


African Americans and Climate Change:
An Unequal Burden

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Congressional
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Executive Summary

Where U.S. Energy Policy is concerned, African Americans are proverbial canaries in the mineshaft. We are on the frontline of the likely social, environmental, and economic upheaval resulting from climate change. As a consequence, energy policy and climate change are issues of fundamental importance to the African American community. The inadequacy of current U.S. energy policy generates a range of adverse environmental and economic impacts. This report for the Congressional Black Caucus examines the relationship between energy policy, climate change, and African Americans in order to inform the growing policy discussion.

The fundamental conclusion of this report is that there is a stark disparity in the United States between those who benefit from the causes of climate change and those who bear the costs of climate change. The basic findings of this report are threefold:

1) African Americans are already ***disproportionately burdened*** by the health effects of climate change, including deaths during heat waves and from worsened air pollution. Similarly, unemployment and economic hardship associated with climate change will fall most heavily on the African American community.

2) African Americans are ***less responsible*** for climate change than other Americans. Both historically and at present, African Americans emit less greenhouse gas.

3) Policies intended to mitigate climate change can generate large health and economic benefits or costs for African Americans, depending on how they are structured.

Unless appropriate actions are taken to mitigate its effects or adapt to them, climate change will worsen existing equity issues within the United States.

1) African Americans Disproportionately Bear the Effects of Climate Change

Health Effects:
It is clear that African Americans will disproportionately bear the substantial public health burden caused by climate change. Health effects will include the degradation of air quality, deaths from heat waves and extreme weather events, and the spread of infectious diseases. Globally, climate change *already* causes an estimated 160,000 deaths annually, and this number will only worsen as the rate of change increases over the coming decades.

Air pollution is already divided down racial lines in this country, with over seventy percent of African Americans living in counties in violation of federal air pollution standards. The number of people affected will increase as the higher temperatures of global warming are expected to further degrade air quality through increased ozone formation. In every single one of the 44 major metropolitan areas in the U.S., Blacks are more likely than Whites to be exposed to higher air toxics concentrations. Partially as a consequence of this disparity, African Americans are nearly three times as likely to be hospitalized or killed by asthma as whites, with climate change expected to increase the incidence of asthma in the general population.

Similarly, at present, African Americans are at a greater risk of dieing during **extreme heat events**. The most direct health effect of climate change will be intensifying heat waves that selectively impact poor and urban populations. Future heat waves will be most lethal in the inner cities of the northern half of the country, such as New York City, Detroit, Chicago, and Philadelphia, where many African American communities are located.

African Americans may also be disproportionately impacted by the increased prevalence of **extreme weather** events and the spread of **infectious diseases**, such as malaria and dengue fever, primarily in Southern states. More importantly, the possibility of catastrophic climate change outlined in a recent Department of Defense study may have severe impacts on weather and human lives, with resulting resource shortages engendering military conflict. All of these problems are compounded by the fact that Blacks are 50% more likely than non-Blacks to be uninsured.

Economic Effects:
African American workers are likely to be laid off disproportionately due to the **economic instability** caused by climate change. In general, economic transitions strike hardest at those without resources or savings to adapt. In the United States, drought, sea level rise, and the higher temperatures associated with global warming may have sizeable impacts on several economic sectors including agriculture, insurance, and buildings and infrastructure. Generally, Southern states fare most poorly in economic modeling of the effects of climate change. Globally, climate change is likely to cause damages in excess of $600 billion per year, with particularly negative effects in Africa. Similarly, the health and environmental effects of climate change will incur substantial costs for the African American community.

While many of these figures have appeared elsewhere in the scientific literature, this is the first time that the impacts of climate change have been assessed specifically for the African American community. The synthesis indicates that there is a substantial equity issue in the unequal distribution of the impacts of climate change.

2) African Americans Are Less Responsible for Climate Change

In contrast to the burden of climate change, *responsibility* for the problem does not lie primarily with African Americans. African American households emit **twenty percent less carbon dioxide** than white households. Historically, this difference was even higher. Despite emitting less greenhouse gas, African American families are more vulnerable to shifts in the prices of fossil fuels. African Americans spend a significantly higher fraction of their expenditures on direct energy purchases than non-African Americans across every income decile. As a consequence, African Americans dedicate a much higher share of expenditures to energy purchases. Additionally, African Americans are more than twice as likely to live in poverty: the group most impacted by energy prices. Increases in the price of energy will negatively affect African Americans more significantly than the general population.

These novel findings were estimated by combining modeling of consumer expenditures on both direct energy purchases (gasoline, natural gas, electricity, etc.) and purchases of embedded energy (the energy used to produce other goods such as food or clothing), with an input-output analysis of the carbon intensity of the U.S. economy.

3) Well Crafted Energy Policies Can Protect African American Health and Employment

African Americans will be directly affected by climate policies in three basic ways:

Reduced Pollution:
First, the African American community will disproportionately benefit from climate policies that **slow climate change or reduce ancillary pollutants** such as criteria air pollutants. Reducing emissions to fifteen percent below 1990 levels would mitigate these health effects of climate change, while concomitantly decreasing air pollution related mortality, saving an estimated *10,000 African American lives per year* by 2020. The heat-related and extreme weather deaths outlined in Chapter One will be mitigated by a concerted effort to address climate change.

Energy Prices:
Second, African Americans will be disproportionately helped or harmed by the effects of climate policies on **the price of energy**. As Chapter Two rigorously documents, African Americans dedicate roughly a 25% greater share of income to energy and energy-related goods. Poorly designed climate policies will most directly harm African American families. Such policies include those that suddenly increase the price of energy but do not raise revenue and recycle it in a progressive manner, or fail to promote clean energy technologies. In contrast, properly designed energy policies can create large net benefits for African Americans. When the revenue from carbon charges is used to offset distortionary taxes, such as payroll taxes, dramatic employment benefits can be reaped across the nation. Several studies find net job creation from climate policies on the order of 800,000 to 1,400,000 jobs. Based on historic hiring patterns, this increase in employment will disproportionately profit African Americans.

Fossil Fuel Dependence:
Third, African Americans will significantly benefit from **transitioning the economy away from fossil fuel consumption**. Currently, energy prices, and oil prices in particular, have undue influence on the general state of the economy and employment. Nine of the last ten recessions have been preceded by periods of rising oil prices. During such periods of economic downturn African Americans are far more negatively affected in terms of employment and wages than other Americans, with the unemployment rate for Blacks hovering around *twice* the unemployment rates for Whites. Shifting away from fossil fuels to renewable sources will reduce this vulnerability. Moreover, renewable energy sources are significantly more labor intensive than the highly-automated fossil fuel energy sector.

Replacing coal and oil with renewable energy or energy efficiency will likely increase overall employment levels in the energy industry per unit of production.

A number of policies exist that either intentionally or unintentionally affect climate and energy use in the United States. Policies specifically considered in this report include many outlined in current and proposed energy legislation, including:

- Appliance efficiency standards,
- Exploration of the Arctic National Wildlife Refuge,
- CAFÉ standards,
- Ethanol promotion,
- An array of fossil fuel tax incentives,
- Several hydrogen energy initiatives,
- LIHEAP and Weatherization Assistance,
- Modifications to New Source Review,
- Nuclear energy promotion (in S.2095)
- Various incentives for renewable energy (e.g. S.2095),
- Renewable portfolios,
- The Climate Stewardship Act (S.139),
- Multi-Pollutant Power Plant Legislation (e.g. S. 366, S. 485, H.R. 999, S. 843)

Summary
The Congressional Black Caucus Foundation and Redefining Progress see this report as an important contribution to the energy and climate policy dialogue. Equity is a critical, and often neglected, concern for energy policy debate. We clearly document that African Americans are less responsible for, and disproportionately burdened by, the health and economic effects of climate change. African Americans are also most likely to bear the brunt of poorly structured energy policy. We are hardest hit by the impacts of climate change, and have the most to gain from the policies that promote more efficient technologies and lower overall energy costs.

The benefits of reducing carbon emissions such as lower air pollution, new jobs and reduced oil imports would help all Americans, and particularly African Americans. Policies that reduce carbon dioxide emissions can also lower emissions of other pollutants including particulates, ozone, nitrogen and sulfur oxides. These reductions would create major health benefits, particularly for urban African American communities.

While the impacts of climate change are global, the effects are not spread evenly across the world. Instead, climate change is likely to have different impacts on people of different socioeconomic and racial groups. It is important to determine the distribution of these costs and benefits in order to create fair and responsive climate policy.

African Americans, who have contributed the least to climate change and stand to gain the most from mitigation, are least able to bear the burden of poorly designed policies. African Americans would benefit most from policies that reduce energy consumption and improve energy efficiency. Because African Americans spend a larger share of income on energy purchases, policies that increase the price of energy disproportionately harm our communities if they do not recycle revenues. Conversely, policies that reduce energy consumption, such as energy efficiency standards and home weatherization programs will provide disproportionate benefits to African Americans.

We must be in the forefront of the effort to advance energy policies that address the complex array of issues and problems associated with climate change. In pursuing a comprehensive energy strategy, the most important elements include further reducing the air pollution harming our communities, decreasing America's dangerous addition to fossil fuels, and offsetting the regressive effects with fair, efficient, and equitable solutions.

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A Report Prepared for the Congressional Black Caucus Foundation

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Chapter One: The Health and Economic Impacts of Climate Change on African-Americans

Chapter Findings:

Section 1: African American Health and Climate Change
African Americans will disproportionately bear the substantial public health burden caused by climate change.

Heat Waves and Climate Change
Heat-related deaths will disproportionately come from the African American community: Due to global warming, the frequency and the intensity of heat waves are both rising. Incidents like the 2003 heat wave that struck Europe causing upwards of 20,000 deaths will only become more common.

1) Heat waves are most deadly in temperate urban areas like New York City, Detroit, Chicago, and Philadelphia, where heat-related mortality is expected to triple. African Americans are significantly more than twice as likely to live in such urban areas.
2) In addition, African Americans are more likely to live in rented dwellings, to lack access to health care or air conditioning, and to be exposed to higher levels of air pollution, all of which compound the health threats of heat waves.
3) Empirical evidence from across the U.S. (Chicago, Texas, Memphis, Tennessee, St. Louis, Kansas City, etc.) indicates that African Americans are already up to twice as likely to die during heat waves than non-African Americans.

Air Pollution and Climate Change
Air pollution disproportionately affects the health of African Americans. Climate change will exacerbate current inequities by worsening air pollution through increased temperatures and the continued burning of fossil fuels.

1) Reducing carbon dioxide emissions could save 10,000 African American lives annually by 2020, through the reduction of associated air-pollution related mortality.
2) Currently, over 70 percent of African Americans live in counties in violation of federal air pollution standards. Exposure to air pollution is largely influenced by race: In each of the 44 major metropolitan areas in the U.S., Blacks are more likely than Whites to be exposed to higher air toxics concentrations in every single one.
3) African American mothers are almost twice as likely to live in the most polluted counties in the nation than white mothers, even after controlling for education and

region. The African American *infant* mortality rate is nearly twice that of the whites.

4) African Americans are more than three times as likely to be hospitalized or to die due to asthma than Whites. Similarly, the incidence of respiratory distress syndrome and sudden infant death syndrome is roughly three times that of the general population.

Extreme Weather and Climate Change

African Americans will also be affected by the extent to which climate change alters the frequency and intensity of extreme weather events such as storms, flooding, drought, and tornadoes.

1) Currently, the number of weather related deaths in the United States is around 600 casualties per year.
2) The possibility of abrupt or catastrophic climate change explored by a recent Department of Defense study, may entail severe impacts on weather and human lives. Subsequent resource shortages may engender military conflict, with clear health ramifications particularly for African Americans.

Disease and Climate Change

African Americans will be more affected by changes in the spread of disease due to climate change for two reasons. While climate change will shift the physical range of numerous diseases such as malaria and cholera, many range increases are likely to occur in the south where the African American population is concentrated. Susceptibility to diseases is magnified by the fact that Blacks are fifty percent more likely than the general population to lack medical insurance.

Section 2: African American Employment and Climate Change

African Americans are likely to be seriously impacted by shifts in the economy resulting from climate change. Depending on the speed and severity of climate change, economic effects range from small to catastrophic.

Global Economic Damages from Climate Change

While there are many uncertainties associated with climate change, there is a consensus that the overall economic effects will be negative and possibly very large.

1) The average estimate for the damages done by climate change across the academic literature is $600 billion per year.
2) Impacts will fall most heavily on poor and developing nations that lack the resources to address the problem or adapt to it. Africa will be among the hardest hit continents, with Africans least able to adapt to the rising temperatures and shifts in rainfall patterns.

U.S. Economic Damages from Climate Change

In the United States, economic damages will occur to both market sectors and non-market sectors.

1) Market effects of climate change are likely to be concentrated in the agricultural, timber, water, energy, and coastal sectors. Specifically, agricultural production may be hurt by heat waves or flooding, water resources may be strained through overuse, and energy prices can be driven up by the increasing demand for air conditioning or irrigation.
2) Integrated Assessment models indicate that the annual cost of gradual climate change with no adaptation may be as high as 1.0 to 1.5 percent of GDP (roughly $80 to $120 billion per year). Assuming that the economy adapts to climate change, economic effects will be more limited, or potentially even positive in some regions or sectors.
3) The most significant unknown is the effect of climate change on U.S. agriculture. Slow, moderate changes may improve agricultural productivity. However, rapid or catastrophic changes could be disastrous. The National Research Council (NRC) reports that an abrupt climate change scenario could create $100 billion to $250 billion in damages from U.S. agriculture alone.
4) There are large regional disparities, regardless of the scenario. Generally, the northern states and the mid-west are the largest winners, while southern states fare most poorly.
5) African Americans may be disproportionately impacted by these changes, due to the higher fraction of incomes spent on food and energy.

Chapter One: The Health and Economic Impacts of Climate Change on African-Americans

The effects of climate change on African Americans will be wide reaching and they will be negative. This chapter provides a brief primer on the current understanding of climate change and investigates its likely effects on African Americans. In the first half of the analysis, the health effects of climate change are explored. The primary effect of changing weather patterns on health is likely to be an increase in the prevalence of heat-related deaths. Secondary health effects are expected to include increased death and illness from air pollution, changes in the range of communicable diseases, and energy-associated health problems.

The second half of the chapter focuses on predicted economic impacts of climate change. By altering weather patterns, climate change directly affects numerous sectors of the economy, such as agriculture and energy use. In addition, by harming health and habitats, climate change is likely to have non-market effects as well.

Background – An Introduction to Climate Change

It is important to clarify at the outset that climate change is no longer a theoretical possibility; it is a reality. Demonstrable changes in the Earth's atmosphere have already occurred due to the continuing buildup of greenhouse gases. Between 1750 and the turn of the millennium, the atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) – the three most important greenhouse gasses in dry air – have increased by 32%, 151%, and 17%, respectively (IPCC, 2001). Whereas for the past 420,000 years atmospheric carbon dioxide levels fluctuated within a range of 180 to 280 parts per million, the current concentration now exceeds 370 parts per million and is rising quickly (Figure 1) (Epstein, 2002).

As a consequence of this buildup, the capacity of the atmosphere to trap and retain energy as heat has steadily increased. **The Intergovernmental Panel on Climate Change (IPCC) affirms that since the 1850s, the world has warmed by roughly 0.6°C, mainly in the past thirty years, and that the pace of global warming is increasing** (Figure 2). Since 1950, the warming rate has been around 1.0°C per century, and minimum nighttime temperatures have been rising at twice that rate, or 2.0°C per century. The World Meteorological Organization (WMO) reports that the ten hottest years on Earth since the 1850s have *all* occurred since 1990, including each of the last five years (WMO, 2004). The extent of Arctic sea ice has reached a 30 year low, glaciers are retreating worldwide, and coastlines are witnessing a slow but inexorable rise in sea levels (WMO, 2004).

Figure 1: Changes in global atmospheric concentrations of three well-mixed greenhouse gases (IPCC, 2001)

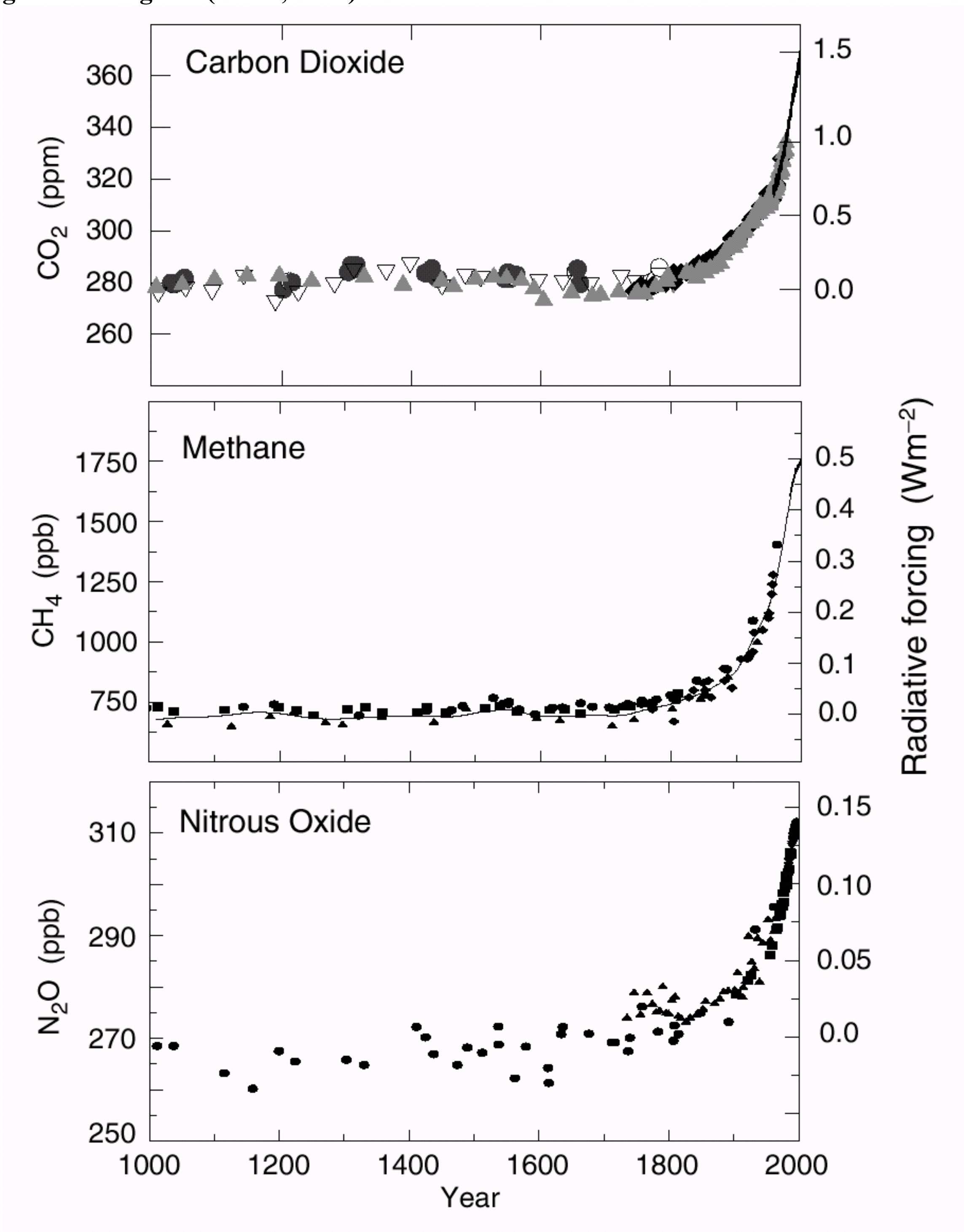
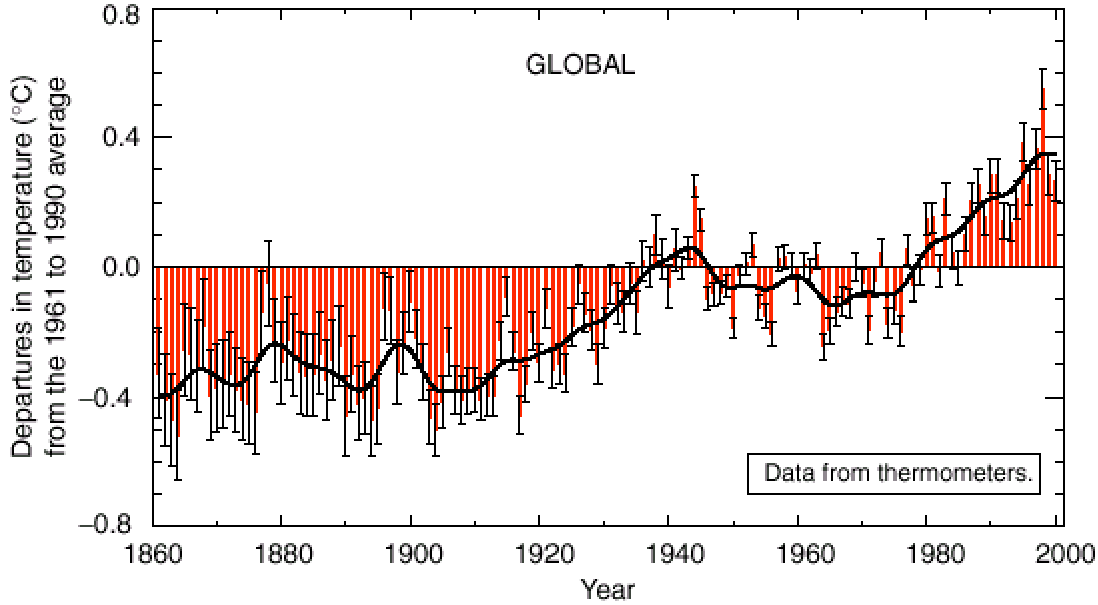


Figure 2: Variation of the Earth's Surface Temperature: 1860-2000 (IPCC, 2001)



While climate change is occurring, what remains less clear is the ways in which that change will manifest itself in a complex and dynamic system—the pace at which glaciers and sea ice will melt, the extent to which increases in cloud cover may increase or decrease the warming process, the possibility of unforeseen effects on ocean circulation. Similarly, there is considerable uncertainty with regard to the extent that these physical changes will affect the functioning of social and economic systems, and it remains unclear how society will choose to react, or not react, to the reality of climate change. Despite these uncertainties, the IPCC predicts that over the coming century, **global *average* surface temperatures will rise 1.4-5.8°C (2.5-10.4°F).** The expected rate of warming is simply without precedent over the last ten thousand years.

The unparalleled alteration of global climate will clearly have consequences for many facets of human life. Climate, as expressed through local and regional weather patterns, affects basic health and well-being, regional food and water supplies, the viability of businesses and industry. Warming of the planet, together with more drought conditions in some regions and flooding in other regions, is capable of inducing crop failures, famines, flooding and other environmental, economic and social problems (IPCC, 2001). Water shortages, forced migrations, increased air pollution and disease; regionally, all are likely results of climate change (Hansen, 2000).

While the impacts of climate change occur on a global scale, their effects will not be spread evenly over the population. Instead, climate change is likely to have differential impacts on people of different socioeconomic and racial groups. For equity reasons, one of the challenges is to predict how these costs and benefits are likely to be distributed in order to better inform policy. This chapter investigates the likely health and economic effects of climate change, and analyzes to what extent those effects are likely to disproportionately impact African-Americans.

Section One: Health and Climate Change

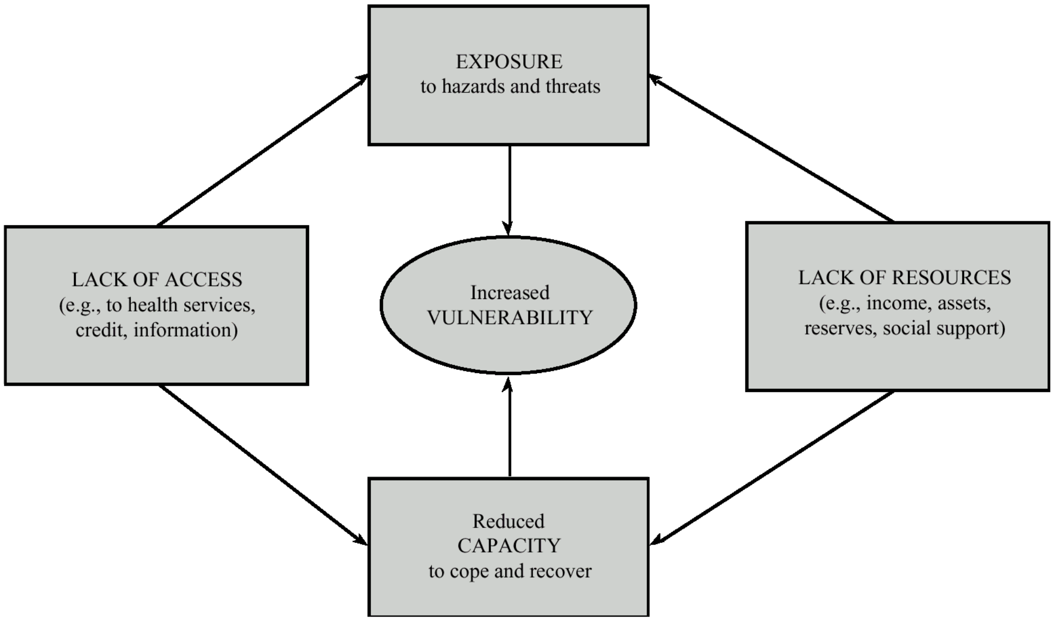
In recent years, a sizable body of epidemiologic work has addressed the likely health effects of climate change. However little work has focused on effects on African Americans in particular. The first half of this chapter focuses on the expected health effects of climate change on African Americans.

In general, impacts on health stem from a range of climate-related factors such as changes in temperatures and the frequency of heat waves, vulnerability to flooding and droughts, alterations in the frequency of regional weather patterns such as El Nino, and secondary effects including varying concentrations of air pollution, allergens, and infectious diseases (Haines and Patz, 2004; IPCC, 2001). While not all of the health effects of climate change will be detrimental, the IPCC (2001) has concluded that negative health effects are likely to outweigh positive health impacts. Current health effects of climate change are believe to claim 160,000 lives annually (Doyle, 2003).

Moreover, the positive and negative effects of climate change will not be shared equally. Climate change has been characterized as “one of the largest environmental and health equity challenges of our times (Patz and Kovats, 2002).” The wealthy are those most responsible for causing climate change through energy use and greenhouse gas emission, while those most vulnerable to detrimental effects include the poor, the elderly, the infirm, and the poor (Patz and Kovats, 2002; Bunyavanich et al., 2003). Similarly, climate effects are likely to vary between regions (Benson et al., 2000).

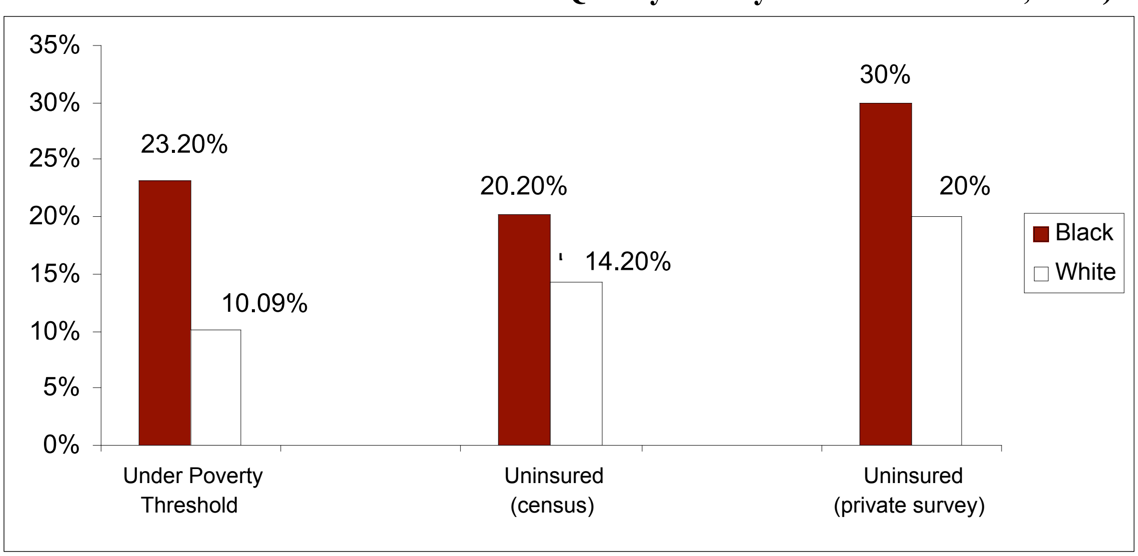
This section focuses on the health effects of climate change in the United States, particularly as they relate to African Americans. As a caveat, one of the difficulties in characterizing the effects of climate change on the health of any group is that it is impossible to foresee all future health effects, particularly because many of the anticipated scenarios represent previously unencountered environmental conditions for which it would be inappropriate to simply extrapolate current risk models (IPCC, 2001). Moreover, health is influenced by many non-environmental factors such as demographic, social, and temporal that are difficult to incorporate into models. In particular, vulnerability is influenced not only by exposure to health hazards, but also by access to resources that allow one to mitigate them, such as wealth or health insurance (Figure 3). It is important to note that, regardless of the particular threat to health, African Americans are less likely to have the **resources** necessary to properly address them: A disproportionately high percentage of African Americans live in poverty, have limited housing options, and lack adequate health care or insurance.

Figure 3: Diagrammatic illustration of vulnerability to health effects (IPCC, 2001)



For reference, between 2000 and 2002 an average of 12% of Americans lived in poverty. However, whereas only 10.1% of whites had incomes under the poverty threshold, **23.2%** of blacks lived in poverty. Partially as a consequence of this disparity, African Americans are much less likely to have access to healthful living environments or quality health care than the general population. African Americans are one and half times as likely to be uninsured as white Americans, with 20-30% of African Americans between the ages of 18 and 64 lacking any health insurance (Figure 4) (Census, 2002; Collins et al., 2002).

Figure 4: Poverty and Health Insurance Status by Race (Source: Census 2002, and *Commonwealth Fund 2001 Health Care Quality Survey from Collins et al., 2002)



This resource inequity and comparative lack of capital should be kept in mind as we explore the likely effects of climate change. Many of the detrimental effects of climate change, such as exposure to heat waves and air pollution, will only be magnified by the lack of resources to cope with the threats.

For organizational purposes, the congressionally-mandated National Assessment of Climate Change divided the potential health effects of climate change into five discrete areas: impacts stemming from temperature changes, extreme weather events, air pollution, and both waterborne and vector-borne disease (Patz et al., 2000). This review will mirror the National Assessment's structure but incorporate more up-to-date research and relate those impacts more specifically to African Americans.

Climate Change and Heat Deaths

The most obvious health effect of a warmer planet is the increasing risk of over-exposure to heat and heat-related mortality. Extreme heat events, or heat waves, are growing increasingly common. As previously noted, the hottest years in recorded history have all occurred over the past decade. While average temperatures have increased, we have also witnessed an increasing number of severe heat waves. For example, the World Meteorological Organization (2004) reports that the 2003 heat wave that struck Europe (France, Italy, the Netherlands, Portugal, Spain and the United Kingdom) caused upwards of 20,000 deaths. The IPCC predicts that both the frequency and the intensity of heat waves will continue to rise, and that the oppressive temperatures will only be exacerbated by increases in humidity (2001). Heat waves have serious implications for human health, particularly in temperate regions.

The primary cause of death during extreme heat events is a broad group of circulatory and respiratory diseases that are not typically classified by coroners as heat-related. In medical terminology, both cardiovascular disease and myocardial infarctions are most likely to cause death (Braga et al., 2002). Prolonged heat exposure is associated with heat cramps, fainting, heat exhaustion, and heatstroke. McGeehin and Mirabelli (2001) describe the varied mortality effects of heatstroke in greater detail:

> "The ability to respond to heat stress is limited by the capacity to increase the maximum cardiac output required for cutaneous blood flow…. Under extreme or chronic heat stress, the body loses the ability to maintain temperature balance and death may occur. The most common cause of death and the most acute illness directly attributable to heat is heatstroke, a condition characterized by body temperatures of 105.0°F (40.6°C) or higher and altered mental status. Other causes of death observed to increase following heat waves include heart disease, diabetes, stroke, respiratory diseases, accidents, violence, suicide, and homicide."

Because heat waves are statistically associated with deaths from this wide range of causes, heat is typically considered a "mortality correlate" rather than recorded as the direct cause of death (Davis et al., 2003). Regardless of the exact causes, the empirical evidence of the effect of heat waves on mortality is abundant (e.g., Laschewski and Jendritsky, 2002; McGeehin and Mirabelli, 2001; Kalkstein, 1992). Mortality increases when the ambient temperature swings either above or below an optimum temperature value. The Centers for Disease Control very conservatively estimate that on average there are at least 240 annual heat-related deaths in the U.S. (CDC, 1995). However, impacts can be considerably larger. For example, a 1995 heat wave is estimated to have caused over 500 heat-related deaths in Chicago alone, and two London heat waves (1995 and 1976) both resulted in a 15% increase in total mortality (IPCC, 2001).

Deaths attributable to heat waves tend to be limited to within a day of the high temperatures (Braga et al., 2001; Braga et al., 2002). These spikes in mortality due to heat waves are often followed by reduced death rates in subsequent weeks (Pattenden et al., 2003; Laschewski and Jendritsky, 2002; Braga et al., 2001; Hunyen et al., 2001). This phenomenon implies that the heat-associated mortality largely consists of people who may have died in the following weeks anyway, an effect sometimes known as "harvesting." Despite this harvesting effect, there is a high level of certainty that climate change will only increase the number of additional deaths from hot weather (IPCC, 2001). For example, a 1992 study of the fifteen largest cities in the U.S. found that climate change would increase heat-related deaths by more than 90% (Kalkstein, 1992). Kalkstein and Greene (1997) concluded that annual excess deaths in New York City are likely to increase by 500 to 1,000 by 2050.

Somewhat counter-intuitively, heat-related mortality is not generally concentrated in the hottest area. Rather, populations in cold regions tend to be those most sensitive to hot weather (Patz and Kovats, 2002). This phenomenon is due to acclimatization, or the extent to which populations learn how to cope with their environmental conditions. Weather variability, rather than the magnitude of temperature highs, can be a more important determinant of heat-mortality vulnerability (Kalkstein, 2000; Keatinge, 2003): If climate change increases temperature variability, this effect could outweigh simple mean temperature increase effects. As such, most of the U.S. climate-health models indicate that the largest increases in heat-related deaths and morbidity will occur in northeastern and midwestern U.S. cities (McGeehin and Mirabelli, 2001). Models indicate that the most vulnerable populations are those in cities with extremely high but infrequent temperature spikes such as Philadelphia, New York, Chicago, Milwaukee, and St. Louis (McGeehin and Mirabelli, 2001). West Coast cities with similarly high mortality rates include Los Angeles, San Francisco, Portland, and Seattle (Davis et al., 2003).

Distributional Impacts

Within a region, the distribution of heat-related illness and mortality is not even. Those populations most vulnerable to mortality include the very old and very young, as well as individuals who are ill or bedridden (Patz and Kovats, 2002; IPCC, 2001; McGeehin and Mirabelli, 2001). The IPCC found with high confidence that in addition to disproportionate effects on the elderly, children, and the infirm, heat-waves have stronger effects on urban populations, particularly the urban poor. McGeehin and Mirabelli of the CDC (2001) note that, "Within heat-sensitive regions, urban populations are the most vulnerable to adverse heat-related health outcomes."

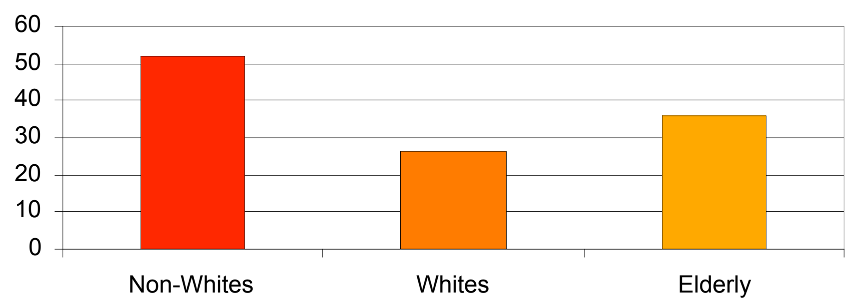
One of the main reasons that heat-related deaths tend to be concentrated in urban areas is the urban "heat island" effect. Urban areas are typically covered in surfaces such as asphalt and concrete, which retain heat. As a result, these surfaces create higher daytime and sustained overnight temperatures during heat waves. A second reason that mortality is higher in urban areas is that the same areas often have worse air quality, and elevated air pollution is often associated with heat waves (IPCC, 2001).

In addition to residing in urban environments, poverty is also an important factor in heat-related vulnerability (Patz et al., 2000). The poor are less likely to have adequate access to well-insulated housing or air-conditioning due to the combination of capital costs and utility bills (Patz and Kovats, 2002; McGeehin and Mirabelli, 2001). The National Assessment found that, "High risk subpopulations include people who live in the top floors of apartment buildings in cities and who lack access to air-conditioned environments (Patz et al., 2000)." As of 1995, only a quarter of housing units in the Northeast were furnished with air-conditioning (Census, 1997).

Unfortunately, African Americans represent a greater share of almost all of these vulnerable groups. To start, African Americans are more than *twice* as likely as whites to live in the inner city. As of January 2004, over 43% of African Americans lived in the central sections of cities. In stark contrast, less than 20% of whites lived in the same areas (Data from CPS, 2004). Moreover, the African American housing stock is likely to be relatively poor. African-Americans are twice as likely as Non-African Americans to live in rented dwellings, with over 50% of Blacks renting their homes (Data from CPS, 2004). Similarly, as previously mentioned, African Americans are nearly twice as likely to live in poverty (Census, 2002).

As a consequence of these factors and limited access to health care, it is no surprise that African-Americans are already among the most common victims of heat-waves. During the 1995 Chicago heat-wave, over 500 excess deaths occurred: Mortality rates for non-Hispanic Blacks were roughly 50% higher than mortality rates for non-Hispanic Whites (Whitman et al., 1997; McGeehin and Mirabelli, 2001). Similarly, Kalkstein (1992) found that African Americans in St. Louis were twice as likely to die in a heat wave (Figure 5). The vulnerability of African Americans in Chicago and St. Louis is by no means unique. Similar results have emerged in several other areas that studies have been conducted including Texas, Memphis, Tennessee, and Kansas City (McGeehin and Mirabelli, 2001).

Figure 5 - Percent Increase In Deaths due to St. Louis Heat Wave (Kalkstein, 1992)



With respect to climate change, the elevated number of heat deaths is likely to continue to fall most heavily on African Americans. For example, Kalkstein and Green (1997) modeled the climate-mortality relationship in the 44 largest metropolitan areas in the United States. Their efforts indicated that for the years 2020 and 2050, summer mortality will increase "dramatically." The most precipitous declines in health are expected from cities in the East and Midwest. Estimated mortality increases in 2050 ranged from 70% to over 100%. With respect to race, nearly two-thirds of all African Americans currently live in those 44 large metropolitan areas (Data from CPS, 2004). Moreover, Kalkstein and Green indicate that summer mortality in New York City, Philadelphia, Chicago, Detroit, and Minneapolis is likely to triple: African Americans are three times as likely as non-African Americans to be residents of those cities (Data from CPS, 2004).

As a caveat, it should be noted that several empirical studies have not documented a link between race and mortality. For example, Davis et al. (2003) found no physiological disposition to heat vulnerability based on race in multiple U.S. cities over the past four decades. Similarly, Braga et al. (2002) analyzed eight years of mortality due to hot and cold events in 12 U.S. cities, and found that race did not modify the effect of either cold or heat waves. However, the log-linear regression model employed in these studies estimate the temperature effects as a relative or percentage change in *each* city. In cities with higher baseline mortality rates, a greater absolute effect is implicit. As a consequence, Braga et al. (2002) comment that, "This makes the failure to find interactions with direct or indirect markers of baseline risk understandable and the association with the temperature variances more impressive." Where more detailed analyses have been employed, there is generally a significant connection between race and mortality. O'Neill et al. (2003) examined mortality data from six northern U.S. cities (Denver, Detroit, Minneapolis, New Haven, Pittsburgh, Chicago, and Seattle) by race, income, and other factors. The study found that the elevated chance of dying during a heat episode (29°C) in any of the aforementioned cities is twice as large for Blacks as for Whites.

Clearly, climate change will cause additional heat-deaths, and those deaths are likely to disproportionately come from the African American community. Two factors that may offset this mortality to some extent are acclimatization and reduced winter deaths from cold weather. Each is addressed below.

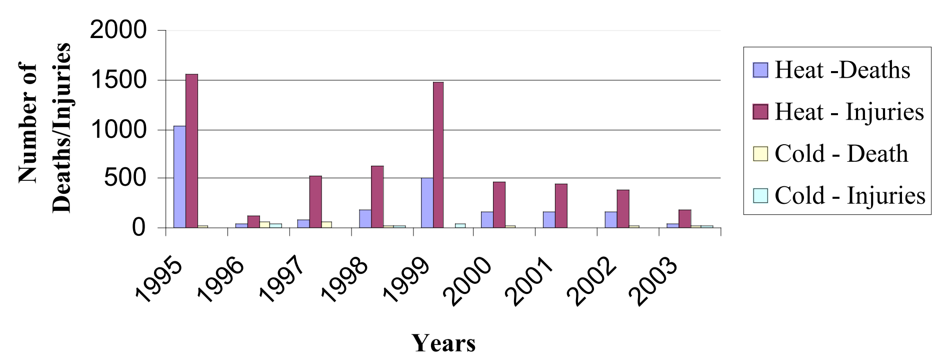
Acclimatization

One of the most important factors in modeling future mortality from climate change is estimating the extent to which populations will acclimatize to warmer weather through behavioral or technological adaptation (IPCC, 2001). It should be noted that adaptation is already occurring (Donaldson et al., 2003; Davis et al., 2003). Davis et al. (2002; 2003) studied mortality rates due to heat waves in several U.S. metropolitan areas over the past four decades. The authors found that whereas mortality rates in southern cities remained relatively constant, northern metropolitan areas have seen decreasing mortality rates during periods of high apparent temperatures over the past few decades. This trend applies to almost all cities north of D.C. and east of Chicago, and appears to be a much broader phenomenon (Donaldson et al., 2003; Davis et al., 2003). Davis et al. (2002) surmise that, "These statistically significant reductions in hot-weather mortality rates suggest that the populace in cities that were weather-sensitive in the 1960s and 1970s have become less impacted by extreme conditions over time because of improved medical care, increased access to air conditioning, and biophysical and infrastructural adaptations." This reduction in mortality casts some doubt on other findings that overall heat related mortality would increase in the United States with climate change (Davis et al., 2003). National excess mortality rates on hot, humid days dropped from 53 per million in the 60s and 70s, to 15 per million in the 90s (Davis et al., 2003). However, it remains likely that mortality will increase *relative* to the declining mortality baseline. The IPCC notes that, "Recent modeling of heat wave impacts in U.S. urban populations, allowing for acclimatization, suggests that several U.S. cities would experience, on average, several hundred extra deaths per summer." Moreover, the increasing reliance on adaptation (e.g., health care and air-conditioning) is likely to create a larger disparity between mortality of the rich and poor.

Reduced Cold Deaths

One positive health effect of climate change is that it will reduce the severity of winter in many regions. In general, more people die during winter than in summer. However, the causes of winter deaths are more varied and difficult to model. Braga et al. (2002) note that, "Although cold temperatures show greater effects than do hot temperatures, other factors such as respiratory epidemics, usually present during the winter, make unclear the precise role of temperature on increased morbidity and mortality." Major causes of winter death, such as influenza, pneumonia and accidents are not clearly connected to temperature, such that warming may not lessen the seasonal contribution to mortality and morbidity. Moreover, cold as a direct cause of death is smaller in the U.S. than heat-related mortality (Figure 6).

Figure 6 - Heat and Cold Deaths in the U.S (NWS, 2004)

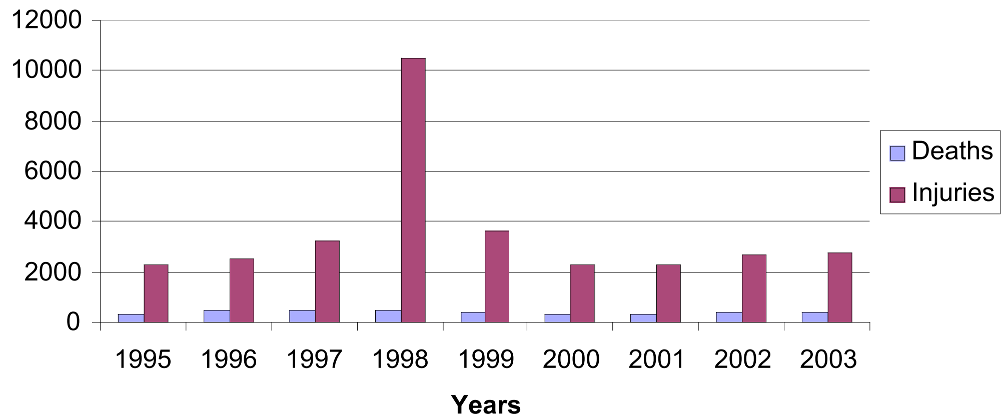


A few studies, particularly European studies, have indicated that reductions in winter mortality due to climate change may be greater than increases in summer mortality (IPCC, 2001). In contrast, several other models have concluded that reductions in cold-related deaths are unlikely to compensate for increased heat-deaths. For example, modeling by Kalkstein and Green (1997) indicates that increases in heat-related mortality in the United States are likely to outweigh reductions in winter mortality by a factor of three. In reviewing this issue, the IPCC noted that uncertainty remains but concluded that it is likely that the increase in heat related deaths will be the greater effect. Moreover, it is unclear to what extent reductions in cold-related deaths will come from the African American community. More research needs to be devoted to the environmental justice aspects of this question.

Climate Change and the Health Effects of Extreme Weather Events

In addition to hotter temperatures, models of future climate change predict potential changes in the frequency and intensity of extreme weather events such as floods, hurricanes, and tornados (Patz et al., 2000). Climate change has the capacity to alter the frequency of such occurrences by changing land and ocean temperatures, ocean circulation, and regional weather patterns, such as El Nino and the North Atlantic Oscillation. Climate anomalies are already occurring (Figure 8). Extreme weather is commonly associated with loss of property and life. Currently, the National Weather Service estimates that from 1991-2000, an average of 600 Americans were directly killed each year during severe weather events (NWS, 2000). In addition to fatalities, numerous injuries and economic losses are also associated with these events (Figure 7).

Figure 7 - Deaths and injuries due to extreme weather events in the U.S. (NWS, 2004)



However, it is important to note that there is considerable uncertainty regarding the effects of climate change on extreme weather events. Regional climate change is likely to increase and decrease the prevalence of extreme weather events in different areas. It is extremely difficult to predict future changes in weather, as opposed to climate.

Most reviews ascribe a high likelihood to the possibility that there will be an increase in the prevalence of extreme precipitation events and flooding due to climate change (IPCC, 2001). Specific to North America, the IPCC (2001) notes that, “There is some evidence of increases in the intensity or frequency of some extreme events at regional scales throughout the 20th century. Frequencies of heavy precipitation events have been increasing in the United States and southern Canada.” Regional flood risks may increase as a result of these high precipitation events. Increases in flooding are likely to cause significant hardship, as flash floods are among the most lethal natural disasters in the United States, averaging around eighty victims per year (Greenough et al., 2001). Seven to ten percent of housing units in the U.S. are located on 100-year floodplains, which may be vulnerable to increased flood risks (Miller et al., 2000).

In addition to strong storms, climate change appears to be increasing the frequency and strength of El Nino events, in which the temperature of waters in the Southern Pacific affects much larger weather patterns and processes. For example, the 1997-1998 El Nino was associated with forest fires in several parts of the world, and significantly reduced air quality and increased respiratory problems in Florida and Texas (Greenough et al., 2001; Haines and Patz, 2004). Haines et al. (2000) note that any assessment of future health outcomes is complicated by the fact that many of the climatic conditions have not previously been encountered.

Likely effects on the prevalence of droughts are even harder to predict than changes in flooding (IPCC, 2001). The United States is currently undergoing widespread drought. According to the WMO (2004), by the end of 2003, moderate to extreme drought and depleted reservoirs affected 37 percent of the continental United States, in several areas for the fourth or fifth year in a row. Droughts that occur in poor regions have traditionally been associated with crop failure, malnutrition and starvation. In the United States, the main health effect of drought is likely to be the heightened potential for fires, and associated direct and respiratory health impacts.

The overall effect of climate change on the frequency and intensity of tornadoes, ice storms, and hurricanes in the United States remains unclear. The National Assessment (2001) concluded that, "Whether these changes in climate risk will result in increased health impacts cannot currently be assessed."

The majority of the research in the literature focuses on gradual climate change. However, a recent report by the National Research Council and a second report commissioned by the U.S. Defense Department have both raised the specter of abrupt climate change, which would entail unknown but wide-reaching implications for national health (NRC, 2002; Schwartz and Randall, 2003). Such dramatic climate change scenarios, generally involving a slowdown of the ocean's thermohaline circulation[1] or a sudden collapse of the West Antarctic ice sheet, have a much higher chance of being catastrophic.

The Defense Department scenario summarizes that abrupt climate change could involve, "Harsher winter weather conditions, sharply reduced soil moisture, and more intense winds in certain regions that currently provide a significant fraction of the world's food production. With inadequate preparation, the result could be a significant drop in the human carrying capacity of the Earth's environment. The research suggests that once temperature rises above some threshold, adverse weather conditions could develop relatively abruptly, with persistent changes in the atmospheric circulation causing drops in some regions of 5-10 degrees Fahrenheit in a single decade (Schwartz and Randall,

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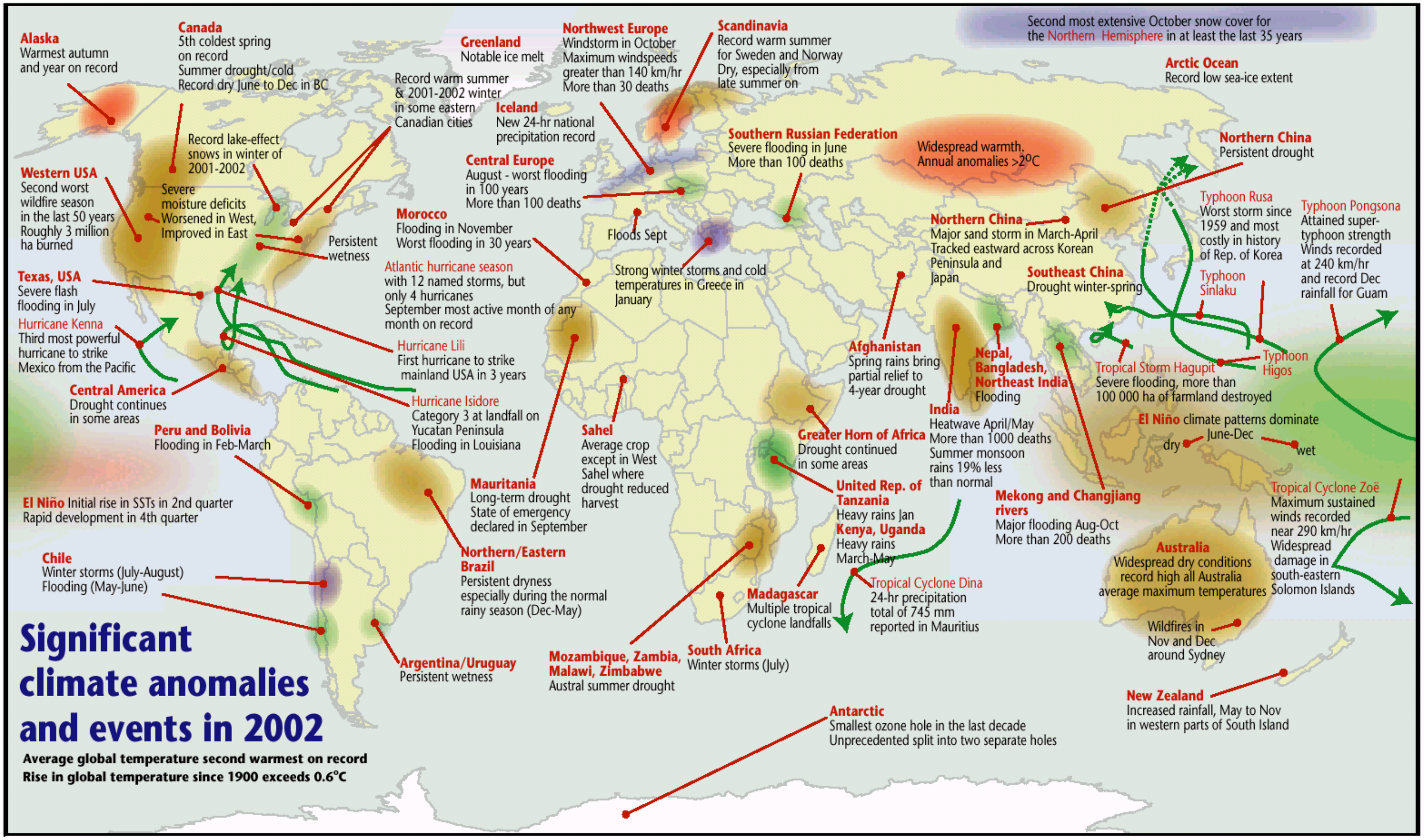
[1] The thermohaline circulation has been called the ocean circulation "conveyor belt." Heavy, cold water sinks in the North Atlantic, driving a long slow process of currents responsible for many of the oceans currents. Were the thermohaline circulation to slow or stop, due to precipitation or ice melting in the north that reduced the density of the North Atlantic waters, the current pattern of ocean currents would be strongly disrupted. Ironically, one possible result of this scenario is severe *cooling* in Europe and North America.

2003).” As a consequence of these changes in the earth’s carrying capacity, the Defense Department scenario explores how abrupt climate change could destabilize the political environment, generating conflict over food and water shortages, or disrupted access to energy supplies. Clearly, the health effects of such a scenario would be enormous, particularly for African Americans who are both more vulnerable to resource shortages and more likely to serve in the U.S. military, comprising roughly 22% of enlisted men in the Department of Defense (DoD, 2000a). One political theorist recently commented that, “As the organizations principally responsible for national security, and commanding a large share of public resources for that purpose, the world ’s militaries will increasingly have to manage the challenges of climate change (Barnett, 2003).”[2]

With respect to gradual climate change scenarios, little work has been done quantifying the health effects of climate-induced changes in extreme weather events on communities of color in the U.S. Relevant considerations for future study would include the percentage of African Americans with health insurance or living in vulnerable regions (floodplains, tornado alley, etc.). Economic losses will presumably be affected by the prevalence of homeowners or renters insurance.

[2] It is an interesting tangent to note that militaries are also major emitters of greenhouse gases. Of all the U.S. agencies, the military has been among the most responsive to concerns over climate change. Apparently the U.S. Department of Defense reduced greenhouse gas emissions by twenty percent between 1990 and 1996 (DoD, 2000b: Cited in Barnett, 2003).

Figure 8 – Climate Anomalies in 2002 (WMO, 2004)



Climate Change and Health Effects from Air Pollution

Climate change is likely to exacerbate the negative health effects of air pollution effects on Americans, and African Americans in particular, for both direct and indirect reasons (Figure 9). With respect to direct reasons, climate change can alter local and regional weather patterns, including temperature and wind patterns, which influence the formation and transport of pollutants. Smog, which causes a variety of respiratory ailments, is created by the combination of air pollutants and light and heat from the sun. The higher temperatures resulting from global warming will further drive the chemical reactions that increase the concentration of hazardous air pollutants in urban areas.

Indirectly, climate change is associated with detrimental health effects from air pollution on at least two levels. First, climate change can indirectly contribute to air pollution by encouraging increased energy use during heat waves (e.g. air conditioning in urban areas), or by increasing natural sources of air pollution such as ash or pollen. Second, climate change and urban air pollution share a common cause: the combustion of fossil fuels. As such, many policies that attempt to mitigate climate change are also likely to reduce the health effects of air pollution.

Figure 9 – Effects of Climate Change on Air Pollution (Source: Bernard et al., 2002)

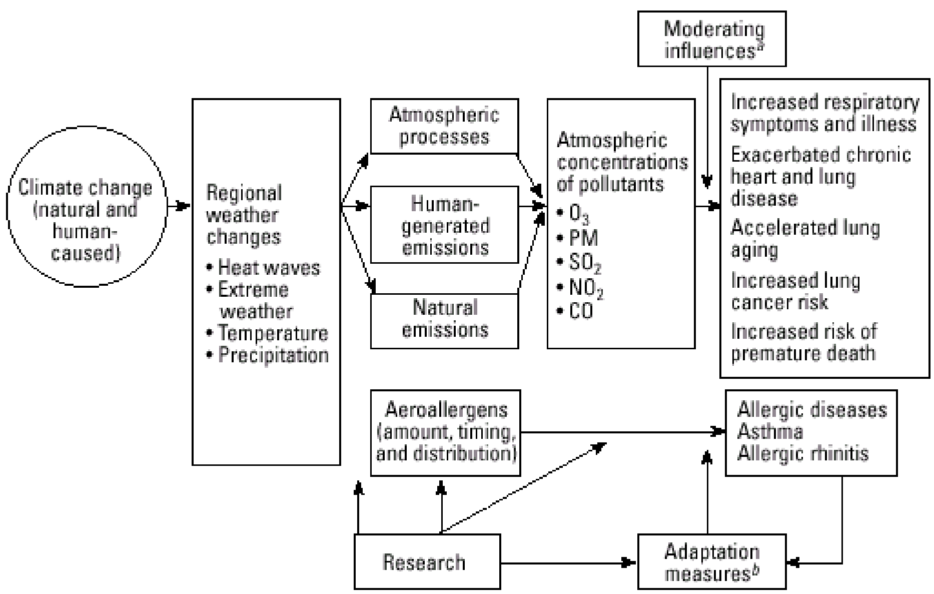


Figure 1. Potential air pollution-related health effects of climate change. [a]Moderating influences include nonclimate factors that affect climate-related health outcomes, such as population growth and demographic change, standards of living, access to health care, improvements in health care, and public health infrastructure. [b]Adaptation measures include actions to reduce risks of adverse health outcomes, such as emission control programs, use of weather forecasts to predict air quality levels, development of air quality advisory systems, and public education.

With respect to the environmental justice, a large body of scientific literature indicates that African Americans are at substantially greater risk to air pollution than the general public. Increases in morbidity and mortality from climate change related air pollution are likely to continue to fall most heavily on the African American community.

1.3.1: Direct Increases in Air Pollution due to Climate Change

The Effects of Ozone (Smog)

The IPCC (2001) predicts with medium to high confidence that climate change is likely to trigger the deterioration of air quality in vulnerable urban areas. Of the few studies that have attempted to quantify air quality effects of climate change, most have focused on concentrations of trophospheric ozone, commonly known as smog (Bernard et al., 2002). Ozone (O_3) is a naturally occurring gas formed through the photochemical interaction of nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Due to the presence of anthropogenic sources of NO_x and VOCs, ozone is often found at much higher concentrations in polluted areas.

Ozone pollution is associated with numerous negative effects including reduced agricultural productivity and respiratory problems, particularly in asthmatics. Epidemiologic studies clearly indicate that increases in ground-level ozone are linked to acute asthma attacks (Peden, 2002). Similarly, ozone can contribute to onset of asthma in children, and cause respiratory impairment even in health individuals (Patz and Kovats, 2002). In the long-term, ozone exposure can increase the frequency of asthmatic attacks, and permanently damage airways and lungs. Bernard et al. (2002) summarize that:

> "Time-series studies also indicate that O_3 may be a more general cause of morbidity and mortality. Numerous time-series studies have reported that increased O_3 (and other pollutants) are associated with increased daily mortality counts. Total mortality counts are associated with O_3 levels, as are some cause-specific categories, including cardiac causes. Studies of hospitalization also show associations of O_3 concentrations with cardiac and respiratory admissions, even after taking other pollutants into consideration."

Global Warming and Ozone

Most studies indicate that climate change is likely to increase concentrations of ground-level ozone, though to an uncertain degree (Bernard et al., 2002; Patz et al., 2000). Air quality models generally indicate that reductions in stratospheric ozone and increased temperatures are likely to increase the concentrations of this pollutant. The models predict that tropospheric ozone concentrations will increase in polluted environments with increasing temperature. Increases in atmospheric temperatures accelerate the photochemical reaction rates through which tropospheric O_3 is produced (Bernard et al., 2002). Moreover, higher temperatures also reduce the formation of peroxyacetylnitrate (PAN), an important sink for NO_x (and thus ozone formation) (Sillman and Samson, 1995; Jacob et al., 1993). There is speculation that an increase in the number of hot days could also increase natural and human emissions of VOCs and NO_x, for example increased emissions from fuel-injected automobiles, or the heightened release of hydrocarbons and NO_x from forests, shrubs, grasslands, and microbes (IPCC, 2001; Bernard et al., 2002).

Numerically incorporating some of these effects, Morris et al. (1995) used a three-dimensional air quality model to study the effects of climate change on trophospheric ozone. The authors found that a 4°C increase in temperature created changes in peak ozone concentrations ranging from –2.4% to 20%. Reportedly, "The number of exceedences of National Ambient Air Quality Standards for O_3 concentrations was estimated to increase by **1 to 2 times** over the number of exceedences in the base case (i.e., no future temperature change scenario) (Bernard et al., 2002)."

There is considerable empirical support for these findings. A strong positive relationship between tropospheric ozone and temperatures above 32°C already exists in several U.S. cities (Figure 10) (Patz and Kovats, 2002). Empirical research has documented that air-pollution has a small but consistent confounding effect on mortality from heat stress, even in relatively unpolluted cities (Rainham and Smoyer-Tomic, 2003; Bernard et al., 2002, Piver et al., 1999). These findings support previous work tentatively documenting the temperature dependence of mortality effects from air pollution (Katsouyanni et al., 1993).

Figure 10 – Tropospheric Ozone and Temperature in New York and Atlanta (Source: Bernard et al., 2002)

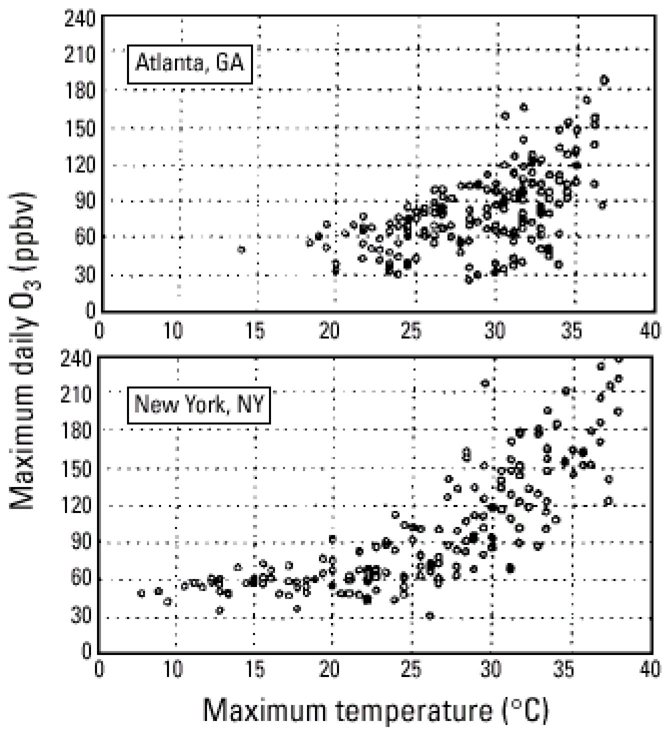


Figure 3. Maximum daily O_3 concentrations in Atlanta, Georgia, and New York, New York, versus maximum daily temperature, May–October, 1988–1990. ppbv, parts per billion volume. Data from U.S. EPA (*13*).

Global Warming and Allergens

A growing body of literature also suggests that global warming will increase the abundance of certain allergens such as ragweed. Ragweed is the primary cause of allergies during the autumn, affecting roughly 10% of the U.S. population. In general, allergies affect more than 50 million people in the U.S. alone, costing around 18 billion per year (Wan et al., 2002).

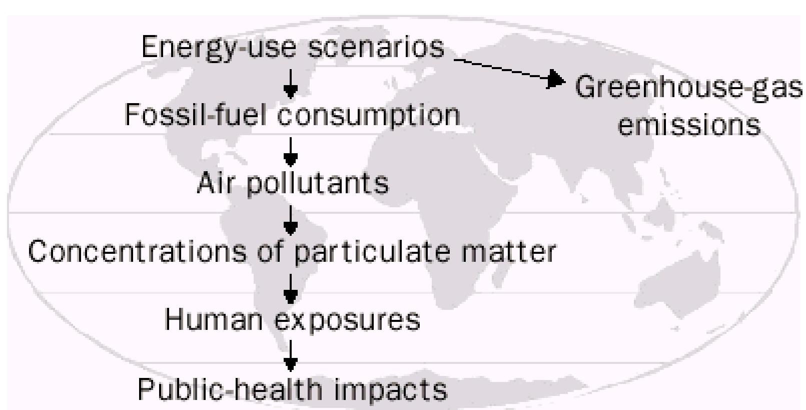
Controlled experiments indicate that doubling atmospheric CO2 increased ragweed pollen production by over 60% (Wayne et al., 2002). Other plants are also likely to increase pollen production. A recent metastudy of 110 research efforts indicated that elevated CO2 results in the production of roughly 20% more flowers than growth at ambient CO2 (Jablonski et al., 2002). Similarly, experimental warming increases ragweed production, resulting in higher ragweed pollen burdens (Wan et al., 2002). The combination of higher CO2 and higher temperatures associated with climate change may cause significant increases in exposure to allergenic pollen (Wayne et al., 2002).

In addition, it is interesting to note that temperatures and carbon dioxide concentrations are often higher in urban areas than in rural areas. As a consequence, in situ observations indicate that ragweed grows faster and produces significantly greater amounts of pollen in urban locations (Ziska et al., 2003). Those living in urban areas are already exposed to higher levels of particulate air pollution. The combination of these factors may act synergistically to increase the incidence of asthma in urban areas, a rate which has already been on a dramatic rise over the past few decades (see Section 1.3.3)

1.3.2: Indirect Increases in Air Pollution due to Climate Change

In addition to the likely detrimental effects of ozone, climate change is likely to change the nature of pollution emissions. For example, some adaptive responses to climate change will involve increased fossil fuel use. For example, the National Assessment noted that "if warmer temperatures lead to more air-conditioning use, power plant emissions could increase without additional air pollution controls (Patz et al., 2000)." In addition, climate change may affect natural sources of air pollution, such as the distribution and types of airborne allergens (Bernard et al., 2002). The IPCC (2001) also speculates that climate change may affect concentrations of radon or particulates from forest fires, thereby increasing morbidity and mortality.

Figure 11 – Energy Use and Air Pollution Impacts (Source: Davis et al., 1997)

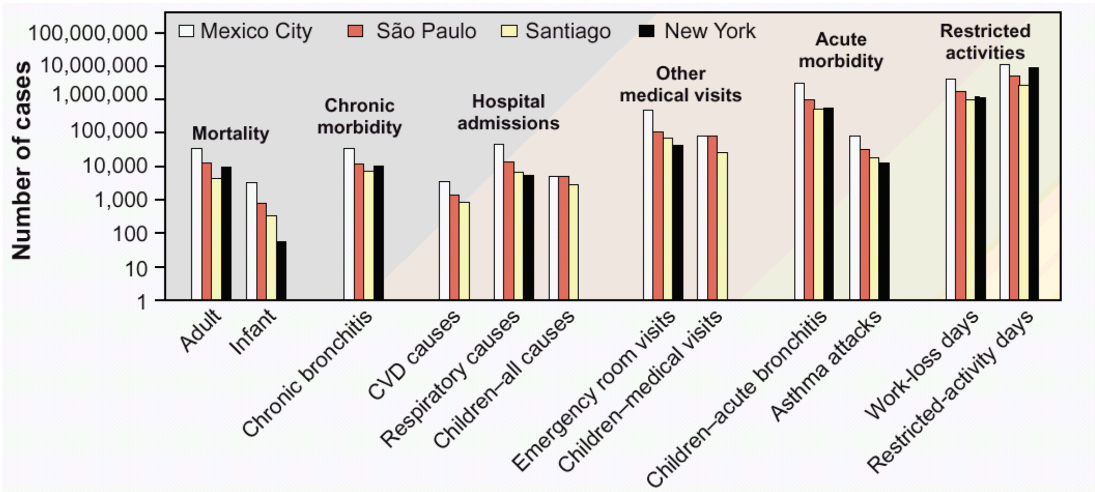


In addition, the large-scale energy production and use that drive climate change also have serious effects on human health (Figure 11). Unlike the benefits of energy use, which tend to be reaped exclusively by those who have purchased the energy, the negative effects of energy use are generally spread across local, regional, and global scales. As previously discussed, the most obvious detrimental effect of fossil fuel combustion is air pollution, which can have dramatic implications not only for human health but also for ecosystem health (Figure 12 and Figure 13). Air pollution is a major problem in the United States. As of September 2002, roughly 126 million Americans lived in 124 non-attainment areas for at least one criteria pollutant (EPA, 2003). As such, strategies aimed at mitigating climate change can include large concomitant health benefits. In contrast, strategies intended to mitigate climate change by reducing carbon dioxide emissions (i.e. energy efficiency, CAFÉ standards, or renewable energy) are likely to reduce the concentration of other criteria air pollutants such as ozone and particulate matter.

A 1997 study by a Working Group assembled by the EPA and others found that the ancillary health benefits of implementing a climate change strategy could be enormous. In the United States, the effect of decreasing particulate matter and other pollutants associated with reducing CO_2 emissions to under Kyoto targets are likely to be significant. The energy-policy-health model created indicated that, "In the USA, by the year 2020, at least **33,000 deaths a year** could be avoided from implementation of the climate-policy scenario. This projected number of avoidable deaths in the USA is of the same order of magnitude as currently occurs as a result of several major causes of death from illnesses, each of which is subject to major public-policy interventions, including human immunodeficiency and chronic liver diseases (Davis et al., 1997)." Given the disproportionate effects of air pollution and heat deaths on African Americans (typically 2-3 times the general population), it is likely that close to 10,000 of those avoided deaths would come from the African American community. Global benefits of such an effort were estimated to be closer to 700,000 avoided deaths.

A second detailed study indicates that reducing emissions from older coal-fired power plants in the United States would save over 18,000 lives, three million lost work days, and 16 million restricted-activity days annually (Schneider et al., 2000). Similarly, reducing emissions from just *nine* older coal plants near Chicago would avoid an estimated 300 deaths, 2000 emergency room visits, 10,000 asthma attacks, and 400,000 days of respiratory symptoms annually (Levy and Spengler, 2001; Cifuentes et al., 2001). Cifuentes et al. (2001) examined the ancillary health benefits of pursuing a climate policy (Figure 12). They found that in New York alone, thousands of lives and millions of lost work-days could be avoided.

Figure 12 – Health Benefits from a GHG Strategy (Cifuentes et al., 2001)



Potential human health benefits from reductions in ozone and particulate matter air pollution associated with implementing GHG mitigation measures (2001–2020) (*18*). CVD, cardiovascular disease.

In order to capitalize on these immediate co-benefits, over 140 municipalities in the U.S. and over 560 worldwide have already set greenhouse gas targets in concert with local action plans. Many of these local actions have been spurred by the recognition of the substantial co-benefits and cost savings associated with emissions reductions (Kousky and Schneider, 2003). On a national or international scale, the co-benefits of climate action are likely to be even larger.

Figure 13 – Health Effects of Power Plant Pollutants (Adapted from Keating and Davis, 2002)

Pollutant	What is it?	How is it Produced?	Health Effects	Most Vulnerable Populations
Ozone (O_3)	Ozone is a highly corrosive, invisible gas.	Ozone is formed when NO_x reacts with other pollutants in the presence of sunlight.	Rapid shallow breathing, airway irritation, coughing, wheezing, shortness of breath. Makes asthma worse. May be related to premature birth and low birth weight.	Children, the elderly, people with asthma or other respiratory disease. People who exercise outdoors.
Sulfur Dioxide (SO_2)	SO_2 is a highly corrosive, invisible gas that is formed in the gases when coal is burned. Sulfur occurs naturally in coal.	SO_2 is formed in the gases when coal is burned. SO_2 reacts in the air to form sulfuric acid and sulfates. Together with NO_x, it forms acidic particles.	Coughing, wheezing, shortness of breath, nasal congestion and inflammation. Makes asthma worse. SO_2 gases can de-stabilize heart rhythms. Low birth weight, increased risk of infant death.	Children and adults with asthma or other respiratory disease.
Particulate Matter (PM)	A mixture of small solid particles (soot) and tiny acidic particles.	Formed by SO_2 and NO_x in the atmosphere.	PM is inhaled deep into the lungs, affecting respiratory and cardio-vascular systems. Linked to low birth weight and premature birth, and sudden infant death.	The elderly, children, people with asthma. African American children may be especially susceptible.
Nitrogen Oxide (NO_x)	A family of chemical compounds including nitrogen oxide and nitrogen dioxide.	NO_x is formed when coal is burned. In the atmosphere can convert to nitrates and form fine acidic particles. Reacts in the presence of sunlight to form ozone smog.	NO_x changes lung function, increases respiratory disease in children. Helps form ozone and acidic PM particles which are linked to respiratory and cardio vascular disease, low birth weight and premature birth.	The elderly, children, and people with asthma.
Mercury (Hg)	A metal that occurs naturally in coal.	Mercury is released when coal is combusted.	Developmental effects in babies that are born to mothers who ate contaminated fish while pregnant. Poor performance on tests of the nervous system and learning. In adults may affect blood pressure regulation and heart rate.	Fetuses and children are directly at risk. Pregnant women and women of child bearing age need to avoid mercury exposure.

1.3.3: Air Pollution and African Americans

A growing body of work indicates that African Americans are significantly more likely to live and work in locations where they are exposed to higher levels of pollution than the general public. As a result of this disproportionate exposure, African Americans disproportionately suffer the consequences of air pollution, including asthma and respiratory problems.

Disproportionate Exposures

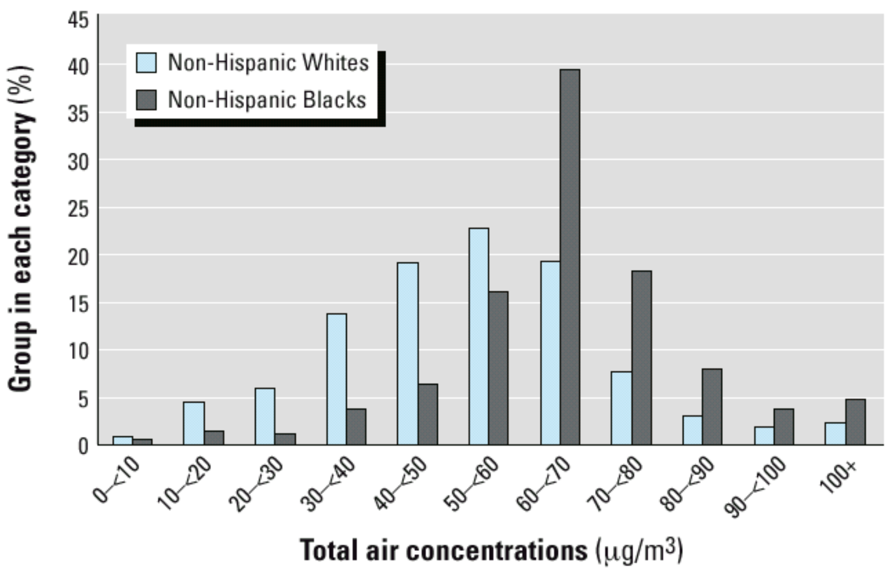
As with heat-deaths, the negative effects of air pollution already fall most heavily on African Americans. Air pollution and subsequent health effects such as asthma represents one of the most significant environmental equity issues facing the United States today (Northridge et al., 2003). Over the past few decades, a spate of work has focused on the topic of environmental justice, with air pollution receiving considerable attention because of the larger concentration of minorities and low-income residents living in areas with unhealthful air quality (Samet and White, 2004). The reasons for this disparity are both socioeconomic and racial: African Americans are more likely to live in urban areas, are more likely to be poor, are more likely to be discriminated against, and are more likely to lack access to resources to resist the siting of power plants in their neighborhoods. The evidence that African Americans are already exposed to worse air quality is sound. A review of the recent literature indicates that:

- In 2002, an estimated 71 percent of African Americans lived in counties in violation of federal air pollution standards, as compared to 58 percent of the white population (Keating and Davis, 2002).

- 78 percent of African Americans are located within 30 miles of a coal-fired power plant, where the environmental and health impacts of the smokestack plumes are most acute, as compared to 56 percent of whites. Similarly, African Americans comprise nearly a sixth of the people living within five miles of a power plant waste site, whereas they comprise 12.3 percent of the total U.S. population (Keating and Davis, 2002).

- Even within areas violating federal air quality standards, African Americans are more likely to be exposed to worse air quality. Lopez (2002) examined 1990 Census data from the 44 largest U.S. metropolitan areas. In *every* single area, Blacks were significantly more likely than Whites to live in tracts with higher air toxics concentrations (e.g., Figure 14). In general, metropolitan areas in the Midwest and East—the cities also expected to have the highest increase in heat deaths from climate change—had the worst inequality.

Figure 14 – Exposure to air toxics in the Los Angeles metropolitan area (1990) by race (Figure from Lopez, 2002). Note: Los Angeles represented an average city. Many cities had significantly more skewed exposures.



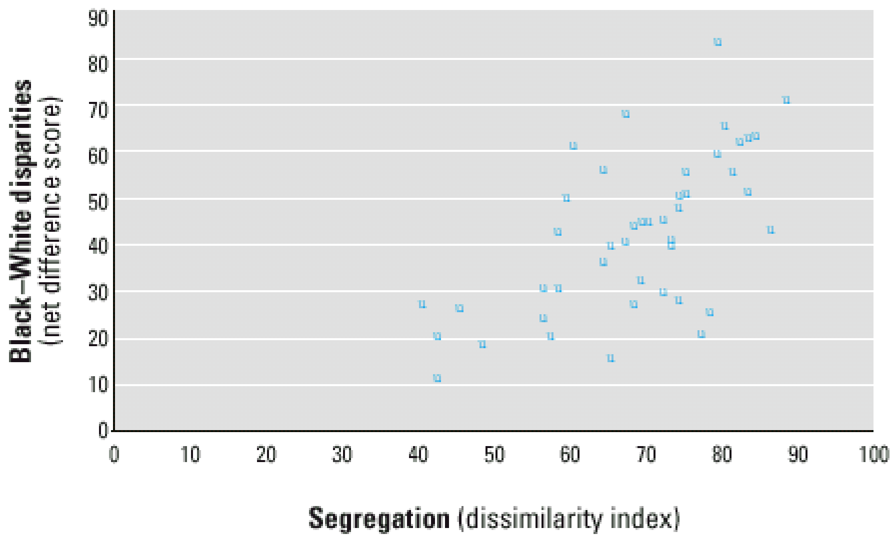
- African American mothers are exposed to higher levels of air pollution than white mothers, and are almost twice as likely to live in the most polluted counties in the nation, even after controlling for education and region (Woodruff et al., 2003).

- Numerous studies have investigated exposure to air toxics in more specific regions. Perlin et al. (1999) investigated the sociodemographic characteristics of people living near Toxic Release Inventory (TRI) facilities in three areas of the United States. The authors found that in all three areas, a larger percentage of blacks compares to whites live in near proximity to the facilities.

- African Americans are often more vulnerable to these effects due to pre-existing illness. For example, multiple studies have indicated that people suffering from diabetes are more vulnerable to the deleterious effects of air pollution. In the United States, diabetes is significantly more common among African Americans and urban residents than among the general population (O'Neill et al., 2003a).

Due to the variety of study methods, there has been some debate in the literature about the extent to which race and income play a role. Many studies that focus on a very small area, e.g. comparing limited areas that contain hazardous waste facilities against areas that lack them, often find that race is not a significant factor. In larger-area studies that include adjacent areas, race and ethnicity are found to be more important. For example, Lopez (2002) found that the degree to which metropolitan areas are segregated is a relatively strong predictor of the degree to which African Americans suffer higher exposure to air toxics (Figure 15).

Figure 15 – Segregation and air toxics exposure: Black-White differences in air toxics exposure for major U.S. metropolitan areas in 1990. Source: Lopez, 2002.



Even within a community, mortality can be associated with air pollution and income levels (Finkelstein et al., 2003). For example, nonwhites in New York City face significantly elevated concentrations of ozone and PM_{10} when compared to whites (Gwynn and Thurston, 2001). While in New York City, differences in the relative risk of exposure to criteria pollutants appear to be most closely linked to factors such as poverty and insurance status (Gwynn and Thurston, 2001), these factors are also racially influenced.

Disproportionate Impacts

Partially as a consequence of higher exposures to air pollution, there is a higher incidence of related health problems in the African American community. The most commonly discussed health problem stemming in part from energy-related pollution is asthma, but other effects include general mortality, sudden infant death syndrome, and mercury exposure.

Asthma[3]

Asthma is a growing and serious health problem in the United States. Asthma is a type of allergic respiratory disease often characterized by constriction of the airways and limited breathing ability (Donaldson et al., 2000). According to the CDC, between 1980 and 1996, the number of individuals in the U.S. self-reporting asthma grew nearly **75 percent** (Mannino et al., 2002). In the period from 1992 to 1999 the rate of emergency department visits for asthma increased by almost a third. As of 1997, 22.7 million people (nearly a tenth of the population) reported having a physician diagnosis of asthma during their lifetime, and 11.1 million people (4.1% of the population) had an attack within the past year. The national economic costs of this epidemic are significant. Asthma accounts for 10 million lost school days, 1.2 million emergency room visits,

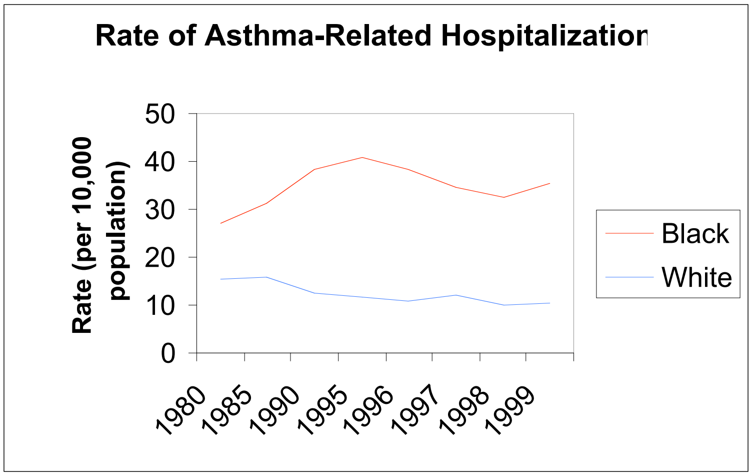
[3] "Asthma is a complex respiratory condition operationally defined as a respiratory disease with three primary features. These include 1) airway inflamation associated with cytokine formation, eosinophilic infiltration, and altered T-cell lymphocytic function b) altered epithelial function associated with thickening of the basement membrane… and c) recurrent airflow obstruction often presenting in acute phases as decreased forced expiratory volume and reversible bronchospasm (Leikauf, 2002)."

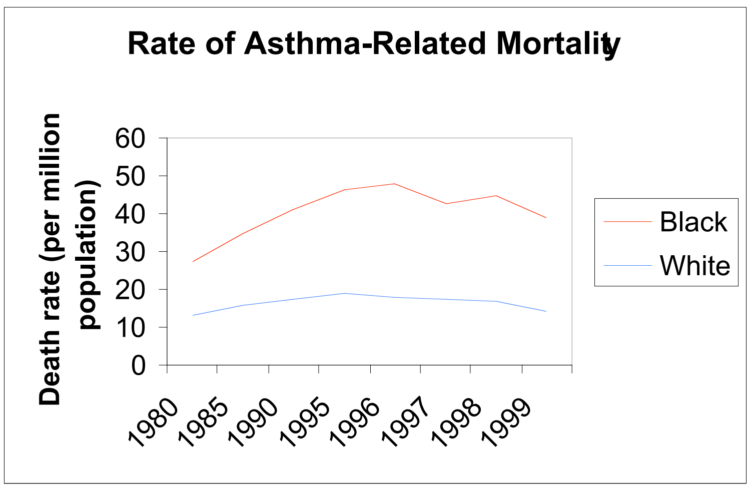
15 million outpatient visits, and over 500,000 hospitalizations each year in the United States (NIH, 1997). In 1990, direct and indirect costs were calculated to be approximately $6.2 billion. By 1998 the costs are believed to have more than doubled, reaching **over $12.5 billion** (Redd, 2002).

The incidence of asthma has been clearly connected to air pollution, especially ozone and particulate matter. A review by Leikauf (2002) notes that ozone, NO_x, particulates, and diesel exhaust exposure can all increase bronchial reactivity among asthmatics, and that those with asthma tend to have an increased susceptibility at lower doses. Asthma symptoms can be worsened by increases in the levels of PM_{10}, which has also been associated with increased rates of hospitalization (Donaldson et al. 2000; Peden, 2002). Pope and Dockerty (1999) found a 2% increase in hospitalizations and a 3% increase in asthma symptoms for every 10 mg/m^3 rise in PM_{10} as an average across multiple studies (cited in Donaldson et al., 2000). Similarly, O_3 is believed to contribute to the onset of asthma onset in children (O'Neill et al., 2003a).

Unfortunately, asthma is most prevalent among those least able to afford its burden, particularly African Americans (Chen et al., 2002; Mannino et al., 2002). In particularly, asthma prevalence is often higher in inner-city areas more likely to have degraded air quality. Brown et al. (2003) note that, "Asthma has become perhaps the primary disease in which poor and minority people have pointed to social inequality, and it is a useful class and race indicator of health inequalities." Asthma is recorded as the main cause of death for over one thousand African Americans each year. Importantly, the chance that an African American will die from asthma is nearly **three times** that of a White American. Similarly, the rate of emergency room visits due to asthmatic attacks remains more than **three times** higher for blacks than for whites (Figure 16) (Mannino et al., 2002). The highest incidence of asthma in the U.S. is among African-American toddlers and low-income toddlers. It has been estimated that a quarter of the children in Harlem are asthmatic, and they are concentrated along bus routes (Mitchell, 2004).

Figure 16 – Black and white differences in the prevalence of asthma in the U.S. (Data: Mannino et al., 2002)





General Air Pollution Exposure and Mortality

In addition to asthma, air pollution is associated with several other causes of mortality, such as heart disease and cancer. A recent study linked ambient air pollution from 150 U.S. metropolitan areas to individual risk factors for half a million adults. Over the course of 16 years, exposure to fine particulate matter and sulfur dioxide was associated with death from lung cancer and cardiopulmonary disease. The mortality risk associated with high concentrations of fine particulate air pollution was comparable to the risks associated with being moderately overweight (Pope et al., 2002).

Infant Mortality

Multiple studies have reported a connection between air pollution and "adverse birth outcomes, such as low birth weight, premature birth, and infant mortality (Woodruff et al., 2003)." In a comparison of 86 cities in the U.S., researchers found that the mortality rate of infants living in a highly polluted city during their first two months of life was 10% higher than infants living in the city with the cleanest air (Woodruff et al., 1997). Investigators in this study found that high levels of particulate matter were related to a 26% increased risk of Sudden Infant Death

Syndrome and a 40% increased risk of respiratory mortality. Similarly, higher exposures to hazardous air pollutants are statistically associated with higher levels of childhood leukemia (Reynolds et al., 2003).

In a preliminary study extending this work, researchers have estimated that 11% of the infant mortality in the U.S. is attributable to particulate matter, even at low to moderate levels (Kaiser et al., 2001). The black infant mortality rate is nearly twice that of the white rate. As such, it is not surprising that black infant mortality appears to be significantly more sensitive to reductions in air pollution (total suspended particulates) than white infant mortality (Chay and Greenstone, 2003).

Mercury Exposure
One indirect pathway through which the energy use affects the health of African American is by increasing exposure to mercury pollution. Methylmercury interferes with the development and function of the central nervous system in humans (NRC, 2000). A powerful neurotoxin, methylmercury can cause demyelination of neural axons and delayed nerve conduction (Wooltorton, 2002; Weir, 2002). Evidence from adults exposed to high levels of mercury suggests that exposure reduces neurocognitive function, including reduced memory retention, decreased fine motor skills, and attention deficits. These findings are consistent with the theory that mercury exposure affects the cerebellum, a region of the brain associated with fine motor control and coordination (Yokoo et al., 2003). Children and developing fetuses are most vulnerable to mercury exposure, with prenatal exposure capable of causing later age impairments in children (NRC, 2000; Budtz-Jorgensen et al., 2002).

While mercury exists naturally in the environment, exposure levels have risen substantially from ambient levels due to the discharge of mercury from various activities such as the incineration of municipal and medical waste, and coal-fired power plants (Abelsohn et al., 2002). Coal-fired power plants are the largest industrial dischargers of mercury, producing approximately one third (33%) of all mercury pollution in the U.S (EPA, 1997; EPA, 1998). Airborne mercury is frequently deposited into water bodies where it is biologically converted to methylmercury and bioaccumulated in the food web. Human exposure to mercury primarily occurs by eating contaminated fish, particularly carnivorous fish (EPA, 1998). Most of the methylmercury that is ingested by humans is absorbed, with a half-life in the body of around one and a half months.

Currently, forty-five states in the United States have issued fish consumption advisories following the wide spread mercury contamination in fish across the country (EPA, 2003a). Nineteen states out of the above have consumption advisories for every inland water body, and eleven states for all coastal waters. In 2002, areas with mercury advisories comprised over 12 million acres of lakes and nearly 500,000 miles of American river miles. Studies show that as recreational fishermen, African Americans are more likely to eat what they catch, eat more of it, and be less aware of health advisories than the white fish-eating population (Tilden et al., 1997; Burger et al., 1999; FWS, 1996).

Climate Change and Water- and Vector-Borne Disease

The final major health concern stemming from climate change is the potential for changes in the spread of infectious diseases. Climate change brings with it an unknown potential for the invasion of new or exotic diseases, particularly vector-borne disease with complex transmission cycles that involve hosts (e.g. mosquitoes) with ranges limited by temperature. Over the past three decades there has been a global resurgence in the extent of infectious diseases. While it is recognized that this spread has numerous causes, most notably urbanization and the collapse of certain public health systems, it has been hypothesized that global climate change has contributed to this spread (Sutherst, 2004; Epstein, 2002).

Specifically, research has considered two main routes through which climate change influences the spread of infectious disease. First, by changing the geographical distribution of environmental conditions suitable to disease pathogens and their vectors, climate change can change the range and activity of disease (Sutherst, 2004). In particular, insects and ticks are highly temperature sensitive, such that temperature often constrains the range of the vector-borne diseases. Epstein (2002) comments that "Ticks have been moving northward in Sweden as winters warm, mosquitoes are appearing in mountainous regions where plant communities and freezing levels have shifted upward and glaciers are rapidly retreating." Small increases in temperature can, in some instances, increase the risks of transmission of certain diseases disproportionately (Figure 17).

Figure 17 – Links between environmental changes and disease (Sutherst, 2004)

Global Change	Potential effects on vector, pathogen, and host environments	Potential effects on vectors, pathogens, and hosts
Higher CO_2 concentration	Increased ambient temperature and plant biomass; range expansion of woody vegetation; longer plant growth season with humid microclimates	Increased vector longevity for the same rainfall and temperature through more humid microclimates, with possible range expansion of humid-zone vectors
Temperature increase (regional/temporal variation)	Expansion of warm climatic zones, with longer growth seasons, less extreme low temperatures, and more frequent extreme high temperatures	Faster vector and pathogen development, with more generations per year; shorter life spans of vectors at high temperatures, reduced low-temperature mortality of vectors, and range expansion of warm-climate vectors and pathogens
Rainfall	Too uncertain and regionally variable to estimate but increased frequency of extreme rainfall events	Altered patterns of breeding of mosquitoes, with more flushing of mosquito breeding with increased flooding

For example, an increase of 12-27% in the epidemic potential of malaria has been projected as a result of climate change (Martens et al., 1997; Cited in, Sutherst, 2004). Similarly, there is clear empirical evidence that climate change had increased the frequency of cholera in Bangladesh over the past century (Rodo et al., 2002). The IPCC assessment concludes that in some regions, increases in temperature will cause vector-borne diseases such as malaria and dengue to spread to higher altitudes and latitudes, unless limited by the public health system. In other regions, climate change may decrease transmission rates of certain diseases.

Second, the prevalence of vector-borne diseases may also be influenced by climate-induced extreme weather events, such as large-scale flooding. Extreme weather events have the capacity to change the pattern of epidemics, either by altering habitats or by changing the ecological landscape by affecting the balance of predators and prey (Sutherst, 2004). For example, floods can increase disease vectors by creating mosquito breeding grounds or driving rodents from burrows (Epstein, 2002). The largest outbreak of a vector-borne disease following a natural disaster in the U.S. was the spread of Western equine encephalitis that followed the Red River flood of 1975 (Greenough et al., 2002; CDC, 2001). However, statistically detecting changes in the frequency of communicable diseases attributable to human-induced extreme weather events remains unlikely given the short time frame involved (Sutherst, 2004).

With respect to the United States, a warmer climate is likely to increase the area hospitable to certain insects and rodents that can carry a range of communicable diseases including malaria, St. Louis encephalitis, Western equine encephalitis Lyme disease, Dengue fever, and hanta virus (Figure 18). For example, since 1957 there have been over 1,000 cases of malaria reported annually in the United States, primarily occurring after travel or immigration (Gubler et al. 2001). However, in the 1990s several cases of malaria emerged in multiple where the virus was contracted locally. Though these outbreaks were small, they fit model projections that malaria occurrence will increase with warmer and wetter weather conditions.

Figure 18 - Major vector-borne diseases expected to see range changes through global warming (Adapted from Kiska, 2000)

Disease	**Predicted sensitivity to climate change**
Malaria	Highly likely
Filariasis	Likely
Onchocerciasis	Likely
Schistosomiasis	Very likely
African trypanosomiasis	Likely
Arboviral disease	
Dengue	Very likely
Yellow fever	Likely
Other	Likely

Major epidemics of these diseases in the United States remain unlikely, barring a significant degradation of the public health system (Sutherst, 2004). The National Assessment (2001) concluded that, “The moderating effect of [demographic sociological, and ecological] factors makes it unlikely that increasing temperatures alone will have a major impact on tropical diseases spreading into the U.S. There is greater uncertainty regarding more indigenous diseases that cycle through animals and can also infect humans.” While epidemics are unlikely, there remains considerable uncertainty about the direction and magnitude of changes in the spread of infectious disease. One element that is clear is the importance of the public health system in dealing with these diseases (NRC, 2002; IPCC, 2001). Many of these disease cause flu-like symptoms that can be treated when caught early. However, several diseases can be fatal when not treated, and even with treatment, can be fatal in seniors and people with compromised immune systems. As previously discussed, many African Americans lack health insurance and regular medical access, are remain particularly at risk.

Section Two: Economics and Climate Change

Introduction

As with the health effects of climate change, the economic effects of global warming are likely to be both large and widespread.

The links between climate change and the economy are relatively straightforward. Clearly, climate and weather wield a strong influence on numerous economic sectors: Climate largely determines the productivity of our forests and fields, whether we heat or cool our homes, and the amount of water available to drink or irrigate crops. Similarly, the prevalence of storms and the variability of weather influence diverse components of the economy such as shipping and insurance, construction and recreation. Despite these linkages, the precise effects of anthropogenic climate change on the economy are less clear, because any assessment of change in future climate remains fraught with uncertainties. There is uncertainty associated with future levels of greenhouse gas emissions, uncertainty surrounding the impacts of CO_2 on climate, the uncertain effects of climate on the economy, and the unknown potential for climatic and social catastrophes that would dramatically alter the costs assessment (Clarkson and Deyes, 2002).

Estimates of the Economic Damages from Climate Change

Recently, a number of economic studies have estimated the effects of climate change on the economy through the use of integrated climatic-economic assessment models (IPCC, 2001; Clarkson and Deyes, 2002). As a consequence of the multiplicative uncertainties listed above, a wide range of answers has resulted. Typically, the damages of climate change in the economic literature are expressed as a figure known as the Social Cost of Carbon (SCC). The social cost of carbon is the amount of damage in dollars caused by a ton of carbon (in the form of carbon dioxide) emitted to the atmosphere.

The Intergovernmental Panel on Climate Change (IPCC, 1996) notes that estimates of the economic damages stemming from the emissions of carbon dioxide range between $9 per ton of carbon ($9/tC) and $190/tC for the time period 2001-2010, a factor of more than twenty. Recent reviews have observed even more disparate results: Tol (2003) collected 88 estimates of the social cost of carbon, from 22 studies. These results ranged from net benefits of $7/tC to massive costs of $1,666/tC, with an average estimate of over $100/tC across all studies. Given that humanity currently emits over 6.3 billion tons of carbon annually, the **average estimate** for total global damages from climate change across Tol's survey of the literature is **over $600 billion per year**.

Effects on the United States

Clearly, the potential economic effects of climate change are both enormous and uncertain. With respect to the United States specifically, the most likely scenarios involve alterations in weather patterns that will affect several sectors of the U.S. economy, most notably the agricultural, timber, water, energy, and coastal sectors (Mendelsohn, 2002). For example, in different regions, agricultural production may be hurt by heat waves or flooding, water resources may be strained through overuse, and energy prices can be driven up by the increasing demand for air conditioning or irrigation (Figure 19). Other economic sectors will be affected less directly through changes in energy and commodity prices.

Figure 19 – Vulnerability of U.S. Economic Sectors to Climate, 1994 (Nordhaus, 1998)

Sector	% GDP	Sector Output (billions)
Total Gross Domestic Product	**100.0**	**6,931.4**
Major Potential Impacts	1.7	
Farms	1.2	82.2
Agricultural services, forestry, fisheries	0.5	35.7
Moderate Potential Impacts	**4.2**	
Water transportation	0.2	10.6
Energy	1.2	82.3
Real estate: coastal property	0.9	60.5
Hotels and other lodging places	0.8	56.1
Outdoor recreation	1.2	81.2

Several early studies attempted to quantify this overall economic impact of climate change on the U.S. by 2050. Modelers estimated that doubling the concentration of atmospheric carbon dioxide would incur annual economic costs to specific sectors of the economy summing to around 0.2 to 0.9 percent of U.S. gross domestic product (GDP) (see Figure 20).

Figure 20 - Economic Effects of Doubling CO_2 (Mendelsohn and Smith, 2002)

Study	Change in U.S. GDP
Nordhaus, 1991	-0.3%
Cline, 1992	-0.9%
Fankhauser, 1995	-0.8%
Tol, 1995	-0.4%
Mendelsohn and Neumann, 1999	0.2%

In addition to these impacts on market sectors such as agriculture and forestry, a variety of non-market impacts are likely to result from climate change, including the detrimental effects on human health detailed in Section One, as well as negative impacts on wildlife habitat and ecosystem services, and damages to cultural and amenity values. While few studies have systematically addressed these non-market impacts of climate change in an economic framework (Mendelsohn, 2003), their incorporation generally increases the total estimated loss from climate change to around **1.0 to 1.5 percent of GDP each year** (roughly \$80 to \$120 billion per year).

Multiple studies suggest that these effects are likely to increase prices across the economy, although the increases will generally be small. American consumers may find that climate change reduces the relative value of the dollar (Fankhauser and Tol 1996). The most significant changes in prices would derive from changes in agriculture, due to changing and unpredictable growing conditions, and increased costs of electricity, due to an elevated demand for air conditioning and irrigation. More modest price increases would occur for other agricultural and silvicultural products such as tobacco, lumber, and textiles, due to weather variability (Scheraga et al. 1993). Of all the sectors, the impacts of warming on agriculture are likely to be the most important market effect of climate change (Mendelsohn, 2002).

The Pivotal Role of Agriculture

Early work on the effects of climate change on agriculture suggested extremely large, negative impacts. For example, Scheraga et al. (1993) estimate that worldwide agricultural production will fall by 10 percent relative to the baseline by 2050, which could increase global food prices as much as 20 percent (Scheraga et al. 1993). As a consequence, the study estimates that the relative decrease in real household consumption in the United States in 2050 due to climate change will be approximately $200 billion (in 1990 dollars). Of that $200 billion decline, almost three-quarters would come from effects on the agricultural sector, corresponding to a total loss of $711 per person (in 1990 dollars). Since low-income households spend proportionally more of their income on food and energy (see Chapter Two), their decline in real consumption from the impacts of climate change be significantly greater than that of wealthier households. Forced to spend more for basic necessities, low-income households will have even less potential to purchase less-essential goods.

The Role of Adaptation

Several recent reviews (e.g. Mendelsohn, 2003; Pearce, 2003; Tol and Downing, 2000) have downplayed the economic risk detailed in earlier studies by noting that adaptation can reduce many of the damages. Clearly adaptation is important in many sectors. For example, farmers can switch the types of crops they plant in anticipation of warmer weather or reduced water supplies. As such, they may even be able to maintain their incomes or even use climate change to their economic advantage under certain scenarios (Doering et al., 2002). Because of they neglected adaptation, many of the early estimates of the monetary damages of climate change may be overstated.

Most optimistic scenarios that assume perfect adaptation find that a relatively small amount of warming (1.5 to 2.5 degrees C) may actually benefit agriculture and forestry (e.g. Mendelsohn and Smith, 2002), while others find small losses (Nordhaus and Boyer, 2000). As climate change continues and warming increases (e.g. 5 degrees C), those benefits are likely to be outweighed by the detrimental effects (Mendelsohn and Smith, 2002). The National Assessment of Climate Change indicates that about half of the modeled scenarios result in small losses for the U.S., while the other half results in small gains. Under most of these scenarios consumers benefited from lower prices. However, consumer savings on food and clothing expenditures were generally less than one percent of current expenditures on these products (Reilly et al., 2001).

However, none of these assessments included the potential effects of extreme weather events such as flooding, drought, and heat waves. Nor do current models incorporate the potential effects of increased ranges of pests, diseases, and insects, let alone damages to ecosystems or non-market values. The authors of the National Assessment conclude that, “Ultimately, the consequences of climate change for US agriculture hinge on changes in climate variability and extreme events. Changes in the frequency and intensity of droughts, flooding, and storm damage are likely to have significant consequences (Reilly et al., 2001)."

Regional Differences
While the net economic effect of climate change on agriculture may be positive or negative, there are significant regional disparities under different climate change scenarios. In the United States, longer growing seasons in the colder areas and the CO_2 fertilization effect could increase productivity in some regions, while heat stress in the South, increased evaporation, and changes in pest populations could negatively effect agricultural production. Predominantly White agricultural producers in the Midwest, Northern Plains, and Northwest show gains under climate scenarios with adaptation, while the Southwest, New England, the Southern Plains, and the Southeast are all negatively affected under some scenarios even with full adaptation (Adams and McCarl, 2002). For example, one study estimated that agricultural production will fall by 16 percent in the Southern Plains and 21 percent in the Delta states (Adams, Hurd, and Reilly 1999). Modeling by Pfeifer et al. (2002) indicates that even within the relatively stable Upper Midwest, southern locations generally have the same or lower agricultural yields, in contrast to northern locations. Households that rely upon farming in the Southern Plains and Delta states will see their incomes fall from decreased agricultural production. Across the range of scenarios surveyed, the National Assessment determined that, "The southern region of the US is persistently found to lose both relative to other regions and absolutely. The likely effects of climate change on other regions within the US are less certain (Reilly et al., 2001)."

With respect to African American farmers specifically, little information is available. With respect to minority-owned businesses in Agriculture, Forestry, and Fisheries, The 1997 Census of Minority Owned Firms indicates that only 2.5% of businesses in the Agriculture, Forestry, and Fisheries sector are owned by African Americans (Census, 2001). Collectively, those operations accounted for just 0.65% of sales and receipts. Similarly, the Current Population Survey indicates that less than three percent of African Americans are farmers, and that the few African Americans who are farmers are concentrated predominantly in the South, the region most likely to be negatively affected by climate change (Data from CPS, 2004).

The Role of Catastrophe

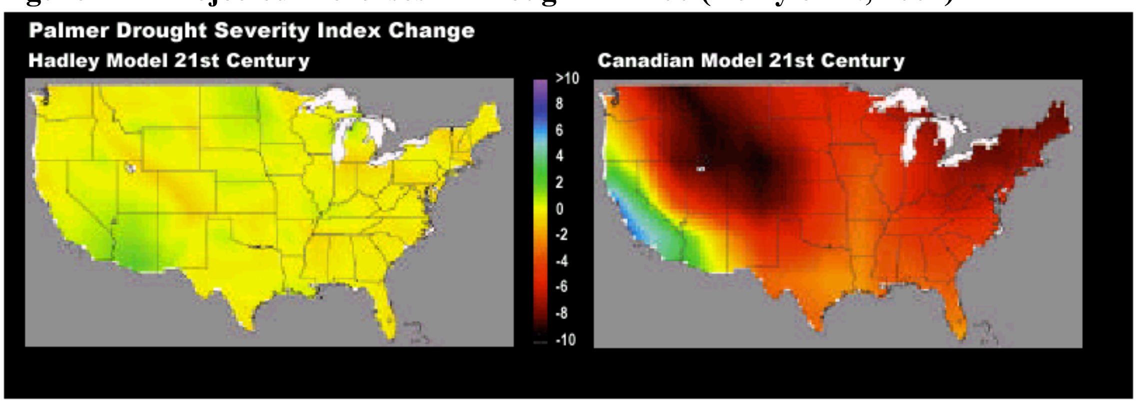
However, adaptation is most likely to occur when climate change occurs gradually, and even then it may be too fast for natural systems or for groups lacking the economic resources to adapt quickly. As such, the rate of change is very important. The National Research Council (NRC, 2002) reports that with the limited adaptation likely from an abrupt climate change scenario, economic-climate models predict global impacts on agriculture from \$100 billion to \$250 billion for a 4°C temperature rise:

> "Serious impacts to ecological or economic capital stocks can occur when they are disrupted in a manner preventing their timely replacement, repair, or adaptation. It is generally believed that gradual climate change would allow much of the economic capital stocks to roll over without major disruption. By contrast, a significant fraction of these stocks probably would be rendered obsolete if there

were abrupt and unanticipated climate change. For example, a rapid sea-level rise could inundate or threaten coastal buildings; abrupt changes in climate, particularly droughts or frosts, could destroy many perennial crops, such as forests, vineyards, or fruit trees; changes in river runoff patterns could reduce the value of river facilities and floodplain properties, warming could make ski resorts less valuable and change the value of recreational capital…"

Similarly, wide-scale drought could have devastating impacts on the U.S. economy. The Palmer Drought Severity Index (PDSI) is a measure of drought severity. The maps in Figure 21 are taken from the National Climate Assessment, and show modeled changes in the PDSI over the 21st century, based on two efforts: the Canadian and Hadley climate scenarios. The Canadian scenario projects widespread intense droughts over much of the nation by 2100. In contrast, the Hadley model projects much more moderate conditions. This disparity illustrates the considerably uncertainty that remains in estimating effects of climate change on extreme weather events, and demonstrates that the potential for large-scale weather disruptions exists.

Figure 21 – Projected Increases in Drought in 2100 (Reilly et al., 2001)

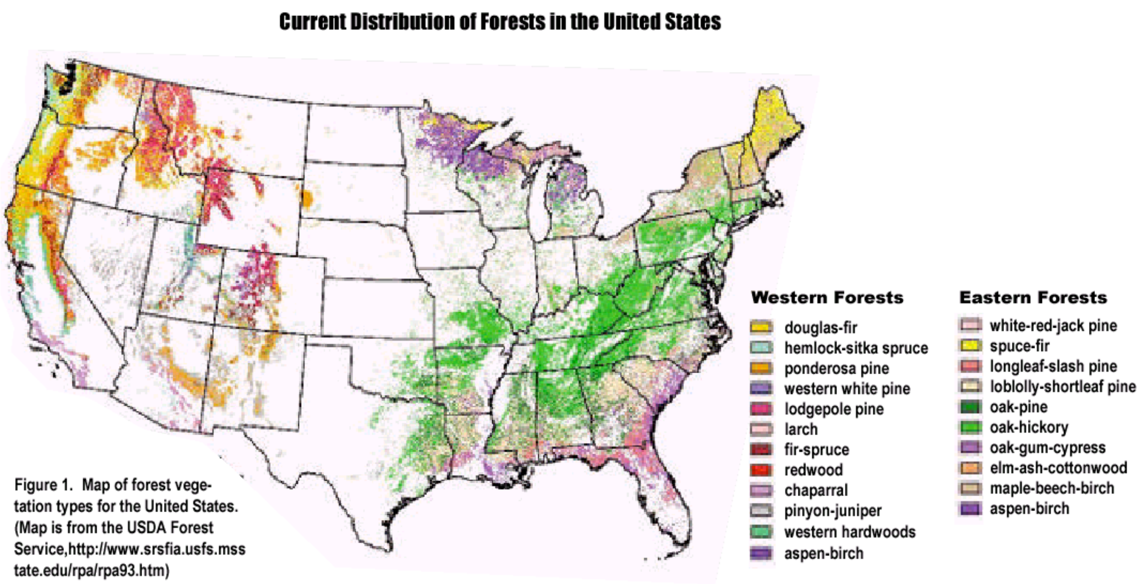


Economic studies that have included the potential for such abrupt catastrophes, notably a breakdown of the thermohaline circulation or a collapse of the West Antarctic ice sheet, have uncovered dramatically *increased* costs of global warming. For example, Gjerde *et al*. (1999) found that the emissions reductions required for potential catastrophic damages exceed the corresponding reductions for continuous damages. A more recent analysis by Pizer (2003) calculated that damages per ton of carbon will reach $30/tC by 2060 if the potential for catastrophe is excluded. However, damages may reach $500/tC (more than seventeen times larger) if catastrophic risks are not ignored. Similarly, many of the scenarios detailed in the Defense Department's review of catastrophic climate change would entail vast social costs (Schwartz and Randall, 2003). Resource wars over water and food, forced migration, and other socially-contingent economic damages may be of dramatic proportions.

Forests

Similar to the predicted effects on crops, forests and forest products are likely to be directly affected by climate change. Nearly one-third of the United States is covered in forests, primarily in the eastern and western regions of the country (Figure 22). As with agriculture, climate change will affect these regions differentially. Most models predict an overall increase in forest productivity due largely to the fertilization effects of carbon dioxide, triggering decreases in the costs of wood and paper products.

Figure 22 – Forest Distribution in the United States (Joyce et al., 2001)



However, forests are also susceptible to changes in weather including drought and wildfires. The National Assessment's review of climate and ecological models indicates that the seasonal severity of fire hazards is likely to increase by around 10% across much of the United States, with larger increases possible in the southeastern U.S. and Alaska (Joyce et al., 2001). Similarly, alpine and sub-alpine habitats in the conterminous United States will be severely affected by climate change, with ranges of some tree species such as sugar maples contracting dramatically.

Insurance

The insurance industry is one of the economic sectors most vulnerable to global warming and consequently has been one of the industries most vocal about the issue. Insurance companies are concerned about climate change both because of the increased unpredictability and the increased likelihood of extreme weather events associated with climate change including heavy storms, flooding, drought, wind, and wild fires (IPCC, 2001). A recent report by a Swiss reinsurer noted that climate has the potential to increase catastrophic losses in some regions. The report comments that, "Exposure to certain extreme weather events may increase in the 21st century on account of both established and expected climate change. In the long term, climate protection measures are necessary to buck this trend (e.g. reducing greenhouse gas emissions, scaling back the use of fossil fuels, developing new technologies) (Sigma, 2004)." There has been a marked increase in insurance claims over the past three decades, though it is difficult to quantify to what extent this is due to climate change.

An unforeseen rise in the number extreme weather events, particularly coastal storms, could be devastating to the insurance industry. There is over $2 trillion in insured property along the Atlantic and Gulf coasts alone. A research study by the insurance industry estimates that a class-5 hurricane (equivalent to the 1998 Hurricane Mitch) striking Miami or a class-4 hurricane (equivalent to the 1992 Hurricane Andrew) making landfall at New York City would generate around $50 billion in damages (World Press Review, 1995).

Sea Level Rise

In addition to changes in weather, global climate change is likely to cause economic impacts by increasing the physical level of the ocean. Over the past century, ocean temperatures have risen significantly and sea level has already risen by 4 to 8 inches. Sea ice across much of the Arctic has thinned by one to two meters, losing almost half of its thickness over the past forty years (Field et al., 2001). Continued polar ice melting and thermal expansion of the ocean are expected to cause further sea level rise between one and four feet in the next century (EPA, 2004). This will have a variety of economic impacts over the United States' 100,000 miles of coastline, including:

- Coastal property will be damaged or lost. Some of this property may be protected by dikes and other structures, which, while expensive, may be more cost-effective than abandoning the properties. For example, New Orleans—a predominantly African American city—already lies two feet *below* sea level, and will come under increasing risk from floods. The UK government expects flood damage to increase by up to a factor of 30 over the next 75 years (King, 2004).
- Wetlands and low lying land could be flooded leading to lost agricultural and other lands as well as lost ecological services. The ecological services provided by wetlands are substantial. One of the seminal works on ecosystem services estimates that estuaries and tidal marshes provide society with services (e.g. food production, nutrient cycling and waste treatment) valued at over $9,000 and $6,000 respectively (Costanza et al., 1997). Tidal marshes in particular are vulnerable to rising waters, as their retreat is often cut off by development.
- Beaches are currently being eroded across the nation, leading to economic losses associated with public and private recreation.
- Fisheries may be damaged, both by saltwater intrusion into freshwater areas and by the flooding of estuarine and marshland habitats.
- Fresh water aquifers used by municipalities could be damaged by saltwater intrusion.

Clearly the overall impacts of sea level rise will be negative and are likely to be large. However, because of the uncertainty associated with the overall magnitude of sea level rise and the variety of sectors impacted and adaptations possible, no credible overall estimate for damages has been produced.

Changing Precipitation and Water Flows

Climate change is expected to lead to changes in rainfall patterns making some areas of the U.S. drier and other areas wetter. Some areas are likely to see drops in lake levels and river and stream flows, while the reverse will occur in other regions. There are a number of potential economic impacts of these changes.

- Hydropower production will be affected by changing water flows.
- Municipal water supplies are likely to be affected. Municipalities with decreased or degraded water supplies could suffer substantial economic consequences. Saltwater intrusion in aquifers from rising sea levels could also affect municipal water supplies.
- Changing water levels may affect navigation, requiring new navigational infrastructure.
- Flooding intensity and frequency could increase in some areas, causing direct economic damage or leading to abatements costs.

Economic Effects on African Americans

With respect to the economic effects of climate change specific to African Americans, it is difficult to disaggregate the general effects to this more detailed level. The main effects are likely to be borne by African American consumers, as opposed to entrepreneurs, who are scattered across a number of industries. Generally, increases in the prices of food or energy are felt most by those with low incomes who spend a larger fraction of their expenditures on these categories. African Americans currently dedicate a significantly larger fraction of their expenditures to these purchases than others do, even when adjusted for total spending. As a consequence, African Americans may be most affected by changes in the prices of these commodities due to climate change. Chapter Two will investigate in greater detail the extent to which African Americans are vulnerable to increases in the prices of these commodities.

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Chapter Two: The Greenhouse Gas Footprint of African-Americans

Chapter Findings:

African Americans are less responsible for causing climate change than other Americans. On average, Blacks emit 20% less carbon dioxide in total than Whites. However, despite emitting less carbon, African Americans are more affected by changes in energy prices, as Blacks spend a significantly higher fraction of expenditures on energy and fuels than others do.

Average Emissions by Race
African Americans contribute significantly less to greenhouse gas emissions than others in the U.S. This finding is true for both direct emissions of carbon dioxide from energy use, and for indirect emissions, or emissions generated during the production or delivery of consumed products.

1) African Americans generate roughly *20% less carbon dioxide* than Whites on both a per capita basis.

2) In 2002, African American households were responsible for releasing an estimated 165 million tons of carbon, roughly half of which occurred through energy use and half of which occurred through the purchase of other goods and services that required energy to produce and deliver.

3) On average, African American households generate 14% less carbon than White households directly through fuel use (i.e. gasoline, electricity, natural gas, and home heating), but are responsible for emitting 36% less carbon indirectly through other purchases.

4) Despite emitting less carbon, African Americans spend a higher fraction of expenditures on carbon-intensive purchases. Consequently, African Americans are more likely to be affected by changes in the price of energy or carbon. In particular, low-income African Americans are among the most vulnerable populations in society to sudden increases in the price of energy.

Average Emissions by Race and Income
The major source of difference in average household carbon emissions is variation in income. The wealthiest deciles emit several times as much carbon as the poorest deciles. Blacks currently comprise a quarter of all Americans living in poverty, and 22% of individuals with household incomes of less than 150% of the federal poverty standard. As a consequence, blacks emit considerably less carbon dioxide. However, in addition to this income effect, there are significant income-independent factors with respect to carbon emissions and race.

5) There is a large difference in the **direct carbon emissions** per dollar of expenditure between Blacks and Whites, particularly in the bottom half of the income bracket. African Americans spend a larger fraction of expenditures on fuels. This is particularly true in the lowest income bracket where the carbon intensity of Black expenditures is nearly *50% greater* than the intensity of non-Black expenditures.

6) With respect to **indirect carbon emissions** per dollar of expenditure, there is no statistically significant variation, either by race or by expenditure decile. The average dollar spent by any group has indirect carbon dioxide of between 0.20 and 0.23 kg.

Average Emissions by Race and Region
African Americans have significantly smaller carbon footprints than Whites across all four regions.

1) In all four regions, Blacks emit less carbon dioxide than their White neighbors. There are only modest differences in the size of the African American carbon footprint across regions.

2) For Blacks, average carbon emissions are highest in the West, followed by the South and Midwest, and lastly the Northeast.

3) Blacks and Whites living in the South have the highest direct carbon dioxide emissions of any region, but also have the lowest indirect carbon dioxide emissions, resulting in an average total emission. In contrast, Blacks and Whites living in the West have the highest indirect carbon dioxide emissions in the nation, but average direct carbon emissions.

Average Emissions by Race and Urbanization
African Americans have significantly smaller carbon footprints than Whites in both urban and rural settings. In 2002, rural households had 8% smaller carbon footprints on average than urban populations, regardless of race.

1) Blacks have smaller carbon footprints than Whites in both urban and rural communities, but dedicate a larger share of income to direct energy purchases in both settings.

2) African Americans in rural areas have the smallest carbon footprint of any of the four groups, 23% below the national average. As a share of expenditures, rural Blacks dedicate between 10% and 11% of expenditures to energy, nearly double the fraction spent by urban Whites.

3) African Americans in urban areas have carbon footprints slightly larger than the rural Black footprint, but still 15% below the national average.

Chapter Two – The Greenhouse Gas Footprint of African Americans

Introduction

Chapter Two provides a quantitative analysis to estimate African Americans carbon dioxide emissions. Specifically, the analysis looks at both direct carbon dioxide emissions from fuel and energy use, and indirect carbon dioxide emissions in the fuel used to produce other goods and services consumed by African Americans. For the first time in the literature, U.S. carbon dioxide emissions have been disaggregated by several important factors including race, income, region, and occupation.

Purpose and Outline

Chapter Two explores the contribution of African Americans to global climate change by modeling current greenhouse gas emissions, based on consumption data. This analysis is intended to provide insight into two important issues.

First, estimates of carbon dioxide emissions by group are of great concern for equity considerations. Determining to what extent African Americans are *responsible* for greenhouse gas emissions can highlight the disparity between those who cause the problem and those who bear the costs. The difference between the distribution of costs and benefits is a fundamental component of cost-benefit analysis, as well as of moral concern.

Second, the analysis of emissions provides important and as yet unquantified information on how policies that combat global warming will specifically affect the African American community. Most climate policies have some effect on energy prices, which in turn, have significant effects on consumers, both directly and indirectly. Directly, consumers purchase a variety of energy products such as electricity, gasoline, and heating fuels. These expenditures generally comprise anywhere from 5% to 15% of total household expenditures depending on factors including income and race. Apart from fuel, the remainder of one's income is spent on a wide range of goods and services, each of which employs some amount of energy in the production and distribution process. As a consequence, changing energy prices can indirectly affect the prices of almost all goods or services that consumers can purchase. The extent to which African Americans spend a greater or lesser share of income on energy (directly or indirectly) can serve as a proxy for the community's vulnerability to changes in energy prices. Moreover, vulnerability varies not just by race, but also by other factors such as region and income. This analysis helps to determine exactly who is most vulnerable to change, thereby informing policy decisions that attempt to offset or avoid regressive effects.

The Chapter graphically presents results from the several factors analyzed:

- Average Emissions and Cumulative Emissions by Race
- Average Emissions by Race and Expenditures
- Average Emissions by Race and Region

- Average Emissions by Race and Urbanization

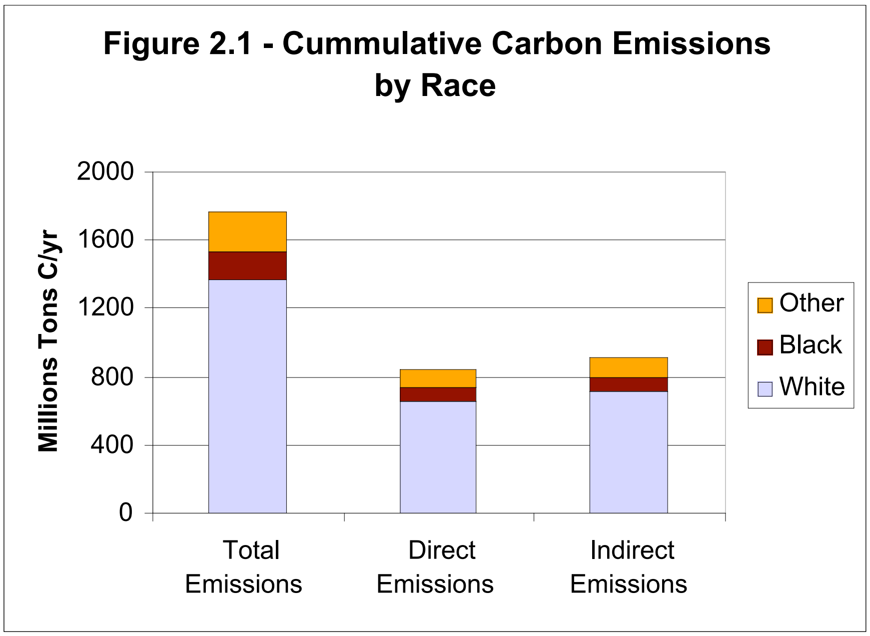
Methodology

The methodology combines two data sets. The first is consumption data from the Consumer Expenditure Survey (2002), administered by the U.S. Bureau of the Census, which provides information on household expenditures on a range of products for a representative sample of the American population. Consumer Expenditure (CEX) data can be broken down along a number of lines including region, income, and race. The CEX data set on consumer purchases has been combined with Bureau of Economic Analysis figures on carbon emissions by industries. The carbon figures have been run through an Input-Output analysis to estimate the indirect carbon intensity of products consumed by consumers. In addition, the direct carbon intensity of fuels is incorporated. The analysis has been restricted to carbon dioxide emissions, which globally account for approximately 60% of current anthropogenic radiative forcing. An analysis of other gasses (e.g. methane, sulfur hexaflouride, nitrous oxide, etc.) is clouded by the difficulties in obtaining precise emissions figures, and is consequently left for future studies.

Analysis

Cumulative and Average Emissions by Race

In 2002, African Americans (defined in the Census as Non-Hispanic Blacks) were responsible for releasing an estimated 165 million tons of carbon, or 9.3% of the national total. Of that 165 million tons, 86 million tons were direct emissions from energy purchases and 79 million tons were indirect emissions, or emissions occurring during the production or delivery of goods and services purchased by African Americans (Figure 2.1). Respectively, African Americans were responsible for 10.1% of national direct emissions and 8.6% of national indirect emissions.



The results of this analysis indicate that, in per household or per capita terms, **African Americans emit significantly less carbon dioxide either directly or indirectly than other groups**. African Americans generate roughly *20% less carbon dioxide* than Whites on both a per household and a per capita basis (Figure 2.2 and Figure 2.3).

Figures 2.2 and 2.3 also illustrate that there is a difference in both direct and indirect emissions by race. The difference between average Black and White emissions is much larger for indirect carbon dioxide emissions than for direct emissions, implying that Whites have larger incomes on average. Whites generate approximately 14% more carbon dioxide directly through fuel use (i.e. gasoline, electricity, natural gas, and home heating). However, indirectly Whites release *36%* more carbon dioxide than Blacks.

The analysis indicates that on average Blacks lead more environmentally responsible life-styles. The typical black household uses significantly less gasoline and electricity than other groups, and emits less carbon dioxide. To some extent this reflects the African American community's greater reliance on public transportation and greater residence urban areas where public transportation is more feasible. In addition, the spending patterns indicate that African Americans are simply less prolific consumers than the rest of America, spending a considerably smaller amount per capita on other energy-intensive material goods, thereby contributing more than one-third less to indirect carbon dioxide emissions.

Overall, the data presented indicates that Blacks both directly and indirectly emit less carbon dioxide than Whites. As such, Blacks are simply less responsible for the U.S. contribution to climate change than Whites.

Figure 2.2 - Average Household Carbon Emissions by Race

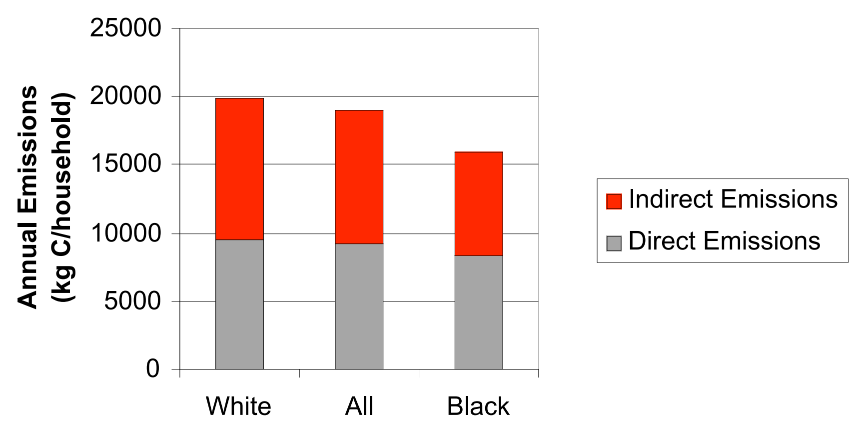
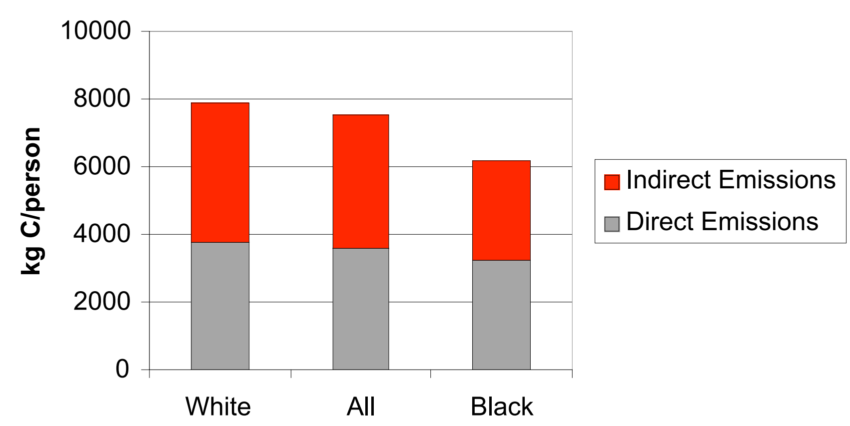


Figure 2.3 - Per Capita Carbon Emissions by Race

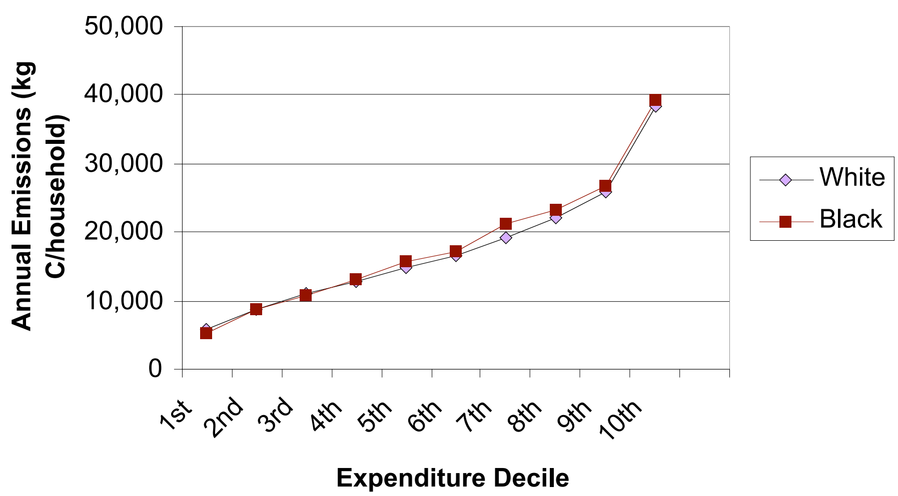


Average Emissions by Income Group

Whereas Section 2.2 demonstrates that Blacks emit less carbon dioxide than Whites, the analysis does not provide any guidance on the *vulnerability* of different races to changes in the energy system. Section 2.3 investigates average emissions by expenditure levels (a proxy for income).[4] The basic finding is that households in the lower expenditure deciles emit less carbon dioxide (either directly or indirectly), but are forced to spend a greater share of their income on these energy purchases.

Figure 2.4 illustrates that average carbon dioxide emissions are highest in the wealthiest segments of society, regardless of race. This is true for both direct and indirect carbon emission (Figure 2.5 and 2.6). As a consequence, the less-wealthy half of America is far less responsible for carbon dioxide emissions, with the average household in the wealthiest decile emitting roughly seven times as much carbon dioxide as the average household in the bottom expenditure decile. Due to the relatively close correlation between total expenditures and total emissions it is difficult to discern any significant effects by race. At present, White Americans are more likely to be in the highest income deciles and as such to represent the largest contributors to carbon dioxide emissions.

Figure 2.4 - Average Total Carbon Emissions by Expenditure Decile



[4] Much of the analysis is broken down by expenditure decile, rather than income decile. Expenditure is used as a proxy for income information, because reported income has empirically been unreliable. Many households under-report income either through error (e.g. not reporting gifts, etc) or intentionally (e.g. illegal incomes), while other households either borrow or save money to offset changes in income over longer periods of time. As such, expenditures as a percentage of total expenditures provide a normalized and reliable estimate of a group's vulnerability to energy prices.

Figure 2.5 - Average Direct Carbon Emissions by Expenditure Decile

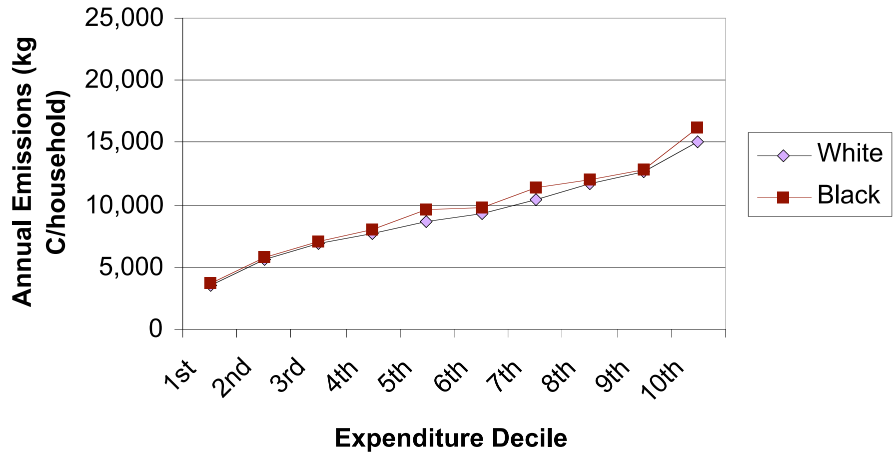
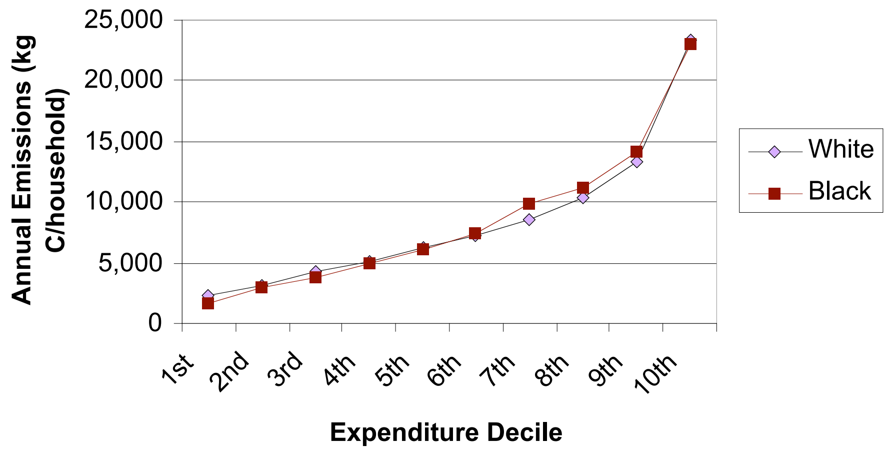


Figure 2.6 - Average Indirect Carbon Emissions by Expenditure Decile



The previous graphs indicate that non-Blacks and those in the higher expenditure deciles are disproportionately responsible for climate change in the United States. However, the analysis can give a misleading impression of vulnerability to changes to the energy system. In order to estimate how much groups spend on energy, it is possible to look at carbon dioxide emissions per dollar of total expenditure by race and expenditure decile (Figure 2.7). From this analysis it is evident that even though Blacks are less responsible for climate change, *Blacks spend a higher fraction of expenditures on carbon-intensive purchases* in the lowest five income deciles (Figure 2.7).

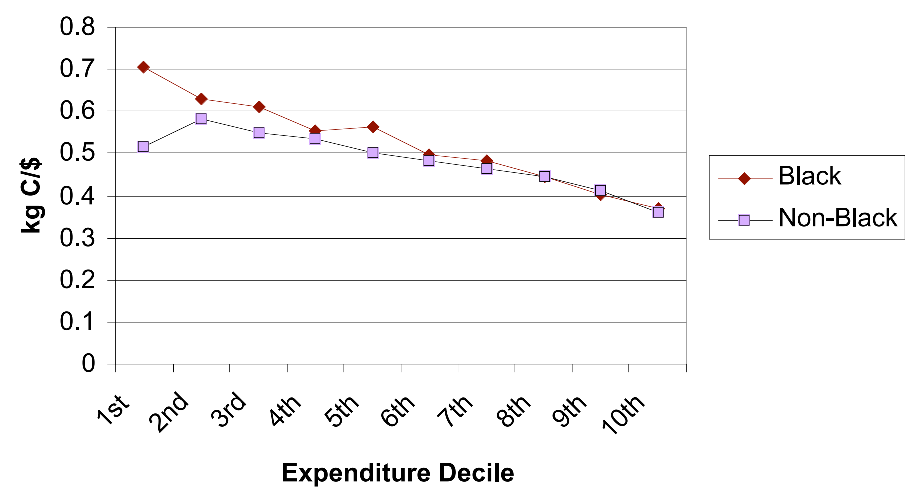
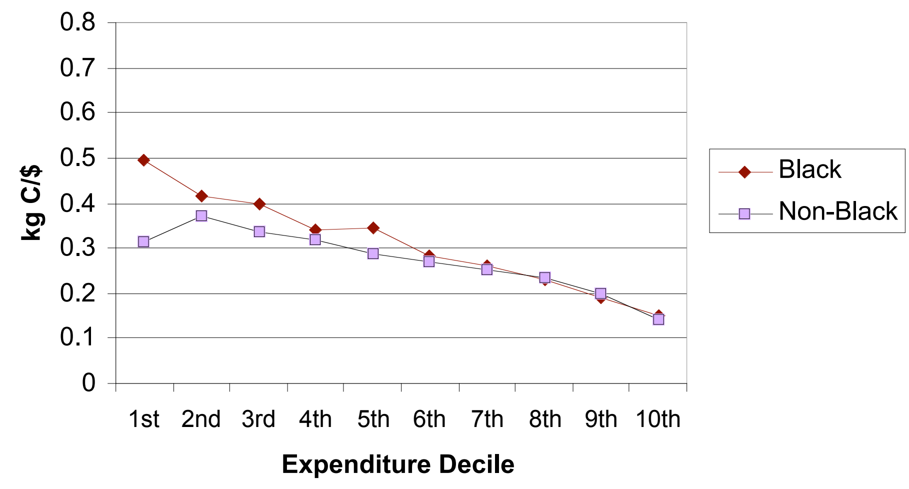


Figure 2.7 - Average Total Carbon Emissions per Dollar Expenditure, by Expenditure Decile

When total carbon emissions are split between direct and indirect carbon emissions the trends become more clear. With respect to **direct carbon emissions** from fuels, there is a large racial difference between Blacks and Whites by expenditure, particularly in the bottom half of the income bracket (Figure 2.8). Notably, in the first expenditure decile, the amount of carbon released by African Americans per dollar spent is *60% greater* than for non-Blacks. Notably, carbon emissions from electricity and home heating use are significantly higher for African Americans than for non-African Americans in the same income decile. In contrast, gasoline and motor oil expenditures are lower for African Americans than others in every decile.

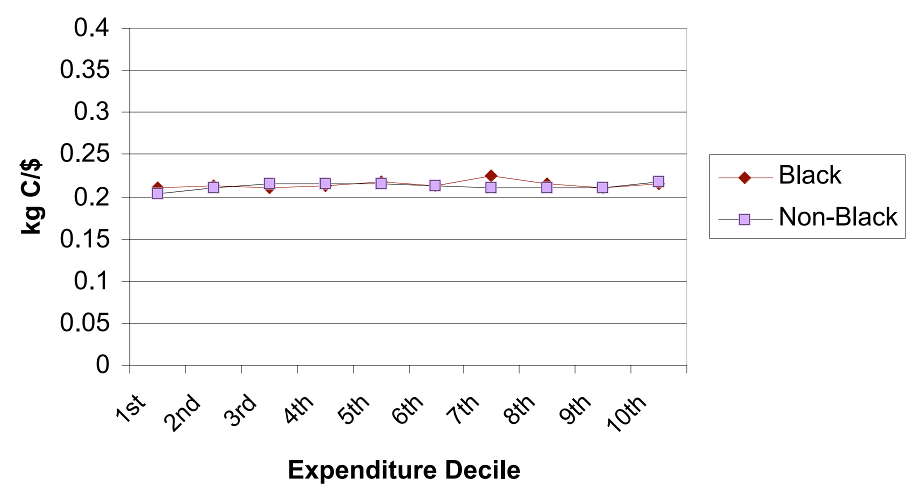
These findings indicate that *low-income African American families are among the most vulnerable sections of society to increases in the price of energy*. Increases in the price of energy (or carbon), would have over three times as large an impact on African Americans in the poorest expenditure decile than those in the wealthiest decile. This is particularly true for changes in the price of home heating fuel and electricity.

Figure 2.8 - Average Direct Carbon Emissions per Dollar Expenditure, by Expenditure Decile



With respect to **indirect carbon emissions** per dollar of expenditure, there is essentially no statistically significant variation, either by race or by expenditure decile (Figure 2.9). Regardless of income or race, the average dollar spent by any group has indirect carbon dioxide of between 0.20 and 0.23 kg. These findings surprisingly indicate that the average carbon intensity of non-energy consumption is relatively constant regardless of changes in overall income.

Figure 2.9 - Average Indirect Carbon Emissions per Dollar Expenditure, by Expenditure Declie



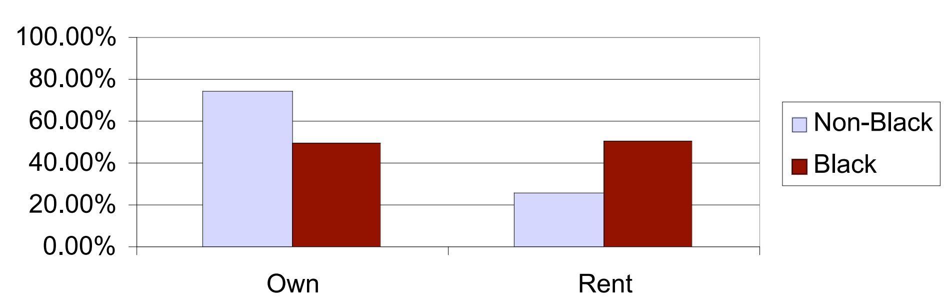
The results of Section 2.3 indicate that, relative to high-income African Americans or the poor in general, low-income African Americans are far more vulnerable to high energy prices or carbon prices for multiple reasons.

First, African Americans in the lowest income deciles spend a higher fraction of their expenditures on direct energy purchases (Figure 2.7). Low-income African Americans spend a larger fraction of expenditures on energy than any other income or racial group, and by a wide margin. African Americans in the lowest income decile reported spending 13% of total expenditures on direct energy purchases, relative to just 9% of total expenditures for other Americans. Incorporating indirect carbon emissions dampens the trend somewhat, but not entirely.

Second, African Americans are more likely to have lower incomes than non-African Americans. Currently, African Americans make up 12.7% of the U.S. population. However, African Americans currently comprise a quarter of all Americans living in poverty, and 22% of individuals with household incomes of less than 150% of the federal poverty standard. The effects of this disparity are likely to be significant. The available of reliable and affordable energy is essential to general health and well-being. African Americans are consequently substantially more likely to be "fuel poor"; spending a substantial fraction of their income on energy requirements and therefore forced to choose between purchasing fuel (home heating and cooling, transportation, cooking fuel, etc.) and purchasing other household necessities. Policies that increase the price of energy or carbon emissions ought to consider these differences prior to implementation.

While African American households emit significantly more direct carbon than non-African American households in the same income decile, the reasons are unclear. The analysis appears to indicate that some African American households are less energy efficient than other households. This may be due to several factors including poor building stock, inefficient appliances, etc. A contributing factor is the fact that homeowners are more likely to invest in energy efficient appliances and weatherization than home renters. The percentage of African Americans who rent rather than own homes is over 50%, compared to just 25% of non-African Americans (Figure 2.10). Moreover, the percentage of African Americans renting homes is concentrated in the lower half of the income bracket where the divergence in emissions per dollar is most striking.

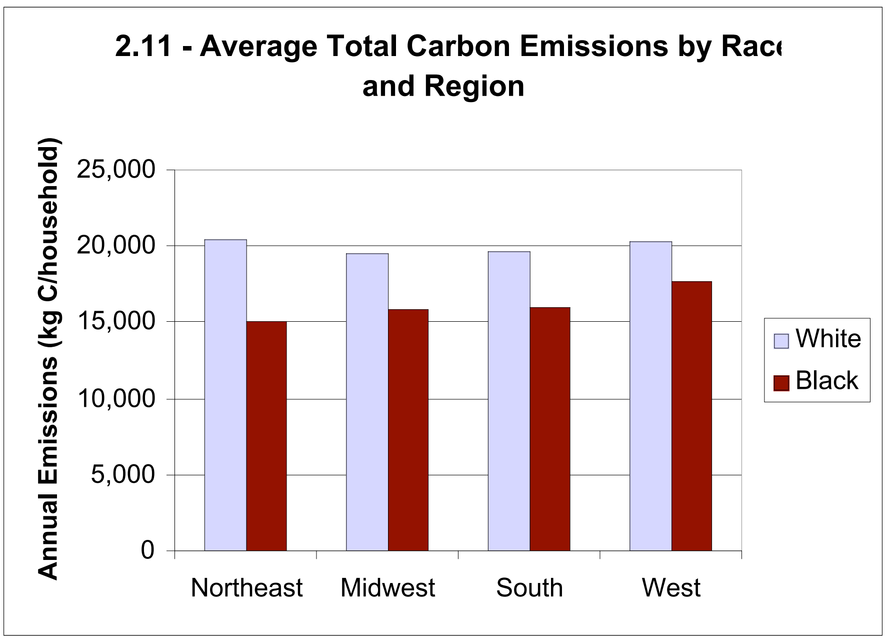
Figure 2.10 - Home Ownership by Race



Average Emissions by Race and Region

In addition to income, it is possible to examine differences in carbon emissions by race and region. The majority of African Americans live in the South, and may be subject to different patterns of energy use (e.g. through heating and cooling requirements) than those in other regions.

The fundamental finding of a regional breakdown is that the significant difference in the carbon footprints of Blacks and Whites exists across all four regions (Figure 2.11). In every single region in the United States, Blacks emit less carbon dioxide than Whites. There appears to be only modest differences in average emissions by region with racial groups. Overall, there is less than 5% variation in the average carbon dioxide footprint of Whites across the four regions. For Blacks, variation is only somewhat more significant, at 17%.



For Blacks, average carbon emissions appear to be highest in the West, followed by the South and Midwest, and lastly the Northeast.[5] Average carbon emissions were highest for Whites in the West and Northeast, followed by the South and Midwest.

As with emissions by income, further detail can be gained by breaking out direct and indirect carbon dioxide emissions (Figure 2.12). Regional differences in the two types of emissions appear to partially offset each other. For example, Blacks and Whites living in the South have the *highest direct* carbon dioxide emissions of any region, but also have the *lowest indirect* carbon dioxide emissions, resulting in a near-average total emission. In contrast, Blacks and Whites living in the West have the highest indirect carbon dioxide emissions in the nation, but the lowest direct carbon emissions.

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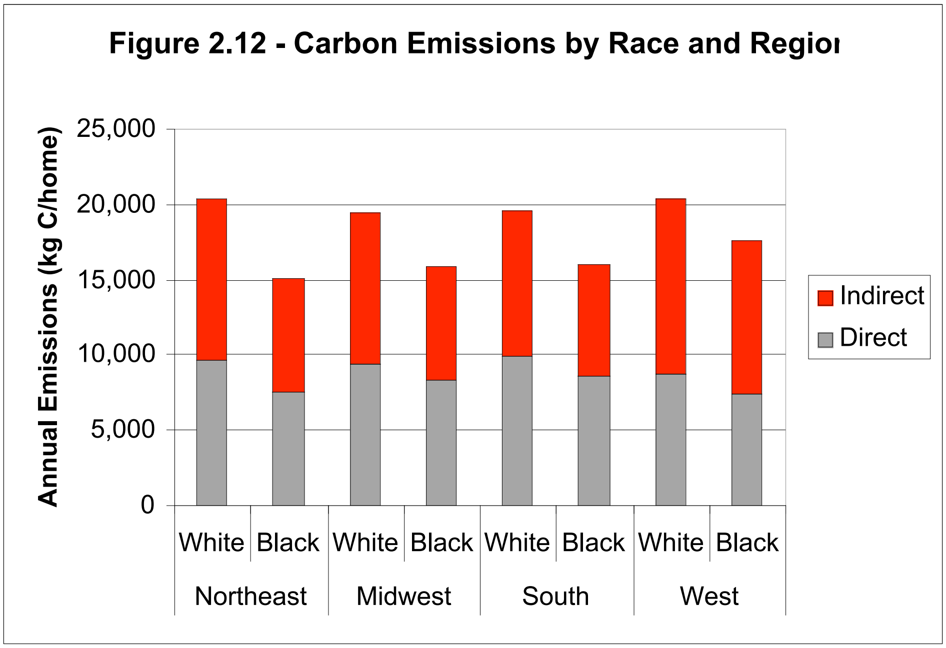
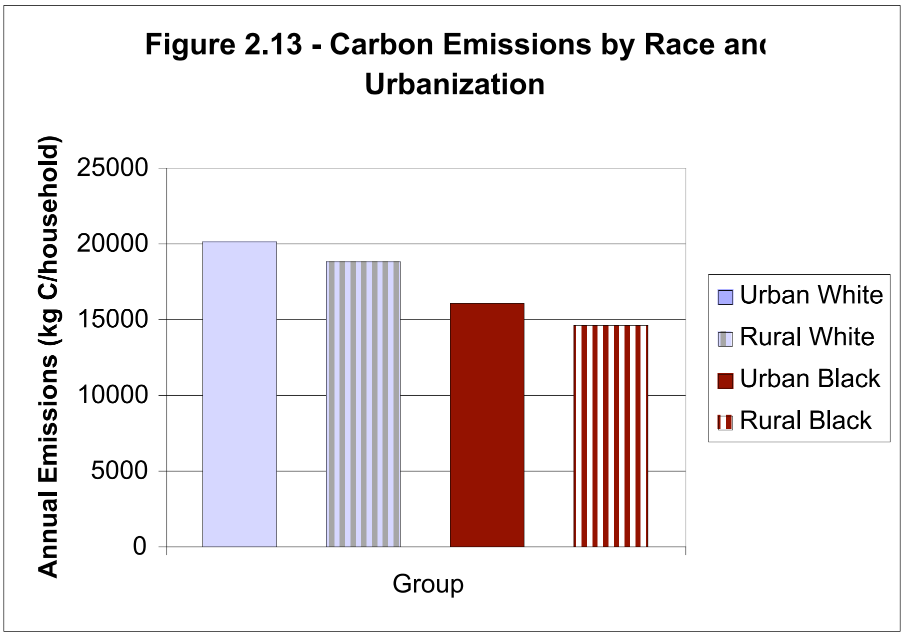
[5] This difference may also be due to regional variations in the price of energy – a factor which was not explored in this analysis.



In policy terms, these findings imply that, for consumers, changes in the price of energy or carbon emissions are not likely to have huge regional differences. However, small differences, particularly in the split between direct and indirect carbon, may need to be addressed on policy fronts.

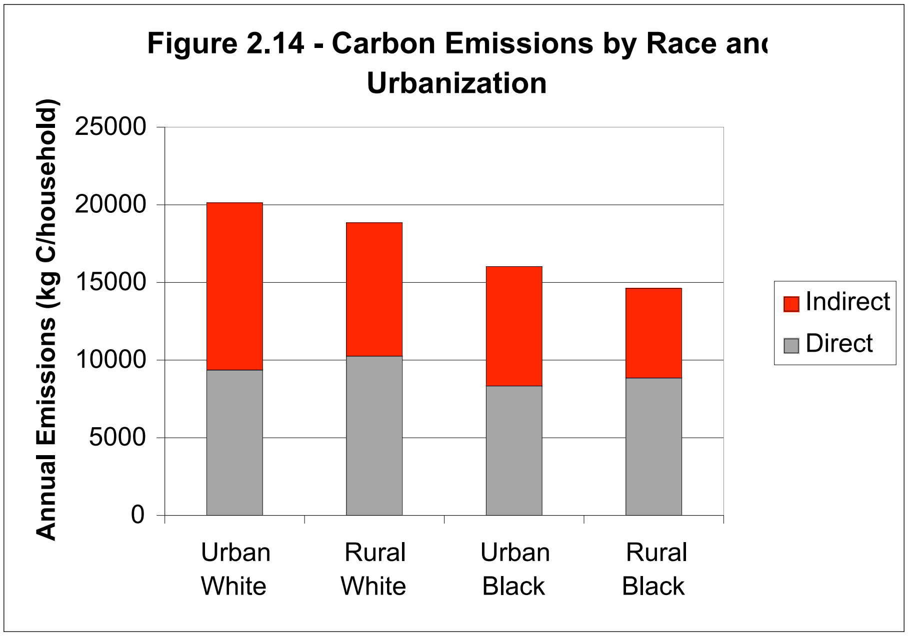
Average Emissions by Race and Urbanization

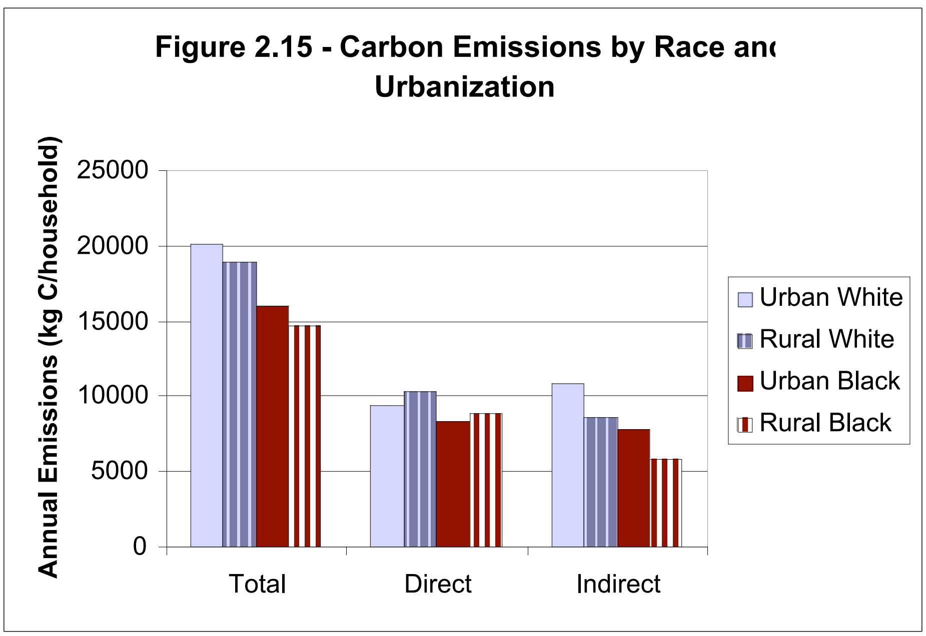
A third factor analyzed in combination with race and carbon emissions is the difference between urban and rural populations. There are large differences between patterns of energy use in urban and rural communities, both with respect to direct fuel consumption, and the purchase of other goods and services. Again, this segmentation indicates that Blacks have lower carbon dioxide emissions than the rural and urban White counterparts. In addition, this analysis indicates that *urban populations* have approximately 8% higher carbon emissions than rural populations for both Blacks and Whites (Figure 2.13).



With respect to direct and indirect emissions, the differences are even larger. Due in part to higher expenditures on gasoline and motor oils, rural populations actually have higher direct emissions of carbon dioxide than urban populations. However, because rural communities tend to be less wealthy, they have significantly lower indirect emissions of carbon dioxide for both Blacks and Whites (Figure 2.14 and Figure 2.15). This difference in indirect emission large enough that, on average, urban populations have larger carbon footprints.

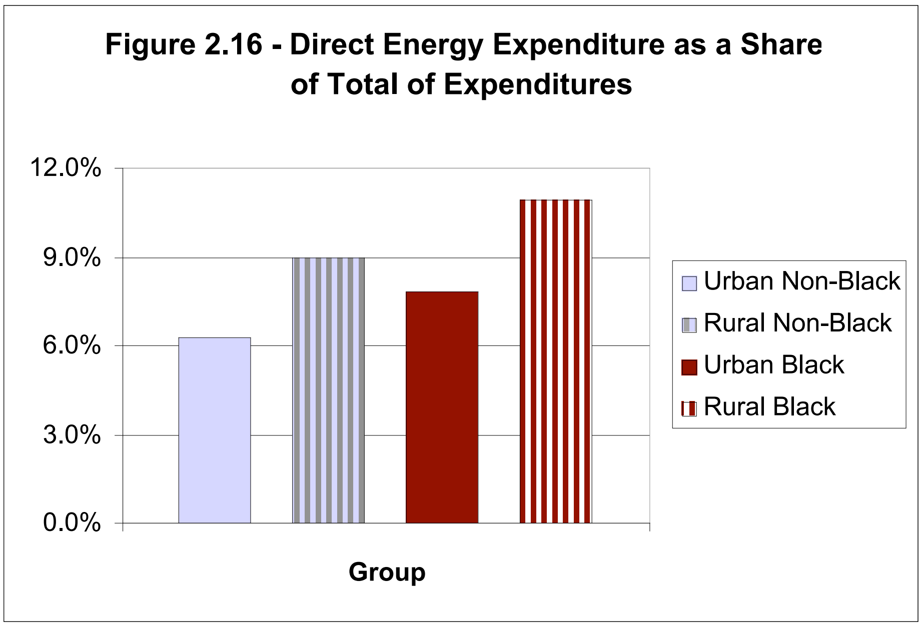
With respect to racial differences, Blacks have smaller average carbon footprints in both urban and rural communities, but dedicate a larger share of income to direct energy purchases. Policies that differentially increase the direct prices of fuels purchased by consumers, but not industry, will selectively harm African Americans and in particular, rural African Americans.





Rural Blacks:
African Americans in rural areas have the smallest carbon footprint of any of the four groups, 23% below the national average. This is driven by the fact that indirect carbon emissions in this group are very small, or more than 40% below the national average (Figure 2.14 and Figure 2.15). In contrast, rural Blacks have relatively high direct carbon dioxide emissions (within 4% of average), indicating that they spend a very high proportion of income on direct energy purchases. As a share of expenditures, rural Blacks dedicate between 10% and 11% of expenditures to energy, nearly double the fraction spent by urban Whites (Figure 2.16). As a consequence, African Americans living in rural areas may be more vulnerable to sharp increases in the price of certain forms of energy (e.g. gasoline).

Urban Blacks:
The carbon footprint of African Americans in urban areas is slightly larger than the rural Black footprint, but still 15% below average. As with rural Blacks populations, direct emissions of carbon dioxide are high (within 10% of the national average) but indirect emissions from other goods and services are small (Figure 2.14 and Figure 2.15). It is interesting to note that while urban Black households also dedicate a higher fraction of expenditures to direct energy purchases (Figure 2.16), the types of energy forms purchased are markedly different. Blacks purchase *less* electricity as a fraction of expenditures than others, but considerably *more* home heating fuels. In contrast, motor oils and gasoline are comparably low for all urban populations.



Chapter Three: An Analysis of Energy and Climate Change Policy Proposals

Chapter Findings:

In addition to the effects of climate change itself, energy and climate related policies will have an array of effects on African Americans. The main areas include:

Health Effects of Climate Polices on African Americans

1) Climate policies generate a variety of benefits for African American health. These include benefits resulting from reduced global warming (e.g. fewer heat deaths or malaria deaths), as well as ancillary benefits from reductions in other pollutants.

2) Climate policy may save as many as 10,000 African American lives per year, through reductions in local air pollution.

3) Other benefits may include reduced air pollution, reduced traffic congestion and vehicle accidents, reduced damages to materials and crops, improved visibility, reduced solid waste loads, and new market opportunities for eco-friendly technologies.

4) The optimal climate policy from a health perspective involves substantial reduction in carbon dioxide emissions and associated pollutants, and encourages international cooperation in mitigating climate change.

Economic Effects of Climate Polices on African Americans

1) There is an economic consensus that for many policies to reduce greenhouse gas emissions, the total benefits outweigh the total costs.

2) Climate policies will affect African American consumers by changing the price of energy. Such changes may be positive or negative depending on the specific portfolio of policies. In general, African Americans are more sensitive to changes in the price of energy, and particularly the African American poor.

3) Perhaps the main economic effect of a robust climate policy is the potential to reduce the vulnerability of the U.S. economy to recessions triggered by oil price shocks. Such recessions have terrible effects on African Americans.

4) Properly designed climate policies can have positive effects on employment, with some studies finding employment gains in the range of 800,000 to 1,400,000 new jobs.

Introduction

Chapter Three is an analysis of how African Americans are affected by climate policies. The goal of this chapter is to identify the means through which climate policies and elements of climate policies impact the African American community. As a preface, it is important to distinguish the effects of climate change from the effects of climate change policies. Whereas Chapter One discussed the health and economic consequences of climate change itself, Chapter Three addresses the health and economic consequences of an array of policy options that exist to mitigate climate change, particularly as they relate to African Americans.

For clarity, this report has operationally defined “climate-related policies” as any policy likely to have a significant effect on greenhouse gas emissions. Due to the overwhelming contribution of fossil fuel combustion to global warming, “climate policy” and “energy policy” are almost inseparably intertwined.

Chapter Three is divided into two main sections. The first section of Chapter Three examines, in general terms, the economic effects of climate policy. This section is concerned with outlining the relationship between African American health, the economy and climate policy, including the effects of climate policy on energy prices and the macroeconomy, as well as impacts on African American employment. With that as background, the second section of Chapter Three explores a range of specific policies that are part of existing or new legislation being considered for reauthorization or alteration. The benefits and drawbacks of each policy are considered, alongside their specific implications for African Americans.

Section One: The Economic and Health Effects of Climate Policy on African Americans

The toolbox of climate policy options includes a wide range of subsidies and taxes, permits and fees, regulations and laws, many of which can operate counter to each other. As a result, it is difficult to accurately characterize how "climate policy" in general will benefit or harm the African American community. In order to better structure this discussion, this section discusses the main types of effect climate policies will have on African Americans.

This section briefly examines two key ways in which climate policies can affect African Americans and others:

1) Health benefits of climate policy to African Americans,
2) Economic effects of climate policy on African Americans,

In particular, the economic effects of climate policy are explored on several levels, including the direct effects of changing energy prices, the indirect effects of macroeconomic vulnerability to oil price shocks, and the net effect of climate policy on employment and GDP. Section 1 concludes with a summary of the findings that describes elements of an optimal climate policy for African Americans.

Health Benefits of Climate Policies to African Americans

One of the fundamental benefits of any policy aimed to mitigate climate change is that it will reduce the health and economic harms of global warming outlined in Chapter One. As previously detailed, African American health will be disproportionately affected by climate change in a number of ways including a likely increase in heat-related deaths, air pollution, extreme weather events, and communicable disease.

With respect to the direct health and economic impacts of climate change itself, benefits will be proportional to the extent that humanity slows growth in the atmospheric concentration of CO_2 and other greenhouse gasses. Because CO_2 is a global pollutant, reductions will depend on total global emissions. However U.S. action on climate change is of primary importance for two reasons. First, the U.S. currently accounts for roughly a quarter of current global CO_2 emissions, making it the largest single source of global warming. Second, international cooperation on greenhouse gas emissions has been severely hindered by the lack of aggressive action in the U.S. Ratification of the Kyoto protocol or an alternative international accord will continue to depend on U.S. involvement in the process.

In contrast to the direct health benefits of reducing greenhouse gasses globally, the ancillary benefits of action to reduce climate change will be reaped locally and regionally. As discussed in Chapter One, the energy consumption that causes climate change also generates a variety of other health and economic harms for African Americans. In turn, policies that reduce greenhouse gas emissions will also have a variety of ancillary benefits, or "co-benefits" to African American communities (Kousky and Schneider, 2003; Dessus and Connor, 2003; Gielen and Moriguchi, 2002). These benefits may include:

- Reduced air pollution, health and environmental damages.
- Reduced traffic congestion and vehicle accidents.
- Reduced materials and crop damage.
- Improved visibility.
- Reduced solid waste loads.
- New market opportunities for eco-friendly technologies.

While significant uncertainties are associated with monetizing these benefits (Rabl and Spadaro, 1999), it is important to include co-benefits in analyses of the costs and benefits of CO_2 mitigation. This is because these benefits, particularly the health benefits, are generally comparable to the economic costs of reducing carbon emissions (Aunan et al., 2004). Ekins (1997) writes that, "At present the secondary benefits of reducing CO_2 emissions are of the same order of magnitude as gross abatement costs for significant levels of abatement…. It begins to seem as if there is a strong economic case for reducing the consumption of fossil fuels, irrespective of the threat of global warming, in order to reduce other polluting emissions." Similarly, Burtraw et al. (2003) modeled the ancillary benefits of a $25 carbon tax on the electricity sector in the United States. They found that every ton of carbon avoided yields approximately $13-14 in health and economic benefits from reduced NO_x and SO_x emissions. With the average marginal cost of a $25 carbon tax around $12, co-benefits and direct costs appear to largely offset each other. As such, policies intended to address climate change and policies intended to address local air pollution, energy use, and traffic congestion ought to be carefully coordinated (Rubbelke, 2003).

In this light, African American health will be most benefited by climate policies with two elements. First, policies that take meaningful action on domestic greenhouse gas emissions but also foster international cooperation on the problem will likely be the most effective at mitigating the detrimental health effects of climate change. Second, the largest ancillary benefits for African Americans will occur with policies that focus on reducing air pollution, particularly emissions affecting air quality in urban areas. For example, policies that limit diesel emissions will have large benefits for some communities.

Economic Effects of Climate Policy on African Americans

One of the most contentious elements to the climate debate is differing estimates on the economic effect of climate policy on Americans. Several energy industry-funded studies suggest that policies to reduce carbon emissions will have a devastating impact on jobs in the U.S. However, a collection of studies by government agencies, academics, and non-governmental organizations have found that climate policies may indeed help the economy and increase employment. Both the U.S. Department of Energy's Five Laboratory Study (1997) and their Scenarios for a Clean Energy Future (2000) estimated that the overall costs of pursuing a renewable and energy efficiency strategy would be more than offset by the benefits. This latter position appears to be a more general consensus. For example, in a 1997 letter organized by

Redefining Progress over 2,500 economists, including eight Nobel Laureates, signed a statement written agreeing that:

> "Economic studies have found that there are many potential policies to reduce greenhouse-gas emissions for which the total benefits outweigh the total costs. For the United States in particular, sound economic analysis shows that there are policy options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run."

To better understand the different types of effects of climate policies on the economy, this section looks at three key issues. The effect of climate policy on energy prices, the effect of climate policy on economic health, and the effects of climate policy on unemployment.

Effects of Energy Prices on African Americans

At their heart, most policies intended to address climate in a significant manner are aimed at reducing the greenhouse gas emissions stemming from energy consumption. As such, climate policies generally change energy prices. It is these changes in energy prices that are likely to most directly affect African American households. Some programs, such as subsidies for renewable energy or regulations governing energy efficient appliances or fuel efficiency standards, will arguably reduce energy prices by decreasing demand or increasing supply. Other policies, such as carbon taxes or permits, typically increase the price of energy. These policies are based on the standard economic theory that one should tax or limit pollutants to compensate for negative externalities. The overall magnitude and the direction of the change in energy prices depend on the specific portfolio of climate policies selected. Appendix 1 provides a more detailed discussion of the types of policies available to address climate change.

What is clear is that African Americans are more affected by changes in the price of energy than other groups. As Chapter Two demonstrated, African Americans dedicate a substantially larger fraction of their income to direct energy purchases than other groups. This is true on two levels: First, on average African Americans have lower incomes than others, and as such are forced to spend a larger fraction of their disposable income on energy-related necessities (home heating, cooking fuel, electricity). Second, even when African Americans at a specific income or expenditure level are compared against others in the same expenditure level, African Americans tend to spend more on direct energy purchases. While it is unclear exactly why this is the case, possible factors include poor housing stock, less efficient appliances, and possibly less access to information. Based on our analysis of data from the Consumer Expenditure Survey (Census, 2004), the percentage of total household expenditures spent on direct energy purchases is roughly 23 percent higher for African Americans than for others. This difference is greatest for low-income households, where African Americans spend almost 50 percent more on energy than non-African Americans.

As a consequence of the larger fraction of expenditures African Americans spend on energy, policies that increase the price of energy will harm African Americans more than non-African

Americans, and particularly harm low-income households.[6] Conversely, policies that reduce energy consumption, such as energy efficiency standards and home weatherization programs will provide disproportionate benefits to African Americans. For example, a recent survey of energy and weatherization assistance programs (LIHEAP and WAP) indicated that African Americans are nearly twice as likely to receive benefits as non-African Americans (RP, 2004). Again, these benefits apply particularly to lower-income households. Similarly, appliance efficiency standards are of elevated importance to African American households, who are more than twice as likely to live in rented dwellings than the general population (CPS, 2004). Unlike homeowners, landlords have little incentive to purchase expensive but more efficient appliances, since they will not benefit from reduced operating costs. Removing less efficient appliances from the marketplace should significantly benefit those who rent, through lower utility bills.

As a consequence, it appears that African Americans will be disproportionately benefited by policies that increase the supply of renewable energy or encourage energy efficiency. In contrast, African Americans will be most negatively affected by regressive energy/carbon taxes or permits. However, it is possible to structure carbon taxes and permits in such a way as to compensate vulnerable or low-income groups. Current estimates are that 10-20% of the revenues raised are necessary to offset regressive effects. The economic effects of climate policies are further explored in the following two sections.

Effects of Oil Price Shocks on African Americans

In addition to influencing the price of energy, climate policy has serious ramification for national economic health. At present, African Americans are highly vulnerable to unemployment and depressed wages triggered by oil price shock. Effective climate policy can reduce the vulnerability of African Americans and the U.S. economy to these detrimental effects of oil shocks.

As background, most post-war recessions can be attributed, at least in part, to global energy price shocks. Energy price shocks typically occur when energy demand temporarily outpaces supply, and the price of energy jumps. These sudden spikes in energy prices (and particularly oil prices) can cause significant damages to U.S. economic health. The exact mechanism by which energy price increases cause economic downturns is controversial. Possible candidates include a subsequent reduction in consumer demand as a result of having fewer dollars to spend on non-fuel goods, changes in the terms of trade that harm America (a major net fuel importer), reduced production efficiencies, and increased uncertainty about prices and costs (Balke et al., 1999; Brown, 2000; Hamilton, 2000; IMF, 2000; Jones et al., 2004). Recent research suggests that at least part of the problem comes from an abrupt reallocation of workers between industries (Davis and Haltiwanger, 2001).

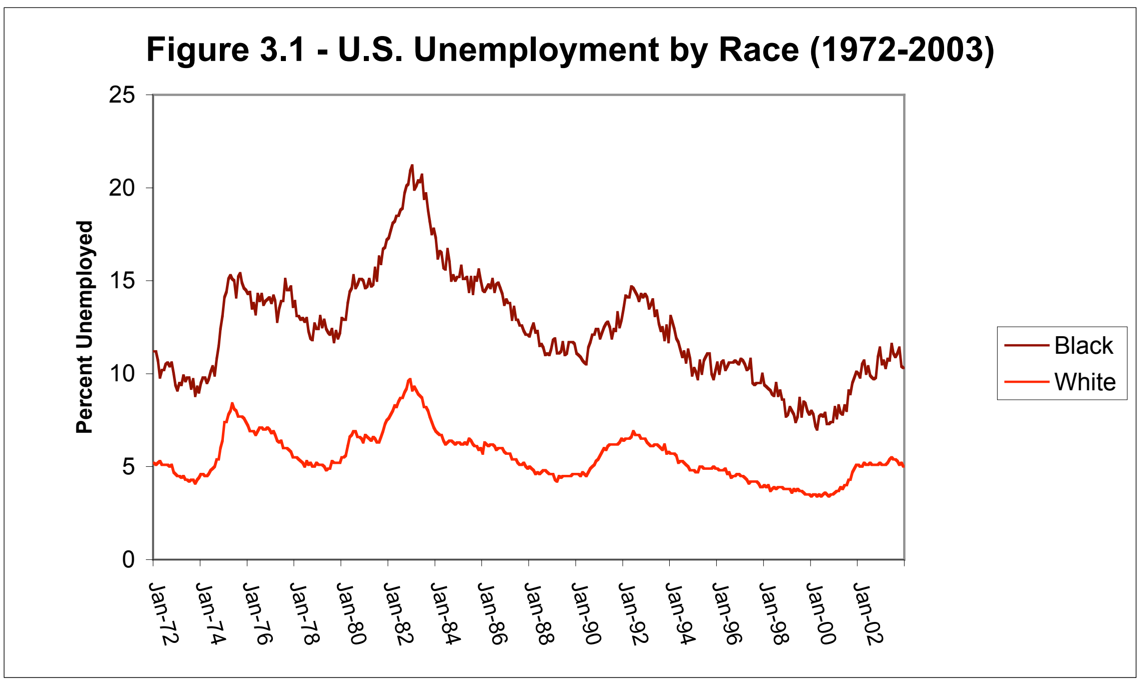
However, there are several aspects of the energy price/GDP relationship that appear to be well-established. First, the relationship is asymmetrical: price increases hurt the economy more than price decreases benefit the economy (Mork, 1989). Second, much of the economic injury comes from the element of surprise. Anticipated or gradual increases seem to have a much smaller economic effect than sudden, unanticipated increases (Lee et al., 1995). Third, the relationship is

[6] One exception appears to be gasoline and motor oil, as African Americans consume less gasoline compared to non-African Americans with the same income levels.

non-linear. As shocks increase in size, GDP effects increase more rapidly, so that smaller shocks may have little or no effect on GDP, whereas large shocks can have devastating effects.

The macroeconomic impact of energy price shocks is particularly important to the African American community. It is well known that the African Americans are disproportionately vulnerable to economic downturns. In particular, during downturns the unemployment rate of African Americans increases by a larger percentage than the unemployment rate of non-African Americans, and mean income follows a similar pattern (Bradbury, 2000a; Bradbury, 2000b; Eaton and Kisor, 1996). This can be seen in Figure 3.1. Over the last 30 years, the African American unemployment rate has ranged from 80% higher to 180% higher than that of the white unemployment rate (averaging 120% higher), based on monthly data. Moreover, African American unemployment has reached levels *greater than 20%* during economic downturns.

As such, the optimal climate policy for African Americans from a macroeconomic perspective is one that reduces current vulnerability to oil price shocks. To counter the threat of price shocks to African Americans, energy policy can pursue two overarching strategies. The first is to reduce the consumption of fossil fuels. The second is to increase the domestic supply of fossil fuels. The effectiveness of each strategy is explored below.



Policies that Reduce the Consumption of Fossil Fuels
With respect to national climate policies, most reduce dependence on fossil fuels. As such, these policies can decrease the economy's vulnerability to price shocks, and subsequent economic effects. Policies to promote energy efficiency and new renewable energy sources reduce the percentage of fossil fuels and imported fuels in the overall energy mix. The less the economy relies on fossil fuels, the less it is affected by sudden price increases. And because large energy price shocks, but not smaller ones, trigger recessionary effects, the more that the U.S. invests in energy efficiency and renewables, the more likely it is that any given energy price shock will be

too small to cause serious damage to the economy in general, and African American workers in particular.

Similarly, market-based climate policies can have even larger effects in reducing our current dependence on fossil fuels. Such market-based climate policies include tradable carbon emission permits or European-style environmental tax reform (raising taxes on fossil fuels proportionally to their carbon content and lowering taxes on labor or payroll). These policies raise energy prices, but reduce energy consumption.

The effects of market-based policies depend largely on the method in which they are structured and introduced. The literature on the impact of energy price shocks on the economy suggests that, if a market-based climate-policy were to be introduced suddenly, unexpectedly, with a large increase in energy prices, and without recycling the revenues through tax cuts or other assistance, then the economic consequences could be severe for the economy as a whole and for African Americans in particular. On the other hand, if the charges or permits were introduced in a gradual and anticipated manner, with the **revenue recycled progressively** through a mixture of tax cuts aimed at ordinary working families and the poor, and investments in new clean technologies, then the direct impact on the economy and on African Americans would be small, and would likely be positive. Such a system can be designed to be progressive in its overall distributional effects, such that the poor are most benefited by its implementation (Barrett and Hoerner, 2000).

Policies that Increase the Supply of Fossil Fuels

The other main strategy to reduce African American vulnerability to energy prices is to increase the supply of fossil fuels, such as opening the Arctic National Wildlife Refuge to oil exploration. To the extent that global fossil fuel supplies are increased, global prices are likely to fall. However, it is important to note that not all policies that increase domestic fuel production will not necessarily decrease domestic energy prices. Some energy markets, such as the market for natural gas, are primarily domestic in nature. In these markets, increased supplies will tend to lower prices (although if increased extraction rates deplete domestic wells, lower prices in the short run may be offset by higher prices in the long run). Other energy markets, particularly the market for oil, are global. In these markets, even quite large increases in domestic supply will not significantly reduce domestic prices, which are determined by the price of oil on the much larger global market. Since U.S. oil production is very small compared to the scale of the global oil market, even a large percentage increase in domestic oil production will have little impact on global oil supply. This effect implies that oil production increases will do little to buffer the African American community from the recessionary effects of global oil price shocks.

The relative importance of the direct effect of energy price shocks on African American households and the indirect effect of such shocks through their tendency to cause recessions depends on the level of the price shock. Consider a very large energy price shock, such as a doubling of oil prices. This would cause significant hardship for many African American families, but the burden would still amount to less than three percent of total household expenditures on average (although more for low income households). On the other hand, such a severe price increase would almost certainly trigger to a recession. As discussed above, recessions have a terrible effect on African Americans. In recent years, the difference between

African American unemployment in the peak and trough of the business cycle has been about four percentage points. In the 1982 recession, that difference was nearly ten percentage points. In addition to unemployment, the wages of the employed are also depressed during economic downturns. Overall, such a recession would probably cost the African American community more that eight percent of their total income. Thus, for large energy price shocks, the macroeconomic effects are substantially greater than the direct price effects, though both are painful. For smaller shocks, the macroeconomic effects will be small or negligible, and the direct price effects will cause more damage.

This dichotomy implies that the most important element of a climate strategy for African Americans is reducing vulnerability to oil price shocks. As such, there are several reasons to prefer a strategy that focuses on reducing fossil fuel use, rather than increasing supply, including:

- Increasing supply is likely to exacerbate the negative health effects of climate change and urban air pollution, outlined Chapter One. As these effects fall disproportionately on the African American community, the costs of supply-side policies are largely regressive.

- As a means to reduce the effects of oil price shocks, increasing domestic supply seems to be ineffective. Not only is the price of oil determined on the global market, but economic downturns are caused primarily by large, unexpected energy price *shocks*, rather than by high energy prices *per se*. Increasing the domestic supply may partially drive down prices, but will do little to reduce the magnitude of shocks. Moreover, as fossil fuels are exhaustible resources, increasing extraction today will only reduce the amount available in future years, thereby increasing vulnerability.

- During times of high energy prices, the U.S. sends a tremendous amount of money overseas to pay for imported oil. In contrast, increasing the use of renewable energy recycles those resources domestically.

Overall, the fundamental economic component of a best-case climate policy for African Americans is that it decreases vulnerability to oil price shocks by reducing U.S. dependence of the global oil market. To the extent that it is possible, increases in the price of fossil fuels ought to be minimized by demand-side policies (e.g. efficiency standards and R&D), or their regressive effects offset by redistribution of revenues. Such a strategy appears to be feasible. For example, the U.S. Department of Energy's 2000 report, Scenarios for a Clean Energy Future, concludes that an advanced climate policy is likely to modestly increase the price of electricity relative to the baseline scenario, but that electricity prices will be less than current prices.

Effects of Climate Policy on African American Employment

A final component to the debate over climate policies is the extent to which such policies affect jobs. For example, the World Resources Institute (1997a) surveyed a collection of studies of the economic impact of climate change policy, finding costs ranging from a loss of 4.3% of GDP to an increase of 3.5% of GDP. While differences in these results are partly associated with the differing methodologies and assumptions employed by the modelers, most of the variation can be explained by the different selection of policies and timeframes that the various studies are assessing.

Generally, it has been found that the sudden application of strict greenhouse gas emission limits with zero revenue recycling harms the economy. In contrast, the more gradual introduction of auctioned greenhouse gas permits with revenue recycling and a stimulus for R&D would have a beneficial effect on the economy. More specifically, environmental tax reform, in which moderate carbon taxes or auctioned permits are applied with the revenue used to lower taxes on work or investment, can benefit the economy if properly structured. While there are not many U.S. studies on the effect of carbon taxes or other environmental charges on employment level, there are over 100 European studies that examine the relationship between environmental taxes and job creation. The majority of these studies find that environmental taxes with revenue recycling create jobs on net (Hoerner and Bosquet, 2001).

Ultimately, the selection of policy instruments chosen to reduce greenhouse gas emissions will have job impacts, positive or negative, in the same way that other public policy choices do. If done correctly, policies to reduce greenhouse gas emissions can stimulate the economy while offsetting the negative impacts on different sectors of society. Figure 3.2 provides a summary of some of the studies.

Figure 3.2 - Studies on the Economic Impact of Properly Designed Climate Policies

Study	Effects on GDP	Effects on Employment
U.S. DOE, 1997: U.S. Carbon reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies.	Reducing CO_2 levels to 1990 levels: Neutral or positive effect on GDP	
ACEEE, 1997: Energy Innovations: A Prosperous Path to a Clean Environment	Reducing CO_2 levels to 10% below 1990 levels: Economy wide savings of $58 billion per year	+ 800,000 jobs
Union of Concerned Scientists, 1998: A Small Price to Pay: U.S. Action to Curb Global Warming is Feasible and Affordable	Significant reductions in greenhouse gas emissions: Little or no effect on GDP.	
Tellus Institute, 1999: America's Global Warming Solutions.	Reducing CO_2 levels 7-14% below 1990 levels: Economy wide savings of $43-46 billion per year	+ 900,000 jobs
Interlaboratory Working Group, U.S. DOE, 2000: Scenarios for a Clean Energy Future.	Reductions of 9.5% to 29.4% of carbon emission compared to business as usual: net savings of $47.7 to $107.6 billion per year.	
Economic Policy Institute and Center for a Sustainable Economy, 2002: Clean Energy and Jobs	Reducing CO_2 emissions 50% by 2020: Increase in GDP of 0.6%	+ 1,400,000 jobs

While the economy as a whole is likely to benefit from a well-structured comprehensive energy policy, there will still be winners and losers in different sectors. If energy prices increase substantially, it is likely that some energy intensive industries may incur job losses. At the same time, other industries, such as energy efficiency, emission control devices, and alternative energy, are likely to experience job gains. By encouraging the development of cleaner technologies, the U.S. has the potential to become more internationally competitive in this growing field, similar to the Danish experience with wind turbines.

With respect to African American employment specifically, African Americans are not concentrated in firms likely to be impacted by increasing energy prices. The total percentage of African Americans directly employed in the U.S. energy sector has fallen from around 1.8% in 1983, to 1.1% today. Similarly, the number of African Americans employed in the energy industry has fallen over the past two decades, from a high of 215,000 in 1989 to approximately 176,000 in 2002 (Census, 2004). In contrast, employment in the renewable energy sector is on the rise. African Americans comprise approximately 8.5% of all employees in industrial categories that include renewable industries (Census, 2004). This share is roughly equivalent to black employment in the energy in general. However, renewable energy is much more labor intensive per unit of energy produced. As such, a shift toward renewable energy is likely to increase African American employment numbers in the energy sector (REPP, 2002).

With respect to African American-owned businesses, the energy intensity of black-owned firms appears to be roughly equivalent to the energy intensity of all firms. In 1997, African Americans owned 4.2% of U.S. firms in industries with greater than average energy intensities (Census, 2001). Those firms were responsible for less than half a percent of sales and receipts in their industries.

An Optimal Climate Policy for African Americans

Overall, the preceding factors suggest that a coherent energy and climate policy for African Americans will possess the following components:

Effective at Reducing Carbon and Ancillary Pollutants

The optimal policy will reduce carbon dioxide emissions in such a way as to facilitate meaningful international cooperation to reduce global emissions of carbon dioxide. Of equal importance to African American health, there is significant room from policies to generate substantial co-benefits by reducing emissions of particulates, NOx, SOx, and mercury. The larger the reduction in carbon dioxide emissions, the larger these two health benefits are likely to be. Small or marginal reductions in carbon will be unlikely to significantly mitigate health threats from climate change, but may still create sizable co-benefits.

Economically Efficient

Given the estimated damages from climate change, the optimal climate change policy will employ market mechanisms such as tradable permits or taxation to maintain economic efficiency. Additionally, economic efficiency can be aided by stimulating significant public investment in energy efficiency and renewable energy. If designed properly, climate policy is likely to have positive overall effects on the economy. There are significant long-term employment and GDP benefits that can be reaped by shifting away from carbon fuels toward energy efficiency and renewables. Generally, policies that generate revenue by taxing carbon pollution or auctioning carbon permits will be more economically efficient than those that do not generate revenue. As such, an optimal climate policy is flexible in where carbon abatement occurs, and uses revenues from abatement to pursue an efficient transition. An additional substantial economic benefit of such a policy is the reduced vulnerability of economy to oil price shocks that such a shift is likely to entail.

Equitable

A final important component of any climate policy is the ability to offset detrimental effects on vulnerable populations and individuals. For example, regressive increases in the price of energy can be offset by redirecting a fraction of revenues, e.g. by lowering payroll taxes. Generally, the best-case scenario appears to be a gradually phased-in system of carbon charges (e.g. auctioned carbon permits). Properly designed carbon charges represent a particularly efficient way to reduce the greenhouse gas emissions and global warming affecting African Americans. One issue with carbon permits is whether to give away permits (e.g. "grandfather" them to existing polluters) or auction permits. Auctioning permits has the added benefits of generating revenues that can be used to offset any regressive or transitional economic effects of the charges on African Americans. It is estimated that this would require in the range of 10-20% of revenues. The remaining revenues can be used to reduce distortionary taxes, address budget deficits, or provide essential services. In any case, policies that address climate change or energy policy need to be aware of the distributional effects they have, and designed to alleviate such hardships.

Section Two: Policy Overview

The table below summarizes findings for the policies considered.

Figure 3.3 – Climate Change Related Policy and African Americans

Policy	Benefits	Drawbacks	Issues Specific to African Americans
Appliance Efficiency Standards	• Significant life-cycle consumer savings • National energy savings • Reduced fuel use and associated externalities	• Higher initial appliance costs • Reduced profitability in some sectors	• Higher life-cycle savings for low-income groups • Significant benefits for home-renters • Reduced urban air impacts
Arctic National Wildlife Refuge	• Increased domestic oil supply • Marginally reduced energy prices • Economic benefits for oil and gas sector, and regional benefits (e.g. Alaska)	• Environmental concerns over Arctic wilderness and climate • Only marginal effects on energy prices or price volatility	• Disproportionately small employment benefits
CAFE Standards	• Significant consumer savings over life of vehicles • Reduced national petroleum consumption, and economic susceptibility to oil price shocks	• Possibly higher traffic fatalities • Higher initial vehicle costs • Reduced profitability for vehicle manufacturers • Economic efficiency concerns	• Fewer direct effects due to lower rate of car ownership among African Americans • Disproportionate benefits in terms of improved air quality and reduced economic vulnerability to oil price shocks.
Ethanol Promotion	• Potential improvements in air quality • Reduction in dependence on foreign oil • Stimulates domestic agriculture industry	• High costs of production • Environmental issues associated with higher agricultural production • Opportunity cost of tax dollars spent on promotion, or economic efficiency issues associated with regulatory burden	• Few African American farmers to directly benefit • Potential air quality benefits
Fossil Fuel Tax Incentives	• Reduced energy prices • Increased domestic oil, gas, and coal supplies and reduced reliance on foreign energy. • Economic benefits for domestic energy industries.	• Three billion in lost revenues • Environmental and health externalities associated with fossil fuel. • Reduced competitiveness of renewable sectors	• Higher benefits from reduced energy prices. • Higher costs from fossil fuel externalities.
Hydrogen Promotion	• Environmentally clean fuel	• High economic costs of production • Environmental issues associated with source of hydrogen • Possible safety issues	• Improved air quality disproportionately benefiting African Americans. • Reduced vulnerability to oil price shocks disproportionately benefiting Blacks.

LIHEAP and WAP	• Improved health and reduced financial burden for low income households • Improved energy efficiency	• Opportunity cost of LIHEAP and WAP funds • Subsidizes environmental and health externalities	• Significantly higher use of LIHEAP program than general population
New Source Review Modifications	• Reduced costs for existing generating facilities and other point sources • Potential marginal cost savings for consumers	• Significantly higher levels of air pollution	• Unclear effects on jobs or fuel prices. • Notably higher health effects due to air pollution from existing facilities.
Nuclear Promotion	• Carbon-free electricity generation • Marginally reduced fuel imports	• High costs of electricity generation • Opportunity costs of nuclear subsidies • Environmental concerns associated with nuclear waste and proliferation	• Few issues specific to African Americans
Renewable Tax Incentives	• Economic benefits through learning-by-doing • Environmental benefits • Increased labor requirements per unit of energy produced	• Lost governmental revenue	• Health benefits of reduced fossil fuel consumption disproportionately benefit African Americans
Renewable Portfolios	• Reduced carbon dioxide, NOx, and SOx emissions • Reduced vulnerability to global energy prices • Potential consumer savings	• Potential price increases • Regulatory burden	• Disproportionate health benefits from reduced fossil fuel combustion
Climate Stewardship Act	• Reduces greenhouse gasses in economically efficient manner. • Likely to reduce emissions of other criteria pollutants. • Recycles revenues with adjustment fund	• Distributional effects on economy • Continued environmental externalities • Probable increase in price of electricity	• Health benefits disproportionately go to African Americans • Impacts of higher energy prices likely to be disproportionately felt by African Americans unless adjustment fund dedicated to relieving effects.
Multi-pollutant Power Plant Legislation	• Reduces four criteria pollutants • Reductions in health impacts from mercury and ozone. • Economically efficient trading program created	• Distributional effects on economy • Continued environmental externalities • Probable increase in price of electricity	• Reduced air pollution disproportionately benefits African Americans, as do efforts to mitigate climate change • Energy price increases negatively affect African Americans

Appliance Efficiency Standards

Overview

Appliance energy efficiency standards are a regulatory tool used by the government to encourage increased energy efficiency as well as to reduce electricity demand. These standards are designed to reduce energy use by improving energy efficiency. Standards are useful because consumers tend to overemphasize initial appliance costs and downplay future savings with regard to energy efficient appliances. More efficient appliances often offer considerable cost savings to consumers over time and they reduce overall energy demand.

The federal government has regulated appliance efficiency since 1987 and every administration has strengthened the standards.

Arguments for Appliance Efficiency Standards

Consumer savings

The projected cumulative net savings to consumers, including the cost of more efficient equipment, are approximately $33 billion from 1990 to 2010 in the U.S. If fuel and electricity prices decline over the next decade, net savings would still approach $30 billion. The average benefit/cost ratio for consumers for residential appliance efficiency standards is about 3.5 (Koomey et al., 1998). So for every dollar consumers spend on efficiency, they save 3.5 dollars.

Researchers at Lawrence Berkeley National Laboratories (LBNL) estimated that additional appliance efficiency improvements of 35% would create savings for four out of five households under the full range of hypothetical scenarios (McMahon and Liu, 2000).

National savings

Appliance efficiency standards are responsible for a reduction in primary energy use in the United States in 2004 of approximately 700 trillion Btus, with cumulative savings from 1990 to 2010 of around 10 quadrillion Btus (Koomey et al., 1998).

Financially, appliance efficiency standards in the residential sector have been a successful, cost-effective method for promoting energy efficiency. According to research at LBNL, every federal dollar spent on administering and implementing appliance standards will contribute *$165* of net present-valued savings to the U.S. economy between 1990 and 2010.

Environmental benefits

- LBNL has projected that between 2000 and 2010, federal appliance efficiency standards will reduce carbon emissions by approximately nine million tons per year, which is approximately equivalent to 4% of annual emissions in 1990 (Koomey et al., 1998).

- The American Council for an Energy-Efficient Economy estimates that the most recent appliance efficiency standards finalized in January, 2003, which cover clothes washers, air conditioners and water heaters, will reduce the need to build 170 new power plants over the next two decades. (ACEEE, 2003)
- Reduced electricity generation not only reduces greenhouse gas emissions, but also decreases emission of associated pollutants such as NO_x, SO_x, ozone, and mercury.

Arguments Against Appliance Efficiency Standards
A potentially important drawback to appliance efficiency standards is that they can increase appliance purchasing costs to consumers, as well as increase manufacturing costs. The burden of an additional up-front cost is hardest felt by those with low incomes and seniors. However, according to most reviews, these additional costs are, on average, significantly outweighed by energy savings. In most instances appliance market transformations have had low incremental costs and rapid paybacks (ACEEE, 2003).

Impacts on African Americans
Although the burden of higher up-front costs for appliances can be particularly difficult for low income groups, as noted above, the benefits of reduced electricity use are even greater for low income groups who spend a greater proportion of their income on energy.

The benefits of appliance efficiency standards are disproportionately reaped by people who rent, as renters pay for electricity use but usually do not purchase large appliances. Given that over 50% of African Americans in the U.S. rent (compared to less than 30% of other Americans), this factor is particularly important for African Americans.

The health benefits of reduced primary energy use will be disproportionately felt by African Americans (See Chapter 1).

Current State of Legislation
S. 2095 includes legislation to promote efficiency in suspended ceiling fans, refrigerated bottled or canned beverage vending machines, commercial refrigerators, freezers, and refrigerator-freezers, illuminated exit signs, compact florescent lights, and other items. In most cases the bill does not establish efficiency standards but rather requires standards to be developed and imposed. It is impossible to know at this point how effective these standards will be at improving overall efficiency of national appliances.

Arctic National Wildlife Refuge Oil Exploration

Overview
The Arctic National Wildlife Refuge (ANWR) is composed of 19 million acres in northeastern Alaska. It is administered by the U.S. Fish and Wildlife Service (FWS), a part of the Department of the Interior (DOI). This area is believed to hold at least two billion barrels of economically recoverable oil and it could hold as many as 13 billion barrels of economically recoverable oil, depending on the price of oil (Corn et al., 2003). ANWR is one of the largest undeveloped areas in the world. It is home to a variety of flora and fauna.

Current federal law prohibits oil exploration and drilling in ANWR. A variety of current energy legislation measures would allow for oil exploration in part or all of ANWR.

Purpose
The reasons for opening up ANWR to oil exploration include reducing dependence on foreign oil, marginally reducing the price of gasoline to consumers, stimulating job creation, both in Alaska and nationally, and reducing the U.S. trade deficits.

Arguments for Arctic National Wildlife Refuge Oil Exploration
The primary argument for opening ANWR to oil exploration is that it could provide a relatively large new source of U.S. oil at a time when many U.S. oil reserves have passed peak production. This domestic supply would help to partially reduce the growing natural resources trade deficit of which petroleum products are the largest factor. Proponents argue that increasing the supply could help decrease volatility in the world oil markets.

Large repositories of natural gas may also be found in ANWR, which could be used to increase the domestic gas supply and potentially reduce gas prices. While there is currently no economically viable means to deliver the gas to market, current proposed energy legislation also calls for support for the construction of a natural gas pipeline that could deliver this gas (CRS, 2003). Proposals include tax credits to guarantee a minimum price for Alaskan natural gas, a $10 billion loan guarantee for companies that undertake the project, and allowances for accelerated depreciation on natural gas gathering and distribution lines (CRS, 2002).

An additional argument for drilling in ANWR is that this would create petroleum extraction and refining jobs, both in Alaska and elsewhere, as well as associated jobs due to the economic multiplier effect. Drilling would also help to protect existing jobs by extending the life of the trans-Alaska oil pipeline.

Arguments Against Arctic National Wildlife Refuge Oil Exploration
The primary argument against drilling in ANWR is that drilling and related activities will cause significant and long-term harm to this relatively pristine area. Another environmental concern is that increasing the existing supply of oil, rather than working to find alternatives to burning oil, will further add to climate change gases in the

atmosphere, increasing the risk of climate change, and will further add to urban air pollution as well.

An addition argument against drilling in ANWR is that proponents of drilling in ANWR overstate the national security benefits of increased domestic production. Peak production, which would occur around 2027 if drilling commenced immediately, would most likely produce 750,000 bbl per day, at best, or less than 4% of daily U.S. petroleum consumption (USGS, 2003). Average production levels would only account for 1% of U.S. oil consumption, less than is saved through increased appliance efficiency. This level of production would have virtually no effect on the price of oil because the price of petroleum is determined in the global petroleum market, and domestic supplies enter that market as a very small percentage increase in total global production. Increasing domestic petroleum supply generally will not provide substantial protection against global petroleum price spikes.

In terms of the efficiency of promoting drilling in ANWR as a solution to oil shortages and price shocks, improved energy efficiency and increased renewable incentives could reduce energy consumption more quickly and without comparable environmental externalities. Phasing in CAFE standards of 40mpg by 2012 would save an amount of oil over the next fifty years an estimated fifteen times greater than ANWR is likely to produce (NRDC, 2003).

Issues specific to African Americans

Drilling in ANWR will have minimal direct impacts on African Americans. While exploration and extraction in ANWR is likely to create jobs, for which estimates vary, most jobs will be located in Alaska where African Americans comprise less than 4% of the population. Jobs are also likely to be concentrated in the oil and gas extraction and petroleum refining industries for which African Americans represent approximately 5% and 10% of the workforce, respectively, and primarily in the South. Therefore, African Americans are unlikely to reap significant direct employment opportunities from opening ANWR to oil exploration. Indirect benefits through general economic growth are likely to be too marginal to speculate on.

With respect to more general health and economic effects, African Americans are likely to disproportionately benefit from any marginal reduction in the price of natural gas and electricity, but benefit less than the average American from reduction in gasoline and motor oil prices. Increased oil consumption will lead to increased pollution emissions which will disproportionately negatively impact African-Americans. (See Chapter 1)

Current State of Legislation

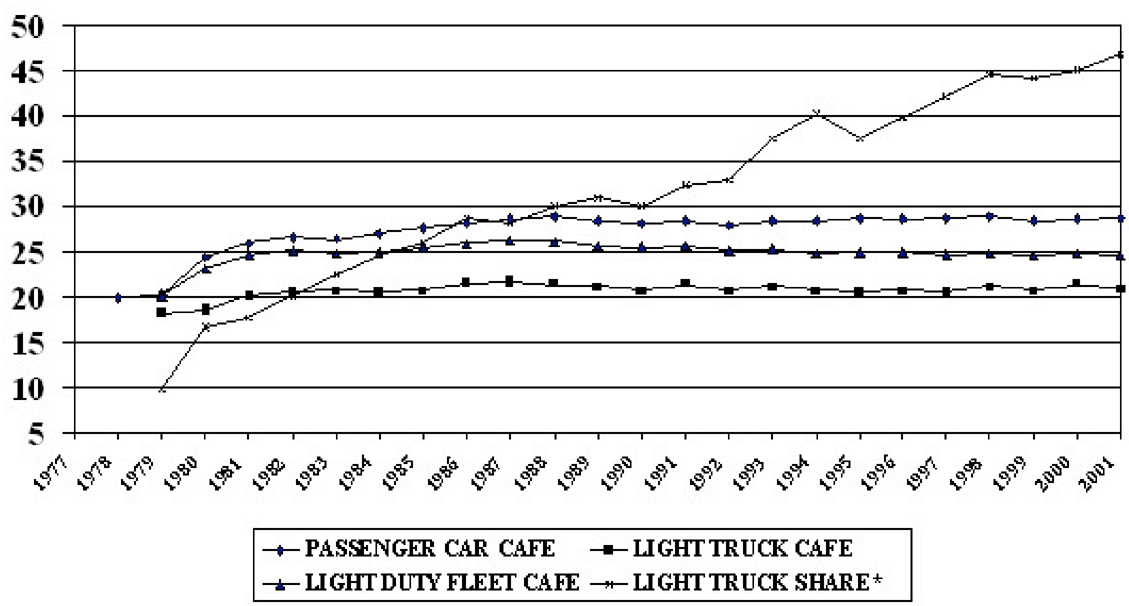
S.2095 provides tax incentives for the development of Alaskans natural gas. S.2095 includes the Alaska Natural Gas Pipeline Act, which requires the President and the Secretaries of the Interior and of Energy to expedite the Federal decision-making process for access to Federal lands for energy projects.

There is no legislation currently being debated regarding opening up ANWR but the Administration's FY'05 budget includes income from ANWR oil so legislation is being planned. Most likely it will be as an amendment to an unrelated bill.

Corporate Average Fuel Economy (CAFE) Standards

Overview
Following the 1973 oil crisis, Congress passed the Energy Policy and Conservation Act of 1975. As part of this legislation, CAFÉ standards were introduced as a measure to reduce U.S. dependence on foreign oil. The program requires automobile manufacturers to meet sales-weighted average fuel economy standards for both passenger cars and light-duty trucks. If a manufacturer does not meet the standard, it is liable for a civil penalty of $5.00 for each 0.1 mpg its fleet falls below the standard, multiplied by the number of vehicles it produces. As of 2002, the standards were 27.5 miles per gallon (mpg) for passenger cars, and 20.7 mpg for light trucks (NRC, 2002). CAFÉ standards have remained essentially unchanged since 1985, despite improved technologies which would enable higher fuel efficiency standards to be met. Due to the popularity of sport utility vehicles (SUVS), vehicles have become, on average, 20% heavier and less fuel efficient.

Corporate Average Fuel Economy Standards (NHTSA, 2002)



The majority of the following assessment relies on the 2002 report of the National Research Council's Committee on the Effectiveness and Impact of Corporate Average Fuel Economy (CAFÉ) Standards. The NRC's review is one of the most comprehensive studies of CAFÉ standards to date.

Purpose

- Fuel efficiency standards are intended to reduce overall fuel consumption in order to address two major externalities: the impact of motor vehicle fuel consumption on environmental quality, and the macroeconomic impacts of oil demand.
- Reduced petroleum consumption both lessens the contribution of motor vehicles to urban air and water pollution, which can have significant health impacts, and

lessens the accumulation of carbon dioxide in the atmosphere, thereby mitigating the future effects of global climate change.
- Reduced imports of petroleum will lessen both the downward pressure that oil imports currently place on the strength of the American dollar and the vulnerability of the U.S. economy to macroeconomic shocks (NRC, 2002).

Arguments for Increasing CAFÉ Standards
There are multiple arguments for increasing the stringency of CAFÉ standards:

Improved CAFÉ standards can result in significant fuel savings to consumers.
- The NRC's average scenario indicates that if cost-efficient standards are set based on the 14-year average life of a vehicle, consumers would save between $700 and $2,500 during that period despite the higher initial cost of the vehicle (assuming a 12% discount rate). These savings are highest for large pickup trucks and SUVs, and more moderate for cars.

CAFÉ standards can reduce national fuel consumption.
- A 15% increase in fuel efficiency (mpg) would reduce national consumption of gasoline by 22 billion gallons between 2000 and 2030.
- A 45% increase would correspond to a fuel savings of 55 billion gallons over the same period (NRC, 2002).
- The NRC (2002) estimates that the social value of reduced fuel associated with climate change alone at $0.12 per gallon of gasoline (corresponding to social damages of $50/ton carbon dioxide emitted). For a 15% increase in fuel efficiency, this would translate to a savings of $2.64 billion between 2000 and 2030. This is not including the social cost of air pollution, water pollution and other externatities associated with motor vehicle fuel use, as well as the economic damages associated with fuel dependency.

CAFÉ standards can reduce other criteria pollutants such as NO_x and volatile organic compounds. While these pollutants are already controlled by federal- and state-mandated limits on grams per mile, some especially efficient vehicles operate well below established standards.

Arguments Against Increasing CAFÉ Standards
CAFÉ standards may marginally increase traffic fatalities. While there was some dissension, the NRC (2002) estimated that the downsizing of vehicles partially due to CAFÉ standards "probably resulted in an additional 1,300 to 2,600 traffic fatalities in 1993."

CAFÉ standards generally result in higher sticker prices. The NRC states that, "The price for higher fuel economy technology is paid when a vehicle is purchased." Part of the costs of improved efficiency technologies may be borne by the car manufacturers. NRC reports that the effects of CAFÉ standards on overall employment will be insignificant. Improvements in air quality associated with improved fuel economy may be somewhat offset by the fact that fuel economy standards may encourage the increased use of diesel engines. While more fuel efficient, diesel engines create emissions that are considerably more toxic than those from unleaded gasoline.

Policy Efficiency
Other policies may accomplish the same goals of reduced fuel consumption at lower overall costs.

- CAFÉ standards with trading. The NRC (2002) supports the institution of a trading regime, wherein automobile manufacturers can purchase fuel efficiency offsets from other manufacturers. Such a regime would both encourage innovation and reduce overall costs to consumers and manufacturers.
- Gasoline taxes. Gasoline taxes would encourage consumers to buy more fuel efficient automobiles as well as to drive less. Gasoline taxes also encourage improved vehicle maintenance to maintain engineered fuel economy levels, and the retirement of low fuel economy vehicles. Tax revenue could be used to offset the regressive aspects of gasoline taxes.

Issues specific to African Americans

Economic Issues:
African Americans would be relatively *less* affected by the *direct* economic costs and benefits of enhanced CAFE standards than non-African Americans.

The consumer expenditure survey indicates that African Americans dedicate a lower fraction of household expenditures to gasoline and motor oil than other groups, due in part to lower levels of car ownership. As a consequence, the costs and benefits of increased fuel efficiency may be proportionally less important to African Americans than to non-African Americans in America.

African-Americans may be more susceptible to economic downturns resulting from oil price shocks. In this way, CAFE standards may be disproportionately beneficial.

Health Issues:
The health and environmental benefits of CAFÉ standards are likely to be enjoyed disproportionately by African Americans. Besides the reduction in greenhouse gases that result from CAFÉ standards, increased CAFÉ standards are likely to be accompanied by reductions in the emissions of other pollutants such as NOx and volatile organic compounds. The resulting improvements in air quality would disproportionately benefit urban, African Americans who are among those most adversely affected by current poor air quality standards. (See Chapter 1)

Current State of Legislation
Neither House nor Senate decided to take decisive action to increase CAFÉ standards. A loophole was created in Conference Committee that would give CAFÉ credit to manufacturers of cars that can burn alcohol fuel. This loophole could lead to an erosion of CAFÉ standards of up to 5% (ACEEE, 2003)

Ethanol Promotion

Overview

Ethanol is used as an oxygenate additive in gasoline, which acts to reduce air pollution from carbon monoxide and ozone, and increase octane levels. Ethanol is primarily produced and consumed in the Midwest, where corn, the primary feedstock for ethanol production, is grown. In past legislation, ethanol production has been stimulated through partial exemption from the motor fuels excise tax, as well as the Clean Air Act Amendments of 1990 which require reduced carbon monoxide and volatile organic compounds emissions through use of oxygenated or reformulated gasoline in non-attainment areas (Yacobucci and Womach, 2003).

Ethanol use is encouraged in existing legislation through tax incentives for ethanol and requirements for oxygenates to be added to motor fuels.

Purpose

The ostensible goals of subsidizing ethanol of mandatory ethanol requirements are both improving air quality and reducing reliance on fossil fuels.

Arguments for Ethanol Promotion

Gasoline additives such as ethanol can lead to improvements in air quality:

- The EPA estimates that reformulated gasoline (RFG) use has decreased toxic emissions by one-third because oxygenates in fuels displace other, more dangerous compounds such as benzene. RFG use has reduced volatile organic compounds (VOCs) emissions from vehicles by 17%. Carbon monoxide emissions are also reduced by using oxygenates such as ethanol.
- According to a study by the Argonne National Laboratory, RFG containing 10% ethanol will reduce greenhouse gas emissions by 1%. By 2010, with improvements in production processes, the reduction in greenhouse gas emissions from gasoline containing 10% ethanol could be as high as 8-10% (Wang, 1999).

The use of ethanol as a motor fuel may also minimally reduce U.S. reliance on oil imports therefore reducing susceptibility to price shocks and oil shortages. Although the energy requirements associated with the production of ethanol are high, most of the energy that is used to produce liquid ethanol comes from natural gas or electricity (i.e. coal, nuclear, and natural gas).

Due to the increased demand for corn, Ethanol promotion benefits portions of the agriculture sector (Olsen, 1997).

Arguments Against Ethanol Promotion

Economic costs:

- Ethanol is expensive to produce leading to a price that is roughly twice that of gasoline. While there are currently a number of federal and state incentives that act to reduce the effective price of ethanol, without these incentives, little or no ethanol would be used in the transport sector (Yacobucci and Womach, 2003).

- The tax exemption for ethanol is a corporate subsidy that may encourage the inefficient use of agricultural and other resources. It may also increase the cost of corn (Yacobucci and Womach, 2003).
- Ethanol tax incentives also deprive the Highway Trust Fund of needed revenues. In 1997, the General Accounting Office estimated that the tax exemption lead to approximately $7.5 to $11 billion in foregone Highway Trust Fund revenue between 1979 to 2000 (Wells, 2000).

Environmental Issues:

- RFGs are associated with increased emissions of nitrogen oxides (NO_X) (EPA, 1999).
- As of the mid-1990s, the amount of energy required to produce ethanol was approximately equal to the amount of energy obtained from its combustion. As a consequence, ethanol use may not lead to decreased fossil fuel use or decreased greenhouse gas emissions (Shapouri, 1995).
- Increased agricultural output is associated with numerous environmental externalities including soil erosion, nitrate pollution, and eutrophication.

Issues Specific to African Americans

Economic Effects:

- There is little direct economic benefit from ethanol subsidies or requirements since most economic benefits from ethanol promotion go to areas with few African-Americans.
- Ethanol requirements could moderately reduce the effects of petroleum price shocks.

Health Effects:

- Ethanol use could lead to improved air quality in urban areas where are African Americans are disproportionately affected.
- Similarly, ethanol use could reduce greenhouse gas emissions, which may have disproportionate impacts on African-Americans.

Current State of Legislation

S.2095 authorizes the Secretary of Energy to:
Make loan guarantees for private sector construction of facilities that will process and convert municipal solid waste and cellulose biomass into fuel ethanol and other commercial byproducts;
Provide grants for construction of ethanol production facilities.

S.2095 also directs the Administrator of the EPA to promulgate regulations to ensure that domestic motor vehicle fuel consumption includes renewable fuel containing an increasing percent of ethanol and other biomass components. After 2013, 5 billion gallons a year of ethanol needs to be added to the fuel supply annually. Ethanol producers are also granted continued tax credits under S.2095.

Total appropriation for ethanol in S.2095 amounts to $5.912 billion.

Fossil Fuel Industry Tax Incentives

Overview
A number of federal tax breaks exist for the various fossil fuel production industries to promote the research and development of new technologies related to fossil fuel exploration, extraction, refining and use. Tax incentives also promote the development of marginally economically viable sites, and help defray the cost of environmental control technologies. Tax incentives also reduce royalty payments for fossil fuel extraction on public lands

The tax expenditures listed for energy production (excluding alcohol fuel credits and conservation subsidies) for the fiscal year 2003 were:

FY 2003 Federal Tax Expenditures on Energy (OMB, 2004)

Category	*Expenditure ($ Millions)*
Expensing of exploration and development costs	210
Excess of percentage over cost depletion, fuels	640
Alternative fuel production cost	1,280
Exception from passive loss limitation for working interests in oil and gas properties	20
Capital gains treatment of royalties on coal	100
Exclusion of interest on energy facility bonds	90
Enhanced oil recovery credit	400
New technology credit	280
Total	3,020

Purpose
The purpose for tax expenditures on fossil fuels depends on the specific category. In general, the goal is to provide economic assistance to domestic energy industries while providing affordable and reliable energy supplies to consumers.

Arguments For Fossil Fuel Industry Tax Incentives
The primary benefits of tax incentives for the fossil fuel industry are economic. These incentives reduce the overall production costs, and therefore sales costs, of energy supplies such as electricity, home heating fuels, and gasoline. In addition, reduced energy prices can help to decrease the price of other goods, such as food and appliances, that require energy inputs in the production and distribution processes. Additional benefits

include job creation and preservation in certain energy industries, increased investment by energy corporations, and general economic stimulation.

Arguments Against Fossil Fuel Industry Tax Incentives
There are a variety of drawbacks associates with fossil fuel tax incentives.

Economic Effects

- By creating tax incentives for the energy industry, the federal government loses approximately $3 billion in revenues each year. There is an opportunity cost associated with this lost revenue in that this revenue could be used other purposes such as education, health care, or tax incentives for other industries.
- Tax incentives also create an "unequal playing field" between fossil fuel industries and other industries in general and especially with competing industries such as renewable fuels, and energy efficiency and weatherization sectors.
- It is not clear that these tax incentives are passed onto consumers in the form of lower prices for energy. Recent increased energy prices and record profits for energy companies have led to allegations of purposefully reducing energy supplies to increase price.

Externalities
As discussed in Chapter 1, fossil fuel use includes a variety of environmental and health externalities. The list of externalities associated with the fossil fuel energy system includes global climate change through the release of carbon and other gasses, acid rain, reduced agricultural productivity, infrastructure damage, increased atmospheric deposition of nitrogen, mercury pollution, and various health effects such as respiratory illnesses and asthma. For a full review of the climate effects of fossil fuel use, see the IPCC report on global climate change (2001). Health effects are well summarized on EPA and other governmental health related web-sites.

Issues Specific to African Americans
African Americans are both disproportionately benefited and harmed by fossil fuel tax incentives. The primary benefit received by African Americans is a marginal reduction in the price of energy, in particular home heating fuels and energy embedded in purchased products. As African Americans spend a considerably higher percentage of expenditures on fuel purchases, a reduction in the price of fuel disproportionately benefits the African American community.

In terms of health effects, tax incentives for fossil fuels disproportionately harm African Americans because these incentives promote fossil fuel development and use. Chapter 1 indicates that the health effects of energy use are disproportionately felt by African Americans. Similarly, there are reasons to believe that climate effects will also affect African Americans more than the average American.

Current State of Legislation
S.2095 includes incentives for the oil and gas industries. S. 2095:

- Directs the Secretary of Energy to implement initiatives that target research, development, and commercial application in fossil energy and ultra-deepwater and unconventional natural gas, and other petroleum resource exploration and production;
- Sets forth a program of production incentives that includes oil and gas royalties in kind, marginal property production, oil and gas leasing in the National Petroleum Reserve in Alaska, and natural gas production in the Gulf of Mexico;
- Appropriates $2.906 billion for fossil fuel research and development programs;
- Provides tax credits for oil and gas production from marginal wells worth approximately $414 million.

Total authorized spending for oil and gas (not including R&D) in S.2095 is $949 million and for coal is $3.925 billion. Some of this is in the form of tax incentives and some in direct funding.

Hydrogen Promotion

Overview

Although it appears in pure form in only small quantities, hydrogen is the most common element on the planet. The largest repository of hydrogen is water. Other sources are fossil fuels and other hydrocarbons. Hydrogen has recently attracted significant attention as a secondary fuel source: a means to store and transport energy derived from other sources such as solar energy, nuclear energy, or fossil fuels. The benefit of using hydrogen as an intermediary is that it is a zero-emissions fuel and the byproduct of combustion is only water.

Hydrogen can be generated from water or stripped from hydrocarbons. Currently, natural gas is the main source for hydrogen fuel production. Because fuel can be continuously supplied, fuel cell-powered electric vehicles do not face some of the range and fueling limitations as battery-powered electric vehicles. At this time, no production vehicles are powered by pure hydrogen.

Hydrogen use as a fuel has received government support since the early 1990s. In recent energy legislation and proposed legislation, hydrogen has been promoted in a number of ways (Bamberger, 2003; Sissine, 2003).

- In January 2003, President Bush announced a new $720 million research and development program for hydrogen as a transportation fuel. The Hydrogen Fuel Initiative, as it is termed, works together with the FreedomCAR initiative, with a goal of producing hydrogen-fueled engine systems that achieve much higher efficiency than today's conventional engines at a comparable cost by 2010.
- The Administration's 2004 budget request would increase overall funding for research into hydrogen fuel, fuel cells, and vehicle technologies by roughly 30%, or an additional $720 million over five years. The House Appropriations Committee elected to increase hydrogen funding by $700 million. The Senate Appropriations Committee agreed to fully fund the President's hydrogen budget request. The Senate energy legislation, however, does not authorize increased funding for hydrogen.
- The Senate version of H.R. 6 would require the production of 100,000 hydrogen-fueled cars by 2010 and 2.5 million vehicles by 2020 and annually thereafter.
- The Administration is also seeking $4 million for the Nuclear Hydrogen Initiative, a new DOE program in which nuclear reactors would produce hydrogen to fuel motor vehicles. The Senate approved legislation that included a $500 million authorization to construct a demonstration reactor in Idaho to produce hydrogen.

Purpose

The fundamental purpose of hydrogen promotion is to develop a clean and cost effective fuel.

Arguments For Hydrogen Promotion

Environmental Benefits:

Because hydrogen use (not production necessarily) as a fuel is inherently very clean, hydrogen powered vehicles could greatly improve air quality, particularly urban air quality where vehicle emissions represent a large portion of total emissions.

Hydrogen use produces no greenhouse gases so if it is produced from non-fossil fuel sources, it can help mitigate the inputs to anthropogenic global climate change.

Arguments Against Hydrogen Promotion
Producing hydrogen is very expensive at this time, relative to producing other fuels. As fossil fuels are currently the main source of hydrogen production, increased prices for gas, oil, or coal would also increases the price of hydrogen.

Hydrogen production can have significant environmental impacts (Morgan, 1995):

- Hydrogen could ultimately be produced using solar or other renewable sources of energy. However, in the near- and mid-term it is more likely to be produced from fossil fuels and nuclear-generated electricity. Unless fossil fuels are paired with sequestration efforts, the carbon benefits of hydrogen are essentially zero, or even negative. The benefits can be negative because hydrogen production from fossil fuel leads to higher carbon dioxide emissions for amount of embodied energy produced than the emissions from using the fossil fuel itself as a fuel.
- Production of hydrogen from renewable sources might considerably reduce production emissions, but these techniques are not, as of yet, adequately developed.
- In the future, hydrogen could be generated from water using solar energy, making an emission free fuel cycle.
- In the near-term, the most likely source for hydrogen is natural gas. Although not emission-free, the use of natural gas as a feedstock for hydrogen would still lead to much lower overall emissions compared to petroleum.

Hydrogen development may reduce funding and political will-power critical to other programs (CRS, 2002). Critics of the hydrogen program suggest that it reduces the automotive industry's responsibility for developing technological innovations and that it is intended to undermine attempts to significantly improve vehicle CAFE standards. Funding for hydrogen development has reduced funding for other programs that could have a greater positive impact on the environment in the short run.

Safety Issues:
Hydrogen is highly flammable. As a consequence, the manufacture, transport, storage and distribution of hydrogen must be arranged carefully. Currently, there is little of the necessary infrastructure to support a move towards using hydrogen as a common fuel (CRS, 2002).

Issues specific to African Americans
Economic Effects:

- In the near-term, any hydrogen fuel system is likely to be more expensive than the fuels that it is replacing, particularly automobile fuels. Currently African Americans spend a smaller fraction of expenditures on gasoline and motor oils, and as such are less likely to be affected.

- A large-scale transition to hydrogen will reduce U.S. dependence on the global oil market. African Americans are more vulnerable to economic downturns associate with price spikes in this market, and as such will be disproportionately benefited.

Health Effects:

- Hydrogen has the potential to improve urban air quality significantly, which would disproportionately benefit African Americans. (See Chapter 1)

State of Current Legislation

S.2095 directs the President to establish an interagency task force on hydrogen fuel infrastructure for hydrogen-carrier fuels. It also instructs the Secretary of Energy, in partnership with the private sector, to conduct programs that address production of hydrogen from diverse energy sources. A total of $2.148 billion is appropriated for various aspects of hydrogen promotion. In addition, S.2095 appropriates $1.135 billion to establish an advanced nuclear reactor hydrogen co-generation project.

LIHEAP and WAP

Overview
The Low Income Home Energy Assistance Program, or LIHEAP, is a Federal program administered by the Department of Health and Human Services' Division of Energy Assistance. WAP is the Department of Energy's Weatherization Assistance Program. These federal programs provide block grant funding to state governments and tribes to aid low-income households in need of weatherization, heating, and cooling assistance. LIHEAP provides heating and cooling assistance to more than 5 million low-income households. WAP provides energy efficiency services to more than 70,000 homes every year.

LIHEAP and WAP funding on a constant dollar basis has declined substantially over the past two decades despite the fact that over the last two decades the number of LIHEAP eligible households rose 50 percent, according to the Department of Health and Human Services. In 2003, 23% of the $1.8 billion in LIHEAP appropriations, roughly $400 million, was dedicated to home energy assistance.

Purpose
The intent of these funds is to reduce the number of cold- and heat-related deaths, while decreasing the economic burden of fuel prices on the poor.

Arguments For LIHEAP and WAP
LIHEAP and WAP are associated with improved health for low-income households by reducing the risk of heat- and cold-related deaths and, in particular, the risks of hypothermia. LIHEAP particularly focuses on households with children under the age of six, elderly people, and disabled individuals. These groups are at highest risk for life threatening illnesses or death due to extreme temperatures.

LIHEAP also leads to a reduction in the use of unsafe methods to keep homes warm, such as improperly vented portable heaters, stoves, fireplaces, or barbecue grills. These methods are fire hazards, and also create the risk of carbon monoxide poisoning.

WAP improves household energy efficiency through weatherization:
- WAP is estimated to return $1.30 in energy-related benefits for every $1 invested.
- WAP reduces the economic burden of home energy purchases on low-income households.
- Low-income households typically spend 14% of their total annual income on energy, compared with 3.5% for other households. Rising energy prices can increase this burden to 20% or more. WAP reduces average annual energy costs by $224 per household.

Both LIHEAP and WAP are successful at leveraging other funds. For example, for every dollar invested by DOE in WAP, the program leverages $3.39 in other federal, state, utility and private resources.

Environmental benefits

- Weatherization assistance can reduce the amount of electricity and heating fuel used by households, thereby improving local air quality and mitigating adverse health effects, particularly asthma.
- Improved energy efficiency can also reduce the quantity of greenhouse gases emitted to the atmosphere.

Arguments Against LIHEAP

The main argument against subsidy programs such as LIHEAP and WAP is that the funds used in these programs could be more efficiently employed elsewhere. For example, other potential uses of such funds are reduced federal income taxes, particularly for low-income brackets, increased spending on education or healthcare, and increased spending on renewable energy sources.

In addition, LIHEAP can have unintended negative environmental effects. Unlike weatherization assistance, heating and cooling subsidies can act to increase total household energy consumption, adding to atmospheric pollution and greenhouse gas emissions. No information is available on the relative effects of LIHEAP and WAP in terms of increasing or decreasing total energy use.

Issues Specific to African Americans

Most states do not currently collect information on LIHEAP and WAP fund recipients by race. RP's analysis, however, suggests that African American households are almost twice as likely to be eligible for LIHEAP assistance as non-African American households. African Americans comprise 12.7% of the overall population. Based on an eligibility model, African Americans are estimated to receive an estimated 23% of LIHEAP funds. In the few states in which data is actually available, the amount of LIHEAP funding directed toward African Americans exceeds the level predicted by a simple eligibility model. This implies that African Americans stand to benefit disproportionately from increased funding for LIHEAP and WAP.

The significant decline in LIHEAP and WAP funds on a CPI-adjusted basis over the past two decades has disproportionately impacted African American community's ability to pay for heating and weatherization.

Current State of Legislation

S.2095 increases LIHEAP funding to $3.4 billion annually for fiscal years 2004-2006. WAP is increased from $325 million in fiscal year 2004, to $400 million for fiscal year 2005, and $500 million for fiscal year 2006.

New Source Review Modifications

Overview
As part of the Clean Air Act Amendments of 1977, regulations were passed requiring large polluters to install state of the art emission control equipment when making major modifications to existing facilities. Approximately twenty thousand facilities fall under these provisions. Types of facilities include incinerators, power plants, iron and steel foundries, oil refineries, cement plants, chemical plants paper mills, and some manufacturing facilities.
These "New Source Review" provisions have been recently weakened though administrative changes within the EPA.

Before the EPA suggested modifications, the existing NSR provisions were an efficient and effective regulatory tool because of the remedial actions EPA could seek the court to impose on affected utilities. EPA can ask the court to require a facility that violates NSR to install the most recent BACT. Existing emission control technologies can reduce emissions of SOx and NOx by approximately 70-90%, depending on the specific case (Parker, 2000).

EPA rule changes for NSR are threefold:

- Allowing facilities to chose their emission baseline from any two years of the last ten. Traditionally, NSR requires the baseline to be based on emission from the last two year.
- Exempting facilities from requirement to install new pollution control when making modification to a piece of equipment, if the existing pollution control equipment was considered adequate as much as 15 years ago. This is called the "clean unit exemption".
- The EPA's "plantwide applicability limit"(PAL) would allow facilities to trade emission increases with past emission reductions within the same plant. (NRDC, 2002; McCarthy, 2002)

EPA changes of NSR provisions have been successfully challenged in court based on the negative impact these changes will have on air quality and human health.

Purpose
The purpose of changing the NSR provisions has been to decrease the regulatory burden on polluting facilities.

Arguments for NSR Changes
Reducing NSR requirements can save existing electrical generating facilities and other large polluters significant money through reducing investments and litigation requirements. Some of these savings could be translated into cost savings for consumers.

Arguments Against NSR Changes
The changes in NSR will increase air pollution and negatively impact public health.

According to the EPA (2002), the change in baseline rules could reduce the facilities subject to NSR by 50%, increasing overall air emissions. The "clean units" exemption and PAL requirements will also allow for increased air emissions (NRDC, 2002). Air emission of primary concern are:

- greenhouse gases,
- mercury,
- acid forming emissions,
- ozone precursors, and
- particulates.

Because of increased air emissions, these changes to NSR will have a detrimental effect on people living near polluting facilities. Changes in NSR will also detrimentally effect air quality and acid rain production in more distant areas. Acid rain has numerous associated health impacts including deteriorization of public water quality due to increased metals leaching. Reducing NSR requirements will increase the emission of greenhouse gases, increasing the human impact on climate change

Electrical market deregulation may further encourage the trend of extending the life of existing coal-fired capacity, as a cost-effective alternative to constructing new capacity. Given this trend, NSR is an even more important tool for mitigating the environmental effects of existing plant modifications with its BACT requirements (Parker, 2000).

Issues specific to African Americans

Economic Effects:

- The job impacts are unknown. The jobs impact in the energy sector is likely to be small due to the small percentage of African Americans in the energy sector. Job saving resulting from plants not needed to adhere to stronger NSR may be similar to jobs created in the pollution control industry if NSR is left intact.
- Changes in the price of energy and other goods are unknown, though they are likely to be minimal.

Health Effects:

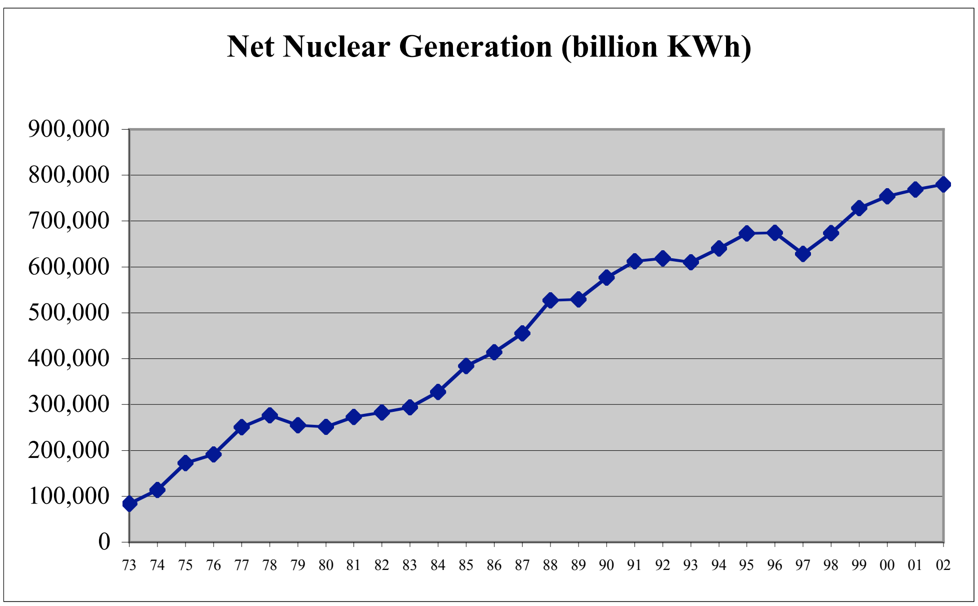
Like other regulatory or structural changes that increase air emissions, these changes in NSR will disproportionately affect African-Americans (see Chapter 1).

- These changes in NSR will detrimentally affect air quality in the vicinity of polluting facilities. African-Americans may be disproportionately adversely affected.
- Climate change may disproportionately impact African-Americans.
- Increased mercury in the environment may disproportionately affect African-Americans.

Nuclear Industry Promotion

Overview
Recent federal legislation and proposed legislation provides assistance to the nuclear industry through government bonds, tax incentives, and government backed insurance.

The United States began using nuclear power to produce electricity in 1957 (EIA, 2004b). There are currently approximately 104 commercial nuclear generating units licensed to operate in the United States. Net generating capacity has increased steadily since 1957 with a short decline in 1997. Nuclear power now accounts for approximately 20% of total electrical generation. A total of 780,064,087 MWh of electricity was generated by nuclear power plants in 2002 (EIA January 2004 Monthly Energy Review). Net generation can increase in the future through rerating existing facilities to produce more energy and through the construction of additional nuclear generating facilities. Net generation decreases when existing facilities are not operating at full capacity or when plants are taken off-line.



Source: EIA, http://www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/reactsum.html 2/10/04

Purpose
The purpose of government promotion of nuclear power is to produce clean, reliable energy at low cost. An additional goal is the diversification of the electricity generation portfolio.

Arguments for Nuclear Promotion
Nuclear energy generates less air emissions of criteria pollutant and toxins than fossil fuel plants. While the construction of nuclear power plants does entail significant releases of

greenhouse gases due to the amount of concrete used, the production of energy itself is cleaner than fossil fuels.

- For every 1000MW capacity nuclear power plant operating at 90% capacity, approximately 1,275,000 metric tons carbon equivalent is displaced given the current energy mix in power generation (50% coal, 2.3% petroleum and 18% natural gas) (Hagen, 2001; EIA, 2003).
- The existence of nuclear electricity generation significantly reduces potential levels of SO_2, NO_x and mercury emissions.
- Given the predicted increase in power consumption over the next 20 years, if nuclear power generation does not also increase, greenhouse gas emissions will grow unless expanding energy needs can be met with non-emitting renewable energy sources and efficiency improvements.

Nuclear power plants are able to provide consistent power generation and can run at a higher capacity than many other types of generating facilities.

Arguments Against Nuclear Promotion
While the full cost of nuclear generation is difficult to estimate, by most accounts nuclear power is expensive.

- Capital costs are higher than with other generating facility types, comprising about 80% of total generating costs. Since estimates of the cost of nuclear power generation depend heavily on economic assumptions such as the discount rate, it is difficult to assess the full cost of nuclear power.
- The future costs of plant decommissioning are not well known and could also change the calculation of the cost of nuclear energy generation. The discount rate selected would influence this as well.
- The cost of fuel disposal is another addition to the total cost of generation.
- All aspects of nuclear power generation, from research to construction, have received government subsidies over the past half-century. 56% of federal energy R&D funding from 1948 to 2003 has gone to nuclear (as apposed to 11% for all renewables.) These subsides could be included in the full cost accounting of nuclear power.

Nuclear power is potentially dangerous.

- There have only been a few, small radioactive releases in the United States, with minimal overt damage to human health and well-being. There is the potential, however small, of a larger release, which could cause significant loss in human, environmental and material well-being (Lochbaum, 2000).
- The problem of nuclear waste disposal has also not yet been solved. Given the half-life of nuclear waste, this is a problem for future generations as well as current.

Economic Efficiency of Nuclear Promotion
It may be that other policies can accomplish the same goals (clean, reliable energy) at lower costs. Government assistance for energy efficient technologies and renewables has been and continues to be much smaller than the assistance to nuclear power. Government support of energy sources such as solar and hydrogen could potentially allow for the

generation of electricity at lower costs than nuclear and without many of the problems associated with nuclear power such as radioactive waste and plant decommissioning.

Issues specific to African Americans

Economic Effects:

- Nuclear energy (and its subsidies) is relatively expensive. African-Americans, on average, spend a larger portion of their income on electricity expenses. Therefore, the high cost of electricity burdens African-Americans more than other sectors of society.
- Government subsidies for nuclear power could be used for programs that would be of greater benefit to African-Americans.

Health Effects:

- Nuclear power reduces the health burdens associated with fossil fuel use, which fall heavily on African-Americans (see Chapter 1). By offsetting air emissions, nuclear power reduces the risk of asthma and other health effects of air pollution in nearby communities.
- Nuclear power generation is associated with lower greenhouse gas emissions than fossil fuel power generation, reducing the human impact on the climate. As discussed above, African Americans may be more susceptible to climate change than some other segments of society. Therefore, the health benefits of reducing climate change gases may be more important to African Americans than many other groups.
- It is unclear whether the location of nuclear power plants and nuclear waste repositories are disproportionately closer to communities with high concentrations of African Americans.

Current State of Legislation

S.2095 directs the Secretary of Energy to implement initiatives that target research, development, and commercial application in nuclear energy. $10,000,000 for each of fiscal years 2004, 2005, and 2006 is authorized to be appropriated to the Secretary of Energy for:

- Cooperative, cost-shared agreements between the Department of Energy and domestic uranium producers to identify, test, and develop improved in situ leaching mining technologies, including low-cost environmental restoration technologies that may be applied to sites after completion of in situ leaching operations;
- Funding for competitively selected demonstration projects with domestic uranium producers relating to enhanced production with minimal environmental impacts;
- Restoration of well fields;
- Decommissioning and decontamination activities.

In addition, a $16 million grant is made for a test nuclear power plant decommissioning. Additional authorization is given for a total of $1.135 billion for a hydrogen/nuclear project and $675 million for nuclear infrastructure support.

S.2095 also includes the Price-Anderson Amendments Act of 2003 which modifies and extends indemnification authority and liability limits for Nuclear Regulatory Commission (NRC) licensees and Department of Energy (DOE) contractors.

Renewable Tax Incentives

Overview

Several renewable tax incentives currently exist in the Federal budget. For fiscal year 2003, there were two tax expenditures listed for energy production relevant to renewable energy and conservation:

- $30 million in alcohol fuel credits (see the section on ethanol), and
- $80 million in exclusion from income of conservation subsidies provided by public utilities (OMB, 2004)

In addition there was an expenditure of $70 million in tax credits and deductions for clean-fuel burning vehicles. A recent review of CAFÉ standards by the NRC has recommended the removal of this tax credit due to its relatively ineffectiveness (NRC, 2002).

Most energy-related tax credits are structured in such a way as to provide a percentage of the value of investment in specific eligible equipment. It has been found that, in many cases, the bulk of the tax credit funds go to businesses or consumers who would have purchases the eligible equipment in any event. This suggests that credits are generally ineffective in promoting the development of new technologies (EIA, 1999). There is, however, an important special case where credits may be cost-effective. This is when they are targeted to new industries that are still achieving rapid cost reductions through learning-by-doing effects. Learning by doing is associated with a decrease in production cost and price caused by the experience of producing a larger number of units. It is usually measured in terms of the number of doublings in total output that have taken place since some base period. (See Leiby et al., 1997, for a discussion of learning-by-doing.) The reduction in price, in these cases, due to the technological advance can cause the value of the credit to consumers to exceed the cost of the credit to the government, providing an economic benefit to the economy as a whole (Hoerner and Gilbert, 2000).

Purpose

The general purpose of the tax credits is to encourage the growth of the renewable energy industry.

Arguments for Renewable Tax Incentives

There are multiple environmental and health benefits associated with encouraging renewables. These include reduced carbon emissions and the impact on global climate change, reduced air pollution for most renewables (e.g. wind, solar, geothermal, hydro), and reduced health impacts from fossil fuel use.

Current tax incentives for renewables are unlikely to affect the price of energy much. To the extent that they do, subsidized energy sources can have economic benefits by reducing the price of commercial energy in some situations (e.g. by reducing commercial demand through solar usage or by installing large wind production facilities). Employment benefits are generally higher for investment in renewables than for investment in other energy industries. Renewables tend to be significantly more labor intensive per unit of energy produced or dollar spent than fossil fuels. As a consequence, for a given amount of production a shift to renewable energy would likely increase overall employment levels in the energy sector. According to the DOE (1997): "There are two main reasons why renewable energy technologies offer an economic advantage: (1) they are labor-intensive, so they generally create more jobs per dollar invested than conventional electricity generation technologies, and (2) they use primarily indigenous resources, so most of the energy dollars can be kept at home."

Few studies consider the employment effects of switching to renewable energy. One study calculates that 35.5 person-years of labor are required per every megawatt of PV, 4.8 person-years for every megawatt of wind energy, and 3.8-21.8 person-years for every megawatt of biomass, depending primarily on the type of fuel (REPP, 2001). REPP also estimates that wind and PV generate about roughly 40% more jobs per dollar spent than coal, where a higher percentage of the funds go into capital and fuel costs.

A similar early 1990s study by the Worldwatch Institute estimated that for 1000 gigawatt-hours of production would require 100 workers in a nuclear plant, 116 in a coal-fired plant, 248 on a solar thermal plant, and 542 on a wind farm (Sonneborn, 2000). While these studies only provide estimates which are somewhat outdated, the renewable sector does appears to have overall higher labor intensity per unit of production. An interesting consequence of these findings is that successful incentives to increase renewable energy generation would increase the overall level of employment in the energy sector.

Arguments Against Renewable Tax Incentives
The fundamental drawback of the renewable industry tax incentives is the opportunity cost of the current lost federal revenues from renewable industry tax breaks. A further argument is that tax incentives distort the playing field.

Issues Specific to African Americans
The health effects and climate impacts from switching to renewables are likely to disproportionately benefit African Americans, particularly in urban and non-attainment areas (See Chapter 1). Also, as stated above, reduced vulnerability to oil price shocks disproportionately benefits the African American population. However, given current incentive levels, these effects are likely to remain small. There are few economic employment issues specific to African Americans. Those relating to specifically to ethanol production have been addressed in the section on ethanol. RP has conducted its own analysis of African American employment in the renewable energy sector and found that African Americans make up approximately 8.5% of employees, roughly the same as for conventional energy. Therefore, the employment impact on African Americans is expected to be minimal except for the overall increase in employment associated with a move towards more renewables.

Current State of Legislation
A number of provisions in S.2095 promote renewable energy in general, some of which will be in the form of tax incentives. S.2095:

- Includes tax incentives for renewable electricity generation;

- Directs the Secretary of Energy to implement initiatives that target research, development, and commercial application in renewable energy and allocates $3.009 billion for these activities;
- Instructs the Secretary of Energy to make incentive payments to promote hydroelectric production.
- A total of $1.155 billion is authorized for renewable energy projects in addition to the R&D funding.

Renewable Portfolios

Overview

A renewables portfolio standard (RPS), also called a national renewable electricity standard (RES), requires that a given percent of national electrical generation be produced through the use of renewable energy sources such as solar, hydroelectric, geothermal, biomass, tidal or wind energy. Bills presented to congress suggested increasing the percentage of renewable generation in the range of 10% by 2020 (H.R. 6, and S. 1766) beyond existing renewable generation as of January 1, 2002.

Currently, approximately 8.3% of electrical generation is from renewable energy sources (primarily hydropower). The EIA predicts this figure to increase to 8.7% in 2020 and then drop to 8.4% in 2025 (EIA, 2004a). Most of this generation will continue to stem from conventional hydropower. Geothermal and wind are predicted to each comprise approximately 1% of total electrical generation. Other renewable source will make up the remainder of total renewable generation.

An RPS of 10% would require an additional 10% of renewable generation above the approximately 8.3% that existed pre-January 1, 2002. As some of the pre-2002 facilities may be taken off-line, total renewable generation will be less than 18.3%, even if all utilities are able to make the 10% target.

The proposed program will be implemented through a tradable credit program, allowing for considerable flexibility between utilities and making the proposal more cost efficient. With the tradable credit program, utilities that are able to exceed their required RPS can sell their credits to utilities that are unable to meet the RPS. Any utility that is unable to meet the RPS target and does not purchase credits to make up for the shortfall, must pay a penalty based on total KWh produced. (See EIA, 2002, for more details on proposed legislation.)

Purpose

The purpose of an RPS is to increase the use of renewables for electrical generation.

Arguments For Renewable Portfolios

The increased use of renewables to generate electricity is predicted to reduce the externalities associated with various other forms of electrical generation.

- According to a study by the Energy Information Administration (2002), an RPS of 10% by 2020 will reduce air emissions of CO_2 by 7%.
- An RPS would reduce fossil fuel use and the environmental impacts associated with mining, transport, and burning of fossil fuels.
- An RPS is predicted to have little impact on NO_x and SO_2 emissions, depending on the type of renewables that replace fossil fuel use (such as biomass) and the technology used for burning.
- Increased use of renewables would buffer the energy market against price spikes associated with the global petroleum price fluctuation.

Electricity prices may decrease with an RPS.

- A study by the Interlaboratory Working Group, in the Department of Energy, found that an RPS of 7.5% by 2010, when combined with energy efficiency programs, would save consumers over $65 billion per year by 2020(1997$) (CEF, 2000).
- A report by the Union of Concerned Scientists indicates that by including energy efficiency incentives (such as those suggested in S. 1333), an RPS of 20% by 2020 would save consumers $35 billion per year by 2020 (UCS, 2001).

Because of decreased demand for natural gas used for electrical generation, the price of natural gas is also expected to fall, leading to potential savings for consumers. By 2010, the total residential natural gas bill is predicted to be 1% lower ($534 million) in the RPS case than in the base case. The savings for the commercial and industrial sectors are 2% and 4% respectively.(CEF, 2000)

Arguments Against Renewable Portfolios

According to the EIA RPS scenario, electricity prices may increase moderately. (However, the study by the Interlaboratory Working Group found that the EIA report overestimates the cost of using more renewable electricity because it uses higher cost and worse performance assumptions for renewable technologies than used in projections by the Electric Power Research Institute or DOE. These assumptions are also higher than are found by experience (CEF, 2000). Using more accurate assumptions, an RPS could be found to save more money than predicted from gas price decreases alone (CEF, 2000)).

Issues specific to African Americans

Economic Effects:

- Since African-Americans may be more susceptible to price shocks than other groups, as well as price induced recessions, reducing the probability of energy price shocks will be particularly beneficial to African-American families.

Health Effects:

- Electrical generation with renewables somewhat reduces the health burdens associated with fossil fuel use, depending on the renewable used, which fall heavily on African-Americans (see Chapter 1).
- Increased use of renewables reduces greenhouse gas emissions, which may disproportionately benefit African Americans.

Current State of Legislation

RPS have been left out of S.2095 and the current (as of March 2004) version of H.R. 6

The Climate Stewardship Act

Overview
The Climate Stewardship Act of 2003, S.139, proposed by Senators McCain and Lieberman, would, if passed, require system-wide greenhouse gas reductions. The legislation would lead to the establishment of a cap-and trade program for all six of the Kyoto Protocol greenhouse gases. The program would be administered by the United States Environmental Protection Agency (EPA). Greenhouse gas emitters (covered entities) are required to submit a tradable allowance to the EPA for every metric ton of CO_2 equivalent they emit each year. The permits would have serial numbers that are retired after use, but they do not have to be used in the year that they were issued.

Purpose
To slow the anthropomorphic contributions to global warming by using the market to reduce greenhouse gas emissions to 5,896 million metric tons of CO_2 equivalent from 2010-2015, and 5,123 million tons in 2016 and after (roughly 1990 levels). Additionally, the legislation is intended to create a just transition fund for workers and consumers.

Arguments For S.139
Efficiently reduces environmental externalities:
External costs associates with carbon dioxide emissions are likely to be significant. The IPCC reports that the range of estimates for damages from a ton of carbon lie anywhere from a few dollars to over two hundred dollars. By taking an economy-wide approach it avoids piecemeal policy solutions that are likely to be less economically efficient and administratively cumbersome. Economic efficiency is also encouraged by establishing a permit auction mechanism to generate revenue. The revenue from auctions is used to establish a just transition fund for workers that would be displaced from the policy and consumers that would face increased energy costs.

Not only would this bill reduce green house gas emissions but reduced greenhouse gas emissions are likely to be associated with reductions in other pollutants and concomitant health benefits.

Arguments Against S.139
Economic Costs
The overall costs associated with policies which address climate change are heavily debated. Several studies have indicated that the total economic costs are likely to be small, or even negative, due to the option of revenue recycling. However, strong measures are likely to have distributional effects within the larger economic umbrella. Specific energy intensive industries, such as coal-fired electric utilities, are unlikely to be as economically viable in the future relative to other facilities such as gas-fired or wind-powered plants.

Continued Environmental Externalities:
- The emission caps proposed by the Climate Change Stewardship Act are less ambitious than the Kyoto Protocol standard of 7% below 1990 emissions, and

even the second phase leaves the United States on course for drastic climate change. Scientific consensus indicates that emissions will ultimately need to reach levels of no more than 50% of 1990 emissions at most, and even this will likely only mitigate climate change, not avoid it entirely.

- Only a fraction of the permits are auctioned, the rest are assigned freely to polluters. Windfall gains, as such, are not as economically efficient as recycling revenues from permit auctions. The impact on energy prices will ultimately be the same, and the returned revenue is crucial in offsetting the impacts of energy prices increases, costs associated with global warming, and investing in clean energy and energy-efficiency research and development.

Issues Specific to African Americans

Since global warming is expected to disproportionately impact African Americans, a policy that aims to meaningfully reduce global warming is important. As African Americans are disproportionately impacted by global warming, the just transition fund mentioned above could be expanded to address the costs associated with global warming as well as the policy itself. This would be particularly helpful to households that lack the resources to adapt to climate changes.

State of Current Legislation

S.139 was defeated in the 107^{th} Congress. The Climate Stewardship Act, or similar legislation, may be revisited.

Multi-pollutant Power Plant Legislation

Overview

S.366, the Jeffords/Lieberman/Collins Clean Power Act, sets regulations for the four main pollutants emitted by power plants: nitrogen oxides (NO_x), sulfur dioxide (SO_2), mercury (Hg) and carbon dioxide (CO_2). There are three main versions of the bill discussed in congress: the Clean Power Act (S. 366), the Clean Air Planning Act (S. 844), and the Bush administration's Clear Skies Act (S. 485) (which does not include CO_2). The Bush administration has implemented several pieces of the Clear Skies Act through the executive branch, and the Clean Air Planning Act has received little attention of late. Therefore, we will focus on the Clean Power Act. (See a chart comparing these legislations below.)

Purpose

The goal of S.366 is to reduce the four most harmful pollutants from power plants in a comprehensive piece of legislation. The Clean Power Act sets the following emission caps by 2009:

- NO_x - 1.51 million tons
- SO_2 - 2.26 million tons
- Hg - 5 tons
- CO_2 - 2.05 billion tons by 2009.

The bill allows trading of all pollutants except for mercury.

Arguments For

Economic Efficiency:

This legislation establishes a comprehensive mechanism for addressing pollution from power plants.

- By addressing all of the pollutants at once, power companies achieve more certainty over how their business will be regulated and all modifications to plants may be done simultaneously.
- It establishes a system-wide market for the trading of pollution permits, which is likely to be more efficient that command-and-control.
- It establishes transition assistance for individuals and communities by allocating a percentage of revenue generated from emissions allowances to this assistance. The percentages for assistance starts at 6 percent in 2008, and then is reduced by 0.5 points each year thereafter until 2017.
- By using a multi-pollutant approach, S.366 has the potential to address toxic hotspots in an economically efficient manner.
- The Clean Power Act prohibits the trading of mercury, which is a particularly harmful toxic for neighboring communities, and should not be traded so that hotspots can not form.

Health and Environmental Benefits:

- Reduction in the environmental and health externalities associated with criteria pollutants.
- Reductions in total greenhouse gas emissions.

Arguments Against

Continued Externalities:

- Critics have argued that the cap placed on CO_2 emissions is not sufficiently low to halt global climate change.
- Though the legislation prohibits trading of mercury, it does allow inter-pollutant trading of SO_2, NO_x, and CO_2, which have different levels of toxicity and impacts. This inter-pollutant trading could lead to the creation of toxic hotspots. Proponents, however, argue that the levels of reductions are tight enough to eliminate this problem.
- Permits created for trading in this legislation are given away, rather than auctioned, creating windfall gains for existing polluters. As a consequence, there is no double dividend for the fiscal policy.

Economic Costs:

- Increased pollution control is likely entail economic costs, particularly for the power generating industry. There will be some distortionary economic effects from permits, as well as transaction costs and enforcement limitations.

Issues Specific to African Americans

- Pollution from power plants disproportionately impacst African American communities (Chapter One). As such, reducing air pollution in an efficient and comprehensive manner would disproportionately benefit African American communities.
- Hotspots are disproportionately located in African American communities. Ensuring that these hotspots do not occur would also disproportionately benefit the same communities.

State of Current Legislation

S.366 was reintroduced in the Senate in February 2004.

Multi-Pollutant Legislation in Comparison

	Clean Power Act, S. 366 – Jeffords/Lieberman/ Collins	*Clear Skies Act, S. 485 – Bush admin/ Inhofe/ Voinovich, H.R. 999 – Barton*	*Clear Air Planning Act, S. 843 – Carper, Gregg, and Chafee*
Nitrogen oxide (NOx) cap	Limit emissions to 1.51 million tons by 2009.	Limit emissions to 2.1 million tons by 2010, 1.7 million tons by 2018.	Limit emissions to 1.87 million tons by 2009, 1.7 million tons by 2013.
Sulfur dioxide (SO_2) cap	Limit emissions to .28 million tons in western region (Western Regional Air Partnership plus California, Montana and Washington) and 1.98 million tons in eastern region by 2009.	Limit emissions to 4.5 million tons by 2010, 3 million tons by 2018.	Limit emissions to 4.5 million tons by 2009, 3.5 million tons by 2013, 2.25 million tons by 2016.
Carbon dioxide (CO_2) cap	Limit emissions to 2.05 billion tons by 2009 (roughly 1990 levels) plus flexibility measures.	Does not include CO_2 program, though Bush administration advocates a voluntary program aimed at reducing greenhouse gas intensity.	Limit emissions to 2.6 billion tons by 2009 (roughly 2005 levels) plus flexibility measures, 2.3 billion tons by 2013 (roughly 2001 levels) plus flexibility measures.
Mercury cap	Limit emissions to 5 tons by 2009.	Limit emissions to 26 tons in 2010, 15 tons in 2018.	Limit emissions to 24 tons by 2009, 10 tons in 2013.
Emissions trading	Allowed for NOx, SO_2, CO_2. No mercury emissions trading.	Allowed for NOx, SO_2 and mercury.	Allowed for NOx, SO_2, CO_2 and, in a limited way, for mercury.
New Source Review	Retains the Clean Air Act program. Also contains a "birthday provision" requiring facilities by 2014 to install Best Available Control Technology within 40 years after commencing operation.	New, reconstructed and modified sources exempt from NSR and Best Available Retrofit Technology (visibility for national parks/wilderness areas) requirements as long as each unit meets new "national emission limits" or the following two requirements within three years after enactment: 1. The unit properly operates technology to limit particulate matter emissions or is subject to an emission limit of 0.03 lb/mm Btu within eight yeas of enactment; and 2. The unit uses good combustion practices to minimize carbon monoxide.	Reforms included. New sources remain subject to most NSR requirements. For existing sources, NSR requirements begin in 2009 if modifications are made that increase emissions. States are also allowed to take action to prevent local air quality deterioration by specific facilities.

Emission Credit Allocation Method	Based on facility share of total year 2000 energy output. Allowances for SO_2, NO_x and CO_2 distributed annually by the Environmental Protection Agency starting in 2008 to five main categories: consumers/households; transition assistance; renewable energy-efficiency-cleaner energy; carbon sequestration; and existing units (with such units receiving 10 percent in 2008 and declining one point annually until it reaches 1 percent in 2017).	Input based allocations with auctions for a portion of allowances each year. In the first year, 1 percent is auctioned and the percentage increases each year.	NO_x, mercury and CO_2 would be output based, using average annual new generation from most recent three-year period. SO_2 would be based on CAA Title IV Acid Rain program with provisions for new sources

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Appendix A: The Economists' Statement on Climate Change

As a result of work by Redefining Progress, this statement was endorsed by over 2,500 economists including eight Nobel Laureates:

1. The review conducted by a distinguished international panel of scientists under the auspices of the Intergovernmental Panel on Climate Change has determined that "the balance of evidence suggests a discernible human influence on global climate." As economists, we believe that global climate change carries with it significant environmental, economic, social, and geopolitical risks, and that preventive steps are justified.

2. Economic studies have found that there are many potential policies to reduce greenhouse-gas emissions for which the total benefits outweigh the total costs. For the United States in particular, sound economic analysis shows that there are policy options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run.

3. The most efficient approach to slowing climate change is through market-based policies. In order for the world to achieve its climatic objectives at minimum cost, a cooperative approach among nations is required -- such as an international emissions trading agreement. The United States and other nations can most efficiently implement their climate policies through market mechanisms, such as carbon taxes or the auction of emissions permits. The revenues generated from such policies can effectively be used to reduce the deficit or to lower existing taxes.

The original drafters of this statement are: Kenneth Arrow, Stanford University; Dale Jorgenson, Harvard University; Paul Krugman, MIT; William Nordhaus, Yale University; and Robert Solow, MIT

The Nobel Laureate signers are: Kenneth Arrow, Stanford University; Gerard Debreu, University of California, Berkeley; John Harsanyi, University of California, Berkeley; Lawrence Klein, University of Pennsylvania; Wassily Leontief, New York University; Franco Modigliani, MIT; Robert Solow, MIT; and James Tobin, Yale University.

Appendix B: Discussion of Market Mechanisms

One of the fundamental differences in types of policies to address climate change is whether they rely on traditional command-and-control strategies or regulations to reduce pollution, or whether they use market approaches, such as taxes and permits, to reduce pollution.

The two most important market-based regulatory systems to be enacted in the U.S. are the tradable sulfur dioxide emissions permit system under the Clean Air Act Amendments of 1990 and the Ozone-Depleting Chemicals Tax. Both of these systems have produced significant reductions in emissions at a cost far below that projected by either the Environmental Protection Agency (EPA) or industry (Cook, 1996; Schmalensee et al., 1998). Similar systems have been proposed for emissions of greenhouse gases, oxides of nitrogen, mercury, and other pollutants.

The reason for their popularity is that such systems, if properly designed, allow emitters the maximum flexibility in the time, place, and manner of reductions. This in turn permits emissions reductions to be achieved at the lowest possible cost. Furthermore, while some market mechanisms, such as carbon taxes and carbon permit systems, result in increased costs to industries which emit high levels of carbon, the revenue from these taxes can be used to benefit the economy in a number of ways including reducing income or payroll taxes, providing benefits to workers displaced in high carbon emitting industries, funding education, etc. Given that many energy intensive industries are not labor intensive, using carbon tax revenue to cut taxes or support other industries can have an overall benefit to the economy.[7]

African-Americans have a particular interest in the choice of environmental policies for two reasons. First, African Americans are generally more vulnerable to pollution impacts because of their spatial distribution (see Chapter One). Therefore, African Americans may be disproportionately worse-off with the use of market mechanisms for pollutants that cause local hot spots, unless additional safeguards are added to limit the impact of local concentrations.

Second, as a result of lower average income and wealth, African Americans are more vulnerable to environmental policies with regressive impacts. These include environmental policies that have distributional patterns similar to consumption taxes. In as much as market mechanisms reduce the overall costs of emission control, these methods can reduce the transmitted costs to African Americans. African Americans also stand to generally benefit from revenue-raising mechanisms such as auctioned permits and taxes over non-revenue mechanisms such as grandfathered permits, with the additional proviso that the revenues should be distributed progressively (through taxes, transfers, or provision of public services) or used to finance further emission reductions or efficiency improvements.

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[7] This beneficial aspect of carbon taxes is referred to as the double dividend. Carbon taxes both reduce greenhouse gas emissions and other pollutants and can be used to help the economy.

This appendix provides a comparison of two traditional regulatory approaches, best available control technology (BACT) and plant-level emissions restrictions, to four market-based approaches. These market-based approaches are tax incentives for specified new technologies, emissions permits that are given to firms (grandfathered), emissions permits that are auctioned, and pollution taxes. The six types of policies are examined for several relevant concerns including economic efficiency, information and transaction costs, local impacts, revenue recycling, and technology promotion.

When evaluating the appropriateness of different regulatory methods for a given policy goal, there are a number of factors to consider: cost efficiency, information requirements and transaction costs, need for set reductions in emissions or set costs, local impacts, windfall profits, revenue recycling possibilities, and promotion of new technology.

Efficiency

Because the cost of emission controls can vary tremendously between different facilities, different control methods, and even different times, allowing for flexibility in achieving overall emission reduction goals will decrease the cost of achieving these goals. For example, a command and control approach (or BACT) provides little choice as to place, manner or time or emission reductions. Plant-level emissions caps allow full choice as to the manner of achieving the reduction, while continuing to specify time and place. Tax incentives for new technologies specify the manner of the reduction while allowing full freedom on the time and place of the reduction. Tradable permits and pollution taxes both provide the full range of flexibility.

Information requirements and transaction costs

While regulatory methods that allow for the maximum flexibility may appear to be the most cost effective, there can be other regulatory costs that can offset the savings associated with flexibility. For example, in a situation where there are numerous small emitters, monitoring of emission levels can be both difficult and costly. In these cases, BACT-type regulations or tax incentives for clean technologies may be less expensive than alternatives that require direct emissions monitoring. Indeed, these technology-based approaches may be the only feasible regulation type in such cases.

However, this is not true when emissions are closely associated with some more easily observable quantity. For example, since the emission of carbon dioxide is directly proportional to the consumption of fossil fuels, carbon emissions can be deduced from fossil fuel purchases. It is probably less expensive to regulate fossil fuel purchases through tradable permits or taxes than to monitor the technology of fuel consumption at tens of thousands of individual sites, which would be required for BACT regulations of technology tax incentives.

Set emission reduction and regulatory burden limits

Depending on the pollutant in question, the key goal of a regulatory regime may be to meet a set emission level, or it may be to achieve a more flexible level of emission reduction but with a predetermined cost to the industries being regulated. With BACT, if the technology cost and effectiveness if well understood, then both the emission outcome and overall cost can be determined in advance. With emission permits, the total level of allowable emissions can be set yet often the costs of meeting this limit is unknown and could be higher (or lower) than regulators predicted. With emission taxes, the total cost burden on regulated facilities can be estimated but if the cost of achieving emission reductions are not clearly known by regulators, the tax level chosen might only achieve a much lower level of emission reduction than desired. This might force regulators to change the tax level, leading to uncertainty within industry of the future cost requirements and appropriate technology investments for changing tax levels.

With tax incentives for emission reductions through new technologies or processes, there is no cost burden on industry, rather there is a cost to the government that can be unknown. Overall emission reductions with tax incentives are likely to be difficult to determine because it is hard to predict how many firms will use the tax incentive.

Local impacts

An important concern with tradable permits of allowances is that they might lead to some areas becoming more polluted, even as overall pollution levels decrease. This would occur if the cost of control in some area is so high that it is cost effective for the industries there to purchase emission permits or allowances than to reduce emission levels. The result could be a toxic hotspot which could have detrimental effects on local health and environmental quality. This problem is especially relevant when the health impact of a pollutant increases more than directly proportionally with emissions.

In principle, this problem can be addressed with a more complex trading mechanism that takes into account local effects. However, this added complexity increases the cost of administering the market mechanism and somewhat reduces its cost advantage over more traditional regulatory forms. In such cases market mechanisms may be inappropriate, or it may be desirable to use the market mechanism to set overall targets while retaining a regulatory backup to address the worst of the local impacts.

Windfall profits

Regulating pollution emissions generally increase production costs because firms need to purchase new equipment or pay taxes on emissions etc. However, such regulations typically raise the cost of the marginal (last) unit of production by more than it raises the cost of the average unit of production because the lowest-cost reduction opportunities are normally used first.

Because price in competitive markets is set equal to marginal cost, at least in theory, regulations will raise the price of output sold to consumers by more than the average cost of production. Giving away emission permits, like grandfathered permits, therefore give rise to windfall profits. In the case of auctioned permits, no such windfall arises, because the auctioneer (presumably the government) captures the difference between average and marginal cost. This money can then be returned to consumers in the form of tax cuts or as essential public services.

Tax incentives can also create windfall profits in a different way. Individuals or firms that were planning to buy the eligible technology even without the tax incentive will generally receive the tax incentive, even though it has not affected their behavior. Thus the subsidy constitutes a windfall to these individuals or firms.

Revenue recycling

Auctioned permits and taxes generate government revenue. In general, these mechanisms do not impose a higher cost on consumers than non-revenue mechanisms such as grandfathered permits. Instead, both mechanisms should raise costs to consumers by the same amount but in the case of grandfathered permits, the firms take the profit and in the case of auctioned permits and taxes, the government takes the additional revenue(See, e.g. Fullerton, 2001).

If the revenues from auctioning or emission taxes are used to reduce other taxes, a second source of efficiency can come into play. Since most taxes cause economic distortion costs in addition to the revenue they raise, this "revenue recycling" effect can produce additional efficiency benefits for the economy. These efficiency benefits may partially or fully offset the economic costs of the environmental regulation. It is more likely that the economic costs will be fully offset if the revenues are used to cut highly distorting taxes, and if the market mechanism is combined with "no regrets" technology promotion policies and with the elimination of market barriers to new, cleaner technologies (Parry et al., 1999; Krause et al., 2002).

Technology promotion

Another way to increase the efficiency of emission reductions is to promote the development of new emission control technologies. Some regulatory methods stimulate the development of new control technologies that can achieve a specified level of emission reductions at a lower cost than current technologies.

BACT-type regulations generally do not provide any stimulus to developing new control technologies, and indeed may impede the development of such technologies by specifying the allowable technical approach and providing no incentive for improvement. Taxes and tradable permits do provide an impetus to develop new technologies, as all emissions reductions result in economic savings proportional to the tax rate or permit cost.

The stimulus to technology effect is more ambiguous in the case of tax credits. Like BACT regulations, tax credits typically apply only to specified technologies. Thus, they are generally effective in stimulating technological advance only in the case of relatively immature industries that are still achieving rapid cost reductions through learning-by-doing effects (Leiby et al., 1997). However, in such cases, the reduction in price due to the technological advance can cause the value of the credit to consumers to exceed the cost of the credit to the government (Hoerner and Gilbert, 2000).

The following table summarizes the effects of different policy instruments discussed above.

Market and Regulatory Instruments and their Effects							
Instrument	Least-cost reductions	Information requirements	Meeting emission and/or cost limit goal	Local hot spots	Windfall profits	Recycling efficiency	New techno.
Regulation: BACT	No	Low	Both	No	No	No	No
Regulation: Facility caps	Partial	High	Emission	No	No	No	Yes
Tax incentives	Partial	Low	Neither	Yes	Yes	Negative	Yes
Grandfathered permits	Yes	High*	Emission	Yes	Yes	No	Yes**
Auctioned permits	Yes	High*	Emission	Yes	No	Yes	Yes
Pollution tax	Yes	High*	Cost	Yes	No	Yes	Yes

*Information costs may be lower if emissions are easily monitored, as when they are proportional to fuel purchases. See text for discussion.
**For young industries with rapid learning curves only.