How to Become Energy Efficient to Surmount the Effects of Climate Change

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Abstract

In this paper, we provide findings from an array of energy saving studies and experiments conducted by various sources to analyze the effects of using “energy efficient” technologies such as LEDS and EVs or “renewable energy” such as wind and solar energy to reduce our carbon footprint. Data-driven intervention designs with high-resolution data in terms of sampling frequency enabled the savings, and the high-resolution data proved to be crucial for an efficient waste behavior investigation. Simply put, the use of renewable energy versus nonrenewable energy such as oil, coal, or nuclear energy. While the quantitative result was encouraging, I also noticed many uncontrollable factors, such natural climate change. In addition to that, renewable energy technologies are still in fact relatively new. Here I will not only address the research problem and give my hypotheses but explain the methods, results, and implications of my findings. My hypothesis: “By utilizing energy efficient technologies such as solar energy, we will aid in decelerating the levels of carbon dioxide and other pollutants in the atmosphere that cause climate change.” The null hypothesis (H0) is: “Utilizing energy efficient technologies will not decelerate the levels of carbon dioxide and other pollutants in the atmosphere that cause climate change.” Overall, I conclude that making the transition to energy efficient and renewable energy is paramount for energy savings and combating climate change.

Keywords: Climate change, global warming, energy efficiency, renewable energy, sustainable energy, clean energy, electrical grids, electric vehicles, solar panels, utility companies, environment, energy saving, data-driven

Introduction

Multiple reports conducted in peer-reviewed scientific journals1 indicate that 97 percent or more of actively publishing climate scientists believe that the past century's warming patterns are almost certainly due to human activities. The majority of the world's leading research organizations have released public statements supporting this stance. When it comes to climate change, disagreements rarely boil down to a clear disagreement over reality. Evidently, cognitive factors and motivated reasoning tend to influence people's interpretation of climate change knowledge.

As the use of oil and gas has decreased, renewable energy sources such as wind and solar have exploded in popularity. After the Department of Energy (DOE) was given the authority to guarantee loans for businesses that minimize greenhouse gas emissions or introduce new energy-saving technologies the renewable industry has exploded. Despite the downturn in the economy, the industry is now booming. While the government does not have to finance these ventures, it does guarantee loan repayment to any bank or lending entity that arranges the financing.

Following the global recession in 2009, the Department of Energy started actively seeking renewable energy ventures. The DOE backed projects that included the building of the world's largest wind farm, several major solar power plants, an ethanol production hub, and the first new nuclear power plant constructed in the United States in three decades due to funding provided by the economic stimulus package. One of these ventures was a little-known company called, Tesla. Mitt Romney called Tesla a loser in the 2012 presidential debate with Barack Obama, a company worth that is now worth over $700 billion today. After reelection, President Barack Obama set a target of achieving 80% "clean" energy by 2035, however, the objective is unlikely to be met we should strive to be as energy efficient as soon as humanly possible.

Chapter One

Section 1 - Statement of Purpose

The purpose of this project is to determine how we can mitigate the disastrous effects of global warming by changing how we generate electricity. The following chapters in this project will review the current literature available regarding global warming and the related studies of its effects. Supplementarily, how we can mitigate global warming by employing energy efficient technologies and renewable energy resources. The transition to renewable energy necessitates a rapid change to zero-carbon sources such as wind, solar, geothermal, and nuclear energy, as well as increased energy storage and a revamped grid.

As part of the 2015 Paris Climate Agreement, countries around the world officially agreed to reduce their emissions by setting new targets and developing new strategies to meet or even exceed those standards. To avert hazardous climate change, drastic reductions in emissions are needed, as well as the widespread use of alternatives to fossil fuels. One of the most powerful weapons we have in the battle against climate change is renewable energy. In addition, as fossil fuel emissions are displaced by renewable technologies, consumers can save money as well.

Over the last decade, wind and solar energy have seen tremendous growth and cost reductions. Renewable energy is becoming more competitive with fossil fuels around the world as prices decreasing rapidly. Renewable energy has become less expensive than keeping old, obsolete, and polluting fossil-fuel or nuclear power plants operational. By 2050, renewable energy could account for up to four-fifths of global electricity supply, significantly reducing carbon emissions and aiding in climate change mitigation. The world's transition to a sustainable energy future focused on renewables makes economic sense with this increasingly favorable cost equation.

Section 2 – The Setting the Problem

The effects of global warming can be felt all over the globe. The National Climate Assessment confirms that evidence of human-caused climate change is growing stronger, and that impacts are becoming more widespread across the world (Climate Change Science Program, 2014). Warming temperatures are fueling longer and hotter heat waves, more intense droughts, heavy rainfall, and more robust hurricanes, according to scientists around the world.

In particularly, the United States has been feeling the effects of global warming. Droughts jeopardize access to safe drinking water, fuel out-of-control wildfires, and cause dust storms, severe heat events, and flash flooding. Winters are usually milder and shorter due to warmer and drier weather. The snow melts sooner which is why wildfires in the West start earlier in the spring, last later into the fall, and burn more land. Summer sea ice that once covered the coasts has receded in Arctic Alaska, and autumn storms are now causing further flooding, threatening the relocation of many residents.

Since the summer seasons has been extended, the growth of pollen-producing ragweed, allergies, asthma, and infectious disease outbreaks people are recognizing the intensity and duration of their seasonal allergies are being drawn-out. Precipitation trends are shifting, sea levels are rising and oceans are becoming more acidic. Many plant and animal species could become extinct if ecosystems such as coral reefs and alpine meadows are disrupted. During hurricanes and high tides, residents of some coastal cities see their streets flood more often. Flooding is more frequent in inland towns near large rivers, especially in the Midwest and Northeast.

The sea level off the coast of New York alone has risen by up to 9 inches since 1950. It took 48 years for the sea level to rise 6 inches around Battery Park (Nyack College's home base).

According to scientists, the sea level will increase another 6 inches in the next 14 years. (Water Levels - NOAA Tides & Currents.) Due to the city's unique location, elaborate system of underground railroads, and proximity to other major coastal cities, solutions can be complex. Which is why New York is investing more than $4 billion in sea level rise solutions, including increasing bridges, improving drainage, and constructing seawalls. Global warming is one of the most important issues in the world today, threatening the lives and livelihoods of billions of people.

When sea levels rise as quickly as they have, even a slight increase can have catastrophic consequences for coastal ecosystems further inland, including destructive erosion, wetland flooding, salt pollution of aquifers and agricultural soil, and loss of habitat for fish, birds, and plants. In some disadvantaged communities, insurance premiums are increasing, while in others, insurance is no longer affordable. The plant varieties that grow in their crops and the variety of birds they see each month are changing as well. New pests will wreak havoc on forests, crops, and towns. All of these things have the potential to damage or kill agriculture and fisheries.

In many areas around the world water scarcity is the leading cause of death and disease. At the opposite end of the spectrum, heavier floods cause streams, rivers, and reservoirs to flood, causing property harm, contaminating drinking water, causing hazardous-material spills, and encouraging mold infestation and unhealthy air. Foodborne and waterborne diseases, as well as disease-carrying insects like mosquitoes, fleas, and ticks, benefit from a warmer, wetter climate. For instance, the Zika virus, West Nile virus, Chikungunya virus, dengue fever, and malaria are all diseases transmitted by mosquitos (Centers for Disease Control and Prevention 2016) In areas such as Africa, drought, desertification, and resource shortages have exacerbated disputes between crop farmers and cattle herders (United Nations: Severe Consequences for Africa)

Section 3 – History and Background of the Problem

Scientist research indicates that heat-trapping gases like carbon dioxide are warming the earth and that we produce these gases by burning fossil fuels like coal, oil, and gas. Independent evidence also reveals that the rapid global warming during this past half-century is due primarily to human activities. The carbon emissions we cause by burning fossil fuels and the pollution capture we produce are destroying our oceans and forests as a result. As carbon dioxide (CO2) and other air pollutants accumulate in the atmosphere, they absorb sunlight and solar radiation that has bounced off the earth's surface, causing global warming.

In ordinary circumstances, this radiation will escape into space, but these contaminants, which can persist in the atmosphere for years to decades, trap the heat and cause the earth to warm. Greenhouse gases are heat-trapping emissions such as carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorinated gases, and their impact is known as the greenhouse effect. The global annual temperature has risen by 0.18 degrees Celsius (0.32 degrees Fahrenheit) per decade over the last 40 years. (Global Warming 101. NRDC)

Since 1880, nine of the ten warmest years have occurred since 2005, with the five warmest years on record all occurring since 2015. We refer to prolonged droughts, wildfires, flooding, tropical storms, and other disasters as climate change. Though natural factors and events have caused the earth's temperature to shift numerous times over the last 800,000 years, our current period of global warming is due to human activity—specifically, our burning of fossil fuels including coal, oil, gasoline, and natural gas, which results in the greenhouse effect.

In the graph generated by the National Oceanic and Atmospheric Administration and Scripps Institution of Oceanography (Figure 1), illustrates the carbon dioxide levels since roughly 800,000 years ago. The Industrial Revolution is to blame for a drastic upward surge that

began around the 1760s. No one could have predicted that the combustion of fossil fuels would have such an immediate impact on the atmosphere in the early days of the Industrial Revolution. Prior to the Industrial Revolution, Britain and America made significant progress throughout the 18th and 19th centuries. The British Agricultural Revolution took place during this time period, and it was a period of major agricultural growth marked by new farming techniques and innovations that resulted in a huge increase in food production. People could now leave their farms and migrate to cities due to the fact that agricultural output was capable of sustaining life away from the farm.

As a result, the world's population grew exponentially, and this, combined with rising living standards, resulted in the depletion of natural resources. Increased air and water emissions, as well as increased use of fossil fuels, resulted from the use of chemicals and fuel in factories. The conveniences of city life generated a market for other goods that enhanced quality of life, such as clothing and non-essential objects. To meet the increasing demand for these goods, new technologies were developed, leading to the establishment of the first industrial factories. People were flocking to cities in greater numbers in pursuit of industrial jobs. The next great revolution, known as the Industrial Revolution, began as a result of this.

The Industrial Revolution began in Great Britain when manual labor was gradually being replaced by machines powered by new energy sources. The mechanization of England's textile mills, the invention of iron-making techniques, and the expanded use of coal rather than wood and water power for heating, industry, and transportation were the first indications of this revolution. Steam power was developed around 1850 as a way to more effectively utilize coal energy, and steam engines were soon used to power trains, ships, and various types of industrial machinery.

These innovations spread throughout Europe, the United States, and other parts of the world, causing massive changes in culture and trade. Later in the nineteenth century, scientists discovered how to produce electricity, and the discovery of oil led to the invention of the internal combustion engine, all of which revolutionized how people lived and worked all over the world. By the turn of the 21st century, the world had become entirely reliant on and was quickly depleting the planet's fossil fuels—resources such as coal, natural gas, and oil derived from the decomposed remains of ancient plants and animals.

Joseph Fourier, who lived in the 1820s, was the pioneer of the discovery process. During this time, scientists were starting to realize that the gases that make up the atmosphere could be trapping the heat emitted by the Sun. Scientists discovered that gases in the atmosphere, such as CO2, create a "greenhouse effect" that influences the temperature of the atmosphere in the 19th century. The greenhouse effect was discovered, surprisingly, not because scientists were seeking to explain global warming, but since they were looking for the mechanism that sparked ice ages.

Svante Arrhenius, a Swedish scientist, was the first to propose that burning fossil fuels contributes carbon dioxide gas to the atmosphere, potentially increasing the planet's surface temperature, in 1896.The mainstream scientific community, however, rejected Arrhenius's observation of the greenhouse effect at the time and for decades thereafter, argued that such massive climate change could not be caused by human activity and could only occur gradually over tens of thousands of years. Improved instruments for measuring long-wave radiation enabled scientists to prove that Arrhenius' theory was in fact correct by the 1950s and 1960s.

Carbon dioxide levels in the atmosphere were 280 parts per million in 1750, however by 2005, levels had risen to 380 parts per million, a one-third increase. Much of this acceleration

has occurred in recent years, after 1959, as global energy consumption has skyrocketed (NOAA: Atmospheric Carbon Dioxide 2020). When carbon-absorbing forests are cut down to make room for human growth and woodlands, grasslands, and prairies are turned to farmland for agriculture, carbon emissions rise. Assuming current levels of production efficiency and current deforestation rates, emissions will rise by 15 to 20% by 2050 under the business-as-usual scenario (Mckinsey: Agriculture and Climate Change 2020).

Section 4 – Scope of Project

Knowing that human actions are the primary cause of global warming allows us to better understand how and why our environment is changing, and it clearly describes the issue as one that we can solve. We are both the cause and the cure for global warming. The aim of my data collection is to show that incorporating energy efficient technologies into our everyday routines, such as solar energy, will help mitigate the impact of carbon dioxide (CO2) and other air pollution and greenhouse gases accumulating in our environment, which contributes to extreme climate change.

Ocean sediments, ice cores, tree rings, sedimentary rocks, and coral reefs all reveal that current warming is ten times higher than it was when Earth emerged from the ice ages, at a pace unheard of in the last 1,300 years (How We Know Today's Climate Change Is Not Natural, February 2019). Scientists use data sets and climate models to try to replicate the changes that have already been observed in order to better understand this rapid change in climate. In my project, I will be show casing the models that cannot replicate the changes that have occurred so far when scientists only input natural phenomena such as the sun's strength, changes in the

Earth's orbit, and ocean circulation thus not only proving global warming is caused by us but what technologies we can implement to slow it down.

By using energy efficient technologies such as solar or wind energy we will help reduce the amounts of carbon dioxide and other contaminants in the environment that cause climate change. Using mixed methods studies in conjunction with hypothesis testing will aid in the collecting of all relevant data to aid in a better understanding of this study including limitations and weaknesses. I will describe in depth the multitude of energy sources we have available to us such as coal, natural gas, nuclear, hydro, wind and solar. Furthermore, the difference between non-renewable energy which takes a substantial amount of time to be naturally produced and replenished versus renewable energy sources are easily replenished almost instantaneously.

Section 5 – Importance/Significance of the Project

Keep in mind that technology is meaningless to the average consumer unless we communicate with it and make the connection. For example, the average energy consumer may not see the point of installing solar panels unless they see a benefit that enable them to use energy in a way that saves money for their household—and the rest of the grid users as I will demonstrate in my surveys. According to a recent poll conducted by Pew Research Center, even as concerns about the spread of infectious diseases have grown, public concern about climate change has remained consistent. Only six out of ten Americans believe global climate change is a major threat to the world, up from 44% in 2009.

According to a January 2020 poll, nearly two-thirds of U.S. adults (64%) believe environmental protection should be a top priority for the president and Congress, while about half (52%) believe the same about coping with global climate change. Since 2011, these

percentages have increased significantly. (Figure 2) Climate change was once regarded as a bipartisan issue but what has changed? In the 1980s, the attitude shifted. When climate change research progressed, media outlets started to put scientists' fears into the mainstream. Climate change made the front page of the New York Times for the first time in 1981. NASA scientist James Hansen testified before the Senate Energy Committee in 1988, saying it was "time to stop waffling" on the matter.

In early 2019, 81 percent of Democrats supported tighter environmental legislation, compared to 45 percent of Republicans (How Americans see climate change and the environment, Pew Research Center). The empirical evidence supporting man-made global warming has evolved over the last three decades, with scientists now verifying the phenomenon with near-certainty. Climate change, on the other hand, has gone from being a bipartisan topic to a polarized political subject in Washington over the same time span.

The United States withdrew from the Paris Climate Agreement, rolled back or eliminated hundreds of clean-air regulations, and opened up federally controlled lands, including culturally sacred national monuments, to fossil fuel production under President Donald Trump's administration (a man who wrongly referred to global warming as a "hoax"). Despite the Trump administration's lack of cooperation, local and state governments made significant progress during this period with initiatives such as the American Cities Climate Challenge and ongoing partnerships such as the Regional Greenhouse Gas Initiative.

Industry and business leaders have been collaborating with government officials to develop and implement innovative clean-energy technologies, as well as improve energy efficiency in homes, appliances, and manufacturing processes. Developers, municipalities, and community advocates are collaborating to ensure that new affordable housing is constructed

efficiently, reducing energy demand and decreasing residents' electric and heating bills. Renewable energy continues to grow in popularity as the costs of production and distribution decrease. For the first time in US history, renewable energy sources such as wind and solar generated more electricity than coal in 2020.

President Biden has made mitigating climate change a top priority. He recommitted the United States to the Paris Climate Agreement on his first day in office, sending a clear signal to the global community that we were committed to partnering other nations in reducing carbon emissions. We cannot change what we do not acknowledge and our current administration has acknowledged that global warming is a pressing issue that must be mitigated expeditiously without further delay. Energy efficiency programs have a lot of potential for decreasing our greenhouse gas emissions in the energy sector, and a lot of it could be provided for free or cost negative nonetheless renewable energy is not a panacea for the issue of climate change, however, it will certainly surmount the effects of climate change.

Chapter Two: Literature Review

Section 1 – Statement of Purpose

Understanding and having the proper knowledge on what causes climate change in the first place lies in the solution to avoid it and subsequently solve its extraordinary consequences. The purpose of this research paper is for the reader to not only grasp the concept of climate change but how we can become energy efficient to surmount the negative effects of it. The reality is the number one cause of global warming is human factors, especially the carbon emissions we cause by burning fossil fuels and the pollution capture we prevent by destroying forests. We emit carbon dioxide, methane, soot, and other contaminants into the atmosphere,

which serve as a shield, trapping the sun's heat and causing the earth to warm. Carbon dioxide is a pollutant in the atmosphere that triggers rapid climate and temperature changes on a global and regional scale. Carbon dioxide levels in the atmosphere have risen so dramatically that they are now 50% higher than they have been in millions of years, and they are rising faster than they have ever been.

Plate tectonics, ocean current patterns, variations in the Sun's activity, giant volcanic eruptions, and even changes in Earth's orbit around the Sun have all contributed to global climate change throughout Earth's history, long before humans ever came to be. Scientists have hundreds of millions of years of accurate climate data, so we have a clear idea of how the Earth has evolved over time—sometimes the climate is warmer and sometimes much colder (Ice Age). Global climate change is a blanket term that encompasses a wide range of changes in regional temperature and precipitation trends caused by a variety of natural and man-made causes.

Section 2 – Conflict

The majority of the Earth’s temperature increase occurred in the last 200 years, due to the combustion of hydrocarbons and coal—that is, the burning of fossil fuels such as coal, oil, and natural gas, which emit water and carbon dioxide as their primary end products. Carbon dioxide and methane, for instance, absorb the ultraviolet radiation that rises from the Earth's surface until it can escape into space. These gases absorb the energy and then release it as infrared energy, some of which is emitted into space and some of which is absorbed back into the atmosphere. A loop of energy is created when energy bounces back and forth between the ground and the atmosphere, keeping the lower atmosphere warm. The “greenhouse effect” is the name given to this phenomenon.

The greenhouse effect is not necessarily a negative phenomenon; on the contrary, it is typically beneficial for us. For instance, a greenhouse's aim is to magnify the sun's light while also shielding plants from freezing temperatures. If it weren't for greenhouse gases, the Earth's surface would be more than 30°C colder than it is now. At the surface, all of Earth's oceans will be frozen, however, the issue is the amount of carbon dioxide emitted from fossil fuel combustion is causing the earth's temperature to rise at an unprecedented pace that has put us in this predicament.

According to a studies of atmospheric energy changes, greenhouse gases contribute 3 watts per square meter to the temperature of the Earth's surface: 2/3 from carbon dioxide, 1/6 from methane, and 1/6 from all other gases that humans release (The Science of Energy: Resources and Power Explained, 2016). Methane levels have risen three times faster than carbon dioxide levels, and are now three times higher than they were in 1700. This is important because methane is more than twenty times more powerful as a greenhouse gas than carbon dioxide. That being said, methane in the atmosphere will decay and convert into carbon dioxide in a relatively short period of time.

Global temperatures have begun to rise as a result of a stronger greenhouse effect, at a rate of about 1° per century, although this rate is rising. The only way to explain the global warming is to blame it on the 9 billion tons of carbon emitted by humans. Just half of these 9 billion tons have remained in the atmosphere, with the remaining 1/4 going into the biosphere and 1/4 going into the ocean. In the last few years, the acidity of the world's oceans has risen by around 30%, causing dramatic changes in the ocean biosphere as well. NASA satellite data has shown that the massive continental glaciers of Antarctica and Greenland are increasingly losing ice. Every season, the Arctic Sea ice layer at the North Pole shrinks dramatically.

This is paramount since this impacts how much sunlight ice and ocean water reflects. The polar ice sheets, white snow and ice, reflect most of the sunlight that hit the earth. The water in the ocean absorbs 94 percent of the sun's rays, warming it and causing the sea levels to rise. On the opposite side of the spectrum, while some parts of the world are suffering from floods others are suffering from extreme droughts. Droughts have become more common across the world.

Since the 1960s, the cumulative area of droughts has nearly doubled. Northern latitudes have become slightly drier, while equatorial areas have become significantly drier. As a result, since 1970, the cumulative amount of land destroyed by forest fires in North America has nearly doubled. In the start of a disastrous year that was 2020, bushfires in Australia burned over 46 million acres (72,000 square miles) killing billions of animals and threatening the extinction of a variety of species. The fires destroyed over 3,500 homes and killed at least thirty-four people. Insurance claims for bushfire damages totaled around $1.3 billion. Due to the difficulty of calculating intangible damages such as lost income and production, it may not be possible to fully quantify the economic damage caused by the bushfires.

In California alone, more than 4 million acres were burned last year as well, setting a new record for a single year. The 2018 California wildfires claimed the lives of 106 people and thousands more have been displaced ever since. The reality is, over the last two decades, climate change has inexorably stacked the table in favor of larger and more destructive fires across the America, according to scientists. Warming temperatures, shifting rain and snow cycles, variations in plant populations, and other climate-related developments. According to the World Meteorological Organization (WMO), the world is around one degree Celsius warmer than it was before and the last five years were the warmest on record according to the study. We know climate change is the cause of these changes but what exactly are we doing to contribute to it?

Section 3 – Non-Renewable Energy Sources

Climate change or "climate crisis" as it is now referred to is a reality and its effects will be catastrophic. Practical activities, which would also result in a cleaner, healthier environment, could, however, delay and ultimately stop the process. Which is why we need in innovate our technology in order to generate energy in a clean and safe manor. Everything that humans do requires energy, from the food we eat to the homes we live in and the cars we drive. Humans use an enormous amount of energy for a wide variety of purposes. That need continues to increase as the human population grows and the levels of industrialization increase for much of the world.

We take electricity for granted since it is invisible to us. We use it unceasingly but do not think about it. It is increasingly difficult when bridging its usage with climate change mitigation. Utility companies go through a great deal of effort to create kilowatts to generate energy for our everyday use. We, the conventional user has very little consideration for how much energy is created in the field. To provide these energy needs, humans draw on a wide portfolio of energy resources that include both renewable and nonrenewable sources.

For most of the 21st century, nonrenewable sources of coal, oil, gas, and nuclear fission will likely continue to dominate until the effects of global warming become undeniable. Using nonrenewable energy sources like coal, oil, and natural gas can result in toxic emissions that have a negative effect on our health and the environment. Consequences that scientists had predicted in the past have already come to fruition as a result of climate change. As I mentioned before, more frequent wildfires, longer drought times in some areas, and a rise in the number and strength of tropical storms are all possible future consequences of global climate change. The world has already been affected by global climate change with glaciers shrinking, ice on rivers

and lakes has broken up earlier than expected, plants and animal's ranges have changed, and trees have begun to bloom earlier.

Burning natural resources, such as fossil fuels, is linked to a slew of public health issues, including breathing difficulties, heart attacks, and increased cancer rates. These are just a few of the negative consequences of depending on conventional energy sources like coal and oil. Coal, petroleum, and natural gas are our primary energy sources, providing the vast majority of fuel, power, and heat to people all over the world. In 2005, fossil fuel combustion provided a staggering 86 percent of the global energy consumption.

- *Coal:* Is fossil energy source, a combustible black or brownish-black sedimentary rock with a high amount of carbon and hydrocarbons. Coal is classified as a nonrenewable energy source because it takes millions of years to form.
- *Petroleum (Oil):* Is a type of fossil fuel, a liquid mixture of hydrocarbons that is present in certain rock strata and can be extracted and refined to produce fuels including gasoline, kerosene, and diesel oil.
- *Natural Gas (Pipelines):* Natural gas is a fossil energy source that formed deep beneath the earth's surface. Natural gas contains many different compounds. The largest component of natural gas is methane, a compound with one carbon atom and four hydrogen atoms (CH4).

When coal is burned, it produces more CO2 than any other fossil fuel. It's also the world's most common source of energy, accounting for 83 percent of greenhouse gas emissions in the electric power industry in the United States. It's no surprise that coal combustion is the leading cause of CO2 increases in the atmosphere due to human activity. Simply mining for coal produces methane, a greenhouse gas. The gases are so toxic canaries were brought into coal

mines to alert the miners of poisonous gases such as carbon monoxide. Since birds are more vulnerable, they will become ill before the miners, giving them time to flee or put on protective respirators.

Petroleum produces about three-quarters as much CO2 as coal, and thanks to its status as the world's most widely used transportation fuel, it's battling coal for the title of leading greenhouse gas producer. Oil can be found in underground lakes, sedimentary rock cracks, crevices, and pores. In the case of tar sands oil and oil shale, it's reached by fracking on land or at sea, or by strip mining. Hundreds of millions of tons of CO2 are released in the oil-refining process, on top of the massive quantities of CO2 emitted when petroleum is consumed as gas by cars and trucks. Oil discovery and fracking can have a detrimental impact on endangered species long before the oil reaches the plants.

Natural gas is also referred to as the "cleanest" of the fossil fuel triumvirate because it releases only half the CO2 that coal does when burned. However, it remains a significant contributor to global warming-causing emissions and its contribution is expected to increase. The processing of liquefied natural gas, which is natural gas that has been "supercooled" and converted to a liquid for storage or transportation, causes significant climate change (Biologicaldiversity.org, Energy and Global Warming). Liquefied natural gas production from only one plant will generate more than 24 million tons of greenhouse gases per year, equivalent to the annual greenhouse gas emissions from around 4.4 million cars. Researchers at Carnegie Mellon University have estimated that liquefied natural gas can produce almost as much greenhouse gas pollution as coal. The key concerns inside fracking sites are air pollution and water contamination due to the hazardous chemicals used in hydraulic drilling, while wastewater disposal and declining water sources are also pressing issues directly related to the process.

Section 4 – Conflict of Interests

Fossil fuels are not a renewable energy source, and once depleted, they are no longer usable. It is for this reason that renewable energy is so important. Any of these detrimental consequences can be mitigated or even reversed by switching to renewable energy. Energy efficiency or "conservation" implies using less energy to accomplish the same task, lowering energy bills and lowering emissions. Due to inefficiencies and energy loss, many goods, households and buildings use more energy than they need. Causing unnecessary waste and damage to the earth. One of the simplest ways to minimize energy waste and lower energy costs is to decrease energy usage. It's also one of the most cost-effective options available to us as well. The Sun is a readably available, no cost, maintenance free fusion reactor that we all can see in the sky that works every day and produces an absurd amount of energy every single day.

What we as consumers not only affects our electricity bills but also influences the health of a "smart" grid. Using today's new technology, distributed energy resources, and third-party developers, consumers can produce energy and manage their own energy consumption. Public perception and support of renewable energy is largely controlled my major utility companies spreading false narratives. For utilities, these new choices mean less power for them and possibly lost revenue which is why some of the nation's largest utility companies have used lobbying and other devious tactics to sabotage solar power from becoming mainstream.

"Blocking the Sun: Utilities and Fossil Fuel Interests Undermining American Solar Power", published by Environment America in 2017, outlines the activities of twenty fossil fuel-backed special interests and electric utilities in twelve separate states. In the United States, electric utilities are fighting solar panel distributors over regulations that both sides claim could put them out of business, complete with negative political advertising. The consumer is stuck in

the middle. The majority of utilities are for-profit corporations and all of them have stockholders that expect high returns on their investments. Customers generate less revenue when they produce their own energy from solar thus generating less revenue for the company.

Another area of tension for the utility companies is that revenue declines are not accompanied by cost reductions. They must also maintain the same infrastructure, including power plants, electric lines, and offices. A significant hazard to the infrastructure of the current grid is mostly due to its age, with some portions of the grid dating back over a century. More than 60% of the existing circuit breakers connected to the grid are older than 30 years, and about 70% of the main power lines and transformers have been in operation for more than 25 years. Some company executives understandably fear that this puts their whole business model in peril, and that utility companies are unwilling to respond to such transformations. They've developed a lot of infrastructure that needs to be maintained on a regular basis, and state laws make it difficult for them to implement new policies.

Utilities, like all major corporations want to bill and represent as many consumers as possible. Unfortunately, revenue takes precedence over environmental protection. It can add a few additional tasks and costs as they accommodate solar power users as well. Utilities in some areas, for example, must submit check payments to some customers that generate more electricity than they use. Any excess energy you produce is fed back into the grid and used for homes without solar. Some property owners opt for off-the-grid systems, which enable them to completely eliminate their utility bills but those are a select few.

Falling equipment prices have utilities concerned about losing their complete monopoly over power generation. As the cost of residential solar has plummeted, solar power has increased significantly. Solar panels installed at home have made it simple for millions of Americans to

save money on their energy bills. Although homeowners have benefited greatly from the solar revolution, utility companies have been less than thrilled. We are somewhat eliminating the middleman by transitioning to green energy but we cannot entirely, just yet.

Utility companies have more experience and expertise than any other energy player in sustaining grid health. They can serve as our guides through the unfamiliar terrain, but only if they can hold our attention. Electric utility companies simply want to maintain complete control of energy production and delivery, which is why they are opposed to renewable energy in certain regions. They want to optimize power plants so that they can generate various quantities of electricity depending on the grid's needs at different times. For instance, properly timed and controlled use of home energy storage systems can reduce grid congestion during peak demand times. This saves utilities money by avoiding the use of costly and sometimes polluting emergency generators.

For example, utility companies such as Duke Energy, one of the country's largest energy holding firms, provides and sells electricity to nearly 7.7 million customers in the Southeast and Midwest have incentive programs such as the Duke Energy Small Business Energy Saver Program and Smart $aver where they contract companies such as Lime Energy to retrofit old incandescent lights to energy efficient LEDS. Programs such as these helps fund the switch for the consumer since it is forthrightly more cost-effective to pay them to consume less energy than it is for utility companies to produce it. Utility companies want to you to consume less energy but not too much where you no longer rely on them.

In Florida, Duke Energy, Florida Light and Power, Gulf Power Electric, and Tampa Electric Company funded a front group called Consumers for Smart Solar. Rather than being a pro-solar organization, the group was the primary supporter of a failed ballot initiative in 2016

that would have limited rooftop solar development. Regrettably, Florida Power and Light provided language to legislators in 2017 for a bill that would limit the growth of solar power in the state. The Salt River Project and Arizona Public Service, two of Arizona's largest utility firms, have had some success in supporting anti-solar initiatives, such as those that minimize the benefit that customers receive from net metering. These utilities have also been active in imposing new demand charges directly on solar system owners, eroding their savings.

Former President Donald Trump's dismissal of renewable energy such as wind power as a buggy, expensive, and bird-killing means of generating electricity is out of date and erroneous. He claimed that wind power is dirtier and more expensive than natural gas and once stated, “When the wind doesn't blow, just turn off the television.” During his presidency, Trump’s administration slowly loosened regulation of polluting industries, weakened protections for protected species, and stymied Obama-era attempts to solve climate change. Last year, before the election, his administration intensified its drive to deregulate, easing requirements on power plants that leak waste into rivers, weakening performance standards for dishwashers, reducing regulation of mine protection, and approving seismic drilling in an Alaska wildlife refuge.

While Trump vowed he would revive the coal industry by weakening regulations due to the “cost” of pollution controls, President Joe Biden as kept his promise by reversing Trump's environmental actions. During Trump’s presidency, Trump overturned many Obama-era promises to combat climate change, including withdrawing from the Paris Agreement, repealing clean water regulations, and attempting to expedite environmental reviews of hundreds of new energy and infrastructure projects, including drilling, fuel pipelines, and wind farms. As part of a larger initiative to combat climate change, President Joe Biden unveiled a major infrastructure package aimed at reshaping the US economy and expanding renewable energy infrastructure.

Section 5 – The Politics and Perception of Energy Efficiency

The Biden/Harris administration introduced an infrastructure proposal that proposes $100 billion in funding to modernize the country's electric grid and make it more resilient to worsening climate disasters, such as the recent winter storm in Texas that resulted in widespread blackouts. The propose to repair aging infrastructure such as roads and bridges to make them more resistant to weather events such as droughts, floods, and wildfires. Millions of homes will be retrofitted to improve energy quality, with an emphasis on low-income and minority neighborhoods, which are the most vulnerable to climate change.

The president is urging Congress to spend $35 billion in research and development for projects including carbon capture and storage, hydrogen, offshore wind, and electric vehicles, all of which would help to combat climate change and generate employment. Part of the spending will be paid for by cutting tax incentives and subsidies for fossil fuel producers. In addition, the proposal includes $16 billion in funds to help fossil fuel employees move to new employment by hiring them to cap oil and gas wells and reclaim old coal mines to prevent methane leaks to make sure no worker is left behind.

These are all positive steps in the right direction. Congress must now act quickly to make this vision a reality by passing legislation to fund renewable energy, safe drinking water, public transportation, and affordable housing. In order to combat the disastrous effects of global warming or “climate change” we must first consider the infrastructure involved in generating energy. Energy infrastructure refers to the organizational framework that allows for large-scale energy transportation from producer to consumer.

Whether or not we get our kilowatts from coal, natural gas, nuclear plants or renewable sources we must mine, drill, contain, maintain, or build there are substantial investments

involved. Utilizing energy efficient technologies and implementing energy efficient technologies in our everyday use can certainly help to fight climate change. Renewable energy would not entirely halt deforestation or reduce methane or other industrial greenhouse gas emissions, however, it's a fantastic start.

During a speech at The Empire State Building, former President Bill Clinton once stated, *"We'll never conquer climate change until we prove it's good business to do so."* The owners of the most famous Building in the world announced a "green" retrofit that is expected to save 38 percent of the building's electricity and $4.4 million a year. The project was part of a Clinton Foundation initiative to reduce the global carbon footprint of large buildings. Energy companies guarantee reductions in energy consumption to achieve those savings and will provide the difference if their savings fall short.

The Empire State Building has 6,514 windows and they retrofitted every single one of them during the retrofit, quadrupling the energy efficiency while reusing over 96 percent of the original materials on-site. Some tenants in the building also use an automated system to manage their energy consumption. The system switches off designated power outlets at night and on weekends, avoiding "vampire energy" use by devices that are left plugged in.

The transformation of the building's lighting system, which included an adaptive dimming system that changes based on light coming in from the outside, is one of the inventions. Furthermore, much of the original lighting in the building was replaced with energy-efficient fixtures. The 1,200 tower lights were changed to LED fixtures as well. The Empire State Building is a 102-story Art Deco skyscraper in the heart of NYC, built in 1930 and was still able to demonstrate the economic feasibility of energy efficiency and sustainability investments. Proving to the energy efficiency industry in terms of sustainability, it can be done.

Section 6 – Plenty of Green to go Green

The Empire State Building's comprehensive retrofit to help reduce their carbon footprint and save millions on their electric bill is not an isolated event. There are numerous examples across the world that demonstrate how reducing emissions and striving to mitigate the impact of climate change is great business. For instance, the Bill Clinton backed “Climate Change Capital,” is one of the world's leading low-carbon fund managers and advisors. They believe it is critical that both commercial property owners and tenants realize the benefits of utilizing current clean technology and best practices to minimize their carbon footprint. Their mission is to demonstrate the financial and environmental advantages of constructing and occupying low-energy buildings.

Solar panels at the local high school in Batesville, Arkansas, less than 20 miles away from the state's largest coal-fired power plants went from spending $600,000 a year on their utility bills to saving $1 million in two years. This was Arkansas' first solar and energy efficiency venture. Entegrity, a firm that specializes in energy efficiency, conducted an energy audit of the Batesville School District in 2017 and projected that they could save at least $2.4 million over the next 20 years. They managed to save half of it in merely two years, which is a phenomenal feat plus were able to give their staff raises and bonuses.

Former President Jimmy Carter Built a Solar Farm in his hometown of that now supplies electricity to half of the city. The 94-year-old leased 10 acres of land near his hometown of Plains, Georgia, in 2017 to construct a massive solar farm. Carter's solar field, which consists of 3,852 panels, now produces 1.3 MW of power each year. (equivalent to burning 3,600 tons of coal). In1979, he installed water heating solar panels on the roof of the White House, making him one of the first proponents of green energy. President Ronald Reagan, ordered their removal.

Section 7 – Renewable and Energy Efficient Sources

Currently, fossil fuels – coal, oil, and gas – account for 79 percent of global energy output. We know a planet run on fossil fuels is not safe or sustainable, they threaten future generations' lives and livelihoods, as well as the biosphere around us, as they account for 87 percent of global CO2 emissions. Since we recognize how the greenhouse effect works, we can make the link between the human release of carbon dioxide and the rise in the average global temperature the global warming.

Enabling consumers to access renewable energy will help them save money on their energy bills while also reducing grid stress and demand for fossil fuel electricity. This will help us ratepayers save money while still allowing us to breathe healthier air. We must now achieve comparable progress in all other renewable sources, as we look to help reduce the worst effects of climate change through a rapid energy transition.

There are plenty of ways to become energy efficient, for example making the switch to energy efficient lighting. LED bulbs use 25 to 30 percent less energy than incandescent bulbs and last 25 times longer, resulting in significant cost savings. Some LEDs can last up to 20 years. Although these bulbs are slightly more costly up front than incandescent bulbs, they quickly pay for themselves in energy savings and reduced replacement costs. We also save energy by retrofitting HVAC equipment since it works more smoothly. Nevertheless, we benefit from more consistent temperatures and humidity regulation. It makes less noise thus producing less drafts from moving air, depending on the retrofit options. Even if all of these small changes add up to major changes, they will not be enough to achieve a rapid energy transition in order to tackle climate change.

It's crucial that renewable energy sources like offshore wind and hydropower storage will lower costs to the point where fossil fuels become unprofitable and thus undesirable. According to the International Energy Agency, offshore wind alone has the ability to meet global energy demands 18 times over. Despite this, it now only provides a small portion of the world's power. Fossil fuels have some advantages, one of which is that burning fossil fuels to produce energy has so far been reasonably cost-effective in the short run. If wind and other renewables are to replace fossil fuels, support must be acquired toward mirroring solar energy innovation curve, and lessons learned about the value of accelerating the implementation of enabling technologies.

Solar will become even more affordable in the coming years as technology advances. This will also benefit the atmosphere and tackles climate change. Solar power has been one of the most successful energy industry success stories in recent decades. Solar has dropped in price dramatically, making it the cheapest energy source on the planet today, according to the International Energy Agency (IEA), which forecasts that solar will be the "king" of renewables development over the next decade. Elon Musk once stated, “We Can Power America by Covering a Small Corner of Utah With Solar.” Global warming is a reality, and we should begin incorporating renewable energy into our daily lives as soon as possible. Some renewable resources include:

- *Solar Energy*: The transformation of heat, the energy that comes from the sun. It has been used in a variety of ways by people all over the world for thousands of years. Solar energy has been used for heating, cooking, and drying since the dawn of time.
- *Wind Energy:* A form of solar power. The method of using wind to produce electricity. Wind turbines transform the wind's kinetic energy into mechanical

energy. A generator is a device that converts mechanical energy into electrical energy.

- *Hydropower Energy:* Water in motion generates energy that can be stored and converted into electricity. The most popular form of hydroelectric power plant stores water in a reservoir behind a dam on a river. Water emitted from the reservoir spins a turbine, which then stimulates a generator, which generates electricity.
- *Ocean Energy:* All types of energy extracted from the sea. Ocean technology is divided into three categories: wave, tidal, and ocean thermal. Both sources of ocean energy are still in their early stages of commercialization. Wave energy continues to be more expensive than any other ocean technology.
- *Hydrogen Energy:* Is an energy carrier, not an energy source, and it has the ability to deliver or store massive amounts of energy. Hydrogen may be used to produce electricity or power and heat in fuel cells.
- *Energy Storage Technologies:* Captures and deliver energy securely for future use. Mechanical, electrical, chemical, electrochemical, and thermal energy storage methods exist, including lithium-ion batteries.

One of the downsides of renewable sources is their sporadic supply cycle. The wind and sun are not consistent since the weather fluctuates continually. Electric power storage technologies, such as batteries, are critical for balancing the fluctuating supply from renewables with the inflexible demand for electricity. I've established many data-driven behaviors monitoring methods to confirm that the quantitative result was due to behavior changes rather

than uncontrollable causes in future chapters. With these measures, it was possible to analyze behavioral changes, as opposed to merely analyzing quantitative variations.

CHAPTER 3: DATA COLLECTION AND ANALYSIS

Observational evidence is fundamental in qualitative studies because they allow the researcher and/or investigator to discern undisputable patterns or performance. In order to conduct adequate research, one must utilize an assemblage of research methods and statistics. Data collection and data analysis consist of surveys, key informant interview, observation of program implementation, content analysis, thematic coding, summary statistics, time-series and parametric tests.

All these evaluations help determine how success will be judged and how will assumptions of the theory of “climate change” is correct. These methods will facilitate which data will be collected and how it will be collected and lastly how the data will be analyzed? Initially we will typically need a combination of qualitative data and quantitative data from independent sources to increase the credibility of the conclusions drawn here and answer the key evaluation questions. Secondly, as I conducted my research, I needed to analyze what data is already available on the subject. For instance, program performance and monitoring data in addition to records and communications. Additionally, I checked the external statistics or surveys from government and other agencies as well.

Consequential climate action begins with data and methods—and analytical rigor, state-of-the-art approaches, and technical competence are used to bring it to pass. Despite spending hundreds of billions of dollars annually on renewable energy, the planet is still not

decarbonizing fast enough to avoid dangerous climate change consequences. Consumers have more energy management options than ever before, having said that, how do utilities design programs that support consumer demands for distributed energy resources—while enhancing grid reliability, and ensuring practical prices?

Using proprietary analytics platform, utilities treat general population as grid partners and design programs that meet their needs and lifestyles. Climate experts have executed hundreds of action planning projects and greenhouse gas inventories, and deliver a data-backed approach to climate impact assessment and risk analysis, mitigation technologies, adaptation analysis, and the economic, equity, and health benefits of decarbonization.

Statement of Purpose

A “Data Collection Plan” guarantees that everyone comprehends the data collected. The plan's goal is to ensure that all relevant data is collected and that the data collected is meaningful and reliable. The *purpose of my data collection* is to prove applying energy efficiency technologies such as solar energy to our everyday lives *will help counteract the effects* of carbon dioxide (CO2) and other air pollutants and greenhouse gases collecting in our atmosphere *that cause extreme climate change*.

You cannot manage what you do not measure. Gaining an understanding of our current state of emissions will allow us to develop best-in-class emission reduction targets. Setting well-informed climate qualification and sustainability objectives will assist in addressing manmade climate change. As our Research and Design textbook states, it defines a hypothesis as a prediction about a specific event or relationship between variables. For the hypothesis

testing procedure, it states in our class textbook, "Statistics: Concepts and Controversies" in a test of significance we focus on a signal hypothesis and single probably.

Hypothesis testing is an essential system to accomplish when you want to make conclusions about a certain collected data using random samples. These conclusions include estimating population properties such as the mean, differences between means, proportions, and the relationships between variable. My hypothesis*: "By utilizing energy efficient technologies such as solar energy, we will aid in decelerating the levels of carbon dioxide and other pollutants in the atmosphere that cause climate change."* The null hypothesis (H0) is: *"Utilizing energy efficient technologies will not decelerate the levels of carbon dioxide and other pollutants in the atmosphere that cause climate change."*

After formulating my hypothesis, I must find the right test, execute the test and lastly make a decision based on the result. There are two hypotheses that we have to make. The null hypothesis, denoted H0, and the alternative hypothesis, denoted H1or HA. It is important to distinguish the different between "manmade climate change" and normal "evolutionary climate change." The rate in which the temperature of the earth is increasing at a much higher rate than ever before.

The global average surface temperature rose 0.6 to 0.9 degrees Celsius (1.1 to 1.6° F) between 1906 and 2005, and the rate of temperature increase has nearly doubled in the last 50 years.[1]

We are fully cognizant that driving our much-loved ICE vehicles (Internal-Combustion Engine) such as SUVs (sport utility vehicle) release carbon monoxide, nitrogen oxides, and hydrocarbons. Contrastingly their EV (electric vehicles) battery powered counterparts do not.

[1] https://earthobservatory.nasa.gov/features/GlobalWarming/page2.php

Since they do not discharge carbon monoxide, EVs can run in enclosed spaces such as garages safely. Will making the switch to EVs and LEDS help combat climate change? When it comes to science, the null hypothesis is akin to the phrase "innocent unless proven guilty." We will assume my question is true and the alternative will cover everything else.

Using mixed methods studies as related with hypothesis testing will help gather all the information to help those to better understand the topic. How can we lower our energy consumption and better control our energy loads? How do we create energy saving services that are tailored to the needs and desires of the utility company's customers? Lastly, how do you do it all in a cost-effective way?

Energy efficiency simply means using less energy to perform the same task – that is, eliminating energy waste. Energy efficiency brings a variety of benefits: reducing greenhouse gas emissions, reducing demand for energy imports, and lowering our costs on a household and economy-wide level.

Data Collection Plan/Matrix Introduction

Climate change must be factored into any aspect of utility planning, construction, operations, and emergency response. What is the reason for this? Extreme heat waves, the debilitating polar vortex, catastrophic floods exacerbated by sea level rise, devastating wildfires, and other events necessitate a shift in mindset. In order to determine for whom and in what ways a program or policy has been successful, impact assessments need to go beyond measuring the size of the effects (i.e., the average impact). Data collection is characterized by standard validated techniques as the method of gathering, measuring and analyzing accurate insights for

study. Based on collected data, a researcher may test their hypothesis. Data collection is the primary and most important step for study, regardless of the field of research, in most cases.

The greatest challenge I faced was to make sure I did not overlook any information and by creating a matrix, it enabled me to find the answer of each evaluation question tackling climate change and how it impacts us on a daily basis. There are a few data collection and analysis issues that I must not only be mindful of, having said there are a few difficulties I should address as well. Since my personal research paper is for a class and not a global study, my resources are limited compared to university funded research, I comprised my data from various studies and techniques. For instance, there are three types of sampling alone.

The three types of sampling techniques are: Probability, purposive and convenience.

- *Probability sampling:* Is any method of sampling that utilizes some form of random selection. You must set up some mechanism or protocol to ensure that the various units in your population have equal chances of being selected in order to have a random selection system.
- *Purposive sampling*: A purposive sample is a non-probability sample that is selected based on characteristics of a population and the objective of the study. Purposive sampling, also known as judgmental, selective, or arbitrary sampling, is distinct from convenience sampling.
- *Convenience sampling*: as a method adopted by researchers where they collect market research data from a conveniently available pool of respondents. It is the most widely used sampling technique because it is

extremely fast, simple, and cost-effective. Members are also approachable and willing to participate in the study.

A masterly sampling strategy is a generalization of all three sampling strategies to help determine the effects of man-made climate change. The *quality of data* needs to be managed throughout this process. For instance, the validity, reliability, completeness, precision, integrity and lastly timeliness. Mistakes in this process leads to invalid data and there are ethical guidelines to follow as well. Sourcing studies that are conducive for the health of humanity as opposed to profit.

CO2 levels in the atmosphere have risen since the Industrial Revolution, according to atmospheric tests collected in ice cores and more recent direct measurements. Take a look at Figure 1. The National Aeronautics and Space Administration or NASA, displays a graph demonstrating that for millennia (one thousand years) the atmospheric carbon dioxide had never passed a certain threshold. For the last 650,000 years, Earth's climate has evolved naturally, going in and out of ice ages and warm periods. Changes in climate occur because of alterations in Earth’s energy balance, which result from some kind of external factor or “forcing”—an environmental factor that influences the climate. Changes in solar production, Earth's orbit, ocean circulation, albedo (the reflectivity of the Earth's surface), and atmospheric composition have contributed to ice ages and climate shifts (the amounts of carbon dioxide and other greenhouse gases such as water vapor, methane, nitrous oxide and ozone that are present). This data came from a sampling study from the American Meteorologist Society or AMS journals.

Which is why oil and gas companies that are frequently viewed as the most polluting field of the energy industry, are major corporations that have begun to invest in green technology in an attempt to clean up the economy and environment. Many oil companies have invested billions in renewable energy projects, like BP, Shell, Chevron, Total, Eni, and Exxon, but questions remain on whether they are doing enough. Despite the growth of renewables, “big oil” only spent 1% of its overall investment in 2018 on green energy initiatives.

Limitations

Cities are not only significant contributors to global climate change, but they are also at the forefront of the effects of climate change. Quantifying and evaluating the risk posed by climate change is important for cities to adopt positive climate adaptation and risk reduction strategies. However, most recent studies have focused on global, national, or regional dimensions, with only a few attempting to address the issue on a global, national, or regional level. Earlier research focused on global, national, or regional dimensions and even fewer in the case of a recent literature review, have attempted to explore climate change risk at an urban scale.

According to polls, 52 percent of Americans believe most climate scientists accept that the Earth has been warming in recent years, and 47 percent believe human activities are a major cause of that warming (i.e., there is a scientific consensus).[2] Based on a review of 11,602 peer-reviewed papers on "climate change" and "global warming" published in the first seven months of 2019, the consensus among research scientists on anthropogenic global warming has risen to

[2]https://sta.uwi.edu/iir/normangirvanlibrary/sites/default/files/normangirvanlibrary/documents/Examining%20the%20Scientific%20Consensus%20on%20Climate%20Change.pdf

100 percent.[3] The science is out on climate change but why have we not made the transition to sustainable and renewable energy? The biggest limitation I found was not in the vast information on global warming or climate change but rather the public's perception of it.

Chi-square tests are often used in the behavioral sciences to assess patterns and associations between variables that can be inferred from frequency data. As a result, chi-square tests can be used to assess if the frequencies found in a sample vary from those predicted by chance. As an exemplification, how do we convey the human implications of climate change? Why is it such a politically charged issue? The words 'Climate Change' and 'Global Warming' have recently become very clear to the general public and their perception of what is going on with the climate. The public's reaction to all of the climate-related news and publicity has been a quest for understanding and comprehension, which has resulted in either support or disbelief.

A chi-square analysis was conducted using Pearson's formula. This test measured the difference ratio for each emotional response category and compares them to assess the dependence and likelihood of interactions between the variables, in this case global warming and climate change. I curated my personal questionnaire (Figure 5), however, surveys on a platform such as Twitter, with an average of 187 million active users daily and our former President's favorite platform (until he was permanently banned) are much more reliable. The results from the Pearson's chi-square analysis showed that the relationship between the variables was significant (Pearson's chi-square –763.98, d.f. = 2, $P<0.001$). Negative climate change tweets

[3] https://www.zmescience.com/science/denialists-100-consensus-anthropogenic-global-warming/

represented 33.1% of the total while neutral tweets totaled 49.8%, while positive climate change tweets totaled 17.1%.[4] (Figure 2)

Understanding the relationship between greenhouse gases and climate change has sparked academic interest, as well as widespread interest on social media. In another comparison polling and chi-square tests show a strong connection or link between respondents' educational levels and their belief in using renewable energy to mitigate environmental problems. This demonstrates that their level of education has a huge impact on their awareness and understanding of how to use renewable energy to mitigate environmental issues. As a result, more educational programs about renewable energy knowledge need to be channeled and implemented at the primary school and college levels in order to address this obstacle. If the evidence on climate change is reliable, it is up to public opinion to implement energy efficient technologies in our everyday lives.

Figure 1.

[4] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4587979/

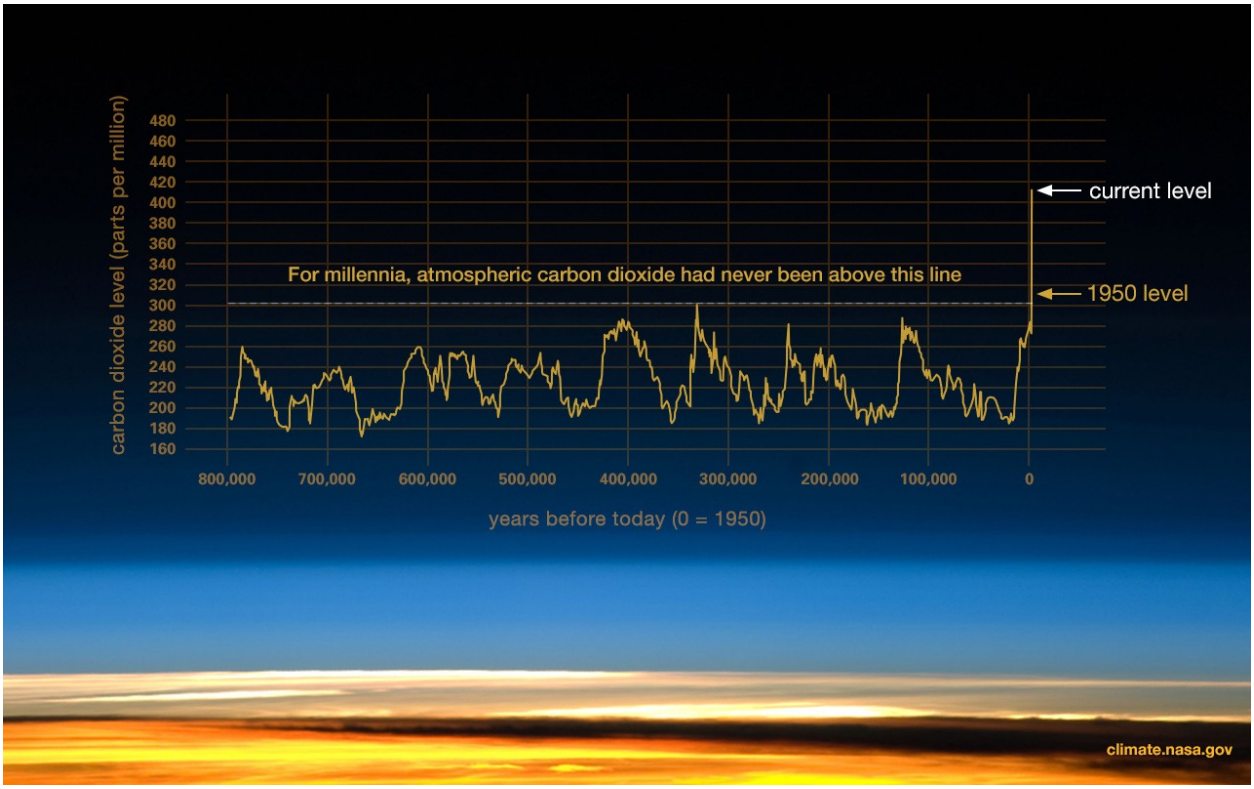
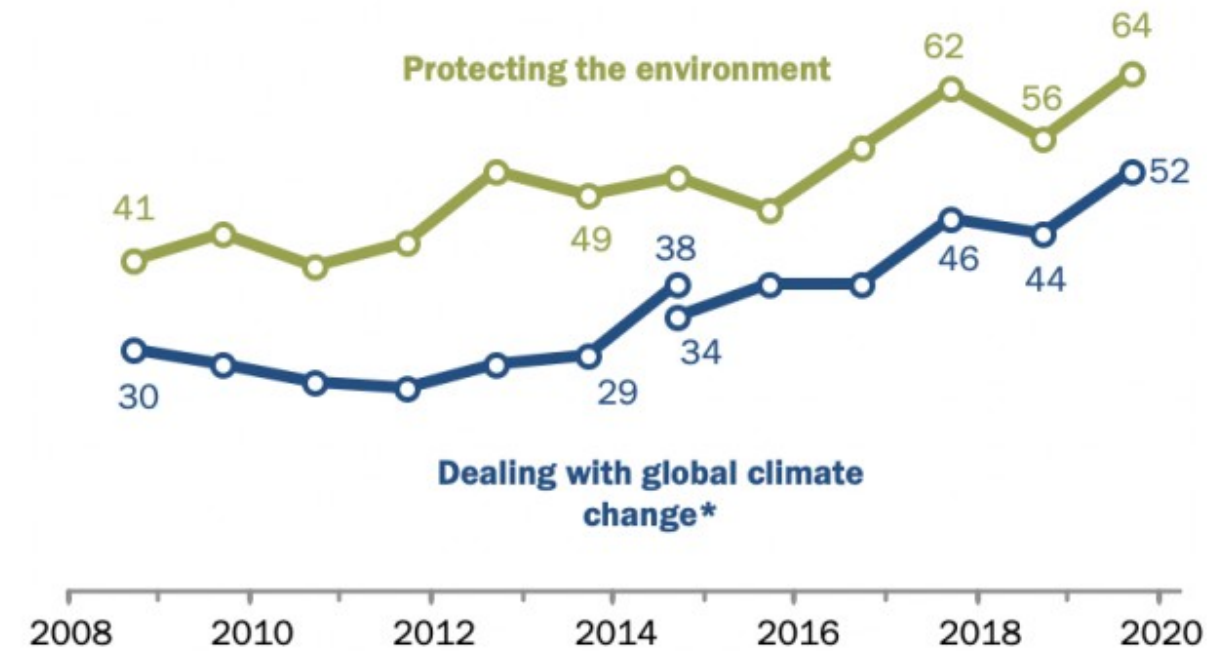

carbon dioxide level (parts per million)
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
For millennia, atmospheric carbon dioxide had never been above this line
current level
1950 level
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
years before today (0 = 1950)
climate.nasa.gov

Figure 2.

Increased support for prioritizing policies on the environment, climate change since 2011

% U.S. adults who say ____ should be a top priority for the president and Congress



*In 2014 and earlier, respondents were asked about dealing with "global warming." In 2015 half the sample was asked about either "global warming" or "global climate change"; 34% called "global climate change" a top priority while 38% said this about "global warming."
Source: Survey of U.S. adults conducted Jan. 8-13, 2020.
"As Economic Concerns Recede, Environmental Protection Rises on the Public's Policy Agenda"

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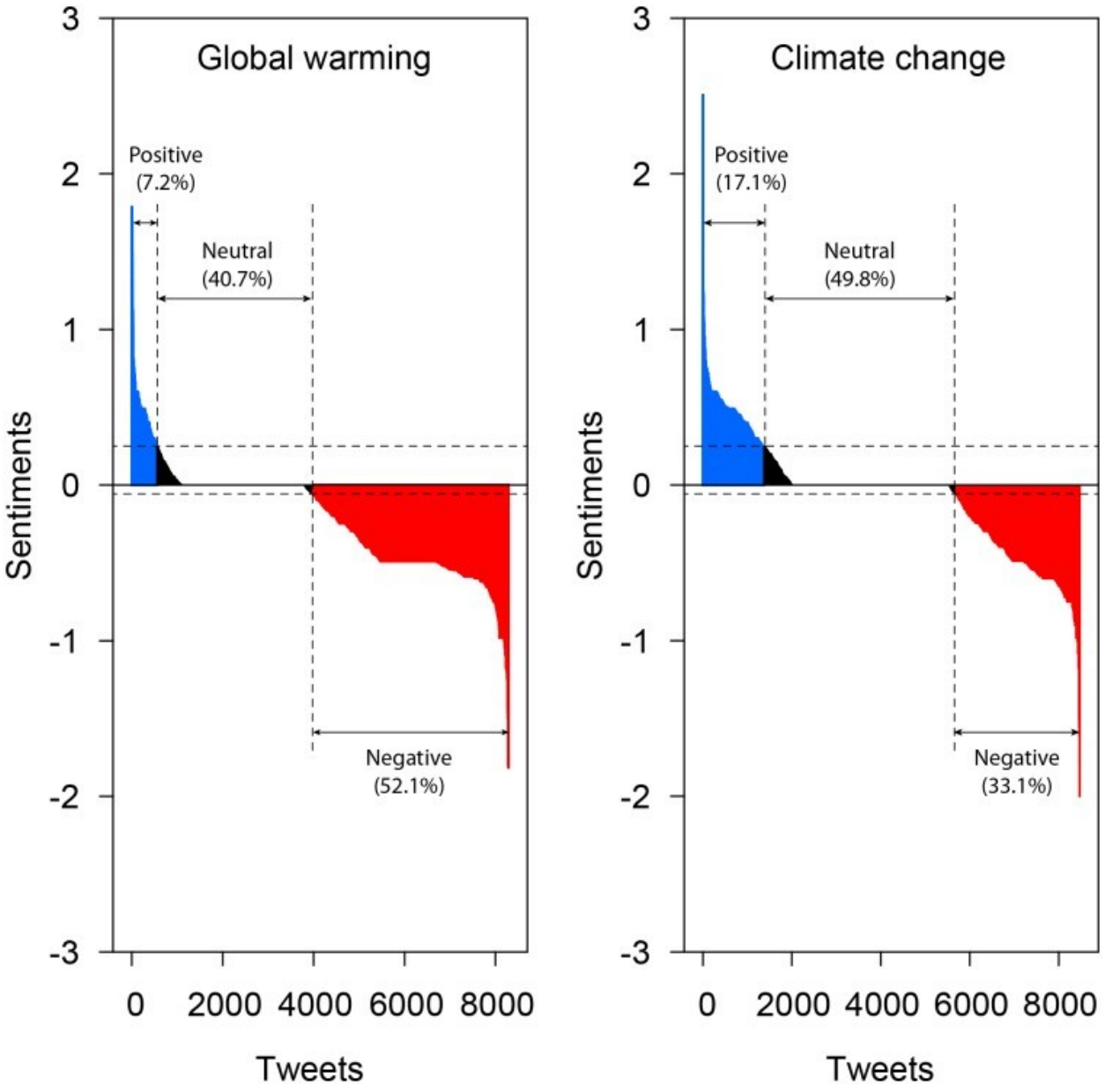
Global warming
Positive
(7.2%)
Neutral
(40.7%)
Negative
(52.1%)
Sentiments
Tweets
Climate change
Positive
(17.1%)
Neutral
(49.8%)
Negative
(33.1%)
Sentiments
Tweets

Figure 3.

			Level of education			
			Primary / Secondary	College / Polytechnic	University	Total
Believe in using renewable energy	Yes	Count	46	49	192	287
		% within Believe in using renewable energy	16.0	17.1	66.9	100
	No	Count	6.0	2.0	7.0	15
		% within Believe in using renewable energy	40.0	13.3	46.7	100
Total		Count	52.0	51.0	199.0	302
		% within Believe in using renewable energy	17.2	16.9	65.9	100

Figure 4.

Sample Letter for Questionnaire

Dear Team Member:

Please read the cover letter and choose if you would like to proceed. This survey is conducted as part of a school research project I am conducting. The theme of the research project is assessing the impacts of becoming energy efficient to combat climate change. You are invited to participate in a survey, entitled "Energy Efficiency for Climate Change." This study is being conducted by Jessica Lugo of Nyack Christian College 2 Washington St. New York, NY 10004, 201-906.3869, 1JessicaLugo@gmail.com.

The purpose of this study is to examine factors involving global warming and its impact environmentally and financially. Your participation in the survey will help better understand the public's knowledge on the subject. We estimate that it will take about 30 minutes of your time to complete the questionnaire. You are free to contact the investigator at the above address and phone number to discuss the survey. Please complete questionnaire by November 3, 2020.

Risks to participants are considered minimal. There will be no costs for participating, nor will you benefit from participating.

Identification numbers associated with email addresses will be kept during the data collection phase for tracking purposes only. A limited number of research team members will have access to the data during data collection. This information will be stripped from the final dataset.

We have taken all reasonable measures to protect your identity and responses. The questions in this survey do not ask you to reveal any personally identifying information, the data are SSL encrypted and stored in a password protected database, and IP addresses are not collected. However, email and the internet are not 100% secure, so it is also suggested that you clear the computer's cache and browser history to protect your privacy after completing the survey.

Your participation in this survey is voluntary. You may decline to answer any question and you have the right to withdraw from participation at any time without penalty. If you wish to withdraw from the study or have any questions, contact the investigators listed above.

If you have any questions or would like us to email another person for your institution or update your email address, please call Jessica Lugo at 201.906.3869 or send an email to 1JessicaLugo@gmail.com. You may also request a hard copy of the survey from the contact information above.

To complete the survey, click on the link below:
https://www.surveymonkey.com/s/X82WMCB

This study has been reviewed and approved by Nyack Christian College. If you have questions about your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish - by phone at (212) 625-0500 or email at nyack@n6a.com

IRB Approval Number: 12.026

If you agree to participate please press the yes button at the bottom of the screen otherwise click no at the bottom of the screen or use the X at the upper right corner to close this window and disconnect.

Thank you,

Jessica Lugo
201-906-3869

Name: _____ Send Results: ☐

You can visit out privacy policy here: https://www.surveymonkey.com/s/HPKJ39Q

Figure 5 **Sample Questionnaire**

Considering your knowledge about the risks associated with climate change, how likely are you to recommend a friend or a colleague to promote activities that will help reduce global warming or to live a clean and green life?

0	1	2	3	4	5	6	7	8	9	10

Very Unlikely — Very Likely

Please state your level of agreement for the following statements regarding global warming/climate change.

	Completely Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Completely Agree
It poses a serious threat for people around the world.	○	○	○	○	○
It poses a serious threat to you and your family.	○	○	○	○	○
It is caused by human activities.	○	○	○	○	○
Problems and its impact are underestimated in the news.	○	○	○	○	○
Climate change is happening right now.	○	○	○	○	○
I am ready to reduce my energy usage to tackle climate change	○	○	○	○	○
You completely understand what climate change means.	○	○	○	○	○
The global temperatures have changed compared to the previous decade.	○	○	○	○	○

On a scale of 1 to 10 please rate, how much do you think climate change threatens your personal health and safety?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

On a scale of 1 to 5, please rate, which issues are of more concern in your opinion?

	1	2	3	4	5
Terrorism	○	○	○	○	○
Poverty	○	○	○	○	○
Climate change/global warming	○	○	○	○	○
Overpopulation	○	○	○	○	○
Unemployment	○	○	○	○	○
Violence/War	○	○	○	○	○
Infectious diseases	○	○	○	○	○
Crime	○	○	○	○	○
Economic situation	○	○	○	○	○

In your opinion, do you think the temperature on earth has been rising over the past decade?

- ○ Yes, because of human activities
- ○ Yes, because of natural causes
- ○ No, there is no change
- ○ Don't know

Are you aware of the global policies or initiatives taken by various organizations to reduce climate change/global warming?

- ○ Yes
- ○ No

How much do you think the following has contributed to global climate change?

	Strongly	Moderately	Slightly	nothing	Don't know
Greenhouse gases	○	○	○	○	○
Land use and land cover	○	○	○	○	○
Sun	○	○	○	○	○
Aerosols	○	○	○	○	○
Melting of Ice or volcanic eruptions	○	○	○	○	○
El Niño or irregular warming of surface water	○	○	○	○	○
Deforestation	○	○	○	○	○

In your opinion, how important do you think the following issues are on a global scale?

	Very Important	Fairly Important	Important	Slightly Important	Not at all Important
Air pollution	○	○	○	○	○
Pollution of rivers and seas	○	○	○	○	○
Flooding	○	○	○	○	○
Litter	○	○	○	○	○
Poor waste management (e.g. overuse of landfills)	○	○	○	○	○
Traffic/ congestion	○	○	○	○	○
Temperature rise or drop	○	○	○	○	○
The hole in the ozone layer	○	○	○	○	○
Using up the earth's resources	○	○	○	○	○
Extinction of species	○	○	○	○	○

What is the level of trust on information about climate change, if you were to receive it from the following?

	A lot	A little	Not very much	Not at all
Family members	○	○	○	○
Colleagues	○	○	○	○
Scientists	○	○	○	○
Government bodies	○	○	○	○
Energy suppliers	○	○	○	○
Environmental organizations	○	○	○	○
Media (TV, radio, newspaper, etc)	○	○	○	○

Please rank as per who do you think should have the main responsibility to tackle climate change?

Drag your choices here to rank them

- Environmental organizations like Worldwide fund for nature
- Individuals
- International organizations like the UN
- Local government
- Businesses and industries
- The country's government

Q5 How sure are you that mean global temperatures have risen compared to pre-1800s levels? (Question displayed only if respondent thinks temperatures have risen).

1.	Extremely sure	55.98%
2.	Very sure	31.26%
3.	Somewhat sure	11.16%
4.	Not at all sure	1.59%

Q10 How sure are you that mean global temperatures have remained constant compared to pre-1800s levels? (Question displayed only if respondent thinks temperatures have remained constant).

1.	Extremely sure	7.14%
2.	Very sure	14.29%
3.	Somewhat sure	64.29%
4.	Not at all sure	14.29%

Q11 How sure are you that mean global temperatures have fallen compared to pre-1800s levels? (Question displayed only if respondent thinks temperatures have fallen).

1.	Extremely sure	66.67%
2.	Very sure	0%
3.	Somewhat sure	0%
4.	Not at all sure	33.33%

Q12 How sure are you that human activity is a significant contributing factor in changing mean global temperatures? (Question displayed only if respondent thinks human activity is a contributing factor).

1.	Extremely sure	53.23%
2.	Very sure	35.32%
3.	Somewhat sure	10.45%
4.	Not at all sure	1.00%

Q13 How sure are you that human activity is not a significant contributing factor in changing mean global temperatures? (Question displayed only if respondent thinks human activity is not a contributing factor).

1.	Extremely sure	33.33%

(Continued.)

2.	Very sure	27.78%
3.	Somewhat sure	38.89%
4.	Not at all sure	0%

Q18 Climate science is a credible science.

1.	Strongly agree	78.79%
2.	Moderately agree	15.30%
3.	Slightly agree	3.03%
4.	Undecided	1.06%
5.	Slightly disagree	0.61%
6.	Moderately disagree	0.91%
7.	Strongly disagree	0.30%

Q19 Compared to my field, climate science is a mature science.

1.	Strongly agree	17.10%
2.	Moderately agree	33.74%
3.	Slightly agree	12.67%
4.	Undecided	8.09%
5.	Slightly disagree	11.15%
6.	Moderately disagree	10.38%
7.	Strongly disagree	6.87%

Q20 Compared to my field, climate science is.

1.	Much less trustworthy	8.62%
2.	Slightly less trustworthy	21.85%
3.	About equally trustworthy	62.92%
4.	Slightly more trustworthy	4.15%
5.	Much more trustworthy	2.46%

Q25 Which of the following statements comes closest to describing your research?

1.	The majority of my research concerns climate change or the impacts of climate change	5.50%
2.	Some of my research concerns climate change or the impacts of climate change	42.45%
3.	None of my research concerns climate change or the impacts of climate change	52.04%

Q26 Where do you get your information about climate change?

1.	Mostly from popular media	14.88%
2.	Mostly from scientific literature	32.82%
3.	About equally from popular media and scientific literature	52.30%

Q27 Please indicate how strongly you agree or disagree with the following statements about climate change:

	Strongly agree (%)	Moderately agree (%)	Slightly agree (%)	Undecided (%)	Slightly disagree (%)	Moderately disagree (%)	Strongly disagree (%)
Atmospheric concentrations of greenhouse gases have increased sharply since the Industrial Revolution.	86.55	10.36	2.16	0.77	0.15	0	0
Variation in solar activity is responsible for the majority of the observed warming in the past century.	0.93	3.88	3.88	20.00	10.39	26.98	33.95
Higher emissions of greenhouse gases will lead to greater atmospheric warming.	68.32	20.56	6.65	3.25	0.62	0.46	0.15
Climate predictions are largely inaccurate because of the inherent limitations of computer climate models.	4.81	11.49	15.68	8.39	11.34	32.45	15.84
Climate models have improved in their ability to predict surface temperature patterns.	31.53	40.80	13.60	9.74	0.93	1.39	2.01
Climate change is independent of atmospheric carbon dioxide levels.	0.93	2.17	1.70	6.50	5.57	21.21	61.92

Q28 People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly do you agree or disagree with each of these statements?

	Strongly agree	Moderately agree	Slightly agree	Slightly disagree	Moderately disagree	Strongly disagree
The government interferes far too much in our everyday lives.	2.95	6.56	13.77	16.07	33.44	27.21
Sometimes the government needs to make laws to keep people from hurting themselves.	2.97	1.32	1.32	12.87	37.95	43.56
It's not the government's business to try and protect people from themselves.	2.97	4.29	8.58	16.50	3993	27.72
The government should stop telling people how to live their lives.	3.06	8.50	15.99	19.73	33.33	19.39
The government should do more to advance society's goals, even if that means limiting the freedom and choices of the individuals.	6.40	6.40	10.77	29.63	32.32	14.48
Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.	7.51	8.87	9.22	28.67	32.08	13.65

Q29 People in our society often disagree about issues of equality and discrimination. How strongly do you agree or disagree with each of these statements? (Omitted for half the respondents).

	Strongly agree	Moderately agree	Slightly agree	Slightly disagree	Moderately disagree	Strongly disagree
We have gone too far in pushing equal rights in this country.	2.09	2.44	6.27	9.06	24.74	55.40
Our society would be better off if the distribution of wealth was more equal.	4.47	3.09	2.75	16.84	27.84	45.02
We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women.	3.77	2.74	7.53	16.44	25.34	44.18
Discrimination against minorities is still a very serious problem in our society.	1.03	2.41	2.41	15.46	41.58	37.11
It seems like blacks, women, homosexuals, and other groups don't want equal rights, they just want special rights just for them.	0.34	2.41	5.86	8.62	22.07	60.69
Society as a whole has become too soft and feminine.	1.05	2.10	8.39	7.34	15.03	66.08

Q30 Thinking about the environmental movement, do you think of yourself as:

1.	An active participant in the environmental movement	21.55%
2.	Sympathetic towards the environmental movement, but not active	65.61%