A Framework for Climate Change Policies in the United States

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May 11, 2007

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Abstract

Climate change is quickly becoming an important global concern with considerable and varied long-term consequences. In order to lessen the effects of this phenomenon it is necessary to institute regulatory policies that control carbon dioxide emissions, since they have been shown to directly correlate with temperature changes. Despite the prevalence of climate change initiatives, both internationally and within the United States, there is no comprehensive national policy with respect to the issue. The public and political conditions in the United States are presently ideal for the institution of a federal climate change policy, the most effective of which involves the incorporation of multiple emissions reductions measures.
Acknowledgements

I’d like to thank my advisors Dr. Eric Strauss and Dr. Peter Auger for their invaluable guidance in the writing of this undergraduate thesis, and my mentor Deborah Brown for the endless opportunities she has provided me over the past few years.

I’d also like to thank my older sister, the soon to be Dr. Veronique Hayek, for always being there for me and helping me at every step of the way. No matter how bleak things may have looked, you were always there to lend a helping hand and get me through the day. I love you and I only hope that I can support you in your life half as much as you have supported me.

To my best friend Marika Jackson, even when we are miles apart, you and I remain like twins separated at birth. You were there by my side during what were undoubtedly some of the most difficult times in my life and for that I thank you.

Finally, I’d like to thank my dear friends Veronica Joseph, Amanda Russo, and Richard Elliott. My college experience would have been very different without the constant reassurances of people like you. You have made my four years at Boston College unforgettable and for that you will always have a special place in my heart.
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Introduction

The Carbon Cycle

There are about seventy-five million trillion kilograms of carbon on Earth, only 1/100,000 of which is found in plants and animals. The remainder is distributed throughout the atmosphere, the ocean, and rock formations. These massive amounts of carbon are continually redistributed in the biogeochemical Carbon Cycle illustrated below. (Figure I-1) Changes in distribution over millions of years can occur through the processes of weathering, sedimentation, and volcanism. For example, the weathering of rocks containing silicate material may eventually sequester some carbon dioxide as

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1 (“Carbon”)  
2 (“The Carbon Cycle”)  
3 (MacKenzie)
limestone. The limestone then undergoes erosion and weathering, with the sediments washing away and eventually being deposited on the floors of water bodies. Volcanic eruptions can emit large amounts of water and carbon dioxide into the atmosphere, some of which remains in the atmosphere or settle onto the Earth’s surface. In either case, carbon is constantly being recycled throughout the world on a geologic scale.

Short term changes in carbon distribution (over the course of a few hundred years) occur via phenomena such as photosynthesis, respiration, and decomposition. In photosynthesis, plants take in carbon dioxide and convert it to sugar and oxygen through a reaction with water: $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. As a result, some carbon dioxide is removed from the surrounding atmosphere. Meanwhile, respiration—the reverse of the photosynthesis reaction—releases carbon dioxide back into the atmosphere. The processes of decomposition and the burning of organic matter are additional sources of carbon dioxide in the atmosphere.

*Rising Levels of Atmospheric Carbon and Rising Global Temperatures*

While some early scientists were aware that carbon dioxide levels in the atmosphere would rise during the industrial revolution, it was assumed that the rate of this increase would be extremely slow, and therefore, hardly presenting a cause for anxiety. Charles David Keeling, a chemist at the California Institute of Technology in the mid-1950s, designed a unique method for measuring concentrations of atmospheric carbon dioxide. In 1958, his methods and instrumentation were adopted by the United

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4 (MacKenzie)  
5 (MacKenzie)  
6 (Kolbert 40)  
7 (Kolbert 42)
States Weather Bureau for application at a field station in Mauna Loa, Hawaii. The graphical representation of this data is commonly known as the Keeling Curve. (Figure I-2) The curve adopts a jagged appearance, much like the teeth of a saw. Due to the effects of the Earth’s rotation around the Sun, each peak in the curve corresponds to the passage of a single year. Since the Earth’s land mass is more heavily distributed in the Northern hemisphere than in the Southern hemisphere, there is more vegetation in bloom when the Northern hemisphere is experiencing summer than there is when the Southern hemisphere experiences summer. Therefore, the yearly minimum atmospheric carbon dioxide levels occur when it’s summer in the Northern hemisphere. Correspondingly, the maximum yearly atmospheric carbon levels are measured when it is summer in the Southern hemisphere. Despite this constant up and down variation, a general upward trend is evident in the yearly average of the concentrations. This alone is not necessarily

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8 (Kolbert 43)
a cause for concern, but when placed in a context of the geological scale, it is difficult to ignore.

Current technologies have allowed us to examine past atmospheric conditions using data from mature ice sheets. The top layers of snow on all glaciers are less compact, but as new snow falls, it packs down the old snow, forming thinner layers of ice, while trapping air bubbles from the atmosphere. If one were to descend through these layers by drilling an ice core, it would be feasible to obtain a record of atmospheric conditions dating as far back as the age of the ice sheet. One such data set obtained from an Antarctic ice core is shown below in figure I-3. Recent history shows an unprecedented spike in carbon dioxide concentrations (red). Although the exact role of carbon dioxide in climate change is still unknown, there is a direct correlation between atmospheric carbon dioxide levels and average temperatures. One explanation for this uncanny correlation lies in the role of carbon dioxide as a greenhouse gas. (Figure I-4)

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9 (Fedorov, et al. 1485)
All molecular compounds, including those that are dispersed throughout the Earth’s atmosphere, vibrate at certain frequencies. As a consequence of these vibrations (the combination of which varies from one chemical species to another), incoming light, depending on its wavelength, can either be absorbed by the molecule in question or allowed to pass directly through without hindrance. When light that enters through the atmosphere hits the Earth’s surface, some is absorbed and the remainder is scattered back into the atmosphere. The newly scattered light has several different wavelengths, due to the inelastic collisions of the light particles with the ground and the tendency of these particles to lose energy in that process. According to Planck’s law, energy is inversely proportional to wavelength, thereby indicating that the reflected wavelengths tend to be longer. Some of these reflected light rays have the wavelengths that are absorbed by the greenhouse gases and emitted as heat waves in all directions, a portion of which act to warm the planet.11

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10 ("The Real 'Inconvenient Truth': Greenhouse, global warming - and some facts")
11 (Edmonds)
If greenhouse gases, including carbon dioxide, continue to build in the atmosphere, average temperatures will similarly continue to rise. The greenhouse effect gains intensity as the atmospheric concentrations increase, making it important to monitor these concentrations. While it was previously discussed that carbon dioxide does not merely remain in the atmosphere, but is instead involved in continuous recycling processes, one must consider the time scale on which these transfers occur. In the case of carbon dioxide, atmospheric lifetimes can range from two hundred to four hundred and fifty years, making the effects long-term, with an approximate eighty year lag between the correlated temperature changes. Action must be taken before a point is reached at which the long-term damage can no longer be prevented, plunging the Earth into an unstoppable and catastrophic chain of events.

**Subsidiary Effects of Climate Change**

Melting glacial ice sheets have been observed in polar regions as a result of rising global temperatures. Cracks formed within the ice are filled to create pockets of water that proceed to tunnel through the ice mass, creating inner caverns and pathways which thereby increase the surface area of ice that is exposed to the surrounding water. Increased exposure of surface area expedites the melting process. Pieces may become detached, breaking off and crashing into the water. The process is further exacerbated by an increase in the temperature of the surrounding water. Since darker colors absorb light and the white ice that had previously reflected most of the sunlight that hit it is being replaced with darker, more light-absorbent water, the oceans are absorbing more heat. In
effect, the melting of the glaciers is intricately involved in a positive feedback loop that is difficult to disrupt.

During the formation of glaciers, the crystallized structure of the ice will force out any impurities, such as salt, over long periods of time, making any water from their melting fresh water. The addition of fresh water to the oceanic whole will decrease the salinity of the water body, which can affect major ocean currents that carry massive amounts of heat northward from the Equator, such as the Gulf Stream.\textsuperscript{12} Cold surface water in the North Atlantic sinks because it is less buoyant than the warm, salty water from the tropics that is drawn up by currents to replace it. If fresh water is added to certain sensitive areas in the North Atlantic, the buoyancy of surface waters will increase, causing currents such as the Gulf Stream to decrease or even cease circulation.\textsuperscript{13} Without the immense amount of heat carried by these currents, the Earth could potentially be plunged into another ice age.\textsuperscript{14}

Another global problem involves the encroachment of rising water levels, which has already been observed in several areas. Figure I-5 below illustrates elevated sea levels in Falmouth, Massachusetts from 1900 to 2000. Notice that certain rocks in the stone wall are lettered or numbered to allow easy comparison. This type of change can be attributed to the interplay of two principles that have already been discussed: the melting of the glaciers and the rising temperatures of oceanic waters. Glaciers can be of two varieties: those that float and those that extend to the ocean floor. In the first case, melting will not change the sea level. However, if the glacier is resting atop of something, either land or more ice, the sea level will rise through the direct addition of

\textsuperscript{12} (Curry 1772) 
\textsuperscript{13} (McManus) 
\textsuperscript{14} (Rahmstorf)
volume when the section of ice that did not originally contribute to the ocean’s volume melts. Warmer waters contribute to changes in sea level by more indirectly affecting the overall volume. As water heats it expands, occupying a larger volume. In smaller water samples, such as a glass or a pot of water, this expansion tends to be negligible for small changes in temperature. Unfortunately, with a body of water the size of the Earth’s oceans, the effect is much more substantial. If heating continues, water levels will continue to rise even after all of the glaciers have melted, eventually submerging much of

Figure I-5: Rising sea levels in Falmouth, Massachusetts.\(^ {15}\)

\(^{15}\) (Coastal Resources Working Group 9)
the United States’ coastlines, including parts of densely populated cities such as San Francisco, Orlando, and New York City.\textsuperscript{16}

Warmer water is also responsible for ocean acidification. As the temperature of water is increased, the solubility of carbon dioxide gas also increases. With greater aqueous concentrations of carbon dioxide, equilibrium shifts will cause the formation of carbonic acid through the following reaction: $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$. The resulting elevation in pH poses a great hazard to biodiversity within marine ecosystems. Most directly threatened are calcifying organisms that build their external skeletons from calcium carbonate, including sea urchins, cold-water corals, coralline algae, and some plankton.\textsuperscript{17} As their surrounding environment becomes more acidic, their skeletons will disintegrates and since these organisms provide food and habitat for many others, a significant decrease in their populations could have far-reaching effects within marine ecosystems.

Biodiversity of plant and animal species on land will also be affected by climate change. Species tend to live over habitat ranges based on their optimal survival conditions. If temperatures and climates continue to change, then these ranges will begin to shift while concurrently experiencing a reduction in size. The effects on biodiversity will be extremely detrimental, with species more easily approaching extinction as their living conditions progressively worsen. This, in turn, could affect humans, who rely on the use of many plants and animals in various modes of production and sustenance. Additionally, agriculture may begin to flounder as ideal growing conditions dwindle. This would cause a shortage in food supplies, eventually leading to other associated

\textsuperscript{16} [Gore]
\textsuperscript{17} [Orr, et al. 681]
problems, such as malnutrition.\textsuperscript{18}

Other effects of climate change can be observed in weather patterns. While there is no real indication that climate change is affecting the frequency of major storms, there is sufficient evidence that it has caused an increase in the intensity, or power, of the storms that do occur.\textsuperscript{19} More intense hurricanes cause greater damages when they make landfall, including water damage, wind damage, and damage from flying debris. The associated costs are tracked by insurance companies through the claims filed after each disaster. Figure I-6 shows the insured losses from billion-dollar hurricanes and typhoons from 1950 through 2005. The graph shows a definite increase in damages over the last decade, especially keeping in mind that these figures only convey the damages that are incurred by insured entities. Included in the data set is Hurricane Katrina, which made

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure.png}
\caption{Insured losses from billion-dollar hurricanes and typhoons by decade, 1950-2005.\textsuperscript{20}}
\end{figure}

\textsuperscript{18} (Peters)  
\textsuperscript{19} (Emanuel 686)  
\textsuperscript{20} (Larsen)
landfall in Louisiana, Alabama, and Mississippi in August of 2005. The most recent estimates from insurance companies show almost forty-one billion dollars in damage claims, making it the most costly and damaging hurricane to ever hit the United States.\textsuperscript{21} These numbers are all underestimates of the actual costs, since they again only include those who were insured. As a result of the observed trends, insurance companies have raised rates for homeowners in high-risk coastal areas.\textsuperscript{22} Homes on barrier islands, such as those on Cape Cod, can be refused coverage altogether, presenting a financial dilemma for governments that are attempting to provide the denied assistance.

In the face of imminent changes in weather patterns, it is important to consider other weather-related health effects. These include, but are not limited to: “heat stress, respiratory disease…, allergic disease, vector-borne disease, reproductive effects and to some extent secondary health effects due to comprised nutrition.”\textsuperscript{23} Heat waves tend to be accompanied by a higher mortality rate, indicating that high heat levels can put stress on the human body. Changes in humidity, sunshine, and temperature affect the production of pollen, mold, and other allergens, which will affect asthmatics. Weather patterns may also become increasingly favorable for insects such as mosquitoes, which transmit vector-borne diseases, resulting in widespread infections. This particular effect has already been observed with the spread of Malaria to higher altitudes in the Andes.\textsuperscript{24}

\textit{Natural Causes v. Human Intervention}

The root causes of global warming have been widely debated in popular media.

\textsuperscript{21} (Swindell)  
\textsuperscript{22} (Larsen)  
\textsuperscript{23} (Longstreth 208)  
\textsuperscript{24} (Longstreth 210)
While information shows a high correlation between atmospheric concentrations of carbon dioxide and global temperatures, correlation does not necessarily imply a unique causation. Some articles claim that the process of climate change is completely natural, citing the various rotations and oscillations of the Earth as a probable cause for rises in global temperature. However, the rotations of the Earth are regular in nature, but carbon dioxide concentrations have skyrocketed in recent decades, reaching unprecedented heights. Figure I-7 shows more detailed increases in these concentrations during the timeframe of the Industrial Revolution from the years 1800 through 2000.

Whether or not carbon dioxide is the sole cause of climate change, the fact that increases in atmospheric concentrations are directly linked to anthropogenic forces is difficult to deny. Since these concentrations are, therefore, somewhat under human control, it is

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25 (Philander 2)
26 (Carbon Dioxide Information Analysis Center)
better to try and reduce carbon dioxide concentrations, rather than remain idle and suffer unknown consequences.

Further opposition arises from proponents who believe that nature will set itself straight with more vegetation. Even though there is some evidence that plant growth increases due to the increased potential for photosynthesis, it is difficult to keep up with the current emissions. Since plants can only absorb so much carbon dioxide, the net result will remain an increase in atmospheric levels. As the Keeling curve indicates, the reduction of these gases cannot simply be left to nature.
The Role of Public Perception

Public Perception

In 1987, the director of the United States Environmental Protection Agency (EPA) commissioned a study on risk perception to ensure that government resources were being properly allocated in a way that would provide the most efficient reductions in environmental risk. Thirty-one problems were presented to two groups: one composed entirely of risk assessment specialists and the other made up of the general public. Each group was asked to rank the list based on the level of environmental risk that each problem presented, with one being the highest risk and thirty-one being the lowest risk. As the first study of its kind, the differences between the two lists were extreme, with Superfund sites ranking as the number one risk for the general public, whereas it considered by the risk assessment specialists to pose the least environmental risk, ranking as number thirty-one on their list. Furthermore, the results of the study, published in a paper entitled *Unfinished Business*, indicated that the contemporary budget was allocated towards the problems that are perceived as high-risk by the public and Congress, not the specialists.

Public perception has always played an important role in political action. Many elected politicians feel pressured to curry public favor in order to be reelected, such that favorable administrative or legislative actions must not only be deemed prudent by specialists, but also by the general public. Unfortunately, as the above information indicates, the two opinions do not necessarily overlap, and often lie in direct opposition to each other. Therefore, if political action is expected to be taken with respect to the issue
of global warming, the idea must first earn greater credibility and raised awareness within
the public sphere. Up until recently, articles on global warming were limited to scientific
journals. Since only about one fourth of Americans have a college education or higher
according to the 2005 U.S. Census Bureau, it can be assumed that at least three-fourths of
the population does not regularly read scientific journals, which are written for a more
highly educated audience. In recent years, global warming has gained increasing
coverage in popular media, exposing the majority of the United States general population
to information that they would not have otherwise encountered.

National polls have proven to be an effective tool for measuring public opinion. The
Washington Post, in conjunction with ABC News and Stanford University, published
the results of a poll about national environmental trends on April 20, 2007. The data was
obtained by surveying approximately one thousand Americans via telephone in 1998,
1999, 2006, and 2007. If governments can be expected to effectively pass climate change
policies, three conditions must first be satisfied: there must be a consensus that climate
change is actually occurring, a belief that the causes are mostly anthropogenic as opposed
to natural, and a willingness to participate in any legislated counter-measures. Responses
to questions included in the national poll serve to shed some light on the current public
atmosphere in the United States. Some of the questions were also posed by paper survey
to one hundred and nine students here at Boston College in order to provide a stimulating
point of reference.

The Occurrence of Climate Change

Before legislation even becomes an option, the general public must first pass
judgment on the veracity of climate change. The question on the nationwide poll reads “How much do you feel you know about global warming?” The results, illustrated in Figure II-1, show that Americans have gained a significant amount of knowledge about the issue between 1998 and 2006, with the percentage of people who claim they know a moderate amount or more about global warming rising from about forty-two to about sixty. The recent poll taken at Boston College reveals similar levels of knowledge, although more students in the academic setting are confident in their knowledge about the subject. So what brought about this improvement of nearly fifty percent between 1998 and 2006? Much of the credit can be given to former vice president, Al Gore, and his award-winning documentary *An Inconvenient Truth*. After spending eight years pushing for climate measures as Vice President under the Clinton Administration, Gore attempted to run for President in the 200 election. After his defeat, he focused his efforts on educating the American public about the occurrence and effects of climate change. His relentless worldwide campaigning culminated in the release of his film in the summer of 2006 and the subsequent publication of a corresponding book with the same title. The change that resulted from his work has earned him a 2007 Nobel Peace Prize nomination.

**Figure II-1: Survey results for the question “How much do you feel you know about global warming?”**
However, it can not be assumed that all of the knowledge which appears to be gained is credible knowledge. It is possible that Michael Crichton is equally responsible for the increased awareness of global warming in America with his best-selling novel *State of Fear*. Unfortunately, most of the information in his novel is erroneous. The plot pertains to an MIT professor who fabricates a huge conspiracy on “abrupt climate change,” banding with a group of highly sophisticated eco-terrorists to stage environmental disasters across the globe. While the idea seems wild in and of itself, Crichton’s prominent reputation in American social culture makes his views difficult to discount. The problem is exacerbated by the attention that his ideas have received from certain public officials on respectable positions. For example, Crichton is widely cited in a speech given by the recently replaced Chair of the Senate Committee on Environmental and Public Works, James Inhofe, during which global warming was declared to be “the greatest hoax ever perpetrated on the American People.”  

Similarly, much of President George W. Bush’s information was also obtained during an hour-long discussion with Michael Crichton, which reportedly ended with the two in total agreement.  

Other forms of popular media have become increasingly focused on climate change. It is difficult to open a newspaper without finding at least one article that is related to climate change in some capacity. These articles collectively illustrate an ongoing debate about the occurrence of global warming, even though there is little to no debate within the scientific community. Reports of conflicting nature about the subject make it more difficult for people to establish a significant trust in the scientific community since they are not sure which scientists to believe as each side of the debate

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27(Kolbert)  
28(Kolbert)  
29(Gore)
discredits the other. This only intensifies a more deeply rooted problem in which people tend to distrust things they do not fully understand. The national poll asked “How much do you trust the things scientists say about the environment?” (Figure II-2) The data show that only about thirty percent of Americans trust the scientific community a lot or completely when it comes to the issue of climate change. This amount doubles when the poll is conducted in the university setting of Boston College, where students are more exposed to science as a core requirement.

The question remains: how important is global warming to the American people on a personal level? (Figure II-3) While there has been a slight increase in the percentage...
of Americans that feel global warming is at least somewhat important to them on a personal level, it is more significant to note that within that population, there has been a shift towards feelings of very or extreme importance. Long term thinking is a difficult task for humans, an important thing to consider when the given time-frame under which climate change is generally discussed is fifty years or more. Back in 1997, the effects of climate change had not yet become widespread. Since then, the effects of climate change have become more realistic, with occurrences around the globe that are already affecting people’s lives.

Perceived Causes of Climate Change

After establishing that climate change is in fact a problem and that it is an important issue for most Americans on a personal level, it becomes important to identify the root of that problem. Therefore, another question that was posed in the national survey asked whether subjects believed that a rise in the world’s temperature is mostly a result of the things people do, mostly a result of natural causes, or equally a result of both. The data, represented in figure II-4, indicate that a minority of Americans, only about twenty percent, believe that temperature rises are mostly from natural causes. While nature does play a role, it has become more acceptable that the things people due are at least equally responsible, if not more so, as knowledge about global warming has increased. The acceptance of this fact is even more evident at Boston College, with only about five percent in the minority, indicating that higher levels of education on the topic of global warming correlate with the idea that humans are responsible for amplifying or accelerating the rise of global temperatures.
Figure II-4: Survey results for the question “Do you think a rise in the world’s temperature is mostly caused by things people do, natural causes, or equally by both?”

The Motivation to Act

With the majority of the population now realizing that climate change is a problem for which people are at least partially responsible, how willing are Americans personally to change some of the things they do in order to help improve the environment? Survey results indicate that the majority of Americans are, at the least, somewhat willing to change their activities, with even more openness being observed within the college community. (Figure II-5) The will to act is a very important
prerequisite for implementing changes in federal policies. Since every emission of carbon, no matter how small, contributes to the overarching problem, even small reductions, like those from the use of more efficient light bulbs or the installation of low-flush toilets, can make a difference.

While the willingness of individuals to take these actions may serve as a precursor to larger actions in the future, it does not necessarily mean that federal intervention is desired, so the final question of interest is whether the American public believes that the measures currently being taken by the federal government are fully appropriate or whether they should be doing more or less than they are doing right now to try to deal with global warming. (Figure II-6) There is an overwhelming desire in the general public to see more Federal action with respect to the issue of global warming. This desire only becomes more pronounced within the college community, where students tend to be more politically active. The need for a federal climate change policy in the United States is undeniable, but it is, as of yet, unclear to politicians what method of intervention or regulation would be best. Unfortunately, the longer we remain inactive, the worse the problem will get.

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**Figure II-6**: Survey results for the question “Do you think the federal government should do more or less than it's doing now to try to deal with global warming?”
The United Nations

In 1988, the United Nations organized the International Panel on Climate Change (IPCC) to scientifically evaluate the impact of humans on climate change. In response to the publication of the IPCC’s first assessment report, the United Nations Conference on Environment and Development met in Rio de Janeiro to develop a treaty pertaining to the issue of global warming in 1992. The treaty drafted at this meeting, known as the United Nations Framework Convention on Climate Change (UNFCCC), was designed with room for future amendments. One such amendment is the Kyoto Protocol, which was negotiated in Kyoto, Japan in December 1997. Countries that sign the Kyoto Protocol agree to reduce their carbon dioxide emissions (as well as those of five other greenhouse gases) using a cap-and-trade system. In a cap-and-trade system, emissions are capped at a certain value, and then shares are allocated to industries that produce that chemical substance. If an entity has emitted less than the amount allowable under their allocated shares, the subsidiary shares can be sold to other entities that have exceeded their allowable limits. Through these means, the Kyoto Protocol is designed to reduce worldwide greenhouse gas emissions to five percent below their 1990 rates by 2008 to 2012.

The highlights of the Kyoto Protocol include common but differentiated responsibilities, financial commitment, emissions trading, revision, and enforcement. “Common but differentiated responsibilities” maintains that responsibility for global

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30 (Grubb, et al.)
warming lies proportionately with those countries that generated the greatest percentages of worldwide greenhouse gas emissions in 1990. The underlying principle is that the “largest share of historical and current global emissions of greenhouse gases”\(^{31}\) has come from developed countries, while the per capita emissions of developing countries are still relatively low. In other words, developed countries have already experienced their industrial revolutions, so undeveloped countries should not be deprived of having their own. This created some animosity in the ratification stage since developing countries like China and India would be exempt from Kyoto regulations, even though their emissions are presently on the rise. Finally, financial commitments that were outlined in the UNFCCC were reiterated, dictating that developed countries should pay and supply technology for further studies on climate change.\(^{32}\)

There are two necessary conditions for the enactment of the Protocol. First, at least fifty-five countries must sign the treaty (a goal that was reached in May 2002 with the signing of Iceland). Second, these fifty-five or greater countries must be responsible for at least fifty-five percent of the world’s 1990 carbon dioxide emissions (a goal reached in November 2004 with the addition of Russia as a signatory country). As indicated in the body of the document, the treaty went into effect on February 16, 2005, ninety days after the second condition was filled.\(^{33}\) The majority of Europe is currently working to institute climate change policies that will allow them to meet the goals set in the Kyoto Protocol.

\(^{31}\) (Grubb, et al.)
\(^{32}\) (Grubb, et al.)
\(^{33}\) (Grubb et al.)
The Kyoto Protocol and the United States

Responsible for almost twenty-five percent of the global emissions of greenhouse gases in 1990, the United States had the potential to induce significant changes as a signatory nation under the Kyoto Protocol. In 1998, the Clinton Administration signed the protocol, agreeing to an emissions reduction of seven percent by 2008 to 2012. However, the signature was revoked in 2001 under the Bush Administration due to dissatisfaction with the terms of the treaty. The United States’ withdrawal from the Kyoto Protocol created a great animosity within the international community, both in its specific detriment to the fifty-five percent requirement for enactment, and as part of a more general trend of rejecting international treaties. The particular opinions of the Senate can be found in the Byrd-Hagel Resolution, which holds that the United States should not sign on to any international treaty that does not require developing countries as defined under the UNFCCC, such as India and China, to meet similar requirements within the same time-frame. Additionally, the Resolution also prohibits the United States to sign international agreements to reduce greenhouse gas emissions if the measures dictated within the treaties would cause harm to the nation’s economy.

The United Kingdom

The idea that a nation’s economy can not continue to grow while reductions are being made in greenhouse gas emissions is a common misconception. The Stern Review, published in the United Kingdom, demonstrates that contrary to popular belief, it is actually more economically favorable to reduce carbon emissions than it would be to reframe from regulation. Building on the principles in this report, the United Kingdom is

34 (Byrd, et al.)
doing especially well in meeting their Kyoto reduction of twelve and a half percent, having already reduced their emissions to fourteen and six tenths of a percent below the base levels.\(^{35}\) They are projected to achieve a reduction of close to nineteen and four tenths of a percent by 2010. Successful methods that were employed include a restructuring of the United Kingdom’s energy supply, improving energy efficiency and intensity, controlling pollution in industrial sectors.

Prior to 1983, the energy sector in the United Kingdom was subject to significant government regulations. As time progressed, it was believed by the government that competitive markets would better lend themselves to energy security and diversity, offering consumers the greatest benefit.\(^{36}\) The processes of privatization and deregulation truly began with the passage of the Electricity Acts in 1983 and 1989. When the United kingdom agreed to its emissions reductions targets under the Kyoto Protocol, the government was able to draw on one of the statutes from the 1989 Electricity Acts, the Non-Fossil Fuel Obligation (NFFO), to require that the country’s twelve regional electricity companies must secure a certain specified amount of their generating capacity from non-fossil fuels. As a result of this and other similar statutes, renewable energies have had the ability to flourish, with two hundred and forty-eight projects already running by 2000.\(^{37}\) Improvements in energy efficiency have also been achieved in the United Kingdom through the institution of the Climate Change Levy (CCL) in 2001. The CCL is a tax on energy use in both the business and private sectors, with the rate being determined by the type of energy in use.\(^{38}\) Through this levy, it is hoped that citizens will

\(^{35}\) ("The UK response")
\(^{36}\) (UK Department of Trade and Industry)
\(^{37}\) (Runci 13)
\(^{38}\) ("The Climate Change Levy Package" 5)
be persuaded to use renewable energies, which are not as highly taxed, and become more conscious of their energy use and thereby decrease individual consumption.

Pollution control in industrial sectors has gained momentum in the United Kingdom through the Pollution Prevention and Control (PPC) Regulations. The PPC provides an integrated approach for regulating air, water, and land emissions, along with additional environmental effects. The PPC is the local approach to the European Union’s Integrated Pollution Prevention and Control (IPPC) Directive, which all participatory members of the European Union required to enact by October of 2007. Aimed particularly at industrial production processes, which are a large source of overall pollution in Europe, the Directive allows for the issuing of permits with emissions limit values based on the best available technologies. The effectiveness of the IPPC Directive is currently under review.

**European Trading Markets**

The European Union has been particularly active with respect to the reduction of carbon dioxide emissions. Another policy that has been introduced across Europe is the Emissions Trading Scheme. Phase I of the Scheme began on January 1, 2005 and will run until December 31, 2007. Phase II will run from 2008-2012 to coincide with the first Kyoto Protocol commitment period. The trading scheme is based on the principles of a cap-and-trade market. Each participating government is responsible for setting their own cap, with subcommittees within each industry to determine the proper allocation of emissions.
allowance. Each party must track their emissions throughout the year to ensure that they do not exceed their allowed contribution. If an entity were to exceed that amount, they could purchase shares from other sources that emitted less than their allowable portion. The number of tradable allowances is set in the National Allocation Plan. The progress and value of this particular emissions trading scheme was tracked by a web survey of stakeholders and participants, conducted from June to September of 2005. The published results indicate that the Emissions Trading Scheme has already had an impact on corporate behavior by putting a price on carbon dioxide and largely influencing long-term decisions.
In response to the Kyoto Protocol taking effect on February 16, 2005, Mayor Greg Nickels of Seattle challenged mayors across the country to join his city in taking local action against climate change. Those who agreed became part of the US Mayors’ Climate Protection Agreement, which is currently comprised of 494 mayors that collectively represent over 64 million Americans. Signatory mayors accept the challenge to locally meet or beat Kyoto targets while urging state and federal governments to enact policies and programs and urging Congress to pass bipartisan greenhouse gas reduction legislation. The methods by which each city reaches its goals are not dictated by the agreement, but tend to vary according to the feasibility of implementation in each city. One extraordinary example is seen with the most recent campaign for sustainability in New York City.

In 2006, Mayor Michael R. Bloomberg of New York City presented ten key goals in attaining a sustainable future for New York City, inviting the city’s over eight million inhabitants to help create a plan by which to achieve those goals. New Yorkers from all five boroughs contributed to the ultimate establishment of a new urban plan, part of which will reduce the city’s greenhouse gas emissions by over thirty percent. Four key strategies are essential to the city’s success in achieving this particular goal: avoided sprawl, clean power, efficient buildings, and sustainable transportation. Under this

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44 ("US Mayors Climate Protection Agreement")
45 (Mayor’s Office 134)
plan, New York City will attempt to create sustainable affordable housing, clean up waterways and all contaminated land, and ensure that all New Yorkers are within a ten minute walk of a park in an effort to attract 900,000 new residents. The underlying notion is that the movement of this population to the city will avert the equivalent amount of urban sprawl that would have occurred. In addition, clean power will be achieved by replacing old power plants and promoting renewable energies. Making existing buildings more efficient and requiring more efficient construction of new buildings will help to reduce the city’s overall energy consumption. Finally, improvements in public transportation will encourage more widespread use of the system, reducing the number of vehicles on the road. A more controversial suggestion in Mayor Bloomberg’s campaign involves the institution of a congestion fee for driving south of Eighty-Sixth Street in Manhattan during peak hours on weekdays.46

**States**

Several States have instituted their measures to combat climate change in the hopes of eventually pressuring the Federal government to establish a national initiative, whether it be as a signatory nation under the Kyoto Protocol, or through a comprehensive national climate change policy. California, for example, has always been particularly active in environmental issues. The Climate Action Team, established by Governor Schwarzenegger, is responsible for implementing emission-reduction programs and reporting on the progress of those programs twice a year.47 The state employs a wide variety of techniques to lower greenhouse gas emissions, including but not limited to

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46 (Newman)
47 (“California Climate Action Team & Climate Action Initiative.”)
motor vehicle standards, recycling programs, and green building. The state goals are set to exceed those outlined by the Kyoto Protocol in an effort to reaffirm California’s position as a national leader in environmental reform.

Across the country on the East Coast, Massachusetts has also been trying to maintain its position as a forerunner in environmental policy. The establishment of the 2004 Massachusetts Climate Protection Program (MCPP) aspires to improve the Commonwealth’s energy efficiency while reducing greenhouse gas emissions. The goals are outlined in terms of time, with short-term, medium-term, and long-term aims. Actions in the near term are expected to protect the climate, reduce pollution, cut energy demand, and nurture job growth, while ultimately reducing emissions to 1990 levels by 2010. Reductions of an additional ten percent are expected by 2020 as part of the medium-term goals. Long-term goals include emissions reductions of seventy-five to eighty-five percent from current emissions levels.

Regional Initiatives

In addition to statewide initiatives, several governors have joined forces to form regional initiatives. In 2003, the governors of Washington, Oregon, and California banded together to form the West Coast Governors’ Global Warming Initiative, approving a series of recommendations for action. They are currently working on further developing a regional plan. Aside from reducing greenhouse gas emissions, they aim to develop a market-based carbon allowance program and expand the markets for energy efficiency, renewable resources, and alternative fuels. In doing so, the West Coast States...

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48 ("State of California Agencies' Roles in Climate Change Activities."
49 (Romney)
50 (“West Coast Governors’ Global Warming Initiative”)
hope to become global leader in the development of renewable energy and energy-efficient technologies.

Meanwhile, North Dakota, South Dakota, Iowa, Minnesota, Manitoba, and Wisconsin have taken an interdisciplinary, collaborative approach with the Powering the Plains (PTP) Initiative in the Midwest. Comprised of government officials, utility industry executives, agricultural producers and farm organization representatives, and renewable energy advocates from each participating state, the PTP initiative meets quarterly. Many of the group’s efforts, such as renewable energy development, hydrogen production, environmental credit trading, carbon sequestration, and coal gasification, are designed to draw on the region’s comparative advantages. The various stakeholders work to develop and implement policies, initiatives, and projects to combat greenhouse gas emissions while helping the region’s economy. Of note among their objectives is development and advocacy for federal policy recommendations.

In the Northeast, Governor Pataki was responsible for setting in motion the events that led to the formation of the Regional Greenhouse Gas Initiative (RGGI). In April 2003, he sent letters to the governors of eleven states from Maine to Maryland, inviting them to meet and discuss a regional cap-and-trade system for carbon dioxide emissions from power plants. The resulting coalition has been working since 2005 to develop a successful plan that will ideally go into effect during 2009. Together, representatives from signatory states have developed a model rule which can be used as a guideline in developing each of their individual state plans, which members have agreed to draft by December 31, 2008. If the guidelines of the model rule are properly followed, carbon dioxide emissions will have stabilized by 2015 at an average of 2002-2004 levels.
Emissions would then be further reduced by ten percent from 2015 to 2020, mainly through the regulation of power plants since they tend to be the largest producers with the most easily measurable emissions. The model is structured so that it can readily be extended to cover other greenhouse gases, as well as other sources. Furthermore, the coalition is designed to allow any state to sign on to the agreement at any time. There are currently ten states involved in RGGI: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, and Maryland.

Current Federal Policies

In lieu of the Kyoto Protocol, George W. Bush proposed a national policy that was geared towards slowing the growth of emissions, strengthening science, technology and institutions, and enhancing international cooperation. Announced in 2002, the plan involves a voluntary program with incentives to encourage a ten percent reduction of emissions by 2012. Many believe that such a voluntary program is not enough and that carbon dioxide emissions should be regulated by the United States Environmental Protection Agency (EPA) under the Clean Air Act (CAA). During a more recent State of the Union Address in January of 2007, President Bush touched briefly on climate change, saying that it needs to be addressed, but that a mandatory emissions cap would not be the proper channel through which to do so.

In 1999, a collection of nineteen environmental groups filed a rulemaking petition, requesting that the EPA regulate greenhouse gas emissions, including carbon dioxide, in new motor vehicles under the CAA. The EPA Administrator under the

51 ("About RGGI.")
52 ("About RGGI.")
53 ("U.S. Climate Policy and Actions.")
previous Administration had acknowledged the possibility of using the CAA for regulation of carbon dioxide. However, the new EPA Administrator responded to the petitioners in 2002, claiming that EPA lacked the authority to regulate carbon dioxide under the CAA. Furthermore, he avered that even if EPA did have this authority under the CAA, the agency is utilizing its discretionary right to decline the establishment of regulations, deeming it unwise for a variety of reasons. It was at this point that the states intervened on behalf of the environmental groups and the case of Massachusetts et al. v. United States Environmental Protection Agency (05-1120) was brought to the Court of Appeals. Twelve states and several cities petitioned that, based on the broad wording in the policy, the EPA does have authority to regulate carbon dioxide as a pollutant under the CAA and that it was going beyond its discretionary scope in refusing the request. Once in court, the EPA maintained their stance, with their main defense questioning the plaintiff’s right to sue. In order to bring a case to court, one must demonstrate “standing,” which requires the satisfaction of three main conditions: 1) the issue disproportionately affects the plaintiff, 2) that the defendant caused the actions that are injuring the plaintiff, and 3) the court can provide an effective remedy for the problem. EPA argued that none of these conditions were satisfied since everyone is experiencing global warming and coastline loss, the effect can’t be directly linked to truck and car emissions, and a national effort can’t solve a global problem. The judges in the lower court returned a final ruling in favor of the EPA because the states could not demonstrate standing.

The case was appealed and argued before the Supreme Court on November 29,

54 (Massachusetts, et al. v. Environmental Protection Agency, et al.)
2006. A decision was returned on April 2, 2007, with a five to four ruling in favor of the states.56 The majority opinion of the Court, written by Justice Stevens, granted standing to the states, acknowledging them as sovereign entities under the Federalist Act.57 According to the ruling, the EPA does have authority to regulate carbon dioxide under the Clean Air Act based on the intentions of Congress during the legislation of the statute.58 Furthermore, the Court determined that the wording of the statute does not allow the EPA to discretionally decline regulation based on the reasons given in 2002. To be clear, the court ruling does not require the EPA to take action, it only requires that the EPA reevaluate whether or not carbon dioxide will “cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.”59 If this criteria is satisfied, then according to the statute the EPA is required by law to act.

As a result of this trial, the EPA is faced with three possible courses of action. The first option is to stall the determination, which would eventually result in another citizen lawsuit. If a determination is made, there are two possibilities: either carbon dioxide does “endanger public health or welfare” as defined by the statute, or it does not. If EPA claims the latter, they could be subject to an arbitrary and capricious hearing, which maintains that the decision was not made in a properly informed manner. Both of the scenarios that have already been discussed imply that the enactment of any federal climate change policy will be slow and drawn out, but there is a third possibility. If the EPA determines that carbon dioxide does “endanger public health or welfare”, then the agency must take action, though the statute does not prescribe exactly what course of

56 (Massachusetts, et al. v. Environmental Protection Agency, et al.)
57 (Massachusetts, et al. v. Environmental Protection Agency, et al.)
58 (Massachusetts, et al. v. Environmental Protection Agency, et al.)
59 42 USC 7521(a)(1)
action should be taken. This leaves a variety of opportunities in designing of a Federal Climate Change Policy, which are discussed in more detail in the next section.
The Direction of Federal Climate Change Policy in the United States

Taking an Interdisciplinary Approach

As the issue of global warming gains prominence in the United States social and political spheres, scientists have increasingly devoted time to developing measures by which to minimize or reduce carbon dioxide emissions. One popular suggestion is that of physicist Robert Socolow and ecologist Stephen Pacala of Princeton University. Instead of relying on a single “quick-fix” to reduce atmospheric concentrations below five hundred parts per million, the two professors advocate for a multifaceted and diverse approach, employing a variety of remedies, each of which can be responsible for a “wedge” of reduction.60 (Figure V-1) For the sake of simplicity, each wedge is defined in their publication as the action necessary to prevent a million metric tons of carbon per year from being emitted by 2054. Socolow and Pacala further discuss the possible technologies and the scale on which they would be necessary to achieve a complete

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60 (Pacala 968)
61 (Pacala 969)
wedge of reductions in their paper, but the principle remains that the reduction of atmospheric carbon dioxide is cumulative so every little bit helps. The following sections will explore a variety of options for emissions reductions in the United States. Since no one method can solve the problem entirely, some combination is necessary if the United States will do its part in lessening the effects of climate change.

*Investments in Renewable Energy*

The current administration has generally increased their investments in renewable energies. Figure V-2 illustrates the allocation of the Department of Energy’s Budget, spanning from the 1998 fiscal year’s budget to the projected budget for the 2008 fiscal year. Investment in energy conservation initially rose, dropping again after the 2001

![Figure V-2: Trends in the DOE budget over fiscal years 1998 to 2008.](image_url)
fiscal year with the 2008 budget showing a net decrease of ten to fifteen percent from the
1998 budget. According to the data presented in the figure, funding for oil and
geothermal research are anticipated to become nearly nonexistent in 2008. Funding for
other sources of renewable energy, with the exception of geothermal energy, has
increased over the decade. Though the case of geothermal energy may appear to be an
anomaly, government funding is only one half of the complete picture. More research is
conducted in the private sector. Unfortunately, due to the private nature of this research
it tends to be very difficult to track. In the modern world, greater confidence is stored in
these advancements within the private sector, as well as in venture capitalist investments.
The Department of Energy has stopped funding research in geothermal power and
hydropower because they claim that both are “mature technologies” and the market can
now take the lead in these fields.62

The American Energy Report, released by the Worldwatch Institute and the
Center for American Progress last September, provides a summary of the current state of
renewable technologies, markets, and policies in the United States. According to
information in the report, opportunities to increase energy efficiency represent the
greatest potential for reductions in future emissions.63 The American Solar Energy
Society’s report, Tackling Climate Change in the U.S. Potential Carbon Emissions
Reductions from Energy Efficiency and Renewable Energy by 2030, similarly
demonstrates confidence in energy efficiency, while proposing that a combination of
energy efficiency and renewable energies alone could potentially reduce carbon

62 (“US to Cut Funds for Two Renewable Energy Sources.”)
63 (Worldwatch, et al.)
emissions by over 60% from their 2005 levels by 2030.\textsuperscript{64} (Figure V-3) The *American Energy Report* also discusses the current progress in areas such as biofuels, wind power, solar power, hydropower, geothermal power.

![Figure V-3: Potential carbon reductions in 2030 from energy efficiency and renewable energy technologies.\textsuperscript{65}](image)

*Underground Carbon Sequestration*

The Department of Energy is currently investing in the research and development of carbon capture and storage (CCS) technology. The first step of CCS technology involves the capture of carbon dioxide from large, stationary sources, such as power

\textsuperscript{64} (Kutscher)
\textsuperscript{65} (Kutscher)
plants. This must be done in a way that separates the gas from other emissions and converts it into a concentrated stream under high pressure that is then suitable for the second step of CCS: injection into underground geological formations. Carbon capture becomes increasingly difficult when emissions contain smaller percentages of carbon dioxide, such as the case with pulverized coal plants, which account for about ninety-nine percent of all coal-fired plants in the United States. In an attempt to develop more efficient methods of coal power with better chances of carbon capture, particular attention is being paid to a process known as Integrated Gasification Combined Cycle (IGCC). This new technology enables the carbon dioxide to be separated from a much more concentrated gas stream before it mixes with the air.

Before the captured carbon stream can be injected underground, an adequate chamber must be identified for storage. An ideal location generally consists of deep underground, porous rock that is “capped” with a layer of nonporous rock to trap the pressurized carbon dioxide. Geological storage is primarily targeted to three types of formations: depleted coal and gas reservoirs, unmineable coal seams, and saline formations. An alternative storage method is being tested in Iceland, where President Olafur Grimsson is working in conjunction with scientists from Columbia University and other partners to store carbon in basalt deposits. Together, they will attempt to inject carbon dioxide-rich water underground over the next two years. If the carbon dioxide were to react with the basalt beneath the ground it would form a stable mineral, theoretically trapping it underground for millions of years.

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66 (“CO2 Capture”)
67 (“CO2 Capture”)
68 (“CO2 Storage”)
69 (Mahr)
Carbon Trading Markets

The possible institution of a carbon cap-and-trade market system has received a considerable amount of attention in the United States. This type of program has several benefits, such as a clear goal in the emissions cap and source responsibility and accountability. The flexibility of the program allows sources to design and implement their own compliance strategies, which generally include the reductions that are deemed most cost-effective by each source. In addition, the simplicity of the design and operation of the program keeps administrative costs low. One example of a successful cap-and-trade program in the United States can be found in the Acid Rain Program. Begun in 1990, the United States Acid Rain Program has achieved greater emission reductions in such a short time than any other single United States program to control air pollution.

Though many of the regional initiatives discussed above have already included trading markets in their coalition’s agreements, the feasibility of a carbon-trading market is questionable on a larger, national scale. A cap-and-trade system is most appropriate when the problem is occurring over a large area and is being caused by many sources that have consistently and accurately measurable emissions and varying costs of control. These prerequisites are satisfied in the case of carbon dioxide, evidenced by the existence of current trading markets, such as those instituted regionally within the United States, and the EU Emissions Trading Scheme previously described in detail. Furthermore, the regulating party for a cap-and-trade system must be able to receive and verify large amounts of emissions data, to determine compliance fairly and accurately, and to strongly refer to external sources:

70 ("Allowance Trading Basics and Concepts")
71 ("Progress Reports: Acid Rain Program.")
72 ("Allowance Trading Basics and Concepts")
and consistently enforce the rule.\textsuperscript{73} The EPA has already shown itself capable of the first two of these conditions through its regulation of the Acid Rain Program. However, the third condition, which calls for strong enforcement, may present a problem with the current Administration. Despite the documented advantages of a cap-and-trade market, President George W. Bush has argued against such a program, claiming that industries can sufficiently reduce emissions through development of new technologies.

In response to the President’s reluctance, a group of large businesses and leading environmental organizations joined to form the United States Climate Action Partnership (USCAP). Representing over one million environmentalists and a seven hundred and fifty billion dollar capitalization, members of the USCAP collaborated for a year before releasing their recommendations in a report entitled \textit{A Call for Action}. On January 22, 2007, USCAP called on the Federal Government to “quickly enact strong national legislation to achieve significant reductions of greenhouse gas emissions.”\textsuperscript{74} All of the USCAP’s recommendations are structured so that Climate Change Policy will encourage early action and be environmentally effective while accounting for the global dimensions of climate change, recognizing the importance of technology, and creating economic opportunity and advantage.\textsuperscript{75} Among these recommendations, the USCAP maintains that “cap and trade is essential” in a federal policy, vowing to work with stakeholders, and Congress to enact a program as soon as possible.\textsuperscript{76}

\textsuperscript{73} (“Allowance Trading Basics and Concepts”)
\textsuperscript{74} (Files 1)
\textsuperscript{75} (“A Call for Action” 4-5)
\textsuperscript{76} (“A Call for Action” 7, 11)
Urban Centers and Green Building

As populations continue to boom, the issue of urban sprawl becomes increasingly prevalent across the United States. While the allure of a home in the country with friendly neighbors and a pie cooling on the window sill is deeply imbedded in American culture, there are some very real reasons for urban-rural migrations, which usually follow a general pattern. Since colleges tend to be located near urban centers, the urban scene is particularly appealing to young students, especially with the associated post-study job opportunities. As an individual begins to raise a family, they tend to move to more rural areas in pursuit of better-quality schooling systems for their children. Finally, once their children have moved out, individuals will move back to the city because it provides certain conveniences. These conveniences can also lead to inherent emissions reductions. Unlike what has been seen in the Midwest, a denser and more compact city enables inhabitants to quickly and easily travel from one location to another. When stores, restaurants, or even workplaces are closer, cars become less of a necessity, thereby decreasing vehicular travel and increasing biking and walking for these shorter distances. Vehicular travel for longer trips can be further reduced with a coherent and preferably comprehensive public transportation system. Additionally, the proximity of the buildings lends itself to better energy efficiency, minimizing the escape of heat and allowing the buildings to use less electricity to maintain a given temperature.

Major advances in the building sector are expected in the near future, since buildings account for almost half of the United States’ energy consumption and are typically used for fifty to one hundred years. Initiatives for change have already begun with organizations such as Architecture 2030, the American Institute of Architects, and

77 (Mazria 7)
the United States Green Building Council. Since costs can be high for custom-designed single homes, there tends to be an erroneous perception among developers that green building is more expensive. However, it is entirely possible to have sustainable development that is not only profitable for developers, but affordable for homeowners, such as the Solar Village Project in Longmont, Colorado. New buildings can currently be designed to consume half of the energy they previously would have used at little or no additional cost. Techniques employed in the construction of some New York apartment buildings include the reduction of air leakage, the installation of working thermostats in individual rooms, and the incorporation of better ventilation systems.

Enhancing Urban Forests

Along the same vein of city planning, enhancement of the urban forest can also prove to be an extremely effective method. As mentioned earlier vegetation will sequester carbon through photosynthesis via the following reaction:

$$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

While all vegetation uses the above method to sustain life, trees tend to be more efficient at carbon sequestration because they have a greater number of photosynthetic cells. It is for this reason that several of the policies mentioned above will allow for offsets based on forest maintenance in a designated area. Unfortunately, some relatively recent research has credited vegetation with contributing to increased levels of atmospheric methane, a more volatile greenhouse gas than carbon dioxide. While this initially raised skepticism

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78 (Spiess 48)
79 (Mazria 8)
80 (Gifford)
about the use of trees as carbon-sequestering offsets, doubt over their effectiveness has since abated.

In January 2006, Frank Keppler and his colleagues at the Max Planck Institute in Germany published a study on methane production in vegetation. Laboratory experiments were conducted separately on both living plants and litter. In each case, the subjects were monitored in glass containers through a series of variations in sunlight and atmospheric methane content. The study then extrapolated the obtained data from the individual plants to present a global representation of the phenomenon, stating that vegetation is responsible for the emission of sixty-two to two hundred and thirty-six megatons of methane each year.\footnote{Keppler et al.}

However, the method that Keppler utilized for his extrapolation involved the multiplication of his experimentally observed emission rates with estimates of the net primary production (NPP) of an area. The NPP for an ecosystem is the rate at which it accumulates energy or biomass, excluding the energy it uses for the process of respiration. A large component of NPP is roots (which don’t receive sunlight) and woody material (which is “metabolically inert”). Both would therefore emit methane at different (probably lower) rates than those measured for soft tissue. Furthermore, a proportion of soft tissue is shed or eaten by herbivores, meaning that the duration of emissions is not the whole season.\footnote{Kirschbaum et al.}

Two alternate methods were proposed for the global calculations, each with a different basis than the other. In both cases, all of the factors neglected by Keppler were accounted for as best as possible. Leaf-mass-based estimates were calculated by

\footnote{Keppler et al.}
\footnote{Kirschbaum et al.}
summing the contributions of each biome based on biomass densities. This yielded global methane emissions of fifteen to sixty metric tons per year from vegetation. Calculations were also outlined on the assumption of photosynthetic connections. The result in this case was even lower than that above, with global emissions of nine and six tenths metric tons of methane per year from vegetation.\(^{83}\)

Even with these lower estimates, the question is raised as to whether trees do in fact sequester carbon. In reality, the level of carbon dioxide intake is still higher than the level of methane emission. The value of tree plantings is illustrated in figure V-4 below.

| Minimum | 18.3 | 183 | 8 | 77 | 8 | 69 | -0.4% |
| Median  | 18.3 | 183 | 8 | 216 | 22 | 194 | -1.1% |
| Maximum | 18.3 | 365 | 12 | 850 | 44 | 806 | -4.4% |

\textbf{Figure V-4:} Value of tree plantings (in t CO\(_2\)e ha\(^{-1}\) year\(^{-1}\)), calculated methane emissions for trees and grass, and the net percentage reduction in net benefit due to inclusion of methane emissions based on leaf-mass-based estimates.\(^{84}\)

The calculations reported by Miko U. F. Kirschbaum and colleagues indicate that, carbon sequestration benefits are reduced by only one and one tenth of a percent under likely conditions and only four and four tenths of a percent under extreme and unrealistic conditions.

More research should be done into the pathway of the emissions, as well as the effects of temperature, time, and irradiance. Finally, there needs to be a comparison of different species and their respective emissions under various conditions. All of this information will help in choosing which kinds of trees should be planted to maximize carbon sequestration. For example, it has been shown that trees with light colored leaves

\(^{83}\) (Kirschbaum \textit{et al.})
\(^{84}\) (Kirschbaum \textit{et. al}.)
tend to be better since those with dark colored leaves would absorb more light and thereby contribute to the heating effect. Aside from their photosynthetic sequestering capacities, trees can also reduce carbon emissions by saving energy. The shade provided by trees, if properly placed, can significantly reduce air conditioning costs in the summer by lowering local temperatures and allowing the air condition to work more efficiently since it is less likely to overheat. Trees can also serve to block winds in the winter, possibly reducing energy use during the windier months.

A robust urban forest can also provide a variety of other benefits, influencing physical, aesthetic, economic, social, and psychological factors. Human health and well-being are connected to naturally occurring processes such as air quality, temperature, wind speed, noise, and water runoff, all of which are affected by tree canopy. It’s been shown that the presence of trees can increase the desirability and value of neighborhoods, having a positive effect on individual and community self-images. This increased sense of self can heal individual relationships and enhance community interactions, universally making trees a valuable asset to any community.

85 (Sommer 180)
While the occurrence of climate change is a global problem, the cumulative property of carbon emissions allows for solutions on individual, regional, and national scales. Although significant federal action has remained elusive with respect to climate change in the past, recent conditions in the United States’ social and judicial spheres have set the stage for a vital turning point, with the opportunities for a federal climate change policy ranging from the simple actions of planting trees to the more overarching development of cap-and-trade carbon markets, though the most effective approach would be a combination of multiple techniques.

Even with these ideal conditions, little change can be expected under the current Administration with the reiterated reluctance of President George W. Bush to support a national climate change policy. The topic has quickly become relevant to the upcoming presidential election, with the previously discussed results of national polls indicating that it will be an important factor of consideration for the American public. Regardless of when or how action is brought about, timeliness is of the essence.
Bibliography


McManus, Jerry and Delia Oppo. “The Once and Future Circulation of the Ocean: Clues in seafloor sediments link ocean shifts and climate changes.” *Oceanus Magazine*.


United States Climate Action Partnership (USCAP), A Call for Action: Consensus, Principles and Recommendations from the USCAP. 2007.


