, the simplest approach would be to not provide free permits or tax-free thresholds to these industries. This

would also help make the case that Vietnam should be exempt from any carbon border adjustments imposed by other countries.

It is widely believed that carbon pricing could stimulate green growth by incentivizing investments in energy efficiency and renewable energy such as solar and wind. Vietnam has the potential to achieve over 90% penetration of domestic solar and wind power plus off-river pumped hydro energy storage in its electricity mix, with a levelized cost of electricity of US\$63–85/MWh based on 2020 technology costs (Lu et al. 2021). Carbon pricing would also spur the development of low-carbon industries and the adoption of electric vehicles (Neefjes, 2018). Nevertheless, the interviewees held that the transition pace would mostly depend on other energy policies such as the National Power Development Plan for 2021–2030 to be issued in 2021 rather than carbon pricing.

5.3 Environmental impacts

All three options received positive evaluations from interviewees in terms of environmental impacts. Benefits from Vietnam’s contribution to global efforts to slow climate change would include fewer droughts in the south and fewer incidents of flooding in the north and center of the country, improved water availability for rice cultivation and fishery for the Mekong Delta, and reduced risks associated with sea level rise.

There would also be sizeable benefits from improved local air quality. A simulation shows that a carbon price of US\$1.85 per tCO₂ in 2022, rising to US\$3.97 in 2030 (in year-2022 prices), could potentially reduce cumulative emissions of non-CO₂ air pollutant emissions by about 2.9% over the period 2022–2030. This is equivalent to an average reduction of 43Kt annually of emissions of total suspended particles (TSP), 39Kt of PM₁₀, 39Kt of PM_{2.5}, 26Kt of NO_x, 90Kt of SO_x, 442Kt of CO, and 47Kt of non-methane volatile organic compounds (NMVOC) (Table 5).⁸ Improved air quality would result in improved human health, increased crop productivity, reduced building and infrastructure damage, and increased tourism.⁹ Additional measures such as strengthened enforcement of emission regulations may be needed to address local air pollution problems in large cities.

⁸ These reductions are considerable. For example, the average annual reductions in TSP and SO_x emissions are about 5 and 7 times the year-2017 TSP and SO_x emissions in Ho Chi Minh City respectively (Ho et al., 2020).

⁹ Co-benefits from GHG reductions in Vietnam have previously been estimated at about US\$21 per tCO₂ (Do, 2014).

Table 5. Estimated average reductions in annual emissions of pollutants other than CO₂ due to a carbon price, Vietnam, 2022–2030.

Pollutant (Kt)	Carbon price of US\$1.85 per tCO ₂ in 2022, rising to US\$3.97 in 2030	Carbon price of US\$3.86 per tCO ₂ in 2022, rising to US\$8.27 in 2030
TSP	43	89
PM ₁₀	39	81
PM _{2.5}	39	79
NO _x	26	52
SO _x	90	185
CO	442	905
NMVOC	47	96

Assumptions: All fuels reduce as the same proportional rate because of carbon pricing. Fuel mix data as of 2018 (International Energy Agency, 2020a). Non-GHG emission coefficients from the European Environment Agency (2019). GHG emission coefficients from Singapore National Environment Agency (2020).

A key issue for a rapidly developing economy such as Vietnam is that future emissions demand is highly uncertain. A carbon tax and an ETS may thus differ substantially in terms of their final emissions outcomes. An ETS provides more certainty over the upper bound of emissions, as emissions are capped. However, the risk is that the cap would be set loosely, especially given Vietnam’s generous BAU emissions trajectory. A carbon tax delivers less certainty that Vietnam would meet its NDC target, but certainty over the emissions price. Certainty about the emission quantity appears to be more of a priority in the eyes of Vietnamese policymakers.

5.4 Social impacts

Social impacts associated with increasing energy prices due to carbon prices will likely not be highly significant. Indeed, a carbon price of as high as US\$30 per tCO₂ was found to have progressive distributional effects in countries with GDP PPP per capita below US\$15,000 per year in a study by Dorband et al. (2019). Vietnam’s GDP per capita, PPP, was US\$8,374 in 2019 (World Bank, 2020a). As discussed in Section 5.2.1, a carbon price of US\$1.85 per tCO₂ will cause small increases in the prices of two common fuels consumed by the low-income households of gasoline and kerosene of only 0.7% and 1.1% respectively in the initial year. While electricity retail price pass-through would be ideal from an environmental point of view, the cross-subsidy and block-tariff pricing approaches in Vietnam mean that price pass-through could be focused on high income households to help ensure progressive distributional effects (Neefjes, 2018).

Our interviewees assessed that by improving environmental conditions, carbon pricing would help to reduce social pressures in Vietnam, where concern over pollution is mounting. Climate change mitigation efforts (including carbon pricing) may even lead to increased employment in the short-term, with jobs created in the renewable energy sector exceeding the jobs lost in the fossil fuel sector (Audinet et al., 2016; Neefjes, 2018). The EU ETS was found to have an insignificant net impact on employment in Europe (Metcalf and Stock, 2020). Further studies on the likely effects of carbon pricing and clean energy development on local employment in Vietnam would provide additional insights.

With no generation of public revenues, Option 2b was assessed as being less advantageous from a social point of view, as funds would not be available for other purposes. Our interviewees suggested that earmarking funds for investments such as electricity transmission grids and electric public transport would likely win greater acceptability than income tax reductions and direct transfers. This is because income tax reductions often benefit high-income groups and there are issues associated with direct transfers reaching the lowest-income citizens in Vietnam, as seen in the case of spending in response to COVID-19 (Tuoi Tre, 2020).

5.5 Administrative feasibility

The experts agreed that, if introduced, a carbon tax would be simpler to administer than an ETS given that it does not involve permit trading or allocations and could simply involve an increase in existing environmental protection taxes for fossil fuels. A carbon tax would fit within Vietnam's revenue-collection architecture given that it could be collected under the General Department of Taxation's systems. However, a carbon tax would need to be initiated by the Ministry of Finance, an agency that is yet to strongly prioritize climate change mitigation.

Having been legalized in the revised Law on Environmental Protection, an ETS would be developed by the Ministry of Natural Resources and Environment, an agency that has more active interest in the issue. However, it is likely that it will still take years to establish Vietnam's ETS, as was the case in China (Jotzo et al. 2018). Lessons could be learned from China's scheme, which covers entities that emitted 26,000 tons of CO₂ in any year during the period 2013–2019. Enterprises from across the electricity sector, major refineries, and manufacturing facilities with captive power plants (including steelmakers) are participating in China's scheme (Upstreamonline, 2021).

An ETS requires careful design of an emission permit trading market. This potentially includes mechanisms to address price predictability and cost containment, to determine optimal temporal flexibility, and to ensure oversight of market integrity (Partnership for Market Readiness and International Carbon Action Partnership, 2016). Imposing a price floor is one option to address overly low carbon prices due to allowance over-allocation, a common problem experienced in other ETSs (Narassimhan et al., 2017) and a large risk in Vietnam given the likelihood that a generous cap would be set. A carbon tax could also be introduced simultaneously to ensure a minimum carbon price is retained. The government could also intervene by buying excess permits. To deal with permit shortages, a market stability reserve could be established as in the EU ETS (Narassimhan et al., 2017). A ceiling price could also potentially be imposed.

Vietnam's ETS will likely be subject to a high level of market concentration and the potential for strategic behavior in permit sale and purchase decisions, as seen in the pilot ETSs in China (Zhu et al., 2020). State-owned utility EVN may also not fully pursue the lowest-cost emissions reductions given that it may seek to protect its fossil fuel generation assets (Lee and Gerner, 2020). However Vietnam is concurrently pursuing a move to a competitive wholesale electricity generation market with separation from EVN (Lee and Gerner, 2020), so concerns over these issues are likely to decrease over time.

Altogether, an ETS involves greater administrative burdens than a carbon tax, particularly given that this would be Vietnam's first time to introduce an ETS. Option 2b is administratively more complex than Option 2a given that it involves allocating emission allowances.

5.6 Political viability

Our interviewees emphasized that communicating the benefits of carbon pricing is essential for gaining political and social support. The experts believed that Option 1 would be more difficult from a political point of view as it involves the word "tax". This is likely the case even if tax-free thresholds are used (Pezzey and Jotzo, 2013). Political unpopularity has also been a key barrier to carbon taxes in other ASEAN countries such as Indonesia (Dyarto and Setyawan, 2020). Carbon pricing labelling matters (Klenert et al., 2018), and "ETS" was assessed as the preferred term as in Vietnamese "ETS" sounds like routine commodity market transactions rather than a new impost. An ETS with free permits was assessed as being the most politically viable, as concentrated opposition from enterprises would be reduced (Richter and Mundaca, 2015; Skovgaard et al., 2019). Therefore, Option 2b was rated as the most politically viable.

A phased approach for any ETS was assessed as being suitable from a political point of view and to ensure the long-term success of the policy. China employed a phased approach to develop the national ETS based on eight years of piloting in seven provinces. This approach would involve starting with a modest emission cap and therefore a relatively low carbon price to minimize potential negative effects on productivity and on low-income groups (Bataille et al., 2018). A gradual and iterative tightening of the cap could occur, with the aim of moving to a net-zero emission level in line with the Paris Agreement’s goal of stabilizing the global climate. A phased approach would give time for government agencies to build technical and institutional capacity and for businesses and others to adapt.

6. Option ranking

Results from option ranking based on the interviews and analysis are presented in Table 6. The option rankings received near consensus support among the interviewed experts in the post-interview follow-ups, with 13 of the 15 experts agreeing with the result and two being unsure. Options 1 and 2a were ranked equal first, indicating the same overall assessed impacts on a multi-criteria basis. Option 1 was ranked as being more administratively feasible, while Option 2a was thought to be more politically viable. Option 2b was ranked below the others because of its greater administrative complexity and its lack of revenue raising.

Table 6. Multi-criteria analysis of carbon pricing options.

	Option 1: Carbon tax	Option 2a: ETS for the energy sector, auctions	Option 2b: ETS for the energy sector, free allowances
Economic impacts	0	0	0
Environmental effectiveness	1	1	1
Social impacts	1	1	0
Administrative feasibility	1	0	-1
Political viability	-1	0	1
Total score	2	2	1
Overall ranking	1 st	1 st	2 nd

Note: Scores of 1 and -1 indicate positive and negative evaluations respectively. A zero (0) score indicates a neutral evaluation.

7. Conclusions and policy implications

This paper is the first to investigate carbon pricing options in Vietnam using both quantitative and qualitative analysis while focusing on meeting the country’s updated NDC. Suitable carbon price levels for meeting the country’s emission reduction target were calculated using carbon price-emission reduction parameters from the extant literature. A multi-criteria analysis was informed by interviews with key stakeholders.

The paper concludes that even a relatively low initial carbon price ranging from US\$1.85 to US\$3.86/tCO₂, starting from 2022 with a real annual increase of 10%, would be capable of making a key contribution to the achievement of Vietnam's updated NDC and to reducing greenhouse gas and local air pollution emissions. Sizeable negative economic and social impacts are unlikely, as effects of the low initial carbon price on final energy prices would mostly be minimal. Even after ten years of carbon price growth at 10% per annum, the rates would remain quite low at about US\$3.97–8.27/tCO₂. This is well below the prices prevailing in some other economies such as South Korea.

The multi-criteria analysis in this paper suggests that a carbon tax would be highly suitable if deemed politically viable and that an ETS is an attractive option in Vietnam's context due to higher perceived political viability. However, if the ETS emissions cap is set too loosely, the ETS will be ineffective, particularly under the high BAU emissions trajectory stated in the NDC. It is possible to have both an ETS and a carbon tax at the same time. The benefit of doing so is reduced uncertainty over revenue collections and emissions levels, as the carbon tax would function as an effective price floor.

Careful design and effective communication on impacts are important for carbon price schemes. The interviews revealed that a gradual introduction starting with a modest carbon price and efforts to raise awareness are likely to be crucial in Vietnam's context. Improving capacity in monitoring and enforcement is also needed. Other important issues include scheme coverage, ETS allowance allocation mechanisms, price stability mechanisms, and the treatment of emissions-intensive trade-exposed industries. Public revenues could also be invested in much-needed infrastructure such as transmission lines to connect to renewable energy zones.

The COVID-19 recovery period appears to be an ideal time for Vietnam to implement carbon pricing to put the country on a more sustainable development path. Vietnam would also benefit from complementary policies in the form of fossil fuel subsidy reforms, renewable energy development and storage, energy efficiency, and transport electrification (Bataille et al., 2018; Rosenbloom et al., 2020). Investments in the electricity transmission grid are also important to facilitate uptake of solar and wind power (Do and Burke, 2021). Continued progress in the development of a competitive wholesale electricity market would also be helpful to ensure that low-carbon generation sources are genuinely prioritized in the dispatch order. An additional priority for Vietnam is to consider reducing its BAU emissions trajectory or setting a target

that involves absolute emissions reductions. Otherwise, local air pollution problems would continue to grow – as would Vietnam’s contribution to climate change.

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References

- Aldy, J.E., Stavins, R.N., 2012. The Promise and Problems of Pricing Carbon: Theory and Experience. *J. Environ. Dev.* 21, 152–180. <https://doi.org/10.1177/1070496512442508>
- Amann, M., Klimont, Z., Ha, T.A., Rafaj, P., Kiesewetter, G., Gómez-Sanabria, A., Nguyen, B., Thu, T.N.T., Thuy, K., Schöpp, W., Borken-Kleefeld, J., Hoglund-Isaksson, L., Wagner, F., Sander, R., Heyes, C., Cofala, J., Trung, N.Q., Dat, N.T., Tung, N.N., 2019. Future air quality in Ha Noi and northern Vietnam, International Institute for Applied Systems Analysis and Vietnam Academy of Science and Technology, Laxenburg, Austria.
- Audinet, P., Singh, B., Kexel, D.T., Suphachalasai, S., Makumbe, P., Mayer, K., 2016. Exploring a Low-Carbon Development Path for Vietnam, Exploring a Low-Carbon Development Path for Vietnam. World Bank, Washington DC. <https://doi.org/10.1596/978-1-4648-0719-0>
- Bataille, C., Guivarch, C., Hallegatte, S., Rogelj, J., Waisman, H., 2018. Carbon prices across countries. *Nat. Clim. Chang.* 8, 648–650. <https://doi.org/10.1038/s41558-018-0239-1>
- Best, R., Burke, P.J., 2020. Energy mix persistence and the effect of carbon pricing. *Aust. J. Agric. Resour. Econ.* 59, 1–20. <https://doi.org/10.1111/1467-8489.12370>
- Best, R., Burke, P.J., 2018. Adoption of solar and wind energy: The roles of carbon pricing and aggregate policy support. *Energy Policy* 118, 404–417. <https://doi.org/10.1016/j.enpol.2018.03.050>
- Best, R., Burke, P.J., Jotzo, F., 2020. Carbon pricing efficacy: Cross-country evidence. *Environ. Resour. Econ.* 77, 69–94. <https://doi.org/10.1007/s10640-020-00436-x>
- Lu, B., Blakers, A., Stocks, M., Do, T.N., 2021. Low-cost, low-emission 100% renewable electricity in Southeast Asia supported by pumped hydro storage. *Energy* 236, 121387 <https://doi.org/10.1016/j.energy.2021.121387>
- BP, 2021. BP Statistical Review of World Energy [WWW Document]. URL <http://www.bp.com/statisticalreview> (accessed 6.5.21).
- Burke, P.J., 2014. Green pricing in the Asia Pacific: an idea whose time has come? *Asia Pacific Policy Stud.* 1, 561–575. <https://doi.org/10.1002/app5.39>
- Climate Action Tracker, 2020. Vietnam - Country Summary [WWW Document]. URL <https://climateactiontracker.org/countries/vietnam/> (accessed 5.30.20).
- Csereklyei, Z., Rubio-Varas, M.M., Stern, D.I., 2016. Energy and economic growth: The stylized facts. *Energy J.* 37, 223–255. <https://doi.org/10.5547/01956574.37.2.zcse>
- Cummings, L.G., Taylor, L.O., 1999. Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *The American Economic Review* 89(3):649-665.
- de Ridder, W., Turnpenny, J., Nilsson, M., Von Raggamby, A., 2007. A framework for tool selection and use in integrated assessment for sustainable development. *J. Environ. Assess. Policy Manag.* 9, 423–441. <https://doi.org/10.1142/S1464333207002883>
- Do, T.N., 2020a. Vietnam pioneers post pandemic carbon pricing [WWW Document]. East

- Asia Forum. URL <https://www.eastasiaforum.org/author/thang-nam-do/> (accessed 12.11.20).
- Do, T.N., 2020b. Vietnam's environmental challenges risk EU free trade [WWW Document]. East Asia Forum. URL <https://www.eastasiaforum.org/2020/07/06/vietnams-environmental-challenges-risk-eu-free-trade/> (accessed 6.28.20).
- Do, T.N., 2014. Cobenefits of climate change mitigation measures (in Vietnamese). *Sci. Tech. Hydro- Meteorol. J. (in Vietnamese)* 643.
- Do, T.N., Bennett, J., 2010. Using choice experiments to estimate wetland values in Viet Nam: implementation and practical issues, in: Bennett, Jeff, Birol, E. (Eds.), *Choice Experiments in Developing Countries: Implementation, Challenges and Policy Implications*. Edward Elgar Publishing, Cheltenham, pp. 33–49.
- Do, T.N., Burke, P., Nguyen, N.H., Overland, I., Suryadi, B., Swandaru, A., Yurnaidi, Z., 2021. Vietnam's solar and wind power success: Policy implications for the other ASEAN countries. *Energy for Sustainable Development* 65, 1-11.
- Do, T.N., Burke, P.J., Baldwin, K.G.H., Nguyen, C.T., 2020. Underlying drivers and barriers for solar photovoltaics diffusion: The case of Vietnam. *Energy Policy* 144. <https://doi.org/10.1016/j.enpol.2020.111561>
- Dorband, I.I., Jakob, M., Kalkuhl, M., Steckel, J.C., 2019. Poverty and distributional effects of carbon pricing in low- and middle-income countries – A global comparative analysis. *World Dev.* 115, 246–257. <https://doi.org/10.1016/j.worlddev.2018.11.015>
- Dorband, I.I., Jakob, M., Steckel, J.C., 2020. Unraveling the political economy of coal: Insights from Vietnam. *Energy Policy* 147, 111860. <https://doi.org/10.1016/j.enpol.2020.111860>
- Dyarto, R., Setyawan, D., 2020. Understanding the political challenges of introducing a carbon tax in Indonesia. *Int. J. Environ. Sci. Technol.* <https://doi.org/10.1007/s13762-020-02925-4>
- Energy Policy Institute at the University of Chicago, 2020. Air Quality Life Index [WWW Document]. URL <https://aqli.epic.uchicago.edu/the-index/> (accessed 2.27.20).
- Electricity Regulatory Authority of Vietnam, 2021. About results of inspection of EVN's financial report 2019 (in Vietnamese) [WWW Document]. URL <http://www.erav.vn/d4/news/Ve-cong-bo-ket-qua-kiem-tra-chi-phi-san-xuat-kinh-doanh-dien-nam-2019-cua-Tap-doan-Dien-luc-Viet-Nam-1-722.aspx> (accessed 8.28.21).
- EREA and DEA, 2019. Vietnam Energy Outlook Report 2019. Hanoi.
- European Commission, 2020. Impact Assessment Guideline [WWW Document]. Better Regul. Guidel. toolbox. URL <https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines-impact-assessment.pdf> (accessed 8.1.20).
- European Environment Agency, 2019. EMEP/EEA air pollutant emission inventory guidebook 2019, Society. Luxembourg.
- Fuller, R., Sandilya, K., Hanrahan, D., 2019. Pollution and Health Metrics: Global, Regional, and Country Analysis. New York and Geneva. <https://doi.org/10.2307/3958682>
- Government of Vietnam, 2021. Draft government decree on GHG emissions mitigation and

- ozone layer protection (in Vietnamese) [WWW Document]. URL http://chinhphu.vn/portal/page/portal/chinhphu/congdan/DuThaoVanBan?_piref135_27935_135_27927_27927.mode=reply&_piref135_27935_135_27927_27927.id=4308 (accessed 7.21.21).
- Government of Vietnam, 2020. Updated Nationally Determined Contribution. Hanoi.
- Government of Vietnam, 2019. The Third National Communication to the UNFCCC. Hanoi.
- Government of Vietnam, 2016. Prime Minister of Vietnam's Decision No 1250/QD-TTg on Updated Power Development Plan 7.
- Government of Vietnam, 2012. Prime Minister of Vietnam's Decision No 1319/QD-TTg on National Strategy on Green Growth.
- Government of Vietnam, 2011. Prime Minister of Vietnam's Decision No 2139/QD-TTg on National Strategy on Climate Change.
- GreenID, 2021. Report on costs and benefit analysis of power development scenarios in the Mekong Delta (in Vietnamese) [WWW Document]. URL <http://greenidvietnam.org.vn/bao-cao-nghien-cuu-phan-tich-chi-phi-va-loi-ich-cac-kich-ban-nguon-dien-tu-goc-nhin-dong-bang-song-cuu-long.html> (accessed 8.28.21).
- Harris, J.M., Roach, B., 2018. Environmental and Natural Resource Economics: A Contemporary Approach, Fourth Edit. ed. Routledge Taylor & Francis Group, New York and London.
- Ho, B.Q., Vu, K.H.N., Nguyen, T.T., Nguyen, H.T.T., Ho, D.M., Nguyen, H.N., Nguyen, T.T.T., 2020. Study loading capacities of air pollutant emissions for developing countries: a case of Ho Chi Minh City, Vietnam. *Sci. Rep.* 10, 1–12. <https://doi.org/10.1038/s41598-020-62053-4>
- IMF, 2020. Inflation rate, average consumer prices [WWW Document]. URL <https://www.imf.org/external/datamapper/PCPIPCH@WEO/LTU/EURO/EU> (accessed 9.8.20).
- Ingebritsen, S.E., Galloway, D.L., 2014. Coastal subsidence and relative sea level rise. *Environ. Res. Lett.* 9 091002.
- International Carbon Action Partnership, 2020. Allowance Price Explorer [WWW Document]. URL <https://icapcarbonaction.com/en/ets-prices> (accessed 1.31.21).
- International Energy Agency, 2021a. Coal. [WWW Document]. URL <https://www.iea.org/reports/coal-2020/prices-and-costs> (accessed 7.15.2021).
- International Energy Agency, 2021b. Main spot natural gas prices. [WWW Document]. URL <https://www.iea.org/data-and-statistics/charts/main-spot-natural-gas-prices-october-2020-december-2021> (accessed 7.15.2021).
- International Energy Agency, 2021c. Energy Price. [WWW Document]. URL <https://www.iea.org/reports/energy-prices-overview> (accessed 7.15.2021).
- International Energy Agency, 2020a. Data & Statistics - IEA [WWW Document]. URL <https://www.iea.org/data-and-statistics> (accessed 9.9.20).
- International Energy Agency, 2020b. Key World Energy Statistics 2020, Key World Energy

- Statistics 2020. Paris. https://doi.org/10.1787/key_energ_stat-2014-en
- International Energy Agency, 2020c. Global Energy Review 2020, Global Energy Review 2020. Paris. <https://doi.org/10.1787/a60abfb2-en>
- International Renewable Energy Agency, 2019. Renewable Power Generation Costs in 2019 [WWW Document]. Int. Renew. Energy Agency. URL https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf (accessed 8.1.20).
- IQAir, 2019. World Air Quality Report, 2019 World Air Quality Report.
- Jotzo, F., Karplus, V., Grubb, M., Löschel, A., Neuhoff, K., Wu, L., Teng, F., 2018. China's emissions trading takes steps towards big ambitions. *Nat. Clim. Chang.* 8, 265–267. <https://doi.org/10.1038/s41558-018-0130-0>
- Klenert, D., Mattauch, L., Combet, E., Edenhofer, O., Hepburn, C., Rafaty, R., Stern, N., 2018. Making carbon pricing work for citizens. *Nat. Clim. Chang.* 8, 669–678. <https://doi.org/10.1038/s41558-018-0201-2>
- Kompas, T., Pham, V.H., Che, T.N., 2018. The Effects of climate change on GDP by country and the global economic gains from complying with the Paris climate accord. *Earth's Futur.* 6, 1153–1173. <https://doi.org/10.1029/2018EF000922>
- Kumar, A., Sah, B., Singh, A.R., Deng, Y., He, X., Kumar, P., 2017. A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renew. Sustain. Energy Rev.* 69, 596–609. <https://doi.org/10.1016/j.rser.2016.11.191>
- Lee, A.D., Gerner, F., 2020. Learning from power sector reform experiences: The case of Vietnam.
- Metcalf, B.G.E., Stock, J.H., 2020. Measuring the Macroeconomic Impact of Carbon Taxes. *Carbon Tax Policy* 110, 101–106. <https://doi.org/https://doi.org/10.1257/pandp.20201081>
- Michaelowa, A., 2018. Opportunities for carbon pricing in Vietnam [WWW Document]. URL [https://www.undp.org/content/dam/vietnam/docs/Publications/Opportunities for Carbon Pricing in Vietnam_Eng.pdf](https://www.undp.org/content/dam/vietnam/docs/Publications/Opportunities%20for%20Carbon%20Pricing%20in%20Vietnam_Eng.pdf) (accessed 6.1.20).
- Narassimhan, E., Gallagher, K.S., Koester, S., Rivera Alejo, J., 2017. Carbon Pricing In Practice : A Review of the Evidence. *Clim. Policy Lab* 50.
- Neefjes, K., 2018. Long-term Greenhouse Gas Emission Mitigation Opportunities and Drivers in Vietnam [WWW Document]. URL https://www.vn.undp.org/content/vietnam/en/home/library/environment_climate/long-term-greenhouse-gas-emission-mitigation-opportunities-and-d.html (accessed 6.1.20).
- Nong, D., Nguyen, T.H., Wang, C., Van Khuc, Q., 2020. The environmental and economic impact of the emissions trading scheme (ETS) in Vietnam. *Energy Policy* 140, 111362. <https://doi.org/10.1016/j.enpol.2020.111362>
- Overland, I., Sagbakken, H.F., Chan, H.-Y., Merdekawati, M., Suryadi, B., Utama, N.A., Vakulchuk, R., 2021. The ASEAN climate and energy paradox. *Energy Clim. Chang.* 2, 100019. <https://doi.org/10.1016/j.egycc.2020.100019>
- Parry, I., 2019. Putting a price on pollution [WWW Document]. URL

- <https://www.imf.org/external/pubs/ft/fandd/2019/12/the-case-for-carbon-taxation-and-putting-a-price-on-pollution-parry.htm> (accessed 8.1.20).
- Partnership for Market Readiness, 2020. Partnership for Market Readiness [WWW Document]. URL <https://www.thepmr.org/> (accessed 7.20.20).
- Partnership for Market Readiness, International Carbon Action Partnership, 2016. Emissions Trading in Practice: A Handbook on Design and Implementation. Washington DC.
- Pezzey, J.C.V., Jotzo, F., 2013. Carbon tax needs thresholds to reach its full potential. *Nat. Clim. Chang.* 3, 1008–1011. <https://doi.org/10.1038/nclimate2054>
- Pigou, A.C., 1920. *The Economics of Welfare*. Macmillan and Co., ltd., London.
- Podhora, A., Helming, K., Adenäuer, L., Heckelei, T., Kautto, P., Reidsma, P., Rennings, K., Turnpenny, J., Jansen, J., 2013. The policy-relevancy of impact assessment tools: Evaluating nine years of European research funding. *Environ. Sci. Policy* 31, 85–95. <https://doi.org/10.1016/j.envsci.2013.03.002>
- Richter, J.L., Mundaca, L., 2015. Achieving and maintaining institutional feasibility in emissions trading: the case of New Zealand. *Mitig. Adapt. Strateg. Glob. Chang.* 20, 1487–1509. <https://doi.org/10.1007/s11027-014-9557-4>
- Rosenbloom, D., Markard, J., Geels, F.W., Fuenfschilling, L., 2020. Why carbon pricing is not sufficient to mitigate climate change—and how “sustainability transition policy” can help. *Proc. Natl. Acad. Sci. U. S. A.* 117, 8664–8668. <https://doi.org/10.1073/pnas.2004093117>
- Singapore National Environment Agency, 2020. Carbon Tax [WWW Document]. URL <https://www.nea.gov.sg/our-services/climate-change-energy-efficiency/climate-change/carbon-tax> (accessed 6.1.20).
- Skovgaard, J., Ferrari, S.S., Knaggård, Å., 2019. Mapping and clustering the adoption of carbon pricing policies: what polities price carbon and why? *Clim. Policy* 19, 1173–1185. <https://doi.org/10.1080/14693062.2019.1641460>
- Stretton, S., 2020. A simple methodology for calculating the impact of a carbon tax (No. 23). Washington DC.
- Teske, S., Morris, T., Nagrath, K., 2019. Renewable Energy For Vietnam [WWW Document]. URL <https://www.uts.edu.au/sites/default/files/article/downloads/Teske-Morris-Nagrath-2019-Renewable-Energy-for-Viet-Nam-report.pdf> (accessed 1.9.20).
- Timilsina, G.R., 2018. Where is the Carbon Tax after Thirty Years of Research? (No. 8493). Washington DC. <https://doi.org/doi.org/10.1596/1813-9450-8493>
- Tuoi Tre, 2020. Boosting support for low income households in COVID-19 (in Vietnamese) [WWW Document]. URL <https://tuoitre.vn/da-ho-tro-60-nguoi-kho-khan-do-covid-19-chinh-phu-giuc-day-nhanh-20200602175324207.htm> (accessed 8.11.20).
- Upstreamonline, 2021. China sets rules for emissions trading scheme as launch nears [WWW Document]. URL <https://www.upstreamonline.com/energy-transition/china-sets-rules-for-emissions-trading-scheme-as-launch-nears/2-1-940335> (accessed 1.28.21).
- Vietnam Communist Party’s Central Committee, 2013. Resolution 24/NQ-TW (in Vietnamese) [WWW Document]. URL <https://tulieuvankien.dangcongsan.vn/van-kien->

tu-lieu-ve-dang/hoi-nghi-bch-trung-uong/khoa-xi/ngghi-quyet-so-24-nqtw-ngay-0362013-hoi-nghi-lan-thu-7-ban-chap-hanh-trung-uong-dang-khoa-xi-ve-chu-dong-ung-pho-voi-578 (accessed 4.3.2020).

Vietnam's Partnership for Market Readiness Project, 2020. Task 1: Analytical Report on carbon pricing options and recommended carbon pricing policy package. Hanoi.

Vietnam Energy Institute, 2021. 3rd draft of Power Development Master Plan 8 (in Vietnamese) [WWW Document]. URL <https://moit.gov.vn/tin-chi-tiet/-/chi-tiet/bo-cong-thuong-xin-y-kien-gop-y-du-thao-de-an-quy-hoach-phat-trien-dien-luc-quoc-gia-thoi-ky-2021-2030-tam-nhin-toi-nam-2045-21618-15.html> (accessed 3.1.21).

Vietnam Ministry of Planning and Investment, 2021. Draft National Strategy on Green Growth 2021-2030 (in Vietnamese) [WWW Document]. URL <http://www.mpi.gov.vn/Pages/tinbai.aspx?idTin=49910&idcm=140> (accessed 7.28.21).

Vietnam National Assembly, 2020. The Law on Environmental Protection (in Vietnamese) [WWW Document]. URL <https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Luat-so-72-2020-QH14-Bao-ve-moi-truong-2020-431147.aspx> (accessed 7.28.21).

Vietnam National Assembly, 2018. Environmental Protection Tax (in Vietnamese) [WWW Document]. URL Parliament Resolution 579/2018: <https://luatvietnam.vn/thue/ngghi-quyet-579-2018-ubtvqh14-ve-bieu-thue-bao-ve-moi-truong-168048-d1.html> (accessed 5.30.20).

Wang, M., Zhou, P., 2017. Does emission permit allocation affect CO2 cost pass-through? A theoretical analysis. *Energy Econ.* 66, 140–146. <https://doi.org/10.1016/j.eneco.2017.06.011>

Wang, X., Zhu, L., Fan, Y., 2018. Transaction costs, market structure and efficient coverage of emissions trading scheme: A microlevel study from the pilots in China. *Appl. Energy* 220, 657–671. <https://doi.org/10.1016/j.apenergy.2018.03.080>

World Bank, 2021. Carbon Pricing Dashboard [WWW Document]. URL <https://carbonpricingdashboard.worldbank.org/> (accessed 4.1.21).

World Bank, 2020a. World Development Indicators | DataBank [WWW Document]. URL <https://databank.worldbank.org/source/world-development-indicators> (accessed 4.3.20).

World Bank, 2020b. Decisive Reforms Needed for Vietnam to See Full Benefits of EU Trade Agreement: Report [WWW Document]. URL <https://www.worldbank.org/en/news/press-release/2020/05/21/decisive-reforms-needed-for-vietnam-to-see-full-benefits-of-eu-trade-agreement-report> (accessed 4.3.20).

World Bank and Institute for Health Metrics and Evaluation, 2016. The cost of air pollution: Strengthening the Economic Case for Action, The World Bank. Washington DC. <https://doi.org/10.1080/000368497326688>

Zhu, L., Wang, X., Zhang, D., 2020. Identifying Strategic Traders in China's Pilot Carbon Emissions Trading Scheme. *Energy J.* 41, 123–142. <https://doi.org/10.5547/01956574.41.2.lzhu>

Appendices

Appendix A. Emission factors for GHG emissions

Product	CO ₂ emission per one tonne of product (tCO ₂ e)
Anthracite	2.64
Lignite	1.21
Brown coal briquettes	2.03
Other bituminous coal	2.45
Diesel oil	3.19
Residual fuel oil	3.14
Kerosene	3.16
Lubricants	2.96
Motor gasoline	3.10
Natural gas	2.69

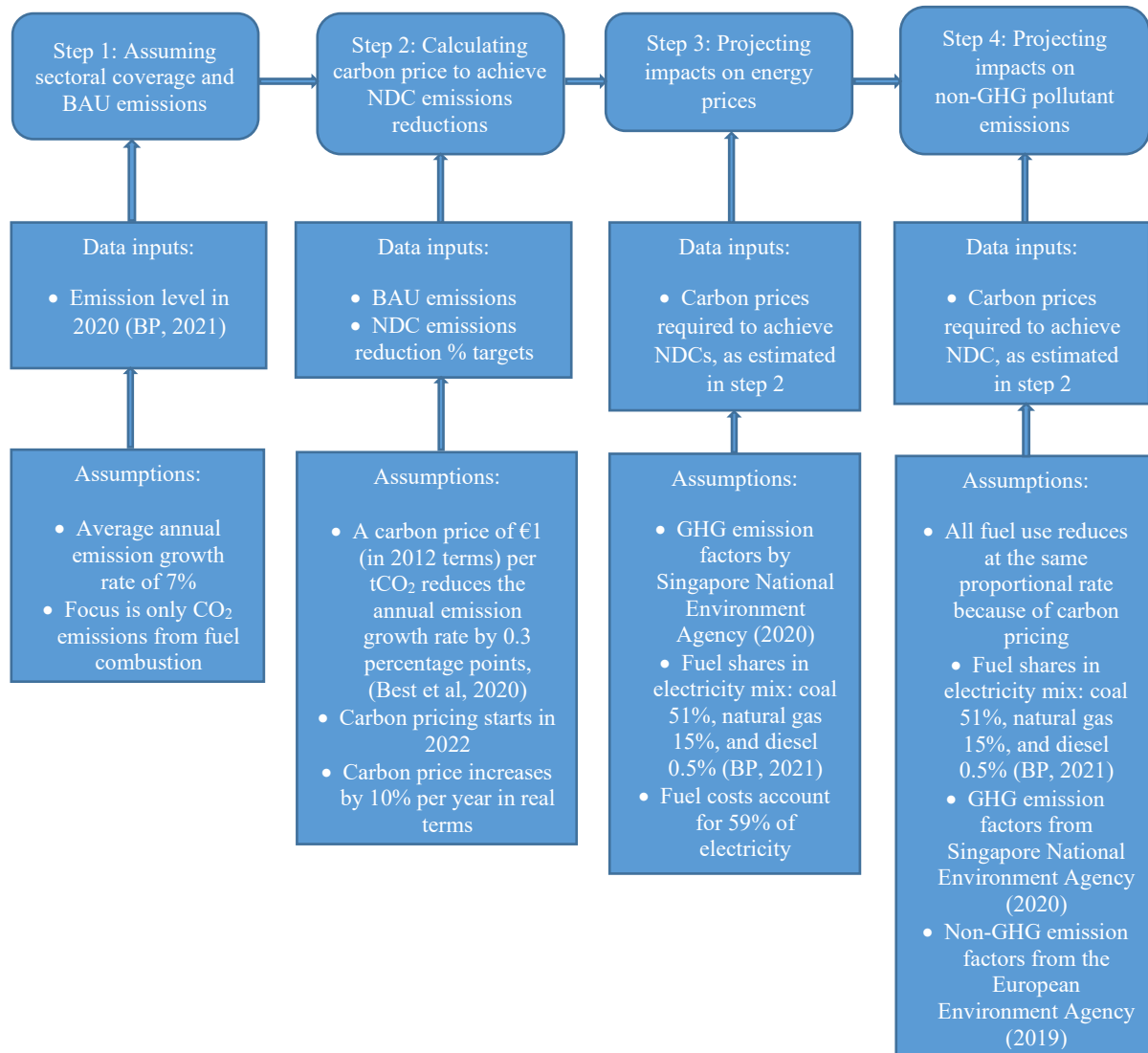
Source: Singapore National Environment Agency (2020).

Appendix B. Emission factors for non-GHG emissions

Pollutant	Emission per tonne of coal (kg)	Emission per tonne of motor gasoline (kg)	Emission per tonne of natural gas (kg)
NO _x	3.22	14.19	1.46E-03
CO	134.81	4.31	7.45E-04
NMVOC	14.18	0.93	5.45E-05
SO _x	26.38	4.36	8.6E-06
TSP	13.01	0.97	3.44E-05
PM ₁₀	11.84	0.97	3.44E-05
PM _{2.5}	11.66	0.83	3.44E-05

Source: European Environment Agency (2019).

Appendix C. Simulation of economic and environmental impacts of carbon prices



Appendix D. Questionnaire

(English version; original in Vietnamese)

Your Opinion about Carbon Pricing Adoption in Vietnam

This is part of a study conducted by the Australian National University. The questions are to facilitate discussion.

Responses will be used for the study only. Respondents are kept confidential.

Carbon pricing options

Carbon pricing puts a price on carbon emissions; hence, incentivizes reducing the use of carbon-containing products. Carbon pricing can be in the form of a carbon tax or an emissions trading scheme (ETS).

Suppose that the Government of Vietnam is considering the following three carbon pricing options:

1. Option 1 – Carbon tax: A levy put on fossil fuels (coal, gas, and oil), calculated based on their carbon contents. The tax would be collected at 150 fossil fuel producing and importing companies.
2. Option 2a – ETS for the energy sector with auctioned permit allocation. 150 fossil fuel producing and importing enterprises would be required to have emission permits to emit, and these would be auctioned. Enterprises can trade the permits among themselves. The ETS would be designed so that the carbon price and impacts on energy prices would be expected to be similar to the tax level in Option 1.
3. Option 2b – ETS for the energy sector with free permit allocation. Similar to option 2a, but the permits would be given out free of charge.

Details of the mechanisms including the starting dates are to be determined. Although the options are hypothetical, please think about them as if they were to be introduced in 2022.

Your opinion

1. In your opinion, what would be the potential economic impacts of the options?¹⁰
2. What would be the potential environmental impacts of the options?¹¹
3. What would be the potential social impacts of the options?¹²
4. What would be the administrative feasibility of the options?¹³
5. What would be the political viability of the options?¹⁴

¹⁰ Discussion points: energy prices, business competitiveness, GDP, and so on.

¹¹ Discussion points: climate change impacts, air pollution, and so on.

¹² Discussion points: via changes in employment, human health, energy prices, and so on.

¹³ Discussion points: legal aspects; procedures; monitoring, reporting and verification, and so on.

¹⁴ Discussion points: responses from government agencies, businesses, and the community.

6. Are there any other carbon pricing issues that you would like to discuss?

The following is optional:

Name:

Position:

Institution: