ISBN: 978-93-48091-07-9

16. Policy Measures to Minimize Climate Change (SDG 13)

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Abstract:

The alarming rise in global temperatures and its devastating impact on economies, human livelihoods, and biodiversity necessitates the urgent actions to combat climate change. Addressing climate change requires the adoption of carbon pricing schemes, which highlight the dual purpose of lowering greenhouse gas (GHG) emissions and promoting sustainable economic growth. The chapter talks about globally available and adopted carbon pricing instruments to mitigate climate change. These are divided into two parts - Direct and Indirect Pricing. Direct pricing includes carbon taxes and emission trading schemes (ETS); by placing a direct penalty on carbon content, carbon taxes encourage the use of renewable energy sources and reduce dependence on fossil fuels. While, ETS works on a cap-and-trade base, ensuring that emissions stay within a certain threshold. The authors also explain Indirect pricing techniques which involves measures like reducing fuel subsidies and increasing fuel taxes that indirectly incentivize lower emissions. Well-designed carbon pricing strategies can help achieving net-zero targets, spur innovation in low-carbon technologies, and generate revenue for sustainable development projects. This comprehensive analysis underscores the transformative potential of carbon pricing in mitigating climate change and promoting global sustainability.

16.1 Introduction:

The world is in a climate emergency – "a code red for humanity" according to the UN Secretary-General. Global Climate Change is becoming an alarming problem of 21st century, with global warming as the biggest challenge. Global warming has the potential of condemning over one-third of the earth's animal and plant species to extinction by 2050 if greenhouse gas (GHG) emissions continue to rise unchecked.

The concentration of GHG emissions in the atmosphere is threatening lives, economies, health and food. According to Intergovernmental Panel on Climate Change, emissions resulting from human activities are substantially increasing the atmospheric concentrations of GHGs, which will enhance the greenhouse effect, resulting in an additional warming of the earth's surface and rising of sea levels

Systematic studies show that since 1990 there has been a continuous rise in the amount of global net anthropogenic GHG emissions and carbon di-oxide (CO2) is the major contributor to GHG emissions. India roughly contributes 7% of the world's CO2 emissions, making it the third highest in the world after China and the US. So, governments globally are taking stringent steps in order to reduce carbon emissions. Even the research highlights the growing number of publications in carbon trading field with 212 articles published in year 2023 (Scopus database) (Bareja Shaifali & Bhargava Vidhi, 2024).

Efforts to address climate change is gaining momentum globally. Governments, industries, and individuals are increasingly adopting carbon pricing techniques and sustainable practices to mitigate emissions. Even standard setting bodies like the International Accounting Standards Board (IASB) is working towards setting of reporting standards like International Financial Reporting Standards (IFRS) to ensure proper reporting of climate related facts in financial reports officially and mandatorily (Bareja S & Bhargava V, 2024).

India owing to its diverse flora and fauna has huge potential to reduce its carbon emissions. To mitigate climate change we either reduce emissions or try and negate the impact of these emissions by taking up some remedial actions.

To promote reduction, imposing taxes is one man-made action i.e. to control climate change impose some kind of taxes or penalties on harmful emissions or GHG emissions. Among the most effective tools in this battle against emissions are market-based mechanisms like carbon offset programs and carbon pricing.

Carbon Offsets are created to mitigate GHG emissions by providing funds for projects that cut or eliminate emissions. Once emissions are measured, people or organizations can buy carbon offsets equal to the quantity of emissions they wish to offset. The investments in these offsets go towards initiatives aimed at removing or lowering atmospheric concentrations of GHG emissions.

There are many carbons offset projects available, including energy efficiency programmers, afforestation and reforestation (planting trees), renewable energy projects (such as wind or solar farms), methane capture from landfills or agriculture, and projects that enhance waste management or support sustainable agriculture.

After being purchased, carbon offsets are usually retired or cancelled to prevent double counting and to prevent numerous parties from claiming the emissions reductions they represent.

Through the purchase of carbon offset plans, people and institutions can accept accountability for their carbon footprint by funding initiatives that assist international efforts to reduce emissions.

It is imperative to acknowledge that carbon offsets must not supplant endeavors aimed at directly mitigating emissions via strategies such as energy efficiency, adoption of renewable energy, and sustainable behaviors.

The second (first being carbon offsets) and most effective tool to soften the assault of climate change are **Carbon pricing instruments** that impose a monetary value on GHG emissions. By making emissions costly, Carbon pricing deters emissions and pushes people and companies to embrace greener methods. The most common forms of carbon pricing are (i) Direct pricing and (ii) Indirect pricing (as shown in below figure).

16.2 Carbon Pricing Instruments Operating Worldwide:

Investment in cleaner options. In this chapter the authors describe the carbon pricing instruments that have been implemented by different countries over various time spans since the inception of the concept of carbon trading. Carbon pricing instruments are categorized into two parts -Direct and Indirect Pricing.

Direct pricing includes carbon taxes and emission trading schemes, where a price is directly set on carbon emissions. Indirect pricing involves measures like reducing fuel subsidies and increasing fuel taxes, which indirectly incentivize lower emissions. The Others category includes some strategies that might not directly impose a price on emission but yet help to cut emissions.

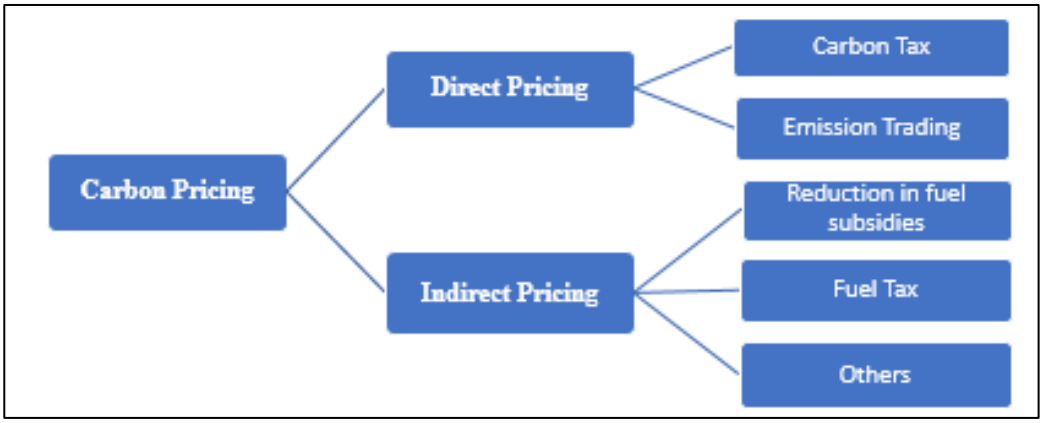

Figure 15.1: Carbon Pricing Instruments Operating Worldwide

16.2.1 Direct Carbon Pricing:

Direct carbon pricing drives climate action by providing an incentive to reduce emissions. By incorporating social costs (i.e., damage caused by GHG emissions) into economic decision-making, carbon pricing is a critical policy intervention that can help address climate change and provide broader environmental, fiscal, and social benefits.

Pricing can be implemented through a range of instruments with a spectrum of policy designs to meet national objectives and circumstances. The most significant direct carbon pricing tools are (i) Carbon Tax and (ii) Emission Trading.

A. Carbon Tax:

A carbon tax is a fee imposed on businesses and individuals that emit greenhouse gases. It imposes a direct cost on the carbon content of fossil fuels thus making the usage of fossil fuels like coal, oil and natural gas more expensive. This higher cost incentivizes companies and consumers to reduce their carbon footprint by switching to cleaner energy sources or adopting more energy-efficient practices.

Carbon Tax was first proposed in the year 1973, but was first implemented in the year 1990. Countries like Denmark, Finland, Sweden, Netherlands and Norway were the first adopters of carbon tax (as shown in below Table1). India has not yet introduced any carbon tax but has placed a tax on both imported and domestically produced coal since 2010 (Ellerbeck, 2022).

Economists and international organizations support carbon taxes as they are simpler to implement and can lead to greater reductions in carbon emissions while having less of a detrimental impact on economic growth (Dong et al., 2017; Guo et al., 2014; Lin & Li, 2011; Wittneben, 2009).

The Organization for Economic Co-operation and Development (OECD) defines carbon tax as "an instrument of environmental cost internalization. It is an excise tax on the producers of raw fossil fuels based on the relative carbon content of those fuels". Carbon tax a pollution tax (Deepa R, 2023), is an efficient instrument to transfer losses caused by GHG emissions to those responsible for such emissions. It raises the direct cost of buying energy supplies like natural gas, petrol and home heating fuel and indirectly increases the price of other carbon-intensive goods and services (Baranzini et al., 2017; Yu et al., 2024).

Carbon tax has dual impacts. Firstly, it incentivizes the substitution of fuel products, leading to shifts in energy production and consumption structures, fostering energy conservation and investment in improving energy efficiency. Secondly, it affects investment and consumption patterns through the allocation of revenue generated from the carbon tax. Carbon Tax also called as Carbon fee, Carbon support price, Fuel charge etc. has been implemented by different countries under various names and formats starting from 1990 and in many countries, it is still under consideration.

The growing trend underscores the rising recognition of carbon taxation as an effective mechanism for reducing GHG emissions. This trend signals a growing alignment with international frameworks such as the Paris Agreement, showcasing carbon taxation as a weapon against climate change.

Carbon taxes around the world target various GHGs depending on the emission profiles and priorities of each country. Carbon dioxide (CO_2), the primary contributor to global emissions, is the most commonly taxed gas, as it results from fossil fuel combustion and industrial processes. Some systems also include methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs,) and sulphur hexafluoride (SF_6). Certain jurisdictions, such as Poland, Denmark, Japan and British Columbia Singapore etc adopt an inclusive approach by covering all major GHGs under their carbon tax.

In 2022, carbon taxes generated substantial revenues globally, with countries like France (US$8400 million), Finland (US $1734 million), Norway (US$2157 million) and Sweden (US$2343 million) etc. Following is the list of Carbon Taxes in operation.

Table 16.1: Global Carbon Tax Implementation

Sr. No.	Country Name	Start Date	Gases Considered	Government revenue in 2022 (US $)
1	Finland carbon tax	1990	CO2	1,734 million
2	Poland carbon tax	1990	All	7 million
3	Norway carbon tax	1991	CO2, CH4, HFCs, PFCs	2,157 million
4	Sweden carbon tax	1991	CO2	2,342 million
5	Denmark carbon tax	1992	All	468 million)
6	Slovenia Carbon tax	1996	CO2	85 million
7	Estonia carbon tax	2000	CO2	2 million
8	Latvia carbon tax	2004	CO2	8 million
9	Switzerland carbon tax	2008	CO2	1,617 million
10	BC carbon tax	2008	CO2, CH4, N2O, HFCs, SF6, PFCs	1,757 million
11	Liechtenstein carbon tax	2008	CO2	5 million
12	Albania Carbon tax	2008	N/A	N/A
13	Iceland carbon tax	2010	CO2, HFCs, PFCs	55 million
14	Ireland carbon tax	2010	CO2	874 million
15	Ukraine carbon tax	2011	CO2	113 million
16	Japan carbon tax	2012	All	1,800 million
17	UK Carbon Price Support	2013	CO2	927 million
18	France carbon tax	2014	CO2	8,400 million
19	Mexico carbon tax	2014	CO2	217 million
20	Spain carbon tax	2014	HFCs, PFCs, SF6	77 million
21	Portugal carbon tax	2015	CO2	495 million
22	Chile carbon tax	2017	CO2	0 million
23	Colombia carbon tax	2017	All	113 million
24	Zacatecas carbon tax	2017	All	28 million
25	Argentina carbon tax	2018	All	314 million
26	South Africa carbon tax	2019	All	115 million
27	Singapore carbon tax	2019	All	146 million

Sr. No.	Country Name	Start Date	Gases Considered	Government revenue in 2022 (US $)
28	Northwest Territories carbon tax	2019	CO2	35 million
29	Canada federal fuel charge	2019	All	5,896 million
30	Netherlands carbon tax	2021	CO2, N2O	0 million
31	Luxembourg carbon tax	2021	CO2	287 million
32	Uruguay CO2 tax	2022	All	255 million
33	Queretaro carbon tax	2022	All	N/A
34	State of Mexico carbon tax	2022	CO2, CH4, N2O	N/A
35	Yucatan carbon tax	2022	All	N/A
36	Guanajuato carbon tax	2023	N/A	0 million
37	Hungary Carbon tax	2023	N/A	N/A
38	Taiwan carbon fee	2024	N/A	0 million
39	Durango carbon tax	2024	N/A	0 million

Source: State and Trends of Carbon Pricing Dashboard (https://carbonpricingdashboard.worldbank.org/compliance/instrument-detail)

B. Emission Trading Scheme (ETS) or Cap &Trade:

ETS is defined as a market-based mechanism used for reducing GHG emissions by putting a limit on the number of emissions from different entities within a compliance period. It follows the principle of Cap & Trade. Under this system, a cap is set on the total emissions allowed, and entities can trade emission allowances within that limit. This cap limits the amount of GHGs that can be emitted by covered sectors, creating a finite number of emission allowances. Governments distribute these allowances, either freely or through auctions, which regulated entities must use to cover their emissions (Narassimhan et al., 2018). As shown in the picture, a emission cap is being provided by the government. Entity 1 is emitting below the cap and earning allowances which can further be traded while Entity 2 is emitting beyond the prescribed cap and has to buy the allowances from the carbon market. Through flexible trading, ETS programs seek to give industry a financial incentive to implement cleaner technology and lower emissions. They have been put into practice at various levels, usually modified according to the specific environmental and economic circumstances of each jurisdiction as shown in Table2. The system is designed to achieve cost-effective and reliable emission reductions while incentivizing low-carbon energy and technology adoption (Jiang et al., 2016).

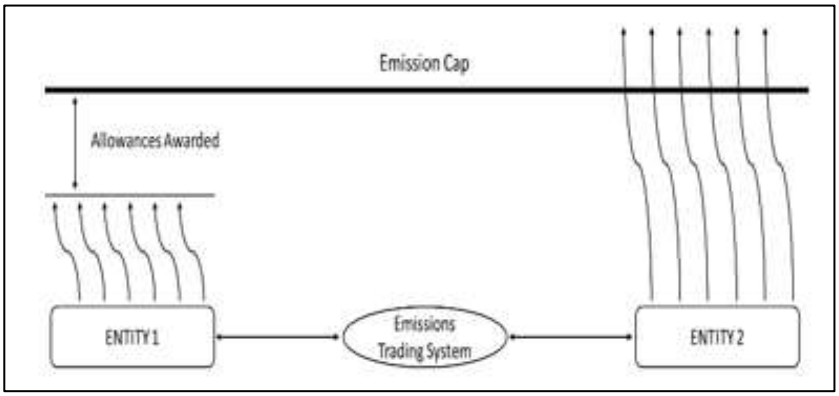

Figure 16.2: Emission Trading Scheme (ETS) or Cap &Trade

ETSs accounted over 70% of global government carbon pricing revenues, primarily due to the greater amounts of emissions they cover, and because of the high price levels in large ETSs, like the EU ETS. ETS has proven to be a critical tool for combating climate change and achieving global climate goals of carbon net zero by 2030.

The goal to achieve net-zero carbon by 2030 is to balance the quantity of GHG emissions that are released into the atmosphere means reducing emissions from activities like burning fossil fuels for energy and transportation etc. to near-zero levels. To achieve this ambitious target, countries and businesses would need rapid transition to renewable energy sources, improve energy efficiency, and adopt carbon pricing techniques.

Since the launch of the EU ETS in 2005, which generated a substantial $42,838 million in 2022, ETS mechanisms have proliferated across regions, signalling a strong commitment to carbon pricing as a policy solution.

Key systems like the UK ETS ($8,061 million) and Germany ETS ($7,076 million) illustrate the effectiveness of established markets in reducing emissions while generating significant revenues for reinvestment in climate initiatives.

This global expansion of ETS frameworks not only incentivizes emission reductions but also creates a pathway for countries to meet ambitious climate targets while fostering economic opportunities in low-carbon innovation.

Table 16.2: Global Emission Trading Scheme (ETS) implementation

Sr. No.	Country Name	Start Date	Gases Considered	Government revenue in 2022 (US $)
1.	EU ETS	2005	CO2, N2O, PFCs	42,838 million
2.	Alberta TIER	2007	All	476 million
3.	Switzerland ETS	2008	All	47 million
4.	New Zealand ETS	2008	All	1,406 million

Sr. No.	Country Name	Start Date	Gases Considered	Government revenue in 2022 (US $)
5.	RGGI	2009	CO2	1,194 million
6.	Tokyo CaT	2010	CO2	0 million
7.	Saitama ETS	2011	CO2	0 million
8.	California CaT	2012	All	4,027
9.	Quebec CaT	2013	All	1,069
10.	Kazakhstan ETS	2013	CO2	0 million
11.	Shenzhen pilot ETS	2013	CO2	4 million
12.	Shanghai pilot ETS	2013	CO2	22 million
13.	Beijing pilot ETS	2013	CO2	18 million
14.	Guangdong pilot ETS	2013	CO2	128 million
15.	Tianjin pilot ETS	2013	CO2	13 million
16.	Hubei pilot ETS	2014	CO2	14 million
17.	Chongqing pilot ETS	2014	All	13 million
18.	Korea ETS	2015	All	262 million
19.	BC OBPS	2016	N/A	N/A
20.	Fujian pilot ETS	2016	CO2	0 million
21.	Massachusetts ETS	2018	CO2	54 million
22.	Newfoundland and Labrador PSS	2019	All	0 million
23.	Canada federal OBPS	2019	All	93 million
24.	Nova Scotia OBPS	2019	N/A	42 million
25.	Saskatchewan OBPS	2019	All	0 million
26.	Mexico pilot ETS	2020	CO2	0 million
27.	Germany ETS	2021	CO2	7,076 million
28.	UK ETS	2021	CO2, N2O, PFCs	8,061 million
29.	China national ETS	2021	CO2	Not available
30.	New Brunswick OBPS	2021		0 million
31.	Ontario EPS	2022	All	Not available
32.	Montenegro ETS	2022	CO2	Not available
33.	Austria ETS	2022	All	Not available

Sr. No.	Country Name	Start Date	Gases Considered	Government revenue in 2022 (US $)
34.	Australia Safeguard Mechanism	2023	CO2, CH4, N2O, HFCs, SF6, PFCs, Other	0 million
35.	Washington CCA	2023	All	0 million
36.	Indonesia ETS	2023		0 million

Source: State and Trends of Carbon Pricing Dashboard (https://carbonpricingdashboard.worldbank.org/compliance/instrument-detail)

C. Emissions Covered by Carbon Tax and ETS:

By 2024, carbon pricing mechanisms globally cover 24% of GHG emissions (12.8 GtCO2e), with ETS contributing 19% and carbon taxes 6%. This demonstrates the growing adoption of market-based strategies to combat climate change. This highlights the significant role of carbon pricing in addressing climate change, with ETS playing a dominant role in the global effort to regulate and reduce emissions. This graph depicts the percentage of global GHG emissions covered by carbon pricing mechanisms, specifically through Emissions Trading Systems (ETS) and carbon taxes, from 1990 to 2024. The Y axis shows the percentage of global emissions covered, while the X axis shows the emissions in gigatonnes of CO_2 equivalent ($GtCO_2e$).

Carbon tax is represented by red bars, ETS by Blue bars while the purple bar shows the overlapping between the two instruments.

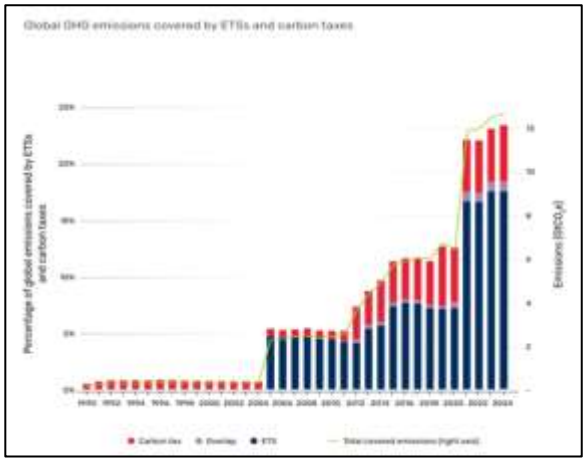

Figure 16.3: Emissions Covered by Carbon Tax and ETS

Till 2004 the coverage is seen to be minimal and constant but it began to rise significantly after 2005 when Kyoto Protocol officially came into force. Both ETS and carbon taxes started to gain momentum globally.

The green line shows the total emissions covered by these policies, showing a steady increase over the years, with sharp rises around 2015 and another significant increase post-2020. This increase is a clear indication of the growing use of carbon pricing as a climate change mitigation strategy. With both ETS and carbon tax systems, the graph depicts how the reliance on carbon pricing mechanisms to regulate and reduce GHG emissions globally is continuously rising.

16.2.2 Indirect Pricing Techniques:

Indirect carbon pricing refers to policies that alter the cost of goods responsible for carbon emissions in ways that are not exactly proportionate to the relative emissions of those goods. These tools are mainly used for social and economic goals, including increasing revenue and reducing air pollution, while giving a carbon price signal. It includes fuel and commodity taxes, as well as fossil fuel subsidies affecting energy consumers (World Bank, 2024).

Major components of indirect carbon pricing include: (1) Reduction in fuel subsidies (2) Fuel Taxes and (3) Others. Subsidy reform includes reducing subsidies on fossil fuels. By reducing these subsidies, governments can make fossil fuels more expensive, thereby encouraging consumers and businesses to shift towards cleaner and more sustainable energy sources.

This shift can lead to reduced greenhouse gas emissions and a more sustainable energy landscape. Fuel taxes are levied on fossil fuels based on their carbon content. By increasing the price of fossil fuels, these taxes incentivize consumers to shift towards less carbon-intensive energy sources, such as renewable energy or electric vehicles. Moreover, governments are taking actions for vehicle emissions standards, building energy codes, and appliance efficiency standards etc. for betterment of future generations.

16.3 Conclusion:

Carbon pricing instruments have emerged as powerful tools in the global fight against climate change. By encouraging cleaner production methods and fostering innovation in low-carbon technologies, carbon pricing instruments not only drive emissions reductions but also generate revenue that can be reinvested in sustainable development projects or used to mitigate the socio-economic impacts of climate policies. Total revenues generated by direct pricing instruments in 2023 was USD 104 billion out of which ETS contributed US$75 billion and Carbon Tax US$29 billion.

Countries such as Sweden, which has implemented a high carbon tax, and the European Union, through its Emissions Trading System, have demonstrated the potential of these instruments in achieving climate targets. However, challenges such as policy design, equitable implementation, and global coordination remain critical to their success. This paper explores the role, effectiveness, and future potential of carbon pricing mechanisms in mitigating climate change and fostering sustainable economic growth. As countries continue to grapple with the urgent need to reduce emissions, carbon pricing offers a promising pathway towards a sustainable future.

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