INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY
ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 4)
Available online at: https://www.ijariit.com

Role of Carbon Markets in India to meet its Climate Commitments

Aaditya Gupta
aadityagupta003@gmail.com
Delhi Public School, New Delhi, Delhi

ABSTRACT

This paper is an exploratory study to understand the key features of a carbon market and the context in which a carbon market can possibly be introduced in India. The paper examines the potential for a Pilot Carbon Market in India based on a review of existing global carbon markets and an understanding of the attempts by the Indian authorities to usher in market-based instruments for emission control. In this context, the paper recommends a specific pilot and incorporates the views of a few stakeholders to get a sense of its feasibility.

Keywords: *Carbon markets, Greenhouse gases, Carbon trading, Emissions trading scheme, Carbon dioxide, Carbon dioxide equivalent, Pilot markets*

1. INTRODUCTION

This paper is an exploratory study to understand the key features of a carbon market and the context in which a carbon market can possibly be introduced in India. The paper examines the potential for a Pilot Carbon Market in India based on a review of existing global carbon markets and understanding of the attempts by the Indian authorities to usher in market-based instruments for emission control. In this context, the paper recommends a specific pilot and incorporates the views of a few stakeholders to get a sense of its feasibility.

2. BACKGROUND

2.1 The Paris Agreement

To address the climate change challenge, several countries came together at the Paris climate conference in 2015 to adopt an international agreement that required deeper emissions reduction commitments than the Kyoto protocol (1997). The agreement aimed to limit the global temperature rise to 2 degrees Celsius--while making best efforts to keep it to 1.5 degrees Celsius--by the second half of this century. To achieve this goal, 188 nations and the EU , which together are responsible for 97 percent of global emissions, had submitted their climate commitments and the agreement contained provisions to hold countries accountable for the same.

The Paris climate agreement came into force on November 4, 2016. The Agreement allows signatories to use market-based mechanisms for GHG (Green House Gases) mitigation. Ninety-six countries made commitment for the use of market-based or price-based mechanisms in their national climate plans (also known as Nationally Determined Contributions or NDCs).

It establishes a new activity based Sustainable Development Mechanism (SDM) for countries to meet their NDC goals by using emission reduction credits. Like the earlier Clean Development Mechanism (CDM), this mechanism allows private sector participation in GHG mitigation, and channels a share of the proceeds from the SDM from the developed countries to meet the cost of adaptation in vulnerable developing countries.

allows voluntary trading between countries in their effort to meet their NDC goals. If a country overachieves by reducing more GHG emissions than its target, it can sell to an underachieving country the right to emit its excess emission reduction as an "internationally traded mitigation outcome" (ITMO).

2.2 India's Nationally Determined Contributions (NDC's)

India's international climate commitments include (a) reducing greenhouse gases (GHG) emission intensity of GDP by 33-35% by 2030 (compared to 2005 levels), (b) increasing the share of non-fossil energy sources to 40% by 2030. Toward this end, India has set a target to install over 175 GW of renewable energy by 2022, with a more recent announcement that it aims to have 450 GW of renewables by 2030. (WRI India, January,2020) and (c) to create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 e through additional forest and tree cover by 2030.

India has since adopted policies and plans to meet its commitments. With a successful adoption of its National Electricity Plan (NEP) in 2018, India remains on track to achieve its 2-degree Celsius compatible rated Paris Agreement climate action targets. According to the analysis of the Climate Action Tracker, given India's plans and policies, its share of non-fossil power generation capacity will reach 60-65% by 2030 and its emission intensity by that year will be ~50% below the 2005 levels, which is beyond its commitment.

2.3 What is Carbon Trading?

In response to the growing threat of climate change due to global warming, which in turn results from the emissions of carbon dioxide and other greenhouse gases, some economists came up with the idea of creating a financial incentive system to curb carbon emissions by establishing tradable rights to emit carbon.

What is carbon trading? Carbon trading, also known as the Emissions Trading Scheme, is a market based system aimed at reducing greenhouse gases--particularly carbon dioxide emitted by burning fossil fuels--that contribute to global warming. The mechanism involves placing a cap on emission at the country level or company level and allowing counties or companies to emit more than their respective (allotted) caps *only if* they can buy carbon credits from those countries or companies that emit less than their caps in any given period of time. The trade occurs at a price determined transparently by the market. Like in any other commodity, the price of carbon credit reflects its relative scarcity. This mechanism serves two purposes: (a) it allows authorities to set and achieve pre-determined limits on aggregate carbon emission at a country level or region level or industry level and (b) it creates incentives for emitters of carbon to become more emission efficient (that is, to produce same level of output with less carbon emission). Carbon markets are now the largest class of environmental or emissions trading markets in the world, in terms of both volume and market value, by a very wide margin. As of September 2017, carbon markets covered about 10 percent of global GHG emissions and two thirds of the carbon pricing initiatives. (World Bank, 2017b)

3. NEED FOR CARBON MARKETS IN INDIA

India, which is still a developing economy, is highly vulnerable to the impacts of climate change, because of the high priorities it accords to accelerated economic growth, and thereby create millions of jobs, mitigate widespread poverty, improve public health, and ensure energy security. Furthermore, given India's large population size, and its (already) high growth trajectory, it is reasonable to expect a sharp increase in aggregate emissions in the 'business as usual' scenario over the next decade or so, even though its current per capita emissions of 2.4 tCO2 is relatively low, as compared to world average of 6.3tCO_2e (WRI, 2018 b). This coupled with India's vulnerability to climate change creates a strong case for India to develop a low carbon pathway for its growth and economic development. In this context, it has already begun to be recognized in India that carbon pricing is one of the key tools to facilitate a low carbon transition and meet climate targets at the lowest costs, and that India ultimately needs a national carbon market.

4. ESTABLISHING A CARBON MARKET IN INDIA

Where does one start? For an emerging market like India, the first step towards designing and implementing a national carbon market, would perhaps be to run pilot and simulation programs, as was done in the case of China (see below). In this respect, a review of both international and domestic experience may be useful to draw valuable lessons.

4.1 Lessons from international experience

4.1.1 Lessons from global experience: Carbon markets are now underway in over 50 jurisdictions around the world that are home to over 1 billion people. The turnover in global emissions trading has risen over the years and has hit a record high of $214 billion in 2019 (five times greater than in 2017), according to analysts at Refinitiv. (https://carbon-pulse.com/). The growth of the market has varied widely across the globe and over time. What are the important lessons to be learnt from the global experience?

4.1.2 Key takeaways from the EU ETS- The largest Global Carbon market: Of all jurisdictions where the carbon markets have been introduced, the EU experience is the most significant, mainly because the European Union's Emissions Trading Scheme (EU ETS) has to this point dominated the marketplace, with far greater volumes and liquidity than any other market place. In 2019, for example, it accounted for about 80 percent of the global traded volume. What are the key features of the scheme that contributed to its success?

Flexibility Notably, the EU ETS follows an experiential learning approach, which probably accounts for a large part of its success. At the heart of the experiential learning approach is the high level of flexibility that EU ETS allows to accommodate local diversities and competing priorities. Over time, as different states and actors developed capacity, the market has moved progressively towards higher efficiency by adopting a single EU-wide target. Considering the diversity of its industrial sectors as well as competing mandates among key stakeholders, India can design a carbon market with a long term vision while accommodating for flexibility in the short term and improving efficiency over time.

Single authority Another key aspect of the EU ETS is the presence of one single authority, European Commission, which drafts the framework and structure of various aspects of the carbon market. With multiple actors involved in the Indian legislative processes as well as climate action, it would be critical to ensure a single regulating authority for the carbon market that coordinates amongst the various actors, in order to ensure transparency, efficiency and accountability. *Free allocation of allowances* Finally, as in the case of the EU ETS, allocation of allowances in India can be made free while preparing regulated entities for auction based allocation in the future. (Hingne, 2018). In the EU, this proved to be a key factor in the success of the market.

4.1.3 Key takeaways from pilots and simulations in China: China being an emerging market like India, the Chinese experience of Pilot markets would be very valuable for India. In 2013-2014, China instituted 7 regional pilots in 5 cities. The pilot regions were intentionally selected to be at varying stages of development. The authorities in charge of the pilots were given considerable leeway to design their own schemes, while the ultimate goal was to enable China to develop a nationwide ETS. The Pilots had a significant variance in approach to issues such as the coverage of sectors, allocation of allowances, price uncertainty and market stabilisation, potential market power of dominated players, use of offsets and enforcement and compliance. Some of the elements common to all pilots include sectoral coverage, the use of free allowances and flexibility provisions such as banking of allowances. Furthermore, all seven pilot ETS's cover both direct emissions from fossil fuel use and emissions attributable to electricity use, including those from electricity generated outside their boundaries. (Zhang, 2015)

The volume and value of allowances traded varied widely across the pilots in 2018. (as seen in Exhibit 1). Different price levels are the result of differences in cap stringency and market confidence. In most pilot regions, the majority of trading occurred in quarter 2 or quarter 3, which coincides with the compliance deadlines in those pilots as seen in Exhibit 1.

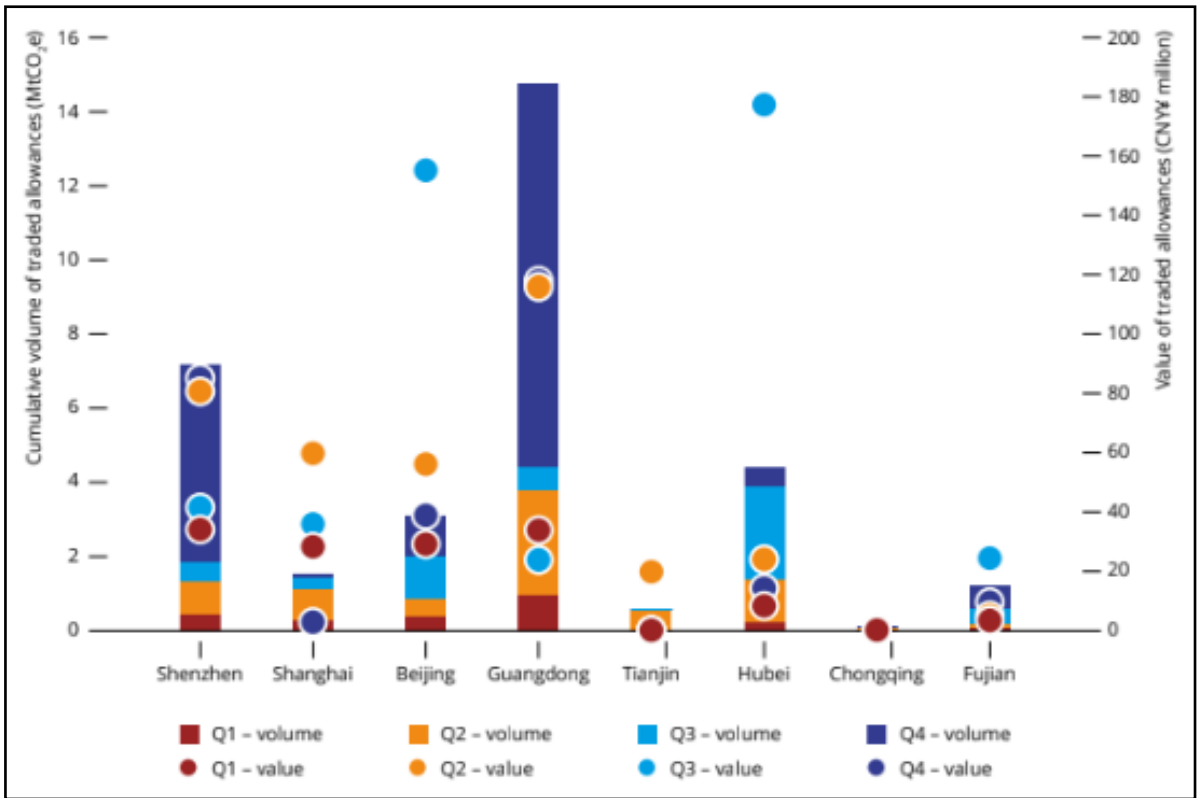


Exhibit 1: Cumulative trading volume and value of the Chinese ETS pilots in 2018

Source: "State and Trends of Carbon Pricing 2019" State and Trends of Carbon Pricing (June), World Bank, Washington, DC.
The crucial learnings that emerged were that educating the covered entities, strictly enforcing compliance rules, and ascribing allowances as financial assets and defining their duration of validity are crucial to enabling active participation in carbon emissions trading. China launched its national ETS in December 2017.

4.2 Review of Indian Experience with Market Mechanisms

4.2.1 Current Market Mechanisms in India: India has already introduced domestic decarbonisation instruments such as Clean Energy Cess, Perform Achieve Trade (PAT) and Renewable Energy Certificate (REC). One way of introducing a domestic carbon market at this stage is to design it in such a way as to supplement the efforts already made. This can best be done by extending the regulations to emission sources that are not already covered under any of the existing schemes.

4.2.2 Pilot scheme in the state of Gujarat: In India, while an implicit carbon tax (national clean energy cess) has already been implemented, additional considerations on a 'cap and trade' scheme are being made to accelerate progress towards India's NDCs. The first Pilot Emissions Trading Scheme (and the only one so far) has been for *particulate matter.* This pilot has been carried out for selected industries in Surat in the state of Gujarat. The salient features of the scheme, which was implemented in 4 phases, are:

- Launched by The Gujarat Pollution Control Board (GPCB) on 15th July 2019.
- It started by setting up the continuous emissions monitoring systems (CEMS) framework as a pilot cluster (Phase 1) and using it for collection of emissions data and effective regulation. (GPCB Circular, 2019)
- The Surat ETS began with two months of mock trading to allow for intensive stakeholder capacity building before coming into full force on September 15,2019, with the design of a sophisticated trading platform in partnership with the National Commodities and Derivatives Exchange.
- Exhibit 2 shows, the parameters set by GPCB, for the 3rd compliance phase. (Parameters for 4th Compliance phase-1st January,2020-31st March,2020, not yet available)

Exhibit 2: Baseline parameters set by regulator in Gujarat pilot. (16TH NOVEMBER-31stDecember, 2019)

Participating Units	Emissions Cap	Free Permit Supply (80% of total)	Auctioned permits (20% of total)	Initial Auction Price	Ceiling Permit price	Floor Permit Price
158	276 tons	220.8 tons	55.2 tons	Rs 5000/ton	Rs100000/ton	Rs5000/ton

Source: GPCB Circular, July 2019

The Surat ETS was an improvement over existing regulation as it aimed to (a)reduce particulate emissions by 29% from existing levels(362 tons per month to 280 tons per month) (b) lower the costs of reducing particulate emissions (c) Increase average Industry profits and every industry's profits, relative to status quo regulations.

4.3 Structured engagement with stakeholders

Engagement of authorities with stakeholders who are directly or indirectly affected by the program and the stakeholders' active involvement are a vital step in implementing the pilot program. The key stakeholders included the participating industries, the trade regulators and policy makers. Views of academics at the time of market design was unavoidable. This experience of the Gujarat scheme will be very helpful while implementing Pilots for carbon trading.

4.4 Study of the key carbon emitting sectors

A more recent study to identify (a) the range of greenhouse gases released, (b) key carbon emitting sectors (c) the source of emitting industries and (d) their proportional contribution of emissions to the economy would need to be carried out, as the pattern of emissions differ not only across sectors and regions, but also across time. Such a study was last carried out in 2014. India's emissions in 2014 were a little more than 2.6 million Gg of CO_2 e of GHG's without Land Use, Land use Change and Forestry (LULUCF). The net national GHG emissions after including LULUCF were 2.3 million Gg of CO2e. LULUCF sector remained a net sink as about 12% of the emissions were offset by the carbon sink action of forestland, cropland and settlements. Absolute and relative contribution to emissions by different sectors is presented in Exhibit 3 and Exhibit 4.

Exhibit 3: Greenhouse gas emissions by sectors in India in 2014(Gg)

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
TOTAL without LULUCF (Gg)	**1,997,891.85**	**-**	**20,005.35**	**475.29**	**1.59**	**2.61**	**0.71**	**0.004**	**2,607,488.12**
TOTAL with LULUCF (Gg)	**2,015,107.88**	**319,860.23**	**20,053.54**	**476.71**	**1.59**	**2.61**	**0.71**	**0.004**	**2,306,295.43**
1. ENERGY	1,844,705.03	-	2,133.37	65.35	-	-	-	-	1,909,765.74
2. IPPU	153,186.81	-	177.85	10.36	1.59	2.61	0.71	0.004	202,277.69
3. AGRICULTURE	-	-	14,709.78	349.39	-	-	-	-	417,217.54
4. LULUCF	17,216.04	319,860.23	48.19	1.42	-	-	-	-	-301,192.69
5. WASTE	-	-	2,984.35	50.18	-	-	-	-	78,227.15
Memo Item (not accounted in total Emissions)	**812,030.60**	**-**	**0.11**	**0.11**	**-**	**-**	**-**	**-**	**812,067.87**
International Bunkers	4,943.53	-	0.11	0.11	-	-	-	-	4,980.81
Aviation	3,681.65	-	0.03	0.10	-	-	-	-	3,714.12
Marine	1,261.88	-	0.08	0.01	-	-	-	-	1,266.69
CO_2 from Biomass	807,087.06	-	-	-	-	-	-	-	807,087.06

Source: India's Second Biennial Update Report to the UNFCCC

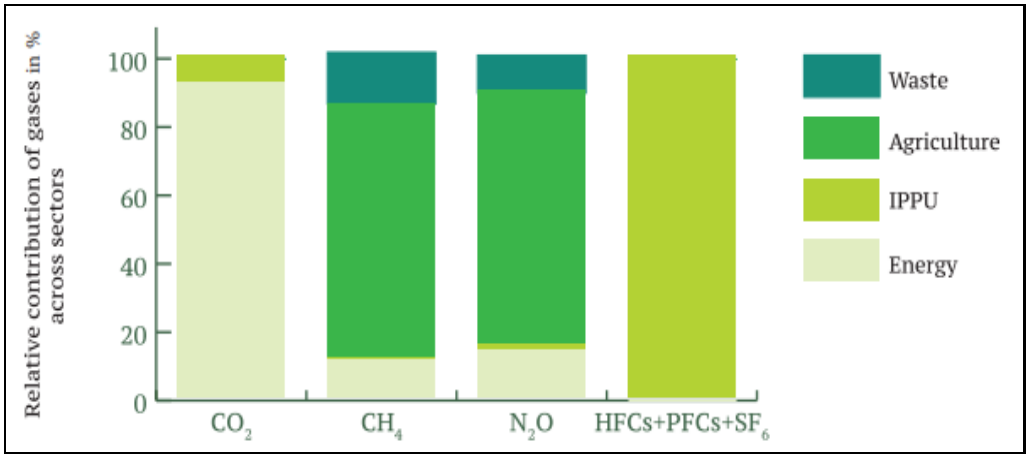


Exhibit: 4 Relative contribution of various GHG's by individual sectors (excluding LULUCF) for the year 2014

Source: https://unfccc.int/sites/default/files/resource/INDIA%20SECOND%20BUR%20High%20Res.pdf

From the Exhibit 3 and 4, it is clear that:

- The Energy sector accounted for 73% of the total GHG emissions for the year 2014. Within energy industries, 94.96% of emissions were from electricity production.
- The Industrial Processes and Product Use (IPPU) category accounted for 8% of the total GHG emissions. Within IPPU, cement production is the largest emission source accounting for about 57% of total IPPU sector emissions.
- In the Transport Sector, road transport accounted for 90.1% of the total emissions. (India: Second biennial update report to the United Nations Framework convention on climate change, 2018)

5. CHOOSING A PILOT CARBON MARKET

Based on the sectoral GHG emission study in 2014, a pilot carbon market with the following specifics has been considered.
Area: The city of Durgapur, district Burdwan in West Bengal.
Sector: Iron & Steel
Pollutant: Carbon Dioxide

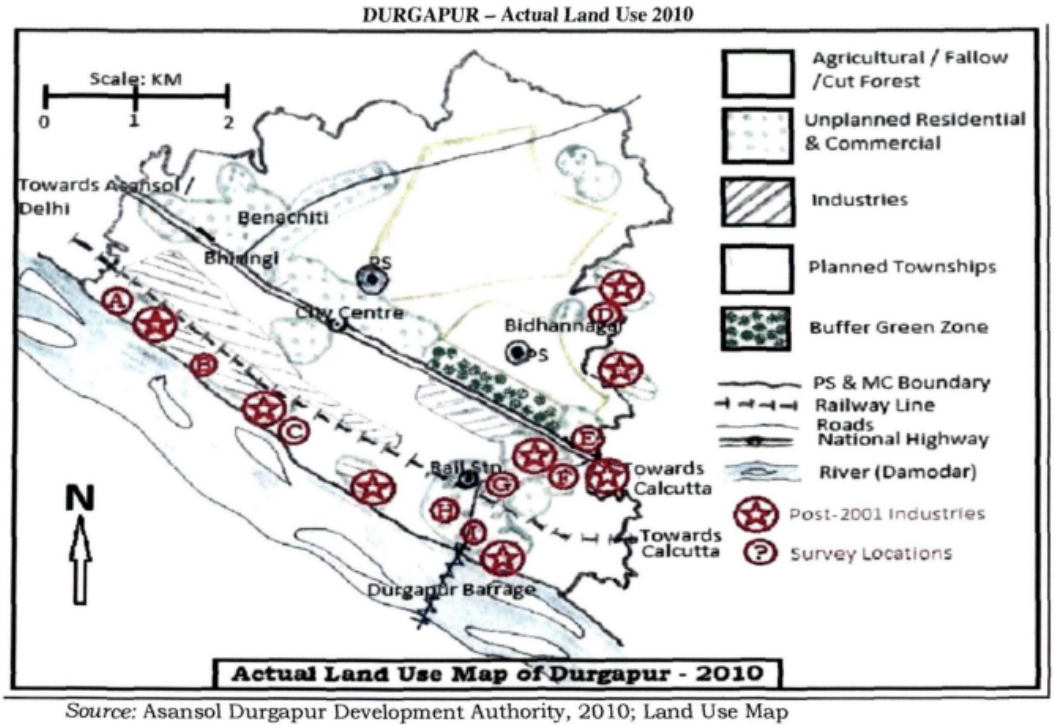
Exhibit 5: Location of Durgapur, West Bengal, India

5.1 Reason for choosing Durgapur for implementing a Pilot Carbon Market

Durgapur known as "*the Ruhr of India*"

Durgapur is undoubtedly, one of the most industrialised cities in Eastern India; it is fairly well known outside India also. It houses a wide range of industries, although it is popularly known as the Steel City of eastern India. The industrial output as well as

diversity in Durgapur has risen sharply in the last decade. This has given rise to increased pollution and emissions. The land use pattern as shown in exhibit 6, shows the already expansive industrial usage of land in Durgapur until the year 2010. Further, industrial land use has increased from 12.75 sq.km in 2008-2009 to 31.4 sq km in 2014-2015.



Source: Asansol Durgapur Development Authority, 2010; Land Use Map

Exhibit 6: Land Use Map of Durgapur

The industries located in Durgapur include major emitters, such as Iron and Steel, and Cement which are the ideal candidates for the implementation of a carbon market. Durgapur has two key steel plants Durgapur Steel Plant (DSP) (SAIL) and Alloy Steel Plant(ASP) with their respective townships. There are a number of power plants, chemical and engineering industries and many small-scale factories as well. Apart, from the core and large-scale industries Durgapur has a large number of small-scale Iron and Steel manufacturing industries which would be the main candidates for the pilot carbon market. Exhibit 6, shows a list of some of the industries that are the potential candidates in Durgapur for such a simulation project.

Exhibit 6: Small Scale Industries in Durgapur

Name	Product
Adhunik Corporation Limited	Sponge Iron
Durgapur Adhunik Ispat Pvt. Ltd.	TMT Bars, Coils
Bhagat Jee Steels(P)Ltd.	Mild Steel, Ingot
Bhaskar Shrachi Alloys Ltd.	Ferro Alloys
C.P. Re-Rollers Ltd.	TMT Bars, Ingot
Jai Balaji Sponge Ltd.	Sponge Iron, Pig Iron,Mild Steel, Billets
Jwala Steel Pvt Ltd.	
Jolla Steels Pvt. Ltd.	Ms Ingot
Kajaria Pig Iron plant	Pig Iron
Shivam India Pvt. Ltd.	Ms Billets, TMT rods
Shri Ramrupal Balaji Steels Ltd.	Pig iron, Thermax TMT Bars
Shyama Sel Ltd.	Ms Ingot
Shyam Steel industries Ltd.	Billet & TMT Bars
ShakamBari Overseas Trade(P)Ltd.	Ms.Ingot
SPS Metal Cast & Alloy Ltd.	Ms. Ingot
SPS Steel & Sponge Ltd.	Sponge Iron &Billet
SPS Steel Rolling mills Ltd.	Elegant Brand TMT Bars
Super smelters Ltd.	Ms rod, TMT Bars
Neo Metallics Ltd.	Pig Iron

Source: http://www.durgapurcity.co.in/industries.html

Visit for complete listing

The preliminary emissions data available indicate that the main emission from Iron and Steel manufacturing units is carbon dioxide, which makes it a suitable candidate to be targeted by the pilot. The data of carbon dioxide emissions for the energy sector in India (Table 1: Annexure), shows manufacturing industries and construction together emitted 351,909.54 Gg CO_2e, which was 18.4% of the total emissions from the energy sector.

The CO2 emissions from the Iron and Steel industries for India in 2014 were 153883.85 Gg and the emissions equivalent to CO2 were 154677.9 Gg, which is 43.9% of the total contribution to the emissions from the manufacturing industries. Hence, it is beneficial to target the iron and steel sector taking into account the proportion of emissions it accounts for amongst the sub-categories.

Views of Stakeholders

INDUSTRY

Dilip Agarwal

Director, Super Smelters Ltd., Durgapur

How many mills/furnaces are there in the Durgapur belt?

There are approximately 90-100 mills/furnaces in the Durgapur Belt and most of them are small and medium scale industry.

If we conduct now a pilot program in Durgapur for the Steel industry, would people be encouraged to participate?

Possibly, not. They are not sufficiently aware about carbon credit. The awareness deficit must be addressed first.

Currently what pollution devices are you using to monitor your emissions?

a) Electronic Precipitator Device (ESP): a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases: DRI, CPP, Pellet
b) Bag Filter – SMS, Ferro
c) Dust Extraction System (DRI)
d) Dust Separation System (DRI)
e) Dry Fog System-Raw Material Handling area, DRI, Ferro, CPP

What Emission Norms are you following under current policies?

Steel companies are required to install specified pollution control equipment/facilities and also operate well within the prescribed Standards/Norms in respect of air, water and noise pollution as well as solid waste generation and utilization. These are monitored by Central/ State Pollution Control Boards.

Source: http://moef.gov.in? Environment/pollution/

Should a pilot like this be implemented sector wise or geographically?

In the absence of data, it is difficult to comment on the subject.

How much activity in the market would you predict in terms of buyers and sellers?

Not enough data to comment on the subject.

POLICYMAKERS

R. R Rashmi

Former Special Secretary, Ministry of Environment, Government of India.

Distinguished Fellow and Programme Director, Earth Science and Climate Change

https://www.teriin.org/profile/rr-rashmi

Do you think Carbon trading is workable in India?

It appears now that it might begin to work, as there is greater awareness about the positive impacts of such markets on the achievement of environmental goals through offsets. However, there is still uncertainty on whether the demand will be adequate and how the statutory regulations shape up.

What are the requirements for a good carbon market?

There should be a clear policy for moderating or driving down CO_2 emissions in line with national or corporate goals. Participation by companies should be mandated or voluntary depending on our goal. It should not remain limited to the consumers of PAT (perform achieve trade) scheme; a larger number of industries should be incorporated. Transparency in availability of emissions data will play a big role in the success of the market. Because, if industries share their emissions data through a public platform without the confidentiality of the data being compromised, regulation will be effective.

What are the risks?

There may be a concern that investments made by participants in carbon credits might not be profitable if there are too many barriers or restrictions on demand. Price of carbon credits may not be high enough to make investment attractive. Further, Government may not give adequate price incentive and financial support, which may be necessary at early stages

How should the pilot be implemented?

The pilots should be implemented Sector wise. This will help in getting a sense to the relevant units being subjected to equal degrees of compliance, as similar industries with similar emission patterns will get clubbed together for the purpose of regulation.

TRADE INFRASTRUCTURE
Stock Market Expert
Do you think carbon trading is workable in India?
Yes, this is a workable option in any jurisdiction including India, provided the government has sufficient will to introduce it. A key factor for trading on a platform such as an exchange or on over-the-counter to be successful is that the product to be traded must be standardized and must be well understood by buyers and sellers. Carbon credit satisfies both the criteria. Secondly, there must be scarcity in the product to be traded. This can be done easily by setting caps at appropriate level. As regards the government's will to introduce market-based instruments for pollution abatement, there is sufficient evidence of it in India.
What are some of the challenges you foresee in the implementation of a carbon market?
At the initial stage, the absence of a large number of potential buyers and sellers may result in the market being too thin, which in turn may affect efficient price discovery. This can be overcome over a period of time through appropriate changes in regulations aimed at raising volumes in the market.
Government regulation will have a pivotal role to play in the successful implementation of such a trading platform.
Besides, the Government needs to have a long-term plan for the introduction of this market. This would require considerable work, which can be done by experts who have hands-on experience.
Introducing the market at a time when the economy is slowing down (such as now) would be more challenging, because most companies would be producing less than in normal times and emitting less and hence, not enough carbon credit would be available for trading.

5.2 Key focus areas to make pilot successful
On the basis of lessons learnt from programs like EU ETS and the Chinese pilots we were able to identify that four areas would be especially important for the successful implementation of a trading pilot scheme. They are:

- **Setting the cap -** The target for aggregate emissions from the iron and steel sector where trading will be introduced must be set to produce reasonable prices and emissions reductions.
- **Allocating Permits -** The permits to emit must be distributed in an equitable way to build support for the scheme.
- **Monitoring -** The quantity of emissions from each industrial plant must be reliably and continuously monitored.
- **Compliance -** The regulatory framework must make industries confident that buying permits is the only way to meet environmental obligations. (Esther Duflo, August, 2010)

Exhibit 7 shows the place of these key components within the overall structure of an emissions trading scheme. The role of the regulator is to ensure compliance rather than fixing emissions for each source.

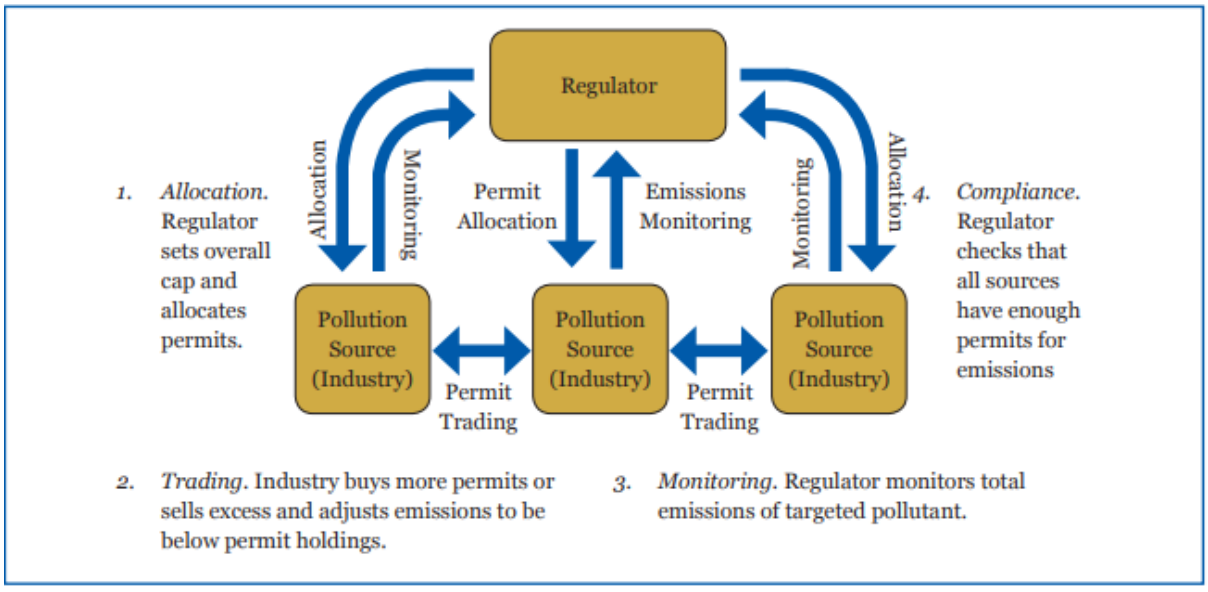


Exhibit 7: Mechanics of an Emissions Trading Scheme

Source: Duflo et al. (2010)

6. CONCLUSION

It is evident from the research that carbon markets with a comprehensive framework can aid and catalyse India's emission reduction objectives while ensuring sustainable economic growth. A carbon market will not only complement the existing emission reduction frameworks, but also help meet other policy objectives such as improving energy security, reducing health costs and decreasing climate vulnerability as well as ensuring sustainable economic development. In establishing an effective carbon market, India would do well to learn from the successes and mistakes from other countries. In this respect, the use of pilot projects emerges as the most feasible starting point. The pilots will allow all parties to test policies, systems and institutions; build capacity; and demonstrate effectiveness. The benefit of a pilot is that it provides real on ground evidence that is relevant to the local economic and market conditions. Insights gained from the Pilots would be invaluable for the success of the carbon market.

7. ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude and appreciation to Professor Shreekant Gupta, Delhi School of Economics, Delhi University for inspiring me to undertake this Research Paper. His guidance enabled me to develop an understanding of the structure and functioning of Carbon Markets and hence successfully complete this research paper.

I would also like to thank Mr. R.R. Rashmi (Former Special Secretary, Ministry of Environment, Government of India) and Mr. Dilip Agrawal (Director, Super Smelters, Durgapur) for sharing their valuable inputs on the possibilities and potential of Carbon Markets in India.

8. REFERENCES

[1] Duflo, Esther, Rohini Pande, Michael Greenstone and Nicholas Ryan (2010). "Towards an Emissions Trading Scheme for Air Pollutants in India: A Concept Note," MoEF Discussion Paper. Retrieved from https://ideas.repec.org/p/ess/wpaper/id3178.html

[2] Gujarat Pollution Control Board (GPCB) Circular No. GPCB-ETS-CEMS-/MOC(1)/527333 dated November 19, 2019. Retrieved from https://gpcb.gujarat.gov.in/uploads/ GPCB_ETS_CIRCULAR_19112019.pdf

[3] Hingne, A. (2018). Carbon Markets In india - Exploring prospects and Design considerations. Retrieved from https://shaktifoundation.in/wp-content/uploads/2018/ 07/Briefing-paper-Carbon-markets-in-India.pdf

[4] India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change . Ministry of Environment Forest and Climate Change, Government of India, (2018).

[5] Michael Greenstone, Rohini Pande, Nicolas Ryan, Anant Sudarshan, "The Surat Emissions Trading Scheme," EPIC India. Retrieved from https://epic.uchicago.in/wp-content/uploads/2019/10/ETS_INDIA_ResearchSummaryFinal-.pdf

[6] Report, U. N. (n.d.). Retrieved from https://unfccc.int/resource/docs/2015/cop21/eng/l09r01. pdf

[7] World Bank Report, "State and Trends of Carbon Pricing", Washington D.C, June, 2019

[8] Retrieved from https://issuu.com/world.bank.publications/docs/9781464814358

[9] WRI India. (2020). Retrieved from https://indiaghgp.org/sites/default/files/ Concept%20Note %20-%20Carbon%20Market%20Simulation.pdf

[10] Zhang, Z. X. (2015). Carbon emissions trading in China: the evolution from pilots to a nationwide scheme. *Climate Policy*, 15:S104-S126.

ANNEXURE

Table 1: Table of India's CO_2 AND CO_2e emissions for the energy sector for the year 2014(values in Gg)

Column1	CO_2 emission	CO_2 Equivalent
TOTAL without LULUCF(Gg)	1997891.85	2607488.12
1. ENERGY (Gg)	1844705.03	1909765.74
A. Fuel Combustion Activities	1844705.03	1871708.65
1. Energy Industries	1135357.11	1140983.46
a. Electricity production	1078153.76	1083437.78
b. Refinery	49969.71	50051.3
c. Manufacturing Industries & Construction	7233.64	7494.38
2. Manufacturing Industries & Construction	350211.44	351909.54
a. Cement	46857.24	47044.77
b. Iron & steel	153883.85	154677.9
c. Nonferrous metals	1749.59	1756.94
d. Chemicals	1994.09	2002.1
e. Pulp & paper	3866.91	3886.04
f. Food & beverages	NE	
g. Non-metallic minerals	NE	
h. Mining & quarrying	3227.15	3237.98
i. Textile/leather	3542.1	3558.14
j. Bricks	2665.71	2678.8
k. Fertilizer	5999.76	6028.47
l. Engineering sector	419.99	421.28
m. Nonspecific Industries	126005.04	126617.12
n. Glass Ceramic	NE	
3. Transport	245845.66	250172.79
a. Road transport	221282.86	225445.85
b. Civil Aviation	13861.21	13983.44

Column1	CO_2 emission	CO_2 Equivalent
c. Railways	7618.43	7648.35
d. Navigation	3083.17	3095.17
4. Other sectors	113290.83	128642.85
a. Commercials/Institutional	25379.95	25489.2
b. Residential	85538.86	85725.5
c. Agricultural/fisheries	2372.01	2383.05
d. Biomass burnt for energy		15045.1
B. Fugitive emission from fuels		38057.09
1. Solid Fuels		16546.56
a. Above ground mining		10988.67
b. Underground mining		5557.89
2. Oil and Natural Gas		21510.53
a. Oil		1660.35
b. Natural gas		16118.61
c. Venting and Flaring		3731.57

Source: https://unfccc.int/sites/default/files/resource/INDIA%20SECOND%20BUR%20High%20Res.pdf

