



Review

Carbon tax as the most appropriate carbon pricing mechanism for developing countries and strategies to design an effective policy

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Abstract: The global consensus on the threat of climate change risk leads to an agreement to mitigate higher greenhouse gas emissions and limit global mean temperature rise to below 2 °C and, ideally, below 1.5 °C by 2050. In achieving the mean temperature target, international organisations like the World Bank, Organisation of Economic Co-operation Development and United Nations strongly suggest that policymakers implement a carbon pricing policy. A carbon tax is a market-based policy that has gained attention from many policymakers to reduce carbon emissions and increase the government's revenue. Designing a feasible carbon tax framework is crucial to ensure effectiveness and public acceptability. However, policy design in developing countries may be more complicated than in developed countries due to insufficient income and resources, social inequity, and poverty. This paper discusses the features of a carbon tax and the dimensions of designing an effective carbon tax policy for developing nations. A simplified framework for carbon tax implementation in developing countries is provided. The framework should be a foundation for developing countries to implement and develop a feasible and acceptable carbon tax policy.

Keywords: developing countries; carbon tax; design implementation; carbon pricing

1. Introduction

A carbon tax is a market-based instrument that uses fixed prices on polluters to reduce or eliminate environmental externalities. This approach was first articulated by Arthur C. Pigou in his 1920 book *The Economics of Welfare* [1]. Pigou advocated the 'polluter pays principle,' known as the Pigouvian

Tax, by levying a tax on a pollutant equal to the cumulative damage to society caused by one more unit of pollution [2]. Many policymakers have applied the principle in their environmental tax approaches, such as the carbon tax. A carbon tax was first implemented in Finland in 1990, followed by other European countries, including Poland (1990), Sweden (1991) and Norway (1991). The Nordic carbon taxes continue to operate until today and have undergone multiple reforms in the interim, as countries have adapted their taxes based on experience and policy developments [3]. By April 2021, 35 countries and sub-national jurisdictions – spanning a diverse range of developed and developing countries – have implemented or scheduled the carbon tax implementation [4].

A carbon tax is defined as a fixed charge on the carbon content of fossil fuel supply at the point of processing or refining coal, petroleum products and natural gas measured in metric tons of carbon dioxide (CO₂) equivalent to tCO₂e of a product or process [3]. The policy addresses the central problem of climate change – that the social cost of burning fossil fuels exceeds the private and market cost [2]. Over time, an efficient carbon tax would increase to reflect the fact that as more greenhouse gases (GHG) emissions accumulate in the atmosphere. International organisations like the World Bank, Organisation of Economic Co-operation Development (OECD) and United Nations (UN) strongly suggest that policymakers implement a carbon tax. The policy, however, can only be effective if carefully designed following the country's fiscal, social, and economic conditions.

2. Common issues in developing countries

Policy design in developing countries (The term ‘developing’ refers to low- and middle-income countries according to the income classification used by the World Bank.) may be more complicated than in developed countries due to several common underlying issues. First, the administrative capacity is often limited and tax collection mechanisms less advanced; middle and low-income countries can generate tax revenues in the magnitude of 10 to 25 percent of gross domestic product (GDP) compared to 30 to 40 percent of GDP for high-income economies [5]. The low percentage of tax-to-GDP means weak fiscal capacity and a lack of resources to improve infrastructure, health and education – keys to the long-term prospects for a country's economy and people.

Second, the public often lacks trust in the government due to poorly functioning institutions. The poorly performing institutions in developing countries are found to be associated with corruption and undermine population wellbeing [6]. Furthermore, the political structure of the government is generally weak, poor check-and-balance and people have scepticism about legislature and judiciary decisions. Available statistics for the developing economies also indicate corruption to be generally higher in countries with energy assets [7].

Third, people in developing countries generally have moderate environmental behaviour [8,9] and are unwilling to pay more to protect the environment [10,11]. Although people understand climate change and global warming issues, they do not consider going green to be one of their priorities and may take anti-environmental actions [12,13]. Studies also show that very few companies in developing countries publish their environmental and sustainability reports [14–16], indicating their lack of sensitivity to protecting the environment.

Forth, social inequity and poverty are common in many developing countries. Approximately 736 million people live in extreme poverty worldwide, and the majority in developing countries, half live in just five countries – India, Nigeria, Democratic Republic of Congo, Ethiopia and Bangladesh [17]. Moreover, the Covid-19 pandemic crisis will significantly affect middle-income countries – the

poverty rates will increase [18], and the nations will be the home to 82% of the new poor [17] (The new poor means people who are more urban than the chronic poor, more engaged in informal services and manufacturing and less in agriculture and live on congested urban settings and work in the sectors most affected by lockdowns and mobility restrictions). Nabi et al. [19] also found a positive relationship between poverty rates and carbon emissions – the higher level of poverty, the higher level of carbon emissions which subsequently slow down economic growth. Developing countries may also not have a reliable instrument for identifying the most vulnerable populations, thus making it difficult for the government to have an equal distribution of wealth.

Fifth, emerging and developing economies heavily rely on fossil fuels to meet development goals, particularly in urban settings [20]. Private investment in transport is significant, and the role of debt in transport for developing countries is generally lower than in developed countries [21]. Furthermore, electricity is also an essential source of human and economic progress through its many services: lighting, refrigeration, water pumping, and machinery operation. Giving access to this and other modern forms of energy is essential to bring people out of poverty and trigger development. Urbanization while reducing fossil fuel consumption is a challenging process for developing countries.

Finally, the energy sector in developing countries has been subjected to heavy-handed governmental intervention. The governments have extensively used a broad array of subsidies to respond to high fuel prices. The main objectives of the subsidy are to alleviate poverty and promote social welfare. However, fuel subsidies are highly regressive in that they indeed accrue mainly to the wealthiest households, who are also the major energy consumers. Consequently, the subsidies failed to protect the real incomes of the poorest [22]. As a result, the question of energy affordability remains a barrier to ambitious climate action, even if practical solutions exist to mitigate these problems, for example, more efficient use of energy via energy efficiency measures or cash transfers to reduce impacts on the poor [5].

The underlying issues of developing countries have led to the following research questions: 1) what are the features of a carbon tax that make the policy a suitable carbon pricing policy for implementation in developing countries? 2) how to design an effective carbon tax policy in developing countries?

3. Research methodology

This study employed a qualitative research methodology to answer the research questions. Document and thematic analysis were conducted to ascertain 1) carbon tax features and 2) the dimensions of designing an effective carbon tax policy for developing nations. The document analysis used secondary data to achieve the research objectives. Documents search for published documents of handbooks, statistics, guidelines and research papers on carbon tax using several search engines and research databases, including Google, Safari, Scopus and Google Scholar. Various keywords or phrases such as “carbon tax”, “framework”, “developing countries” and “environmental tax” were used to retrieve relevant documents. In addition to the database search, the authors manually picked several papers through reference searching.

Then, thematic analysis was conducted by coding the data, reviewing the coded data and categorizing the coded data into common themes. Similar to other methods of analysis in qualitative research, document and thematic analysis require repeated review, examination, and interpretation of the data to gain meaning and empirical knowledge of the construct being studied. The researcher

carefully extracted information related to carbon tax policy, not other carbon pricing and environmental tax policy like emission trading systems (ETS), fuel tax and energy tax.

4. Result

4.1. Features of a carbon tax

An extensive literature compares and contrasts carbon taxes and ETS, another market-based carbon pricing system. Many studies indicated that both systems had been proven as effective policies to reduce carbon emissions and increase revenue [23,24]. Both systems, however, may present varying results due to their architectural structure, not the fact that they are two different policy tools. When design aspects such as income recycling schemes have been changed, the effects of each policy would be dramatically different [2,3,25]. The most important factors favouring carbon taxes over ETS have been price stability and low administrative costs [2,3]. The analysis indicates three main features of a carbon tax suitably adopted by developing countries to reduce carbon emissions and gain revenues.

4.1.1. Reducing carbon emissions

Developing countries have a more significant and growing share of total annual emissions than high-income countries. If emissions growth continues unchecked in middle-income countries, the international objectives for controlling global warming will fail, irrespective of high-income countries' actions. Staying below a 2 °C temperature increase implies that the global carbon budget has to be limited to 800 GtCO₂ equivalent. This means that by 2050 almost 90% of coal, half of gas, and two-thirds of oil reserves have to remain unburnt, which is impossible without significant climate action in developing countries [26].

The effectiveness of a carbon tax policy is often measured by its ability to reduce carbon emissions. However, there is no emissions data for carbon taxes because taxpayers are not required to report the associated CO₂ emissions to policymakers. Many studies used econometric models and estimation methods to estimate carbon abatement [27–30]. The studies revealed that carbon taxes yielded CO₂ reductions up to 6.5% in European countries over several years, as Haites [24] summarised. Using actual data from British Columbia, Murray & Rivers [31] suggest that fuel consumption and GHG emissions have reduced between 5-15% since the carbon tax implementation in 2008.

Recent studies that used data from several countries also showed plausible reductions in carbon emissions. Haites [24] concluded that the introduction of carbon tax coincided with reducing covered emissions over time in most jurisdictions analysed (Haites et al. [32] used data from Norway, Sweden, Denmark, Slovenia, British Columbia, Switzerland, Ireland, Iceland, Japan, United Kingdom and France.). Using OECD 2013 and 2016 carbon tax data, Sen & Vollebergh [33] estimated that a EUR1 increase in the effective carbon rate would lead to a 0.73% reduction in emissions from fossil fuels over time. This means that, for a country that starts from no carbon price, introducing a carbon tax of EUR10 per tonne of CO₂ on its entire energy base would reduce emissions by 7.3%. At the global level, an additional EUR1/tonne of carbon price would reduce emissions by 0.3% per year [34]. However, the actual percentage of CO₂ reduction in each country varied due to different rates, the scope of tax exemption, and the use of tax revenues [35].

Reducing carbon emissions reduces global temperature and improves socio-economic development in developing countries. Air, water and soil resources can be preserved to safeguard wildlife, ecosystems and habitat. This subsequently helps protect human health and develop industrialization, which are critical drivers of economic growth.

4.1.2. Revenue generation

Tax has been used as a policy to strike a balance between securing the governments' revenues to finance social and economic programmes and maximizing the tax system's contribution to a thriving, efficient and inclusive economy. Compared to income tax and sales tax, a carbon tax is a less-distorted tax base since it reduces carbon emissions and generates revenue for the government. Table 1 shows carbon tax collection from 2016 to 2020 in 31 countries and jurisdictions. Total carbon tax collection has gradually increased from 2016 to 2018, from USD16.48 billion to USD23.68 billion, before slightly decreasing in 2019 to USD23.66 billion. Its resilience as an economic policy was demonstrated by the limited effect of the Covid-19 pandemic.

The total carbon collection in 2020 was USD26.9 billion, an increase of USD3.24 billion from the preceding year [36]. A plausible explanation for the increased collection – despite the pandemic – is most scheduled carbon tax rate increases went ahead as planned. British Columbia had a consistent rise in carbon collection during the five years, with an average increment of 8.83% per year. French carbon taxes brought in a staggering USD38.67 billion, making it the world's leading carbon tax collector. The high collection reflected the high carbon pricing from a 35% share of GHG emissions. Developing countries like South Africa, Mexico and Chile collected USD43 million, USD230 million and USD165 million of carbon taxes, respectively, in 2020 [36].

OECD's study on 16 emerging and developing economies (Côte d'Ivoire, Egypt, Ghana, Kenya, Morocco, Nigeria, Uganda, Costa Rica, Dominican Republic, Ecuador, Guatemala, Jamaica, Uruguay, Philippines and Sri Lanka.) found that the countries would raise revenue equivalent to approximately one percent of GDP on average if they reformed fuel subsidies policies and raised carbon rates on fossil fuels to a benchmark of EUR30 per tonne of CO₂ [37]. In addition, the countries would also achieve triple objectives: decarbonisation, domestic revenue mobilisation and access to affordable energy. Furthermore, global estimates indicated that the employment impacts of the energy efficiency and renewable energy sectors could be substantial, generating three times as many full-time jobs as equivalent government spending on fossil fuels [38].

Table 1. Carbon tax collection 2016-2020 [4].

	Jurisdiction	Year implement-ed	Carbon tax collection (USD million)				
			2016	2017	2018	2019	2020
1	Alberta	2017	0	714.618	1,012.971	0	0
2	Argentina	2018	0	0	200.228	179.263	0.488
3	British Columbia	2008	902.333	961.866	1,056.271	1,145.108	1,265.818
4	Canada	2019	0	0	0	1,371.070	3,406.685
5	Chile	2017	0	144.500	165.500	165.500	165.000
6	Colombia	2017	0	171.530	92.628	111.245	29.320
7	Denmark	1992	531.825	593.998	543.431	519.979	575.428
8	Estonia	2000	2.685	3.113	2.821	2.746	1.668
9	Finland	1990	1,262.208	1,567.572	1,458.572	1,419.630	1,524.631
10	France	2014	4,062.585	6,742.030	9,262.953	8,967.523	9,631.720
11	Iceland	2010	30.628	37.237	44.041	41.343	52.696
12	Ireland	2010	465.059	551.711	488.766	481.184	580.252
13	Japan	2012	2,340.920	2,486.726	2,361.360	2,438.186	2,364.834
14	Latvia	2004	6.354	9.740	9.068	9.060	5.000
15	Liechtenstein	2008	4.760	5.087	4.014	4.319	6.353
16	Mexico	2014	440.408	624.451	306.021	210.406	229.892
17	Newfoundland and Labrador	2019	0	0	0	40.743	46.439
18	Northwest Territories	2019	0	0	0	4.911	15.090
19	Norway	1991	1,486.881	1,652.373	1,643.662	1,374.223	1,758.378
20	Poland	1990	1.142	1.327	1.177	1.118	6.278
21	Portugal	2015	133.092	170.895	155.057	280.683	276.031
22	Prince Edward Island	2019	0	0	0	6.612	10.346
23	Singapore	2019	0	0	0	0	143.642
24	Slovenia	1996	79.059	91.681	83.089	80.870	147.295
25	South Africa	2019	0	0	0	0	43.314
26	Spain	2014	0	216.965	123.584	120.296	129.206
27	Sweden	1991	2,556.000	2,861.787	2,572.307	2,314.347	2,283.956
28	Switzerland	2008	1,002.003	1,116.249	1,177.654	1,234.721	1,238.835
29	United Kingdom	2013	1,168.883	1,241.223	1,091.043	1,098.106	947.720
30	Ukraine	2011	3.244	3.709	4.019	47.692	30.848
31	Zacatecas	2017	0	0	0	0	0
	Total		16,480.068	21,970.388	23,860.237	23,670.884	26,917.164

Policymakers in developing countries can choose whether to use the carbon tax revenue for government spending, revenue neutrality, or a combination of the two [39,40]. Experienced countries use carbon tax revenues for different purposes. The United Kingdom, Mexico and Iceland placed the revenue directly into the general treasury for unrestricted spending. Ireland and Chile also included the income in their general budget, but it was primarily used to achieve one of the initial policy implementation goals: to reduce the national debt and increase spending on public education and health, respectively. While India and Japan earmarked revenue specifically for green technology development, other countries, such as Switzerland and Denmark, combined earmarking with a revenue-neutrality

approach to improve public affordability [3]. The revenue-neutrality approach has been used in Portugal, British Columbia and Finland to resolve distribution costs and improve public acceptance of policies by lowering ‘distortionary’ taxes like labour, income, and corporate taxes and refunding revenue to the public, particularly those who are affected by the policy [3,41].

4.1.3. Policy adaptation

Implementing a new tax policy involves significant implementation and administration costs which are the main concerns for policymakers in developing countries. The most straightforward approach to carbon pricing would be for the government to impose a carbon tax [42]. A carbon tax can supplement and overlap with other climate and economic policies, allowing for more effective policy design. Policymakers have used a carbon tax either as a central climate policy or a complementary to the existing environmental policies. Many European countries already subject to the European Union ETS have implemented a carbon tax policy on sources not covered by the existing system to avoid carbon leakage.

On the other hand, Singapore, British Columbia, South Africa, and Japan used a carbon tax policy as the primary policy to address most carbon emission sources [36]. Following British Columbia's success in reducing carbon emissions, Metcalf [2] strongly suggested that carbon taxes should be a central component of Canada's emissions-reduction policy. These experiences have demonstrated that carbon taxes are adaptable instruments capable of addressing a wide range of policy objectives and national contexts [3].

If fixed carbon pricing is part of a long-term strategy that gradually phases in a fee for emissions and specifies how the government would address unexpected events while still achieving the overall goal of lowering GHG emissions at a reasonable cost, it provides stability. Policy and market frameworks predictability would increase business support and allow firms and consumers to plan their investments in low-carbon infrastructure and solutions. Moreover, a stable and rising carbon price encourages a gradual transition to a low-carbon economy, expanding economic prospects and fostering new company models. It may also help maintain government revenue stability [41,43].

Unlike ETS, a carbon tax does not require complex monitoring, reporting and verification systems [41]. As a result, the administration costs are generally low without a need for new administrative systems by 'piggybacking' the policy onto an existing tax administration. This is the case for British Columbia, Portugal and Japan, where the excise and customs agency administer carbon tax collection [3]. In addition, without making considerable adjustments, existing excise legal frameworks for taxpayer registration, returns, payments, auditing, and dispute resolution could be adapted for a carbon tax [44]. Furthermore, with an upstream tax approach, policymakers would have a lower number of taxpayers, which would reduce tax evasion rates and compliance costs, resulting in higher tax system efficiency [39,41].

Another main challenge in introducing a new tax policy is public rejection. One of the reasons for public opposition to implementing carbon taxes is the potential for adverse economic consequences, such as a reduction in overall economic outputs or GDP and social welfare [45,46]. Benavente [47] and Zhang et al. [48], in collaboration with several other studies (include Parry & Mylonas [49], Lu et al. [50], Calderón et al. [51], Fisher-Vanden et al. [52] and Wissema & Dellink [53]), discovered varying magnitudes of negative economic impact from carbon taxes depending on how carbon tax revenue is recycled into the economy. In Mexico, for example, raising carbon taxes to US\$100/tCO₂ in 2025 and US\$700/tCO₂ in 2050 would result in a 3% increase in GDP in 2025, that is, more than an

8% increase in 2050 over the baseline [54]. On the other hand, when the revenue was transferred to households as a lump-sum rebate, South Africa suffered a 0.33 percent welfare loss [55]. According to studies, a regressive distributional cost could be resolved by adjusting the tax rate and the use of revenue [56,57], which will be further discussed in designing an effective carbon tax policy.

4.2. Dimensions in designing an effective carbon tax policy for developing countries

The document analysis gathered 33 documents that provide carbon tax framework suggestions. However, only 16 documents have detailed guidelines. The list of the 16 documents is shown in Table 2. The OECD issued the highest number of guidelines with four publications, one of them was written together with the World Bank. Other organizations include the Institute of Fiscal Studies, International Monetary Fund, UN, World Resources Institute and German Development Institute. Other publications were written by researchers and published in journals, including Harvard Environmental Law Review and William & Mary Environmental Law and Policy Review.

The majority of the guidelines are for policymakers worldwide without specification to any countries. Five publications focused on a specific country like the United States, the United Kingdom and developing countries. More than half of the publications included discussion on implementing a carbon tax and/or environmental tax in developing countries. The longest publications are from the OECD [5] (242 pages), followed by PMR [3] (172 pages) and Cottrell et al. [41] (126 pages). Ten of the 16 publications focused on carbon tax implementation guidelines, while the other publications provided guidelines for environmental tax reform.

Table 2. Papers and guidelines that provide suggestions for a carbon tax framework.

No.	Year	Author(s)	Organisation / Journal publication	Title	Focus of country	No of pages	Discussions on developing countries
1.	2009	Metcalf & Weisbach [44]	Harvard environmental law review	The design of a carbon tax	United States	59	No
2.	2010	Fullerton et al. [58]	Institute of Fiscal Studies	Environmental taxes	United Kingdom	125	No
3.	2011 -	[59]	OECD	Taxation, innovation and the environment. Summary: Environmental taxation a guide for policymakers	Nonspecific	12	Yes
4.	2012	Parry et al. [60]	International Monetary Fund	Fiscal policy to mitigate climate change: A guide for policymaker	Nonspecific	21	Yes
5.	2015 -	[43]	OECD & World Bank Group	The FASTER principles for successful carbon pricing: An approach based on initial experience.	Nonspecific	49	Yes
6.	2015 -	[5]	OECD	Aligning policies for a low-carbon economy	Nonspecific	242	Yes
7.	2015	Kennedy et al. [61]	World Resources Institute	Putting a price on carbon: A book for US policymakers	United States	56	No
8.	2016	Cottrell et al. [41]	German Development Institute	Environmental tax reform in developing, emerging and transition economies	Developing countries	126	Yes
9.	2016	Sewalk [62]	William & Mary Environmental Law and Policy Review	Designing a better carbon tax: Only with reinvestment	United States	45	Yes
10.	2017	Metcalf [63]	Resources for the Future (RFF)	Implementing a carbon tax	United States	37	No
11.	2017 -	[64]	United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)	Environmental tax reform in Asia and the Pacific	Asia and the Asia Pacific	104	Yes
12.	2017 -	[3]	Partnership for Market Readiness & World Bank Group	Carbon tax guide: A handbook for policymakers	Nonspecific	172	Yes
13.	2018	Bordoff & Larsen [39]	Center on Global Energy Policy, School of International and Public Affairs, Columbia University	US carbon tax design: Options and implications	United States	72	No
14.	2019	Burke et al. [65]	London School of Economics (LSE)	How to price carbon to reach net- zero emissions in the UK	United Kingdom	64	No
15.	2019	Heine & Black [40]	International Development in Focus, The World Bank	Benefits beyond climate: environmental tax reform	Nonspecific	64	Yes
16.	2020	Flues & Van Dender [66]	OECD	Carbon pricing design: effectiveness, efficiency and feasibility: An investment perspective	None specific	58	Yes

Although some of the publications do not include discussions on carbon tax implementation in developing countries, the experiences from the countries provide suggestions for best practices that can be adopted. The thematic analysis shows that designing a carbon tax is a lengthy process that policymakers in developing countries must make decisions on ten primary dimensions: objective, subsidy reform, administration, tax base, tax rate, use of revenue, coordination with other tax and environmental policy, preserve business competitiveness, evaluation, review & adjustment, and information dissemination.

4.2.1. Objective

Designing an effective policy begins with clearly defined policy objectives [3,64]. Policymakers should define the medium- and long-term goals of carbon tax policy, including CO₂ reductions and revenue generation goals, as well as other social and economic goals [3,5]. The difference between developing and developed countries stems from underlying economic issues in developing countries. According to the UN [64], the goal of carbon taxes in developing nations should be domestic revenue mobilisation rather than a revenue-neutral green tax shift, which has previously been a critical rationale for industrialised countries. Carbon taxes should increase state revenue for additional spending for developing nations, such as debt reduction, essential infrastructure investment, or environmental or social goals. In developing countries, increased state revenues are required to fund the infrastructure necessary for sustainable development and the transition to a green economy.

4.2.2. Subsidy reform

The elimination of environmentally harmful subsidies is a critical first step toward implementing a carbon tax. Subsidies for fossil fuels and energy and general energy mispricing are destructive and counter-productive policies that undermine the environmental benefits of carbon pricing and should be reduced [43]. According to a study of 32 developing nations (The nations include Bangladesh, Sri Lanka, Cambodia, India, Indonesia, Malaysia, Pakistan, the Philippines, Thailand, and Vietnam), a disproportionate share of price subsidy benefits, especially for gasoline and liquefied petroleum gas (LPG), goes to high-income households, exacerbating existing wealth disparities [67]. The subsidies encourage excessive energy usage and limit incentives to increase energy efficiency or alleviate home pollution and GHG emissions. Furthermore, fossil fuel subsidies frequently deteriorate a country's trade balance and put enormous strain the government finance [40]. Subsidies reform drives government expenditure toward less environmentally hazardous behaviours while also internalising external costs, which can free up considerable sums of money [64]. Carbon pricing and energy price changes are mutually reinforcing policy strategies that increase energy access, higher energy service quality, and environmental sustainability [43].

Any proposal for subsidy reform should thoroughly assess the possible impact of the reform on sensitive sectors such as energy-intensive businesses and low-income groups and quantify the direct and indirect effects of the reform [64]. The experiences of Indonesia and Iran have demonstrated three fundamental aspects to implement a subsidy reform successfully. First, get the energy price right, which means gradually phasing out subsidies consistently and systematically. Second, limit the consequences of change by thoroughly analyzing and implementing their ramifications, particularly on vulnerable populations and international competitiveness. Third, boost reform support

implementing long-term and comprehensive reform programmers [68]. The most significant challenge for policymakers would be confrontation from opposition from political parties, lobby groups, and key stakeholders. To implement the intended reform, inter-ministerial methods, strong leadership, stakeholder participation, and focused, transparent, and open communication to the public are just a few of the actions policymakers may take to establish an enabling environment.

4.2.3. Administration

Coordination among ministries is critical in diagnosing and mapping the climate policy instruments and underlying policy frameworks. In addition, the coordination necessitates political, legal, and financial capabilities, such as a functional and transparent tax system that collects and redistributes funds. In South Africa, for example, the design of tax policy involved not only ministries but also key businesses, civil society organizations, labor unions, and academia [3]. Moreover, the involvement of various stakeholders from the start of policy development increases the likelihood that opposition parties and the general public will accept it. However, such coordination is especially difficult for developing nations since inter-ministerial cooperation institutions are often underdeveloped and primitive, environment ministries have low budgets, less clout than in rich countries, and ministries compete for limited resources and budgets [64].

Carbon taxes must be recoverable in a possible administrative manner, with costs kept to a bare minimum if possible. Feasibility is crucial in poorer countries because administrative capacity is often restricted, and tax collecting systems are less complex. These circumstances would pose administrative and political practicality and economic efficiency [39,41,60,64]. The International Monetary Fund (IMF) suggested that a typical carbon tax would need around 5% of revenue to administer. The quantity of administrative expenditures is determined by the instrument's design and pre-existing tax collecting, monitoring, and enforcement procedures [60]. A minimum administrative cost can be achieved by 'piggybacking' with existing tax administration, for example, the excise and customs agency. With minimal changes, existing excise legal frameworks for taxpayer registration, returns, payments, audit, and dispute resolution can be modified for a carbon tax [44]. Besides, compliance officers who manage excise taxes have the expertise and abilities to apply a comparable regime to a carbon tax [60]. Having a central administration gives advantages in scale and technical competence and allows for a more balanced fight with powerful taxpayers [64].

In countries where the public mistrusts the government, policymakers should increase revenues to support greater enforcement, increase tax collection capacities, and improve financial governance standards, lowering corruption by ensuring that officials are paid enough to reject bribes. Establishing an independent revenue management authority is another option that would reduce opposition and promote openness and accountability, ensuring that policy prescriptions are perceived as credible rather than politically motivated [41,69]. This alternative, however, is also associated with several challenges. In many developing countries, establishing such a council could be a significant administrative burden and a substantial increase in the cost of implementing a specific environmental policy tool, as exemplified by less successful practices in Thailand and India [64].

4.2.4. Tax base

Many international organisations and scholars agreed that the carbon tax base should be as broad as possible with few or no exemptions [39–41,43,62,66,69]. Comprehensive coverage of fossil fuels,

industrial processes, waste, agriculture, and forestry improves environmental impact, increases revenue potential, avoids carbon leakage, and is more cost-effective [3,41]. However, due to limited resources, developing countries may struggle to cover a wide range of sectors. In this regard, the OECD & World Bank [43] proposed charging the largest source of emissions first, then gradually expanding pricing to other sources. Chile, for example, imposed a carbon tax on the electricity sector only, and biomass is used to generate electricity. In Mexico, the carbon tax applies to all sectors except natural gas, the country's primary fossil fuel source. In Columbia, the carbon tax on natural gas only applies to the petrochemical and refinery sectors [70].

It is recommended that a carbon tax be levied upstream in the fuel supply chain to limit collection points and achieve maximum coverage [39,41,60]. An upstream tax can be a powerful tool for developing countries in shifting tax burdens from the formal to the informal sectors. In a well-functioning market with flat supply curves, the cost of adding fossil fuel to the mix will be passed on to energy consumers and, for manufacturers, will be factored into production costs [61]. On the other hand, midstream or downstream approaches are well-suited to sectors with lower carbon combustion, such as industrial processes, agriculture, and forestry [3]. This method covers a substantial portion of energy-related CO₂ emissions in a system that requires only a few responsible parties to play a direct role.

While upstream taxes to maximise coverage may be ideal in theory, political economy and regulatory constraints in some developing nations may imply that taxes are more successful when imposed downstream. For example, upstream taxes on electricity usage will be less effective in changing behaviour and improving energy efficiency in developing countries with tightly controlled energy markets and fixed prices. In contrast, downstream levies on electricity usage will be more effective in changing behaviour and improving energy efficiency [41]. When using the downstream approach, policymakers should set a threshold (Threshold is a minimum level of activity that will trigger responsibility for paying the tax—that is, a minimum level of emissions per entity for the taxation to apply [3]) to reduce the costs of reporting and administration [3].

Exemptions are justified on economic grounds in exceptional circumstances, but these cases must be carefully considered [60]. GHG-emitting activities may be so small or technically challenging to tax that taxing them is not administratively feasible. This issue becomes more pressing when considering taxation of non-fossil-fuel-combustion GHG emissions because most sources are diverse and decentralised, making it difficult to tax them at specific points in their supply chains [39]. Policymakers in most industrialised and developing countries have faced substantial obstacles in enacting an energy tax that does not include exemptions or lower tax rates for energy-intensive industries [41]. However, according to the UN, exclusions cause inefficiencies in pollution abatement and weaken the concept of the 'polluter pays' principle, resulting in an unfavourable trade-off between environmental efficacy and political viability [64].

Based on the experience of developed nations, exemptions should be targeted, time-limited, subject to regular review, and accompanied by certain conditions or agreements, to allow industry time to adjust and adapt to rising prices in the short term while implementing structural responses in the long term, ensuring environmental effectiveness. Timeless exemptions increase the likelihood of advantages being locked in and developing path dependencies that are difficult to reverse [41]. Targeting homes and small businesses, particularly in developing countries with extensive and complex informal economies, necessitates a significant increase in administrative effort for tax collection and monitoring, as well as a reduction in revenue potential. Focusing on a broad, easy-to-

target tax base and revisiting exclusions later may be preferable, especially in the early phases of carbon tax implementation [64].

4.2.5. Tax rate

Another essential factor that influences the efficiency of a carbon tax is the initial and increased tax rates. PMR [3] suggests several methods for determining tax rates, including the social cost of carbon (SCC), abatement target, revenue target and benchmarking target. Each approach entails various relationship estimations (e.g., expected GHG emission, damages to climate change, revenue target). The calculation may be complicated, perhaps even heroic, because it involves combining uncertain science, including predictions for the distant future [41,44]. Metcalf & Weisbach [44] suggest delegating or partially delegating rate-setting authority to an expert agency, which will ensure that the tax rate is re-examined at appropriate intervals and will provide expertise in the relevant parameters for setting the rate. Once the tax rate has been determined, it should be applied uniformly across taxpayers or sectors to achieve cost efficiency and reduce competition distortion [60]. Differentiated tax rates impair competitiveness, resulting in inefficient market results and reducing incentives to decrease environmental damage in some sectors [41].

The increased tax rate can be determined using various approaches – trajectory, adjustment, periodic review or political approach – depending on the country's social, economic, and political context. When a jurisdiction's primary goal is to raise income through the carbon tax, the increased tax rate can be set to yield a specified amount of revenue while staying within supply and demand limitations [3]. Haites [24] suggests that the carbon rate should be higher than the SCC and relative to the prices of the taxed fuels to be effective. A higher carbon price also implies a stronger incentive to reduce emissions [66]. Governments must guarantee that the pricing systems are set to adapt to unforeseeable occurrences while staying predictable enough to maintain incentives for innovation and long-term investments in low-carbon technologies [43,61].

In practice, however, developing and implementing a carbon tax policy, and setting tax rates, is a political process [41]. Chile, for example, had planned to utilise the SCC as its national standard. Nevertheless, due to a lack of agreement on the value of the SCC, the government determined that this strategy was not feasible in the medium term and instead relied on global carbon pricing as a proxy [3]. As a result, tax rates often are too low that may fall short of the OECD's best practice recommendations for achieving significant environmental impacts [41]. Therefore, politicians in developing countries are strongly encouraged to introduce carbon taxes at a modest rate while also including a range of tax rates in legislation to ensure that they can be raised without significant political opposition in the future [64]. Experience in jurisdictions such as British Columbia, Chile, Mexico (Chile, Colombia and Mexico have started with a small rate: US\$3.21/tCO₂ in Mexico and US\$5/tCO₂ in Chile and Colombia [70]), and Sweden shows that the progressive introduction of carbon taxes increases political and provides social support by enabling households and firms to adapt gradually to higher energy prices [5,40].

4.2.6. Use of revenue

Carbon tax revenues must be used productively to keep the overall cost of carbon taxes low. If revenues are not used productively (e.g., to lower tax rates to increase work effort or, worse, for

socially wasteful spending), the policy's overall cost to the economy will significantly increase [60]. In practice, as explained in section 4.2.2, policymakers use revenue in a variety of ways, including revenue neutrality (by redistributing to households or businesses), increased government spending (by putting it directly into the general budget, earmarking, or debt reduction), or a combination of the two. Many international organisations and academics strongly advise policymakers to use a mixed approach strategy, as shown in Table 3. The most recommended approach is to include the revenue in the general budget, where it can be spent across multiple sectors by the government. This flexibility is beneficial in times of unforeseen events or crises, when a rapid shift in policy of expenditures may be required [41].

Table 3. Suggestions for the use of revenue.

Author(s)	Revenue-neutrality		Increased spending		
	Rebates & refunds to households & business	Reductions in other taxes	General budget	Earmark	Debt reduction
Metcalf & Weisbach [44]	√	√		√	
OECD [69]	√	√	√		
I. Parry et al. [60]		√	√		
OECD [5]	√	√	√		√
OECD & World Bank [43]	√	√	√	√	
Kennedy et al. [61]	√	√	√	√	√
Cottrell et al. [41]	√	√	√	√	
Sewalk [62]			√	√	
UN [64]	√		√	√	
PMR [3]	√	√	√	√	√
Bordoff & Larsen [39]		√	√	√	√
Heine & Black [40]	√	√	√	√	√
Flues & Van Dender [66]				√	√

At the same time, policymakers are encouraged to address the distributional issue by distributing revenue among several groups (i.e., 'dividend sharing') to ensure that several groups benefit from carbon taxes [40,60]. For example, incentives to vulnerable populations, rebates for energy-intensive industries, and environmental expenditures / green infrastructure subsidies. Incentives to the public can be given through cash transfers or handouts, food stamps or subsidies, free schooling, cash or food-for-work programmes, free or subsidised health services, housing or utility subsidies, vouchers or green cheques, social or health insurance, labour market policies, and provision of alternatives such as LPG stoves to replace kerosene and lifeline tariffs – zero or lower tax rates for the first units of consumption [64]. This type of assistance can improve affordability and equity while incentivising low-income households to improve energy efficiency and reduce emissions.

Parry et al. [60] argued that the risk of compensation systems is that they may forgo some of the potential economic benefits of recycling carbon tax money. Transfer payments to low-income households, for example, do not affect motivation to work. Furthermore, it is difficult to determine the best way to accurately target the poor and ensure that compensation measures are practical and efficient [41]. As a result, many transfers are inequitable and ill-targeted, disproportionately benefiting the wealthy over the poor. When state resources are limited, middle-class households that lack access

to private means end up being better and more able to demand and obtain government assistance at the expense of poor households [71].

Despite the arguments, refunding some revenue to the public is particularly important in developing countries to resolve social equity issues, protect the vulnerable and prevent the spread of poverty [40,41,61]. Compensation techniques can help mitigate the tax's adverse effects on low-income households while keeping the price signal intact [72]. For example, when fossil fuel subsidies were modified in Iran, all households could apply for compensation, while wealthier households were encouraged not to. Although the goal was to use around half of the recovered funds for this purpose, in the end, 80% of the funds were used to compensate households [73]. For cash transfers to be effective, institutional capability and procedural processes for precisely targeting poor households and distributing funds must be in place [74].

Another revenue-neutral strategy is based on the double dividend hypothesis, in which a government reduces other pre-existing distorting taxes. According to Kennedy et al. [61], distortionary taxes discourage work and investment, encouraged elsewhere in the tax code and other policies. Therefore, using some or all the revenue from a carbon tax to lower distortive taxes like payroll, corporation, and personal income taxes can result in higher economic growth and productivity [43]. Such a prominent policy, known as a 'revenue-neutral tax swap', has been proposed by proponents of carbon pricing. In these plans, the majority or all of the proceeds from the carbon tax are used to reduce other taxes, resulting in no increase or decrease in government revenue [66].

Policymakers are also encouraged to earmark, particularly for environmental programmes (e.g., subsidies for clean technologies, climate finance, research and development, or compensation for the industry). The environmental programmes include, among others, the production of energy from wind, solar, and deep geothermal sources [60,64,66]. Low-income people's well-being can be enhanced by improving the energy efficiency of dwellings, appliances, and transportation services. Increasing the energy cost does not have to result in higher energy bills with such assistance. It also enhances public transportation for those who cannot afford a car and the comfort of poorly heated and insulated facilities [62]. Policymakers must also have strong international and national commitments, apply the principles of non-discrimination, transparency and property protection, strengthen competition policies, public investment in research and incentives for research and development. These strategies will level the playing field across competing technologies, avoid locking in a particular technology, facilitate a cost-effective and economically efficient green economy transition and carbon emission reductions, and avoid execution risks [41]. Moreover, incentives may be removed after aftermarket barriers have been removed to prevent favouring one technology over another [43].

The earmarking of all tax revenues for environmental programmes is generally undesirable because it can severely limit the effective management of public finances [60,75]. Resources are scarce, especially in developing nations, and economic stakeholders typically battle tooth and nail to safeguard their interests. This holds for both ministries and economic entities. As a result, failing to set aside funding for environmental protection risks depriving environment ministries of much-needed resources, leaving them weak and powerless [64]. Furthermore, due to higher rates of corruption and a lack of trust in government, confidence in fulfilling political commitments, such as earmarking resources for a specific environmental development, is lower than in developed countries [76]. Cottrell et al. (2016) and UN (2017) Cottrell et al. [41] and UN [64] suggest that even if revenues go into the general budget and declare spending is made from that available budget, funds should be politically allocated so that the government can publicly state that they will be utilised for a particular purpose.

The lack of a legal link between tax and use of the proceeds is referred to as 'political earmarking'. In terms of political realities, tax resources are allocated and used is often a deciding factor in widespread acceptance [64].

If revenue is used wisely, it will improve economic efficiency and increase total economic benefits by reducing or eliminating market failure. Revenue utilisation is also critical for overcoming opposition and gaining political and public acceptance [77]. Resources are often relatively limited in developing countries, and economic actors often fight hard to protect their interests. Therefore, the most prudent approach to such spending decisions is to consider them from a political and strategic standpoint. For example, identifying the biggest national priority at any given time – which is often unrelated to the environment – and considering using carbon tax funds to achieve this aim can be beneficial. Since all government spending decisions are political, using tax funds to accomplish multiple goals may make the carbon tax appealing to ministries and increase public support for such a policy [41].

4.2.7. Coordination with other tax and environmental policy

The effectiveness of carbon taxes is limited if used without other policies that can enhance and complement them by taking other climate change challenges and market failures [3]. Carbon taxes must be part of a more extensive mix of climate, energy, and budgetary policies. Understanding how these policies complement, overlap, and oppose one another can help policymakers create more successful policies. The interaction of the carbon tax with other applicable taxes is an essential concern (income taxes, corporate taxes, fuel taxes, etc.) Energy taxes on fossil fuels are particularly relevant because the tax amount is proportional to the amount of energy consumed (if not the carbon content of the energy). Carbon pricing tools can generate the 'effective carbon rate', as defined by the OECD [5]. Other policies are needed to drive research and development, unlock non-economic barriers to mitigation, and target emissions reductions with very high abatement costs [36].

4.2.8. Business competitiveness

A slight increase in energy costs could make a big difference in industries with thin profit margins, indicating that policymakers must address some industries' reduced competitiveness [61]. In addition, there are fears that high carbon tax rates will induce enterprises to relocate to lower-taxed countries or expose them to 'unfair' competition from overseas firms not subject to such rules [69]. Relocating to a low- or no-tax jurisdiction would harm the economy of the taxing country while providing no environmental benefit, which is referred to as "carbon leakage" in the context of climate change [5].

Some types of compensation for industries sensitive to worldwide competition can be offered to achieve a consensus for a carbon tax to be implemented [61]. First, policymakers can supplement a carbon tax with well-designed and well-implemented border tax adjustments to address issues of competitiveness and leakage [60,61]. The border tax adjustment is an agreement between countries that allow the same carbon tax costs to a product when it crosses the border into the countries that the manufacturer of a domestically produced item would have to pay. The impetus behind border adjustments is the desire to ensure a level playing field in international trade while internalising the costs of climate damage into prices of goods and services [78]. However, this strategy is rarely implemented due to countries' lack of comparable climate commitments [79].

Tax shifting is a second option for policymakers, in which income is recycled to businesses to lower additional expenses while keeping the tax's incentive effect [64]. Revenues can be recycled to maintain a consistent overall tax burden on businesses while increasing incentives for environmental and energy efficiency improvements. Compensation should be sector-specific where it is deemed necessary to keep the cost of maintaining competitiveness as low as possible. This strategy will keep solid incentives for the entire economy while preserving a country's industrial base [64].

The third approach encourages job relocation, which directly results from the economic transition. As seen in many rapidly industrial developing countries, carbon price increases will be susceptible in jurisdictions where many people rely on emissions-intensive industries for employment. Governments can assist firms in impacted industries in improving their technology, reducing their vulnerability to the effects of carbon prices on employment, for example, by providing access to information, markets and finance, particularly for small and medium enterprises. Increasing adaptation entails improving the overall business environment and labour market flexibility so that workers in affected industries have incentives and can find work in more efficient enterprises or emerging low-carbon sectors [43].

4.2.9. Evaluation, review & adjustment

Once a carbon tax policy is in place, successful programmes conduct regular independent and public evaluations of policy performance, assessing progress toward stated objectives, identifying any potential negative consequences, and determining if performance is in line with policy objectives. Monitoring and verifying emissions and mitigation efforts are essential for public trust and support. OECD & World Bank [43] and PMR [3] assert that carbon taxes need to be accompanied by monitoring, reporting and verification (MRV) systems. MRV collects and organises emissions data that is complete, consistent, comparable, accurate, and transparent emissions which are vital to gaining public trust. Furthermore, MRV programmes are the foundation for understanding the carbon pricing policy's reliability in meeting environmental goals and providing emissions data to verify compliance and measure cost-effectiveness [43]. Econometric modelling and methods would help policymakers know whether the carbon tax effectively reduces CO₂ emissions and understand whether the economic actors respond to price signals and whether the rates need to be adjusted [41].

Following the MRV process is the review process. Policymakers support the tax's continual evaluation and development in response to shifting policy goals and conditions and the tax's evolving implementation experience [3]. In some circumstances, examinations of system operations reveal the need for changes to the system's architecture or administration. In other circumstances, evaluations of the system's impacts can lead to system adaptation. For instance, if the carbon price has a disproportionately negative effect on low-income households, the government may enact additional social policies to mitigate such effects.

In most cases, policymakers must include three types of reviews in their evaluation processes: impact evaluations, comprehensive reviews, and regular reviews. Following the evaluations, adjustments to carbon tax policy should be made. Thus, the review process can help with carbon tax adaptation and improvement. For various reasons, including complexity, shifting goals, economic volatility, and public support, jurisdictions may need to adapt their carbon tax over time. Table 4 shows some examples of policy changes.

Table 4. Adjustment to carbon tax policy [3].

Factor	Example Observation	Example Adjustments in Carbon Tax Design
Emission levels	Emission levels are above target levels	Increase carbon tax rate
Revenue collected	Revenue is above the targeted level	Lower other taxes, increase spending, the lower carbon tax rate
Economic cost	Economic costs are higher than expected	Adopt measures to reduce transactions costs and promote information diffusion, adjust emission targets and lower rate
MRV techniques	New methods of measurement lower the cost of MRV in untaxed sectors/sources	Expand coverage of tax to include additional entities

4.2.10. Information dissemination

Successful carbon pricing involves public dialogues with affected stakeholders about the rationale for the policy and incorporates their feedback into the policy design and implementation [43,59]. Policymakers must be transparent in communicating all aspects of the plan, including revenue allocation, distributional and competitiveness implications, and how the government intends to address them [40]. Information dissemination requires systematic communications and stakeholder engagement programs. For example, as part of the development of its carbon tax, Ireland conducted extensive consultations with community, environmental and business interest groups to improve the public's support [43]. A comprehensive and inclusive engagement process is mandated through the law to enable broad public participation in its rulemaking proceedings. Creating political acceptance for introducing carbon taxes requires scientific evidence and awareness-raising about pollution's environmental and health impacts and opportunities to change behaviour. These can be done by providing basic educational materials, informational campaigns, developing detailed guidelines, holding workshops and consultations, providing training, and supporting research [40,41]. Early and regular communication with all affected stakeholders about the rationale is essential to enhance the feasibility of carbon tax policy, generate public support and allow for prudent planning as policymakers become aware of business and civil society's concerns [64].

5. Conclusions

Carbon tax as a carbon-pricing policy has gained much attention in many countries and jurisdictions. Developing a feasible and acceptable carbon tax policy is crucial for effectiveness and sustainability. However, designing a carbon tax framework for developing countries is more challenging due to its underlying lack of income and resources, high corruption and social inequity. The objectives of this paper are twofold. First, to discuss the features of carbon tax policy that explain why a carbon tax is a suitable carbon pricing policy for implementation in developing countries. Second, providing a simplified framework for carbon tax implementation in developing countries should be a foundation for policymakers to establish a carbon tax policy.

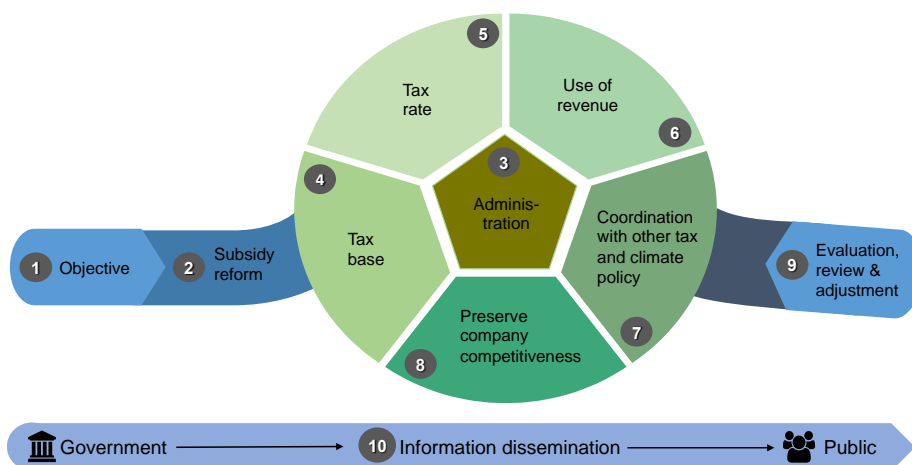


Figure 1. Carbon tax implementation framework for developing countries.

Table 5. General suggestions for carbon tax framework in developing countries.

Component	General suggestions
1 Objective	Domestic revenue mobilisation
2 Subsidy reform	Reform fuel and energy subsidies
3 Administration	Existing tax administrative, coordination with environmental and natural resource ministries
4 Tax base	<ul style="list-style-type: none"> Upstream approach at the mine mouth Exemptions to low-carbon emissions industries Exemptions must be time-limited and regular reviews
5 Tax rate	<ul style="list-style-type: none"> The social cost of carbon or abatement methods. If determined through the political process, the rate should not be too low that it will not have significant environmental impacts. The increased tax rate is determined using the periodic review approach in 5 years interval
6 Use of revenue	<ul style="list-style-type: none"> General budget Revenue-neutrality: cash refunds to low-income households, reduce the income tax rate and tax reliefs for solar panel installation in residential
7 Coordination with other tax and environmental policy	Coordination with existing direct and indirect taxes, and environmental policies
8 Preserve company competitiveness	<ul style="list-style-type: none"> Assist job relocation Support businesses to adapt to changing business environment Re-evaluate the existing tax incentives and subsidies on green technology policy by increasing the tax allowance and broadening the investment scope
9 Evaluation, review and adjustment	Monitoring, reporting & verification (MRV) system
10 Information dissemination	Education & information campaigns, holding workshops and consultations, providing training, supporting research and inclusion of environmental education in school syllabus

The document and thematic analysis show that a carbon tax is feasible for developing countries. It is a climate policy that has proven to reduce carbon emissions, increase government revenue, and have low administrative costs. Carbon tax collection for 31 countries and jurisdictions has gradually increased over the past five years (i.e. 2016-2020), and its resilience as an economic policy was demonstrated by the limited effect of the Covid-19 pandemic. The total carbon collection in 2020 was USD26.9 billion, an increase of USD3.24 billion from the preceding year [36]. Because administrative capacity is generally limited in poorer nations, and tax collection methods are less complex, feasibility is critical. The carbon tax administration can be ‘piggybacked’ with existing tax administration, for example, the customs and excise agency. With minimal changes, existing excise legal frameworks for taxpayer registration, returns, payments, audit, and dispute resolution can be modified for a carbon tax.

The analysis found that an effective carbon tax policy should consist of ten important components shown in Figure 1, with a general explanation of the framework in Table 5.

The framework should be used as a basis for developing countries in designing a feasible carbon tax policy. Malaysia, for example, has proposed a carbon tax as a new tax policy in its 12th Malaysian Plan (2021-2025). The policy proves the government’s strong commitments to Paris Agreements in reducing carbon emissions and one of its fiscal strategies in the Covid-19 economic recovery plan. Future research could adapt the framework with Malaysia and other developing countries’ specific fiscal, social, and economic conditions for implementing a carbon tax.

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Conflict of interest

The author declares no conflict of interest.

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