The Pigouvian Solution to Climate Change

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As humanity begins to take seriously the threat of climate change, governments around the world seek policies and practices to reduce the emission of greenhouse gasses. A potential tool for this is the concept of Carbon Pricing. Through carbon taxing and emissions trading, companies are incentivized to lower their emissions as their pollution would now come with a cost. Carbon pricing policies have seen success in other nations around the world and can serve as an example to policy proposals here in the US. By merging financial and environmental interests, it makes an invisible and often disregarded problem more present and real in everyone's lives. The consequences of climate change are far too great to be ignored any longer and a bright spotlight must shine on the true and immense cost it will have on us.

The threat of unchecked Greenhouse Gas emissions and the resulting increase in global temperatures is one of the most pressing issues facing humanity. Serious action to reduce the release of greenhouse gasses must be taken within the very near future to mitigate the disastrous effects climate change will have on our planet and our society. There are numerous policy proposals to tackle climate change, ranging from hard emissions caps to adaptation measures to reforestation efforts. Here we will be discussing the concept of carbon pricing.

In short, the purpose of carbon pricing is to reduce carbon dioxide emissions by putting an actual price on it. This is achieved through the implementation of a carbon tax on emissions or a cap-and-trade system on emissions allowances. These two policies are two sides of the same coin and are designed to make carbon emitters rethink their emissions as they now become a part of their financial planning. This works as an additional pressure to marketing concerns as people grow more aware and sensitive towards greenhouse gas pollution. Additionally, everyday consumers will have to re-evaluate the cost of their everyday energy and fuel usage and will have to reconsider their consumption habits. A discounted price of energy has been a tremendous boon to people everywhere, but that discount has spurred an unsustainable emission of greenhouse gasses and that must end if we are to continue to enjoy our supremely optimal environment.

Carbon taxes and emissions cap-and-trade are very similar in goals and foundational principle but very different in their methods. With a carbon tax, the government just sets the price of CO2 but not the quantity. While with a cap-and-trade system, the government sets the quantity of CO2 but not the price its traded at. A carbon tax can be as simple as it is effective. A fee is levied on carbon emitters or fossil fuel producers based on the amount of emissions they are responsible for. The cost of this fee is likely passed on to consumers who might adjust their buying habits as prices change. This would make greener products more favorable by comparison and tilt energy prices in favor of renewables and green energy like wind, solar, and nuclear. For example, beef is notoriously intensive in resource consumption and greenhouse gas production. If the price of carbon were to be factored into beef's final price, it would make substitutes such as the plant based "Beyond Burger" have a more favorable price point when compared to the neow higher priced beef.

A cap-and-trade system works by the government determining how much emissions it will allow without fines and dividing into an amount of carbon allowances, like tokens for one metric ton of greenhouse gasses. These tokens are then auctioned to companies at the beginning of the year to companies as they try to predict how much CO2 they will have to emit. Companies that need to emit a great deal of greenhouse gasses for their operations will have to bid a high price to ensure they can operate. If a company ends up not using all its allowances, it is able to sell that allowance to another company. This creates a greater business opportunity in using less greenhouse gasses, thus reducing a company's demand for GHG allowances. It additionally spurs demand for research and techniques to decrease greenhouse gas emissions. At the end of year, the government reclaims all issued carbon allowances and based on companies' carbon emissions, heavily fines the companies whose GHG emissions exceed the amount that they have allowances for. Carbon pricing merges environmental considerations with financial considerations, into a powerful force to drive innovations. With just a few realignments in incentive structures, the government can create win-win opportunities for businesses to operate sustainably.

The economic basis behind carbon pricing is the concept of economic externalities. The idea of economic externalities comes from the early 20th century English economist Arthur Cecil Pigou and his work *The Economics of Welfare*. An externality is a cost or benefit that affects a third party when a transaction occurs. They are like the economic "side effects" of a transaction. In this case, the cost of greenhouse gas emissions is being paid by people in environmentally sensitive places around the world and not carbon emitters and their customers. For example, carbon dioxide emitted by the burning of coal mined in West Virginia can contribute towards a storm striking the coast of Florida. In this case, the people of West Virginia reap the rewards of the coal mining and electrical generation while the people of Florida deal with the consequences of a stronger hurricane season. A Pigouvian tax seeks to re-internalize this externality; having the full cost of the transaction occur between the two parties themselves rather than affect someone else. This would make the actual cost of their pollution be a greater factor in their decision-making. Economic theory on demand states that if the price increases on carbon dioxide and carbon-intensive goods, demand will decrease and therefor

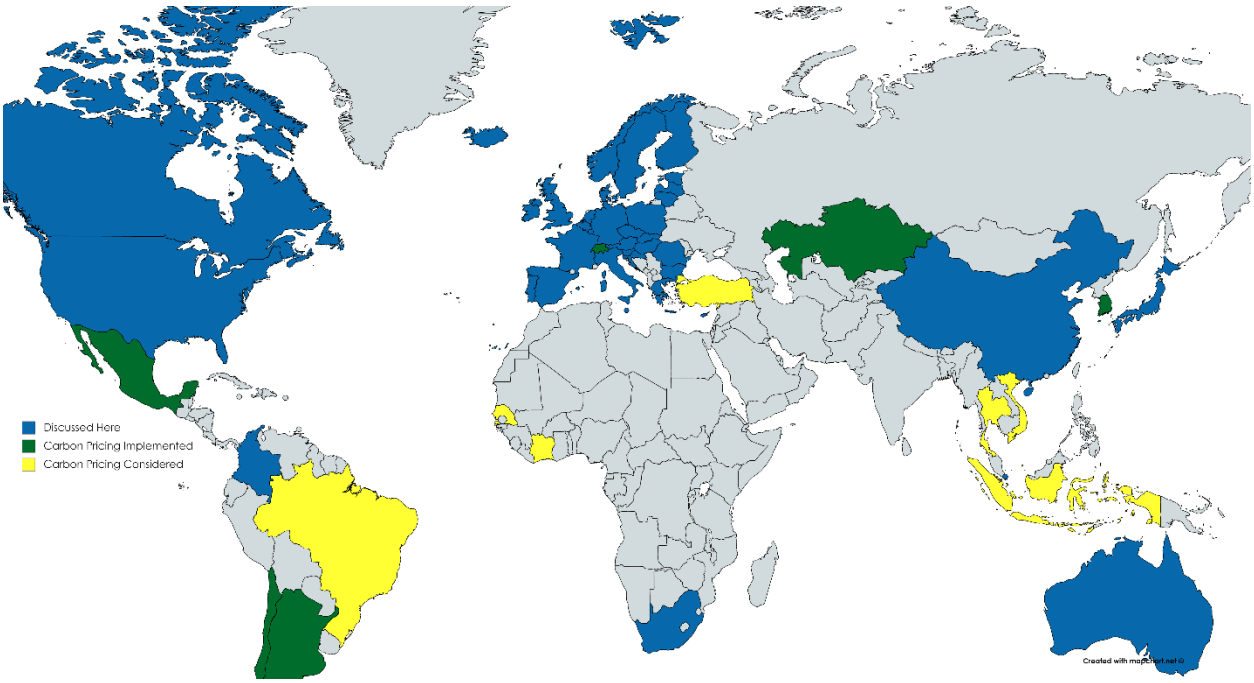
the emission of greenhouse gasses will decrease. Something to remember is that a carbon tax is not primarily meant to be a source of money for the government like an income or sales tax. It is more like "sin" taxes on cigarettes and alcohol. The main goal here is usually to decrease consumption or usage of the product being taxed, rather than to actually raise significant revenues.

Something further to consider with the greenhouse gas issue is that there are many different greenhouse gasses. These all have different effects as a greenhouse gas and are often far more powerful carbon dioxide. This effect is measured as a Global Warming Potential, a multiplier placed on an amount of gas to convert that greenhouse gas amount into a common denominator that can be compared with CO2. While over 80% of greenhouse gas emissions come from carbon, gasses like methane, nitrous oxide, and refrigerants contribute greatly with only a relatively small amount of emissions[1]. For example, a car's leaky air conditioning system may contribute more to global warming over time than its actual burning of gasoline. A farmer's herd of cows are often far more damaging than all his trucks and tractors.

Carbon pricing may sound like a new and novel idea, but carbon dioxide emissions have always had a price on them, we've just never paid for them and the Earth has been tallying this growing cost. For over a century, mankind has been accumulating a great greenhouse debt and reaping the rewards of passing payment on to future generations. The bill for this debt will come due soon, and with interest. We must work to get this debt under control and start paying it down, lest the Earth threaten us with repossession.

[1] https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Carbon Pricing Around the World



Blue countries are discussed further on in this paper. Green countries have implemented carbon pricing but aren't discussed here. Yellow countries are currently considering carbon pricing policies but have not officially enacted them.

Numerous examples of carbon pricing exist around the world and can be used as examples for new policies. By analyzing them, we can get an idea of the do's and don'ts of climate policy and learn the positive and negative effects.

CANADA

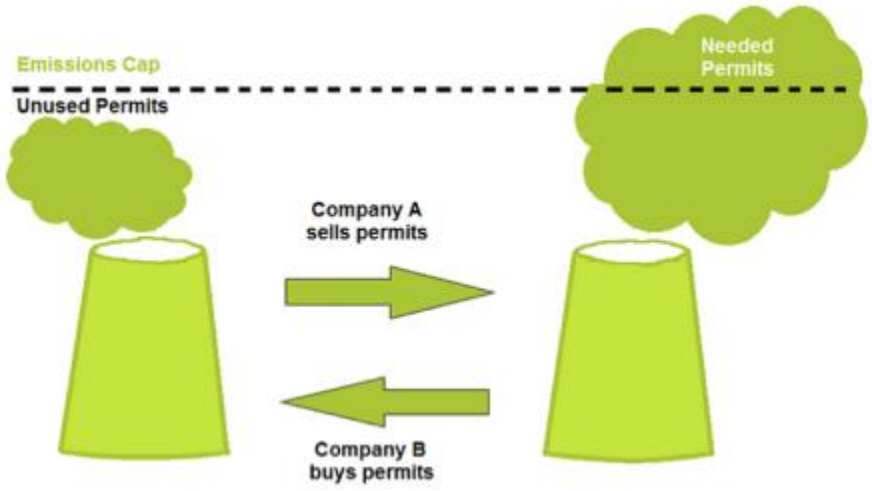
Implemented in 2018, the Greenhouse Gas Pollution Pricing Act (GHGPPA), is a federal law establishing "minimum national standards" for carbon pricing for the Canadian federal and provincial governments in order to meet emission reduction targets under the Paris Climate Agreement. This law applies these minimum standards to the provinces individual carbon tax policies as well as creating a default policy for provinces that lack one of their own. It is the latest step in a ten-year journey that started with Alberta's 2007 law mandating greenhouse gas reporting. The price of carbon started at $20/ton in 2019 but will increase by $10 per year until it reaches $50/ton in 2022. It is forecast to reduce emissions by 50-60 million tons annually by

2022, nearly 12% of total Canadian emissions. In addition, the GHGPPA returns 90% of its revenues to taxpayers, resulting in a net gain for most Canadians[2].

The Canadian carbon tax policy is notable for its usage of such a large carbon rebate coupled with the tax to return its revenues to taxpayers. This rebate helps to reduce the tax's negative affect on average people without compromising its emission reduction effect. In fact, a rebate like this possibly further incentivizes changes in consumption as now an individual profit can be made by having a smaller carbon footprint than others. This return policy is one of the only of its kind and could be adopted in other countries to make carbon taxes are more popular policy for the average person.

EUROPEAN UNION

A common thread in European carbon pricing policies is the presence of the European Union's Emission Trading System (ETS). The EU auctions off permits to emit greenhouse gases that will be returned to the government based on the emissions of each company at the end of the year. To avoid fines associated with not having the correct number of permits, companies can purchase credits from other companies that have extra unused credits.



Source: Climate Policy Info Hub[3]

[2] https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/oct/26/canada-passed-a-carbon-tax-that-will-give-most-canadians-more-money

The program was launched in 2005 but has four planned phases stretching to 2030. The ETS is currently towards the end of phase 3 and on track to meet its target of 21% lower emissions from 2005 by the end of 2020. Phase 4 will see an increased pace of emissions reduction to meet a goal of 43% reduction by 2030[4].

SWEDEN

Sweden is known for having the highest carbon tax in the world. At equivalent to US$123/ton, this far exceeds prices of other countries and even exceeds the target prices of the Paris Agreement. This price actually comes from a dual tax system made up of an energy tax from the 1930s and an addition of a carbon tax in 1991. The 1991 carbon tax was the result of a tax reform push that greatly lowered income taxes in exchange for a broad set of new taxes, as well as being environmental policy. The tax is levied by a fee on fuel based on the emissions associated with that fuel[5].

Sweden has seen great success from their carbon tax policy, with a significant reduction in greenhouse gas emissions. Meanwhile, the competitiveness of the Swedish economy is still very strong with GDP growing by 78% and emissions shrinking by 26% from 1990 to 2017[6]. In fact, the Sweden ranked 8th on the 2019 Global Competitive Index.

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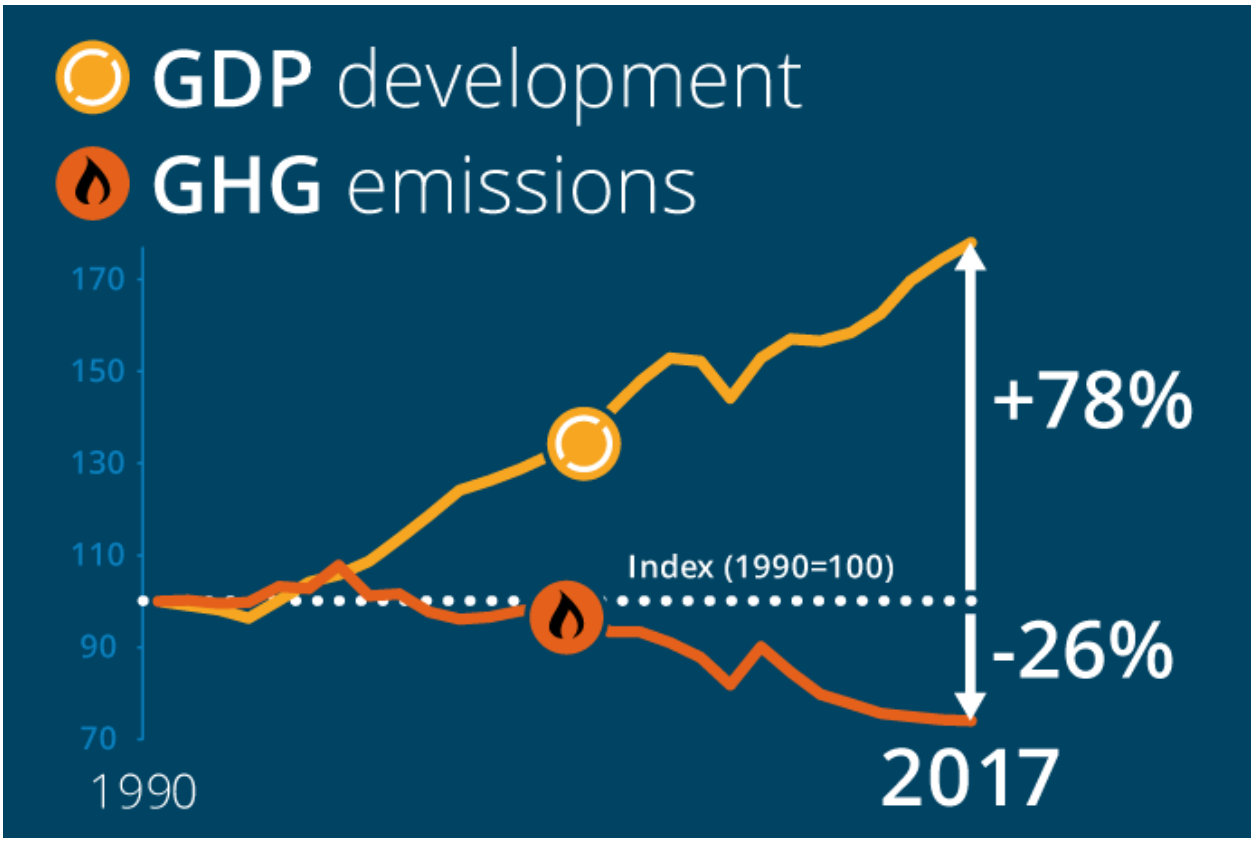
[3] https://climatepolicyinfohub.eu/eu-emissions-trading-system-introduction
[4] https://ec.europa.eu/clima/policies/ets_en
[5] https://www.carbonpricingleadership.org/blogs/2019/10/18/should-every-country-on-earth-copy-swedens-carbon-tax
[6] https://www.government.se/government-policy/taxes-and-tariffs/swedens-carbon-tax/#:~:text=Swedish%20carbon%20tax%20rates&text=The%20carbon%20tax%20was%20introduced,of%20SEK%2010.80%20per%20EUR).

% Change in Swedish GDP vs % Change in Swedish GHG Emissions



Government Offices of Sweden

As the Swedish carbon tax rate is notoriously high, there is very little support for raising the rate, but there are other possibilities for further expansion of similar policy. Currently, the Swedish Environmental Research Institute is studying the prospect of a Kilometer Tax to further reduce emissions. This would target the transport sector which has actually had an increase in emissions over the recent years.

UNITED KINGDOM

The United Kingdom implemented a carbon tax in 2013 as a supplement to the EU's Emissions Trading System (ETS), a cap-and-trade based system. The carbon tax serves as a minimum price for carbon. If the ETS price falls too low, companies pay the difference between the ETS price and the carbon tax price to the UK government.

In 2018, the tax collected £740 million for the treasury while adding an average of £39 to household electricity bills. In addition, the tax has been associated with a significant shift in UK power generation by decreasing coal-fired generation of electricity by 93%[7].

In the event of a No-Deal Brexit, the UK government has plans to implement a £16/ton tax on carbon as it would no longer be a part of the EU's ETS. This would help to maintain the UK's commitment to Greenhouse Gas reduction; however, critics point out that the proposed tax rate would be lower than the current ETS price of £26[8]. Setting the tax rate so low may be a strategy to keep businesses in the UK following Brexit but that probably would not fully counter the added difficulty of re-entering the EU market.

IRELAND

Introduced in 2010, Ireland issued a carbon tax on liquid fuels, natural gas, and solid fuels. The tax rate has periodically increased from €10/ton to €20 in 2014 and currently has been raised to €26 in 2019 for automotive fuels and 2020 for solid fuels[9].

The tax has received criticism from opponents, being described as regressive and "[making] poor people poorer". This is due to poor households spending a greater share of their income on heating and fuel which makes the tax take up a greater portion of their income than middle income or rich households[10]. The reflects a common problem with carbon taxes. They are "regressive", meaning that they impact poor people more than rich people. Problems with a carbon tax's impact on poor communities can be mitigated by a carbon rebate similar to the Canadian system.

Despite its unpopularity, Ireland has seen success with its carbon tax and other environmental taxes. 2011 saw a 6.7% decrease in emissions along with simultaneous growth in

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[7] https://phys.org/news/2020-01-british-carbon-tax-coal-fired-electricity.html

[8] https://www.forbes.com/sites/davekeating/2019/09/09/uk-to-impose-carbon-tax-after-no-deal-brexit/#13b4aa2c3ab5

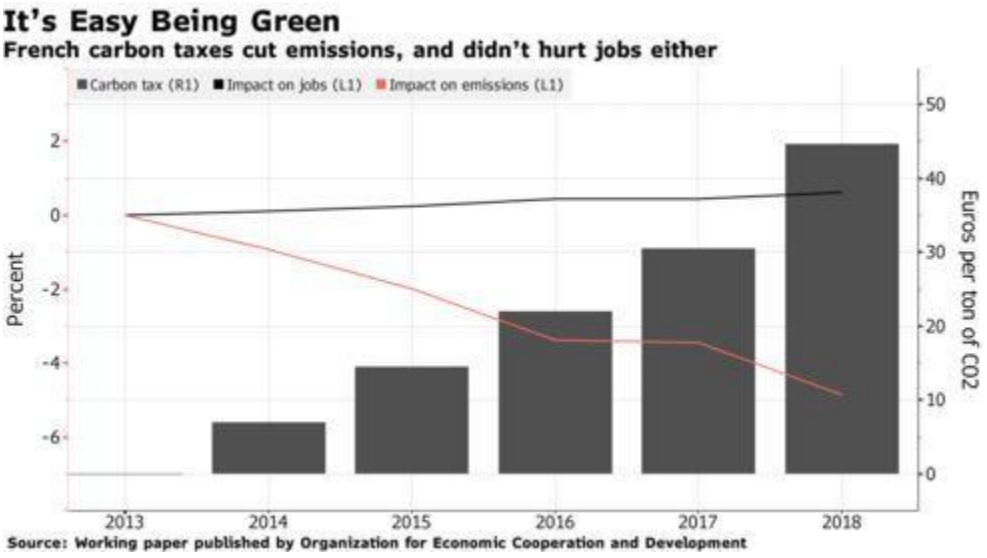
[9] https://www.citizensinformation.ie/en/money_and_tax/tax/motor_carbon_other_taxes/carbon_tax.html

[10] https://www.thejournal.ie/factcheck-carbon-tax-4995203-Feb2020/

the economy. In addition, the environmental taxes have helped to reduce the Irish governments budget deficits left from the 2008 recession[11].

FRANCE

France launched its carbon tax in 2014, originally at €7/ton but has since risen to €44.60/ton by 2018[12]. Unlike the UK system, this tax is levied on top of the EU ETS price rather than serving as a minimum price. A study showed that emissions were 5% lower than a non-tax scenario while total jobs were not affected. A hypothetical fee priced at €86/ton was also simulated to reduce emissions by 8.7%. A paper from the Organization for Economic Co-Operation and Development stated, "The analysis shows that the rise in energy prices triggers a reallocation of production and workers from energy-intensive to energy-efficient firms"[13].



Attempts to continue to increase the tax have been stalled, however. Plans to raise the tax to €86.20/ton by 2022 were met by widespread protests in 2018, known as the Yellow Vest Movement. Future increases to the tax rate will have to be done with consideration on how they will affect the public and other avenues of climate policy may need to be explored.

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[11] https://www.nytimes.com/2012/12/28/science/earth/in-ireland-carbon-taxes-pay-off.html
[12] https://www.climatescorecard.org/2020/03/the-dysfunctional-french-carbon-tax-is-frozen-at-2018-level/
[13] https://www.bloomberg.com/news/articles/2020-02-04/carbon-taxes-may-not-be-the-economic-gamble-governments-fear

Currently, there are many exemptions to the tax for various sectors and industries such as transportation and agriculture. Removal of these exemptions may increase the effectiveness of this policy without further increasing the tax rate on the public.

SINGAPORE

Singapore's Carbon Pricing Act went into effect at the beginning of 2019 at a rate of $5/ton of carbon dioxide equivalent. Plans are to review the tax in 2023 and increase the rate to between $10-15 by 2030. This rate seems quite low compared to those of other countries, but it is possible that this policy could work in conjunction with other policies to have a significant effect on emissions.

Singapore emits a great deal of greenhouse gasses for a country of its size. 2017 saw emissions of 52.5 million metric tons and projections are that 2020 will see 77.2 million tons with 60% of these emissions coming from industry. This tax will also affect electricity prices for general consumers as most of Singapore's electricity comes from natural gas[14].

Additionally, the Singaporean carbon tax would target industries for not just their CO2 emissions but their emissions of other greenhouse gasses like methane and refrigerants. By using the system of global warming potentials, the Singaporean government can apply the tax to other GHG's based on their impact on the environment.

The jury is still out on Singapore's Carbon Pricing Act, it is certainly comprehensive as it taxes multiple gasses based on their different greenhouse effects, but the price may be too low to affect the changes needed by itself.

CHINA

In 2017, the People's Republic of China enacted a national emissions trading scheme to limit and reduce carbon dioxide emissions. Set to start in 2020, it will be the largest ETS region in the world, covering one seventh of the world's carbon dioxide emissions from combustion.

[14] https://iswitch.com.sg/carbon-tax-singapore/

Initially, only power plants will be covered by the program, with allowances being allocated by power output and fuel type. However, plans are to expand to other sectors of the economy as time goes on[15]. As this program is only just now being implemented at the time of writing, the success of the program remains to be seen; but this has the potential to curb the emissions of the largest emitter in the world and that can be a very powerful force towards mitigating global GHG emissions.

JAPAN

Japan began taxing carbon emissions in 2012 with a tax on fossil fuels. The tax rate has been incrementally increased to ¥289 (US$3.70) per ton of carbon dioxide emission which averages to an impact of approximately ¥100 per household per month. The proceeds from the tax is intended to be used for global warming efforts and improving energy efficiency[16]. Frankly, I'm quite skeptical on the effectiveness of a tax rate set at less than the equivalent of $4/ton in a country as wealthy as Japan. A higher rate might be needed in order to affect the changes needed.

Despite being the host of the 1997 Kyoto Protocols, Japan has been criticized for its slow progress in reducing its carbon emissions. Since the Fukushima nuclear disaster, Japan has built many new coal-based power plants rather than expanding their nuclear plants. This goes against current Japanese plans for the energy sector, which is the source for approximately 90% of greenhouse gas emissions. The planned expansion of renewables and nuclear power generation, as well as a 17% reduction electricity consumption, will be critical in achieving their goal of a 26% reduction[17]. One would have expected greater leadership from the nation that hosted a landmark conference on climate change.

AUSTRALIA AND NEW ZEALAND

The story of carbon pricing and the two oceanic brothers highlights the differences between the two neighbors. In 2012, the Australian government passed a carbon tax that

[15] https://www.iea.org/reports/chinas-emissions-trading-scheme
[16] https://www.japanfs.org/en/news/archives/news_id032490.html
[17] https://www.carbonbrief.org/carbon-brief-profile-japan

charged the 348 highest polluters with a A$23 tax per ton of produced greenhouse gas. This was met with protests and the opposition within the government campaigned on an immediate repeal to the tax. They succeeded and it was repealed two years later in 2014 and replaced with a plan to use a government fund to encourage greenhouse gas reductions by companies instead. This has been met with criticism from the environmentalist community and the repeal has left Australia "bereft of credible climate change policy" according the Climate Institute think tank[18]. The Australian government has committed to a 5% reduction of 2000 emissions by 2020. Currently the focus is on expanding renewables, encouraging efficiency, stricter fuel standards, and incentivizing emissions reductions. However, these have been criticized as inadequate to meet current targets are possibly more expensive methods of reducing less emissions than other policies[19].

Across the Tasman Sea in New Zealand, the story is different. The New Zealand government passed an emissions trading scheme similar to the EU's model in 2008. It seeks to create a financial incentive for businesses to reduce their emissions and landowners to earn money by planting forests that absorb carbon dioxide. A unique twist to the New Zealand system is its practice of giving carbon dioxide allowances to tree planters. This provides an incentive to reforestation and carbon sequestration efforts as they can then sell their credits to other companies. Each emissions credit counts as one metric ton of carbon dioxide or its equivalent from another greenhouse gas. All sectors of the economy must report their emissions to the government but the agricultural sector is exempt from surrendering emissions credits back to the government. Unfortunately, agriculture accounts for almost half of New Zealand's emissions. The policy is designed so that the obligations occur high up in the supply chain to reduce administration costs. As such, most businesses don't actually have any emissions obligations to the government, but their suppliers might. Everyone is affected by the price changing as the cost is passed downstream[20].

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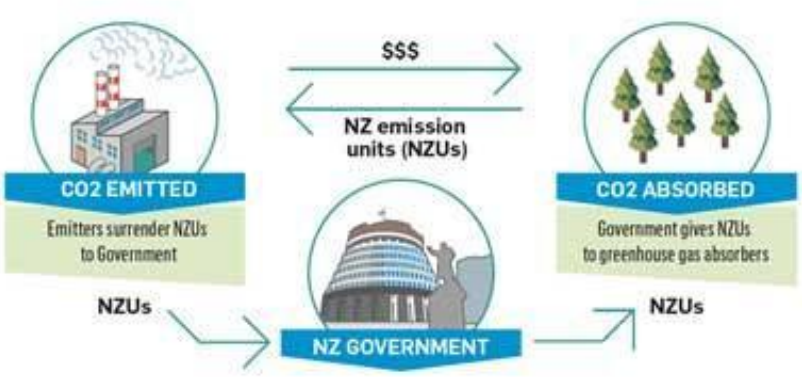
[18] https://www.bbc.com/news/world-asia-28339663

[19] https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook43p/emissioncontrol

[20] https://www.mfe.govt.nz/climate-change/new-zealand-emissions-trading-scheme/about-nz-ets



Source: NZ Ministry for the Environment

Current targets are to halve emissions by 2020, but the Zero Carbon Act that outlines this goal only provides a framework for the policy needed to reach that target. In addition, methane from agriculture is being held to a separate target of at least 24% by 2050. Methane itself is a very potent greenhouse gas and the combined methane emissions from agriculture and waste account for 40% of New Zealand's emissions. The future of New Zealand's climate policy will be in applying strong measures to meet the 2050 goal and to reign in the agriculture sector's emission[21]. This could prove difficult as the dairy industry represents a very powerful force in the New Zealand economy and politics.

SOUTH AFRICA

South Africa is a recent adopter of carbon pricing, adopting a tax in June of 2019. The tax is to be introduced in phases with a rate of $8.24 per ton of carbon dioxide equivalent until 2022. This low rate is further lowered by significant tax breaks[22]. It remains to be seen whether South Africa's carbon tax will be effective, but a lower starting rate may be necessary to ease the transition as the economy adjusts.

COLOMBIA

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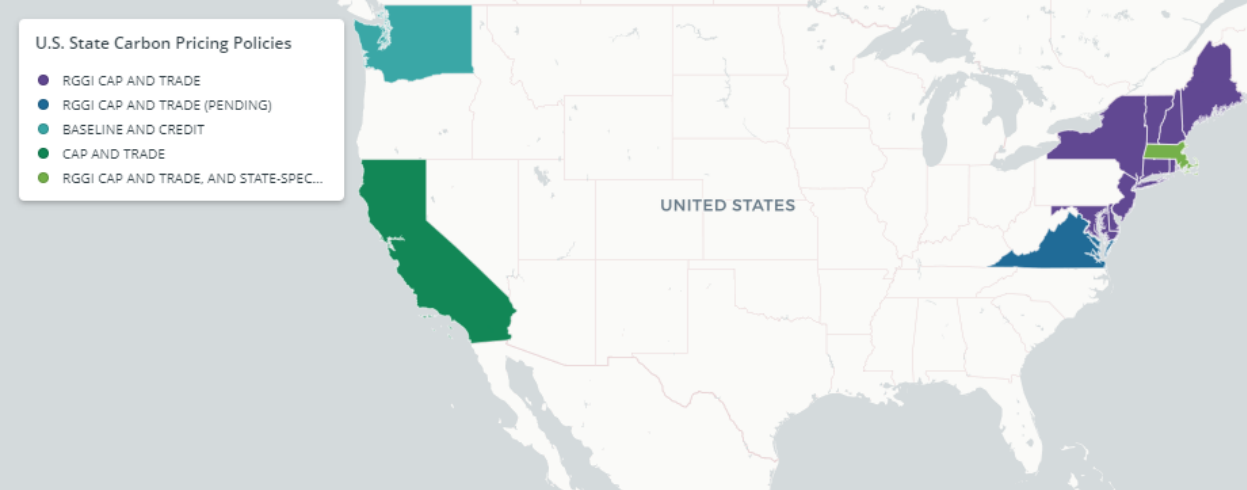
[21] https://climateactiontracker.org/countries/new-zealand/
[22] https://www.npr.org/2019/05/26/727154492/south-africas-carbon-tax-set-to-go-into-effect-next-week

Launched in 2017, Colombia instituted a tax on fuel that comes out to around $5 per ton of carbon dioxide produced. The tax varies by fuel, but all the rates are based on the $5/ton figure. Companies can be exempt from the tax if they are able to mitigate and offset their emissions and become certified as carbon neutral. The proceeds from the tax go towards environment protection activities, such as protect the Amazon rainforest, one of the world's largest carbon holders[23].

Carbon Pricing Here in the US?

Carbon pricing has been shown to be a useful tool for combatting carbon emissions in other countries, but could the concept be applied in America? As one of the world's largest carbon emitters, at over 6 billion metric tons of carbon dioxide equivalent in 2018, the federal government lacks a particularly strong policy to address climate change[24]. Despite that, the US still managed to cut emissions by 42 million metric tons, or 0.5%, in 2017. Most of this has come from efforts to decarbonize the power generation sector by closing coal-fired power plants and investments in renewable energy sources. A proposal for a carbon tax and rebate was proposed in the House of Representatives as H.R. 763, The Energy Innovation and Carbon Dividend Act of 2019, however the bill was kept in committee and died at the end of the 115th congress. The plan involved a $15/ton tax on carbon that would be raised by $10/year that would then be distributed to every adult as a share and a half-share for every child. Estimates show that it would have resulted in a revenue of $2.5 trillion to be redistributed over 10 years[25]. In addition, it proposed a carbon border adjustment to apply the carbon tax to imported goods and reduce incentives to avoid the tax by moving overseas. A carbon tariff of sorts.

[23] https://www.conservationfinancenetwork.org/2018/11/27/colombia-puts-tax-on-carbon
[24] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks
[25] https://www.piie.com/blogs/realtime-economic-issues-watch/carbon-tax-united-states



Center for Climate and Energy Solutions

Carbon pricing has seen some implementation on the state level, however. The states of New England and much of the mid-Atlantic states are members of the Regional Greenhouse Gas Initiative, a cap-and-trade program to reduce carbon dioxide emissions from the power sector. This group is the first of its kind here in the States and represents a large portion of the country's population and economic production[26]. The most populous and economically productive state in the union, California, also has its own cap-and-trade system encompassing multiple sectors in the California economy. Starting in 2013, the program saw a 3% reduction in emissions by 2017, meeting its 2020 goal in 2016. Its future goals include a 40% reduction from 1990 levels by 2030 and 80% by 2050. In addition, it plans to reach 100% carbon-free electricity by 2045. Revenues from the auction of gas allowances go toward programs to reduce emissions with a priority towards environmentally disadvantaged and low-income communities. This has resulted in $5 billion in revenues to be put towards greenhouse gas reduction. California's carbon pricing policy is notable as despite just being a state, California is only just behind Germany, the fourth largest economy in the world. Wider implementation of carbon pricing may result depending on the success of current adopters and the ever-changing winds of American politics. It could be that even without strict policy from the government, the American economy may be propelled into a cleaner future as consumers grow more conscious of climate change and the economies of the rest of the world pull ahead.

[26] https://www.c2es.org/content/regional-greenhouse-gas-initiative-rggi/

In Conclusion

Carbon pricing has seen success in many countries around the world. Progress is being made towards meeting the Paris Agreement goal of keeping global warming below 2 degrees Celsius, but there is still a long way to go. Carbon pricing is not a silver bullet to kill climate change, but it is a powerful tool to help build the society that will beat climate change. A whole toolbox used by a great many people is what we need. A study showed that almost every nation that has had a carbon tax since 2007 has seen reductions in greenhouse gasses compared to those that do not, but these same nations have also embraced a whole suite of climate policies[27]. Carbon pricing is at its best when it works in tandem with numerous policies to make a greener, cleaner economy.

The purpose of this paper is to show how carbon pricing can be an effective policy to combat climate change, especially when paired with other climate policies. Putting a price on carbon serves to make real and tangible what is otherwise an invisible and hidden damage being done to our atmosphere. It spurs and encourages the long, hard, and frankly, expensive work that is necessary to protect the future of the environment in which we all live. We have the luxury of living on a very comfortable planet, let us not take it for granted.

[27] https://www.sciencealert.com/carbon-pricing-definitely-works-confirms-huge-study