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FORECASTING THE IMPACT OF CARBON TAX ON EMISSIONS REDUCTION IN VIET NAM

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ABSTRACT

Carbon taxes have been proposed or applied in many countries and regions around the world to reduce greenhouse gas emissions (GHG). In this paper, the author uses the Stretton model to estimate the impact of a carbon tax in the implementation of the goal of reducing net emissions to 0% by 2050. The results show that the Carbon tax has a positive impact in helping Vietnam reduce greenhouse gas emissions, specifically with scenario 1, the Carbon tax helps reduce CO2 by 9.728% by 2030 and up to 20.28% in 2050 compared to the BAU scenario; with the scenario 2, the emissions will be reduced by 15.619% in 2030 and 20.67% in 2050 compared to the BAU scenario, however, if the tax increase on coal is equal to the tax rate on natural gas, the emission reduction will be 33.206% in 2050. From the research results, the authors also propose a number of recommendations and solutions to help Vietnam successfully apply a Carbon tax to reduce emissions towards the net emission target of equal to 0 by 2050 as committed at the COP 26 in 2021.

Keywords: Carbon tax, CO2 Emission, Climate Change

1. INTRODUCTION

Vietnam is one of the countries with a significant increase in the amount of greenhouse gas (GHG) emissions into the environment. According to the National Greenhouse Gas Inventory Report in 2019, Vietnam's CO2 emission rate is the fastest in Southeast Asia, and the 22nd largest in the world (Do & Burke, 2021). The United Nations has warned that Vietnam will have to face many climate change disasters in the future due to greenhouse gas emission trends (Nhu, 2022). At COP 26 Conference, Prime Minister Pham Minh Chinh highlighted Vietnam's commitments to bring net emissions to 0 by 2050. Many policies have been implemented to control GHG in the world, in which Carbon tax is one of the effective tools implemented successfully by many countries around the world such as Sweden, Japan, England, etc. thanks to its suitability to the socio-economic situation and circumstances (Organisation for Economic Co-operation and Development, 1996). However, policies of building a carbon tax system for organizations and businesses have not yet been issued in Vietnam. Thus, researching the impact of carbon tax on emission reduction in Vietnam is of high urgency and practical applicability.

According to OECD (2013) "Carbon Tax is a form of carbon pricing; it refers to a tax directly related to the level of carbon dioxide (CO2) emissions, usually expressed as a value per ton of CO2 (price/tCO2)''. The Pigou tax is the basis of the carbon tax. The tax principle stated by Pigou is: "The pollution tax rate calculated for each unit of polluting product is equal to the externality cost caused by the unit of polluting product at the socially optimal output level"(OECD, 2013). Carbon tax imposes a level of price on each ton of CO2 emissions caused mainly by consumption

of fossil fuels. From there, the CO2 tax regulates the behavior of emitting CO2 into the environment. From the Pigou tax base, companies in the coal, oil, gases and electricity sector with high Co2 emissions will be directly affected by the Carbon tax, similar to the research results shown for Ireland by Wissema & Dellink (2007). Because paying a carbon tax, depending on CO2 emissions, increases energy costs as a percentage of total production costs. Therefore, businesses have to find new measures and methods to reduce fossil fuel consumption in the most optimal way if they want to reduce costs and optimize revenue. In the long term, individuals and organizations, using fossil fuels, will have to innovate and switch to operating less polluting and more environmentally friendly technologies or searching for alternative renewable energy sources. Clean energy or renewable energy is the foundation for solving the problem of climate change and ensuring sustainable development for each country.

In terms of empirical research, according to the authors' research, papers on the impact of the Carbon tax on emissions reduction in Vietnam are very limited. Therefore, this study forecasts the impact of Carbon tax on emissions reduction in Vietnam through the Stretton model and the feasibility of the proposed Carbon tax scenarios. With clear research methods and processes, the Stretton model is evaluated as a suitable method to calculate the impact of carbon taxes on emissions in Vietnam. Stephen Stretton (2020) also applied this model to calculate carbon emissions for India. Research results show that India, with a carbon tax of 70 USD/ton of CO2, in the short term by 2025, can reduce emissions by 19% and increase revenue by 194 billion USD compared to the situation without carbon tax. Over the long term, by 2030, that carbon tax would reduce emissions by 45% from the baseline, while raising $162 billion in annual revenue. Thus, it can be seen that the Carbon tax will significantly change fuel prices, which is vital for current policymakers to properly calibrate the Carbon tax rate and develop effective energy transition strategies.

From the above arguments, the aim of the research paper is to build Carbon tax scenarios according to the emission reduction scenario and simultaneously apply the Stretton model to calculate the impact of Carbon tax in the goal of helping Vietnam achieve its goal of deflation emissions to zero. From there, the study will make some proposals and recommendations on the design, construction and application of a Carbon tax system in Vietnam to contribute to reducing GHG emission, helping Vietnam effectively implement Nationally Determined Contributions (NDC) to achieve the commitment target, set at COP 26, of net zero emissions.

The structure of this paper was organized as follows. In Section 1, we present the rationale of this study. In Section 2, we presented our research methodology. In Section 3, we analyzed empirical results. The final section was devoted to conclusions and policy suggestions.

2. RESEARCH METHOD

2.1 Stretton Model

The study applies the Stretton model proposed by Stephen Stretton in 2020, which estimates the impact of a hypothetical Carbon tax on fuel prices, fuel use, tax revenue and CO2 emissions. The study modelizes solely fossil fuel consumption, as this is the main source of CO2 emissions. By the time the Carbon tax is high enough, it will affect fossil fuel use through the price elasticity of fossil fuel consumption.

The Stretton model includes 6 main steps in estimating emissions and revenue from each fuel type (coal, natural gas, gasoline, diesel and other oil products) when applying a Carbon tax:

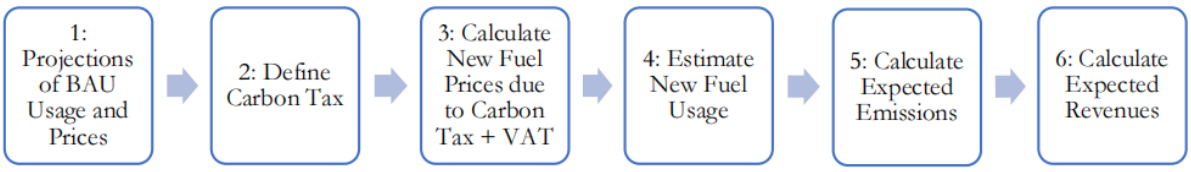

Figure 1. Process for calculating main of Stretton model
Source: Stretton (2020)

Step 1: Determine fuel price after VAT, CO2 emissions and emission factor according to Business-as-Usual Scenario (BAU)

BAU defines a zero-carbon tax (no fossil fuel subsidies and no VAT or reduced rates of fossil fuels or their use).

a) Fuel price under BAU scenario after VAT

Fuel price under BAU scenario after VAT

$$P_{BAU,VAT,i} = (1 + ts) * P_{BAU,Pre-VAT,i}$$

$P_{BAU,VAT,i}$: Fuel price i after VAT in BAU scenario
$P_{BAU,Pre-VAT,i}$: Fuel price i before VAT in BAU scenario
ts : VAT rate
i : Types of fossil fuel (petroleum, oil and coal)

In all calculations, VAT will be applied to fuels at the standard rate. According to article No. 1542/BTC-CST dated February 18, 2022 of the Prime Minister of Vietnam, the tax rate is 10% for petroleum and coal products.

b) Emission factor

Emission factors (EFi) for different fuels will be aggregated according to available national calculated data as follows:

Table 1. Emission factor
Source: Energy Conservation Research and Development Center (2018)

Viet Nam Forecast by BAU, 2050	**Emission factor (EFi) tCO2/GJ (MtCO2/PJ)**
Coal	0.0946
Gas	0.0561
Crude Oil	0.0774
Gasoline	0.0693
Diesel oil	0.0741
Other oil products	0.0774

c) Calculating CO2 emissions in terms of BAU scenario

Since the amount of CO2 emitted is proportional to the amount of fuel used, the amount of BAU emissions produced due to fuel consumption will be calculated as follows:

$$E_{BAU,i} = Q_{BAU,i} * EFi$$

$E_{BAU,i}$: CO2 emissions by BAU scenario
$Q_{BAU,i}$: Expected fuel consumption of *i* under BAU scenario
EFi : Emission factor (tCO2/GJ)

Step 2: Define carbon tax scenarios

a) Determine carbon tax rate (t)

According to the emission reduction scenarios from the national announcement, the tax rates determined will have different scenarios. These scenarios are drawn through previous research papers or Carbon tax policies intended to be applied at the national level.

b) Calculation of carbon tax per unit of fuel

If *t* is the carbon tax rate and EF is the emission factor, then the carbon tax per unit of energy for each fuel *i* is:

$$t*EF_i$$

Step 3: Calculate new fuel prices due to carbon tax and VAT

In VAT using countries, to avoid creating hidden subsidies, instead of applying VAT to the final value of the product, VAT should be applied at a standard rate to the after-tax Carbon price of all products eligible for VAT

$$P_{Carbon\,Tax,i} = P_{BAU,VAT,i} + t * EFi + ts * t * EFi$$

$P_{Carbon\,Tax,i}$: New fuel price *i* with carbon tax
$P_{BAU,VAT,i}$: Fuel price *i* included VAT in BAU scenario
EFi : Emission factor for each fuel *i*
t : Carbon Tax ($/tCO2)
$t * EFi$: Carbon tax per unit of fuel *i*
ts : VAT rate (%)
$ts * t * EFi$: VAT of carbon tax

The coefficient of change in price is calculated as followings:

$$P_{Carbon\,Tax,i} / P_{BAU,VAT,i}$$

Step 4: Estimate new fuel usage

Step 4 calculates the impact of the Carbon tax on energy demand. The price elasticity of demand increases, the demand for low-carbon or zero-carbon energy sources becomes strong and gradually replaces fossil energy sources. This will encourage investment and development of the production of lower carbon energy technologies.

$$Q_{Carbon\ Tax,i} = Q_{BAU,VAT,i} * (P_{Carbon\ Tax,i} / P_{BAU,VAT,i})^{\varepsilon i}$$

$Q_{Carbon\ Tax,i}$: New fuel *i* usage with carbon tax
$Q_{BAU,VAT,i}$: Fuel *i* usage included VAT under BAU scenario
εi : Price elasticity of fuel *i*

The model has constant elasticity, not excluding cross-price elasticity. Compared to the linear model, this model is suitable for both large and small changes in price. According to the research results of Labandeira, Labeaga & López-Otero (2017), for all countries, the price elasticity of energy demand in the short term is -0.21 and -0.61 in the long term.

Table 2. Assumptive elasticity of fuel consumption.
Source: Labandeira, Labeaga & López-Otero (2017)

Type of fuel	**Short-term (< 1 year)**	**Long-term (> 5 years)**
Coal	-0.21	-0.61
Natural gas	-0.180	-0.684
Gasoline	-0.21	-0.61
Diesel oil	-0.293	-0.773
Other products from oil	-0.153	-0.443

Formula for coefficient of change in fuel use:

$$(P_{Carbon\ Tax,i} / P_{BAU,VAT,i}) \wedge \varepsilon i$$

Step 5: Calculate expected emissions

Since the amount of CO2 emitted is proportional to the amount of fuel used, the emissions generated by fuel consumption are calculated as follows:

$$E_{Carbon\ Tax,i} = Q_{Carbon\ Tax,i} * EFi$$

$E_{Carbon\ Tax,i}$: CO2 emissions of fuel *i* with carbon tax (MtCO2/y)
$Q_{Carbon\ Tax,i}$: New fuel *i* usage with carbon tax (PJ/y)
EFi : Emission factor for each fuel *i*

Step 6: Calculate expected revenue

The revenue earned from carbon tax is equal to the tax rate multiplied by the amount of CO2 emissions, aggregated across all fuels:

$$REV = \Sigma_i t * E_{Carbon\ Tax,i}$$

REV : Expected revenue with carbon tax
t : Carbon tax
$E_{Carbon\ Tax,i}$: CO2 emissions of fuel i when tax is included

VAT calculated on the value of the fuel will generate both profit and loss in VAT revenue. The profits from VAT are due to the VAT levied on the carbon tax revenue itself. VAT revenue loss will be due to the reduction in fuel consumption caused by the carbon tax (can be estimated as: reduction in fuel consumption * fuel price * VAT rate). These impacts will be estimated explicitly

in the following sections, and there may be revenue declines due to some other factors, but this model will focus only on carbon tax revenues.

2.2 Data source

Regarding the data source for calculation accoding to the Streton model, data on Vietnam's estimated fuel price before VAT from 2025 - 2050 is taken from the report Fuel price projections for Vietnam (DAE, 2021)

Table 3. Estimated pre -VAT fuel price under BAU
Source: DEA, 2021

Vietnam Forecast under BAU by 2050	**Estimated pre -VAT fuel price under BAU ($P_{BAU,Pre\text{-}VAT,i}$)**					
	$2019/GJ					
	2025	**2030**	**2035**	**2040**	**2045**	**2050**
Coal	3.48	3.69	3.69	3.69	3.69	3.58
Natural Gas	9.95	11.30	11.60	11.40	11.40	11.40
Crude oil	6.77	7.14	7.21	7.28	7.28	7.28
Gasoline	11.87	12.53	12.69	12.79	12.79	12.79
Diesel	11.87	12.53	12.69	12.79	12.79	12.79
Other Oil Products	*(Similar to Crude Oil)*					

Data on Vietnam's Estimated Fuel Consumption Under BAU from 2025 - 2050 is taken from the research of Tran (2019)

Table 4. Estimated Fuel Consumption Under BAU scenario
Source: Tran (2019)

Vietnam Forecast under BAU by 2050	**Estimated Fuel Consumption Under BAU ($Q_{BAU,i}$)**					
	PJ/y					
	2025	**2030**	**2035**	**2040**	**2045**	**2050**
Coal	1651.776	1651.776	4156.404	4156.404	4156.404	4156.404
Natural Gas	432.0359	432.0359	719.795	719.795	719.795	719.795
Crude oil	658.709	658.709	1411.496	1411.496	1411.496	1411.496
Gasoline	658.709	658.709	1411.496	1411.496	1411.496	1411.496
Diesel	658.709	658.709	1411.496	1411.496	1411.496	1411.496
Other Oil Products	*(Similar to Crude Oil)*					

3. RESULTS AND DISCUSSIONS

In order to focus on the most key goal of the study, the authors only calculate the impact of carbon tax on CO2 emissions in Vietnam through fossil fuel consumption from step 1 to step 5 of the Stretton model. For step 6, calculating the revenue contribution to the Vietnamese economy from the application of Carbon tax will be presented in detail in upcoming studies. From the calculation process designed in section 2, the authors directly synthesize the results table without dividing the sections into steps in the process because the paper has to calculate for many types of fuel in many years, but still ensure all necessary formulas for each step as stated in the model.

According to the assumption, the carbon tax will be implemented from 2025 to 2050, Carbon tax scenario and emission reduction scenario based on Vietnam's updated National Determined Contributions (NDC) for 2022 are given as follows: "*Emission reduction target in the fields of energy, agriculture, forestry and land use, waste and industrial processes to 2030 compared to*

BAU in update NDC 2022 increased compared to NDC 2020, specifically Unconditional Contribution increased from 9% to 15.8% and Conditional Contribution increased from 27% to 43.5%" (Ministry of Natural Resources and Environment, 2023).

Regarding the Carbon tax scenario, this paper proposed two scenario as follows:

Scenario 1: Carbon Tax is built with its own tax system and the Carbon tax imposed is the same for all fossil fuels. Vietnam's Partnership for Market Readiness Project (2020) modelizes scenarios involving a carbon tax of 10 - 30 USD/tCO2 for fossil fuels, the tax would be applied to coal, oil and gas used in electricity production, manufacturing industry and transportation. Therefore, the authors propose the following scenario: initially, the tax will be implemented in 2025 with a carbon tax rate of t=10USD/tCO2, then every 5 years, the tax will increase by 24,573% compared to the previous tax rate and maintained until 2050, the tax rate will be 30 USD/tCO2.

Table 5. Input variables in 2050 under Scenario 1
Source: Authors' calculation

	Coal	Natural Gas	Crude Oil	Gasoline	Diesel Oil
Estimated Consumption under BAU (PJ/y)	4156.404	719.795	1411.496	1411.496	1411.496
Estimated pre -VAT fuel price under BAU ($/GJ)	3.58	11.40	7.28	12.79	12.79
Emission factor (tCO2/GJ)	0.0946	0.0561	0.0774	0.0693	0.0741
Carbon Tax ($/tCO2)	30	30	30	30	30
VAT rate	10%	10%	10%	10%	10%
Price elasticity of fuel demand	-0.61	-0.684	-0.61	-0.773	-0.443

Table 6. Aggregate Calculations for All Fuel Types in 2050 under Scenario 1
Source: Authors' calculation

	Coal	Natural Gas	Crude Oil	Gasoline
Estimated Consumption under BAU (PJ/y)	4156.404	719.795	1411.496	1411.496
CO2 Emissions under BAU	393.1958	40.38049	420.90810	854.484
New fuel i usage with carbon tax	2911.203573	655.0944534	4955.478279	8521.7763
Fuel Emissions with Carbon Tax	275.3998580	36.75079884	369.0387147	681.189371
Change in emissions				0.79719343
Reduction of CO2 emission				20.28%

With scenario 1, according to the author's calculation results, Vietnam's emissions will decrease by 9,728% in 2030 and up to 20.28% in 2050 compared to the BAU scenario. Thus, Vietnam, according to the NDC, exceeded the emission reduction target of 9% according to the 2020 NDC but has not achieved the 15.8% deflation target according to the updated NDC in 2022. However, it can be seen that, according to the NDC 2020 or NDC 2022 version, the impact of the carbon tax on emissions reduction in Vietnam is very positive. Carbon tax helps Vietnam achieve a certain amount of emissions reduction when implementing policies on each of fossil fuels.

Scenario 2: Carbon tax is combined with environmental pollution tax, so the carbon tax applied is different for different types of raw materials. The tax rate is based on research by the Ministry of Planning and Investment, the United Nations Development Program (UNDP) and the United States Agency for International Development (USAID) as follows:

Table 7. Current tax rates for different fossil fuels under environmental protection tax.
Source: Michaelowa et al (2018)

	Gas	**Diesel Oil**	**Coal**
Tax rate	3000 VND/liter	1500 VND/liter	2000 VND/ton
Tax rate VND/ton CO2e	1320543	560435	3810
Tax rate USD/ton CO2e (1 USD = 22700 VND)	58.2	24.7	0.2

However, the study of the US. Agency for International Development (2019) has proposed a Vietnamese carbon tax on coal of 15 USD/tCO2 because this tax has the potential to limit future increases in coal use and contribute significantly to the target of NDC's emission reduction. From there, the authors propose a suitable Carbon tax rate for fossil fuels in Vietnam as follows:

Table 8. Carbon tax rate of each fuel.
Source: Authors' calculations

Category	**Nature Gas**	**Diesel Oil**	**Coal**
Carbon Tax (USD/tCO2e)	58.2	24.7	15

In particular, according to the authors' assumption, the increasing demand for fossil fuels, while fossil fuel sources are gradually depleted, the tax rate on fossil fuels will increase by 10% every 5 years in the period 2025-2050.

Table 9. Input variables in 2050 under Scenario 2
Source: Authors'calculation

	Coal	**Natural Gas**	**Crude Oil**	**Gasoline**	**Diesel Oil**
Estimated Consumption under BAU (PJ/y)	4156.404	719.795	1411.496	1411.496	1411.496
Estimated pre -VAT fuel price under BAU ($/GJ)	3.58	11.40	7.28	12.79	12.79
Emission factor (tCO2/GJ)	0.0946	0.0561	0.0774	0.0693	0.0741
Carbon Tax ($/tCO2)	24.157	93.731	39.7795	39.7795	39.7795
VAT rate	10%	10%	10%	10%	10%
Price elasticity of fuel demand	-0.61	-0.684	-0.61	-0.773	-0.443

Table 10. Aggregate Calculations for All Fuel Types in 2050 under Scenario 2
Source: Authors'calculation

	Coal	**Natural Gas**	**Crude Oil**	**Gasoline**
Estimated Consumption under BAU (PJ/y)	4156.404	719.795	1411.496	1411.496
CO2 Emissions under BAU	393.1958	40.38049	420.90810	854.484
New fuel i usage with carbon tax	3075.611802	555.3108986	4777.91207	8408.83477
Fuel Emissions with Carbon Tax	290.952877	31.15294141	355.729404	677.835221
Change in emissions				0.79326808
Reduction of CO2 emission				20.67%

Under scenario 2, results from the Stretton model show if a carbon tax is combined with the environmental tax, Vietnam's emissions will achieve an emission reduction of 15.619% in 2030 and 20.67% in 2050 compared to the BAU Scenario. Thus, there is a clear impact of the carbon tax, Vietnam will achieve a relative emissions reduction goal in 2030 according to the NDC updated in 2022. Besides, under scenario 2, the level of emissions reduction is nearly 1.6 times higher than in scenario 1, which shows the effectiveness of the carbon tax when imposed separately for each fuel type (scenario 2) compared to imposing a general carbon tax for all types of fuel (scenario 1). However, we can see that the carbon tax rate of scenario 2 is much higher than the one in scenario 1, with the high level of Vietnam's fuel consumption, this may hinder individuals and businesses that accept this tax rate.

Besides, under scenario 2, we can see that the increase in emissions reduction from 2030 to 2050 is not high (15.619% to 20.67%) although the initially applied carbon tax is quite high and increases annually. During the evaluation process, the study found that: the tax rate on coal will increase the rate of emission reduction, and Vietnam's coal fuel consumption is relatively high for electricity production leading to high Coal GHG emissions, but its carbon tax rate is much lower than the other ones: natural gas and oil products. Therefore, in 2050, despite the high natural gas carbon tax (93.731 USD/tCO2) and oil products' carbon tax (39.7795 USD/tCO2), the amount of achieved emissions reduction is not high, only more about 5% than in 2030, at the low tax rate of coal (24.157 USD/tCO2). According to the research results, if a carbon tax on coal fuel is 91.731 USD/tCO2 as the natural gas tax rate, the reduction will be 33.206% in 2050, due to the level of Vietnam's coal consumption is higher than others and the level of Vietnam emissions from highly combusting coal to generate electricity.

Thus, we have clearly seen that the carbon tax has a relatively considerable positive impact on emissions reduction in Vietnam through the results of both proposed scenarios, especially scenario 2 where the governments can be flexible in adjusting carbon taxes for each type of fuel to emissions reduction goals while still maintaining the stimulation of national economic development. According to the initial assumption, fuel use is still increasing because Vietnam is on the path of economic development, so policies to protect the environment and reduce GHG emissions are still being designed, adjusted, and coordinated appropriately so that emissions reduction does not affect economic development. Therefore, to achieve the NDC and the goal of net emissions to 0% by 2050, Vietnam needs to establish an appropriate carbon tax system and other combined measures and policies from the government to achieve the reduction goals committed at COP 26.

4. CONCLUSIONS AND SUGGESTIONS

At the COP 26 Climate Summit, Vietnamese Prime Minister Pham Minh Chinh made Vietnam's commitment to reduce net emissions to zero. Carbon tax is one of the Carbon pricing programs proposed to be applied in Vietnam to address climate change issues and reduce net emissions to 0%. This study aims to provide an overview of the impact of a carbon tax on GHG reduction goals in Vietnam for the period 2025 - 2050. The study applies the Stretton model, with two carbon tax scenarios proposed by the authors. The results show that under scenario 1 when applying the carbon tax, emissions will decrease by 9.728% in 2030 and by up to 20.28% in 2050 compared to the BAU scenario; under scenario 2, emissions will decrease by 15.619% in 2030 and 20.67% in 2050 compared to the BAU scenario. However, if the tax rate on coal is equal to the tax rate on natural gas, emissions reduction will be 33.206% in 2050. Thus, the carbon tax has a positive impact on Vietnam's emissions reduction goals. Therefore, some useful suggestions have been proposed by the authors to help policymakers design a carbon tax system that is suitable for Vietnam's socio-economic conditions:

First, Vietnam needs to establish a clear and specific GHG emissions program to determine the amount of emissions generated from production and consumption. To assist researchers in collecting data and policymakers in making decisions, Vietnam needs to maintain a national GHG inventory. Such regular GHG inventory is relatively weak in low- and middle-income countries due to financial constraints. Therefore, support from international organizations, such as the World Bank or the International Monetary Fund, is crucial to help Vietnam establish a carbon market with appropriate measurements. Having adequate data and accurate impact assessments is pivotal for policy design and implementation to ensure sustainable development.

Second, the government needs to set a carbon tax high enough to stimulate the economy and help consumers switch to using renewable energy and lower-emission products and services. This tax needs to ensure that businesses can transition to energy-saving and green technologies, at the same time it is needed to monitor and control to ensure fairness. Besides, the government must regularly survey and adjust the carbon tax in each period to ensure that economic impact is minimal, help businesses and individuals adapt and provide financial support to them to mitigate the impact of carbon tax.

Third, a change of the carbon tax or a decision to review and adjust current tax rates will need to consider the impact on implementation costs and capacity demands at both national and enterprise levels. The new tax means the state needs a high implementation cost to design and set up appropriate infrastructure. Likewise, professional capacity requirements for tax administration at the national level, management of pilot activities, and capacity training should be considered as these factors can influence the Support from individuals and businesses for the selected plan.

Fourth, Vietnam needs to consider options for integrating carbon taxes with other carbon policies. The government trying to achieve GHG reductions in the economy could implement a carbon tax combined with additional policies. A carbon tax could be an attractive option to address emissions that are difficult to regulate through other mechanisms such as cap-and-trade or command-and-control regulation. For example, in the case of Sweden, a carbon tax is usually limited to certain sectors of the economy. Sweden's carbon tax covers the energy and transport sectors but relies on other GHG reduction strategies to reduce overall GHG emissions. Sweden has added cross-sectoral tools such as joining the EU ETS, investing in research and development and local programs, and developing policies to address the waste sector (Ministry of Sustainable Development of Sweden, 2005).

Fifth, there is a need for a monitoring and report system to ensure transparency and reliability of the carbon tax application process. Different impacts of carbon taxes in countries mainly come from different carbon tax rates, tax-free scopes as well as ways of using carbon tax revenues. Environmental externality requires a fixed tax rate for each sector, so Vietnam needs to pay attention to this factor to set and adjust appropriate carbon tax rates. This is the reason that Finland's carbon tax works better than other countries even though it applies a lower nominal tax rate.

Although the research results and findings in this study have a significant contribution to the research of using a carbon tax to reduce emissions, the study still has limitations and shortcomings. Firstly, data on fuel consumption or fuel prices are forecast, so it does not accurately reflect the fuel use situation in Vietnam in the period 2025 - 2050, this may lead to the predicted results of the research being deviated compared to future reality. Secondly, the study only considers the effect of a carbon tax on emissions reduction without considering its impacts on the economy or the reactions of individuals and organizations to a carbon tax. Therefore, the authors expect that the following studies will overcome these limitations to provide a more accurate and specific assessment of the effect of carbon tax on emissions reduction in Vietnam.

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