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Defusing the Ticking Bomb: Legislation that Confronts Climate Change through Clean Energy

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ABSTRACT

This paper analyzes various policies in efforts to determine a feasible and effective next step in advancing energy policy and climate action in the United States. Research consists of a review of literature followed by meta-analysis. The secondary research portion calls for an acceleration of the renewable energy transition, emphasizing the importance of energy reforms. The review acknowledges obstacles hindering the transition such as renewable energy variability and storage limitations. The section calls for technological advancement and identifies four policy targets; investment, accessibility, pricing, and expansion. The review of literature is followed by meta-analysis of aforementioned policy targets by analyzing and comparing five sources, each pertaining to a different policy area. Primary research identifies renewable energy investment using revenue sourced from carbon pricing and fossil fuel subsidy dissolution as the most efficient and feasible next step in strengthening U.S. energy policy, concluding with a call to action in light of findings.

Introduction

Guinness World Records annually publishes record-breaking achievements of humans each year. Yet to be featured in the Guinness publications is one record humans consistently manage to break: the annual amount of greenhouse gasses emitted into the atmosphere. Despite reaching a high of 37.1 million tonnes of annual CO2 emissions in 2021, global emissions surged to 37.5 MtCO2 in 2022 (Global Carbon Budget, 2022). In recognizing GHG emissions as a central catalyst of global warming, many nations are in the midst of combating climate change through the Paris Agreement. Various initiatives of the treaty establish the foundation and timeline on which institutions must achieve net zero emissions by 2050 to limit global temperature increase to 1.5℃ above pre-industrial conditions (UNFCCC, 2015). Limiting global temperatures requires the establishment of zero net emissions, a state in which the amount of emissions absorbed offsets emissions released. In its pursuit, U.S. policy that allocates government funding towards renewable energy (RE) efficiency, greater accessibility, and imposes clean energy integration in grids of developing countries is the most effective legislative route in delivering zero net emissions, both nationally and globally, by 2050. In demonstrating the urgency of energy production and use reform in climate change reversal, this paper will identify the RE technological limitations that must be addressed to accelerate the RE transition (RET), propose and explain zero net favorable policy, and argue on behalf of the legislative responsibilities the U.S. government has in more swiftly implementing a national RET and integrating clean, modernized systems in the developing energy grids of growing economies.

Review of Literature

Second to China, the U.S. is one of the largest producers of carbon emissions (United States Environmental Protection Agency, 2022). In efforts to reduce emissions, initial reform must target the most emission-intensive sectors. An efficient approach is through reform of the energy sector which is the second-highest greenhouse gas emitting sector in the U.S. and the highest emitting sector in the world, accounting for approximately one-fourth of global emissions (United States Environmental Protection Agency, 2022). The existing American energy grid is undeniably carbon-intensive. With the energy sector playing a prominent role as an emitter, energy production and use reform is the most efficient and sustainable measure to be taken in pursuit of climate change reversal.

Shifting the grid away from fossil fuels and towards renewable sources is a sustainable route to revolutionize energy production and reduce emissions. U.S. electricity generation sourced from nonrenewables such as coal and gas, emitted over 1.6 billion metric tons of carbon dioxide in 2021. In contrast, renewables are not fossil fuel nor emission-intensive, making them key instruments in the pursuit of carbon neutrality (EIA, 2021). Additionally, RE, characterized by boundless sourcing, will sustain the population long term. As energy demands have, and continue to surge, RE is a more advantageous energy source that will supply such demands (Kuo, 2019). To illustrate, fossil fuels are rapidly depleting, the MAHB reporting that all fossil fuel reserves will deplete by 2090 (Kuo, 2019). Due to finite availability, fossil fuel energy is not equipped to supply the population moving forward.

With boundless availability, RE will meet energy demand at greater lengths than fossil fuels while simultaneously mitigating harmful environmental effects, furthering the RET. RE capacity has risen 41% since 2007 (Frankf. Sch. Finance Manag., 2018). To illustrate, wind energy alone possesses great production potential that is not currently discarded in the energy grid. Southwest Power Pool data of January 2023 indicates that wind energy has the potential to produce more energy than consumed (SPP, 2023). Prominent forms of RE, such as wind and photovoltaic, exist under the umbrella of solar energy although differ in source as photovoltaic is harnessed directly from the sun's rays and wind as an indirect product of the sun (Blakers et al., 2017). Such forms of solar-sourced RE will deliver substantial emission reductions. According to IRENA, "RE [and electrification] …can deliver 75% of …emissions reductions needed [to meet climate goals]" (2022). Not only is RE capable of supplying the growing population of energy, but its use facilitates the pursuit of zero net emissions in the process.

Production variability of RE is a significant hurdle slowing the RET. Due to varying periods of generation and capacities, current RE systems are not consistently equipped to meet energy demands (EnergySage, 2021). Today's clean energy is economically adverse, unreliable, and inconvenient as it provides energy in limited increments of time (Sarbu et al., 2018). Clean energy systems, specifically solar, draw energy in the form of wind or directly from the sun's rays. In the process, energy potential is undermined as RE production tends to peak during periods of low consumption and much of the energy is not consumed. For example, "less than 10%" of hydro energy generated in Russia makes it to the grid (Xiangchengzhen, 2020). Furthermore, capacity is oftentimes underestimated due to the technological limitations in storing and distributing that diminish its applicability (Xiangchengzhen, 2020). The resulting under-exploitation of RE prevents strides in the RET and prompts the need for advanced storage and transmission systems. Such technological limitations must be further addressed to accelerate the RET.

Storage and hybrid RE systems are often offered as methods to achieve an efficient RE grid. For example, hydro-pumped production and thermal storage are both routes to be considered when combined to create a hybrid system. By offsetting storage limitations with renewable storage technology, such combinations would serve as a sustainable method to store hydro-generated energy (Gerdes, 2018). RE hybrid systems, in which generation and storage are paired, will overcome transmission limitations as sufficient storage is dispatchable for later use in periods of low production (SPP, 2023). For example, Quidnet Energy has created a geomechanical pumped storage system that enables the dispatchability of RE. By storing potential energy of water pumped into repurposed wells using RE, the system is equipped to store and dispatch RE over long periods between generation and consumption (Quidnet Energy, 2023). The widespread availability of stored RE through systems such as that developed by Quidnet would diminish under exploitation and thus expand use. Furthermore, significant emission reductions will sprout from inventions and innovations "not on the market yet" (IEA, 2021). As a result, greater investment in RE technology that targets primary obstacles such as storage capacities is effective. Investment will accelerate the RET by facilitating energy dispatchability and creating flexibility in utilizing various forms of RE.

Increasing access to RE will permit swift implementation of a RET. Using policy to incentivize RE technology developers, businesses, and RET development in emerging economies will drive down the cost and expand accessibility. For example, the aforementioned geomechanical pumped storage development may increase the availability of RE thanks to advanced storage capacities (Quidnet Energy). Through improved storage and the resulting RE dispatchability, factors that often "[diminish] cost competitiveness…such as transmission" would be overcome, bringing the financial advantages of RE to light (EERE, 2022). With this in mind, government investment must be directed toward the advancement of technology in areas such as RE storage and transmission. Such advancements will cut the cost of RE and accelerate the RET.

Technological development to make RE more readily available and dispatchable will incentivize carbon-intensive businesses to shift energy utilization to RE. Policy, specifically carbon pricing, must push institutions toward energy transitions. Pricing can be implemented either in the form of carbon taxation or emission trading systems. "By capturing the external costs of [emissions]" and reallocating the expense into the hands of consumers, carbon pricing is used as a way to offset the external expenses of its consumption such as those resulting from environmental changes and climate disasters (UNFCCC, 2021). Carbon pricing is an effective method that can be incorporated into policy to reduce the usage of carbon-intensive energy, as exhibited in the UK, where carbon pricing resulted in "emissions in the electricity sector.. [to fall] by 58%" in 4 years (Flues, 2020). In the United States, its implementation would result in significant emission cuts as well as long-term economic growth. A $75 carbon tax would not only be predicted to produce over 25% emission reductions compared to the "2030 baseline", but could also result in a GDP surge of nearly 1% as concluded by referenced data (Parry et al., 2022). The economic growth potential demonstrated by carbon tax must be harnessed to incentivize government institutions to pass favorable legislation as its implementation isn't feasible in the U.S. Economies can turn to emission trading systems as the carbon pricing element of policy in instances where carbon taxation is unattainable due to its flexible nature. Trading systems, proven to deliver carbon reductions, limit market carbon consumption to a specific carbon allowance. It offers greater flexibility amongst consumers as it allows for unfulfilled allowance to be exchanged amongst businesses, encouraging entities against using carbon outside the boundaries of their allowance and offering the possibility of profiting off of unmet allowance (Parry, et al., 2022). Such flexibility may increase the feasibility of emissions trading when compared to carbon taxation. In economies where a carbon tax was beyond reach, such as California, carbon pricing has still been implemented in the form of trading schemes as its adoption requires fewer votes "compared to two-thirds for [a carbon tax]" (Parry et al., 2022). Introducing policies that stimulate carbon reductions is a crucial step toward decarbonizing the economy. Stronger implementation is called for in the RET and in pursuit of reductions necessary to achieve carbon neutrality and climate goals.

In addition to the RET-directed policy being applied on a national level, the RET must not be discarded in developing countries. The global integration of RE grid systems facilitates the RET process for countries with fewer resources. Countries in the absence of an energy grid are met with the opportunity to jumpstart with RE infrastructure or opt for that of fossil fuels, which, as mentioned, is disadvantageous long term (Kuo, 2019). Developing countries are confronted with the challenge of creating sustainable sectors that will supply an energy demand guaranteed of considerable escalation, serve the current needs of a smaller and more geographically dispersed population, and perform with low emission production. This process, dubbed "energy leapfrogging", directs the establishment of a modern renewable grid that will serve the aforementioned needs. (Arndt et al., 2019). Energy production missteps may be mitigated if developing countries are advised to start with RE. Furthermore, carbon neutrality efforts in developed economies are inefficient if such efforts are not extended to developing countries, unable to pursue their own carbon neutrality goals. To illustrate, many developed nations aim to "get to zero [net emissions] before 2050" (Tongia, 2021). However, they have begun to recognize the inefficiency of their carbon neutrality without similar efforts being made in rapidly expanding regions. For example, the 26th United Nations Climate Change Conference of the Parties pledged funding to developing countries for carbon neutrality to be delivered and prevent the potential regressions of developing grids to offset overall progress (Chen, 2022). It is evident that stronger policy initiating RE development, both nationally and in developing countries, is required to facilitate a global RET and confront climate change.

In pursuit of international RET, the obstacles that developing grids face, in particular, such as a lack of investment for RE projects and political instability, must be addressed. As demonstrated by the Integrated Resource Plan implemented in South Africa, policies that provide such developing grids with the resources necessary in the form of project funding, will deliver substantial progression towards RET. For example, the IRP's implementation has expanded South African RE to "account for 21%" of energy consumed within the few years following policy adoption (Arndt et al., 2019). The aforementioned carbon policy can be deployed as a method of increasing RE accessibility and consumption in developing economies. Furthermore, such policies, that utilizes the growing cost competitiveness of RE and recognize its effectiveness "[within] grid extension in rural and dispersed communities", will prove most efficient in delivering RET (Pérez-Arriaga, 2018). As concluded by the presented data, carbon tax in "low-income emerging market economies" would result in the highest percentage of emission reduction compared to the reductions expected in other countries. Additionally, carbon pricing is predicted to increase GDP by more than 2% in all investigated economies (Parry, et al., 2022). It is evident that RE-favoring policies, such as government-backed energy projects and technology funding, as well as emission-preventative policies, such as carbon tax, are both essential and effective in aiding developing countries and energy grids. Resourceful governments must allocate investments toward RE-favoring projects and policies in such economies to ensure national emission reduction headways and global progress toward the RET.

In order to deliver sustained emission reductions, legislation must direct investment toward RE taking account of the long-term effects. However, the nature in which much of today's RE policy is created serves short-term goals. For example, short-term oriented policies made to deliver transitions toward RE or mitigate emissions are often curated in the most financially friendly and timely manner. As a result, the outcomes are unsustainable and fail to meet long-term needs in the realm of the RET and climate goals. Current policies are bound to fall short due to such legislative tactics (Hall et al., 2015). Furthermore, dynamic costs must be prioritized over short-term costs. An example of such include expensive incentives to advance today's RE technologies as they are "desirable to attain dynamically efficient outcomes." (Gillingham et al., 2018) Additionally, the more costly the investment, the greater efficiency it will demonstrate in delivering emission reduction. Unfortunately, due to their unattractive traits such as high costs and long-term results, institutions are less incentivized to allocate funding toward more effective policies (Gillingham et al., 2018). This limitation must be addressed as the call for carbon reduction becomes more critical with the growing climate crisis. In order to encourage the feasibility of long-term and dynamic investment, the advantages of RE, such as growing cost competitiveness, capacity, and climate benefits, must be employed. For example, solar photovoltaic costs have been consistently overestimated in the last 8 years (Arndt et al., 2019). Additionally, the cost competitiveness of RE is improving, as demonstrated in a seven-year span in which the cost of photovoltaic energy "decreased by 81%" while increases were observed amongst non-renewables (Ardnt et al., 2019). When legislators are equipped with compelling evidence that demonstrates the increasing benefits of RE, the RET will advance as long-term and dynamic investment will become more feasible.

Incentivizing the use of RE for both producers and consumers will prove as an effective method in grid decarbonization. In order to do this, policy must encourage RE by improving use accessibility, rather than limiting fossil fuel access. Such policy is a feasible approach, being more easily implemented nationally and globally (Cohen, 2015). The importance of RE investment was demonstrated through variable RE integration in the developing sector of South Africa. The future of global RET and its climate advantages will garner greater success and efficiency if government institutions are incentivized to invest in sustainable grid development in today's underdeveloped regions (Arndt et al., 2019). While carbon taxation policy has proved efficient in implementing economies, obstacles present themselves in implementing such legislation in corrupt or politically polar governments. For example, it would be difficult to implement a strong carbon tax in the United States due to the nation's polarized state (Qadir, 2021). Instead, investments in technology development and deployment are the route to be taken in increasing the possibility of a RET under such institutions. The use of investment may drive the RET without strongly depending on carbon pricing policies to achieve emission reductions.

The U.S. is largely accountable for climate change and thus, climate restoration. In order to mitigate climate change and its harmful environmental and public health effects, its primary causes must be swiftly targeted with legislation. An effective approach to preventing the causes, namely greenhouse gas emissions, is through energy reform. Given the lead role the energy sector plays as an emitter, the sector must transition to RE while maintaining production and transmission efficiency as well as widespread accessibility. The obstacles currently restricting the RET, such as production, storage, and accessibility limitations, must be addressed with legislation that promotes the technological advancement and consumption of RE. By encouraging research and development with investment, incorporating emissions reduction incentives into the economy, and using similar tactics to stimulate RE development in the grids of underdeveloped countries, stronger policy will ensure a transition that is effective and sustainable.

Methods

The primary research portion of this paper targets two areas of emissions reduction efforts demonstrated in the energy sector: carbon pricing and RE development. To determine which is the most efficient and feasible next step in strengthening U.S. energy policy, policy areas were further refined into three areas of focus. These include carbon taxation, carbon emissions trading schemes, and subsidizing clean energy technology. As mentioned, meta-analysis was further directed by the objective of determining the most feasible and effective next step to facilitate the RET in the U.S. Referenced data was gathered from four sources consisting of case studies, reviews, and reports. Each source, pertaining to one of the three policy areas, outlined the findings of policy implementation or prospects of theoretical implementation and addressed successes, failures, and limitations to be considered in future legislation. To determine optimal policy, sources were analyzed and compared according to the objective. Defining characteristics of policy feasibility and effectiveness include benefits and shortcomings exhibited by previous implementation elsewhere, required government funds/resources, economic effects, socio-economic impacts, etc. Defining characteristics of the optimal policy include low economic burden, positive socio-economic impacts, stimulation of market growth, substantial long-term benefits, large societal adaptability, etc. Aforementioned factors drove the analysis of policy feasibility and effectiveness, allowing an optimal policy route to be identified.

Results

Prior sections of this paper call for RE technology investment and advancement, widespread accessibility, disincentives of fossil fuel use, and the expansion of RE development. It is hypothesized that such policy areas are the most optimal and feasible paths given theoretical characteristics; market flexibility and low economic burden of implementation. However, the review of literature does not consider nor compare and contrast the real-world advantages and disadvantages between policies. Utilizing five sources, the following sections will consider previous and current implementation, the recommendations of experts, and original findings of other researchers, the following sections will distinguish policies by feasibility and effectiveness in efforts to identify the most optimal legislative route.

The first source, A Report on the European Union Emissions Trading System (EU-ETS), discusses Emissions Trading Schemes (ETS), a policy presented in prior sections. ETS is a form of carbon pricing that limits participants to a carbon cap, the maximum amount of carbon consumed during a specific period. Unlike carbon taxation, in which participants are subject to varying pricing determined by their individual consumption, ETS addresses participants as a whole, allowing flexibility to disperse consumption amongst themselves depending on individual needs while limiting total consumption according to the cap (Parry, et al., 2022). ETS does not give its participants complete freedom to distribute carbon amongst themselves. A portion of the cap is allocated individually, in the form of "carbon credits" according to prior operative requirements while the remaining cap is auctioned off. By allowing participants to bid for, buy, and sell carbon credits, ETS allows for greater market flexibility without subjecting consumers to a definitive budget and makes room for compromise within carbon-intensive industries (Jones, 2013).

The EU-ETS, put into effect in 2005 and composed of four phases, is purposed to ease businesses into carbon mitigation and, gradually, incorporate carbon credit trading into the market and encourage carbon credit acquisition (Jones, 2013). The EU-ETS regulates carbon intake by establishing an emissions cap, limiting the amount of carbon that can be consumed by participating entities, and allocating carbon budgets to be adhered to in a fixed period. Participants are permitted to trade or acquire budgeting from other entities or investments. The system intends to provide businesses with greater freedom regarding their fossil fuel consumption while limiting consumption according to the cap (Jones, 2013). When the EU-ETS was first introduced, aforementioned carbon pricing practices, such as trading, were not yet allowed, giving participants time to adjust. Therefore, Phase I (2005-2007), enforced a cap equivalent to the prior year's emissions. Individual budgets were determined through the "grandfathering" method, in which the fossil fuel consumption trends of years previous were modeled after (Jones, 2013). By implementing "grandfather" budgets, the purpose of Phase I was to limit carbon emissions from surpassing the year's previous. It is also speculated that the grandfather budgets were excessive, as they were determined using participants' carbon reports which may have been exaggerated in effort to attain more credits (Jones, 2013). While Phase II (2008-2012) did not yet allow credit auctioning and selling, it introduced credit acquisition. Participants were permitted to acquire additional carbon credits through Clean Development Mechanisms (CDM) and Joint Implementation (JI) (Jones, 2013). Participants of CDM fund carbon reduction in developing countries while claiming the mitigated emissions as additional credits to their entity's budget. JI refers to multinational partnerships between economies with low and high domestic emission reduction costs. Reduction initiatives are funded in low-cost economies while the mitigated emissions are claimed as additional credits in the investing party's carbon budget (Jones, 2013). Although these mechanisms primarily serve as a way of budget expansion, they promote RE development in emerging countries (Jones, 2013). Thus, ETS can be viewed as a stimulant of RE technological development and RE leaping frogging. In the case of EU-ETS, however, the system lacked a method of measuring and verifying carbon credits attained through CDM and JI (Jones, 2013). The consequences of this insufficiency will be discussed in a later section. Due to the ineffective implementation in the EU, it is difficult to quantify the carbon mitigation potential of ETS through analysis of its first two phases. Later sections call for legislative reforms that may make ETS more effective and feasible in future implementation.

Furthermore, the first two phases of EU-ETS resulted in carbon budget overload. Along with a lack of credit measurement and verification practices, the system also lacked credit regulation (Jones, 2013). The author identifies oversupply as the root issue of the policy, as it resulted in low carbon pricing and little incentive for participants to further their emissions-reducing practices.

The second source, Looking Back on 30 Years of Carbon Taxes in Sweden, discusses the implications of the Swedish tax and its emissions reduction potential. The report discusses the implementation of EU-ETS on Swedish business as well, explaining how the two forms of carbon pricing coincide and the resulting effects.
Sweden has a carbon tax of "(US $126)"/tCO2e (Jonsson et al., 2020). Implemented in 1991, it was introduced as an energy tax, which the economy was familiar with. The tax primarily served to raise revenue, a function that the authors identify as a source of RE funds. Over the years, the tax has quadrupled, and the country's GDP has risen (50%), all while carbon emissions have reduced (27%) (Jonsson et al., 2020). Prior to its implementation, the Swedish economy was already subject to energy taxes. In its implementation, the country underwent a "green tax-switch", in which "environmental tax [increased] while other taxes [decreased]" (Jonsson et al., 2020) Such compromising tax alterations facilitated the adoption of the carbon tax. Additionally, Sweden enacted tax exemptions in order to aid market adoption. For example, the tax cap exempted businesses that emitted enough carbon to exceed it, from paying additional taxes. Businesses subject to the EU-ETS were also exempted from the tax (Jonsson et al., 2020). The authors call attention to how aforementioned exemptions generally applied to only the most carbon-intensive industries.

Sources 3 and 4, *Implications of Switching Fossil Fuel Subsidies to Solar: A Case Study for the European Union* and *Why German households won't cover their roofs in photovoltaic panels: And whether policy interventions,* *rebound effects and heat pumps might change their minds*, were referenced to analyze the significance of subsidy intervention regarding fossil fuels and RE.

The "$233 billion" invested in fossil fuel subsidies create market distortions that promote their use (Sampedro et al., 2018). The authors identify the distortions as economic burdens and disincentives for RE use and development. They call for subsidy reform, characterizing the policy as regressive by disproportionately benefiting the rich, and argue it be gradually suspended to prevent misappropriation of funds that should be invested in climate-change prevention (Sampedro et al.,). The study refers to the "gradual suspension" of fossil fuels subsidies as "phasing-out", analyzing two scenarios, one in which the subsidies are simply terminated, and the second in which they are reclaimed from phase-out and then recycled into RE-favoring ventures. Although both situations would increase the cost of electricity, they would deliver significant GHG emission reductions, and if revenue is recycled, would drive down the costs of RE (Sampedro et al., 2018). Both scenarios would disincentivize the use of non-renewables, and in the recycling scenario, significantly advance RE development and use.

Source 4 concentrates on the implementation of aforementioned RE subsidies and examines their potential outcomes. Using Germany as a case study, the author acknowledges how the country's RE repertoire is considerably advanced, with a "41.8%" share of renewables in 2020 (Galvin, 2022). Focusing primarily on photovoltaic panels for residential energy production, Galvin stresses the potential of PV production, approximately "148 TWh/y", of which approximately 133 TWh/y is being left unexploited (Galvin, 2022). The purpose of the study is to determine the optimal size of residential PV systems and identify specific technologies and policies that may increase their production and economic viability. For example, heat pumps and battery storage systems are suggested as accessories to PV panels that would maximize energy conservation and consumption, further incentivizing individuals to invest in PV (Galvin, 2022). Although PV installations are profitable long-term, the author identifies heavy upfront costs as preventing their use (Gavlin, 2022). The primary policy discussed is a feed-in tariff, used to reward PV owners with incentives for any PV-produced electricity that their installations feed into the grid.

Additionally, the author explains that the gradual abatement of the feed-in tariff over the years has resulted in German households receiving less money for their electricity production feed-in than before. However, it is also argued that reinforcing a greater feed-in tariff would disadvantage the grid, straining transmission with excess electricity (Galvin, 2022). Instead, the author calls for legislation that incentivizes the installation of smaller PV systems as well as the aforementioned efficiency-enhancing tools. The authors offer such legislation to allow more households to profit from the production and consumption of self-produced PV energy, rather than a select few that feed excess into the grid (Galvin, 2022).

Discussion

The primary research portion of this paper demonstrates how carbon pricing is necessary to accelerate the RET. Not only will pricing disincentivize the use of fossil fuel and incentivize the use of RE, but the resulting RE dependency will also drive technological development, thus furthering RE accessibility and economic competitiveness. Secondary research credits ETS policy for the flexibility it encourages regarding interactions between participating entities and the greater implementation feasibility. However, further study on the ETS enacted in the EU demonstrates that it may not be as effective in reducing emissions while simultaneously protecting the business of smaller entities, although, requiring less initial investment and groundwork than other emissions-reducing efforts.

The flaws of EU-ETS implementation revealed in Source I include, over budgeting (Phase I), lack of measurement and verification of acquired carbon credits (Phase II), and need for credit acquisition regulations (Phase II & III). As a result of the flaws, it is difficult to determine whether Phase I truly limited carbon consumption from exceeding consumption of the prior year. Furthermore, with the introduction of CDM and JI in Phase II, there lacked means of reduction measurement or verification and as a result, it is uncertain whether the tangible emissions reductions are truly proportionate with the carbon credits that they attained. If in fact, carbon credits were disproportionately awarded, in which credits exceeded the tangible reductions, then the reductions derived from the EU-ETS are less than reported.

This flaw, in particular, limits researchers in determining whether well-implemented ETS is an effective and feasible GHG reduction strategy.

Lack of credit acquisition regulation, specifying the timeframe and quantity in which credits can be acquired, resulted in budget overload. Participants “stockpiled” their credits, resulting in an abundance of credits in the market budget. Thus, the carbon budget of EU-ETS accumulated an “oversupply of around 2 billion emission allowances ', drastically decreasing the cost of emissions to a low of “€4/tCO2e”(Jones, 2013). Businesses held little incentive to pursue emission reductions as the cost of emitting plunged, allowing them to operate as usual (Jones, 2013). By reflecting upon the flaws and consequences of EU-ETS, researchers can develop an optimal structure for future implementation. For example, the initial oversupply of allowances demonstrated in Phase I suggests greater measures be taken to validate grandfather budgeting. Perhaps businesses could be required for more thorough and long-term carbon reports. Additionally, the need for credit measurement and validation in Phase II can be combated with requirements of detailed, CDM and JI disclosing, accompanied by annual updates in order to proportionately award allowances. Finally, by observing the lack of regulation of credit attainment and the stockpile it generated, a credit phasing structure should be implemented to disperse credit attainment throughout a longer period. Legislators must reflect and adjust according to the outcome of the EU-ETS in order to reimplement more effective and feasible policies.

Although the EU experienced significant emissions reductions, approximately “15% against the 1990 baseline”, during the implementation of EU-ETS, the author acknowledges a portion of reductions stemmed from the concurrent recession, making it hard to quantify reductions exclusively produced by ETS, and thus discern the policy’s reduction potential. The recession is an additional obstacle limiting the examination and extrapolation of the effectiveness of EU-ETS as its performance would not align with that of the standard economic state.

Sources 2 and 5 commend carbon taxation as an effective reducing measure. Authors Johsson and others, emphasize how thousands of economists have identified it as “the most cost-effective mechanism to decrease emission” (2020). Author and policy expert, Ian Parry, argues that a “$35 per ton carbon tax” would allow several developing economies to fulfill their Paris Agreement goals (2019). However, future implementation of carbon tax must be executed with consideration to the flaws and accomplishments of those previous.

As discussed in Source 2, exemptions are identified as the most significant shortcoming of the Swedish carbon tax. Only the largest carbon consumers can obtain relief from the expense by exceeding the tax cap, and thus, have no further disincentive to emit. Furthermore, market distortion, explained in Source 1, gives ETS participants, typically industrial, carbon-intensive entities, little incentive to pursue fossil fuel cuts (Jones, 2013). As a result, the lowest emitters are burdened while large emitters have significant consumption freedoms after surpassing the tax cap or are burdened substantially less under the EU-ETS. Due to its flawed implementation, the Swedish carbon tax does not reach its full reduction potential. The authors direct focus on the newly implemented Canadian Carbon tax and the accompanying carbon dividend structure. The Canadian policy is enforced uniformly, consisting of fewer exemptions. As previously mentioned, the setback of taxing carbon-intensive industries is the costly economic effects that conspire. To offset the extra expense and increase public acceptance of the tax, the country established a carbon dividend, in which returns tax revenue through credits (Johsson et al., 2020). Future carbon tax implementation must be formulated to avoid the consequences of exemptions while promoting welfare.

As explained in previous sections, much of RE production goes unexploited, further decelerating the RE transition (Xiangchengzhen, 2020). For example, Source 4 emphasizes how residential photovoltaics, accounting for only “31%” of German PV, has an approximate potential of “148 TWh/y”. If this estimation is correct, solely advancing residential PV, in Germany, could nearly deliver PV production rates needed, of “150 TWh”, considering the country’s energy transition goals. However, producing and consuming PV at its estimated potential is inhibited by gaps in energy storage and efficiency-enhancing technologies (Galvin, 2022). The author emphasizes the need for such technologies while arguing that the current feed-in-tariff system is not the most optimal incentive and that tools. Given such circumstances, it can be proposed that subsidizing PV along with said technology would be the optimal initiative to resolve the technological limitations of PV systems and steer away from the tariff. To increase the effectiveness and feasibility of the subsidies, policymakers should utilize revenue-raising methods discussed in Sources 1, 2, 3, and 5. For example, the phase-out and recycle situation proposed in Source 3 presents a rare opportunity to reallocate funding toward sustainable energy. Reclaiming and redirecting fossil fuel subsidy investment presents a feasible alternative to the implementation of additional subsidies which are economically burdening and require revenue attainment elsewhere. The carbon pricing discussed in Sources 1, 2, and 5 can be deployed as mobilizing revenue, thus garnering political feasibility, all while enhancing the efficiency of RE production and consumption.

This paper identifies investing in RE through the mobilization of revenue stemming from carbon pricing, such as taxation and emissions trading schemes as well as the dissolution of fossil fuel subsidies, as the most efficient and feasible next step in strengthening U.S. energy policy. However, the lessons learned from the EU-ETS, Swedish tax, German PV feed-in-tariffs, Canadian carbon tax, and the Canadian tax dividend should be considered to ensure the success of tomorrow's energy policies.

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