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Assessment of the Environmental and Economic Impacts of Fossil Fuel Subsidies

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Abstract

Renewable sources of energy remove dependence on fossil fuels. When renewable sources are adopted, they reduce damage to the environment from burning fossil fuels. Currently, fossil fuels are cheaper to produce, causing renewable energy to be used less. In the United States, fossil fuels receive heavy subsidies, keeping renewable energy in the periphery. This research explores the environmental and economic effects of subsidizing fossil fuels. Findings include that governments and citizens lose money when fossil fuels are subsidized. While subsidization initially makes them cheaper, they create expenses that are not factored into original costs, such as damage to human health and the environment. When these expenses are accounted for, fossil fuel costs exponentially outweigh renewable energy costs. Research identifies methods of decreasing fossil fuel subsidies such as “subsidy swapping,” measured workforce sector transitions, regional markets for pollution trading, and adoption of the Green New Deal or similar policy proposals, all of which reduce damage from climate change. When these methods are implemented, job creation results from a growing renewable energy sector, and billions of dollars are saved from stranding in a fossil fuel industry that will soon become economically inefficient and obsolete. Case studies of the United States and developing nations are compared to illustrate how the United States is bound by fossil fuel subsidies, whereas developing nations are taking steps to subsidize renewable energy because they will be disproportionately affected by environmental disasters caused by climate change.

Introduction

Background Information

Climate change is one of the largest problems the world is currently facing. It will create mass extinctions and severe weather events, and exacerbate current economic inequality and global hunger (Shaftel et al., 2020). Climate change results from large amounts of greenhouse gases being released into the Earth's atmosphere when fossil fuels are burned. The most common greenhouse gases are carbon dioxide, methane, and nitrous oxide. These gases act as a blanket and prevent solar infrared radiation in Earth's atmosphere from escaping, which causes gradual atmospheric heating. Resulting environmental issues include rising sea levels due to melting Arctic glaciers and increased prevalence of flooding and drought. Developing countries will bear a disproportionate burden of associated damages because of their geographic locations and corresponding climates. The large portion of the global population residing in these countries will be at greater risk of sickness, death, and community displacement (Shaftel et al., 2020).

Currently many governments are aware of the need to control the effects of climate change. Climate scientists recommend that global temperature increase should be limited to 2 degrees Celsius because at this mark irreversible environmental damages will occur. A target of 1.5 degrees Celsius is preferable, however, because it provides a 0.5 degree buffer to the limit at which catastrophic events will occur (Mutitt, 2016). In an effort to meet these goals, several economically powerful global leaders have formed organizations pledging to take various measures to reduce their carbon output. The reduction goals often revolve around the idea of "carbon budgets," or the calculated amount of carbon dioxide that can be expelled into the atmosphere before surpassing the climate change limit. It is a significant problem if global

governmental agreements fail to meet their goals, because these milestones mark the beginning of irreversible events associated with climate change.

A large reason that countries are making little progress in reducing carbon emissions is the continued subsidization of fossil fuels. According to the World Trade Organization's Agreement of Subsidies and Countervailing Measures, a subsidy is defined as aid provided by the government to increase the economic viability of a specific product (Bridle et al., 2019). This can include cash transfers, instances when the government fails or forgoes collecting revenue, providing services below market rates, and providing income or price support (Bridle et al., 2019). Normally, any resource that is finite such as fossil fuels will have a higher price than an infinite resource like renewable energy. However, because governments subsidize the price of fossil fuels, people can easily purchase them. This makes fossil fuels cheaper to buy than renewable energy, which does not receive the same economic benefits (Bridle et al., 2019).

Subsidizing fossil fuels throughout recent history has created a strong market for the energy source, as opposed to more recently developed renewable energy (Redman, 2017). The United States has implemented this strategy for over a hundred years, as seen in tax breaks to the fossil fuel industry and extensive lobbying campaigns led by owners of large companies targeting members of government who provide aid in return. Continued subsidization results in the use of fossil fuels on a global scale.

Rationale

Fossil fuel subsidies increase the use of fossil fuels as an energy source, leading to environmental issues resulting from climate change. Therefore, governments must make changes to their energy market pricing to favor renewable energy in order to meet global agreement

goals. Countries that remove fossil fuel subsidies will benefit their citizens' health and the environment. Certain countries are already engaging in various strategies to address this issue. Based on these strategies, this study addresses the research question, *How will countries alter their use of fossil fuel subsidies to address climate change?* Many solutions are not widely known by the global citizenry. A list of specific environmental and economically damaging U.S. subsidies illustrates a roadmap for citizens to address this problem. Targeting these subsidies through consensus building and governmental pressure can lead to their removal. Renewable energy will in turn receive a boost in economic viability, and global climate change agreement goals will become more attainable.

A thorough review of the history of fossil fuel subsidies presents their current economic state and why countries choose specific solutions. The study focuses in detail on their entrenchment in the United States. It also illustrates how modern fossil fuel-producing countries should be targeted to reduce subsidies globally because they initiate the subsidy process. Understanding these conditions answers the second research question, *How has the history of fossil fuel subsidies impacted their present state in global politics?* When the antiquated nature of fossil fuels is illustrated, it is clear that fossil fuel companies are fighting strongly to receive subsidies because their products are jeopardized by the increased prevalence of renewable energy. The provided history shows that small groups of wealthy business owners capitalized on fossil fuel reserves and as the environmental damages of their products became clear, they initiated requests for even more subsidies to ensure their wealth would not vanish.

This study also uses economic data to address the research question, *Will a switch to renewable energy sources damage global economics?* Accurate information can alter the consensus of governments and citizens that because the fossil fuel industry has a long, rather

stable history, it ought not to be reformed. This information demonstrates how swapping fossil fuel subsidies for renewable energy subsidies can boost economies and abate climate change. To make this point, analysis of U.S. job reports from 2017 and 2019 shows changes in workforce and job growth associated with energy production. When the information from the two years is compared, changes in workforce and percentage growth of technologies in specific sectors of energy production are used to assess which fuel source is developing or declining. By analyzing changes between these two years, conclusions are made about the dynamics of the renewable energy and fossil fuel industries. These conclusions inform predictions about future trends of the industries and show that a transition to renewable energy will benefit economies.

Literature reviewed for this study was selected based on a number of important aspects such as currency, overall comprehension, and objectivity. Sources produced by scientists and organizations from developed countries were included to compose a document that illustrates the problem of climate change, shows how fossil fuel subsidies contribute economically and environmentally, and lists solutions. These sources provide the best articulated depiction of the current state of climate change and its relationship with fossil fuel subsidies. Studies were selected from organizations including the National Resources Defense Council, National Aeronautics and Space Administration, the International Monetary Fund.

It is crucial to disseminate these resources beyond the scientific community. They have the potential to switch the global consumer population's preference for fossil fuels to renewable energy. When this occurs, governmental policy will match this shift, leading to a decrease in fossil fuel subsidies and abating climate change. Consumers often overlook the information from these studies because tangible benefits like improved renewable energy prices are not clearly and simply conveyed. Additionally, governments often do not widely promote important studies

because certain composing members are bound to the prosperity of the fossil fuel industry. Large bodies of consuming citizens that understand these studies can select government officials who place renewable energy at the forefront of their platform, a crucial step to meeting global climate change targets.

The main goal of this study is to present the current, comprehensive, and objective information from scientific research in a clear and concise manner. It produces accessible and articulated conclusions about the economic and environmental benefits of decreasing fossil fuel subsidies. These conclusions look to alter the perceptions of a large majority of people that know little about how governments make fossil fuels cheaper to purchase. When paired with this information, knowledge of the effect of increased fossil fuel combustion on the environment has the potential to influence public opinion. The result is a general population aware of how fossil fuel subsidies continue the process of climate change. Citizens that absorb this information are equipped to make smart consumer decisions to invest in renewable energy. These decisions, when adopted by large portions of the population, have the power to alter market dynamics and shift the economically viable fuel source from fossil fuels to renewable energy. Without strong support of renewable energy from the global citizenry, it is likely that fossil fuels will continue to receive subsidies because governmental representatives are often bound to the fossil fuel industry through lobbying. However, when fuel source preference is altered, fossil fuel subsidies will become useless because fossil fuels will no longer be used. Governments can then focus their money on renewable energy initiatives, creating a basis that will help them form stronger international coalitions with the capability and desire to meet climate change goals. Ultimately, this will improve the health of current and future citizens, as well as the Earth's atmosphere, environment, and climate.

Historical Analysis

Throughout American history, fossil fuels have been used far more widely than renewable energies. Fossil fuels existed during the founding of the country, whereas renewable energy did not. Once fully formed, the United States began to tax British coal and subsidized American coal, making it cheaper for consumption. Imposing tariffs has often been an important method to promote domestic resources over foreign ones and create economic prosperity for the home country. From the imposition of the first tariff, an era of American nationalism and independence from foreign countries regarding fossil fuels began (Johnson, 2011). However, the true environmental damage has not been factored accurately for over a hundred years because of the subsidization of domestic fossil fuels.

Tax breaks to American fossil fuels throughout history have continued their place of economic and political favorability. Often tax breaks that are given to a specific industry or company do not expire because they are embedded into the U.S. tax code. One prominent tax break was written to fund energy to fuel the Korean War effort. It is still in use and benefits the fossil fuel industry because it has never been removed (Johnson, 2011). Once these tax breaks become a part of the tax code, they promote the consumption of fossil fuels at an increased rate. This is extremely dangerous to the global ability to remain below the 2 degree Celsius target of climate change. If companies are given tax breaks, they can burn carbon more cheaply, accelerating the climate change process exponentially (Johnson, 2011). Evidence of this is seen in a tax break, written in 1926 and still in use today, that can be claimed by a company for completely depleting an oil well (Johnson, 2011). As a result, companies are encouraged to consume fossil fuels in large quantities because they will be economically rewarded.

Since fossil fuels were first subsidized, the practice has continued in various forms. The important aspect to recognize is the discrepancy between pretax and posttax subsidization. Pretax subsidization has been commonly associated with fossil fuel producing countries, a number of which are located in the Middle East region. Posttax subsidization has been associated with the fossil fuel consumers such as the United States and other developed countries. On average, fossil fuels are subsidized 15 to 20 times more posttax as opposed to pretax, to make the pricing convenient for the citizens of the consumer country (Coady et al., 2019).

The trend of subsidizing fossil fuels before taxation contributes immensely to their presence globally. Because fuel-producing countries subsidize their fossil fuels pretax, they force other countries to subsidize the product posttax to make it easy for their citizens to purchase, thereby continuing the subsidization cycle. Pretax subsidization has this effect because if a fuel-producing country chooses to subsidize oil for its citizens, the other countries of the world are forced to do the same. Citizens made to purchase fossil fuels at a far higher price than the citizens of the country that produced them will be generally displeased, leading to unrest and instability of the market.

In more recent times, large companies and powerful individuals like the Koch brothers have begun to influence global governments to ensure they continue to subsidize fossil fuels. This is because developed countries have emerged as world powers wielding compelling economic tools. Companies realize the opportunity to keep a hold on the fuel market by catering to members of these governments who make policy decisions. The Koch brothers worked tirelessly in the early days of discussions about climate change to promote the notion that the science behind the theory was too vague and even false (Mayer, 2019). Much of their wealth exists in the fossil fuel industry, and it was in their best interest to develop a narrative that would

allow for the continued use of their products. During a time when the idea of carbon budgets was developing, a change in policy regarding limits on fossil fuel combustion would have lost the brothers billions of dollars. To ensure this did not occur, they organized the first climate change denial conference at the Cato Institute in 1991. This conference and ensuing events swayed the minds of American citizens and governmental representatives (Mayer, 2019).

Since the Koch brothers began their efforts, the fossil fuel industry has continued to sway public opinion and governmental policy through lobbying. The industry uses lobbying to secure funds to sell their products more cheaply than renewable energy sources. During the years 2016 to 2018, lobbying to members of the U.S. Congress increased every year (Center for Responsive Politics, 2017). ExxonMobil was the leading contributor until 2019, when it was surpassed by the Koch brothers. Interestingly, however, in 2019 the total money contributed by fossil fuel companies to members of Congress dropped from \$125 million to \$92 million. The Koch brothers, like other lobbyists for the industry, gave less money because the Trump administration began voluntarily providing subsidies (Center for Responsive Politics, 2017).

Damage to International Agreements

Historically, fossil fuel subsidies have played an important role in bolstering the economies of countries that use them. Because of this, when countries enter into international agreements to try to curb the effects of climate change, they are reluctant to remove their fossil fuel subsidies because they do not want to destabilize their economies. International environmental agreements have become the staple of the global response to climate change, but many, including the well known Paris Climate Accord, have been hampered by the drawback of member countries not wanting to remove subsidies.

This study focuses on the G7, an international group of highly developed countries, and its declared intent to phaseout of fossil fuel subsidies by 2025. Members include the United States, Italy, Japan, Canada, Germany, France, and the United Kingdom. There is inherent weakness in this commitment, however, seen in the fact that the G7 countries continue to subsidize fossil fuels across more than 50 countries. In total, G7 countries contribute \$100 billion per year in subsidies, with the United States giving \$26 billion annually, the most of the group (Chen & Droitsch, 2018). The G7 Fossil Fuel Subsidy Score Card produced by the National Resources Defense Council is a reference used to measure the G7's commitment to its goals and maintain accountability. The subsidization statistics on the latest score card point to the fact that there is lots of work to be done to meet the goal of complete subsidy phaseout by 2025.

By subsidizing fossil fuels abroad, the G7 countries show that while they are pledging their commitment on the international stage, they are simultaneously taking advantage of developing countries and holding back the progress of renewable energy. This sabotage of developing countries contrasts painfully with the fact that G7 member countries use 64% of the aid they receive from the organization internally on renewable investments. At the same time, they encourage developing countries to build facilities that use fossil fuels (Chen & Droitsch, 2018). By subsidizing virtually all aspects of the fossil fuel industry in developing countries, G7 countries promote economic inefficiency because developing countries will continue to build facilities that will be outdated in the coming years as fossil fuel use declines. When these facilities are unable to be used, developing countries will have to spend money to develop renewable energy facilities.

U.S. Case Study

The fact that the United States promotes fossil fuel subsidies through international institutions such as the World Bank is evidence of the G7s weak commitment to its goals (Chen & Droitsch, 2018). The U.S. action ensures that there will be countries that partake in the economically inefficient fossil fuel industry. Additionally, outside of international meetings, the U.S. Export-Import Bank supports gas-fired power plants in foreign countries (Chen & Droitsch, 2018). This maneuver allows the United States to bypass strict domestic regulations and produce fossil fuels in developing countries that have loose oversight. Engaging in bilateral agreements is a prominent way that G7 member countries counteract progress toward the goals of fossil fuel subsidy they have established.

The United States also exemplifies how internal approval of policies that favor fossil fuel subsidies results in vague commitment to the G7 agreement. The country is divided into 50 states, which contributes to weak commitment on the national level. Oklahoma illustrates this: In order to pay the cost of subsidizing coal and oil for its citizens, the state government cut \$109 million from the public school education budget (Redman, 2017). Lack of commitment at the state level leads to a weakly committed nation. In 2012, contributions from oil lobbyists to U.S. congressional candidates increased from \$34 million to \$79 million. This large increase was a reflection of the price troubles the fossil fuel industry was experiencing at the time. Of this lobbying, 87% went to Republican congressional candidates. These politicians remain open to subsidizing fossil fuels, showing the continued effect of the early climate change denial efforts of the Koch brothers (Center for Responsive Politics, 2017). In the years 2015 and 2016, fossil fuel lobbyists contributed \$354 million to government officials in an effort to promote the

continuation of fossil fuel subsidies. They in turn received \$29.4 billion in subsidies from the U.S. government, an 8,200% return on investment (Redman, 2017).

Of the money given to the fossil fuel industry during these years, \$3.5 billion was taxpayer-funded payments used to alter fuel prices to make them affordable for everyday citizens (Redman, 2017). Without these price alterations, fossil fuels would be too costly for the general population. Other evidence of continued support of fossil fuel subsidies is seen in President Trump's fiscal year (FY) 2018 budget cuts to 10 extremely important national programs (National Association of State Energy Officials, 2019). Interestingly, as Redman (2017) points out, the money saved from these programs equaled the money needed to subsidize fossil fuels for the coming years. This maneuver shows the U.S. government is placing an affordable fuel source that damages the environment, economics, and health of its citizens above other beneficial programs.

Several specific federal subsidies stand out in terms of promoting the continued use of fossil fuels and overall damage to the environment (see Table 1 below). The largest federal subsidy of oil and gas (Subsidy 1 in table) allows companies to deduct 100% of the cost of exploration and drilling (Redman, 2017). The benefits of this subsidy to the fossil fuel industry are unimaginable because it gives an advantage over the renewable energy industry, which receives benefits of no similar comparison.

Table 1: Major U.S. Subsidies

	Subsidy Name	Amount	Description
Subsidy 1	Intangible Drilling Oil and Gas Deduction	100%	Immediately deducts cost of exploration such as labor, surveying, and ground clearing. Integrated companies may immediately deduct 70% of drilling costs.
Subsidy 2	Abandoned Land Mine Grant	\$400 million	Jumpstarts new coal mines.
Subsidy 3	Domestic Manufacturing Deduction	\$805 million	Promotes U.S. fossil fuel usage.
Subsidy 4	Dual-Capacity Taxpayer Deduction	\$530 million	Allows U.S. foreign-operated facilities to use taxpayer money to pay royalties.
Subsidy 5	Royalty-Free Flaring and Venting	\$70 million	Allows royalty-free flaring and venting.

Another subsidy of great detriment to the progress of renewable energy development is the Abandoned Land Mine Grant (Subsidy 2). This subsidy's value is \$400 million and is accumulated by taking a portion of the money from each ton of coal that is mined in the United States (Redman, 2017). However, when the revenue from coal mines is unable to fill the grant, which is increasingly more common because of falling coal prices, taxpayer funds are used to cover the difference. When the \$400 million has been collected, it is used to reopen specific closed coal mines that have been assessed to provide future economic benefit to a region. This is detrimental to renewable energy development because it gives the coal industry a free boost to open new facilities, diverting workers that could have been hired in the renewable energy industry.

A subsidy payment for FY 2015–2016 amounting to more than double the Abandoned Land Mine Grant is the Domestic Manufacturing Deduction (Subsidy 3). The subsidy functions to protect American fossil fuels, a concept that originated during the early days of the nation

(Redman, 2017). This subsidy provided \$805 million in the aforementioned year and neglected to internalize the costs of oil spills and gas leaks associated with the development of fossil fuel industries in the United States as it looked to provide cheap energy for the country (Redman, 2017). By doing this, the U.S. government overlooks billions of dollars in environmental damages to secure a cheap fuel source for the general population. Choosing renewable options would lead to less environmental damage and would save money currently being spent to subsidize fossil fuels. Renewable energy is limitless; therefore, a preference for domestic generation is not required as it is for fossil fuels.

Other subsidies from FY 2015–2016 included the Dual-Capacity Taxpayer Deduction (Subsidy 4), worth \$530 million, and the Royalty-Free Flaring and Venting (Subsidy 5), worth \$70 million (Redman, 2017). The first subsidy allows American fossil fuel plants operated in foreign countries to pay the royalties owed to these countries' governments using taxpayer-provided funds. The second subsidy is extremely wasteful because it allows companies to flare oil reserves and vent natural gas without having to pay a royalty. This practice is horribly destructive to the earth's atmosphere and climate, yet the companies are not made to pay for this—American taxpayer money can be used to cover the cost. Additionally, companies are wasting product by venting or flaring it into the air, but the process is supported because the fuels are so inexpensive as a result of subsidization (Redman, 2017).

Economic Inefficiency

Continued subsidization of fossil fuels while renewable energy sources simultaneously develop is damaging to the national and global economies. Currently investment trends for the two fuel sources do not align. Since 2008, investments in renewable energy have exceeded fossil fuel investments, with \$372 billion and \$200 billion being spent respectively (Bridle et al.,

2019). Also, since 2017 renewable energy generation capacity has exceeded fossil fuel generation capacity. While these figures point to the fact that renewable energy has a large stake in global energy production, the world still met 70% of its energy demand in 2018 using fossil fuels (Bridle et al., 2019). Additionally, in 2012 \$44 billion was spent on fossil fuel subsidies to keep the price of fossil fuels economically viable in relation to renewable energy (Bridle et al., 2019). These figures are important because they show that there is the potential to generate much of the world's energy through the use of renewable sources. However, because of the sheer amount of subsidies governments give to the fossil fuel industry, their prices remain lower than renewable sources. Therefore, consumers continue burning them, damaging the environment and human health.

In 2015, fossil fuels were valued at half their efficient price because of subsidies (Coady et al., 2019). The cost to emit 1 ton of carbon dioxide was between \$5 and \$20 when it should have been between \$40 and \$80. If the fossil fuels had been efficiently priced, global carbon dioxide emissions would have been lowered by 28%, deaths attributed to air pollution from fossil fuel burning would have been lowered by 46%, and government revenue would have increased globally by 3.8% of GDP. These figures show that price reformation will decrease fossil fuel usage. The resulting shift to renewable energy will result in benefits to the environment, economies, and human health globally (Coady et al., 2019).

Subsidizing fossil fuels is especially harmful to a nation's citizens. In the United States, over 30 years, subsidizing coal alone has cost American taxpayers \$30 billion (Chen & Droitsch, 2018). Because 40% of coal burned in the United States comes from public lands, taxpayers have to make up the cost of subsidization when public coal is sold to private companies at a greatly reduced price. Citizens later purchase the same energy, showing that Americans are paying for

fossil fuels at two stages; once to subsidize, and once when they actually purchase the product (Chen & Droitsch, 2018). In the United States, two of the largest fossil fuel reserves are the Williston Basin in North Dakota and the Permian Basin in Texas. According to Chen et al. (2018), these reserves respectively are 59% and 40% subsidy dependent, meaning that lobbying is keeping the producer's price below the efficient value and Americans are being made to pay the difference through their taxes.

Carbon Budgets and Stranded Assets

As long as subsidization prolongs the use of fossil fuels, countries will lose revenue because of inefficient pricing. Additionally, large amounts of fossil fuels will eventually become stranded because current global reserves are inconsistent with the carbon budget necessary to stay below the 2 degree Celsius climate change limit. Currently a large majority of fossil fuel extraction and development facilities are under extreme economic stress because they are at risk of closure long before their expected life cycle concludes. Fossil fuel subsidies exacerbate the situation because they allow fossil fuels to be developed at an inefficient price, later causing production facilities to become stranded assets when they are shut down because renewable energy is cheaper.

Statistics illustrate the degree to which fossil fuels will have to be foregone to combat climate change. Currently, there are an estimated 2,795 gigatons (gt) of carbon dioxide in industrial fossil fuel containers globally. There is also a known 942gt of carbon dioxide in developed reserves, meaning these reserves are ready for production (Mutitt, 2016). Globally, three quarters of all fossil fuels will have to remain unburned. Since 2015, it has been known that to stay below the 2 degree Celsius mark of climate change limitation, no more than 843gt of carbon dioxide must be released. This equates to leaving 68% of known fossil fuel reserves

unburned. To stay below the 1.5 degree Celsius mark, no more than 393gt of carbon dioxide may be released. This equates to leaving 85% of fossil fuel reserves unburned. Respectively, these carbon budgets will be expended by the years 2037 and 2025 if the current trajectory of usage is continued (Mutitt, 2016).

Under these carbon budgets, large amounts of fossil fuels would have to go unburned because they are both smaller than the amount of carbon dioxide stored in developed reserves and in undeveloped fossil fuel containers. Due to the need to leave fossil fuels in the ground, renewable energy prices will become more favorable. The degree to which fossil fuels will become obsolete when renewable energy becomes cheaper is illustrated by a statement of the Chairman of the Financial Stability Board, an international body that monitors the global financial system. He states that a carbon budget consistent with the 2 degree target “would render the vast majority of reserves ‘stranded’—gas, oil, and coal that would literally be unburnable without expensive carbon capture technology which itself alters fossil fuel economics” (Carbon Tracker Initiative, 2017).

Because carbon budgets restrict the allowed burnable amount of fossil fuels, which results in stranded assets, fossil fuel companies are fighting hard to have their products subsidized (Carbon Tracker Initiative, 2017). Essentially, because the market is tipping in favor of renewable energy, any fossil fuels that are unused when renewable energy becomes more profitable will likely never be used. At that point, any remaining fossil fuels will be lost revenue. Therefore, fossil fuel companies spend significant amounts of money lobbying government officials to ensure that their prices remain lower than renewable energy prices. However, lobbying can only influence government officials for so long because eventually the public will become aware of the economic inefficiencies associated with distorting fossil fuel prices. When

this occurs through dispersion of information contained in well-articulated documents, large-scale adoption of renewable energy will ensue and fossil fuel assets will become stranded (Carbon Tracker Initiative, 2017).

The fine balance between fossil fuel and renewable energy pricing can be seen in that 21% of coal energy in India was considered stressed in 2019. As the price of renewable energy approached the price of coal, 21% of coal power in India was on the verge of going unburned because it would have lost the companies money (Bridle et al., 2019). Additionally, a larger study undertaken by the Carbon Tracker organization found that currently, 42% of global coal power plants are economically inferior to alternative generation methods, and that by 2030, 72% of coal power plants could be unprofitable (Carbon Tracker Initiative, 2017). The Carbon Tracker study concluded that by following the Paris Climate Agreement's policy proposal to end coal subsidies and shut down coal plants, China could save \$389 billion, the United States could save \$78 billion, and Russia could save \$20 billion (Carbon Tracker Initiative, 2017).

If fossil fuel companies continue to receive fossil fuel subsidies, they will lose billions of dollars in the future. This is because subsidies promote development of facilities, locking in fossil fuels for the foreseeable future. When fossil fuels become obsolete, the facilities will be worth nothing. In fact, if new oil fields are developed, \$10 trillion will be stranded. Similarly, if transportation technology development continues, an additional \$4 trillion will be stranded (Mutitt, 2016). Currently, Qatar is planning highly subsidized oil and gas expansions that would use 52gt or 13% of the carbon dioxide budget necessary to stay within the 1.5 degree Celsius climate change goal (Mutitt, 2016). If these installations are finalized, they will likely not fulfill their life cycle and will lose money for the developers and the governments that approved them.

One solution to avoid losing trillions of dollars is to stop fossil fuel extraction. This is essential because once fossil fuels have been extracted, they are far more likely to be sold than if they are left in the ground. The Organization of the Petroleum Exporting Countries (OPEC) adjusts prices of fossil fuels; therefore, when these fuels are removed from the ground they have the ability and the economic responsibility to sell them at a price that consumers can easily purchase (Mutitt, 2016). If governments can prevent fossil fuel extraction, then OPEC will have fewer resources to subsidize, and the climate change limit goals stand a better chance of being met.

The Problem of Initial Subsidization

Generally, the problems created by fossil fuel subsidization originate when fuel-producing countries subsidize their fuels. These countries, which are primarily in the Middle East, have access to the largest reserves and sell their products to consumer countries. Producing countries subsidize fossil fuels because they want to provide their citizens with affordable energy, which is critical to the well-being of the nation (International Monetary Fund, 2017). However, when producing countries subsidize their fossil fuels, other countries are unable to sell them at the economically efficient price. They have bought them for a cheap yet economically inefficient price and would lose money if they did not subsidize as well. As a result, consuming countries subsidize the fossil fuels they buy, creating a domino effect that perpetuates the use of fossil fuels.

The Commonwealth of Independent States (CIS), an intergovernmental organization of former Soviet republics, consists of many fossil fuel-producing countries. In total, CIS members have cost the world \$4 trillion in externalities because of their initial decision to subsidize fossil fuels (Coady et al., 2019). If fossil fuels had been efficiently priced in 2015 alone, the total

global energy costs would have been around \$4.5 trillion (Coady et al., 2019). If these prices were efficient, total global consumption of fossil fuels would have greatly decreased because people would have chosen to buy renewable energy instead. By lowering the prices and not factoring in the immense environmental damages and human health effects, fuel-producing countries force virtually all other countries to subsidize the products they purchase, normalizing destruction of the environment and fossil fuel use.

The Middle East illustrates the high degree to which fuels are subsidized initially. The average price for a liter of oil there is \$0.25, or approximately \$1 per gallon. This is extremely cheap and can be explained by the fact that in 2015, Middle Eastern countries accounted for one quarter of global energy subsidies (International Monetary Fund, 2017). However, signs of change are seen in that the United Arab Emirates has eliminated subsidies on its exports and sells products at more economically efficient prices. Additionally, Morocco, Jordan, and Lebanon have chosen to eliminate subsidies on the imports they receive, meaning that they purchase them for the economically and environmentally efficient price. While these maneuvers may reduce the amounts of products these countries are able to sell and purchase respectively, they are taking important steps toward normalizing the use of renewable energy internally. Furthermore, from 2013 to 2016 Middle Eastern subsidies have collectively decreased, meaning their prices are starting to reflect the full environmental effects of fossil fuels. As a result, other countries in the region can start to remove their subsidies because now they will not be losing money (International Monetary Fund, 2017). The decrease in subsidies in the Middle East could begin a critical period where consuming countries decide to discard their subsidies and internalize the environmental costs of burning fossil fuels.

Solutions and Policy Recommendations

Subsidy Swapping and Country-Specific Examples

There are solutions and sufficient economic data that can be analyzed to prove a switch to subsidizing renewable energy will benefit the planet and global economy. One notable solution presented by the International Institute of Sustainable Development is known as subsidy swapping. This process requires that fossil fuel subsidies be reduced, and that the money saved be put toward renewable energy subsidies (Bridle et al., 2019). This causes the economic viability of fossil fuels to decrease to a point that renewable energy becomes more prevalent and fossil fuels will no longer be needed. The swapping process will save money because it will accelerate the transition from fossil fuels to renewable energy and reduce the number of fossil fuel generation facilities that are built and subjected to future asset stranding. Additionally, it will result in massive steps toward the climate change goals. Swapping only 30% of savings from a phaseout of fossil fuel subsidies in 20 countries would lead to a reduction in emissions of 11% to 18% (Bridle et al., 2019).

Currently, there are numerous success stories of countries around the world engaging in this process. Many of them are developing countries who are most exposed to harmful effects of fossil fuel use. In India, where together with China one million deaths were attributed to fossil fuel generation in 2016 and 2017, the government has been working to eliminate most gas and diesel subsidies (Bridle et al., 2019). In turn, the government can reduce kerosene subsidies with the money saved from efficiently pricing these products. Kerosene subsidies are economically inefficient, and the fuel source produces negative health effects. India will access more revenue with this reduction and ultimately put the money toward solar energy generation.

Zambia is a country in a similar situation to India. It has enough installed electrical generation capacity to obtain 85% of its energy from hydroelectric power (Bridle et al., 2019). However, because fossil fuel subsidies remain high, Zambia generates 55% of its electricity from the mining sector (i.e., coal). Recently, the country has saved money by not subsidizing diesel generation; the next step is to put the money saved into subsidizing the hydroelectric sector to increase its economic viability in relation to the mining sector. Additionally, the country is partnering with the World Bank to subsidize solar electric generation. Partnerships such as this are advisable for other developing countries because they allow developed countries to give aid to prevent fossil fuels from taking a large hold (Bridle et al., 2019).

Analyzing 2017 and 2019 U.S. Job Reports

This study contains an assessment of the United States Jobs Reports from 2017 and 2019. The assessment provides economic evidence supporting a measured transition from fossil fuel subsidies to renewable energy subsidies. When the reports are analyzed, comparing the data from the two years in specific sectors relating to energy generation shows that if renewable energy is supported, the United States will see large financial gains and increased job security in renewable energy fields. The reports look to fill gaps in U.S. data that pertains to renewable energy and energy-efficient jobs. Their goal is to make known that these sectors are growing in ways that were unknown because of classifications in previous jobs reports. The U.S. Department of Energy summarizes some of the reports' findings as follows: "Electric generation mix in the United States is changing, driven by the transition of coal-fired power plants to natural gas and the increase in low carbon sources of energy" (2017).

A number of statistics from the 2017 Jobs Report point to the fact that renewable energy has a stronger present and future economic potential than fossil fuels. The first is that in 2016,

1.1 million people worked in the fossil fuel industry and 800,000 worked in the renewable energy industry, with 374,000 working in solar firms (U.S. Department of Energy, 2017). Most importantly, however, the solar and wind workforce increased 25% and 32% respectively in that year, while the fossil fuel sector decreased 8% (U.S. Department of Energy, 2017). If this trend continues, a transition of workers from the fossil fuel industry to the renewable energy sector will occur. The trend relates to fossil fuel subsidization because the U.S. government is supporting an industry decreasing in size instead of one that is growing rapidly. Economically, it makes little sense to pour money into an industry shrinking in workforce and shown to be inconsistent with climate change goals.

The energy efficiency sector in 2016 is also growing, illustrated by the fact that 2.2 million workers spend some or all of their time there. Additionally, 1.3 million of these employees work in a construction job. This aspect of the sector will make a “just” workforce transition from fossil fuel employment to renewable energy easier because workers can convert to the construction industry with less training than more advanced fields. A “just” transition ensures that former employees in the fossil fuel industry are appropriately trained for work in the renewable energy industry. They are also provided renewable energy jobs to ensure continued growth of the sector and stable employment levels (U.S. Department of Energy, 2017). Notably, the energy efficiency industry has the potential to employ 4.2 million of the 6.5 million total construction workers in the United States (U.S. Department of Energy, 2017). The fossil fuel industry has a much smaller potential for employment, especially when it takes the idea of stranded assets seriously and makes companies aware of the danger of continued facility development. When this occurs, companies are equipped with knowledge that will guide them to invest their resources in the energy efficiency sector.

Because of the current decline in coal usage in the United States, the industry will likely experience a decrease in available jobs. This issue is offset by the opportunity to switch large amounts of workers into fields such as energy efficiency. In 2017, 74,000 employees of the fuel sector were employed in coal-related companies, whereas 502,000 worked for the petroleum industry (U.S. Department of Energy, 2017). This shows that a switch is being made from coal to petroleum, a slightly positive development because coal produces more carbon dioxide when it is burned than petroleum. However, in the electricity generation sector, coal still employs 46% of all fossil fuel-related workers (U.S. Department of Energy, 2017). This is a problem and an opportunity because with the sector decreasing its workforce and closing facilities, workers will need to be trained and assimilated into other fields in an equitable manner. Because of the high potential percentage of construction jobs in the energy efficiency sector, workers who transition into this sector will experience a lower social and economic cost. They will be moving to a new sector, but because the work will still be construction oriented, they will not have to learn new skills or spend time being retrained. This will save workers money on education, and energy efficiency companies money on retraining workers.

When the 2017 Jobs Report is compared with the 2019 edition, trends emerge signaling the importance of ending fossil fuel subsidies because the industries associated with them are being phased out. Most notably, the coal industry gained only 650 jobs in 2018, while the petroleum industry gained 33,500. This signals that the phaseout of coal in the United States is likely to continue (National Association of State Energy Officials, 2019). However, the natural gas workforce grew 5%, making it the largest energy-generating source (National Association of State Energy Officials, 2019). With coal generation levels very low, natural gas has begun to receive the subsidies that previously went toward coal, making it cheaper to produce. Such

developments iterate that swapping subsidies from fossil fuels to renewable energy is extremely important because large-scale shifts in workforce placement within related industries present valuable opportunities. Currently subsidies formerly given to the coal industry can be transitioned to renewable energy. However, if they are shifted to the petroleum sector instead this opportunity will be lost.

As detailed by the concept of subsidy swapping, if a transition away from fossil fuels is to occur, switching subsidies from one fossil fuel source to another will not be sufficient. Instead, when subsidies are cut off from one fossil fuel source, in this case coal, the subsidies need to be transferred to support a renewable energy–related industry. A recent decision of Alicia Barton, president of the New York State Energy Research and Development Authority, illustrates this point. She chose to allocate \$70 million to train workers to move into energy efficiency and renewable energy jobs (National Association of State Energy Officials, 2019). This is an economically valuable decision because it takes workers out of steadily declining industries like coal and moves them to developing industries that can employ greater workforce capacities.

Regional Greenhouse Gas Initiative

Another method to reduce the use of fossil fuel subsidies and boost economic generation is seen at the regional level of the U.S. energy market in an initiative known as the Regional Greenhouse Gas Initiative (RGGI, 2020). Formed in 2009, this initiative established a market for companies within the member states in the northeastern United States. The market allows companies to trade credits, which equate to designated amounts of allowable fossil fuel emissions from their factories. When companies purchase credits, they are able to emit more greenhouse gases, and when they sell their credits, they are able to emit less. The market follows a capping system that decreases every year by 2.5%, limiting the total tradable number of

emission credits (RGGI, 2020). While the market has been a great success, its 21st century formation is evidence that the Koch brothers' early climate change denial efforts were successful in delaying the establishment of limits on fossil fuel emissions (Mayer, 2019).

The RGGI is able to function with a decreasing cap of allowable fossil fuel emission credits because it allows companies to invest money acquired from selling credits to other states. When a state sells an emission credit, it receives revenue because the state that purchases the credit is now allowed to expend more fossil fuels, leading to economic activity. Really, however, the state that sells the credit gains an advantage, a phenomenon that shows why markets such as these are excellent ways to reduce fossil fuel use. Frequently, states that sell emission credits are using the money they receive to fund renewable energy initiatives, which will further reduce their dependence on fossil fuels and allow them to sell more of their emission credits in the future. They are then able to continue to invest in renewable energy, forming a positive feedback loop. When renewable energy systems are adopted in specific states, they will adjust the overall fuel markets to favor this form of energy production, which will make it increasingly difficult for fossil fuels to be sold and burned. Therefore, the RGGI has the potential to alter the regional preference of energy sources from fossil fuel dependency to renewable energy, eventually affecting the energy choices of states not participating in the market.

The Investment of RGGI Proceeds in 2017 report details the many initiatives that states have funded from the money they receive when they sell emission credits (RGGI, 2020). The report explains that RGGI member states invested savings from credit sales and received in return: \$1.4 billion in lifetime energy bill savings, 13.9 million MWh of electricity use avoided, 22.6 million MMBtu of fossil fuel use avoided, and 8.3 million short tons of carbon dioxide emissions avoided (RGGI, 2020). These statistics show that when states invest money in

renewable energy and the energy efficiency industry, they can reduce their electricity and fossil fuel usage. States are also able to save money, illustrating that renewable energy sources are more economically beneficial than fossil fuels.

Green New Deal

The Green New Deal is another step toward reducing fossil fuel subsidization that has been put forward as a policy proposal in the United States and replicated in similar forms around the world. While the deal is yet to be adopted, its goals are one of few policy proposals that are actually in line with international agreements such as the Paris Climate Accord and G7 (see Table 2 below) (Doonan, 2019). The Green New Deal presents a roadmap that will bring the United States to 100% renewable energy by the year 2030. Doonan states on the official Green New Deal website that “studies have shown that the technology already exists to achieve 100% clean energy by 2030” (Goal 1) (2019). The deal functions in a similar manner to the World War II mobilization effort enacted in 1941. It contains programs resembling the Works Progress Administration laid out by President Roosevelt’s New Deal following the Great Depression. These characteristics address the issue of climate change by creating 20 million new jobs for Americans in the renewable energy industry (Goal 2) (Doonan, 2019). Many of these positions will be filled by workers who are transitioning from a dying fossil fuel sector, and the deal contains clauses that will allow for a just and equitable process.

Table 2: Key Features of the Green New Deal

	Features
Goal 1	100% renewable energy in the United States by 2030
Goal 2	By switching to 100% renewable energy, create 20 million new jobs
Goal 3	End wars in foreign countries that guard fossil fuel interests
Goal 4	Reduce military personnel by 50% by eliminating oil wars

One aspect of the Green New Deal is the swapping of subsidies formerly given to the fossil fuel industry in exchange for renewable energy subsidies. The deal will redirect funds set aside for research and development of the fossil fuel industry for equivalent activities in the renewable energy industry. Another aspect of the deal related to subsidy swapping is seen in U.S. energy goals for foreign resources. When the deal's fundamental goal of 100% clean energy is achieved, the United States will no longer have to use the military to defend its fossil fuel holdings around the world (Goal 3). The deal estimates that this will allow for a 50% reduction in U.S. armed forces, which will save the country billions of dollars and free up more funds that can be used to bolster the renewable energy industry (Goal 4) (Doonan, 2019). Of course, the personnel that are no longer needed for the military will be equitably transitioned to a new sector, and they will be assured of available positions because of the money saved from no longer having to wage wars for fossil fuels.

When reliance on fossil fuels abroad ends, the United States will also save money formerly spent on specific subsidies. The United States spends \$530 million to fund the Dual-Capacity Taxpayer Deduction, which is paid as a royalty to foreign countries to operate abroad. The government often completes the subsidy funding with money collected from U.S. taxpayers. When the United States ends its fossil fuel use, it will no longer need to defend energy

sources abroad. Therefore, funds that were formerly needed to secure foreign investments can be used on renewable energy subsidies.

Conclusion

In a time when climate science shows a need to halt the rate of climate change, reducing fossil fuel subsidies will be a crucial step to ensuring that catastrophic environmental events do not occur. While subsidies have held a strong position in global politics and economics for over a hundred years, their use needs to be reformed in order to meet essential goals laid out by international climate coalitions. Fossil fuel subsidies promote the use of fossil fuels, which damage the global environment and economic potential. By understanding their history, citizens can reform energy spending habits to reflect awareness of the environmental and economic inefficiencies. When citizens understand these problems, they can alter energy markets themselves, without having to appeal to government officials to make the changes, many of whom may be intertwined in lobbying from the fossil fuel industry. If fossil fuels are no longer used by the general population, fossil fuel subsidies will be useless. This is important because it is likely that governments will be slower than their citizens to adopt viable solutions. The combination of fossil fuel lobbying to government officials and stagnation in difficult-to-enforce climate change initiatives creates a situation lacking motivation. Citizens, however, have the ability to absorb information and adjust spending habits, which contributes directly to the uptake of the renewable energy market.

Citizens who become aware of the history of subsidies will know that they are widely used in the global economy. Understanding that countries initiated subsidies to promote domestically discovered fossil fuels in the early days of fuel generation will allow citizens to foresee that when countries transition to renewable energy, they will no longer need these

subsidies. Renewable energy is limitless, meaning countries will no longer need to guard their limited fossil fuel resources when it becomes prevalent.

When citizens are directly impacted by the benefits of a switch to renewable energy, they will be inclined to become involved in this transition. Understanding this issue has the potential to shift millions of workers out of jobs in the fossil fuel industry that do not deliver the full economic benefits that renewable energy industry jobs do. Workers who shift will become part of an industry that will exist long into the future, and not damage their own health or the health of the environment. They will also be afforded greater job security, for as the world switches to renewable energy sources, businesses will be looking to install renewable energy and energy efficiency measures as opposed to fossil fuel-generation technologies. The fossil fuel industry has limited job positions that reflect the finite amount of fossil fuels. The renewable energy industry, however, has seemingly limitless potential because the energy sources of the sun, wind, and water are constant.

It is critical that citizens become aware of the benefits to ending fossil fuel subsidies in order to meet the 1.5 degree Celsius climate change goal. Scientific studies specifically enumerate that for this to occur, 85% of global fossil fuel reserves must go unburned. Beginning to solve the problem through consensus building in the citizenry is especially important given that the Commonwealth of Independent States begins the global subsidization pattern by initially subsidizing their products. If consuming countries become aware of the money they lose when they subsidize fossil fuels, they can alter their markets and avoid the loss because they will not be dependent on fossil fuel-producing countries. Countries that employ recommended solutions such as subsidy swapping, equitable workforce sector transitions, regional emission trading

markets, and policy proposals like the Green New Deal will experience economic gains from not being a part of the chain of fossil fuel subsidization.

By strongly committing to these measures and reaping the benefits, countries will form stronger international climate change abatement coalitions. These will have more success than current agreements, which struggle to make headway. Countries with a foundation of environmentally conscious consumers undergo the renewable energy transition and form coalitions more committed to the goals they establish. Coalitions with strongly committed members will be more capable of developing global solutions to address climate change. Solutions will be in line with the measures countries have enacted domestically and regionally, making other countries want to commit to them because they are not hollow or lacking support. When governments adopt procedures following these guidelines at the international level, they have the potential to attain climate change goals and begin to undo the environmental damage caused by the widespread burning of fossil fuels, exacerbated by the subsidization of fossil fuels.

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