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Review Article

A Study on Pollution Pricing vs. Cap-and-trade a Legal Comparative Study between Carbon Tax and Emission Trading Schemes

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Introduction

This presents a legal comparative analysis of two predominant price mechanisms on carbon tax schemes and emissions (ETS), also known as cap-and-trade systems. As climate change accelerates due to excessive greenhouse gas emissions (BKG), governments adopt market-based tools all over the world to internalize the external effects on the environment and to promote carbon sequestration. The research critically examines the legal design, the implementation of the tax, and the effectiveness of the tax and the ET CO_2 in the regulation of emissions in various areas of law, with particular attention to the European Union, Canada, China, and India.

The study investigates how the CO_2 tax, due to the direct prices of CO_2 emissions, offers price safety, but lacks guaranteed environmental results, while capitalization systems for emissions offer safety through a fixed limit, although with price volatility. Analyzing legal tools, legal guidelines, judicial interpretations, and conformity mechanisms, the investigation underlines the comparative benefits and disadvantages of each model in legal terms [1].

In addition, the study evaluates the compatibility of these mechanisms with international obligations in the context of the Paris Agreement, the national climate laws, and the Sustainable Development Goals (SDGs). This research investigates institutional roles, the involvement of the interested parties, the transparency standards, and the challenges of application relating to both approaches. The study notes that although ETS is more flexible and politically feasible in large economies with high emissions, carbon loads are more predictable and administratively easier in the development of contexts. The document supports a hybrid legal model that integrates the strengths of both systems, tailor-made for the socio-economic and environmental contexts of the individual nations [2].

This comparative legal research aims to help political managers, environmental arguments and scientists in identifying the most legally effective, economically efficient, and respectful strategies for the environment to reduce climate change through market-based solutions. The results highlight the importance of legal clarity, adaptive governance, and equity considerations for the design of effective pollution price instruments. The growing threat of climate change has prompted international governments and institutions to seek effective legal and economic tools to reduce greenhouse gas emissions (GHG) and promote the sustainability of the environment. Among these tools, pollution prices have emerged as an important strategy, based on the principle of "pollution". Prices for pollution include the imposition of financial costs for activities that emit carbon dioxide and other greenhouse gases, and cleaner practices and low-carbon technologies are promoted [3].

Two primary mechanisms dominate the panorama of the pollution price: the tax on CO_2 and the emissions negotiation program (ETS), better known as cap-and-trade. Each approach reflects a different regulatory philosophy and legal architecture for the fight against the external effects of the environment, and this study aims to perform a detailed comparative legal analysis of both models. A carbon load requires a fixed price

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on the carbon content of fossil fuels, which provides a price for prices, but these emissions may vary according to the behavior of the market. It is a simple legal tool that works through tax statutes and environmental legislation.

On the other hand, a cap-and-trade system has set a legal limit on the total number of permitted authorizations or distributes or auctions for the emission of regulated entities. These reimbursements can be exchanged on the market, creating a flexible system in which emissions or purchase permits can be reduced. Although Cap-and-Trade offers safety in the emission levels, it introduces the plurality of prices and requires an advanced legal and administrative framework for allocation, monitoring, and application. The legal distinction between these mechanisms has a significant impact on the implementation of political implementation, market efficiency, and climate justice. Carbon taxes are often considered easier to manage in the existing tax framework and integrate into integration [4].

Due to concerns about economic competitiveness and social justice, they can be exposed to resistance. CAP-And-Trade-Program.The two systems must be designed within the limits of constitutional, administrative, and environmental law and comply with international obligations such as the Paris Agreement. This firm investigates how different areas of law have detected these tools and the legal implications that underlie them. The European Union's (EU) trading system is one of the most developed and legally robust examples of a cap-and-trade system. Countries such as Sweden, Canada, and South Africa, on the other hand, have implemented various forms of CO_2 taxes, so that they are integrated in a larger framework for tax and environmental management. India, although in the early stages of the development of the carbon market, offers an emerging legal context for these tools.

This analysis not only investigates the legal and regulatory provisions of these systems, but also investigates their mechanisms of application, institutional capabilities, public acceptance, and compatibility with the objectives of sustainable development. In addition, research deals with legal challenges such as overlapping, compliance problems, tax evasion, carbon flight, and administrative feasibility. It also assesses the role of the judiciary and the courts during the conception and the maintenance of these instruments, as well as the principles of constitutional law such as equity, proportionality, and non-discrimination. The intersection of environmental law, climate financing, and international commercial law is particularly important for understanding how pollution price mechanisms are designed and developed in practice.

Evolutionary developments of pollution pricing mechanisms

The concept of pollution prices has evolved considerably in the last century and has been transformed from a theoretical economic construct into a critical legal and political tool for environmental management. In essence, pollution prices derive from the "principle of pollutants", formally introduced into the environmental law in the early 1970s. The principle states that the person responsible for environmental damage must bear the costs to prevent and remove the damage. Although the idea had roots in the economic theory of Arthur Pigou, 1920 - where he supported the corrective load on the negative external effects - it was only in the second half of the 20th century that governments began to integrate these economic principles into environmental legislation.

The United Nations Conference on the Human Environment (Conference of Stockholm) of 1972 marked a crucial point to encode environmental responsibility in international discourse, and the Organization for Economic Cooperation and Development (OECD) formally adopted the policy principle of pollution in the same year. In the same year, in the same year, in the same year, during the same year, during the market, during the market, during the market, during the market during the market, during the market, during the mechanisms based on the market. The emphasis in the field of command and control is in nature. The late eighties and early nineties saw a transition to economic tools, because governments recognized their efficiency in terms of costs and stimulating competitiveness [5].

In 1989, Finland became one of the first countries to implement a national carbon tax, indicating the beginning of the legal mechanisms of formal prices for pollution. This was followed by Sweden (1991) and Norway (1991), which imposed both CO_2 taxes aimed at reducing the use of fossil fuels. At the same time, the United States experienced Cap-and-Trade mechanisms to face other pollutants other than carbon. The changes of the Clean Air Act 1990 introduced an emissions negotiation system for sulfur dioxide (so_2) to combat acid rain.

The program, launched under Title IV-A of the law, is generally mentioned as the first great success story of environmental capital and trade. Everything has allowed the electrical utilities to buy and sell SO_2 allowance, which demonstrates the profitability of the pollution control based on the market within a legal framework. Although he does not directly understand CO_2 emissions, the owner of the United States has thrown the legal and institutional basis of carbon markets around the world. The 1997 Kyoto Protocol marked the first international legal instrument that officially advocates carbon prices through flexible mechanisms. Article 17 of the Protocol introduced the international trade in emissions and has enabled industrialized countries with the broadcasting objectives (Appendix I Country) to act from emission units [6].

The protocol also included Joint Implementation (JI) and the Clean Development Mechanism (CDM), creating an early global market for the global carbon offset market. These mechanisms were designed with legal procedures for validation, examination, and registration by the United Nations Framework Convention on Climate Change (CCNUCC), which has institutionalized the trade in international law. Due to the lack of binding obligations towards significant issuers such as the United States, the effectiveness of the Kyoto framework has been mixed. However, it was under this legal architecture that in 2005 the launch scheme of emissions from the European Union (EU) - a milestone development in pollution prices.

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The EU ETS, launched according to Directive 2003/87/EC, was the first multinational capitalization program in the world that covers carbon dioxide emissions from the energy and industrial sectors. Structured in trading phases (Phase I: 2005: 2013-2012-20; Phase II: 2008 2008-2007; 2021-20), Sophistication, gradually eliminating the free allowances and the introduction of more rigorous emission caps. The legal evolution of the ET of the EU underlines the transition from voluntary regimes to binding ones for the pollution award, supported by legal application mechanisms such as the phrases of conformity and registration systems.

Towards the end of the 2000s, they began to implement various other jurisdictions or CO_2 fees or emissions trading. Article 6 of the Agreement introduced mechanisms for mitigation approaches (ITMOS) and non-markets transferred internationally, so that the role of pollution prices is implicitly recognized when specific contributions are made at the national level (NDC). The legal implications of Article 6 were further clarified by the decisions in Cop24 (Katowice) and Cop26 (Glasgow), layers of the herb herb for the future cool coolse supremes. In this legal panorama after Paris, the pollution price mechanisms are not only a national policy, but also an integral part of the Treaty obligations based on international climate law.

The years 2010 and 2020 saw a rapid expansion and diversification of the pollution prices. China, the largest emitter in the world, has sent regional emissions negotiation programs in seven provinces before launching its national and 2021, which initially focused on the energy sector. Legally supported by the provisional regulations on the administration of the treatment of carbon emissions issued by the Ministry of Ecology and the Environment, the Chinese program is an important step toward integrating carbon prices in internal environmental regulation. Treen, Zuid-Afrika has passed the tax on carbon 15 of 2019 taxes, although for the use of carbon, structured in the consolidated, structured by the use of carbon. The price scheme has adopted preparatory legal measures. The energy law for the conservation of energy (amendment), 2022, provides the legal basis for a carbon credit negotiation program, so that the government can create a regulatory framework for emissions negotiations in sectors such as energy and production [7].

Nowadays, there are more than 70 carbon price initiatives all over the world - 45 national systems and 36 subnational - tensioning carbon load, attack, and hybrid models. Some, such as the carbon load from Sweden, offer simplicity and certainty of prices; others, such as the EU sets, offer safety, flexibility, and emissions. Hybrid mechanisms, such as carbon load from Mexico with offset options, combine the characteristics of both approaches. Legal tendencies are now increasingly preferable to integrated practices that support transparency, international compatibility, and only transition objectives, in accordance with the objectives of environmental, tax, and social objectives.

In short, the evolution of pollution prices reflects a dynamic interaction between legal innovation, economic theory, and environmental cases. From its conceptual origin in the economy of Pigouvian economy to its codification in national treaties and laws, pollution prices have become a central pillar of the climate board. The historical process reveals a trend in the direction of greater legal formalization, integration with international obligations, and the inclusion of shared considerations. With the increase of the climatic crisis, the legal development of mechanisms for pollution prices remains shaped by both global consent and the internal political economy. Future frameworks face persistent challenges, such as carbon losses, administrative capacity, and equitable load division, while they can adapt to technological and geopolitical change. The legal systems will play a crucial role in ensuring that the mechanisms for pollution prices are not only economically effective, but also constitutionally valid, socially right, and ecologically robust.

Current status of carbon taxes in environmental regulation in India

India, one of the fastest-growing economies in the world and the third-largest greenhouse gas THG), is essential in its climate policy and its environmental administration. The integration of carbon prices, in particular in the form of carbon taxation, is an essential instrument for orienting the Indian economy towards a low-carbon and sustainable trajectory. Although India currently has no tax on economic carbon, which is explicitly marked as such, various regulatory and budgetary instruments functionally serve as indirect carbon price mechanisms. The current legal and political status of carbon taxes in India reflects a transition phase against sectoral taxes, energy closures, and an emerging institutional framework that aims to develop a more robust carbon market, which is under legislative reforms and international obligations [8].

In the past, India has used indirect carbon price instruments thanks to an energy tax. One of the most important developments was the introduction of the cleaning tax in 2010 by the 2010 finance law, which imposed coal, lignite, and peat. Initially, with 50 GBP per ton of coal, it was then increased to 100 GBP per ton in 2014, 200 GBP, and finally 400 GBP per ton in 2015. The revenues of this diploma were awarded to the National Clean Energy Fund (NCEF) for financial initiatives for clean energy, technological research, and environmental projects. The detour of the revenues of these environmental ends in budgetary compensation for the States has reduced their role in targeted climate and thus undermines its effectiveness as a carbon tax. Another important area in which carbon prices are manifested in Indian environmental regulations is on consumers, especially oil and diesel. These taxes are not based on the carbon content itself, but have a direct influence on consumption models and the results of emissions.

The union's consumption tax, which includes a basic consumption tax and additional special obligations, acts as a price signal that discourages the consumption of fossil fuels. Between 2014 and 2021, the central government increased these tasks, in particular for petrol and diesel, which have greatly contributed to growth in demand. However, their effects are incoherent because they do not extend to other university sectors such as manufacturing, construction, or agriculture, and their main objective remains the generation of income rather than climate reduction.

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The Indian government's energy conservation law (amendment) has marked a decisive development in the conception of the future of carbon prices, including the prospects for formal carbon taxes. The law introduces a framework for the creation of a carbon credit negotiation system (CCTS), with which the central government can specify sectors and businesses for production and trade in carbon loans. Although the law is currently focusing on a market-based mechanism and not on a tax mechanism, it is the legal basis for more explicit price instruments, including potentially taxes [9].

The proposed regulation will include both the compliance markets and volunteers, and credits can be exchanged nationally and internationally. Administrative control is based on the Energy Efficiency Office (BIJ) and the Central Electricity Regulation Commission (CERC), which means a coordinated institutional structure for the future carbon regulation. In terms of state, however, the carbon load is largely absent, and governments are more dependent on controls and legal stimuli. The lack of decentralized carbon taxation models limits the experiments and diversity of regional policies, although states like Gujarat and Tamil Nadu have shown interest in managing the emissions negotiation mechanisms for specific pollutants.

These schemes are not directly related to the carbon tax and are limited in scale and impact. From an international point of view, India has a growing pressure to carry out stronger carbon price strategies in accordance with global climatic obligations in the context of the Paris agreement and the next climate-related commercial mechanisms, such as the mechanism for passing the board of the European Union carbon (CBAM) [10]. With EU planning based on inclusion based on the inclusion of cabbage, Indian expenses, and the Indian cement sectors, comparable prices of domestic carbon are taken. In this context, the absence of a formal CO_2 tax can become a commercial responsibility. Within the Indian political clubs, the discussions emerged regarding the potential introduction of a CO_2 tax for the sectors exposed to trade, but these measures remain in conceptual phases, pending a wider political consensus.

Economically, India has to face a complex challenge in balancing development needs with environmental imperatives. A carbon tax, although economically efficient, can impose regressive effects on low-income groups if not accompanied by redistribution measures. [9] Critics claim that a scarcely designed carbon load could lead to energy poverty, inflation pressure, and industrial competitive issues, in particular for MSMEs (micro, small, and medium-sized enterprises). The supporters, on the other hand, support a neutral carbon tax on income, for which income is returned through clean energy subsidies, national electrification, or direct transfer of benefits.

The current institutional and legal infrastructure in India is gradually evolving to support wider strategies for carbon prices. The National Action Plan for Climate Change (NAPCC) and the Associated State Action Plans (SAPCC) are creating a political platform, although they do not require a carbon tax. The third national communication with the UNFCCC (2021) outlines the long-term development strategy of India for low emissions, including carbon prices as a potential tool, but stops recommending a direct carbon load. In addition, the long-term strategy of India for 2070, announced in Cop26, implicitly implicitly the internalization of the supply of the carbon dependence of carbon as a vital role [11].

At the judicial level, the Indian courts historically supported the principle of environmental responsibility. The Supreme Court of India has repeatedly confirmed and recognized the 'Polluter' Principle as part of the Constitutional Right To Life, based on Article 21 of the indian constitutional law. The Polluter Pays Principle, a strong doctrine for carbon tax, has no legal case has still led to direct tax or judicial directive for a carbon tax. In terms of public speech and political economy, CO2 taxes confront considerable opposition from lobbies in industry and political groups that are worried about inflation and economic competitiveness. Nevertheless, public support is needed for the climate economy, in particular in the development of young people and town planning. Several reflection groups and political institutions such as Teri, CEEW, and Niti Aayog are recommended for the implementation of the carbon price phase, including taxes, preferably with performance indicators and income neutrality [12].

Although India is currently implementing a tax on explicit carbon on an economic scale, the basis of such a policy is gradually established by tax instruments, legislative reforms, and climate obligations. The experience of clean energy cess offers precious lessons in terms of design, implementation, and institutional coherence. In addition to the international pressure of international trade and legal support for environmental responsibility, the Energy Conservation Act (amendment), 2022, positions India in order to take into account carbon as a viable instrument to achieve climatic objectives. For such a measure to succeed, it must be carefully developed to reflect the socio-economic diversity of India, to protect population groups that need protection, and to support industrial transformation. A well-calibrated carbon fee, edited by legal guarantees, institutional coordination, and equity redistribution in the next decades, can act as a milestone of architecture for the climatic management of India.

Current status of emission trading schemes (Cap-and-trade)

The current structure of Emissions Trading Schemes (ETS) shows a developing and more global approach for market-driven climate management. Originally a new tool for reducing air pollution in the late 20th century, Emission Trading Systems (ETS) have grown to be a basic element of environmental policy aimed at Controlling Greenhouse Gas (GHG) emissions. More than 30 countries are now operating or implementing ETS systems, together accounting for more than 17% of world emissions. The European Union Emissions Trading System (EU ETS), launched in 2005, remains the most prominent and mature example of cap-and-trade in action.

Now in its fourth trading phase (2021–2030), the EU ETS covers over 10,000 installations in the power sector, heavy industry, and commercial aviation within the European Economic Area. The EU has progressively tightened its

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emissions cap, reducing the availability of allowances to stimulate decarbonization. The introduction of the Market Stability Reserve (MSR) and the inclusion of maritime emissions by 2024 further exemplify the system's evolution. Prices of EU carbon allowances (EUAs) have surged in recent years, reaching over €90 per ton in 2022, signifying the system's growing role as a credible driver of climate action and investment reallocation. Beyond Europe, several countries and regions have adopted or piloted their own ETS, adapting the framework to local economic and environmental Aspects [13].

In North America, the Regional Greenhouse Gas Initiative (RGGI) covers power sector emissions in eleven northeastern U.S. states, demonstrating success in reducing emissions while stimulating economic growth. The California Cap-and-Trade Program, launched in 2013 and linked with Québec's system, represents one of the world's most comprehensive subnational schemes, regulating emissions from multiple sectors and using auction revenues to fund climate resilience and social equity initiatives.

These systems illustrate how ETS can be tailored to align climate mitigation with economic policy, particularly when supported by strong institutions and transparent oversight. Asia has emerged as a significant player in the ETS domain, led by China's national ETS, which began operating in 2021. Initially covering the power sector, which alone accounts for over 40% of China's carbon dioxide emissions, the system aims to gradually expand to other sectors such as cement, steel, and aluminium. Though allowance prices remain modest compared to Western counterparts, the Chinese ETS is notable for its scale it is the world's largest carbon market by volume of emissions covered [14].

It signals China's commitment to market-based tools for achieving its dual carbon goals: peaking carbon emissions by 2030 and reaching carbon neutrality by 2060. South Korea's ETS, established in 2015, also covers multiple sectors and has undergone reforms to improve market liquidity and environmental ambition. Likewise, Japan has initiated pilot programs and city-level ETS in Tokyo and Saitama, indicating the potential for broader national integration. Japan's pilot projects and local-level ETS in Tokyo and Saitama indicate the possibility of more nationwide integration. Adoption of ETS is still limited in the Global South but is under increasing study.

As parts of their larger Paris Agreement climate pledges, rising countries, including Brazil, Indonesia, Vietnam, and South Africa, are either designing or piloting Emissions Trading System (ETS) systems. Many of these projects gain from technical and financial assistance offered by global climate funding sources like the Partnership for Market Implementation (PMI) arranged by the World Bank. Designed to lower emissions, these projects also improve institutional capacity and align climate change solutions with aims for economic development [15].

Features and functionality of carbon tax *vs.* cap-and-trade

The comparative evaluation of carbon tax and cap-and-trade (emissions trading schemes or ETS) reveals two distinct yet economically and legally aligned instruments within the framework of market-based environmental regulation. Both mechanisms aim to reduce greenhouse gas (GHG) emissions and address climate change through internalizing the negative externalities associated with carbon pollution. However, they differ significantly in terms of their structural design, enforcement strategies, flexibility, and market behavior. A legal and economic analysis of these instruments allows policymakers and scholars to understand the advantages, limitations, and context-specific suitability of each approach. This section undertakes a detailed comparative study by examining the legal architecture, enforcement mechanisms, and economic functionality of carbon tax versus cap-and-trade, while also reflecting on their regulatory flexibility and behavioral implications in different market conditions [16].

At the structural level, carbon taxes are relatively straightforward regulatory instruments in which governments impose a fixed price per unit of carbon dioxide emitted, typically expressed as a monetary value per ton of CO_2-equivalent. The legal foundation of a carbon tax lies in fiscal legislation, and it functions as a Pigouvian tax—designed to correct market failures by attaching a price to environmental harm. This predictability in price provides certainty to emitters and investors, allowing them to make informed decisions on energy investments, consumption, and emissions control. In contrast, cap-and-trade is grounded in administrative or environmental legislation where the government sets a legal cap (limit) on total emissions allowed from a defined group of sources over a set period. Emission allowances, corresponding to the cap, are either allocated for free or auctioned to emitters, who can then trade these permits in a regulated market. The key structural distinction, therefore, lies in price certainty (carbon tax) versus quantity certainty (cap-and-trade).

In terms of legal and institutional enforcement, both instruments demand rigorous compliance frameworks but differ in their mechanisms. Carbon taxes are enforced through existing tax authorities and require emitters to pay taxes based on measurable emissions or proxy indicators such as fossil fuel consumption. Legal sanctions for non-compliance typically include financial penalties, interest on delayed payments, and criminal liability in extreme cases. The simplicity of the tax system, in this context, facilitates ease of monitoring, transparency, and lower administrative burden. Cap-and-trade schemes, however, necessitate more complex enforcement infrastructure, including robust Monitoring, Reporting, and Verification (MRV) systems, electronic registries, and trading platforms.

Legal sanctions in cap-and-trade frameworks usually involve monetary penalties for exceeding allowances, cancellation of permits, or exclusion from future trading. Institutions such as environmental protection agencies or independent market regulators oversee compliance, verify emissions data, and ensure market integrity. From an economic functionality perspective, carbon taxes and cap-and-trade differ in their approach to cost-effectiveness, revenue generation, and market behavior. Carbon taxes provide a fixed carbon price, ensuring predictability in marginal abatement

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costs but offering less certainty regarding the quantity of emissions reductions achieved. This can be problematic in contexts where strict emission targets are required under international commitments [17].

Cap-and-trade, on the other hand, guarantees a specific environmental outcome by capping emissions, though the price of permits can fluctuate based on market demand and supply, introducing volatility and uncertainty in investment planning. However, through mechanisms such as banking, borrowing, and price floors/ceilings, modern ETSs seek to reduce price instability and mimic the stability of a tax. Both instruments offer the ability to generate public revenue, which can be used to fund climate resilience, subsidize green technologies, or compensate low-income households. Carbon taxes inherently generate stable revenue streams as long as the tax is enforced, while ETSs generate revenue primarily when permits are auctioned.

Strengths and shortcomings of carbon pricing mechanisms

One of the most prominent advantages of a carbon tax is its predictability in price signals. By setting a fixed price per ton of CO_2, carbon taxes offer regulatory and financial certainty to businesses and investors. This allows companies to plan long-term investments in energy efficiency, clean technology, or low-carbon alternatives without facing the volatility often associated with carbon markets. Legislatively, carbon taxes are grounded in tax law, which, although politically sensitive, tends to be straightforward in terms of structure, rate application, and revenue collection. This legal clarity enhances transparency and minimizes opportunities for regulatory capture. A fundamental shortcoming is that carbon taxes offer no guaranteed environmental outcome, as emission reductions depend on how responsive firms and consumers are to price changes [18].

If the tax is set too low, the price signal may be insufficient to alter behavior significantly, undermining climate goals. Furthermore, political resistance to tax increases often prevents periodic adjustments needed to align with tightening emission targets. In contrast, cap-and-trade systems provide environmental certainty by establishing an enforceable emissions cap. This "quantity-based" approach ensures that emissions remain within predetermined limits, aligning directly with national climate targets and international commitments such as the Paris Agreement.

From a legal standpoint, ETS frameworks are codified in environmental regulations and administrative decrees, often involving complex institutional arrangements for permit allocation, trading oversight, and emissions monitoring. This system allows for greater regulatory flexibility, as authorities can adjust the emissions cap, allocation methods, or market design features in response to economic conditions or environmental needs. However, cap-and-trade systems often suffer from price volatility, especially in early implementation phases, leading to uncertainty for businesses. Moreover, designing and maintaining a functioning carbon market entails high administrative costs, extensive monitoring, and advanced legal frameworks for compliance and dispute resolution.

Compliance and enforcement remain critical challenges in both systems, albeit with differing institutional demands. Carbon taxes are typically administered by national tax agencies using existing fiscal infrastructure. This simplicity allows for relatively efficient enforcement, especially in sectors where emissions correlate directly with fossil fuel use. However, enforcement efficacy depends on the integrity of emissions measurement and the absence of tax evasion or underreporting. In low-capacity jurisdictions, tax collection may be hampered by poor data systems, political interference, or lack of public support. On the other hand, cap-and-trade systems require a more sophisticated compliance apparatus, including electronic emissions registries, verified emissions reporting, and third-party audits.

Non-compliance with ETS rules may result in heavy penalties or withdrawal of trading privileges, but the complexity of legal enforcement may overwhelm environmental agencies in developing countries. Moreover, market manipulation, permit hoarding, and over-allocation—especially under politically influenced free allocation schemes—can distort environmental outcomes and erode public trust. When evaluated through the lens of cost-efficiency, both mechanisms aim to minimize the overall cost of emissions reductions, but cap-and-trade arguably has the edge under ideal market conditions [19].

By allowing entities with lower marginal abatement costs to sell unused permits to higher-cost emitters, cap-and-trade encourages reductions where they are cheapest. This market-driven efficiency promotes innovation, facilitates capital reallocation, and spreads compliance costs across the economy. However, real-world imperfections such as information asymmetries, regulatory uncertainty, and trading illiquidity may undermine theoretical efficiency. In contrast, carbon taxes provide a uniform cost of emissions across the economy, encouraging abatement only when marginal costs fall below the tax rate. While this ensures simplicity and reduces administrative costs, it may not always result in the least-cost abatement pathways.

Importantly, both instruments can generate significant public revenue, but carbon taxes offer more predictable fiscal returns, which governments can use to fund renewable energy, infrastructure, or social safety nets to offset regressive impacts. An important socio-political consideration in the assessment of carbon pricing systems is their distributional effects and public acceptability. Carbon taxes, although simpler, are often criticized for being regressive, disproportionately affecting low-income households who spend a larger share of their income on energy. This has led many jurisdictions to adopt revenue-recycling mechanisms, such as rebates or targeted subsidies, to mitigate adverse social impacts. The French "Gilets Jaunes" (Yellow Vest) protests of 2018 underscore the risks of poorly designed carbon taxation without adequate social cushioning. Cap-and-trade schemes also face legitimacy challenges, especially when industries receive free allowances, perceived as corporate windfalls [20].

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International perspectives on carbon pricing strategies

Carbon pricing has emerged as a central strategy in the global effort to combat climate change, driven largely by international legal frameworks such as the Paris Agreement. As climate policy increasingly transcends national boundaries, there has been a growing push toward coordinated approaches that use market-based instruments, particularly carbon taxes and cap-and-trade systems, to achieve cost-effective emissions reductions. The Paris Agreement, adopted in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), marks a legal turning point by mandating all parties to define and update their Nationally Determined Contributions (NDCs), which often include carbon pricing mechanisms. Article 6 of the Paris Agreement further paves the way for international cooperation through carbon markets and mitigation outcome trading. These developments have had a profound impact on how countries conceptualize, adopt, and implement carbon pricing strategies within their domestic legal systems, reflecting a convergence of international environmental law, economic policy, and national sovereignty [21].

The legal architecture of the Paris Agreement encourages but does not mandate carbon pricing, offering flexibility for countries to determine how best to meet their emission reduction targets. However, its normative and diplomatic influence has catalyzed the global proliferation of carbon pricing instruments. As of 2024, over 70 jurisdictions have implemented or are in the process of developing some form of carbon pricing, either as a carbon tax, Emissions Trading System (ETS), or hybrid mechanism. These policies cover nearly a quarter of global greenhouse gas emissions, illustrating the expanding role of international soft law in shaping hard domestic law. Countries integrate carbon pricing into national legislation through climate acts, tax codes, environmental regulations, or energy transition frameworks, often referencing their international obligations as legal and political justification for domestic reforms [22].

In the European Union (EU), the Emissions Trading System (EU ETS) serves as a paradigmatic example of how international commitments can be operationalized through regional integration. Launched in 2005 and now in its fourth trading phase (2021–2030), the EU ETS is aligned with the EU's collective NDC under the Paris Agreement and binds member states to a legally enforceable carbon market. The EU Green Deal and the Fit for 55 package further reinforce this alignment, aiming for a 55% reduction in emissions by 2030 and climate neutrality by 2050. Legal instruments such as the EU Climate Law enshrine these goals, creating binding obligations for member states and enabling cross-border harmonization of carbon pricing.

The EU's proposal for a Carbon Border Adjustment Mechanism (CBAM) illustrates how carbon pricing strategies are not only tools for internal compliance but also instruments of international trade and environmental diplomacy. In North America, responses to international carbon pricing norms have been fragmented but evolving. Canada, as a signatory to the Paris Agreement, has implemented a national carbon pricing framework under the Greenhouse Gas Pollution Pricing Act 2018, which applies a backstop system across provinces. The Canadian Supreme Court upheld the constitutionality of this law in 2021, affirming federal authority to address climate change through coordinated national policies.

Mexico introduced a carbon tax in 2014 and is exploring a national emissions trading system, reflecting its dual commitment to domestic reform and international climate obligations. In contrast, the United States has not adopted a federal carbon pricing system, though subnational initiatives such as California's cap-and-trade program and the Regional Greenhouse Gas Initiative (RGGI) in the northeast demonstrate partial alignment with international carbon pricing norms, especially where legal and political conditions permit. Asia presents a complex landscape of carbon pricing integration, shaped by diverse economic capacities and legal systems. China's national ETS, launched in 2021 and covering the power sector, represents a landmark shift in global carbon governance.

It is the world's largest carbon market in terms of emissions coverage and reflects China's commitment to peak carbon emissions before 2030 and achieve carbon neutrality by 2060. Although allowance prices remain low and legal enforcement mechanisms are still developing, the scheme is underpinned by regulatory instruments issued by the Ministry of Ecology and Environment. The system's evolution is closely linked to China's NDC under the Paris Agreement, and legal reforms are underway to institutionalize trading platforms, monitoring, and compliance procedures. South Korea, another early adopter, has operationalized an ETS since 2015, embedding it within national environmental legislation and linking it to Korea's broader climate finance and industrial policy objectives.

Both nations show how domestic legal systems can adapt international climate mandates into context-specific instruments that align with national development goals. Developing countries are also increasingly adopting carbon pricing strategies, often with technical and financial support from international institutions such as the World Bank's Partnership for Market Implementation (PMI), the International Monetary Fund (IMF), and the United Nations Development Programme (UNDP). For instance, Colombia has enacted a carbon tax and is piloting emissions trading schemes, while Chile and South Africa are progressing toward comprehensive national pricing mechanisms. Legal transplants, where policy models from one jurisdiction are adapted to another, play a significant role in this process, as countries draw on the EU ETS or Canadian carbon tax model while customizing design features to local legal and administrative realities [23].

Issues faced by carbon tax and emission trading in practice

The International frameworks, such as the Paris Agreement, provide normative support for market-based climate

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instruments, translating this into coherent, enforceable, and equitable domestic legislation remains a formidable task. This section explores the primary issues faced by carbon taxes and ETS in practice, focusing on legal uncertainties, institutional limitations, compliance difficulties, coordination problems, and socio-political resistance. From a legal standpoint, one of the fundamental challenges lies in defining the authority and scope of carbon pricing instruments within a country's constitutional and legislative framework. For carbon taxes, questions about the delegation of fiscal powers between central and subnational governments frequently arise, particularly in federal systems such as Canada, the United States, and India [24].

In Canada, for instance, legal challenges were brought against the Greenhouse Gas Pollution Pricing Act, culminating in a landmark 2021 Supreme Court decision affirming federal jurisdiction to impose carbon pricing as a matter of national concern. Such judicial scrutiny underscores the necessity for clear legal mandates to avoid protracted constitutional litigation and ensure the enforceability of carbon pricing schemes. Similarly, emissions trading systems require robust enabling legislation, which must define the cap, coverage, monitoring obligations, penalty structures, and oversight mechanisms. Legal vagueness or gaps can hinder regulatory certainty, reduce investor confidence, and provide loopholes for non-compliance or manipulation.

Administrative challenges are equally pervasive. The success of both carbon taxes and ETS depends on accurate Measurement, Reporting, and Verification (MRV) of emissions. Developing reliable MRV systems requires technical capacity, access to data, and institutional coordination across multiple agencies. In many developing countries, environmental agencies lack the technical infrastructure and skilled personnel to implement such sophisticated systems, leading to weak enforcement and underreporting.

For ETS, the creation and maintenance of trading registries, auctioning platforms, and emissions inventories demand advanced digital infrastructure and consistent regulatory oversight. Moreover, the risk of over-allocation of emission allowances, as seen in the early phases of the EU ETS, can distort the carbon price and weaken the environmental effectiveness of the system. Carbon taxes, though administratively simpler, face difficulties in aligning tax rates across sectors, applying consistent taxation to imports and exports, and preventing tax evasion or avoidance, particularly in fossil fuel-intensive industries. One of the most persistent political challenges is the opposition from stakeholders, especially high-emission industries, consumer groups, and populist political actors who argue that carbon pricing increases the cost of living and undermines economic competitiveness.

Political resistance often leads to the setting of carbon prices that are too low to drive meaningful emissions reductions, or to the proliferation of exemptions and subsidies that dilute the effectiveness of the policy. The "Yellow Vest" protests in France are a striking example of how poorly communicated and socially regressive carbon taxes can spark widespread civil unrest, forcing governments to retreat from their climate policies. Similarly, in Australia, the introduction and subsequent repeal of a national carbon pricing mechanism reflected the volatility of climate policy when faced with electoral backlash. These experiences highlight the importance of designing carbon pricing in a politically palatable manner, which often includes revenue recycling measures, social compensation schemes, and transparent communication strategies to build public trust and acceptance [22].

Harmonization across jurisdictions adds another layer of complexity. While global carbon pricing coordination is desirable for avoiding carbon leakage and ensuring fair competition, actual implementation has been uneven. Differences in legal traditions, economic development levels, and institutional capacities make it difficult to align carbon taxes or link ETS across borders. For example, carbon prices vary widely from less than $5 per ton in some developing countries to over $100 per ton in parts of the EU, creating distortions in global markets [25].

This variation complicates the establishment of international carbon markets under Article 6 of the Paris Agreement, which envisions the trading of mitigation outcomes between countries. Moreover, linking ETS systems such as the California-Québec partnership or the EU-Switzerland linkage requires harmonization of cap-setting rules, MRV standards, enforcement protocols, and dispute resolution mechanisms, all of which involve complex legal negotiations and institutional integration. Equity and justice concerns further complicate the practical application of carbon pricing. Both carbon taxes and ETS can have regressive effects, disproportionately affecting low-income households who spend a larger share of their income on energy and transportation.

Without appropriate compensatory mechanisms, these tools can exacerbate socio-economic disparities and fuel political resistance. In developing countries, there is also the risk that carbon pricing may hinder access to affordable energy or limit industrial development if not carefully tailored. These concerns necessitate integrating carbon pricing into broader legal and policy frameworks that address sustainable development, poverty reduction, and energy access. Social safeguards, just transition policies, and stakeholder consultations are critical to ensuring that carbon pricing measures are not only economically efficient but also socially acceptable and legally resilient.

Another emerging issue is the risk of greenwashing and market manipulation, especially in poorly regulated or voluntary carbon markets. The credibility of carbon offsets used in some cap-and-trade programs has been questioned due to concerns about permanence and double-counting. This undermines public confidence and opens the door for legal disputes over emissions accounting. To address these concerns, many jurisdictions are developing legal frameworks to regulate offset registries, standardize verification procedures, and ensure that carbon credits meet stringent environmental integrity criteria [22].

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Jurisdictional ambiguity and regulatory conflicts

The Jurisdictional ambiguity arises when emission reduction obligations or rights extend beyond domestic borders—such as when countries link their carbon markets, participate in joint implementation projects, or apply Carbon Border Adjustment Measures (CBAMs). Regulatory conflicts, in turn, emerge when domestic laws and international obligations overlap, contradict, or fail to provide clear guidance. This complex legal landscape poses major risks to the effectiveness of climate policy, investor confidence, and the environmental integrity of carbon markets. A major source of jurisdictional ambiguity is the lack of uniform rules governing transnational carbon trading, particularly under Article 6 of the Paris Agreement, which allows for cooperative approaches through international transfer of mitigation outcomes (ITMOs) [25].

While the Article envisions a framework for carbon credit exchange among countries, the absence of binding procedural standards, enforcement mechanisms, and adjudication structures leaves room for inconsistent implementation. States may interpret accounting methods, transparency requirements, or double-counting rules differently, leading to discrepancies in how emissions reductions are measured and reported. When Country A sells ITMOs to Country B, both parties must adjust their emission inventories to avoid double counting, but without uniform auditing and reporting standards, one jurisdiction's compliance may be contested by another.

The resulting legal uncertainty undermines the credibility of international carbon trading and complicates dispute resolution when conflicts arise. Cross-border jurisdictional challenges are also evident in the linking of emissions trading schemes, where two or more jurisdictions allow mutual recognition of carbon allowances. Linking enhances market liquidity and cost efficiency but requires deep regulatory harmonization and legal alignment. The EU-Switzerland ETS linkage provides a valuable example: after years of negotiation, the two markets were linked in 2020 under a formal agreement requiring compatible rules on cap setting, monitoring, and enforcement [26].

Yet even with such agreements, differences in institutional structures, compliance penalties, and enforcement protocols create vulnerabilities. Suppose a firm regulated under the Swiss ETS uses allowances purchased from the EU market but fails to meet domestic compliance obligations. Questions may arise as to whether liability falls under Swiss administrative law or EU environmental regulation. The absence of supranational enforcement authority in many such arrangements means that cross-border breaches can go unresolved, creating legal loopholes and diminishing the environmental effectiveness of the system. Another regulatory conflict stems from Carbon Border Adjustment Mechanisms (CBAMs), which are unilateral trade measures designed to prevent carbon leakage by imposing tariffs on imports from jurisdictions with weaker climate policies.

The EU's proposed CBAM targets carbon-intensive imports such as steel, aluminum, and cement, aligning foreign producers with EU carbon pricing norms. While the measure is justified as an environmental policy under the WTO's Article XX exceptions, it raises significant legal concerns under international trade law. Affected countries argue that CBAMs amount to discriminatory protectionism and could provoke retaliatory measures. Furthermore, overlapping jurisdictional claims emerge when an exporter country asserts its sovereign right to regulate emissions independently, while the importer country imposes extraterritorial carbon pricing through border measures [27].

This legal tension underscores the need for clearer international rules on the interface between trade law and climate obligations, particularly as more jurisdictions explore CBAM-like instruments. Private actors operating across multiple jurisdictions also face regulatory fragmentation that complicates compliance. Multinational corporations may be subject to multiple carbon pricing regimes, such as Canada's federal backstop system, California's cap-and-trade program, and the EU ETS, each with distinct rules on reporting, verification, penalties, and offsets. This patchwork approach leads to increased transaction costs and legal uncertainty regarding which regulations apply, especially when emissions occur along global supply chains [28].

Firms may engage in "carbon arbitrage," shifting emissions-intensive operations to jurisdictions with weaker or less clear regulations, undermining global climate goals. In the absence of harmonized international enforcement, companies exploit legal gray areas, transferring liabilities or avoiding stringent compliance obligations, often without facing penalties. A further dimension of regulatory conflict emerges from overlapping domestic laws, where multiple authorities, such as environmental, energy, trade, and financial regulators, exercise jurisdiction over different aspects of carbon pricing.

The carbon taxes may be administered by a country's finance ministry, while an ETS falls under the environmental agency, leading to fragmented oversight, policy incoherence, and conflicting objectives. In some countries, subnational entities such as provinces or states may enact their carbon pricing mechanisms, creating vertical conflicts with national climate policy. The United States provides a prime example, where state-led initiatives like California's cap-and-trade exist alongside a federal government with no comprehensive carbon pricing scheme. Legal conflicts may arise if federal pre-emption doctrines are invoked or if state policies are challenged as unconstitutional barriers to interstate commerce. Without clearly defined jurisdictional boundaries and coordination mechanisms, regulatory overlaps may paralyze implementation and lead to legal disputes between levels of government [29].

Conclusion

Carbon pricing, through mechanisms such as carbon taxes and Emissions Trading Systems (ETS), has emerged as a central tool in the global response to climate change. These instruments seek to internalize the social cost of greenhouse gas emissions

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and incentivize cleaner technologies, behavioral changes, and investment in low-carbon solutions. The preceding analysis demonstrates that while carbon pricing mechanisms have proliferated globally, their effectiveness and legitimacy are often hindered by legal ambiguities, administrative limitations, socio-political resistance, and jurisdictional fragmentation. National and international legal frameworks must therefore evolve to accommodate and harmonize these market-based tools in a way that reinforces environmental integrity, economic equity, and compliance certainty.

One of the key findings is that legal clarity and institutional capacity are fundamental to the success of carbon pricing. In many jurisdictions, carbon taxes have faced constitutional challenges or political pushback due to unclear legislative mandates or the perception of regressive impacts. Similarly, ETS systems require detailed and enforceable legal frameworks to govern allowance allocation, trading, monitoring, and compliance. Legal reforms must ensure that carbon pricing mechanisms are embedded in primary legislation, supported by enabling regulations, and linked to long-term climate targets under national and international law. Clear jurisdictional authority, strong enforcement provisions, and public accountability mechanisms are essential to avoid litigation, ensure regulatory certainty, and build public trust.

The analysis also highlights the need for regulatory harmonization and cross-border coordination. As carbon markets expand and link across jurisdictions—whether through bilateral ETS connections, carbon border adjustment mechanisms (CBAMs), or international offset trading under Article 6 of the Paris Agreement—legal and policy consistency becomes critical. Differing MRV (monitoring, reporting, verification) standards, penalty regimes, or recognition of offsets can lead to market distortions and enforcement gaps. Countries should adopt internationally recognized standards and promote cooperative legal arrangements, such as mutual recognition agreements or regional trading blocs, to facilitate seamless integration. Institutions like the UNFCCC, WTO, and World Bank can support this effort by developing model legal instruments, dispute resolution protocols, and compliance tracking systems.

In terms of policy recommendations, governments should prioritize the equitable design of carbon pricing to enhance social legitimacy and political resilience. This includes using revenue recycling mechanisms—such as targeted subsidies, green investments, or direct transfers to low-income households—to offset regressive effects and generate public support. Policymakers must also ensure that carbon pricing is part of a broader climate strategy, aligned with sectoral regulations, clean energy standards, and just transition plans. In developing countries, technical and financial support from international organizations is necessary to build the legal infrastructure and institutional capabilities for effective carbon pricing.

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