PONTIFÍCIA UNIVERSIDADE CATÓLICA DO RIO DE JANEIRO
DEPARTAMENTO DE ECONOMIA

MONOGRAFIA DE FINAL DE CURSO

CAN CARBON MARKETS HELP PROMOTE THE ENERGY TRANSITION? A STUDY OF EU ETS' IMPACT ON THE ENERGY SECTOR

Mariana Martins Nunes da Fonseca
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Orientadora: Amanda Motta Schutze
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Declaro que o presente trabalho é da minha autoria e que não recorri, para realizá-lo, a nenhuma forma de ajuda externa exceto quando autorizado pelo professor tutor.

ACKNOWLEDGEMENTS

To my parents, Rosana and Marcelo, with whose support I got where I currently stand, both academically and as a person, with confidence and hope. You taught me to appreciate the world we live in and to be kind. For that, I will always be grateful.
To my grandfather, Mario Augusto Martins Nunes (1940—2022), who inspired me to become an economist when around me the people talked about medicine at the dinner table. Along with my grandmother, Ana Joaquina, you raised me and gave me the support I needed when my parents couldn't be there. From the house next-door and into my heart, the two of you engraved in me values and memories I will never forget. I miss you, and I miss the Sundays I could spend with the three of us.
My family, my four precious friends, I love you, from the bottom of my heart.

SUMMARY

With the intention of encouraging discussions on the use of environmental policy mechanisms to face the pressing climate crisis, this monograph presents an essay on effects of carbon pricing as means to promote the transition to clean energy usage, questioning if it can be a significant piece in our toolkit to promote the renewable energy transition, one of the most important steps to a carbon zero economy. Reviewing recent literature on the topic, and with information from public data available, the goal of this research is to debate whether carbon pricing holds a significative weight on the increase of 'green energy' use — through the European Union Emission Trading System (EU ETS), this work's case study.

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1. INTRODUCTION

The undeniable proof of the human influence in global warming was provided by the latest scientific report by UN's Intergovernmental Panel on Climate Change (IPCC) AR6 Working Group I [1], in August 2021, which set discussions over climate change on a slightly different path than before. Contrary to prior contentment with commitments settled for the future, the data now at hands of both policy makers and the public gives a greater sense of urgency, indicating that the following decade calls for drastic actions in order to prevent the 'worst-case scenario' scientists have long been warning about. The projections given already reveal us a grim outcome: the short-term scenarios are already far-off compared to the latest international climate agreement, signed in Paris on 2015. In other words, by 2100 we are most likely to have surpassed the 1.5°C average global temperature mark, regardless of whether we follow the most positive setting presented by scientists or a rampage of GHG emissions.

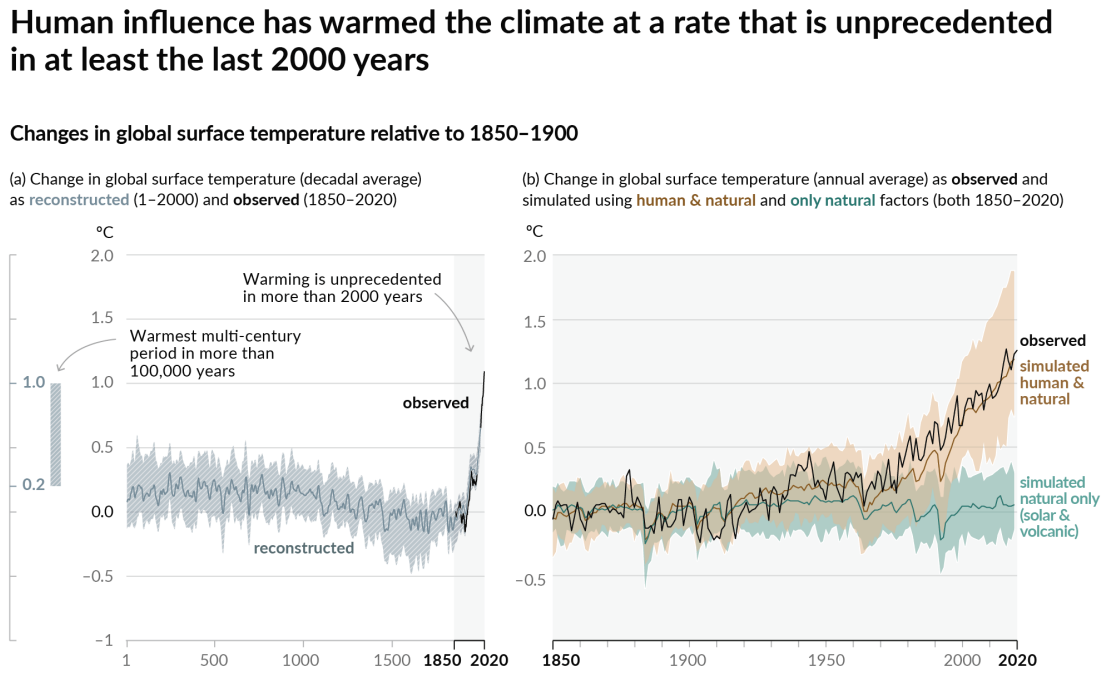

Figure I: Recent human activity has increased the speed of average global temperature change (Source: IPCC AR6 Working Group I — Summary for Policymakers)

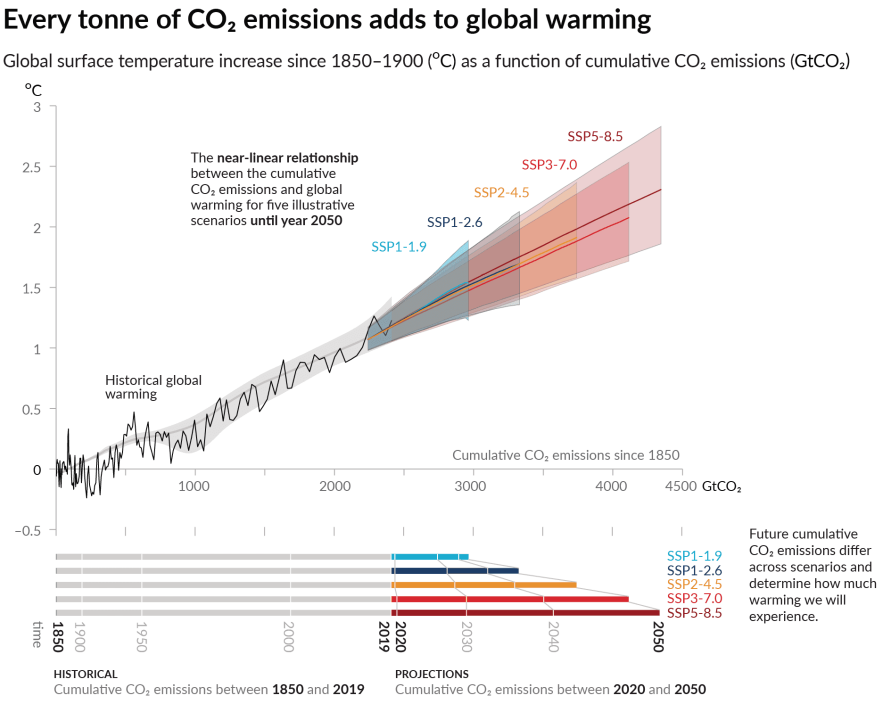

Figure II: Different scenarios of cumulative CO_2 emissions and temperature increase
(Source: IPCC AR6 Working Group I — Summary for Policymakers)

Due to the current climate crisis faced, many efforts are bound to be made on the following years — most of them being reinforcements of previous commitments, that is to say that many trends observed in the previous decade regarding the mitigation of global warming will be intensified. One of them is, evidently, the emerging of the carbon pricing tool. As said in the 2020 report by the Database for Institutional Comparisons of Economies' (DICE), from IFO Institute for Economic Research, regarding carbon pricing [2], economists largely recognize the importance of such mechanism: it's a way of signaling to reduce the costs of transition to a carbon-neutral economy, reinforce the need of right choices and incentivizing innovation. Pricing carbon, through taxation or permit trading, is a way of reducing costs as it equalizes the marginal costs of emission reduction across different sectors in the economy. However, as the DICE report points out, the response to this signaling in the market might take time, and the short-term reactions are almost inelastic, although the long-term effects are sure to be perceived. Considering that, one might argue that such mechanism, despite any present flaws, is one of the best ways we must strive towards the reduction of GHG emissions.

Considering that, the goal of this research is to tie-in two topics which, all things considered, have never truly been separated: the carbon pricing market, which tries to handle the current climate crisis faced, and the energy industry, indirectly present in most, if not all, sectors of the economy. Given the current debate sparkled by IPCC's three groups 6th report and the geopolitical crisis caused by the Russo-Ukrainian war started in February 2022, which led Europe to considering the transition to renewables a more than urgent matter, a question arises: How can we, with the instruments we have at hand, make the economy shift to mostly renewable energy sources in such a short period? The aim of studying the European Emissions Trading System (EU ETS) and asking how it can influence such matter is not to provide the utmost solution to all of the problems faced in the present, but to be a call for action in improving our policies by seeing what works and what doesn't when tackling the issue at hand, learning from the experiences had since the beginning of the century.

2. MOTIVATION

With the growing concern of the scientific community and governments alike over the 1.1°C increase in the average global temperature as reported by the IPCC Working Group I in 2021, all spheres of society have turned the climate debate into one of their main concerns. Thus, setting a course of action to tackle this crisis is top priority amongst all sectors, with the energy industry receiving the utmost attention. According to the International Energy Agency (IEA)'s Net Zero by 2050 report [3], this sector is responsible for most global emissions and, despite previous commitments to handling this issue, CO_2 emissions from energy and industry combined have increased by 60% since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) back in 1992. With such data in mind, the agency has set a pathway that states that, by the year of 2050 (the deadline stablished that, although being quite far from what the urgency of the matter calls for, is realistic), 70% of the electricity generation shall come from solar PV and wind.

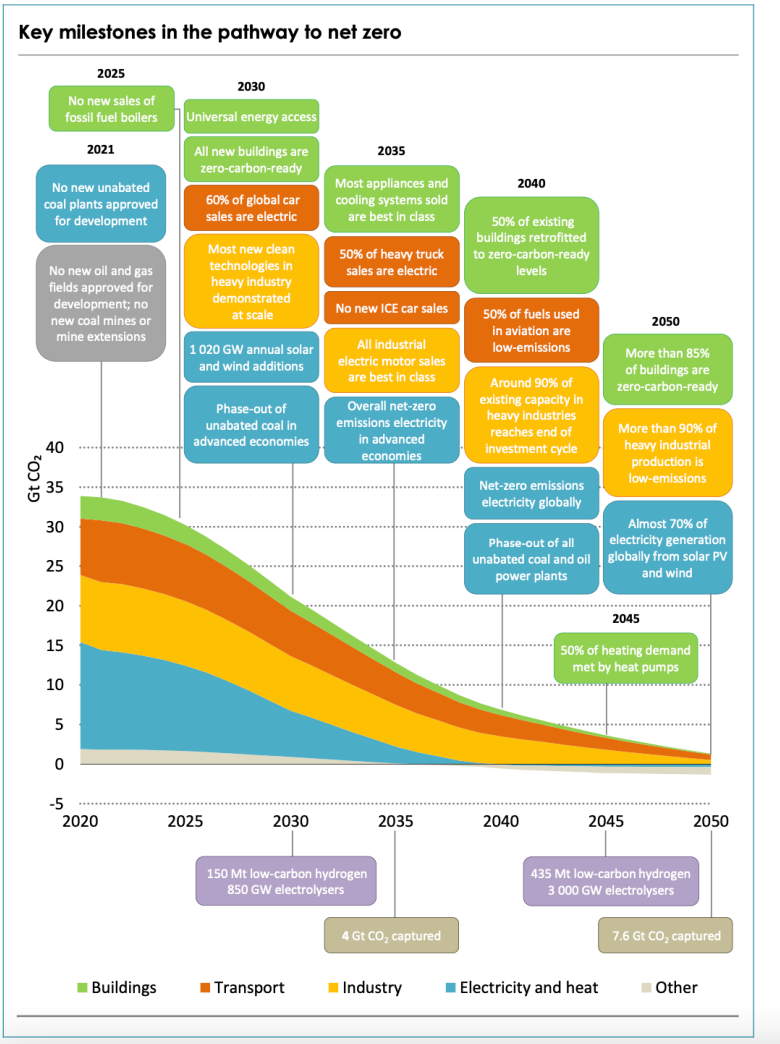

Figure III: Advanced economies are set to have hit net-zero emissions in electricity by 2035 (Source: International Energy Agency – Net Zero by 2050)

To reach such levels of clean energy usage, the course of action recommended prioritizes incentivizing clean energy investment by policies that "need to be designed to send market signals that unlock new business models and mobilize private spending, especially in emerging economies". Despite such advice focusing on the incentives given to innovation in this market, it is also pointed out that a set of behavioral changes should happen in order to

reach the established Net Zero Emissions goals, and by doing that, market-based instruments that include financial incentives and disincentives alike are to influence decision making in key areas. Carbon pricing is one of the primary examples of such.

3. THE EUROPEAN EMISSIONS TRADING SYSTEM (2005—)

Known as the first large GHG trading scheme in the world, the European Emissions Trading System (EU-ETS) started operating in 2005 as an attempt to mitigate global warming. Nowadays it serves as a major pillar in the European Union's energy policy. Operating under a "cap and trade" principle, where a limit is placed on the right to emit certain pollutants and companies can trade emission rights, the ETS has been divided in four phases as of 2022. Before the creation of this join carbon market, each country within the union would decide the allocation of their emissions, however, as of the 1997 Kyoto Protocol setting a legally binding emissions reduction target ("cap") for 37 industrialized countries, the need for policy instruments to help meet such goals surfaced and, with that, after the first drafts, an EU ETS Directive was adopted in 2003 and thus the system was launched two years later, with the cap on allowances set at national level through the National Allocation Plans (NAPs).

3.1. EU ETS TIMELINE: PHASES I TO IV

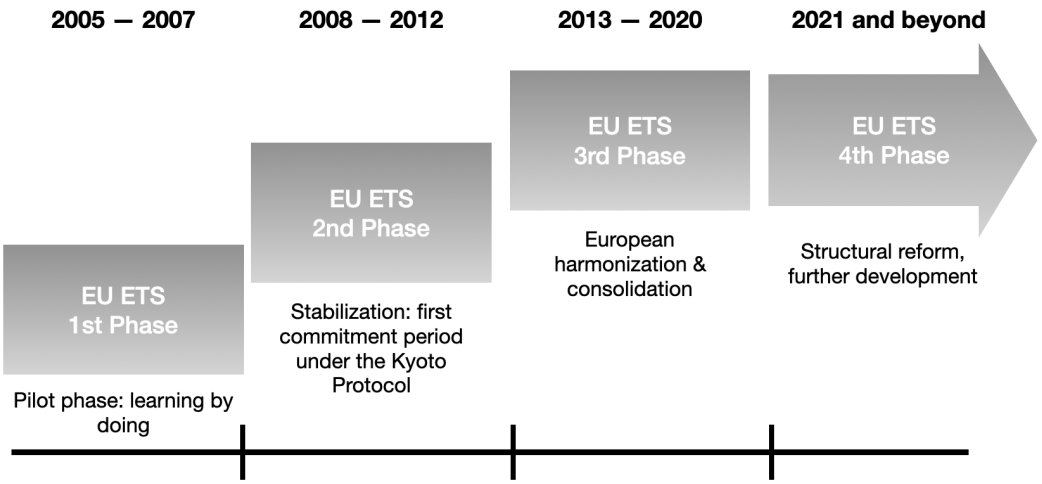

Figure IV: The four phases (2005-2021) of the ETS summarized [Reproduction]
(Source: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety — Regional Dialogue on Carbon Pricing and MRV 2018)

The Phase 1, as stated by the EU itself, was a 'learning by doing' period of preparation for Phase 2, that lasted two years (2005-2007), when the EU-ETS would need to function in an effective manner to help meet the Kyoto Protocol targets. It covered only CO_2 from power generators and energy-intensive industries and almost all emission allowances were given to businesses for free. During that period, the fundamentals of the ETS were already present: there was a 'cap', that limited the trading system, set on the number of emission allowances and, within this limit, companies received or bought emission allowances, which they could trade as needed— the cap, however, was set to decrease every year, ensuring that total emissions fall. As a trial phase, it succeeded in establishing a price for carbon and the infrastructure needed to monitor, report, and verify emissions from the businesses covered by the trading system.

Moving to its second Phase, from 2008-2012 when the EU ETS members had concrete emissions reduction targets to meet, the system began to evolve: it lowered the cap on allowances (a reduction of 6.5% compared to the first year), Iceland, Liechtenstein and Norway joined, Nitrous oxide emissions (another GHG) was included by a number of countries, and businesses started to buy international credits totaling around 1.4 billion tons of carbon dioxide equivalent. Additionally, due to the 2008 Economic Crisis, the emissions reductions were initially greater than expected, which led to a large surplus of allowances and credits, weighting heavily on the carbon price throughout Phase 2.

Its third phase, from 2013 to 2020, is said to have changed the system considerably compared to phases 1 and 2. With Phase 3, NAPs were replaced by a single, EU-wide cap on emissions, and auctioning became the default method for allocating allowances instead of free allocation. Additionally, more sectors and gases were included, giving the EU ETS a larger grasp of the economic agents. After facing the atypical year of 2020, the EU started its Phase 4 (2021-2030) of the ETS still amid a pandemic. What this phase holds is yet to be seen, nevertheless, during the system's latest reform in 2018, it was agreed that there would be a reduction in the number of gratuitously distributed permits and that in the following phase (4^{th}), the number of economic sectors deemed to be at risk of carbon leakage — a phenomenon in which, due to costs associated with climate policies, emitters of GHG outsource their operations to jurisdictions with less stringent emissions rules—, and thus entitled to free emissions allowances, were cut. With the distribution of free allowances, prices for permits reached a peak.

3.2. SPECIFICATIONS AND REPORTED RESULTS

Having covered its history, some specifications are needed in order to better understand the functioning of the EU ETS. First and foremost, the allowances traded give the holder the right to emit one ton of carbon dioxide or the equivalent amount of other powerful GHG, nitrous oxide and PFCs. The ETS focuses on emissions that can be measured, reported and verified with a high level of accuracy: it measures the CO_2 emissions from electricity and heat generation, energy-intensive industry sectors and commercial aviation within the European Economic Area, N_2O emissions from the production of nitric, adipic and glyoxylic acids and glyoxal, and PFCs emitted from the production of aluminium. Finally, despite the participation in the EU ETS being mandatory for companies in these sectors, in some industries only installations above a certain size are included and certain small installations can be excluded if governments put in place fiscal or other measures that will cut their emissions by an equivalent amount — which shows us that, despite establishing an EU single target, the system still allows for member states to set their own climate policies in order to achieve their individual emissions targets.

All things considered, by looking at the seventeen years of the ETS operation, one will ultimately consider it an ever-growing and ever-evolving system. It aims to adapt and learn with the experiences from previous phases and is a fairly organized market that has reportedly achieved its goal in helping to reduce emissions, as it can be seen in Figure V. That said, the EU ETS is undoubtedly a powerful tool in the mitigation of climate change, however, how powerful it is yet to be debated more broadly— understandably so, given how "new" this policy is and how, when talking about climate policies, the short-term effects are not evidently perceived.

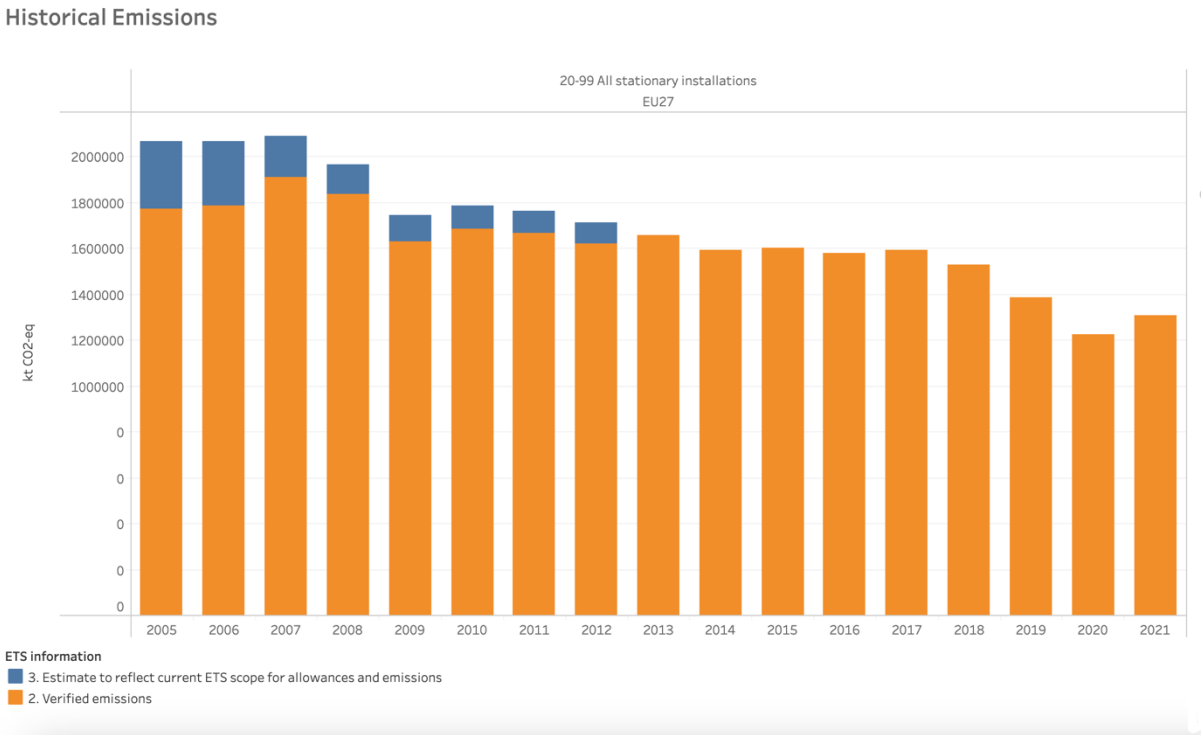

Figure V: Total Verified Emissions from 2005 to 2021
(Source: European Environment Agency — 'EU Emissions Trading System (ETS) data viewer')

4. THE CAP-AND-TRADE MECHANISM

For the purpose of better understanding how the carbon market operates, a thorough explanation of the Cap & Trade System is needed. Posed as an alternative to carbon taxing, its intention is to reduce carbon emissions without presenting an economic toll to the industry. Both are forms of carbon pricing, a market-based strategy, which is a way of quantifying the externality cost of GHG emissions in order to include this factor in our production and consumption decisions. In other words, as put by the American nonprofit organization Union of Concerned Scientists (UCS), its function is to "incorporate climate risks into the cost of doing business" either by a legislative or regulatory action.

This definition is related to the concept of a Pigouvian Tax, a "tax" on an activity that generates negative externalities, discussed in Arthur Pigou's *The Economics of Welfare* (1920). It operates by shifting the marginal private cost of the firm so it matches the cost of externality, reducing the output and reaching a "socially efficient" equilibrium.

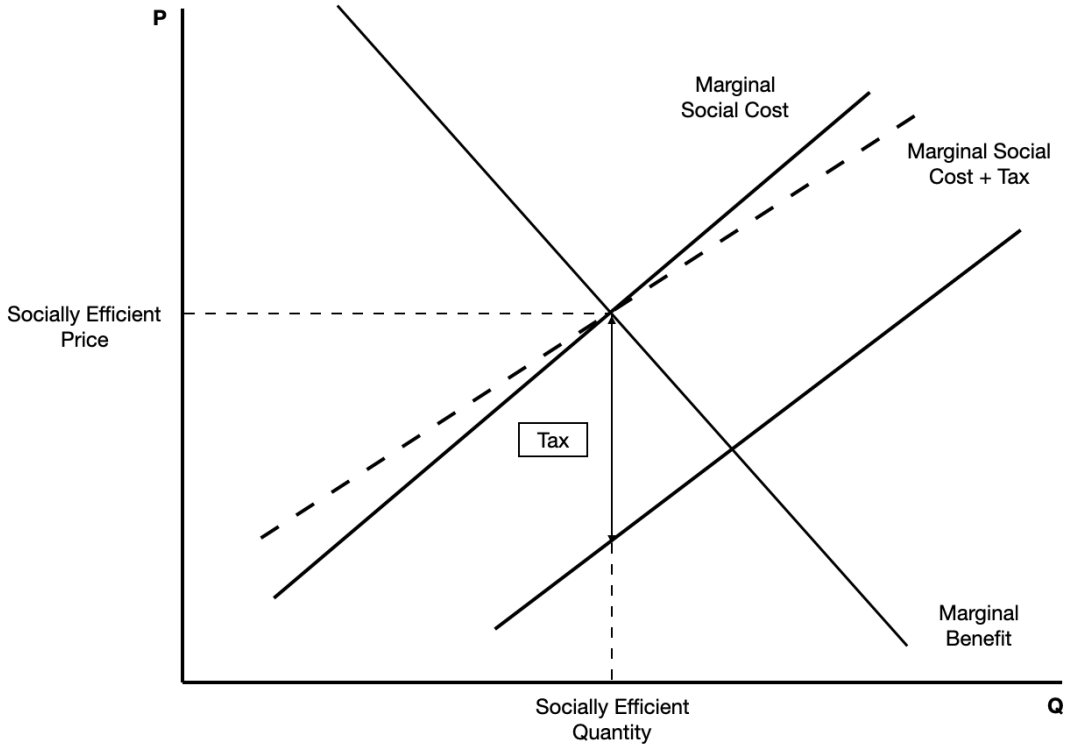

Figure VI: Pigouvian Tax's Effects on Marginal Cost

Albeit operating in a similar fashion to carbon taxes, cap-and-trade follows the principle of regulating emissions by implementing a limit ('cap') for markets or the region as a whole and issuing allowances (or permits) to emit carbon dioxide which can be traded. The theory behind its mechanism is as follows: companies with high-cost measures purchase allowances while the ones with low-costs may buy or sell them on a market where demand and supply schedules can be matches, causing the emerging of an equilibrium market price reflecting a scarcity of permits in the system. Given that all traders have the same marginal abatement cost for being under a unified system, overall reductions costs are minimized, meaning the market has reached static efficiency (Schleich, Rogge and Betz, 2008).

In layman terms, by establishing a ceiling for total GHG released by the industry and simultaneously allowing firms to emit more than their individual quota provided they pay for the "rights to emit" of another one, who in turn emits less CO_2 as a pre-requisite of this transaction, it poses as an incentive for producers to seek ways to lower their emissions each year if they want to increase their profit (paying less for allowances — the cost of emitting more than their individual fixed share). The 'cap' is set to reduce as time passes, proving the system is one that progresses towards its goal of low emissions by evaluating and re-evaluating the market's reactions to an increasingly low target. The following diagram simplifies the system's operation.

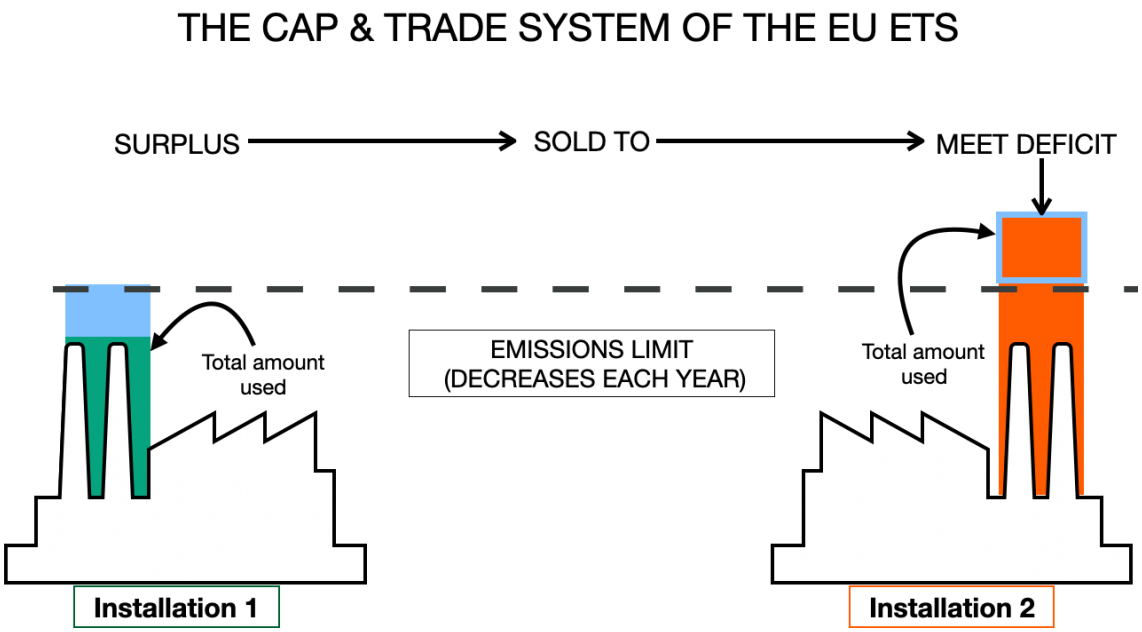

Figure VII: The EU ETS' Cap & Trade System illustrated [Reproduction]
(Source: Investigate Europe — EU Emissions Trading Scheme Explained)

A lot of criticism towards this mechanism points that it doesn't provide a strong enough barrier for companies to keep polluting, given that by buying allowances they can continue to do so, therefore not having enough incentives to change the status quo and converting to cleaner forms of production. Those critics point that regulatory measures should be harsher to prove effective towards those who don't aim to invest in being less dependent on permit trading anytime soon.

Another pressing reason why some may be skeptical of the cap-and-trade is a phenomenon known as "grandfathering": the act of giving free and/or extremely cheap permits to existing companies so as to create an incentive to join the carbon market. It may favor longstanding companies who have historically emitted a great amount and induce lobbying for acquiring more permits, going against the sole objective of stablishing an emissions trading system. The issuing of free allowances indeed happened in the first phase, as it presented a politically palatable solution for its implementation. However, as many studies on Emissions Trading Systems that use cap-and-trade as its operating mechanism — the EU ETS being the most advanced one so far — emissions exchanged and supervised by those markets are, in fact, reducing, and other measures combined to cap-and-trade help ensure that this march towards a net zero emissions economy continues.

5. EFFECTS ON INVESTMENT DECISIONS

The implementation of the EU ETS represented the start of a switch from regulatory measures to market-based instruments in climate policy, with the latter becoming a trend in the following years — one not limited to the European continent. It presented not only a starting point for international level policy and cooperation, but also a catalyst for innovation in carbon emitting industries. Given that the price for allowances may serve as monetary incentive to adopt new and energy-efficient technology and services aiming for more carbon-efficiency and therefore develop original or improved solutions to GHG emissions, looking into EU ETS' potential to incentivize investment decisions in energy transition is an important step to uncovering just how effective its implementation is.

Additional costs of GHG emissions are at least partially passed onto the final product price, making the trading system a tool for increasing demand for improved energy efficiency, such as in energy-intensive industries and private households, therefore not only targeting the energy directly but other related ones indirectly, with the intention of achieving a global effect in the economy. In terms of innovation policy, said system, therefore, represents a demand-oriented technology regulation that leaves the technology selection process to the market rather than an appointed regulator. However, it is important to point out that during to the inelastic nature of the power sector demand and low international competition from outside the EU, the extend of a pass through of carbon costs which in the end would serve as incentive would be identical if under a gratis allowance allocation rather than auctioned in a liberalized competitive electricity market (Schleich, Rogge and Betz, 2008), which would raise concern in regards to "grandfathering" practices — albeit at the current stage EU ETS is at, free allocation is an increasingly rare source of permits.

Concerning the incentives for installation replacement, when making such structural decision, companies need to consider the opportunity costs of covering carbon emissions for the existing facility and that is related to the Make-or-Buy decision on energy generation. The Make-or-Buy decision in this context means that day by day electricity-generating companies decide on the cheapest way of producing energy, which may not automatically be the least pollutive. This means that coal and nuclear based electricity may be the most favored amongst all options if not for the inclusion of emission costs via some form of policy. With EU ETS' cap-and-trade market, the burning of fossil fuels turns into an ever-growing cost to energy-producing companies, theoretically turning the decision towards which installation to run based on their technological capacity and which fuel to use, turning 'clean' energy sources into the most beneficial choice for producers. Nevertheless, a study consulting both German and Danish firms in the energy industry points out that albeit concrete CO_2 reduction measures were implemented when faced with high energy costs or due to other state policies (such as energy efficiency agreements with the Danish government), the participation in the Emissions Trading System had negligible effect in comparison (Knoll and Engels, 2011).

Conversely, past research that further analyses the mechanisms by which innovation investment takes place under the EU ETS paints a slightly more positive picture. Results from a study also set in Germany found that the introduction of the trading system most likely accelerated the innovation process in general, posing as a key driver of the increase in RD&D activities both on carbon capture and storage (CCS) and higher efficiency levels regarding materials and components (Rogge and Hoffmann, 2010). Moreover, it was said to indirectly have benefited research and development on renewables. The authors conclude that the EU ETS served as an instigating factor for an increase in rate and for shifting the direction of technological change of power generational technologies on a sectoral scale. Such findings indicate the existence of an effect in technology investment despite not as significative as one would imagine when advocating for the carbon market policy.

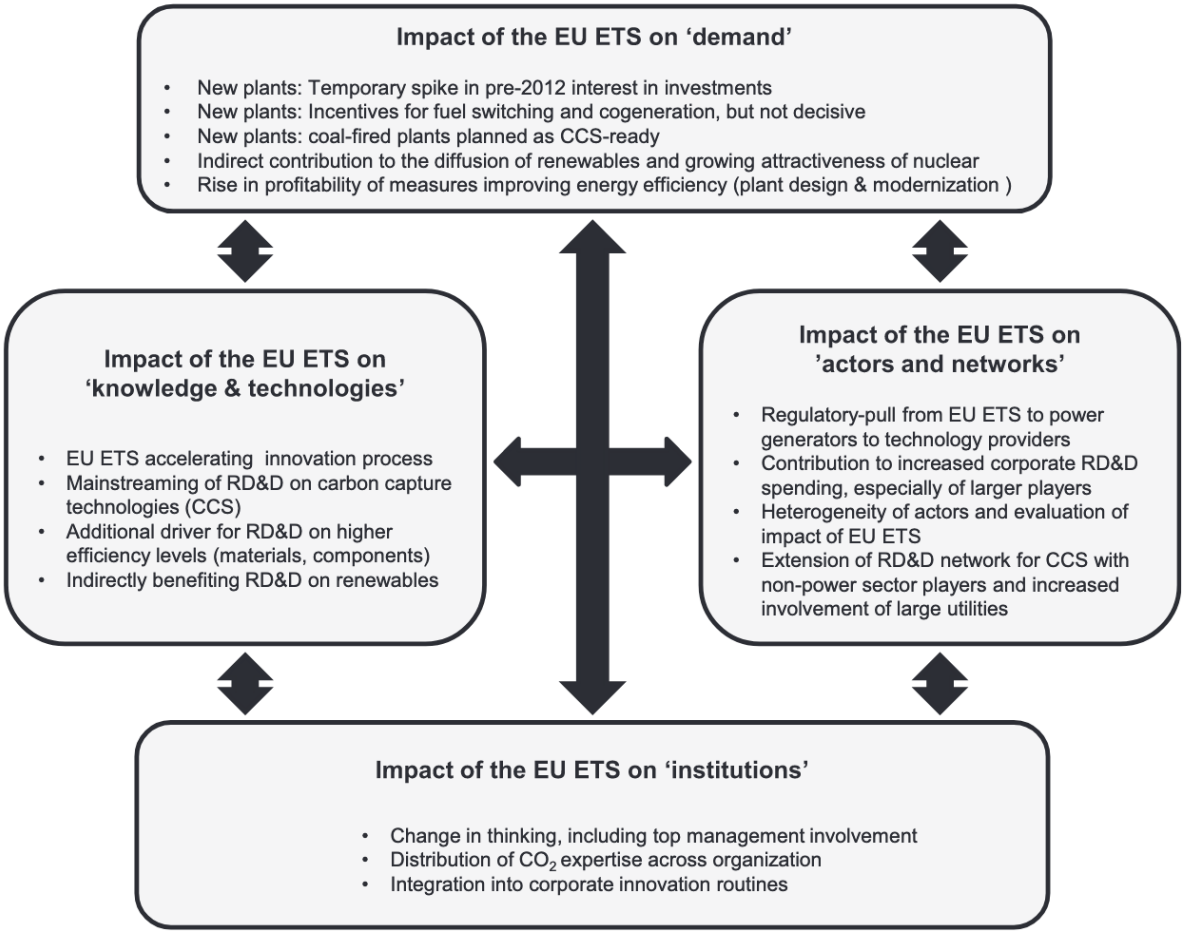

Figure VIII: Overview of findings on the impact of the EU ETS on the sectoral innovation system of power generation technologies in Germany, by Rogge and Hoffmann (2010)
(Source: K.S. Rogge, V.H. Hoffmann / Energy Policy 38 (2010) 7639–7652)

Finally, a dominant argument in literature aiming to isolate the impact of the EU ETS on clean energy technology is that the policy has yet to tap into its full potential and the biggest influence it may have in certain countries are either increased or overshadowed by other policies with similar goals. A pressing question is whether or not the market's constant revision and adaptation over its phases would suffice to solving this meek performance in the long run — an experiment we cannot afford — or if policymakers should use "hybrid" climate policies in order to quickly achieve the crucial objective of Net Zero and posteriorly negative emissions.

6. JOINT EFFORTS: COMBINING THE ETS WITH OTHER POLICIES

As previously stated, according to evidence, the EU ETS by itself won't suffice as means to reaching the low emissions target under the limited period at hand despite being, matter-of-factly, an effective tool. One of the solutions proposed in this monograph is to combine the carbon market with other climate policy tools in order to accelerate the effects it might have had if given the time to naturally develop itself, as such market-based tools do have significant medium to long-term results even under reduced prices (Bayer and Aklin, 2020).

6.1. POLITICAL OVERVIEW

It can be argued that the general debate around climate policy fails to properly consider the sociopolitical aspect of implementing such measures. The conflicts surrounding the environmental issue, often overlooked by academia or, one would argue, by economists, are driving factors in shaping the ongoing development of policy response, that is, the adaptation and self-renovation such tools undergo.

Research suggests governments are reluctant to execute carbon pricing at levels high enough when faced with significant political resistance from affected industries (Ball, 2018; Jaccard, 2016; p.2 cited Markard and Rosenbloom, 2020). Furthermore, political strategies adopted by business reinforce this observations, proving that carbon pricing mechanisms were, and still are, influenced by carbon-intensive groups' interests (Downie, 2017; Markussen & Svendsend, 2005; Meckling, 2011; Meckling, 2015; Wettestad, 2009; p.2 cited Markard and Rosenbloom, 2020). With that in mind, understanding the political conflict surrounding climate policy and the European carbon market is key to comprehending their advancement.

Focusing on the EU ETS exclusivity discourse i.e., the idea that the carbon market should be the principal, if not the sole, climate policy used, Markard and Rosenbloom (2020) point out that those who hold this belief "emphasize the role of efficiently functioning markets in directing actor behaviour and investment decisions toward low-carbon options". It is also argued that the ETS is preferred due to being cost-effective and technology-neutral on top of allowing firms the flexibility to determine the best way to reduce emissions regarding their individual circumstances. Nonetheless, as evidence previously presented shows, the outcomes directly caused by this market-based policy do not present the intensity and scale needed in present times. Ultimately, one may argue that the points raised by actors who hold these positions are valid, although not enough to advocate for the carbon market use as the only policy available. The following sections focus on how joint solutions have presented valuable results.

6.2.RENAWABLE ENERGY CERTIFICATES (RECs)

Albeit not adopted by all EU member states, Renewable Energy Certificates (RECs), a market-based instrument that certifies that its holder owns a pre-determined amount of electricity generated by a renewable source has potential to be combined with the ETS given that they can be sold on the open market as an energy commodity, i.e. they can turn into carbon credit and be bought by polluting entities in order to offset emissions. This tool requires tracking/accounting of the amount of electricity produced by green sources, such as solar or wind power, meaning its reliability is as valid as the carbon market emissions verification. Additionally, they are part of the European Energy Certificate System (EECS), a

commercially funded framework for issuing, holding and transferring EU energy certificates, serving as a regulated platform for Renewable Energy Guarantees of Origin (GOs) defined in 2009, i.e. the Renewable certificates are part of a regulated market.

Despite the literature about this mechanism being extremely limited, a theoretical model by Tao et al., 2021 was able to test how the interaction between the carbon market and the RECs market might take place with the purchase of certificates and their conversion into carbon emission quotas. The framework uses game theory concepts and presents us with three players: P2GSes, renewable energy plants and thermal generators. Each of them will maximize their payoff by solving a bi-level model (shown in Figure IX) and their individual profits are maximized by considering their rivals' strategies

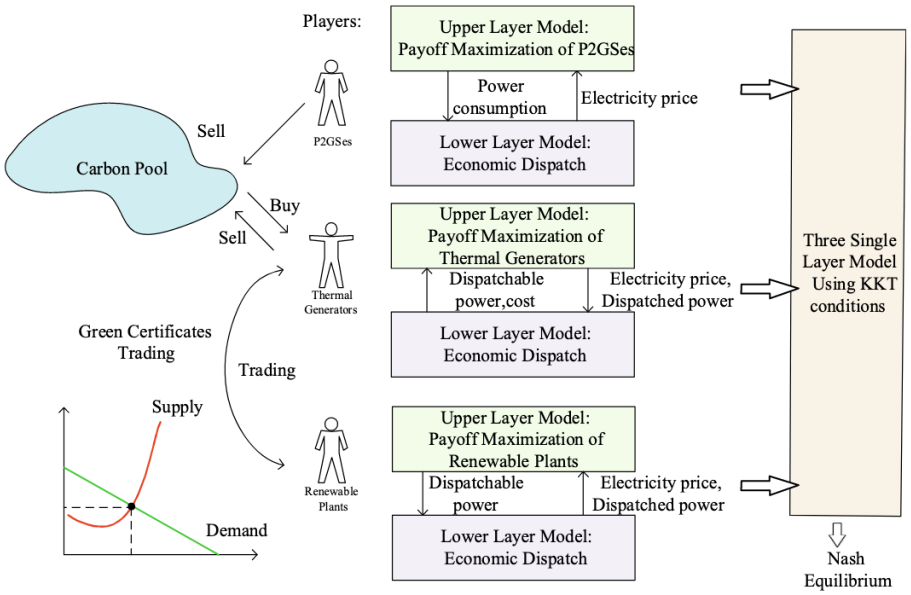

Figure IX: Proposed framework of bi-level game relating RECs and ETS
(Source: Tao et al. / International Journal of Electrical Power and Energy Systems 130 (2021) 106940)

The first type, P2GSes (player I), has its source of payoff on the revenue from selling gas and carbon environment profits (in the ETS) minus the costs of purchasing electricity. The second player, a representative of Renewable Plants owners (player II), finds its source of revenue both from selling electricity and selling RECs. Finally, Thermal Generators, who portray the polluting firms in the energy industry, have from their revenue of selling electricity both the costs of purchasing RECs (from player II) and purchasing carbon emission quotas (from player I) subtracted.

Simulations run by the group of researchers showed that the cooperation of renewable energy plants and power-to-gas stations considering RECs trading can contribute to the penetration of large-scale renewable energy and, in terms of payoff, it was found that energy certificates help renewable energy plants increase their income by 19.4% without considering cooperation. In addition, the extra profit gained by player II, which represents a compression of thermal generations i.e. polluters payoff, is substantially high. Therefore, the study reveals that a combination of the Renewable Energy Certificates market and the EU ETS might produce great results regarding the clean energy transition.

6.3.RENAWABLE ENERGY SOURCES (RES) SUPPORT POLICIES

Many economists may argue against a climate policy mix due to reasons such as potential inefficiency or regulatory capture. However, given that the carbon market's abatement costs are lowered the more are RES used, the case for renewable energy support policies cannot be overlooked without proper empirical studies. A 2014 study conducted by Gawel, Strunz and Lehmann show that "the mainstream argument on the harmful consequences of RES-support policies to the detriment of the ETS as a first-best policy instrument only holds under the restrictive assumptions of case A", which the paper presents as a scenario where optimal climate protection is the only regulatory goal at hand and the ETS is efficiently designed i.e., the cap applied is exogenously given and based on the optimal level where marginal abatement costs the same as marginal social damages from climate change (equilibrium). Under such circumstances, the emissions market would perfectly internalize the climate change externality and additional policies would only undermine the scheme. This case, of course, if purely theoretical and the other scenarios tested conclude that RES-support policies "do not necessarily decrease the efficiency of climate and energy policy and they are not necessarily irrelevant to the overall GHG emissions".

Moreover, recent literature provides case studies and simulations that prove the discourse based on an infallible ETS is only valid under theoretically perfect circumstances, as the 2014 also finds. In 2021 Anke and Möst analyzed the European power market in 2030 using two scenarios featuring endogenous carbon prices as emission caps, ultimately finding that despite tests run in sterile conceptual contexts, in reality slow investments in RES may cause a need for support policies that reduce risks in the industry and providing clear timelines. Even so, it is advised that policymakers "need a sure instinct when setting national RES targets".

7. CONCLUSION

This monograph aims to contribute towards the debate on carbon trading as means to reach CO_2 emission reduction goals, with a focus on the EU's Carbon Market, as it serves as the best example of said mechanism nowadays. It also intended on investigating how cap and trade promotes change in the energy sector transition process through a study of Europe's efforts towards the increase of renewable energy usage.

Additionally, by summing up and reviewing findings of previous literature on the matter, this study hopes to make readers better understand how academic works on this field display the continent's efforts as a single economic union to reach a common goal, which may serve as a trailblazer for international cooperation in the years to come.

The results found throughout the short existence of the EU ETS show a confirmation of the previous statement of how this type of mechanism may serve as a trailblazer for climate solutions in the present and near future but point towards the necessity of further analysis its flaws, adapting them, and continuing to seek policy innovation in order to not rely in a single tool inside a plethora of instruments that can be used. To answer the question this research makes, evidence points towards a positive influence in renewable energy transition, however this does not mean policymakers have a clear pathway when relying solely on carbon pricing to reduce emissions worldwide.

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