Spring 6-17-2016

Do or Die: Environmental History, Environmental Politics and Environmental Economics and Their Implications for Mitigating the Effects of Climate Change

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Recommended Citation
Do or Die:
Environmental History, Environmental Politics and Environmental Economics and Their Implications for Mitigating the Effects of Climate Change

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ENST 4000
Spring 2016
Abstract

Beginning during the Industrial Revolution, global economic growth has been driven mainly by humanity’s ability to harness energy from the combustion of fossil fuels. Energy is a tremendously valuable resource; lands with few other resources yield wealthy nations, businesses, cartels, armies and kingdoms, grown primarily from deposits and reserves of coal, oil or natural gas below the land’s surface. Energy security is perhaps a prerequisite for a nation to achieve industrial and economic development, foreign investment and trade, and in most cases law and order. As energy markets stand today in our global economic system, the burning of oil and other fossil fuels for energy production is still a necessity in ensuring economic growth, upward mobility, the continued advancement of developing nations and ending extreme poverty. However, the social benefits provided by fossil fuels are being outweighed by the unevenly distributed private and social costs of anthropogenic climate change. This thesis, using the disciplines of environmental history, environmental politics and environmental economics, explores why and how governments and societies must transition from fossil fuel to renewable energy sources. Government intervention in energy markets should be used to the advantage of maximizing social welfare and eliminating inefficiencies, to mitigate the effects of climate change, by gradually implementing regulations to internalize the social costs imposed as a result of fossil fuel consumption at opportune moments, when global political momentum is peaking.
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Introduction: If Not Now, When?

Consensus among climate scientists regarding the catastrophic effects of climate change affirms the dire need to develop and globalize renewable energy sources including solar, wind, geothermal and hydroelectric power. Timing often plays a key factor in the successes and failures of environmental regulations. This thesis investigates and analyzes the events and trends that contribute to economic instability and political opportunities and explores how households, firms and governments respond. It scrutinizes these responses and demonstrates how certain choices and behaviors promote both political and economic stability while concurrently shifting market power away from fossil fuel producers and toward renewable energy producers. The actions by households, firms and governments provide historical, political and economic evidence that there are more opportunities to reduce dependence on, and demand for, fossil fuels than most would ever expect using an approach encouraging all levels of government to immediately begin mitigating carbon emissions and addressing the threats posed by climate change.
Chapter 1 - Climate Change: Free Will, Fate and Collective Action

Climate change poses a greater threat to life on our planet than any other problem that exists today. The data presented in this chapter discusses the causes of climate change, observed effects of climate change, and projections of climate change’s future effects, all of which demonstrate the need for tremendous reductions in greenhouse gas emissions in order to prevent the worst forms climate disruptions from occurring.

Human activity, primarily through burning of fossil fuels and the emission of greenhouse gases, has caused our average global temperature to rise by approximately 0.85 degrees Celsius since 1880.¹ The distribution of carbon emissions by source, show:

Liquid and solid fuels accounted for 75.5% of the emissions from fossil-fuel burning and cement production in 2011. Combustion of gas fuels (e.g., natural gas) accounted for 18.6% (1760 million metric tons of carbon) of the total emissions from fossil fuels in 2011 and reflects a gradually increasing global utilization of natural gas. Emissions from cement production (491 million metric tons of carbon in 2011) have more than doubled since the late 1990s and now represent 5.2% of global CO2 releases from fossil-fuel burning and cement production. Gas flaring, which accounted for roughly 2% of global emissions during the 1970s, now accounts for less than 1% of global fossil-fuel releases.²

¹ IPCC, p. 3
² Boden, Marland, and Andres
The greenhouse effect is the cause of increased global temperatures resulting from greenhouse gas emissions:

Of the total solar radiation intercepted by the earth, about 1% reaches the earth’s surface, and most of it is then reflected as longer-wavelength infrared radiation. As this infrared radiation travels back up through the lower atmosphere toward space, it encounters greenhouse gases such as water vapor, carbon dioxide, methane, nitrous oxide, and ozone. It causes these gaseous molecules to vibrate and release infrared radiation with even longer wavelengths. The vibrating gaseous molecules then have higher kinetic energy, which helps to warm the lower atmosphere and the earth’s surface.³

The rate at which humans have emitted greenhouse gases has been steadily increasing, particularly over the past four decades, as demonstrated by the image below:⁴

The following graphs show the observed increases in combined land and ocean temperatures dating back to 1850:⁵

³ Miller and Spoolman, p. 56
⁴ Boden, Marland, and Andres
⁵ IPCC, p. 4
These images provide insight as to how greenhouse gas emissions have caused increases in average global temperature. The correlation between increases in greenhouse gas emissions and increases in global temperature has been verified by independent studies by governments, universities, non-profit organizations and special interest groups. The most significant cause of climate change certainly is greenhouse gas emissions resulting from the generation of energy.

Climate change has caused frequent (though disproportionately distributed) extreme weather events, melting of polar ice caps and glaciers, sea level rise, ocean acidification, changes in the salinity of water bodies, along with the disruption of many species’ migration patterns, population norms and seasonal activities.\textsuperscript{6} The effects of climate change can be categorized into

\textsuperscript{6} IPCC, p. 6
changes in atmospheric conditions, ocean conditions, cryospheric conditions, sea levels and biogeochemical cycles. Other than the broad effects of climate change predicted around the planet, climate change may also interfere with a person’s ability to obtain ecosystem services from a previously productive and reliable ecosystem. “Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.”7 As more greenhouse gas emissions cause global average temperatures to rise, the projected impacts of climate change become ever more severe and uncompromising. The blue SRES-B1 projection displayed in the following image shows a predicted temperature increase of 4 degrees fahrenheit if the human population does not transition to the terms of a multilateral international agreement codifying binding emissions reductions into international environmental law; the red SRES-A2 predicts a 7 degrees fahrenheit temperature increase if there is not a reduction in emissions:

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7 Millennium Ecosystem Assessment, 2005, p. V
Temperatures, precipitation, chemical composition, weather and climate are all components of Earth’s atmospheric conditions. Among the most significant and likely changes to atmospheric conditions are fewer cold days and nights over land, more hot days and nights over land, increases in the frequency and duration of heat waves, and increases in the frequency and intensity of heavy precipitation, as highlighted in the following data.\(^8\)

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\(^8\) IPCC, p. 5
These changes threaten provisioning services including food and water security, and will subject a large and increasing number of populations to severe droughts and flooding events. Droughts put a tremendous strain on public water sources as homeowners and agricultural industries use more tap water to nourish their lawns and crops to compensate for the lack of rainwater. Long and extreme droughts threaten the sustainability of water resources and may completely deplete reservoirs and groundwater aquifers. In certain cases, the construction of costly saltwater desalinization plants may be necessary to supplement or replace other water sources. Communities in which a desalinization plant is not a feasible solution may need to construct pipelines or tunnels to transport water from other regional water sources, or risk potentially lethal instability from drought including but not limited to famine, conflict, civil unrest, and complete desertification.
The temperature of the ocean has increased and ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010... It is very likely that regions of high salinity where evaporation dominates have become more saline, while regions of low salinity where precipitation dominates have become fresher since the 1950s.9

These changes in ocean temperatures and salinity are significant changes in the habitats of millions of species and threaten their abilities to find food, reproduce and sustain their population levels. Disruptions in food webs and provisioning services for aquatic and marine animals directly affect human populations that rely on these species for consumption, and “more than a billion people worldwide rely on food from the ocean as their primary source of protein.”10 Should aquatic species that are depended upon for human consumption become endangered or extinct, the possibility of famine resulting in death of a segment of the population, causing it to decrease to a sustainable level with the amount of food available, or a Malthusian check, would become more likely in many places around the planet. This decreased food security precipitates breakdowns in social, economic and legal norms and may result in unlivable conditions in communities and regions around the planet.

9 IPCC, p. 6
10 NOAA, “What is Ocean Acidification?”
Cryospheric changes include the melting of glaciers, ice sheets and permafrost. Greenland and Antarctica have been consistently and significantly decreasing in size, while average ice and snow cover in oceans and on land in the Northern Hemisphere have also decreased. These melting ice sheets contribute to rising sea levels. Sea levels have risen at a global average rate of 2 mm per year between 1971 and 2010, and at a global average rate of 3.2 mm per year between 1993 and 2010. The rate at which sea levels are rising is increasing. Rising sea levels threaten all coastal assets, property, communities and public goods. Rising sea levels jeopardize the quality of life in coastal villages and cities. Appropriate budgeting for coastal storm and flooding resilience, preparedness and emergency responses are becoming much more difficult to forecast and finance, and is subject to underinvestment in many localities, particularly in developing nations. Public goods such as beaches and parks, which provide recreational services, along with sand dunes and wetlands, which provide regulating services are at much greater risk of erosion as sea levels rise. Residents of coastal communities are at increased risk of property damage, as water levels reach new peaks during coastal storm and flooding events. Critical infrastructure including roadways, bridges, tunnels, public

11 IPCC, p. 7  
12 IPCC, p. 9  
13 UNEP, 2014. p. xiii  
14 UNEP, 2014 p. 34
transportation systems, sewage treatment plants and ports are also endangered by the threats and potential damages of higher sea levels. The combination of these factors risk vast disruptions in economic and social welfare of societies all over the world and may result in the need for abandonment of some developed and previously well-established communities and lands, as the costs of climate change become too great.

Greenhouse gas emissions and deforestation have contributed to disruption of natural biogeochemical cycles. Atmospheric composition of carbon, methane and nitrous oxide are at their highest concentrations in at least 800,000 years, indicating a complete breakdown of regulating services. The spike in emissions is responsible for acidification of the oceans, and anthropogenic factors have caused a 30% increase in ocean acidity.\textsuperscript{15} Ocean acidification interferes with the ability of coral reefs to form skeletons and grow, and weakens the exoskeletons of shellfish, endangering food webs of marine ecosystems.\textsuperscript{16}

The effects of climate change pose overwhelming hazards to biodiversity and human progress. Never before has humanity had the ability to create such an all-encompassing catastrophe, let alone had the scientific tools, knowledge and data to realize that our primary source of energy, economic growth and improved living conditions, fossil fuels, are the cause. Unfortunately, our

\textsuperscript{15} IPCC, p. 10
\textsuperscript{16} NOAA, “What is Ocean Acidification?”
economic system facilitates the consumption of about 96 million barrels of oil and other liquid fuels every day.\textsuperscript{17} Energy demand is forecasted to grow as Earth’s population is projected to rise to nearly 10 billion by 2050, as compared to 2015’s population of 7.3 billion.\textsuperscript{18} These 10 billion people will be well aware of the dangers posed to them by climate change.

Without mandatory emissions reductions becoming international law, the developed nations risk inflicting severe harm on all nations, while altering and damaging the ecosystem services provided to citizens of developing nations. I agree with the ideals set forth by the Millennium Ecosystem Assessment for human well-being, requiring “basic material for a good life… health… good social relations… security… and freedom and choice of action.”\textsuperscript{19} People have died, and more people will die because of anthropogenic climate change. With the knowledge and technology we have one can’t help but wonder, how much longer will the economic justification for choosing fossil fuels over renewable energy hold as a valid reason for subjecting innocent people to the effects of climate

\textsuperscript{17} Oil
\textsuperscript{18} United Nations, World Population Prospects: 2015 Revision, Key Findings and Advance Tables, p. 1
\textsuperscript{19} Millennium Ecosystem Assessment, 2005, p. V
These images demonstrate why the United States must take more action and pass laws in Congress that reduce greenhouse gas emissions.\footnote{Ge, Friedrich and Damassa} \footnote{Ge, Friedrich and Damassa}

There is too much at stake for our progress, our species and our planet for nations to wait for the free market to internalize the externalities caused by fossil fuel consumption. Without government intervention in the form of Pigouvian
taxes, no mechanisms exist within markets to force the market equilibrium price and quantity of fossil fuels toward the optimal price and quantity.

In December 2015, at the United Nations Climate Change Conference (COP21) in Paris, diplomats from the all nations agreed on one main objective while pledging $100 billion per year to help developing nations convert from fossil fuels to green energy. All 196 nations agreed to “holding the increase in global average temperature to well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.” To adhere to a temperature increase of only 1.5 degrees Celsius is an impressive promise for all 196 countries in the world agree to, but that doesn’t mean it will be an easy goal to meet. It means most nations are terrified of climate change. In order to determine which system is more cost effective, generating the lowest emissions levels at the lowest cost, this chart compares various renewable and nonrenewable energy sources and shows the greenhouse gas emissions per kWh of electricity generated:

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22 Domonoske, Camila.
Another condition approved by all parties involved in the Paris Agreement is to have net-zero global greenhouse gas emissions by the year 2050. The price of renewable energy must be less costly than fossil fuels, and these renewable energy sources must be universally accessible in order for this pledge to become a reality. Although President Obama plans on ratifying the treaty using executive powers by the end of 2016, Americans must elect a president and a Congress that will ratify the Paris Agreement and support raising taxes on fossil fuels in order to subsidize renewable energy projects, and research and development in clean energy.

Chapter 2 - Environmental History: How Did We Get Here?

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24 Domonoske, Camila.
There is a striking amount of data and research, and abundant observations and projections to show how climate change will affect our planet in the future; but an analysis of the historical conditions and events that led us to the present situation is particularly useful. Agriculture, colonialism, capitalism, the Industrial Revolution, the rise of modern medicine and pseudoskepticism disseminated by the fossil fuel lobby, all play a distinct role in affecting or exemplifying how anthropogenic climate change and greenhouse gas levels came to their current state.

Agriculture came into existence about 10,000 years ago, as peoples and cultures that were traditionally nomadic or tribal developed farms, villages and eventually cities, to serve as their permanent homes.\textsuperscript{25} The establishment of agriculture laid the frameworks for a “modern” economy as we understand it, as humans began to use the environment as a resource for production and economic gains. As opposed to a hunter-gatherer society, in which people migrated depending on the season and the availability of food, agriculture enabled humans to domesticate and breed crops and animals. This is a form of investment, as agricultural populations invested their labor in their lands and expected returns in the form of food, clothing and other goods to use or trade. People living in agrarian societies had greater incentives to reproduce (to

\textsuperscript{25} Miller and Spoolman, p. 16
increase the labor supply) and better nutrition than those in nomadic cultures, resulting in higher fertility rates. Agriculture generally added greater levels of food security and stability to the cultures that adopted it. The beginning of agriculture marks the beginning of environmental exploitation by humans: livestock were used to plow fields and for transportation, plants and animals were domesticated and selectively bred in order to generate the most preferable offspring, and lands were developed from their natural state into farms, villages and cities. Agriculture was the first step toward the overdevelopment, deforestation, factory farming and genetic modification we observe in our world today.

While colonies certainly existed before 1492, Christopher Columbus’ discovery of the New World began the systematic European colonization of the Americas by “the emerging nation-states of Portugal, Spain, the Dutch Republic, France, and England. By discovery, conquest, and settlement, these nations expanded and colonized throughout the world, spreading European institutions and culture.” These powerful European nations had ships, colonists, missionaries and soldiers sail to foreign territories of the New World and declared the territories annexed by the respective European nation. The newly proclaimed colony was to trade natural resources and raw materials only with the occupying nations.

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26 Bentley, Goldberg and Jasieńska. Fertility.
27 Encyclopædia Britannica Online, s. v. "colonialism, Western"
nation, in exchange for compensation and goods worth less than the value of the exported natural resources. The majority of indigenous populations were either enslaved or killed.\textsuperscript{28} For about 400 years these European nations had the ability to colonize and maintain power over much of the planet. European colonialism demonstrates the tremendous amount of wealth and influence that can be accumulated when a powerful nation is willing to disregard the sovereignty and rights of a weaker nation. It was the first instance of extensive, systematic exploitation and degradation of the environment in most nations by several foreign powers pursuing cheap natural resources, much like today’s wealthy, industrialized nations in regard to fossil fuels and greenhouse gas emissions.

The goals of any economic system include economic efficiency, economic growth and economic stability.

Capitalism [is an] economic system in which most of the means of production are privately owned… Production is guided and income [is] distributed largely through the operation of markets… The development of capitalism was spearheaded by the growth of the English cloth industry during the 16th, 17th, and 18th centuries. The feature of this development that distinguished capitalism from previous [economic] systems was the use of [profits]... to enlarge productive capacity rather than to invest in economically unproductive enterprises.\textsuperscript{29}

\textsuperscript{28} Kohn
\textsuperscript{29} Encyclopædia Britannica Online, s. v. "capitalism"
The markets of capitalism operate by determining the equilibrium price for a good or service at the equilibrium quantity supplied, based on industry-wide market demand and industry-wide market supply. If there is excess demand, or a shortage, price will increase. If there is excess supply, or a surplus, price will decrease. Firms compete for profits by trying to minimize the cost of production. Firms with the lowest production costs can gain the greatest profits. If a firm’s cost of production exceeds the market equilibrium price, the firm must cut costs or exit the industry, as this is indicative of an inefficient use of resources. When goods and services are purchased at market equilibrium, and there is no excess supply nor excess demand, there has been an efficient allocation of resources, unless there is an externality.

Externalities are uncompensated benefits or costs that are given to a party that is not involved with the transaction. Fossil fuel consumption produces negative externalities in the form of pollution and carbon emissions, but the uncompensated external cost is imposed on society, as no one owns the air that was polluted. This is an example of a market failure, indicating an inefficient distribution of resources. In an ideal world, there would be a Pigouvian tax charged on each gallon of gasoline equal to the external costs imposed on society. This would internalize the externality by raising the price of gasoline from the equilibrium price to the socially optimal price, and decrease the quantity of
gallons demanded from the equilibrium quantity to the socially optimum quantity, as demonstrated by the following image:\textsuperscript{30}

The tax revenues could be used to finance a subsidy for the construction of wind farms and the installation of solar panels, directing government spending toward renewable energy sources, which would stimulate demand and lower prices of renewable energy in the future. Since capitalism does not account for social costs and social benefits of different goods and services in prices without government officials approving such taxes and subsidies (or courts awarding the correct legal damages to negatively affected external parties) the “invisible hand” of capitalism does not always guide buyers and sellers to desirable outcomes.

The invisible hand guides buyers and sellers to the outcome that minimizes costs

\textsuperscript{30} Riley, “Negative Externalities”. 
and maximizes profits, with no economic incentives to consider the well being of society or public goods.

The Industrial Revolution was a period from 1760 to 1840 during which great advances were made, allowing for improvements in production and machinery, and the invention of the steam engine and the internal combustion engine. These inventions allowed for the later development of central power plants for electricity generation, like the first one created in the 1880s by Thomas Edison, which was located in Lower Manhattan and powered by coal. The Industrial Revolution enabled economies to grow rapidly, allowing for improved living conditions, higher salaries and greater economic efficiency around the world. The Industrial Revolution was “the process of change from an agrarian, handicraft economy to one dominated by industry and machine manufacture. This process began in Britain in the 18th century and from there spread to other parts of the world.” The following image demonstrates the increases in GDP per capita, particularly in nations that industrialized, during the Industrial Revolution:

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31 Institute for Energy Reserach. "Electricity Generation."
32 Encyclopaedia Britannica Online, s. v. "Industrial Revolution"
33 Thompson "The Economic History of the Last 2000 Years: Part II."
In addition to GDP growth, the Industrial Revolution caused massive increases in energy demand. The following image demonstrates the growth in per capita energy consumption in England during the Industrial Revolution, measured in megajoules:34

Energy consumption nearly doubled in the period between the 1800s and 1850s. The progress humans made during the Industrial Revolution was reliant on fossil fuels, especially coal. This began the trend of economic growth dependant on

34 Wrigley, Tony.
fossil fuel consumption, which is still a phenomenon that holds true for nearly every nation on the planet. It is imperative for the success of climate change legislation and regulations reducing greenhouse gas emissions, for energy from renewable sources to become more abundant than energy from fossil fuels, in order to allow for the continuation of economic growth and improved living standards around the world. Despite the improving energy efficiency of technology and power generation, there is no reason to expect growth to occur under conditions where energy demand cannot be met. Furthermore, one would predict countries finding themselves in this predicament would violate international emissions regulations, because the effects of a shrinking economy are typically felt immediately, deeply and by many, and are often accompanied by civil unrest and anger directed at governments and their leaders.

Modern medicine has both contributed to and mitigated effects of climate change. Medical breakthroughs have dramatically increased life expectancies in nations where access to health care is routine and available. In 1900, a person born in the United States had an average life expectancy of 47.3 years.\textsuperscript{35} In 2007, a person born in the United States had an average life expectancy of 77.9 years.\textsuperscript{36} Some of the most significant medical advances contributing to increased life expectancy during between 1900 and 2007 include vaccination requirements

\textsuperscript{35} CDC/NCHS, National Vital Statistics System
\textsuperscript{36} CDC/NCHS, National Vital Statistics System
for students and soldiers, clean water and improved sanitation, the discovery and improvement of antibiotics and antiviral medications, improved cardiac surgery and care, randomized control trials for testing the effectiveness of new treatments, the invention of CT scans, and improved obstetrics care.\textsuperscript{37} Unfortunately, while all of these treatments increased life expectancy and improved quality of life for humans that have access to them, they contribute to greater energy consumption and demand. The people who would have died had these treatments never existed and been available to them, consume energy for their whole lives and therefore contribute to climate change. According to Dr. Jeffrey Baker of Duke University School of Medicine, “it used to be that 15% of infants would die, and the biggest reason for this was diarrhea brought about from unclean water and milk” so it's likely billions of people would have died or never been born without these innovations.\textsuperscript{38} While these changes ultimately contributed to climate change, the following advances in medical care counter the effects of climate change and lower energy demand. The release of hormonal contraceptives beginning in the 1960s has enabled millions of women to prevent pregnancy, in addition to other non-hormonal contraceptives that were previously available. Emergency contraceptive pills, now sold over the counter with no age

\textsuperscript{37} Childs, Kansagra, ABC
\textsuperscript{38} Childs, Kansagra, ABC
restrictions, can prevent pregnancy up to three days after unprotected intercourse. Lastly, abortion is legal in most developed nations, and like preventative birth control methods, reduces population growth by large proportions.

Pseudoskepticism in regard to climate change is a phenomenon that began in the 1980s, as scientific evidence and data supporting climate change and global warming theories became more prevalent and accepted. Pseudoskepticism has the effect of influencing voters and politicians, causing debates and disbelief over settled scientific issues, and is commonly referred to as climate change denial. Climate change denial is the rejection of the existence of climate change, with little or no evidence to support rejection, despite overwhelming evidence and scientific consensus supporting the existence of climate change. While it is difficult to prove pseudoskepticism is directly caused by the fossil fuel lobby, firms including Exxon Mobil, Koch Industries, Royal Dutch Shell and Chevron Corp have all spent millions of dollars this year lobbying for fewer regulations, drilling rights, exploration subsidies and other benefits from the government. The fossil fuel lobby has mobilized to oppose legislation regulating drilling and emissions.

Publicly available information shows that House Representatives and Senators who deny the realities of climate change accept, on average, almost four times more in contributions from the fossil fuel

39 "Oil & Gas." Opensecrets.
industry than do their colleagues… [There is] overwhelming evidence that, at least in some cases, the fossil fuel industry has been complicit in funding, orchestrating or endorsing attacks on science and scientists, to the detriment of public understanding and political action to mitigate climate change.”

The political influence held and utilized by the fossil fuel industry is clearly detrimental to our democracy, the wellbeing of our planet and human health. This practice demonstrates the need for the United States and foreign governments to place stricter limits on donations by corporations, individuals, and political action committees, as these donations have at the very least correlated to, if not caused, a disproportionate amount of support for the fossil fuel lobby’s objectives in our legislatures.

Despite all of the factors discussed in this chapter that contribute to climate change, I remain optimistic. Evidence has shown us that the effects of climate change are probably not reversible. “Complex systems often show time delays between the input of a feedback stimulus and the response to it… Time delays can also allow an environmental problem to build slowly until it reaches a threshold level, or tipping point, causing a fundamental shift in the behavior of a system.” Additionally, “scientific studies and models indicate that we should try to prevent CO2 levels from exceeding 450 ppm—an estimated threshold, or irreversible tipping point, that could set into motion large scale climate changes

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40 Fossil Free MIT.
41 Miller and Spoolman, p. 46
for hundreds to thousands of years."\textsuperscript{42} NOAA has published data showing the current carbon dioxide levels to be about 407 ppm in April 2016. April 2014 saw carbon dioxide levels at 403 ppm. The following image demonstrates how carbon emissions have continued to rise each year despite efforts to reduce emissions:\textsuperscript{43}

![Graph showing recent monthly mean CO\textsubscript{2} at Mauna Loa](image)

This exemplifies the important steps governments, firms and individuals must take in order to avoid surpassing the climatic tipping point for greenhouse gas emissions. Promising advances have been made in the environmental politics, with new agreements and treaties taking effect this year to reduce emissions. Although the appropriate time to begin decreasing atmospheric greenhouse gas levels has passed, there is still enough time to allow for a reversal of past trends without reaching the carbon dioxide tipping point of 450 ppm. All nations must

\textsuperscript{42} Miller and Spoolman, p. 499  
\textsuperscript{43} NOAA. "ESRL Co2 Trends."
initiate new efforts to lower global emissions immediately if we expect to avoid 
the greatest threats posed by climate change.

Chapter 3 - Environmental Politics: New Windows of Opportunity

There are an increasing number of policy makers and governments that 
have begun enacting policies serving to mitigate the effects of anthropogenic 
climate change. The international community reached an agreement in 
December of 2015 at the COP21 in Paris, and put forth a goal for global 
temperature increase of no more than 2 degrees Celsius, aiming instead for an 
increase of 1.5 degrees Celsius. Governments agreed to meet again every 5 
years in order to evaluate progress and set more ambitious goals to further 
reduce greenhouse gas emissions.\textsuperscript{44} This treaty has yet to become legally 
binding and opened for ratification in April of 2016 and remain open for 
ratification through April of 2017.\textsuperscript{45} The process of ratification has been clearly 
outlined within the agreement: “In accordance with Article 21, paragraph 1, of the 
Paris Agreement, the Agreement shall enter into force on the thirtieth day after 
the date on which at least 55 Parties to the Convention accounting in total for at 
least an estimated 55 \% of the total global greenhouse gas emissions have 
deposited their instruments of ratification, acceptance, approval or accession with 

\textsuperscript{44} Paris Agreement
\textsuperscript{45} “Paris Agreement - Status of Ratification.”
This article within the agreement is crucial to the ratification of the Paris Treaty, as all governments clearly know the deadlines and necessities in order for it to become international law.

Oil exporting nations have demonstrated difficulty maintaining artificially low gasoline prices for their populations as high domestic consumption coupled with low global prices have resulted in revenues so low that production costs are not being met. While their motives are to make profits, not to slow anthropogenic climate change, oil exporters have begun adopting policies that have caused prices to rise and fossil fuel consumption to drop. In February, 2016 the Venezuelan government raised the price of gasoline from approximately 1 U.S. cent per liter to 60 U.S. cents per liter. Venezuela is an excellent example of the woes faced by oil exporting nations in the face of cheap global oil prices:

Hungry Venezuelans are rioting and looting amid worsening food shortages, but the OPEC country’s remote oil fields have been sheltered from the social unrest so far. But Venezuela’s blistering economic crisis is hitting them full on. Output in the country, which has the world’s largest oil reserves, dropped to 2.37 million barrels per day (bpd) in May, according to OPEC data provided by

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46 "Paris Agreement - Status of Ratification."
47 Holodny, Elena.
Venezuela. That's down some 5 percent from April and nearly 11 percent from 2015’s average.\textsuperscript{48}

Within the United States, President Obama has used executive orders to reduce emissions, as congressional gridlock and partisanship have prevented any meaningful climate change legislation from becoming law. Obama’s most ambitious action, unveiled in August of 2015, restricts power plants from using coal to generate electricity under the Clean Power Plan, and requires states to submit plans for compliance to the EPA. The fate of the Clean Power Plan will be determined by the Supreme Court in June of 2016. The requirements set forth by the Clean Power Plan have been stayed by the Supreme Court, pending the court’s ruling coming this June.\textsuperscript{49} Much of the environmental progress made during Obama’s presidency may be undone by the next president, as Republican nominee Donald Trump has stated disbelief in climate change. If he is elected and chooses to overturn President Obama’s executive actions pertaining to climate policy, it is highly probable that greenhouse gas emissions will continue to increase and the Paris Agreement of 2015 would be unravellled.

President Obama has used executive orders to enhance the Corporate Average Fuel Economy (CAFE) standards to increase the average MPG of cars

\textsuperscript{48} Ulmer, Alexandra.

\textsuperscript{49} "Clean Power Plan for Existing Power Plants."
and light trucks to 54.5 MPG by the year 2025.\textsuperscript{50} State governments have also taken steps to reduce demand for fossil fuels. New York has offered subsidies to homeowners and businesses seeking to retrofit their properties with solar panels since 2012 through the NY-Sun Initiative. While these programs are pivotal and assist in reducing emissions, they still fail to align most governments with the goals agreed upon by the United Nations. For this reason, in addition to the possibility of a Republican president overturning Obama’s executive orders, it is imperative that state and local governments expand upon carbon taxes and clean energy subsidies, and not wait for federal laws to require emissions reductions.

Chapter 4 - Environmental Economics: The Bottom Line

Economists have a well deserved reputation for discord regarding economic policy decisions. Much of the disagreement between economists derives from the fact that all economic decisions are accompanied by certain tradeoffs. Economists seek to understand how these tradeoffs will affect the economy as a whole and how the social welfare of various segments of industry and society will be impacted by economic policy decisions. The costs and benefits that come with market intervention and economic policy choices must be weighed in light of an economist’s own moral compass: Economics is intrinsically

\textsuperscript{50} EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks
philosophical and political, and one's opinion is heavily dependent on their worldview. This thesis argues that the avoidance of the effects of anthropogenic climate change is in the best interests of humanity, all species, and the global environment.

Perhaps one of the most difficult issues for our society to overcome is the necessary rejection of laissez-faire economics. There is no evidence to suggest the external social costs of carbon will be internalized into the market price without government intervention. Governments must tax fossil fuels if they expect to curb fossil fuel consumption to levels that are socially optimal and in accordance with the goals created at the COP21 in December 2015. The most prominent method of government intervention to reduce fossil fuel consumption is a carbon tax. “The Economist has long advocated a carbon tax as the best way to deal with climate change. Carbon taxes are a subspecies of Pigovian tax; taxes that are designed primarily to change behaviour rather than to raise revenue. The idea is to try to manipulate the price of a good or a service in order to capture all the negative externalities it imposes.”\textsuperscript{51} At COP21, it was determined that the international goal is to allow warming of no more than 1.5 degrees Celsius. This goal shows indicates a need for vast reductions in carbon emissions in order for it to be met.

\textsuperscript{51} "Some More Thoughts on a Carbon Tax."
As explained earlier in Chapter 2, the market price of fossil fuels neglects the external costs imposed on our society during its consumption. If fossil fuel prices were higher, demand for and consumption of fossil fuels would decrease, as people respond to these higher prices and adapt by consuming less of this expensive good. High fuel prices entice consumers to buy fuel efficient vehicles, solar panels for their homes and appliances that require less energy, among many other behavioral influences. The economic incentives to change one’s behavior to be more energy efficient are rather minimal in the present-day United States, and typically require a person to make a large investment in costly equipment, with below average returns on the investment compared to other investment opportunities. This issue is precisely why it is necessary for governments to force the price of fossil fuels to increase. Should fossil fuel prices increase, the returns on the investments in green technology and fuel efficiency will be greater than they are in the present day, encouraging consumers to opt for the most fuel efficient technologies as to avoid high energy taxes.

Another source of contention among economists and scientists is determining the appropriate tax on carbon emissions. “The social cost of carbon measures the full cost of an incremental unit of carbon (or greenhouse gas equivalent) emitted now, calculating the full cost of the damage it imposes over the whole of its time in the atmosphere. It measures the externality that needs to
be incorporated into our decisions on policy and investment options." It is very difficult to estimate the total future damages that will be caused by carbon emissions and estimates tend to have a wide range of possible monetary damages. The following image is the EPA’s estimated social costs of one metric ton of carbon over the next 40 years:

<table>
<thead>
<tr>
<th>Social Cost of CO2, 2015–2050 a (in 2007 Dollars per metric ton CO2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discount Rate and Statistic</strong></td>
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<td><strong>Year</strong></td>
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<td>2045</td>
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However, these social costs of carbon put forth by the United States government have been disputed by scientists at Stanford University. These scientists believe the true social cost of carbon is approximately $200 per metric ton:

The actual cost could be much higher. “We estimate that the social cost of carbon is not $37 per ton, as previously estimated, but $220 per ton,” said study coauthor Frances Moore... co-author Delavane Diaz... [states] "if the social cost of carbon is higher, many more mitigation measures will pass a cost-benefit analysis," Diaz said. “Because carbon emissions are so harmful to society, even costly means of reducing emissions would be worthwhile.”

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52 Carbon Valuation
53 "The Social Cost of Carbon."
54 Than, Ker
These two sources demonstrate the tension between politicians, academics, scientists, environmentalists and economists as they all strive to find the most accurate representation of the social costs of carbon, without the ability of truly knowing what the damages caused by carbon emissions will be.

Aside from the direct benefits humans derive from decreased consumption of fossil fuels in the form of avoided effects of climate change, governments will accrue revenues that could be spent in a variety of ways to further promote energy efficiency. Governments have already begun to subsidize the development of carbon neutral and energy efficient energy sources.

New York State introduced the Solar Energy System Tax Credit which allows property owners to purchase solar power systems for residences and claim a 25% tax credit for the cost of the equipment, up to $5000. Furthermore, the New York Sun Solar Electric Incentive Program contributes up to $1750 for every kilowatt of solar power sources one choose to install for their home. Finally, solar power systems are exempt from New York’s 8.875% sales tax, providing further incentives for homeowners to equip their homes with solar power equipment. New York’s solar energy subsidies are among the most generous in the nation, with investment return rates as high as 19% annually.

55 "Solar Energy System Equipment Credit."
56 “New York Solar Power for Your House - Rebates, Tax Credits, Savings."
The United States government has granted subsidies as high as $7500 for electric and hybrid-electric vehicles since 2010. These subsidies can be combined with subsidies offered by states and localities for fuel efficient vehicles and significantly reduce the cost of purchasing a fuel efficient vehicle to allow better competition between the more expensive fuel efficient cars and cheaper conventional engines. Subsidizing fuel efficient vehicles allows for greater market share of car sales to go to producers who demonstrate commitment to environmental protection and energy efficiency, who in turn use much of their revenues for research and development of better and more efficient technology.

At the COP21 in 2015, the international community acknowledged the need for developed nations to subsidize clean energy production in developing nations. $100 billion annually will be given to developing nations to assist them in creating carbon neutral energy sources. Without these grants, the world’s developing nations would be unable to implement green energy development while ensuring economic growth occurs; this would be an immoral and unfair task to leave developing nations with, considering how their contributions to climate change have been minimal in comparison to developed Western nations that have used fossil fuels to grow their economies for over 150 years.

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57 "Federal Tax Credits for All-Electric and Plug-in Hybrid Vehicles."
58 Domonoske, Camila
These types of subsidies, whether they be for consumers or businesses significantly contribute to the transition from fossil fuel based energy sources to clean, carbon neutral energy sources. Green energy subsidies used in combination with carbon taxes on fossil fuels provide an optimal combination of taxes and subsidies to promote movement toward greater energy efficiency. Without carbon taxes and green energy subsidies, it would be impossible for energy efficient products to become mainstream and commonplace in society, as the social benefits of energy efficient products would go unrealized in prices, and therefore would never be able to compete with products inefficiently using cheap fossil fuels. The International Energy Agency states “putting a price on greenhouse gas emissions is the cornerstone policy in climate change mitigation. It is widely accepted that without measures that put a price on emissions, it will be significantly more difficult and expensive to implement the economic transformation required to put the world on track to meet the Copenhagen goal of limiting temperature rise to two degrees (OECD, 2009).”\(^ {59} \) The same reasoning holds true for the 1.5 degree Celsius goal that was established in 2015 in Paris. Additionally, in order to ensure carbon emissions decrease as intended by carbon taxes, the International Energy Agency recommends using subsidies to promote sales of and investment in energy efficient products much like New York

\(^{59}\) Hood, 22
State and the United States government have offered for solar power equipment and fuel efficient vehicles.\textsuperscript{60}

\textbf{Chapter 5 - Policy RecommendationsFor the Well-Being of Generations to Come}

In previous chapters, this thesis explored and analyzed many of the factors at play in our planet's transition from fossil fuels to green energy. Today, it seems as though the world is at a turning point, with political momentum and rising emissions aligning to create a window of opportunity to truly change international laws and the global economy for a better trajectory, away from a future marked by the destruction of climate change. This reality is demonstrated by the establishment of the Paris Agreement in 2015 by the COP21, in which all of the world's nations agreed to a framework to mitigate the worst effects of climate change and plan for the damages that we can no longer avoid.

While the international community is at a tipping point of changing humanity's destiny, all levels of government, from United Nations to the smallest municipalities must adopt climate policies seeking to mitigate climate change and allow for a speedy development of an economy founded on green energy. If the United Nations' goals are ever to be realized, now is the time for all governments to act.

\textsuperscript{60} Hood, 23
Nearly all world leaders have spoken in support of climate change legislation. Perhaps one of the most moving viewpoints has been offered by Pope Francis. He states:

> Once we start to think about the kind of world we are leaving to future generations, we look at things differently; we realize that the world is a gift which we have freely received and must share with others. Since the world has been given to us, we can no longer view reality in a purely utilitarian way, in which efficiency and productivity are entirely geared to our individual benefit. Intergenerational solidarity is not optional, but rather a basic question of justice, since the world we have received also belongs to those who will follow us.

It is our responsibility as members of the human race to realize that our children and grandchildren will inherit the world we leave behind. It is our responsibility to be the best stewards of our planet that we can be, in order for people around the world to have a chance of living life to their full potential, and not struggle more than the generations living today ever needed to.

For these reasons, in addition to the preservation and wellbeing of natural resources, ecosystem services, endangered species, economic growth and basic human rights, I recommend that all levels of government pursue vigorous efforts to reduce carbon emissions and expand renewable energy sources beginning now. If this is not done, there will not be enough time for future generations to mitigate the problem of climate change. The only rationale that can be offered as

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61 "Laudato Si"
an explanation to them will be that humans would not cooperate well enough to overcome greed and exploitation to ensure the most basic necessities of human survival are met. As stated in Chapter 1, the Millennium Ecosystem Assessment for human well-being, requires “basic material for a good life [including]… health… good social relations… security… and freedom and choice of action.” If greenhouse gas emissions are left unchecked, it is nearly certain that all of these basic materials for a good life will be eliminated for the most vulnerable people around the planet.\footnote{Millennium Ecosystem Assessment, 2005, p. V}

Governments must impose taxes on fossil fuels to set the private costs of consumption equal to the social cost of emissions. Although the social cost of carbon emission is still being debated, we must continuously rely on the best estimates of scientists and economists to ensure the best possibility of meeting the current COP21 goal of global temperature increases no greater than 1.5 degrees Celsius. As time passes and nations convene to review the progress made, they should adjust goals to lower the optimal global temperature increases. This will ensure minimal disruption of the our environment and allow nations to better coordinate the protection of their populations, cities, assets, natural resources and all species, as well as reducing the likelihood of surpassing climatic tipping points, which would be impossible to reverse.
Governments must use tax revenues to subsidize research, development, access and adoption of carbon neutral energy sources. Cost-benefit analyses should be conducted for each subsidy being considered, to ensure the subsidies reduce the greatest amount of greenhouse gas emissions at the lowest possible costs, maximizing efficiency and allowing for the greatest possible investment in renewable energy. No government should yield any legal authority it possesses in creating tax-subsidy schemes for the promotion of energy efficiency. Policy makers around the world must realize their responsibility to protect the populations they serve from danger, and maximize the impact they can make in reducing emissions. Specifically, governments should consider subsidizing solar, wind, geothermal and nuclear energy generation and end all subsidies to fossil fuel production. They should provide grants for research to improve energy efficient technologies and consider more indirect methods of decreasing carbon emissions and energy demand, such as subsidizing abortion services and contraceptives.

Cooperation between developed and developing nations is necessary for emissions to peak and fall, and the creation of a green economy to occur. Developed nations grew their economies over the past 150 years using fossil fuels, and in order for developing nations to maintain economic growth and improved living conditions for their populations, developed nations must assist
them in financing carbon neutral energy sources and projects. While the Paris Agreement has outlined an estimated $100 billion annual transfer from developed nations to developing nations, this sum should be reevaluated often to ensure it is sufficient in mitigating the effects of climate change and avoiding global temperatures from rising more than 1.5 degrees Celsius. Furthermore, it is the responsibility of developed nations to assist developing nations when climate disasters occur in poorer nations, and an international climate emergency management agency should be established with enough funding to respond to these disasters appropriately, with the ultimate goal of protecting human life.

Cooperation should not be limited to nations in the international arena. Cities, suburbs, coastal communities, rural areas in all different parts of the world will be faced with challenges unique to their level of development and population levels. Best practice methods should be discussed and shared among municipalities with similar population sizes and vulnerabilities in order to prepare for climate disasters, efficiently mitigate climate change and reduce greenhouse gas emissions.

Finally, if there is nothing else to learn from the tremendous problem of climate change, perhaps all of humanity can find motivation in the unusual circumstances of all people around the world facing this problem together. It is difficult to recall an international proposal receiving the support of all countries in
recent history. It is often a challenge to remember that there are some universal truths that exist in this world: we all want safety for ourselves, our friends and our families; we all want to love and be loved; we all want a world free of suffering and hardship; and we all want a fair shot in the pursuit of happiness. Perhaps through climate mitigation, humanity will be reminded that we can achieve great things together in the face of danger if we do not succumb to fear, greed, resentment or hatred. There is no other way to address climate change than by working together if we want to succeed.
Bibliography


