Global Climate Change, the Kyoto Protocol, and Penn State University

From Part of the Problem to Part of the Solution

The Corner of West College Avenue and Burrowes Road

A Report from the Green Destiny Council and the Leonhard Center Technical Writing Initiative

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About the Cover: Photograph of the West Campus Steam Plant on the corner of West College Avenue and Burrowes Road. Last year, 66,928 tons of Pennsylvania bituminous coal were burned here.[1]

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Greenhouse Gas Pledge

We are Penn State scientists who are familiar with the causes and effects of climatic change as summarized recently (January, 2001) by the United Nations Intergovernmental Panel on Climate Change. We endorse this report and observe that the further accumulation of greenhouse gases commits the Earth irreversibly to further global climatic change and consequent ecological, economic and social disruption. The risks associated with such changes justify preventive action through reductions in emissions of greenhouse gases. <u>Our familiarity with the scale, severity, and costs to human welfare of the disruptions that the climatic changes threaten leads us to introduce this note of urgency and to call for Penn State to take a leadership role in early action to reduce its greenhouse gas emissions via the most cost-effective means</u>.

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1. **Kyoto Introduction: "Penn State, We Have a Problem"**

Climate change has been called the most significant environmental issue the world has ever faced. Forecasts and models show a continued warming of the Earth could trigger a wide range of changes in our climate – changes that will have consequences for our health, our children's future, our economy, our national security, and our environment. Penn State scientists have been at the forefront of alerting the world to this problem. And the world has taken notice. Yet America and even Penn State lags behind. In fact, things have gotten worse at Penn State since we promised the nations of the world we would address this problem. Why is that? More importantly, can anything be done about it?

The greenhouse gas pledge made by top scientists researching global climate change at Penn State provides the catalyst to this report. We ask whether Penn State can answer their call. How can Penn State, in their words, "take a leadership role in early action to reduce its greenhouse gas emissions via the most cost-effective means"? So far, the call has gone largely unanswered. Despite the dedication and hard work of Penn State's administration, faculty, staff and students to improve environmental stewardship over the last several years, our greenhouse gas emissions have actually increased. Currently our emissions are 20% over 1990 levels – making Penn State worse in terms of emissions of greenhouse gases than even the national average.

This report addresses one half of the problem: education. We outline why climate change is a problem, what some if its consequences might be, and what can be done to address it. We show you what others think about the problem and what they are doing about it. We then show you how Penn State can reduce its emissions while maintaining its current educational, research, administrative and outreach activities. Adopting our policy recommendations will introduce significant environmental benefits and show the rest of the world how to do it. In fact, in doing so, we will *save money and protect ourselves from increasingly volatile energy costs*!

However, there is another half to the problem: the courage of one's convictions. We think we have made a solid case here. We hope you will keep an open mind in forming your own opinion. We also hope you will support our efforts in whatever way you can should you agree with us. This can happen. We show you how. Will it happen? Will Penn State be part of the problem or part of the solution? We leave that to you.

2. The Causes and Likely Effects of Global Climate Change

Consumption of vast quantities of energy makes our modern way of life possible. The majority of our energy (~85%) is derived from carbon-based non-renewable fossil fuels such as coal, oil and natural gas. Burning fossil fuels for energy emits **carbon dioxide (CO_2)**, a greenhouse gas, which plays a crucial role in determining the earth's climate via the mechanism of the **greenhouse effect** (see Fig. 1). As our energy use increases, we are approaching the physical limits of the planet's ability to adapt to its changing atmospheric chemical composition. The **Intergovernmental Panel on Climate Change** (IPCC), representing 2,500 scientists from more than 80 countries, analyzed over 20,000 relevant articles to report that while the atmospheric CO_2 concentration has increased by more than 30% to the highest level in 160,000 years, the global mean surface temperatures have increased 0.6-1.2°F since the late 19th century.[2] The IPCC projected that average global surface air temperatures will heat up by 1.4 to 5.8°C by 2100 (relative to 1990).[3] The IPCC concludes that human energy use (and thus greenhouse gas emissions) significantly effects the global climate. The predictions of resultant impacts of this warming on society and the planet range from a nuisance to globally catastrophic.

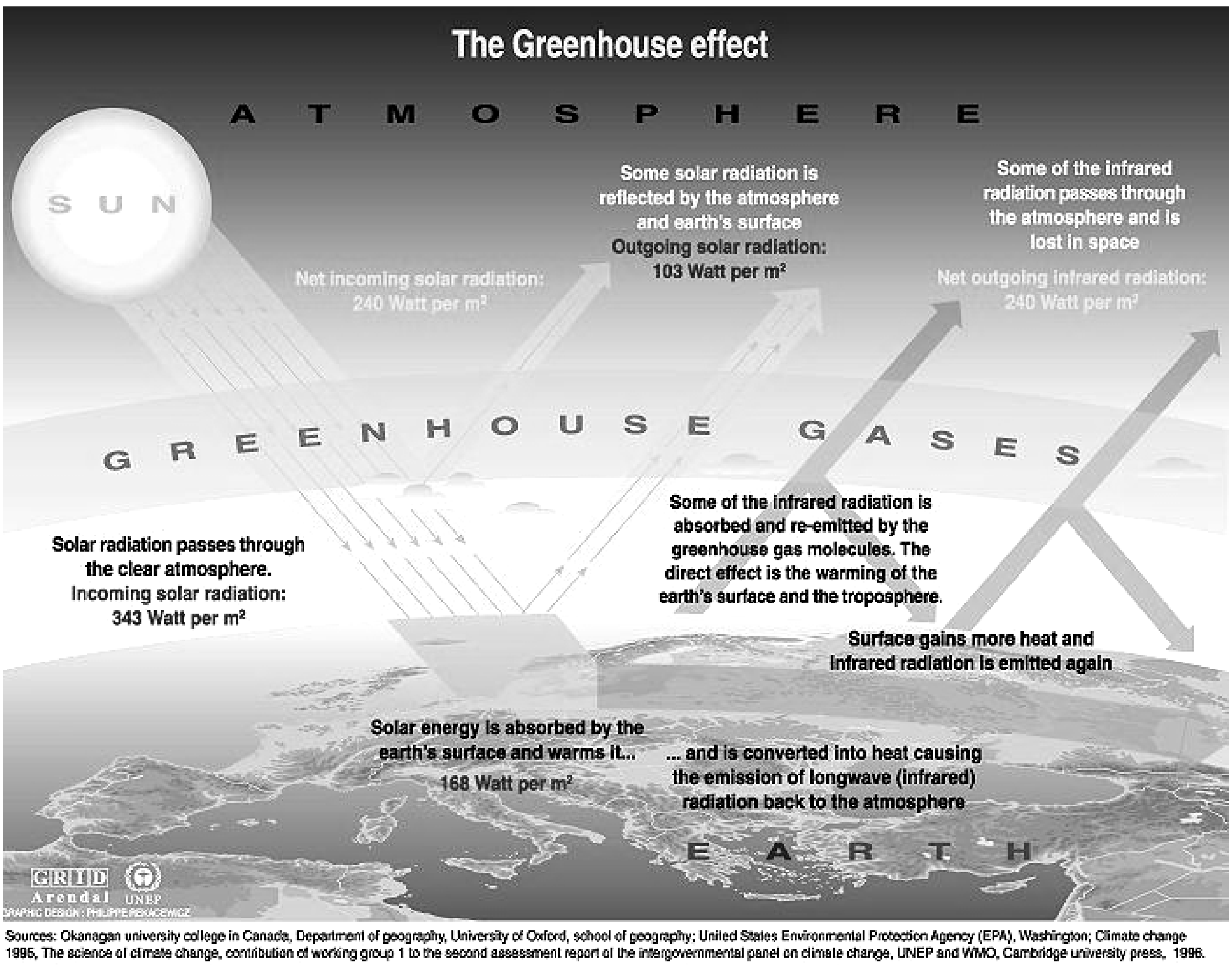
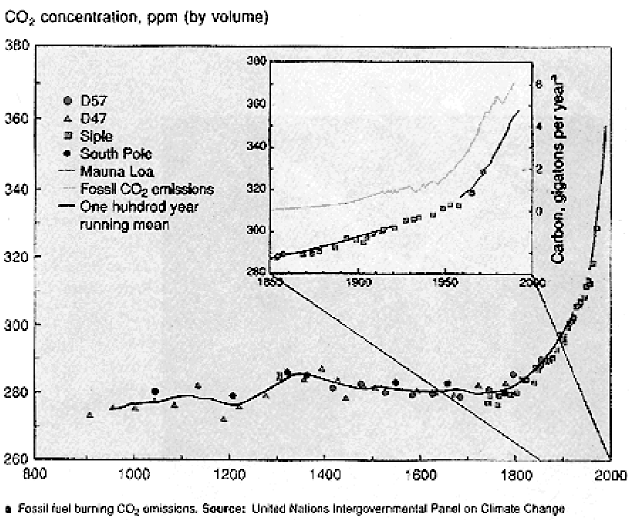


Fig. 1 The Greenhouse Effect[4]

Burning fossil fuels releases over 6 gigatons of CO_2 into the atmosphere each year as shown in Fig. 2 – and this release is increasing CO_2 concentrations in the atmosphere, which then leads to further temperature increases (Fig. 3). Eventually, we hope to stabilize atmospheric CO_2 concentration in order to prevent further warming of the planet. CO_2 concentration stabilizations of 450, 550, and 650 ppm correspond to global warming over the next 100 years of approximately 1.2°C to 2.3°C, 1.5°C to 2.9°C, and 1.7°C to 3.2°C.[5] However, to forestall serious ecological problems like coral reef bleaching, thermohaline circulation shutdown, and a disintegration of the West Antarctic Ice Sheet, global temperatures would need to be limited to 1°, 2°, and 3°C respectively.[6] Each of these seemingly far removed disasters would result in serious difficulties for how we live our lives (more on what those at place like the Pentagon think of this to follow). As it stands today, if we do nothing, CO_2 concentration will pass 550 ppm this century.[7]



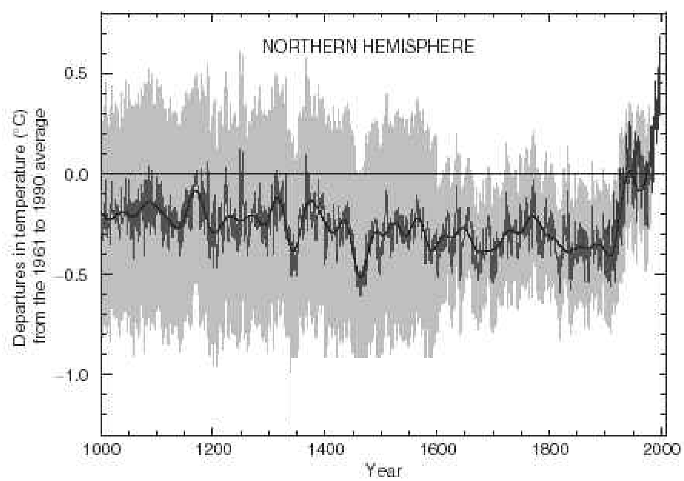


Fig. 2 Global CO_2 concentration, human emissions, and Fig. 3 temperature changes.

As we burn more fossil fuels and emit more carbon dioxide into the atmosphere the following may result:

- **Global Warming:** The temperature will continue to rise. Small changes have a big impact – the last ice age was only ~5˚C cooler than today. If this CO_2 concentration is sustained it could produce global warming comparable in magnitude but opposite in sign to the global cooling of the last Ice Age.[8]
- **Massive Species Extinction:** Sensitive ecosystems will be upset leading to widespread species extinction. As global climate change upsets sensitive ecosystems, the rate of species extinction has spiked sharply in the last few decades.[9,10] Only a small fraction of the planet's species has been catalogued, yet approximately 34,000 of the known species of plants are now approaching extinction.[11] Utilizing projections of species distributions and abundances for future mid-range climate warming scenarios for 2050, Thomas et al. place lower projections of species extinction between 15% and 37%.[12] The American Museum of Natural History reported that a large majority of scientists surveyed believe that during the next 30 years, one of every five species alive today will become extinct.[13] The consensus among those who study life is that the fastest mass extinction in the planet's history is underway.
- **Increased Risk of Infectious Disease:** The risk of some infectious diseases will increase, particularly those diseases that only appear in warm areas. Diseases that are spread by

mosquitoes and other insects could become more prevalent if warmer temperatures enabled those insects to become established farther north; such "vector-borne" diseases include malaria, dengue fever, yellow fever, and encephalitis.[14] The U.N. World Health Organization has already reported that malaria and dengue fever could reach epidemic levels and spread farther from the equator as a result of a warmer climate.[15] Higher temperatures can also have negative effects on the health of the weakest, including the very old and the very young. For example, Fox News reported that over 11,000 people died in France from a heat wave in the summer of 2003 where temperatures rose above 104 degrees.[16] In addition, those with heart problems are vulnerable because one's cardiovascular system must work harder to keep the body cool during hot weather.[17]

- **Melting Ice and Rising Sea Levels:** Snow and ice will continue to melt leading to disturbing occurrences such as when scientists found the North Pole under water.[18] Glaciers will retreat.[19]
- **Sea ice will decrease along with ice thickness**: All of this melted ice and thermal expansion of ocean water will lead to continued global sea level rise, loss of coastal land and beach erosion.[20] For example, consider the effects on Florida if the West and East Antarctic Ice Sheet melt, as pictured below:

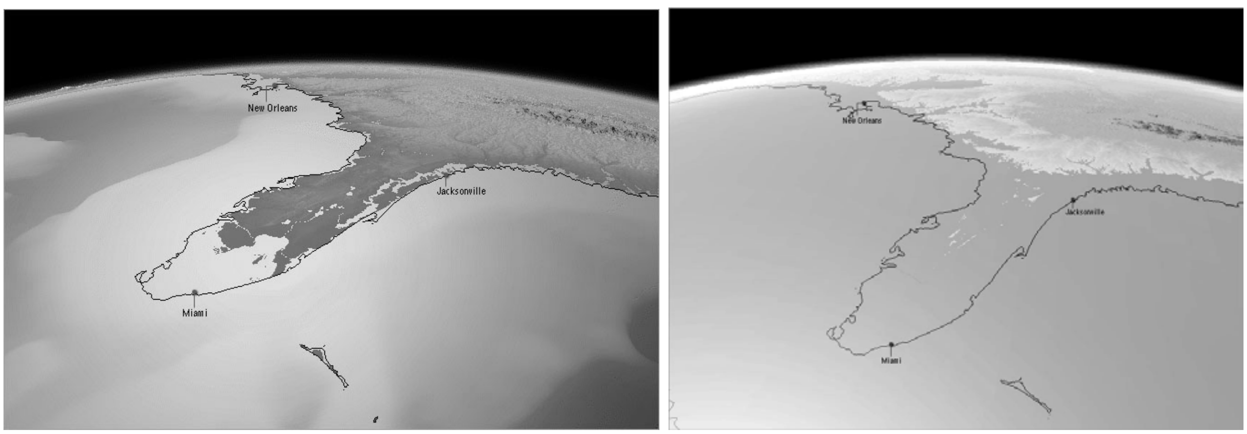


Fig. 4 Florida if a) the West Sheet melted or b) if the East Sheet melted. These images depict a conservative rise of 17 feet if the West sheet collapses and 170 feet if the East sheet collapses. Note that black lines represent current coastlines.[21]

- **Extreme Weather:** The frequency of 'extreme weather events' will increase (e.g. severe flooding, droughts, forest fires, mudslides, tornados, etc.), which can have a significant economic impact. Natural disasters in the United States caused $7 billion in damage from 1978 to 1989, and skyrocketed to $39 billion from 1999 to 2002.[22] Thus, the damages went from less than 1 billion per year from 1978 to 1989 to over 12 billion per year from 1999 to 2002. People with big money at stake are clearly getting the message. According to the Reinsurance Association of America (RAA), "50 percent of the insured losses throughout the world over the previous 40 years that were due to natural catastrophes had occurred since 1990".[23] So insurers are halting sales in areas such as southern Florida and Hawaii because they are seen as too high risk.[24] In 1992, Hurricane Andrew cost the United States roughly 25 billion dollars.[25] In March of 1997, floods alone caused $500 million in property damage along areas of the Ohio River.[26] To illustrate the expansiveness of this problem, consider the following examples from the midwest[27]:

- The severe drought from fall 1995 through summer 1996 in the agricultural regions of the southern Great Plains resulted in about $5 billion in damages.
- The April 1997 flood put nearly 90% of Grand Forks, North Dakota under water and caused over $1 billion in damages.
- The summer 1998 heat wave and drought severely affected roads and pipelines in Texas. In addition, this extreme event resulted in at least 200 deaths and over $6 billion in damages from Texas/Oklahoma eastward to the Carolinas.
- In the fall of 1998, severe flooding in southeastern Texas from two heavy rain events with 10-20 inch rainfall totals caused approximately $1 billion in damages and 31 deaths.
- In May of 1999, an outbreak of F4-F5 tornadoes hit the states of Oklahoma, Texas, Kansas, and Tennessee, resulting in at least $1 billion in damages and 54 deaths.

- **Threatened Food Supplies:** Temperature increases combined with continued flooding and drought, could be devastating to domestic farming and lead to problems in the global food supply. The United States food and fiber industries create 25 million jobs, produce $3.5 trillion in output, and account for 15% of the U.S. Gross Domestic Product; larger than the construction, transportation, and utilities industries combined.[28] If temperatures increase beyond 3 degrees "there would be a dramatic turning point. U.S. crop yields would start to decline rapidly," says Dr. Bill Easterling, a professor of geography and agronomy at Penn State.[29] Tropical areas, which are already on the edge of the temperature range, would see decreased production abruptly.[30] Although farming productivity has increased in the past thirty years in the U.S., there have been noticeable dips in productivity related to weather, crop diseases, and pests that show the trend is becoming more erratic.[31] One-third of U.S. agricultural output and 80% of the world's crops depend on pollinators like insects, bees, birds, and bats, whose populations are in danger due to global warming.[32]

National Security: Is Climate Change "The Mother of All National Security Issues"?

To understand the magnitude of the problem consider that the Pentagon ordered a study[33] to investigate the effects of climate change on U.S. national security. The report was covered by Fortune magazine, in an article titled, "The Pentagon's Weather Nightmare: The Climate Could Change Radically, and Fast. That Would Be the Mother of All National Security Issues," and drew on respected Penn State scientist, Richard B. Alley[34]. It focused on a single effect – the likely consequences of **thermohaline shutdown** and the abrupt climate change that would result. Thermohaline circulation is the part of the ocean circulation caused by differences in density (a function of temperature and salinity) rather than that driven by the wind. In some climate models this circulation is shut down as the concentration of greenhouse gases in the atmosphere increase. If thermohaline shutdown were to happen, it could take place in a few years (a rapid time scale for the climate) and could have severe consequences for the climate of Europe and the United States because the eastern U.S. and northern Europe are warmed by a huge Atlantic Ocean current that flows north from the tropics. This is why Britain, at Labrador's latitude (northern Canada), is relatively temperate. This circulation is known as the "great conveyor". This current gets cooler and denser as it moves north, which causes the current to sink in the North Atlantic, where it heads south again in the ocean depths maintaining the loop. However, if the climate warms, fresh water from melting Arctic glaciers flows into the North Atlantic, lowering the current's salinity. A warmer climate also increases rainfall and runoff into the current, further lowering its salinity. As a result, the conveyor loses its main motive force (density and salinity) and can rapidly collapse, turning off the "huge heat pump" and altering the climate over much of the Northern Hemisphere.

For planning purposes, the Pentagon study focused on a midrange case of abrupt change. Yet even this midrange scenario is frightening beyond comprehension. Consider a similar scenario in our geological past: A century of cold, dry, windy weather across the Northern Hemisphere that suddenly came on 8,200 years ago provides an example from the past (it is located in geological time between the Younger Dryas and the Little Ice Age). This event is thought to have been triggered by a conveyor collapse after a time of rising temperatures similar to today's global warming. Suppose it recurred in our time, beginning in 2010. Here are some of the things that might happen by 2020 according to that national security study[35]:

- At first, the changes are easily mistaken for normal weather variation—allowing skeptics to dismiss them as a "blip" of little importance and leaving policymakers and the public paralyzed with uncertainty. But by 2020 there is little doubt that something drastic is happening. The average temperature has fallen by up to 5˚F in some regions of North America and Asia and up to 6˚F in parts of Europe. (By comparison, the average temperature over the North Atlantic during the last ice age was ten to 15˚F lower than it is today.) Massive droughts have begun in key agricultural regions. The average annual rainfall has dropped by nearly 30% in northern Europe, and its climate has become more like Siberia's.
- Violent storms are increasingly common as the conveyor becomes wobbly on its way to collapse. A particularly severe storm causes the ocean to break through levees in the Netherlands, making coastal cities such as the Hague unlivable. In California, the delta island levees in the Sacramento River area are breached, disrupting the aqueduct system transporting water from north to south.
- Mega-droughts afflict the U.S., especially in the southern states, along with winds that are 15% stronger on average than they are now, causing widespread dust storms and soil loss. The U.S. is better positioned to cope than most nations, however, thanks to its diverse growing climates, wealth, technology, and abundant resources. That has a downside, though: It magnifies the haves-vs.- have-nots gap and fosters confrontational finger-pointing at America.
- Turning inward, the U.S. effectively seeks to build a fortress around itself to preserve resources. Borders are strengthened to hold back starving immigrants from Mexico, South America, and the Caribbean islands—waves of people arriving by boat pose especially grim problems. Tension between the U.S. and Mexico rises as the U.S. reneges on a 1944 treaty that guarantees water flow from the Colorado River into Mexico. America is forced to meet its rising energy demand with options that are costly both economically and politically, including nuclear power and onerous Middle Eastern contracts. Yet, America survives without catastrophic losses.
- As the planet's carrying capacity shrinks, an ancient pattern reemerges: the eruption of desperate, all-out wars over food, water, and energy supplies. As Harvard archeologist Steven LeBlanc has noted, wars over resources were the norm until about three centuries ago. When such conflicts broke out, 25% of a population's adult males usually died. As abrupt climate change hits home, warfare may again come to define human life.

It is important to note here, that no one knows how likely the above scenario is or how bad the effects of global climate change will be. We all know, however, the terrible consequences of politicians and mass media sources ignoring national security implications of potential terrorist threats like those of September 11, 2001. We think human-induced climate disruption is a global experiment that is best avoided.

3. The Kyoto Protocol

To avoid the repercussions of this "dangerous anthropogenic (human caused) interference with the climate system" the United Nations (UN) Framework Convention on Climate Change called for the stabilization of greenhouse gas concentrations.[36] In order to act on this goal an international Climate Summit was held with 160 nations participating in Kyoto, Japan. The outcome of this meeting resulted in the Kyoto Protocol, a legally binding international agreement that would commit industrialized countries to reduce emissions of the six greenhouse gases. Nations agreed to reduce greenhouse gas emissions by an average of 5% from 1990 levels between the year of 2008 and 2012. Under the accord, the United States would lower the emissions by 7%, Japan by 6%, and the European Union countries by 8%.[37] Largely ignored is the fact that even if the Kyoto goals are met (which appears extremely unlikely), reductions in atmospheric CO_2 would be an entire order of magnitude below those necessary to stabilize the global climate (atmospheric scientists generally agree that 60-70% reductions would be needed).[38] If the United States were to adopt the provisions of the Kyoto Protocol, our emissions level would have to drop to below 5.5 billion tons CO_2 equivalent by the year 2010 (Fig. 5). Fig. 5 also shows where our emissions level were as of 1998, which was much higher than expected.

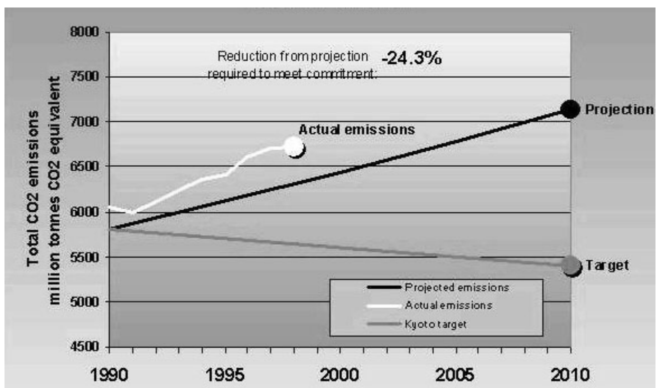
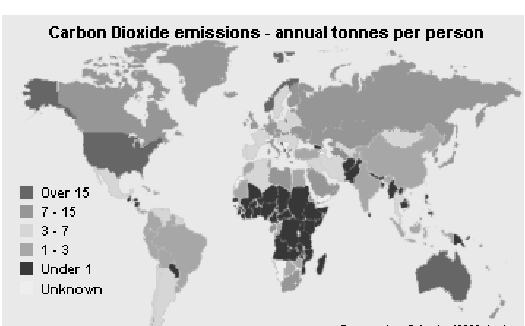


Fig. 5 United States actual, projected, and target CO_2 emission levels.[39]

In order for the Kyoto Protocol to come into force, 55 countries that produce 55% of the developed world's 1990 carbon dioxide emissions must ratify it. The European Union ratified in May 2002, and Japan followed suit a month later, bringing the number of countries signing on to 80, with 36.6% of the emissions. The United States has signed but did not ratify the Kyoto Protocol. This presents a serious problem for the Protocol because the CO_2 emissions per person in the U.S. is the highest in the world – leading to an enormous level of collective emissions (See Fig. 6 and 7).



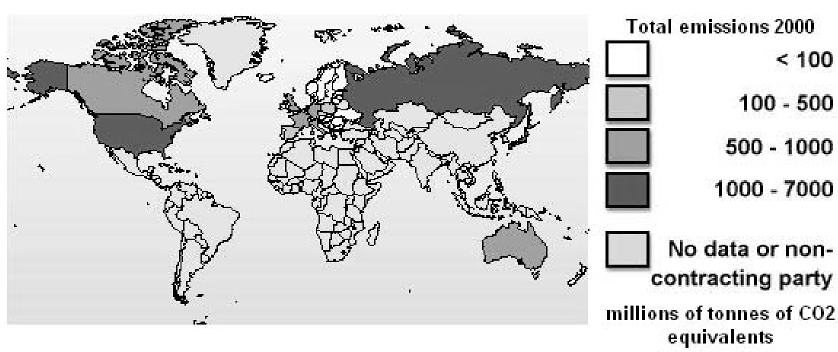


Fig. 6 Annual CO_2 emissions per person.[40] **Fig. 7 Total greenhouse emissions per country.**[41]

Unfortunately, at this time it does not appear the goals of the Kyoto Protocol will be met as seen by the prevailing level of international agreement in Fig. 8 below.

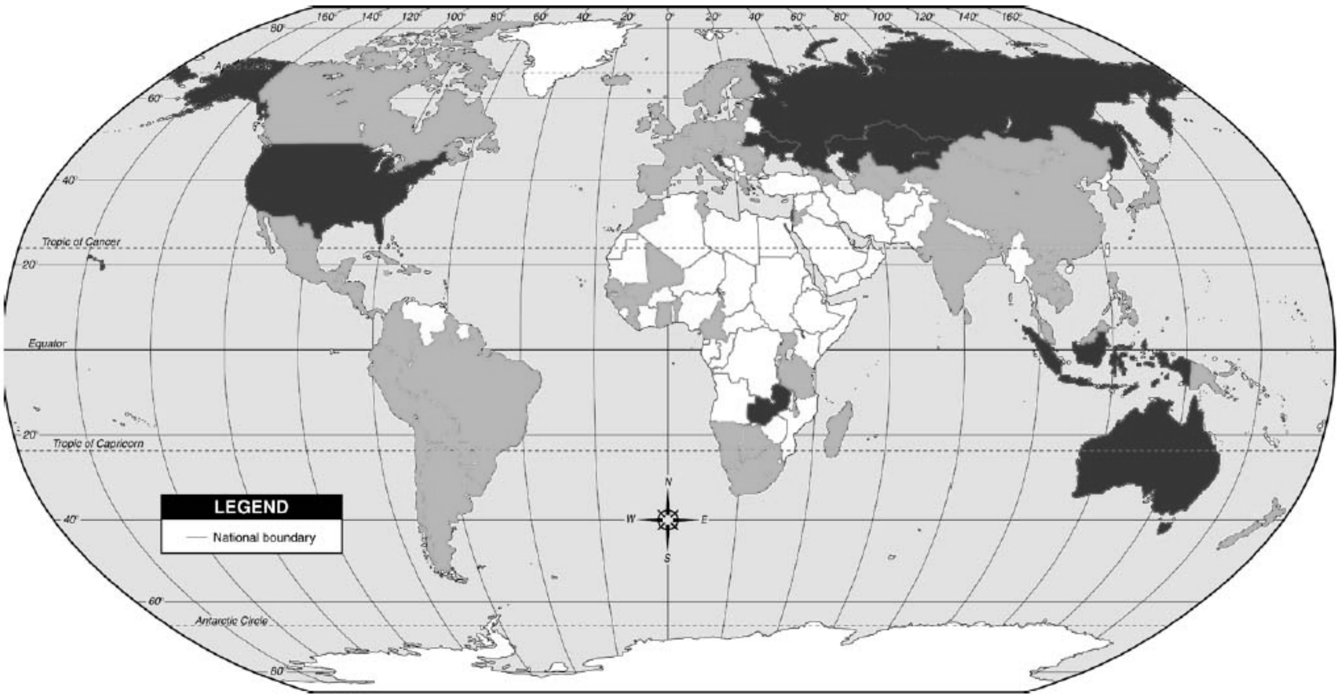


Figure 1: Map of Kyoto Compliance[1]

Fig. 8 The status of each nation regarding the Kyoto Protocol:

- *Grey:* This status of the nation is listed by the United Nations Framework Convention on Climate Change as having given ratification, acceptance, accession, or approval.
- *Black:* This nation signed the original Kyoto Protocol but has not yet agreed to follow it.
- *White:* This nation has not signed nor agreed to follow the Kyoto Protocol.

4. Kyoto and the Media

"Some searching with an open mind is required to sort through the loud voices and identify the leading ideas. I have tried to do so (and you can judge whether I have succeeded), and I believe that the weight of scientific evidence indicates that significant human-induced future warming is the most likely outcome."-- Richard B. Alley – Evan Pugh Professor of Geosciences and Associate of the EMS Environment Institute at Penn State University, *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future*

Although we will never be absolutely certain about the specific conditions and consequences of global warming or climate change or the greenhouse effect, we do know one thing: it is a problem and one significant enough to have three names! Scientific concern with the impact of human activities on the climate is over a century old. In 1896, Svante Arrhenius, a Nobel-prize winning chemist from Sweden, suggested that levels of carbon dioxide (CO_2) in the atmosphere were increasing as a result of industrial activities and that this would lead to increases in the Earth's temperature. Perhaps no other relationship, one characterized as strong cause and effect by NASA scientist James Hansen in 1988, has come under more intense scientific scrutiny over the last two decades. There is no longer any scientific basis for doubt or uncertainty here. Yet why do people still claim global warming is a myth? Why do they think we need still more research before honestly facing up to the problem?

This report addresses these concerns directly by reviewing evidence *based on scientific inquiry* into the conditions and consequences of climate change. One could write a whole other report on evidence *based on mass media sources* to show how and why mistaken views about global warming originate. We showed you what we based our views on and ask only that you keep an open mind in forming your own opinion on the problem. Reviewing the evidence offered in the mass media is both more simple and more difficult because, well, there is none! In fact, the reason for the difference between the consensus on the problem in the scientific community and the apparent confusion in the mass media is one based on public relations and not scientific inquiry. It is the difference between basing your opinion upon evidence and based it on a press release. Stated simply: *it has been the explicit strategy of public relations efforts for 15 years to create the illusion of scientific uncertainty about global warming.*

In the 1980s, climatologists and geoscientists evolved still advancing computer models, Global Circulation Models, and the matter of human contributions to global warming became a consistent concern. Then, on June 23, 1988, NASA's James Hansen gave Congressional testimony that the link between human greenhouse gas emissions (like CO_2) and observed temperature increases could be characterized as a strong cause and effect relations. He was 99% certain the planet was warming.

Almost immediately, the focus on what constitutes scientific certainty became the central point of contention, as the White House *altered the text of the very Congressional testimony Hansen delivered*. What did they change? An official from the Office of the Management and Budget (OMB), an office in the White House, wanted to *increase perceptions of conflict among scientific opinion on the issue, particularly with respect to human contributions to greenhouse gas emissions*. This incident, only the first of many which have increased with regularity over the last few years, is no great secret and was reported in both *The Wall Street Journal* and *The New York Times* on May 8, 1989.

Scientists responded to this challenge with one of the most extensively coordinated global efforts in history. Sponsored by the United Nations, the **Intergovernmental panel on Climate Change (IPCC)** is a global network of scientists set up to provide authoritative assessments of climate change knowledge. It first reported in 1990, a scientific report that formed the basis of the 1992 Framework Convention on Climate Change *signed by the first President George Bush*. This document established agreed upon procedures for reporting and negotiating solutions to the problem between 166 countries.

With this procedure in place, America and other countries patiently waited *another three years* for a comprehensive review of the problem.

In 1995, the IPCC issued its definitive and comprehensive report. There was now clearly no scientific doubt or uncertainty about the existence of the problem. With agreed upon negotiating procedures and definitive knowledge, the countries of the world met once again in 1997 to address the problem. The result of those meetings is the 1997 Kyoto Protocol, an agreement *signed by the United States* yet not ratified by Congress. At the same time, however, something called the *Global Climate Coalition* was created. An organization of some 50 fossil fuel companies and trade associations, formed by *the PR firm Burson-Marsteller*. It began to lobby at international meetings, fund outspoken skeptics, and junk science, and, most importantly, it attempted *to fabricate perceptions of conflict and scientific uncertainty about the science of climate change through mass media channels.*

Since then any number of outright lies, junk science and fake reports have circulated in hopes of making the problem disappear. Worse still, legitimate research is changed before it reaches the American public. Consider the findings of one lawyer reviewing the situation: "The Bush Administration's first instinct when it comes to science has been to suppress, discredit or alter facts it doesn't like. Probably the best-known case is global warming. Over the past two years the Administration has done this to a dozen major government studies on global warming, as well as to a report by the Intergovernmental Panel on Climate Change, in its own efforts to stall action to control industrial emissions. The list also includes major long-term studies by the federal government's National Research Council and National Academy of Sciences, and by scientific teams at the EPA, the National Oceanic and Atmospheric Administration and NASA, and a 2002 collaborative report by scientists at all three of those agencies."

The consequences of this on-going activity are disastrous. Consider just one example detailing how the government and media misled those courageous enough to lend a hand during a national tragedy and ask yourself whether we can afford to wait on their lead with the planet at stake.[42]

"At the time of the World Trade Center catastrophe on September 11, 2001, I had just opened an office at 115 Broadway, cater corner from the World Trade Center and within the official security zone to which access was, afterward, restricted for several months. Upon returning to the office in October my partner, Kevin Madonna, suffered a burning throat, nausea and a headache that was still pounding twenty-four hours after he left the building. Despite the Environmental Protection Agency's claims that air quality was safe, Kevin refused to return and we closed the office. Many workers did not have that option; their employers relied on the EPA's nine press releases between September and December of 2001 reassuring the public about the wholesome air quality downtown. We have since learned that the government was lying to us. An Inspector General's report released last August revealed that the EPA's data did not support those assurances and that its press releases were being drafted or doctored by White House officials intent on reopening Wall Street.

On September 13, just two days after the terror attack, the EPA announced that asbestos dust in the area was "very low" or entirely absent. On September 18 the agency said the air was "safe to breathe." In fact, more than 25 percent of the samples collected by the EPA before September 18 showed presence of asbestos above the 1 percent safety benchmark. Among outside studies, one performed by scientists at the University of California, Davis, found particulates at levels never before seen in more than 7,000 similar tests worldwide. A study being performed by Mt. Sinai School of Medicine has found that 78 percent of rescue workers suffered lung ailments and 88 percent had ear, nose and throat problems in the months following the attack and that about half still had persistent lung and respiratory illnesses nine months to a year later…."

5. Kyoto and the University

As institutions with significant access to the latest knowledge of both ecological problems (such as global climate destabilization) and socio-techo solutions, universities have the responsibility to lead society toward sustainable policies.[43] Other universities have already decided to take this responsibility and lead the country in demonstrating smart and economic methods of reaching the targeted emissions levels of the Kyoto Protocol. These universities include:

- Tufts University has committed to meeting or beating the Kyoto target for university-related greenhouse gas emissions.[44]
- After a semester of collaboration between a student group called Kyoto Now! and the Administration Cornell University in Ithaca, N.Y., committed to reduce greenhouse gas emissions to 7% below 1990 levels by 2008.[45]
- Undergraduates at Lewis & Clark College in Oregon overwhelmingly voted to increase student fees to raise the money for sufficient carbon credits to make their school already Kyoto-compliant![46]
- Students at Connecticut College decided that they would pay the extra costs of buying green energy for the school. Their energy would come from 5% wind, 68% hydro and 27% methane from land fill gas, making it 100% renewable.[47]
- A consortium of all 56 colleges and universities in New Jersey has promised to cut greenhouse gas releases by 3.5% below 1990 levels by 2005.[48]
- In Pennsylvania, 25 campuses have pledged to collectively buy some green energy, including wind power, and to ultimately reduce their greenhouse gas emissions.[49]
- At Oberlin College in Ohio, students and faculty asked the Board of Trustees to adopt a carbon-neutrality policy that would go far beyond Kyoto. The policy would commit the campus to powering itself without producing any carbon emissions by 2020, through buying green energy or producing its own. "Most of the conversation has been about being Kyoto-compliant, but everybody knows that will not solve the problems. It's a very small bite out of a very big meal," says David Orr, professor of environmental studies at Oberlin.[50]

These are only a few examples from a few schools. Yet we can identify the three main methods used to reduce their greenhouse gas emissions: i) improve operational efficiency, ii) expand use of renewable energy, and iii) offset emissions of carbon dioxide elsewhere.

Improved Operational Efficiency

A recent survey by the National Wildlife Federation reports that America's colleges and universities are already emphasizing conservation and efficiency[51]:

- Eighty percent of the schools surveyed have already introduced lighting efficiency upgrades to save energy; 20 percent have plans to do so. Almost all have programs in place or in the works to increase energy efficiency for heating, ventilation, air conditioning and water use.
- Nearly a quarter meet some of their energy needs from renewable sources.
- Twelve percent of the schools power at least part of their fleet vehicles with alternative fuels.

One of the first technologies other universities have improved to reduce greenhouse emissions on their campuses is lighting. Upgrading lighting fixtures, particularly replacing incandescent bulbs with fluorescent bulbs, is an effective way to reduce energy consumption. Another means is by assuring that lights are off when a room is not in use. A way to automate this process is through the use of occupancy sensors. These sensors, when installed in a building, detect motion so that lights are on only when rooms are occupied. They cost roughly $30 to $150 per sensor and have an energy savings of 25 to 75%. Universities can use simple lighting changes like these to improve already existing buildings.[52] Examples include:

- Connecticut College replaced incandescent bulbs with new fluorescent ones, which saves the college 823,007 kilowatt hours per year.
- Cornell University changed all light fixtures that could be economically converted to highly efficient fluorescent sources. This alteration reduces lighting energy use on average by 30% and improved light levels in work areas. Cornell also installed occupancy sensors.
- Middlebury College shuts off every other main overhead light for 24 hours a day. This staggered lighting saves 111,690 kilowatt hours per year, which is an annual savings of $984.21.

A second opportunity for reducing greenhouse gas emissions is found in the systems for heating and cooling. Electric heating is less efficient and more expensive than gas heating. From research, Rensselaer Polytechnic Institute (RPI) notes that making electric heating from fossil fuels is only 38% efficient, and there are also additional losses from the electricity transmission. This means that it is about three times more efficient to use gas heating rather than electric heating.[53] Examples include:

- RPI installed better Heating, Ventilation, and Air-conditioning (HVAC) controls in newly renovated buildings on campus and more efficient pumps and motors.[54]
- Princeton University built a cogeneration plant that uses steam to heat buildings on campus in the winter months. The cogeneration plant also houses machines that will cool the water that is used in the air conditioners for the summer months. The system reduces the CO_2 emissions by 4.5% of the 1990 CO_2 levels (campus has grown 10% since 1990).[55]
- The University of Pennsylvania discovered that high heating and cooling levels were a result of bad windows, which could be replaced to reduce emissions.[56]
- The University of Michigan placed new weather stripping on windows so they seal better when closed and installed one way heating and cooling controls to prevent the heater and the air conditioner from running simultaneously.[57]

In order to avoid inefficient systems in the future, buildings can be designed and constructed to be "green". Green buildings are sustainable energy-efficient buildings that can cost more up front, but they save money through lower operating costs over the life of the building. An extension of this concept, and one of the leading standards for evaluating overall efficiency for buildings, is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system program.[58] Buildings that follow these guidelines are referred to as LEED Buildings. One example of a green building is "San Diego's Ridgehaven Building, which appears to be identical to the other buildings around it. This 73,000 square-foot building was completely renovated with many cost-effective green building methodologies and technologies. As a result, it uses 65% less total energy then its neighbors, yielding a savings of more than $70,000 in annual utility cost."

Renewable Energy

In order to become Kyoto compliant, many universities are purchasing renewable energy. Renewable energy systems use resources that are constantly replaced and are usually less polluting. Examples of renewable energy systems include solar, wind, and geothermal energy (extracting energy from the heat in the earth).[59] Examples of universities utilizing renewable energy include:

- Renewable sources account for 20% of Wesleyn University's electricity. 3,036 metric tons of CO_2 will not be emitted by allocating 20% of Wesleyn's total energy to a renewable source.[60]
- Connecticut College installed solar panels to power a dorm complex's heating system. During the summer the central heating plant is taken off-line to save energy. A more cost-effective boiler plant was installed to compensate in the case of a cold spell during the summer months. Solar panels were installed on the top of the complex in order to power the boiler plant. The use of the solar panel in conjunction with the boiler plant saves Connecticut College 90,769 kW-hrs/ year, roughly what one dorm would use in one academic year. Connecticut College has also committed to purchasing 45% renewable energy.[61]
- Renewable Energy figures at other colleges[3]:
    - The University of Colorado at Boulder will be run by 27% wind energy.
    - Brown University will invest $30 million in renewable building and energy efficiency design and is installing a windmill on top of its tallest building.
    - Carnegie Mellon and the University of Pennsylvania are now purchasing wind power.
    - The University of Oregon purchased solar panels for the student union.
    - The University of Vermont purchased solar panels to put on a number of buildings.
    - The University of California system just made a very large commitment, buying ten megawatts of solar power for the state school system.

Greenhouse Gas Emissions Offsets

We noted that one school went Kyoto compliant almost immediately through CO_2 offsets. Another school, Connecticut College[62] joined the "Klinki Program" in 1999 to reduce its carbon emissions. Through a non-profit organization, Reforest the Tropic, Inc., the college agreed to work with farmers in Costa Rica to plant several fast-growing trees, including the Klinki tree. These trees were planted to compensate for the 593 tons of CO_2 released each year by the electricity use of Crozier-Williams College Center over the next 30 years.

While only select schools' accomplishments have been cited, there are an estimated 39 universities currently making efforts to become Kyoto compliant, and the number of schools participating has been growing every year.

6. Kyoto and Penn State

Penn State University has also made a firm commitment to environmental stewardship. Under the leadership of President Spanier, the faculty senate unanimously passed Penn State's Ecological Mission statement.[63] It called on the University to fully incorporate 10 long-term goals centered around environmental concerns into all future strategic plans. The most important goal from a global warming perspective is to "Significantly Reduce Polluting Emissions Associated with the Usage of Fossil Fuels". The Penn State Ecological Mission was followed two months later by action from the Penn State Finance and Business Administration headed by Gary Schultz to create a formal strategy. This "Environmental Stewardship Strategy," directed by Ford Stryker at the Office of the Physical Plant, for the first time provides concrete initiatives to further the goals of sustainability on campus.[64] Under this leadership a long list of environmental victories followed shortly after at Penn State. For example our materials efficiency improved markedly and the campus waste stream was reduced [65],[66]:

- Pre-consumer food wastes from student dining commons and hospitality service units are mixed with other organic material at a special composting facility on campus. The 1.6 tons of compost collected each day is used in research projects, turf maintenance and landscape projects. Recognized with the 2001 Governor's Award for Environmental Excellence, the project has saved tens of thousands of dollars in landfill tipping fees and is helping the University meet the state's goal of recycling 35% of its waste by 2003.
- Collection of more than 1.6 tons of newspaper each day at the University Park campus, which has produced enough recycled material to cover an entire football field with newspapers nearly 20 inches deep. This recycling effort is estimated to have saved 15,385 trees and 2,710 cubic yards of landfill space to date.
- Penn State students took place in the Rush to Recycling Program, which took place at Beaver Stadium following football games in the fall. Volunteers attempted to recycle over 7.2 tons of garbage during the football season.[67] University Park also uses over 1 billion gallons of treated wastewater each year to water athletic fields and farm crops.

The Environmental Stewardship Strategy focuses on 8 Areas: 1) Purchasing, 2) Conserve energy and water, 3) Minimize solid waste, 4) Minimize toxic material use and hazardous waste, 5) Planning and design, 6) Transportation, 7) Regulatory compliance, and 8) Leadership and education. The Environmental Stewardship Strategy has had major environmental successes in each focus area, but here we concentrate on the initiatives that help to reduce greenhouse gas emissions[68,69,70]:

- **Purchasing more environmentally-friendly products**
    - Penn State purchased $22 million of Energy Star rated computers and copiers. Energy Star is a U.S. government-backed program that helps businesses and individuals protect the environment through superior energy efficiency.[71]
    - Penn State demonstrated the use of life-cycle analysis as discussed in "Mueller Policy Paper #2: Environmental Investments = Financial Investments"[72] by purchasing 930 refrigerators/microwaves that were not the low initial bid but had the best life cycle costs. Because of this decision Penn State saves $6,273 a year in electricity.
    - Penn State hired a purchasing professional to oversee environmental issues and the Purchasing Department has also begun to promote products made from recycled materials (which use less energy during fabrication than extracting raw materials).

- **Improving energy efficiencies of buildings**
    - Penn State became an Energy Star partner, dedicating 24-million square feet of building space to energy efficiency upgrades. As a partner, the University pursues a five-step program aimed at energy conservation by installing more efficient lighting, building tune-ups, reducing energy loads, upgrading air distribution systems and upgrading central plants.
    - Penn State has been reducing building temperatures during winter break under the guidelines of the Continuous Commissioning Program to reduce energy costs by 20%.
    - Another energy efficient effort involves the effluent pipeline, which connects the University's wastewater treatment plant with the spray fields. The excess heat in the pipeline is extracted through a heat exchanger and provides heating and cooling for the building.
    - The University requires energy, indoor air quality and commissioning [ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)] standards on all buildings that meet LEED certification criteria.
    - In addition, some new construction will be LEED (Leadership in Environmental Engineering Design) certified. The first LEED certified building at Penn State is the School of Architecture and Landscape Architecture (SALA) building, which will contain mechanical windows that enhance natural airflow and reduce the need for air conditioning. The building's orientation will also allow it to utilize more natural light. Currently Penn State estimates a 5% "green" premium, but when considering only energy savings, green buildings result in 4.5 to 6.5 year payback. There is also considerable evidence that in addition to the environmental benefits of green buildings, productivity of building occupants also increases.[73]
    - Penn State has an aggressive energy conservation system based on the commissioning of new and existing buildings and an exemplary Guaranteed Energy Savings Program (discussed in detail in section 7).
- **Improving efficiency of transportation and reducing traffic and the amount of pollution released by automobiles**
    - The University Park Campus Master Plan envisions a more pedestrian-friendly campus. Thus, the University promotes walking, bicycling, and mass transit. By accommodating pedestrians and bicyclists, fewer students are dependent on single-occupied vehicles.
    - Penn State offers alternative transportation such as the no fare Loop Service and Link Service, along with Ride Share, a program that links commuters together for carpooling and vanpooling.
    - The Information Technology Services gave its staff and assistants access to free bicycles to ride on campus.
    - Transportation Services initiated a program to help cover the costs of a bus pass for University employees.
    - The CATA buses that service the University daily operate on natural gas, which results in fewer emissions per mile. Penn State built a compressed natural gas (CNG) fueling facility and purchased 59 CNG fueled vehicles in the last 3 years. Besides reducing emissions, this results in a savings of 3 cents/mile for University vehicles.
    - Penn State has also purchased a hybrid vehicle that gets 50 miles per gallon for use by Shaver's Creek Environmental Center.

- **Increasing the use of renewable energy sources**
    - Two newly constructed residence halls at Penn State Erie have used an innovative geothermal heating system. This type of system is environmentally beneficial, conserving depleting fossil fuel inventories and replacing polluting energy resources with clean ones (the Earth's heat).
    - A solar rooftop system has been installed on the Office of Physical Plant building at University Park and on the main building of the Penn State branch campus, Delaware County. The system will be monitored through the Internet so students can see and study solar energy.
    - 5% of electricity used on Penn State campuses is generated by windmill farms in southwestern Pennsylvania (Fig 9). This represents the second largest retail purchase of wind power in the United States and the equivalent in pollution reduction of taking more than 1,500 motor vehicles off the road or cutting more than 1.2 million pounds of coal usage each year.

Fig. 9 Penn State's wind turbines

<u>The Bad News:</u>

Despite the dedication and hard work of Penn State's administration, faculty, staff and students to improve environmental stewardship over the last several years, our greenhouse gas emissions (and thus contributions to global climate destabilization) have actually increased! In his Master's Thesis entitled "A greenhouse gas inventory of the University Park campus of the Pennsylvania State University," Steve Lachman found that the University's total greenhouse gas emissions was 413,750.54 MT CO_2 equivalent. This number is simply enormous and falls pretty close to our emissions determined by Chris Steuer, who is currently completing a study for his Master's thesis, which tracks greenhouse gas emissions from campus from 1990 to 2000. Because of more energy intensive equipment (e.g. computers), student population increase, and building growth **Penn State experienced more than a 20% increase in greenhouse gas emissions over the decade 1990-2000**. This means Penn State needs to reduce emissions by about $1/3^{rd}$ to become Kyoto compliant. We are actually part of the problem rather than part of the solution.

<u>The Good News:</u>

Penn State has an opportunity to make a commitment to reducing our greenhouse gas emissions and becoming Kyoto compliant. By agreeing to comply with the terms of the Kyoto Protocol, The Pennsylvania State University would help set an example to other universities by:

- Reducing global warming
- Raising environmental awareness
- Increasing **"<u>cost efficiency</u>"** of energy use

7. How Penn State Can Save Money by Making A Commitment to Kyoto Compliance

The last bullet in Section 6 is the real promise for Penn State to profit from Kyoto compliance because "cost efficiency" is a fancy way of saying "saving money". Although there is an ongoing national debate about whether attempting Kyoto compliance will be good for the U.S. economy, on a university scale the economic benefits are clear. Penn State University is an energy consumer. We pay someone else to buy the energy we use. The consumption of this energy, most of which is derived from burning fossil fuels, emits greenhouse gases that contribute to global climate destabilization. Thus, by reducing our greenhouse gas emissions to become Kyoto compliant, we could reduce our operating costs. These operating costs are substantial – for example the Penn State University monthly electric bill is roughly 1 million dollars.

The concept of saving money by increasing energy efficiency is not new to Penn State. In 2001 Penn State Green Destiny Council research team, comprised of 2 graduate students and 18 undergraduate students, released a report on the ecological analysis of Mueller Laboratory[74] (the Biology Building at Penn State University Park campus). Their goal was to cut the ecological impact of the Mueller Building in half while creating healthier working conditions for all Mueller occupants. The analysis revealed that by increasing efficiency, by using 'smart' technologies, and by increasing environmental awareness Mueller could cut coal consumption by 755 tons and in the process cut CO_2 emissions by nearly 2,000 tons per year. The most surprising result of the report is that changes which foster environmental stewardship will save the University significant amounts of money – over $45,000 per year in electricity savings alone in just this one building – millions per year if all building stocks are included. For example, if the Eberly College implemented the Mueller Report suggestions College-wide, it could reduce its ecological impact by half, thereby decreasing its greenhouse gas emissions by over 20,000 tons. This reduction in energy use could save the Eberly College of Science nearly half a million dollars per year. All these improvements could be made while in no way compromising the research, teaching, and administrative functions of Mueller occupants. In fact, in most cases, Mueller occupants could see noticeable improvements.

But is it valid to extrapolate the results of the Mueller Building to the rest of campus? Unfortunately, the Mueller building was in no way a remarkable or unusual building. The next year, the Green Design Team, a student club interested in green design, completed a study of the Sackett Building, which houses Civil and Environmental Engineering. Their results were nearly identical to the Mueller Project. The bottom line is that smart design improvements will save money while contributing to environmental stewardship. The broader message of these studies is that our campus buildings suffer from an aggregate of systemic design failures, poor engineering, and inefficient technologies that waste energy and squander money.

In fact, the waste in the average building is so large that companies have formed whose entire purpose is profiting from improvements in building efficiency. These companies are called Energy Service Companies or ESCOs. An ESCO is a business that develops, installs, and finances projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to 10 year time period. ESCOs generally act as project developers for a wide range of tasks and assume the technical and performance risk associated with the project. Typically, they offer the following services[75]: develop, design, and finance energy efficiency projects; install and maintain the energy efficient equipment involved; measure, monitor, and verify the project's energy savings; and assume the risk that the project will save the amount of energy guaranteed. These services are bundled into the project's cost and are repaid through the economic savings generated.

In order to help reduce its energy waste and share in the savings, Penn State brought an ESCO to campus as part of the Penn State Guaranteed Energy Savings Program (GESP).[76] The GESP is an enormous step towards implementing both sound environmental and economic stewardship at Penn State. In starting our GESP, Penn State mimicked the procedures established by the Commonwealth of Pennsylvania, under the Procurement Code, Act 57.[77] The program utilized a State-qualifying ESCO, which provided "turnkey, design - build services" for self-funded energy savings projects. The Office of the Physical Plant selected several buildings with the potential to reduce energy consumption through retrofits called Energy Conservation Measures (ECMs) including: equipment replacement, reprogramming or upgrading control systems, or identifying alternative energy sources.

The current GESP project is in the process of improving the efficiency of 39 buildings at University Park. The two phases of the project will cost ~$8 million, which the Finance and Business Office financed with a 4.36% interest loan. **The operational savings from energy and water conservation under the GESP will provide <u>more</u> than sufficient funds to service the loan payments each year and will completely pay for themselves in ten years.[78]** Many of the ECMs have effective technical lifetimes much longer than 10 years, which means Penn State will garner additional profit from the ESCO program after it is officially ended. Penn State thus benefits from buildings that are more efficient, new equipment, better services (e.g. higher quality lighting, heating and air conditioning), and a decreased ecological footprint while enjoying substantial economic savings.

There is only one problem with the GESP – it is not large enough! The buildings chosen for the project were some of the largest energy consumers on campus, but the opportunity for enormous operational savings are present in the vast majority of University Park's 250 significant buildings. The University Park GESP is currently overseen by a single engineer. In order to expand the GESP to the entire University Park campus ~ 8 more energy engineers could be hired to oversee the programs (assuming each could oversee ~30 buildings). In addition to expanding this program to the rest of University Park, an energy engineer could be assigned to each of the Commonwealth campuses. The University has the opportunity to provide funding to completely capitalize on all the energy conservation opportunities on all campuses. The more we invest, the more we benefit environmentally and economically.

Because the ESCO must pay Penn State if the ECMs do not perform as guaranteed, the estimations were extremely conservative and included a considerable "pad" to insulate the ESCO from any financial penalty. In addition, the GESP project did not include any maintenance, equipment or labor savings.[79] For example, consider the simple retrofit of an incandescent light bulb with a compact fluorescent light (CFL) bulb. The CFL uses only ¼ of the electricity and pays for itself several times over its lifetime through energy savings. However, a CFL also lasts more than 10 times longer than an incandescent bulb. The cost of equipment such as the additional incandescent light bulbs needed over the lifetime of the CFL was not included in any of the ESCO's estimates. Penn State, thus, has an opportunity to begin including maintenance and equipment savings in the life cycle economic decisions on individual ECMs (e.g. fluorescent lamp fixture retrofits and exit sign upgrades). This will result in an expansion of ECMs that meet the State's economic requirements and mean even more benefits for Penn State.

Penn State is clearly moving in the right direction, but the rate of adoption of energy conservation measures continues to be somewhat slow. **Every moment we delay results in significantly negative economic and environmental consequences!** So why wait? OPP simply does not have the staff to oversee more GESPs or to complete all the possible ECMs that they know about (e.g. the incandescent light bulbs in Old Main). In the case of the University's future needs -- OPP does not have enough staff to do the necessary research into new ECMs.

8. Policy Suggestions

Penn State University should commit to meeting or beating the Kyoto target for university-related greenhouse gas emissions.

In order to accomplish this goal the following 10 steps could be followed:

1. Create a Department of Energy Conservation within the Office of the Physical Plant made up of sufficient engineering professionals to provide oversight to expand the GESP program by an order of magnitude at University Park and begin a GESP at each Commonwealth Campus. Then borrow the necessary funds or let the ESCOs provide funding to completely capitalize on every financially sound ECM opportunity at all Penn State campuses.

2. Certify all new construction and renovations beyond the Platinum level in the Leadership in Energy and Environmental Design (LEED) Green Building Rating System[80]. In this way Penn State can continue to construct new campus facilities while maintaining its commitment to environmental stewardship, increasing the comfort of building occupants, and reigning in operational costs (by 20 to 60% per ft^2).

3. Post the economic costs of electricity and steam use in the foyer of each campus building (it would be even better to install visible meters). This technique has been shown to greatly improve energy conservation behavior[81]. For people to act wisely, they need to be aware of the consequences of their actions.

4. Provide financial incentives to university units to improve efficiency (e.g. small grants to departments that reduce energy use through behavior changes or purchasing decisions). The funds to provide these small grants could come from demonstrated energy savings. Money saved from good environmental practices should be reinvested to make more ecological improvements.

5. Provide financial incentives to designers and architects working for Penn State to improve efficiency of new construction. This could also take the form of bonuses for designers: The designers of Penn State new buildings optimize the allocation of development capital based on the initial cost of construction. It is generally believed that this method benefits building occupants by maximizing the area available for the building's function. In fact, there is no better example of institutionalizing stupidity. It tends to foster short-term thinking in design, which is not economically or environmentally optimal. This design flaw can have considerable consequences because the operating costs roughly equal to the initial cost of a building over its lifetime and there is currently no incentive for designers to minimize total cost (initial + maintenance and operation). For example, low capital cost and low efficiency systems (e.g. lighting, heating, ventilation, and air-conditioning) are favored over high capital cost and high efficiency systems that are economically more attractive over their life cycle. The result is that new construction, which is compliant with all codes and laws, is still considerably more costly over the lifetime of the building than is necessary with proven technology. Penn State has an opportunity to institute a "bonus" system based on a percent improvement of the building's

operational performance, which will effectively eliminate this problem. The designers would receive a bonus proportional to the demonstrated percent decrease in total operational costs for their building. This will also encourage innovation in design and produce better results than simply requiring designers to meet specific guidelines.

6. Encourage participation in greenhouse gas reduction amongst students. The University could provide a small incentive to make it worth the time (opportunity cost) to do the necessary research into novel ECMs. A fraction of the money saved from the new ECMs (or other cost savings) identified by students could be used for things they want (e.g. more HUB movies). In addition, if a mechanism is found to get a fraction of cost savings returned to the departments -- the savings could be enormous. For example, Architectural Engineering (AE) and Electrical Engineering (EE) students could model and optimize advanced modern lighting for every room on campus as part of the curriculum -- the savings from instituting the optimization could fund expansion of AE and EE departmental programs.

7. Begin including maintenance and equipment savings in the life cycle analysis of ECMs. Currently, Penn State does not include maintenance and equipment savings in their LCAs for any systems or technologies (e.g. we do not consider the cost of light bulbs when we are deciding on what type of fixture to purchase – only the purchase price and the cost of electricity to run the bulbs). This is economically incorrect and is partially responsible for our incredible deferred maintenance backlog.

8. Use command and control to eliminate the worst energy wasting systems on campus. Ban the use of portable electric heaters, incandescent light bulbs, and single pass water cooling. Synchronize all heating and cooling systems so they never run simultaneously. Finally, use heat recovery systems for all chemical fume hoods[82]. Another method to achieve this goal would be to require written justification for purchases of the most wasteful and inefficient technologies.

9. Actively demonstrate the advances in renewable energy made by Penn State faculty. For example: the Center for Thin Film Devices, a collaboration between Penn State physicists, electrical engineers, and materials scientists, recently received the highest rating from the Department of Energy 2003 Peer Review for their work on solar photovoltaics (solid state devices that convert sunlight directly into electricity without any greenhouse gas emissions). Although, we house some of the best solar cell research in the country, our campus only has a 2kW system (enough to power a small shack). Among many other renewable energy programs at Penn State, we also house the Hydrogen Energy Center, which does state of the art research on hydrogen fuel cells (devices which produce electricity and heat from hydrogen while only emitting water), hydrogen vehicles and hydrogen fuel production, storage and distribution. Penn State could install multi-Megawatt solar cell arrays on campus roofs and walkways and a hydrogen fueling facility for University vehicles.

10. To encourage University employees and students to purchase more fuel efficient vehicles – and thus lower the University's green house gas emissions due to automobile commuting, price parking permits by gas mileage. An alternative might be to offer parking permits for half price to hybrid electric users. In addition, the parking passes for "prime" spaces (Old Main parking lot) would be reserved for the new NO emission electric cars, hydrogen fuel cell cars, or low emissions-hybrid vehicles. Ideally, University leaders would purchase these next-generation cars first to provide a good example for students, faculty, and staff.

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