INNOVATION CARBON EMISSIONS TO ZERO: STRATEGIES TO ACHIEVE CARBON NEUTRALITY

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Introduction

Humans collectively emitted 37 billion metric tons of carbon dioxide in the year 2021[1]. With global temperatures rising, it is critical that we act on limiting this increase to two degrees when compared to pre-industrial levels. Carbon dioxide's role in accelerating the greenhouse gas effect to cause global warming is well documented, as is the scientific consensus that it is necessary to reduce carbon emissions if the world is to avoid a climate-induced catastrophe. The question then becomes, how can we reduce emissions in a way that causes the least disruption to the economy and livelihood of some of the most vulnerable people across the globe? Governments across the world have explored various options to put a cost on pollution. Carbon pricing is one such strategy that has been successfully immolated across many jurisdictions and diverse economies.

In the face of escalating climate change concerns, the urgency to address greenhouse gas emissions and curb global warming has never been more pressing. Carbon cap and trade, a market-based approach to tackling carbon dioxide (CO2) emissions, has emerged as a promising solution to achieve substantial reductions while fostering economic growth. This article explores the concept of carbon cap and trade, carbon offsets, its underlying principles, and its potential as an effective tool for climate mitigation.

The Problem in Numbers

Carbon emissions from factories are urgent and substantial issues contributing to the global climate crisis. According to the International Energy Agency (IEA), industrial activities account for approximately one-fourth of global CO2 emissions[2]. The manufacturing sector alone contributes nearly 21% of global CO2 emissions, with energy-intensive industries such as steel, cement, and chemicals being significant contributors[3]. For instance, the production of cement is responsible for around 8% of global emissions and releases approximately 2.8 billion metric tons of CO2 annually[4]. Moreover, the burning of fossil fuels for energy in factories and industrial facilities results in the release of large quantities of greenhouse gases, further exacerbating the problem.

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[1] https://www.statista.com/statistics/276629/global-co2-emissions/#:~:text=Global%20carbon%20dioxide%20emissions%20from,by%20more%20than%2060%20percent.

[2] https://www.iea.org/topics/industry

[3] https://www.iea.org/topics/industry

[4] https://www.iea.org/topics/industry

The carbon emissions from factories contain not only CO2 but also other potent greenhouse gases like methane (CH4) and nitrous oxide (N2O), which have a significantly higher global warming potential. For example, the chemical industry releases substantial amounts of methane, a greenhouse gas with a global warming potential of over 25 times greater than CO2[5] over a 100-year period. Additionally, industrial processes often involve the use of ozone-depleting substances, which contribute to the destruction of the ozone layer, leading to adverse effects on human health and the environment. The cumulative effect of these emissions from factories amplifies the global climate crisis and underscores the urgent need for effective mitigation strategies and sustainable industrial practices.

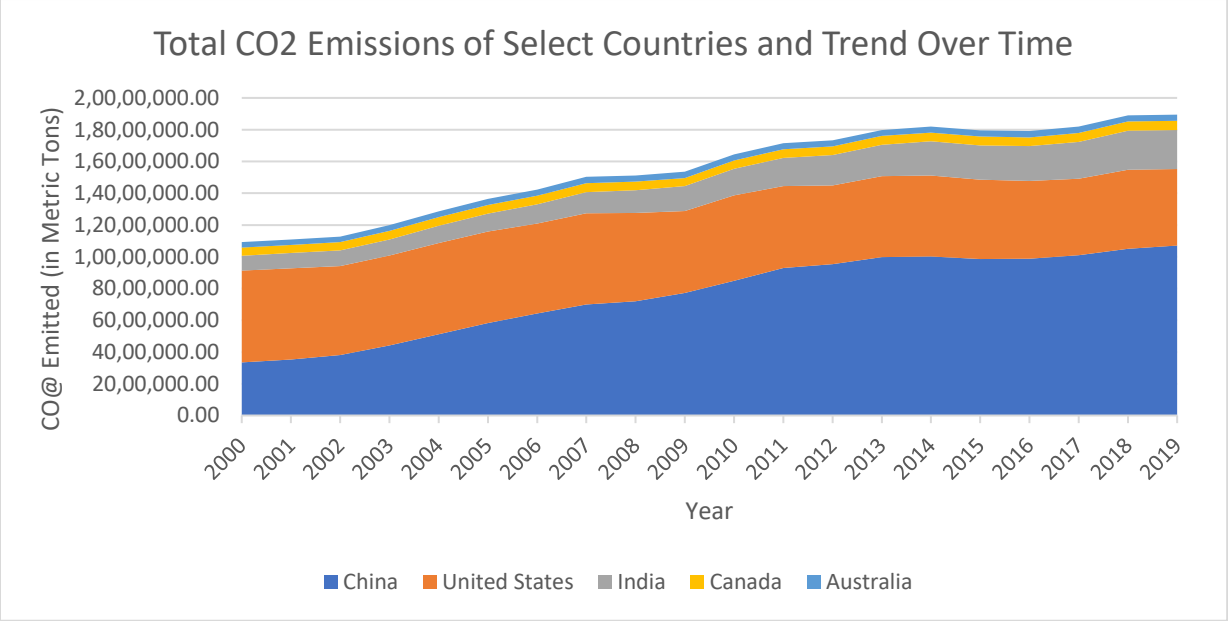


Figure 1: Historically, developed countries have been the most responsible for pollution. However, in recent years, developing countries have sacrificed environmental concerns for rapid economic growth. While pollution has increased, the rate of growth has slowed down in recent years because of increasing concerns for the environment and stronger legislative actions.

Cap and Trade: An Economically Efficient Way to Price Pollution

Carbon cap and trade, also known as emissions trading, is a market mechanism designed to regulate and reduce greenhouse gas emissions. The fundamental idea is to establish a cap, or limit, on the total amount of carbon emissions allowed within a specified jurisdiction or industry. This cap is typically set by governments or regulatory bodies based on scientific targets and climate goals. To facilitate emission reductions, the cap is gradually lowered over time, creating a declining emissions trajectory. Within this

[5] https://www.epa.gov/gmi/importance-methane#:~:text=Methane%20is%20the%20second%20most,trapping%20heat%20in%20the%20atmosphere.

framework, companies and organizations are allocated tradeable permits or allowances that correspond to their permitted emissions. They can then buy, sell, or trade these permits among themselves in a carbon market, creating a market-driven incentive to reduce emissions efficiently.

The strength of the cap-and-trade system lies in its ability to incentivize emission reductions cost-effectively while promoting innovation and economic growth. By creating a market for carbon allowances, businesses can find the most affordable ways to reduce emissions. Companies with lower emission levels can sell their excess allowances to those struggling to meet their targets, encouraging cleaner technologies and practices. This dynamic incentivizes emissions reductions where they are most efficient and allows for flexibility and adaptation in a changing economic landscape. Moreover, the revenue generated from the sale of permits can be reinvested in clean energy initiatives, infrastructure development, and sustainable projects. This will support the transition to a low-carbon economy.

Carbon cap and trade has garnered significant international attention as a powerful policy tool to combat climate change. Several successful cap and trade programs have been implemented worldwide, notably the European Union Emissions Trading System (EU ETS), which covers a range of industries across Europe[6]. In addition, countries such as Canada[7], Japan[8], and China[9] have adopted/are developing their own cap and trade systems. However, challenges such as accurate emissions monitoring, ensuring fair distribution of allowances, and preventing market manipulation must be carefully addressed to maintain the integrity and effectiveness of carbon cap and trade systems on a global scale.

[6] https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en
[7] https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work.html
[8] https://icapcarbonaction.com/en/ets/japan-tokyo-cap-and-trade-program
[9] https://chinadialogue.net/en/climate/the-first-year-of-chinas-national-carbon-market-reviewed/

How Does Cap and Trade Work

Cap and trade works by setting a limit (cap) on the total allowable emissions from a certain group of sources, such as power plants. Permits, also known as allowances, equal to this cap are distributed among these sources. Each permit allows the holder to emit a specific number of pollutants.

Example Illustrating Cap and Trade

Table 1:

Power Plant	Allocated Permits	Actual Emissions	Unused Permits	Permit Price
Plant A	100	80	20	$10(Selling)
Plant B	150	120	30	$10(Selling)
Plant C	50	50	0	-
Plant D	-	-	-	$10(Buying)

In Table 1, "Allocated Permits" refers to permits granted to each power plant, "Actual Emissions" represent real emissions produced, "Unused Permits" indicates unutilized allowances, and "Permit Price" indicates market value. Now, envision three plants: Plant A, Plant B, and Plant C. The government sets a stringent 300-unit pollution cap. Plant A secures 100 permits, Plant B obtains 150, and Plant C attains 50.

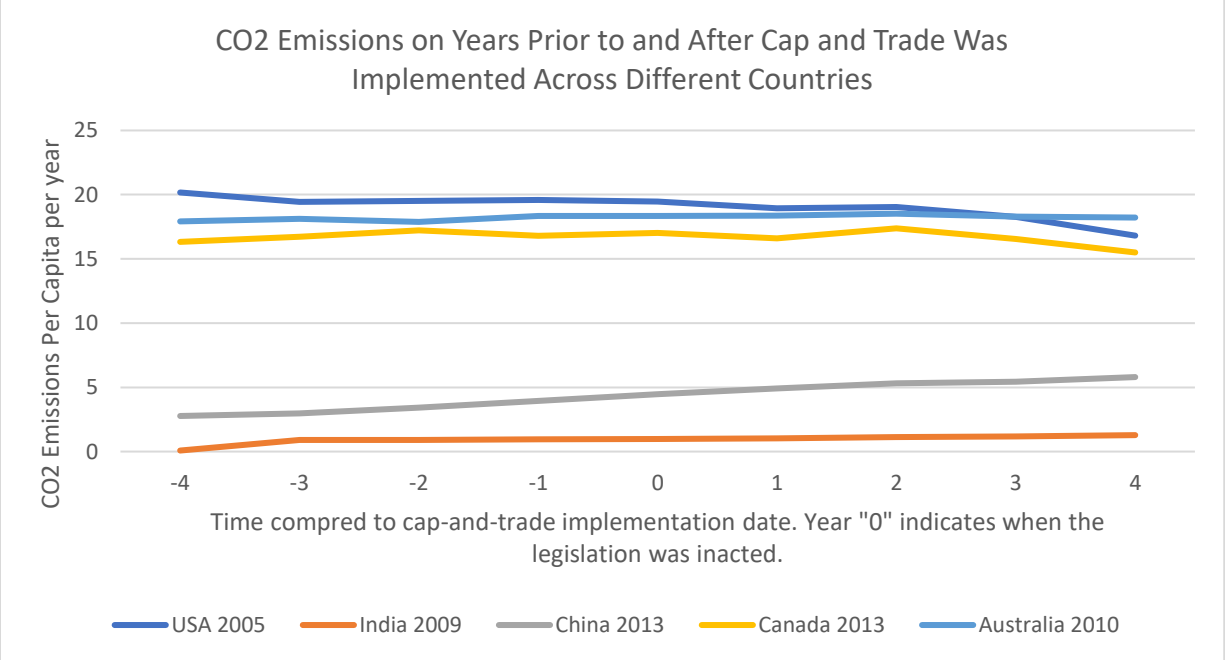
Imagine Plant A reduces emissions, using only 80 permits. Plant B adopts eco-friendly tech, consuming 120 permits. Plant C, however, exhausts its 50 permits. Notably, 50 permits go unused between Plant A and Plant B. These unused permits can be sold to other companies that might exceed their allocated limits. For instance, consider Plant D, if it exceeds allocated permits and is ready to purchase and pay $10 per permit from Plant A and Plant B, it will cost Plant D $500 to emit more pollutants while Plant A and B would earn $200 and $300 respectively.

Incentives for Emission Reduction and Innovation

This system incentivizes companies to innovate and reduce emissions. If Plant A figures out a way to further decrease emissions, it can sell its excess permits to other companies for a profit. Conversely, if a plant struggles to reduce emissions, it can buy permits but at a cost-- usually determined by market forces, thus this system encourages emission reductions and rewards cleaner practices. In this manner, cap and trade encourage overall emissions reduction while allowing flexibility for companies to choose the most cost-effective path toward meeting their emission reduction targets.

Evidence of Cap-and-Trade's Success: Data from Select Countries

While cap-and-trade has a sound theoretical framework, how accurately does it translate into reality? Evidence from historically large polluters has shown that cap-and-trade is a particularly effective strategy for developed nations looking to reduce per capita emissions. The USA, Canada, and Australia all observed reductions in per capita emissions once cap-and-trade rules were implemented. In developing countries like India and China, the policy has done little to slow per capita emissions. However, it is critical to consider these statistics in parallel with improved socioeconomic conditions to ensure a fair comparison. It is fair to say that the increase in emissions in emerging economies has been slower than the economic growth rate. While cap-and-trade may not be the "be-all and end-all" solution to pollution that policymakers across the globe are looking for, it is an important tool to limit CO2 emissions into the atmosphere. A good cap-and-trade program aggressively and progressively reduces the number of permits available each year, ensuring that over time, it is more expensive to pollute, and corporations invest in technologies that are friendlier to the environment.



References:[10,11,12,13,14]

[10] https://www.macrotrends.net/countries/USA/usa/carbon-co2-emissions
[11] https://www.macrotrends.net/countries/IND/india/carbon-co2-emissions
[12] https://www.macrotrends.net/countries/CAN/canada/carbon-co2-emissions
[13] https://www.macrotrends.net/countries/AUS/australia/carbon-co2-emissions
[14] https://www.macrotrends.net/countries/CHN/china/carbon-co2-emissions

Other Models of Pricing Pollution

Various other models like emissions trading and border carbon adjustments are also in practice.

Carbon Pricing Model	Description
Carbon taxes:	A carbon tax is a fee charged on the carbon content of fossil fuels. The tax is typically assessed per ton of CO2 emitted and can be levied at different points in the supply chain (e.g., at the point of extraction, refining, or consumption).
Cap-and-trade	Cap-and-trade systems set a limit, or cap, on the total amount of carbon emissions allowed within a jurisdiction. Companies are then given a certain number of emissions permits, which they can buy and sell on a carbon market.
Emissions trading	Emissions trading is like cap-and-trade but without a fixed cap on emissions. Instead, companies are required to purchase a certain number of emissions credits based on their carbon footprint. The market sets the price for these credits, which can fluctuate based on supply and demand.
Border carbon adjustments	Border carbon adjustments (BCAs) are tariffs or taxes on imported goods that are produced in countries with weaker carbon pricing or emissions regulations than the country where the goods are being imported.
Carbon offsets	Carbon offsets allow companies or individuals to purchase credits or certificates that represent the reduction or removal of greenhouse gas emissions elsewhere.

Community-Based Forests: A Tried and Tested Model to Introduce Carbon Offset.

Community-owned forests are forest lands owned, managed, and used by local communities. These forests can include a variety of land types, including natural forests, plantations, and agroforestry systems. According to the Food and Agriculture Organization (FAO), an estimated 25% of the world's forest area is under community-based management. Community-based Forest management has been found to be associated with lower rates of deforestation and forest degradation. One study found that community-

managed forests in Mexico had a deforestation rate of -0.163% per year[15], compared to a national average of 0.5%[16].

Community-owned Forest management can also benefit local communities economically. For example, in Nepal, community forestry has been estimated to provide over 1 million jobs and contribute to over 2% of the country's gross domestic product (GDP).

In Indonesia, community-based forest management has been associated with improved forest health and reduced carbon emissions. A study by the Center for International Forestry Research (CIFOR) found that forests managed by indigenous communities in the country had lower rates of deforestation and degradation and stored more carbon per hectare than forests managed by the government or private companies.

In the United States, community-based forest management is increasingly used for climate mitigation and adaptation. The US Forest Service's Community Forest Program, for example, has helped to establish over 200 community forests in 31 states, providing a range of benefits such as carbon sequestration, improved water quality, and recreational opportunities[17].

Carbon-Negative Nation: A Case Study of Bhutan

Since 2009, Bhutan has consistently been a carbon-negative nation. This hilly nation's constitution mandates that a minimum of 60% of land in the country is covered by forests; the figure currently stands at 70%[18]. Bhutan can maintain this level of coverage in simple yet efficient ways. Bhutan's community-based approach to forest management ensures that conservation happens at the local level. The country also fulfills most of its energy needs through hydropower projects; a sustainable alternative when compared to the use of its forest resources. In fact, the country also exports electricity to India.

Bhutan's success in being carbon-negative is greatly influenced by its policy decisions. The country currently provides free electricity to farmers in rural areas to reduce its dependency on timber. Furthermore, the country is also investing in alternative sources of energy, like solar and wind. It has also

[15] https://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1029&context=earth_environment_fac

[16] https://rainforests.mongabay.com/deforestation/forest-information-archive/Mexico.htm

[17] https://www.fs.usda.gov/managing-land/private-land/community-forest/program

[18] https://www.gvi.co.uk/blog/bhutan-carbon-negative-country-world/

announced a partnership with a major automobile producer to electrify its cars and reduce its dependency on combustion engines[19].

Bhutan's small size, along with low industrialization levels makes it ideally suited to becoming a carbon sink. However, it remains to be seen if this approach can be replicated by other nations. Bhutan is a small economy, with a population of around 700,000 people. Furthermore, the country is heavily dependent on its neighbor, India, incidentally, one of the largest polluters in the world, for many of its imports. It is therefore reasonable to question if Bhutan is "exporting" its carbon footprint to maintain a sustainable image.

Pricing Away Pollution: Best Practices

In today's rapidly moving world, signified by disruptive megatrends and technological revolutions, it is vital that policymakers debate the pros and cons of various pollution pricing strategies to optimize environmental objectives with economic ones. While there is no "one size fits all" solution when it comes to carbon pricing and reducing the overall carbon footprint, Frost & Sullivan Institute has identified the following best practices which have demonstrated a historic track record of being successful.

- Compared to other pricing strategies, cap-and-trade has seen the most success. In addition to being market efficient, this policy generally enjoys support from a broad spectrum of politicians, ensuring relative ease in enacting legislative steps.
- Free and fair auctions of carbon permits are the core pillar upon which cap-and-trade success depends. A blind auction allows the government to maximize revenue from polluters; funds which can be directed to pollution prevention strategies and other environment conservation efforts. Furthermore, this also allows corporations to determine their own costs of pollution and invest in new technologies to reduce emissions. In addition, corporations can purchase permits from other companies with higher l C02 emission efficiency.
- A progressive yet ambitious reduction of the number of permits available allows for a steady but acceptable reduction in pollution levels each year. If the figures are too low, it may lead to a scenario of "over pollution" where companies are polluting their full allocation of permits even if it is more efficient to reduce the total level of pollution. Incentives for low pollution permits may

[19] https://hir.harvard.edu/carbon-negativity-in-bhutan-an-inverse-free-rider-problem/

encourage cheating and may also result in job losses, rapid inflation, and slowing economic growth.

- A community-based approach is the best way to strengthen conservation. Countries that have adopted the community forest model have seen a reduction in deforestation while also witnessing enhanced economic benefits because of the proportionate use of their forest resources.
- Investment in alternative energy production is essential to moving towards a net carbon-negative economy. Hydropower and solar have proven particularly successful in replacing traditional fossil fuels in national grids.

Conclusion

To prevent the planet from being inhabited, it is essential to limit the post-industrial average global temperature to two degrees. To prevent large losses from climate-induced disasters, it is necessary to contain the rise to 1.5 degrees Celsius. However, it is impossible to ignore the economic and social impact of introducing hyperaggressive policies that contain environmental disasters.

Pricing pollution is one efficient way of achieving this goal. Policy tools such as cap-and-trade, carbon tax, and border carbon tax all contribute to reducing overall pollution levels globally. By introducing a free market philosophy into the cost of pollution, it is possible to reduce overall levels of pollution while maintaining a functioning economy. Furthermore, investing in renewable energy sources can also reduce carbon emissions.

In addition to reducing emissions, it is essential to increase our capacity to absorb carbon from the atmosphere. Despite multiple breakthroughs in carbon capture technology, trees, and particularly community-managed forests remain the most efficient way of removing carbon from the atmosphere. Engaging the community in conservation does not only reduce deforestation in countries like Mexico, it has caused an increase in forest area.

By implementing policy-best practices, the planet can be saved from a disastrous outcome. Policymakers have the necessary task of balancing economic growth with environmental issues. By studying and evaluating the best practices outlined in this article, it will be possible to obtain the best of both worlds where economic growth does not come at the expense of the environment and the future of the planet.