A CALL TO ACTION –

A Prominent Earth Scientist Weighs In on Climate Change and Energy Policy

CONGRESS MUST PASS COMPREHENSIVE ENERGY AND CLIMATE LEGISLATION NOW, BEFORE IT IS TOO LATE TO MAKE A DIFFERENCE.

Editorial Comment by G. Warfield "Skip" Hobbs
Geologist

New Canaan, Connecticut
February 2012

Access to cheap and abundant fossil fuels – coal, oil and natural gas, have powered the economies of North America and Europe and made them great. The developing world has now entered the Consumer Age and has an insatiable appetite for fossil fuels. Commodity prices have soared over the past decade – and our foreign competition is prepared to pay top dollar for the energy resources we always considered ours. A decent standard of living for everyone is a commendable societal goal. However, an unexpected consequence of burning fossil fuels for electric power, manufacturing, transportation and heat, is that mankind is altering the earth's climate, and at a rate that may be faster than predicted, with potentially dire consequences.

This paper is a personal appeal to policy makers, legislators, political candidates, corporate leaders and the public to put near-term self-interest aside, and to take an objective look at climate change and its pending impact on the health, safety and welfare of Americans and the global population at large. It is written by a prominent geologist who was once a "climate denier", but who now realizes that global warming due to human influences is a very serious matter. The essay has four parts. The first part explains why this essay has been written. The second part is a primer on climate change - the evidence for it, the consequences, those who deny that global warming is real, and the positions of several important geological learned societies on climate change. The third part discusses primary energy sources, supply and demand, puts fossil fuels and renewable energy in perspective, and discusses how we can reduce our carbon footprint. The fourth and final part proposes sweeping energy policy initiatives that are designed to reduce carbon emissions and mitigate the impact of global warming – and create new jobs. Hopefully, this essay will stimulate discussion of energy and climate policy during the 2012 election cycle, and serve as a road map for policy makers.

Dealing with climate change requires a fundamental reappraisal of our nation's energy policy, and how we as individuals think about energy use. The historic business model is no longer sustainable. We simply must reduce our emissions of carbon dioxide (CO_2) and other greenhouse gases, and convince the rest of the world to do the same for the good of Planet Earth.

The United States appears to be incapable of reaching legislative agreement on long term energy and climate policies. Any discussion of climate change is now considered politically "toxic" in Washington, and has been pushed aside by debate about the economy. Congress and much of the public are in denial about the impact of humans on global ecosystems and climate change. The EPA is being demonized by the political right and energy intensive business interests. Energy policy is given some lip service as politicians call for "energy independence", yet no one is proposing a comprehensive energy policy that addresses the economic, environmental and physical realities of transitioning from fossil to renewable energy resources. Americans seem to believe they have a God-given, inalienable right to cheap energy and an inexhaustible supply of mineral resources and clean water, regardless of the cost to the biosphere.

Wake up America! It is not too late to make a "mid-course" correction, but it must be done very soon. Energy policy and climate change must be debated in the 2012 election cycle with the same passion given to the economy and job creation.

PART ONE: WHY THIS ESSAY?

I feel compelled to write this essay as I have had a unique, multidisciplinary vantage point from which I can comment authoritatively, and believe I must, as a leader in the earth sciences, express my concerns about the impact of climate change on the future wellbeing of our nation. This treatise is not a simple "one page" position statement. I have provided considerable background information about climate change and energy supply and demand from scientific and other sources, so that readers may fully understand the issues, and the options. If you are not familiar with the importance of energy and climate policy, you soon will be. Please do not dismiss this essay out of prejudice, but read on.

Over the past two years I have had the honor and privilege to serve as the president-elect, president, and now past-president of the American Geosciences Institute (AGI), a federation of 50 professional and learned societies representing over 250,000 earth scientists and the teachers of earth science (*www.aginet.org*). The disciplines encompassed by AGI include all aspects of the traditional geological sciences, as well as hydrology, oceanography, glaciology, atmospheric studies, and fossil fuel resources. As president-elect of AGI, I was invited to join the Council of Scientific Society Presidents (CSSP), a federation of some sixty physical science societies and federations that meets twice a year in Washington for three days to discuss leading edge science technologies, best practices, and science policy (*www.thecssp.us*). The federated organizations that belong to the CSSP represent about 1.4 million scientists and teachers of all scientific disciplines. I was elected to the Executive Committee of the CSSP for the 2010- 2011 term, and currently serve as co-chair of the Energy and Environment Committee. Energy policy, natural resource sustainability and access to clean water in the face of a surging global population, and climate change, are of great concern to the scientists of the CSSP. I refer to my positions in AGI and the CSSP not to boast, but to lay a foundation to be taken seriously for the views and policy recommendations that follow.

Environmentalism

The earth's natural geological processes are inexorable. We cannot stop continental drift; put an end to volcanism; or control weather patterns. The biosphere – earth's land, rivers and lakes, oceans, and atmosphere, and all that lives - from microscopic to massive plant and animal

life forms, and mankind, are intricately interconnected and interdependent. It was not until the extent of human impact on the natural environment became apparent in the last century, that widespread ecological studies began to be undertaken. "Environmental Studies" is a relatively new term; it was not a university degree a generation ago

Geologists love the outdoors and know about the processes that shape the earth's surface. Most are dedicated conservationists who are concerned about environmental protection because our profession often takes us to the earth's most wild and scenic places.

Humans have been impacting the earth's biosphere since the dawn of civilization. Don't let anyone tell you otherwise. Deforestation for timber and agriculture, plowing of the plains and former forest land for agriculture, and the growth of cities and their suburbs, have changed the landscape, and disturbed the natural carbon cycle. Rivers have been dammed, interrupting the natural flow of nutrients and sediments into estuaries and bays. Mines and quarries, and highway systems have obliterated whatever had originally lived on the sites. Agricultural and residential chemical fertilizers, pesticides, herbicides, and fungicides have had a significant cumulative environmental impact, along with the animal and industrial wastes that have washed into, or been dumped into our rivers. Particulate matter, nitrogen and sulfur compounds, mercury and other chemical emissions from power plants, cement manufacture, trucks and automobiles, factories, offices and residences have fouled the atmosphere, and caused multiple health problems. Certain animal species have been hunted to extinction, and others have disappeared due to the changes in their environment. Oceans have been over-fished. As the global population races past the 7 billion mark, this impact is accelerating towards a number of ecological and environmental tipping points that could lead to conditions significantly detrimental to human existence.

I am not opposed to development. Our high standard of living is based on access to food, natural mineral and energy resources, timber and aggregates for construction, and clean water. Land is needed for housing, factories and offices, and infrastructure. However, we can extract the energy and mineral resources we need, grow our crops, fish the seas, build our shelter and work places, and generate electric power without the negative environmental consequences that frequently occur. Education about environmental issues, general acceptance of an environmental ethic, and regulations with "teeth" and rigorous enforcement are required. The good news is that rivers can be cleaned up, trash can be recycled, forests regenerated, fisheries can recover, and air quality improved. It only takes a public commitment to do so. However, there is a cost, and the public must be prepared to accept that expense in the interests of a cleaner environment, preservation of our ecosystems, and improved health.

PART TWO: CLIMATE CHANGE

The earth's climate has never been static. Cycles of warm tropical conditions and frozen glacial periods occur throughout the geological record. The concern of earth scientists today is the accelerating rate of chemical and physical changes in the atmosphere and oceans, and the impact the subtle changes are, and will have on climate and the earth's ecosystems in this century.

Climate change and the implications of global warming due to human (anthropogenic) factors, first came to public attention beyond the academic community with publication of the United Nations Intergovernmental Panel on Climate Change (IPCC) *First Assessment Report* in

1990. Public debate heated up with the publication of the *Third IPCC Assessment* in 2001. Al Gore's epic film "*An Inconvenient Truth"*, released in 2006, generated broad public discussion and concern about the impact of anthropogenic greenhouse gas emissions. The film, however, was discredited by many as being more "sensational" than science-based. When former Vice-President Gore, and Dr. Rajenda Pachauri and his IPCC collaborators, were jointly awarded the Nobel Peace Prize in 2007 *"for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change",* the informed public and policy makers began to realize that there was truly a problem, and that it had to be dealt with for the good of Planet Earth.

As a geologist I was aware that climate has changed naturally from tropical to glacial conditions throughout geological history, long before humans were on the scene. Conventional wisdom was that global warming cycles and cooling cycles are caused by the inclination of the earth's axis to the sun, changes in the earth's orbit, variations in solar radiance, and periods of volcanism. Continental drift moved land masses from the tropics to arctic latitudes, and back. Changes in ocean current patterns due to continental drift also contribute to climate change. These are the geological causes of climate change. Previously, I did not know about greenhouse gases (GHG's), and doubted that the burning of fossil fuels and release of carbon dioxide (CO_2) could have much of an impact on climate. My view was that excess CO_2 could be absorbed by forests and oceans. I did not have anything to worry about as climate change occurs over thousands of years. I was a climate change "denier".

My teenage sons invited me to join them to see *"An Inconvenient Truth"* when our church sponsored a showing of the film. This began to change my thinking, although scenes of glaciers calving off into the sea (I have witnessed that in Glacier Bay in Alaska), were not convincing. What I remember most was Al Gore's graph showing how the market capitalization of General Motors versus Toyota changed over the decade prior to 2006. Detroit auto makers went bankrupt in 2008, in part, because they did not anticipate the rise in oil prices, and fought federally mandated fuel mileage (CAFE) standards. Toyota sales soared because they made fuel efficient cars that the public wanted to purchase. Nevertheless, the film motivated me to start reading scientific papers about climate change.

Since *An Inconvenient Truth*, The National Research Council of the National Academies of Sciences has produced a series of books on "*America's Climate Choices*" that detail the peer-reviewed research that has been done on climate change, man's impact on climate, the future, and what policies must be implemented to mitigate the impacts of climate change (*www.national-academies.org/climatechange*). The Environmental Protection Agency has an extensive webpage about climate change (www.epa.gov/climatechange), as does the National Oceanographic and Atmosphere Administration (www.noaa.gov/climate.html). An excellent summary of the methodology and broad areas of investigation of climate research was published in 2009 by the National Science Foundation, titled *Solving the Puzzle: Researching the Impacts of Climate Change Around the World* (NSF 09-202). Sadly, the general public in America and most policy makers have not read the National Academies reports, or visited the EPA or NOAA websites.

The studies undertaken by the National Research Council have determined that a doubling of atmospheric CO_2 levels from their pre-industrial levels could occur by the middle of the 21st Century – in the lifetimes of much of the current USA population! This would cause temperature increases of between 2.1^{o}C to 4.4^{o}C (3.8^{o}F to 7.9^{o}F) with a best estimate of 3.2^{o}C

(5.8^{o}F). Rising temperatures will result in significant melting of glaciers in Greenland and Antarctica, and thermal expansion of the oceans, raising mean sea levels by 0.5-1.0 meters (20-39 inches). These changes will have significant ecological and social impacts.

Scientific societies that are members of the American Geosciences Institute have undertaken their own assessment of climate change and the anthropogenic factor. The members of these organizations are not a "bunch of left wing academics seeking to stay on the public research dole by alarming the public about global warming with junk science", as alleged by some climate deniers. They include the world's leading earth scientists, and are employed by industry, academia and government. The 22,000 member Geological Society of America (GSA) states on its website that it "*concurs with assessments by the National Academies of Science (2005), the National Research Council (2006), and the Intergovernmental Panel on Climate Change (IPCC, 2007) that global climate has warmed and that human activities (mainly greenhouse gas emissions) account for most of the warming since the middle 1900s. If current trends continue, the projected increase in global temperature by the end of the twenty-first century will result in large impacts on humans and other species. Addressing the challenges posed by climate change will require a combination of adaptation to the changes that are likely to occur and global reductions of CO2 emissions from anthropogenic sources* (http://www.geosociety.org/positions/pos10_climate.pdf).

The American Geophysical Union, an organization that has 50,000 researchers as members, including the scientists whose job it is to study and model the atmosphere, has posted the following statement on its website (http://www.sciencedaily.com/releases/2008/01/080125154628.htm):

The Earth's climate is now clearly out of balance and is warming. Many components of the climate system--including the temperatures of the atmosphere, land and ocean, the extent of sea ice and mountain glaciers, the sea level, the distribution of precipitation, and the length of seasons--are now changing at rates and in patterns that are not natural and are best explained by the increased atmospheric abundances of greenhouse gases and aerosols generated by human activity during the 20th century. Global average surface temperatures increased on average by about 0.6°C over the period 1956--2006.

As of 2006, eleven of the previous twelve years were warmer than any others since 1850. The observed rapid retreat of Arctic sea ice is expected to continue and lead to the disappearance of summertime ice within this century. Evidence from most oceans and all continents except Antarctica shows warming attributable to human activities. Recent changes in many physical and biological systems are linked with this regional climate change. A sustained research effort, involving many AGU members and summarized in the 2007 assessments of the Intergovernmental Panel on Climate Change, continues to improve our scientific understanding of the climate.

During recent millennia of relatively stable climate, civilization became established and populations have grown rapidly. In the next 50 years, even the lower limit of impending climate change--an additional global mean warming of 1°C above the last decade--is far beyond the range of climate variability experienced during the past thousand years and poses global problems in planning for and adapting to it. Warming greater than 2°C above 19th century levels is projected to be disruptive, reducing global agricultural productivity, causing widespread loss of biodiversity, and--if sustained over centuries--melting much of the Greenland

ice sheet with ensuing rise in sea level of several meters. If this 2°C warming is to be avoided, then our net annual emissions of CO_2 must be reduced by more than 50 percent within this century. With such projections, there are many sources of scientific uncertainty, but none are known that could make the impact of climate change inconsequential. Given the uncertainty in climate projections, there can be surprises that may cause more dramatic disruptions than anticipated from the most probable model projections.

With climate change, as with ozone depletion, the human footprint on Earth is apparent. The cause of disruptive climate change, unlike ozone depletion, is tied to energy use and runs through modern society. Solutions will necessarily involve all aspects of society. Mitigation strategies and adaptation responses will call for collaborations across science, technology, industry, and government. Members of the AGU, as part of the scientific community, collectively have special responsibilities: to pursue research needed to understand it; to educate the public on the causes, risks, and hazards; and to communicate clearly and objectively with those who can implement policies to shape future climate. (Adopted by AGU Council, December, 2003; Revised and Reaffirmed, December, 2007)

The Geological Society of London is the oldest geological society in the world, and has over 10,000 members. The Geological Society website (http://www.geolsoc.org.uk/gsl/views/policy_statements/page7426.html) contains the following statement on climate change:

The last century has seen a rapidly growing global population and much more intensive use of resources, leading to greatly increased emissions of gases, such as carbon dioxide and methane, from the burning of fossil fuels (oil, gas and coal), and from agriculture, cement production and deforestation. Evidence from the geological record is consistent with the physics that shows that adding large amounts of carbon dioxide to the atmosphere warms the world and may lead to: higher sea levels and flooding of low-lying coasts; greatly changed patterns of rainfall[2]; increased acidity of the oceans [3,4,5,6]; and decreased oxygen levels in seawater[7,8,9].

What is the Greenhouse Effect?

The Greenhouse Effect arises because certain gases (the so-called greenhouse gases) in the atmosphere absorb the long wavelength infrared radiation emitted by the Earth's surface and re-radiate it, so warming the atmosphere. This natural effect keeps our atmosphere some 30ºC warmer than it would be without those gases. Increasing the concentration of such gases will increase the effect (i.e. warm the atmosphere more)[19].

What effect do natural cycles of climate change have on the planet?

Global sea level is very sensitive to changes in global temperatures. Ice sheets grow when the Earth cools and melt when it warms. Warming also heats the ocean, causing the water to expand and the sea level to rise. When ice sheets were at a maximum during the Pleistocene, world sea level fell to at least 120 m below where it stands today. Relatively small increases in global temperature in the past have led to sea level rises of several metres. During parts of the previous interglacial period, when polar temperatures reached 3-5°C above today's[20], global sea levels were higher than today's by around 4-9m[21]. Global patterns of rainfall during glacial times were very different from today.

When was CO2 last at today's level, and what was the world like then?

The most recent estimates[35] suggest that at times between 5.2 and 2.6 million years ago (during the Pliocene), the carbon dioxide concentrations in the atmosphere reached between 330 and 400 ppm. During those periods, global temperatures were 2-3°C higher than now, and sea levels were higher than now by 10 – 25 metres, implying that global ice volume was much less than today[36]. There were large fluctuations in ice cover on Greenland and West Antarctica during the Pliocene, and during the warm intervals those areas were probably largely free of ice[37,38,39]. Some ice may also have been lost from parts of East Antarctica during the warm intervals[40]. Coniferous forests replaced tundra in the high latitudes of the Northern Hemisphere[41], and the Arctic Ocean may have been seasonally free of sea-ice[42].

(Note: Footnotes cited by the Geological Society position paper are not included in this essay).

A Changed Perception

I have read the technical papers – both in support of, and in opposition to climate change, listened to many lectures, and have talked with some of the principal researchers. There is still much more research to be done. Nevertheless, the preponderance of the scientific evidence has led me, as an earth scientist, to conclude that global warming is happening, and that anthropogenic green house gases (GHG's) are the principal cause. The current rate of change of GHG's in the atmosphere is beyond anything that has occurred throughout recent geological history, and is such that the biosphere cannot adapt, and serious ecological and environmental consequences are occurring, and will continue to occur. This is a 180 degree turn from the viewpoint I previously held. The factors which caused climate change throughout geological history are still at work; but as evidenced by data from multiple avenues of research, the greenhouse gases emitted by human activity over the past century, completely overwhelm the natural geological factors.

There are a several pieces of evidence that were an epiphany for me. The graph below which shows ice core data for the past 800,000 years, is one of them.

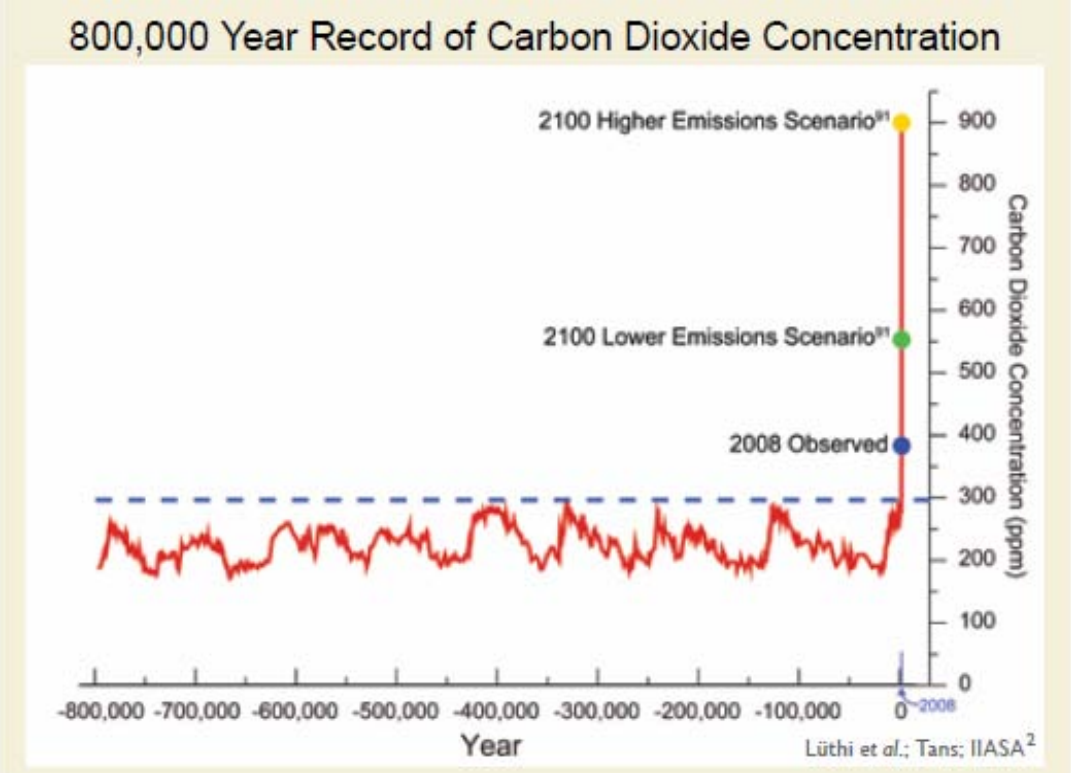

FIGURE 1. Atmospheric carbon dioxide variation from 800,000 years of ice core, and as projected. (*Source: U.S. Global Change Research Program, 2009 Report www.globalchange.gov/usimpacts)*

Naturally occurring CO_2 levels through the past eight glacial and interglacial periods varied between 180 parts per million (ppm) during glacial maximum, and 280 ppm during interglacial warm periods. Carbon dioxide levels are now 392 ppm and are projected to rise to as high as 900 ppm by 2100, under a "higher emissions" scenario of "business as usual" fossil fuel use. Methane levels over the past 800,000 years reached a natural maximum of about 700 parts per billion (ppb), but are now at a whopping 1,790 ppb. The principal sources of anthropogenic methane in the United States include: natural gas production, animal agriculture, landfills, coal mining, petroleum systems and waste water treatment. Methane is twenty-five times a more potent greenhouse gas than carbon dioxide. Ironically, if it were not for the particulate matter and aerosols that we have also pumped into the atmosphere, global warming would be even more intense, as the particulate matter and aerosols serve to "shade" the earth somewhat from the sun's intensity.

Figure 2, which follows, tracks global CO_2 emissions from 1752 to 2006 from the burning of fossil fuels, cement manufacture, and natural gas flaring. Major emitting countries are indicated. Carbon Dioxide emissions for 2010, as projected by The Carbon Dioxide Information Analysis Center of the Department of Energy, total 33,500 million metric tons. The data show the nearly exponential growth in CO_2 emissions since the beginning of the industrial revolution, and that CO_2 is a global issue. China has now surpassed the USA as the largest emitter of greenhouse gases.

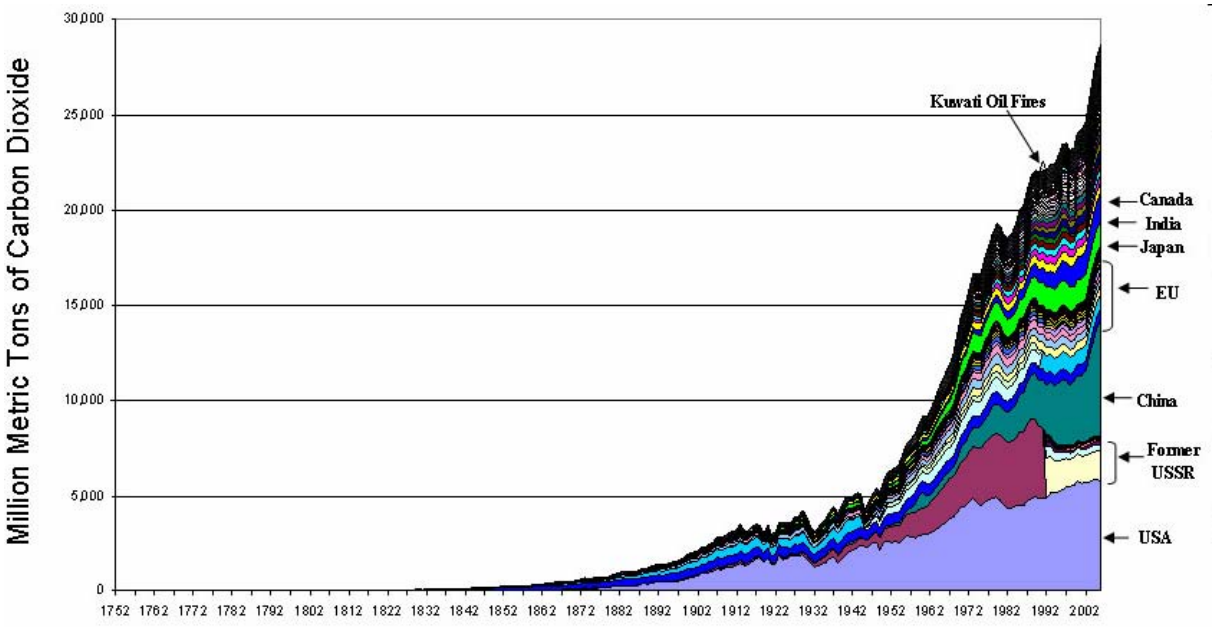

FIGURE 2. CO_2 Emissions since the beginning of the Industrial Revolution.

(Source: Carbon Dioxide Information Analysis Center)

The graph below shows petroleum equivalent energy consumption compared with per capita income for the principal developed and developing countries. As income and the standard of living improve, a consumer lifestyle demands more energy.

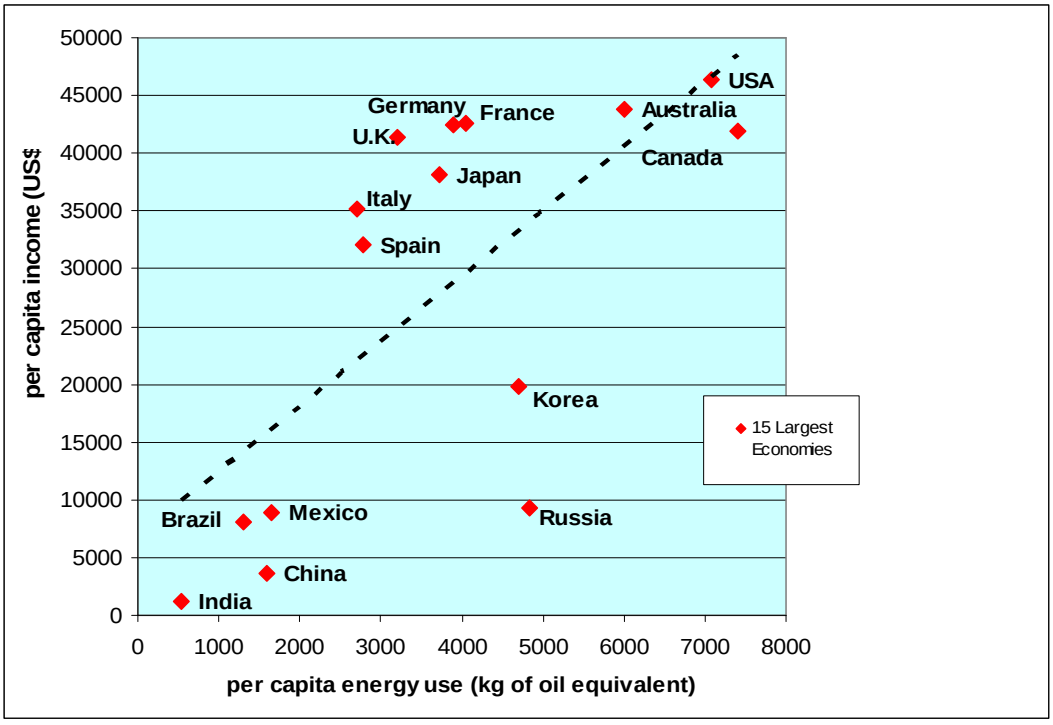

FIGURE 3. Energy use vs. per capita income in 15 largest economies.
(Source: prepared by the author from World Bank data)

This plot should be a wake up call for everyone who is concerned about commodity prices and sustainability. The USA has slightly less than 5% of the world's population, yet over the past half century it has consumed about 25% of the world's production of petroleum, and about the same amount of nearly every other natural resource. As the "BRIC" nations (Brazil, Russia, India, and China) move up the income curve into the comfortable "Consumer Age", not only in terms of their petroleum consumption, but also demand for every other commodity, including water, I question how these resources can be extracted and utilized in an environmentally and economically sustainable manner. This will be a major challenge. What will the graph showing CO_2 emissions by source and country look like by 2100?

Another observation that can be made from Figure 3 is that European countries and Japan, with a similar standard of living as the United States, use significantly less energy per capita. The USA is an energy hog, and needs to improve its energy efficiencies.

The final tipping point for me on the climate change issue was a presentation given to the CSSP by Dr. Richard Feely of NOAA on ocean acidification. The figure below was the title slide to the presentation.

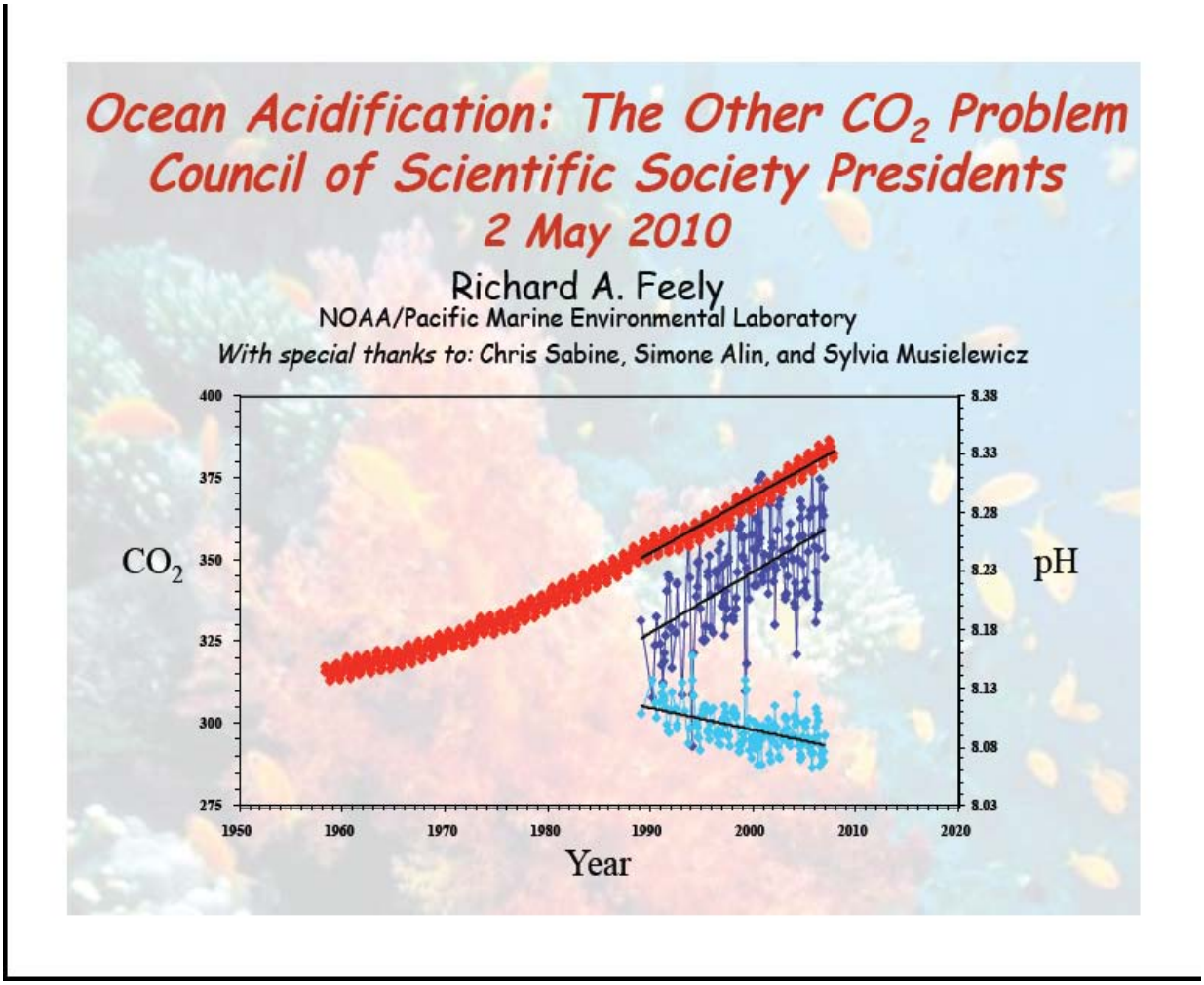

FIGURE 4. Ocean acidification presentation title slide by Dr. Richard Feely. The red color plots CO_2 levels at the Mauna Loa Observatory in Hawaii; the dark blue plots ocean surface CO_2 and the light blue plots pH at the ALOHA Station site in the Pacific Ocean north of Hawaii.

Rising CO_2 levels are resulting in the measurable acidification of the oceans. Atmospheric CO_2 combines with water vapor to form carbonic acid resulting in a reduction of oceanic pH (a lower pH means greater acidity). This is beginning to interfere locally with the normal growth of organisms which secrete calcium shells, such as coral reefs, foraminifera and calcareous algae, tiny pteropods which are food for juvenile salmon in the Gulf of Alaska, and oyster larva. These are the critters at the bottom of the food chain. The oceans have been a "carbon sink" throughout geologic time by locking up carbon through the precipitation of carbonates (lime), which requires an alkaline (higher) pH. Every plant and animal that presently inhabits the oceans has evolved under relatively stable pH conditions for millions of years. If the pH projections in Figure 5 below are correct, then there will likely be major changes to marine organisms and ecosystems, as many biota simply cannot adapt to the rapid rate of change in ocean chemistry that are likely to occur over the next 100 years.

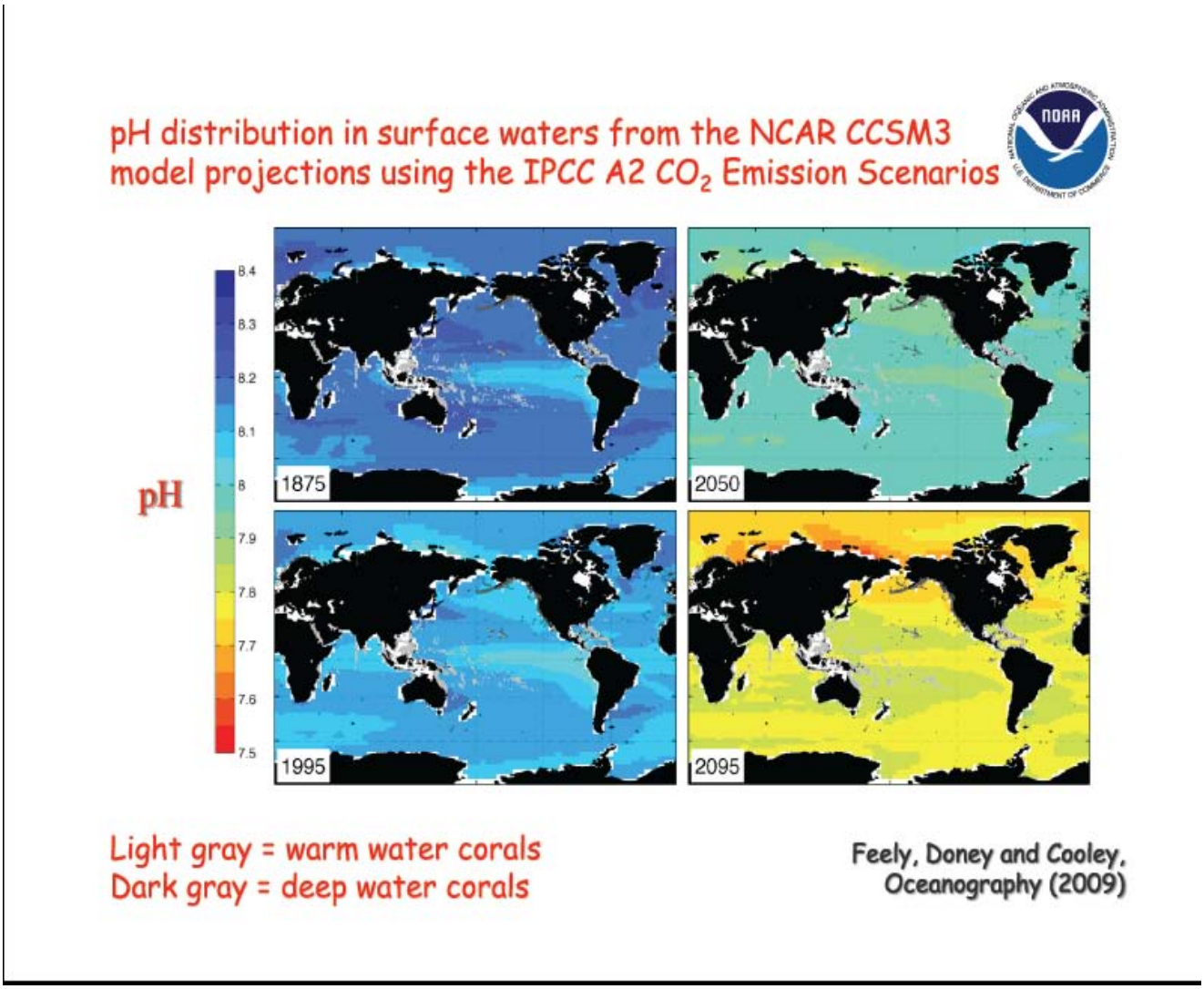

FIGURE 5. Projections of changing Oceanic Acidity

I knew nothing about ocean acidification prior to meeting Dr. Feely. As one who loves marine environments as a sailor and diver, and as a consumer of seafood, I was shocked to learn about ocean acidification. Fortunately, Congress passed the Federal Ocean Acidification

Research and monitoring Act of 2009 (HR 146) to initiate a major study of changes in ocean chemistry, and the likely impact on ecosystems and the food chain. In 2010 The National Research Council published a book titled *Ocean Acidification, A National Strategy to Meet the Challenges of a Changing Ocean.* It makes for worrisome reading.

Abrupt Climate Change

Research by Dr. Paul Mayewski, Director of the University of Maine Climate Change Institute, and others, on ice cores from Greenland, has indicated that there have been abrupt changes in temperature during the last several hundred thousand years by as much as plus or minus 25^{o}F, over periods of less than a decade – sometimes as little as two years, and that these new climate conditions can persist for decades to millennia (ref: Mayewski P.A. and Morrison, M.C., 2011, *Journey Into Climate*). These sharp climate changes are attributed to abrupt shifts in the position and strength of polar atmospheric circulation patterns, and have also been associated with changes in the strength and position of the Gulf Stream. It is the Gulf Stream which brings large volumes of warm waters northward, such that Europe enjoys its present climate and not that of Siberia.

Global warming is rapidly leading to summer melting of the Arctic Ocean ice cover, and significant melting of the Greenland ice cap, and a coincident increase of fresh water influx into the North Atlantic. An ice-free Arctic and significant salinity changes in the North Atlantic from melting of Greenland's ice cap are likely to lead to a major change in polar atmospheric and oceanic circulation patterns. This will cause a migration of the Gulf Stream to the south, causing what would be devastating climate change in Europe. A shift in the Arctic Oscillation atmospheric circulatory pattern this winter is believed to have allowed the jet stream to plunge into Siberia and push bitter cold and snowy weather over much of Europe. In March 2011, I attended a conference organized by the American Geophysical Union on communicating the science of climate change. Seated next to me was Rear Admiral David Titley, PhD, Oceanographer and Navigator of the United States Navy. I asked Admiral Titley why he was at the conference, and he replied "We are about to get a new Ocean" – the Arctic. It's happening! Changes are occurring in Antarctica as well, and the impact of Antarctica on climate is far greater than that of the North Pole.

Vast quantities of biogenic methane - methane gas formed from rotting organic matter, is locked up in naturally occurring frozen methane hydrates trapped beneath arctic permafrost, and on the deep continental margin seafloor. There is at a minimum, an order of magnitude more methane gas in the form of methane hydrates than in all the world's conventional natural gas fields combined. Significant spikes in methane concentrations and in global temperatures noted in the geological record, prior to mankind's influences, are attributed to melting of permafrost which allowed the phase change and sudden release of methane hydrates to the atmosphere. Take note – permafrost is now melting in Alaska and Siberia in the summer, and wrecking havoc with the local infrastructure. Eskimo communities on the northern shores of Alaska are falling into the Arctic Ocean. At what point will methane hydrates begin to be released?

There is a sense of urgency in dealing with climate change because we now know that there are certain tipping points where very rapid climate changes can occur. Current and projected atmospheric greenhouse gas concentrations are significantly greater, and are increasing at a rate faster, than the earth has experienced in at least the last 800,000 years. This increase in greenhouse gases is the engine that is driving global warming.

Climate Change is Happening

Data gathered by the National Research Council indicate that changes that occur per one degree Centigrade of warming include:

- Precipitation increases or decreases by 5-10%
- An increase in the heaviest precipitation of 3-10%
- Summers become very hot ("very hot" defined as the hottest 5% of summers)
- Crop yields decline 5-15% (as presently grown)
- Area burned by wild fires in the western United States increases 200-400%
- Average September extent of Arctic sea ice is reduced by about 25%
- Oceans become more acidic

There is now a pervasive drought in the American Southwest that has caused rivers to dry up, water tables to subside, vegetation to die off (up to a half-billion trees may have died across Texas), massive forest fires to rage across the mountains and plains, and an increased frequency of dust storms. Climate change - absent a tipping point, is a process that slowly creeps upon us. Birds and insects are migrating north earlier each spring. A red-breasted bird that we welcome in Connecticut as the harbinger of Spring, is now appearing in Northern Canada, where the native Innu have no name for the bird we call the robin. Unfortunately, early northward migrating birds run the risk of starving as their natural fodder may not have emerged. The pine bark beetle is devastating forests in the Rocky Mountain States and in British Columbia, as milder winters are not killing off the beetle eggs. Over the past decade, deer ticks have moved to Maine, bringing dreaded Lyme disease with them. Birch trees are dying off in the Mid-Atlantic and New England states as their southern range moves north. Spring melts and associated stream and river flooding in the mountains of Vermont and New Hampshire are earlier and more intense than a generation ago. Mountain snow pack – the source for much of the water supply for agriculture and human consumption in the Pacific and Rocky Mountain states, is melting away earlier each summer. How will farmers be able to water their crops in July and August – and where will Californians get their drinking water a generation from now? Coastal zones are experiencing more frequent flooding, especially during spring tides at full and new lunar phases, due to sea-level rise. All this is going to get worse with rising CO_2 levels.

In November 2011, the U.S. Department of Energy released its analysis of global CO_2 emissions in 2010. The data indicated that the increase in the rate of emissions exceeded the worst case scenario projections of the 2007 United Nations Intergovernmental Panel on Climate Change. The IPCC's worst case scenario forecast global temperatures rising between 2.4-6.4 ^{o}C (4 -11^{o}F) by the end of this century, with a best estimate of 4^{o}C (7.5^{o}F). These data must not be ignored.

The biosphere simply cannot naturally adapt to the rate of climate change today. Evolution is a very slow process over thousands, if not tens of thousands of years. How will the world produce food in the future as growing zones shift and water availability becomes scarce in what are currently major agricultural zones? Where will the world populations and cities that are established at the current ocean shoreline, move as sea level rises?

The average American does not perceive climate change as something that has a near term impact – it's a problem that future generations will have to deal with – not us. Global warming is not seen as real, because temperatures have not risen enough during the Baby

Boomer generation to be persuasively noticeable. Excuse me; but it's happing now, and with significant ecological, social and economic impact. The public does not appreciate that the difference between an ice age and an ice-free Arctic is only a matter of a few degrees mean global temperature. As Dr. Marcia McNutt, Director of the US Geological Survey told the CSSP, her job is not to debate whether the climate is changing, but how to now deal with the real change that is occurring, and how to devise programs to adapt and mitigate the changes that are to come.

The Doubters, Nay-Sayers and Vested Interests

The scientific community that actually deals with earth and atmospheric processes is now solidly behind the science that confirms global warming and the anthropogenic factor. There are still a few doubters and nay sayers - and there will always be, when scientists, who believe their professional standing and credibility may be threatened, refuse to change their opinions in the face of new data. Unfortunately, the press and certain politicians seem to focus on the deniers, and say that since scientists are divided in their view on climate change, Congress should not pass climate legislation. The world was once thought to be flat; and Galileo was persecuted for stating that the earth revolved around the sun! When continental drift was first proposed, there were many distinguished scientists who thought the theory was hogwash.

The oil, coal, utility, chemical, auto and heavy manufacturing industries - virtually every industry that is a significant emitter of greenhouse gases, and their trade organizations, have resisted legislative efforts to limit GHG emissions, and have at one time or another, worked to discredit the science of climate change. Environmental regulations will reduce corporate profits unless there are appropriate offsets. In the face of the abundant research that now supports global warming and the anthropogenic factor, it is now difficult to discredit the science, especially for those companies who pride themselves for being scientifically astute and innovative. Companies recognize that they must reduce pollutant emissions and their carbon footprint, but they want to push the reforms into the future. The recent EPA ruling that mandates deep cuts in emissions from coal-fired power plants is a case in point. The mantra today is that tightening GHG emission standards will harm the economy and result in lost jobs.

In November, the *Economist* magazine ran a poll asking its readers whether they believed government should subsidize alternate energy sources in order to wean the world from fossil fuels. The trade group, Independent Petroleum Association of America (IPAA), which represents thousands of independent oil and gas producers (I am a member), used its e-mail distribution to ask IPAA members to vote "no" in the *Economist* poll. The vote was 52% against subsidizing renewable energy. IPAA wrote to thank its members "for voting to show your support of the oil and gas industry and the abundant, more affordable energy it provides." Why must the petroleum industry focus on short-term gain, and as a generally well-informed and educated group, continue to ignore the overwhelming scientific evidence that global warming is real, and the burning of fossil fuels is the primary cause?

During the administration of President George W. Bush, young, politically motivated staffers, who were not scientists, edited out references to climate change and human contributions to global warming in reports prepared by the EPA, Department of Energy, and other agencies. Sadly, politicians, principally those from the resource states – such as Senator James M. Inhofe of Oklahoma, and Rick Perry, Governor of Texas, continue to refuse to accept

the research that confirms global warming and the human factor – calling it "junk science", as they pander to industry vested interests and oppose climate legislation.

From a standpoint of risk management, companies and state and federal agencies simply must address the realities of climate change and its future impact on our lives. Insurance companies are now beginning to address this matter.

Folks, it's time to pull your heads out of the sand. Read the consensus scientific data, and get behind a plan to mitigate the impact of the climate "freight train" that is speeding towards us.

Who Can You Believe?

Scientists have done a poor job in communicating climate research to the public and policy makers in government – that the climate is changing, that we are the culprits, and that significant policy decisions must be made – and soon. In the same vein, the oil, coal, power and chemical industries have also failed in their public relations campaigns to convince the public that they are truly good stewards of the environment. The public simply cannot believe industry spokespersons in the face of evening news reports about the disastrous Gulf of Mexico oil spill from the BP Macondo well blowout, or scenes of water taps flaming near oilfield hydofracking operations a'la the *Gasland* "documentary". So who can you believe?

It is difficult for the public and elected officials to know what is happening and make informed policy decisions on energy and climate without objective in-depth reporting by television and the press. Prime time TV for the most part focuses on the sensational – like the Macondo blow out, or drilling in the Arctic and its impact on polar bears, with superficial sound bites. The favorite scene on TV when the subject of "energy" arises is an oil well pump jack juxtaposed with a motorist filling the gas tank, and the posted price per gallon prominently displayed.

I read both the *New York Times* and *Wall Street Journal* nearly every day. The papers have diametrically opposed editorial positions on fossil fuels and green technologies, and I believe, have failed the public in not reporting in a scientifically objective manner. The *New York Times* has a very "green" editorial position, with which I often agree. However, *Times* journalist Ian Urbina, for example, appears to be incapable of writing anything positive or balanced about the fossil fuels which supply fully 83% of the nation's primary energy. His current crusade is against the Marcellus Shale natural gas boom in the Appalachian Basin.

The *Wall Street Journal covers* the natural resources industries well, but cannot say anything nice about the EPA or green energy, and poo poo's climate change on its editorial pages. Writers like Bret Stephens are constantly knocking green technologies and global warming. The technologies of bankrupt Solyndra LLC and Evergreen Solar worked, but it is impossible to compete with China, which controls 90% of the rare earth minerals used in many renewable energy technologies, directly subsidizes production of solar and wind products, and has labor costs that are a fraction of those in Europe and North America. Stephens and the editors of the *Journal* would do well to read the National Research Council reports on climate change. Their tax dollars paid for the studies.

The *Times* and *Wall Street Journal* are read by most of the nation's top corporate, investment banking, and government decision makers. How can these people make informed decisions about energy and climate without balanced and objective reporting?

Trade groups and their lobbyists in Washington work hard to discredit the science of global warming, and oppose environmental legislation which they believe will negatively impact corporate earnings and employment within their industries. Their dollars speak, but do they communicate the truth or the positions of vested-interests?

National Geographic Magazine on the other hand, does an outstanding job in documenting climate change with fantastic photographs and convincing text. The photographs don't lie. Unfortunately, not enough people read *National Geographic*.

The Public Broadcasting website (www.pbs.org/climate) has a wealth of information about climate change and global warming. *Nova*, the PBS science channel, has produced excellent documentaries on the Greenland and Antarctic ice sheets, and how they are responding to global warming. A recent *Nova* program about Greenland showed how large fresh water lakes – up to several miles wide and fifty feet deep, are now forming in the summer on the Greenland ice cap. In a matter of hours, these lakes are disappearing down fissures that are opening up in the 3,000 foot thick ice. The surge of "warmer" water from the glacial lakes flows along the bedrock below the glaciers and is lubricating and accelerating their movement towards the sea. The PBS film confirmed what I had heard from the 2010 American Geosciences Institute William L. Fisher Congressional Geoscience Fellow in Washington, who had done her Ph.D. research on water flow beneath the Greenland ice sheets. Some critics challenge the objectivity and "liberal agenda" of PBS. I have no problem with their climate reporting, and believe it is scientifically accurate.

A benefit of our democracy is that when properly informed, the public and Congress can enact environmental legislation that makes a difference. DDT, for example, was banned once the public understood that our national symbol – the bald eagle, was imperiled. Increased ultraviolet radiation resulting from depletion of the ozone strata over Antarctica by chlorofluorocarbons (CFCs) was an abstract issue, until the public began to see photos of blinded sheep in Patagonia. Oops - this is real, and perhaps it could affect me! The Montreal Protocol of 1987, ratified by the United States and 195 other nations, banned the manufacture of CFCs which were used primarily as refrigerants and solvents. As a result, we appear to have avoided a major environmental catastrophe. Can we do the same with green house gases? The United States refused to approve the 1997 United Nations Kyoto Climate Change Protocol because of its many perceived flaws, and the fact that mega-GHG emitters China and India were not parties to the agreement. The Kyoto Accord expires in 2012. Hopefully, a new international climate treaty can be negotiated that will have the approval of all nations, and truly make a difference in reducing GHG's.

The challenge today is to inform and educate all stakeholders about climate change - to communicate that objective, peer-reviewed research indicates that anthropogenic CO_2 and other green house gases are causing unprecedented rates of climate change; damage will occur; and that there is a very significant adverse economic impact of a "do nothing" scenario. When the public realizes that their personal well being will likely be negatively impacted, and that there will be an out-of-pocket cost, they will respond appropriately. If only we could convince some high-profile celebrities to launch a public service campaign about climate change, and throw in Prince William and Kate for good measure, the public's attention would be captured! President

Kennedy inspired the nation to reach for the moon. Can we challenge the nation to roll up its sleeves and make a concerted commitment to a green energy revolution?

PART THREE: THE ENERGY MIX AND REDUCTION OF OUR CARBON FOOTPRINT

Energy Options - Are we Running out of Oil, Gas and Coal?

Since the dawn of the "Petroleum Age" 150 years ago, approximately 1 trillion barrels of crude oil have been extracted from the earth for man's use. Estimates by the US Energy Information Administration (EIA) of the Department of Energy, and *Oil & Gas Journal,* are that remaining proved global oil reserves as of January 1, 2010, were 1.35 trillion barrels. "Proved" reserves are those quantities of resource that have been well defined by drilling and other means, and are economically recoverable with today's technology and commodity price. Current global oil consumption is 31 billion barrels per year, which means at current rates of consumption, there are 43 years proved reserves remaining. Total petroleum resources, including, proved, unproven and yet to be discovered oil and gas, are likely twice this amount. We have probably consumed about one-third of the earth's recoverable petroleum endowment.

The USA consumes about 7 billion barrels of crude oil per year - 23% of the global total, yet has only about 21 billion barrels proved reserves. To meet our demand of about 20 million barrels per day, the USA currently imports 49% of its crude and refined products at a cost of about $1 billion per day.

Oil demand has risen dramatically over the past 25 years from about 60 million barrels of oil per day (BOPD) to nearly 90 million BOPD, due to population growth and increased global consumerism. Prices have been volatile during this period, but the trend has been upward, due to rising demand, and I believe, inadequate investment in infrastructure to deliver crude from the wellhead to the consumer, supply uncertainty due to conflicts in the Middle East and Africa, and investor speculation.

Natural gas is abundant, but until the advent of extensive liquefied natural gas (LNG) infrastructure, gas was not traded globally. EIA and *Oil & Gas Journal* estimates for proved global gas reserves are 6,609 trillion cubic feet (TCF). Annual consumption in 2010 was 113 TCF. At current demand, there are 58 years of supply from proved gas reserves. The USA consumes about 22 trillion cubic feet (TCF) per year, and per EIA estimates, has proven gas reserves of 284 TCF - a 13 year supply at current population and usage.

The advent of abundant natural gas, gas liquids and crude oil from shales is a game changer – thanks to new horizontal drilling and hydraulic fracturing technologies. In the decade from 2000 to 2010, USA shale gas production grew from 0.39 TCF to 4.87 TCF, and now represents 23% of total US production (*source: EIA*). By 2035, the EIA projects that 47% of USA natural gas will be produced from shales. A 2011 study by consulting firm INTEK for the Department of Energy, estimates a total of 750 TCF gas and 24 billion barrels of oil are recoverable from domestic shales, (but not "proven"). Analysts at IHS Energy Inc. project an increase of shale oil production from formations like the Bakken in North Dakota and the Eagle Ford in South Texas, from around 1 million BOPD in 2011, to as much as 3.0 million BOPD by 2018. Globally, Advanced Resources International, Inc. has estimated for the EIA, that

technically recoverable shale gas resource in 48 basins outside Russia and Middle East, could be 5,760 TCF.

Development of unproven resources and new discoveries will extend oil and gas reserve life. New technologies will increase oil recoveries from currently producing fields, which presently average globally, only 34% of the oil in place. If average recovery is increased by an additional 3%, global oil reserves would increase by 200 billion barrels (*source: AAPG Hedberg Conference in 2006*). We are not running out of petroleum. Future commercialization of large scale development of oil from kerogen rich "oil" shales, and production of natural gas from natural gas hydrates, will significantly extend the Petroleum Age. "Peak oil" for conventional petroleum resources keeps getting pushed back by new discoveries and new production technologies, and going forward, will be "delayed" – perhaps to mid-century, by conservation technologies. What is important to appreciate from a geopolitical and economic standpoint, is that most of the world's remaining conventional petroleum resources are in the Middle East and countries of the Former Soviet Union.

The United States is truly the "Saudi Arabia" of coal, with a total of 275 billion tons proved reserves, representing 28% of the world total (*source: EIA and World Coal Association*). Annual domestic consumption of coal is close to 1 billion tons, which means that we have over a 250 year supply.

Given the abundance of relatively cheap fossil fuels, the EIA projects that global consumption of fossil fuels will continue to grow in absolute terms through 2035 as shown by the following graph:

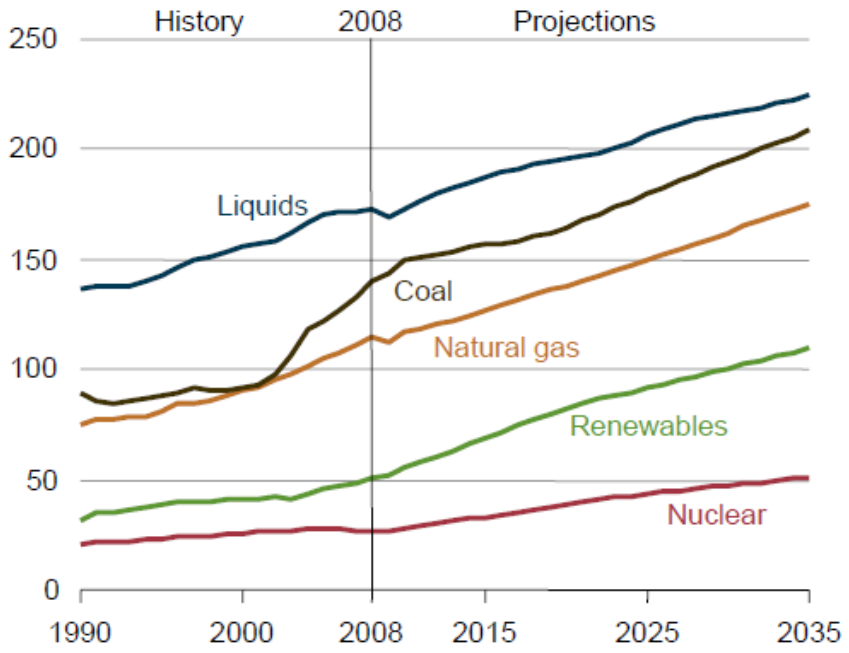

FIGURE 6. World energy consumption by fuel 1990-2035 (quadrillion Btu)
(Source: EIA 2011 International Energy Outlook)

Continued consumption of fossil fuels will result in more greenhouse gas emissions as shown by the graph below:

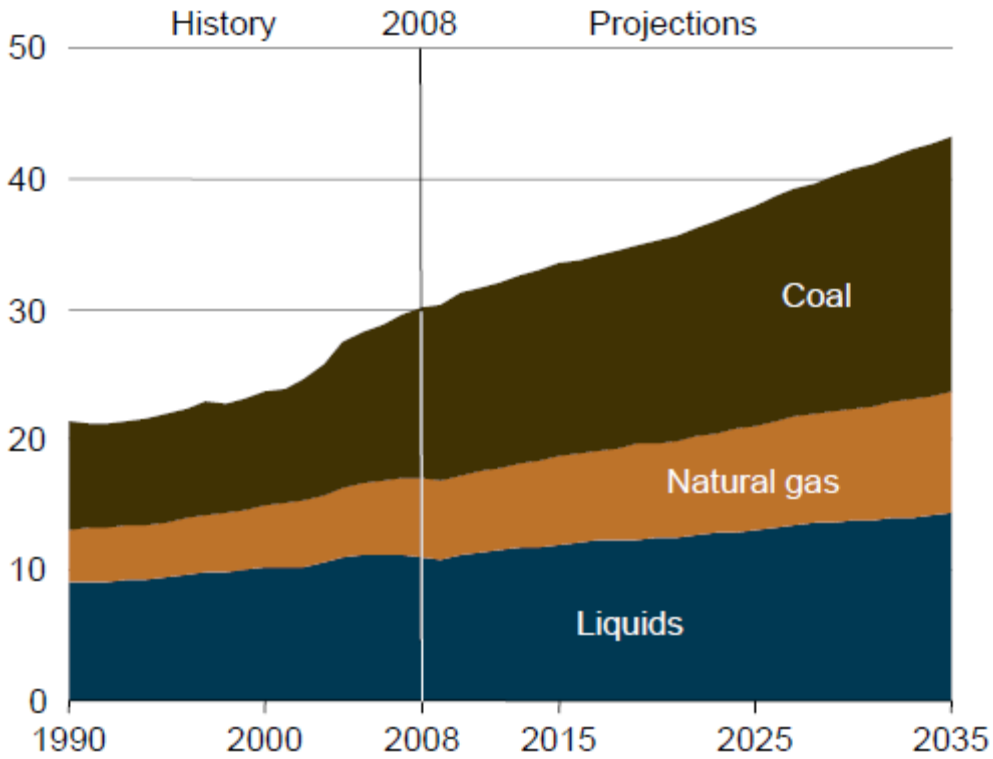

FIGURE 7. World energy-related carbon dioxide emissions by fuel, 1990-2035 (billion metric tons)
(Source: EIA 2011 International Energy Outlook)

More fossil fuels and more greenhouse gas emissions are going to lead to further global warming. If the "business as usual" energy use and global warming projections come to pass, I suggest that those who live in coastal communities head for higher ground. If you live in New Orleans, you should consider moving to Shreveport before real estate prices get too high. Citizens of Florida – Georgia has some nice hill country! New York City – you have a problem. Insurance premiums are going to soar, as will federal appropriations for disaster relief.

What to Do - and Countering the Push Back

America, and all other nations, must take immediate steps to mitigate the impact of anthropogenic climate change by reducing their carbon "footprint" for the good of Planet Earth. It will be costly. We can no longer sustain a life-style and economy based primarily on cheap energy from fossil fuels. Further delay will result in even greater cost in the future to remediate and mitigate the physical impact of climate change. How many trillions of dollars will it cost to relocate the world's major coastal cities if we cannot limit sea level rise to less than two meters? What will it cost to repair the damage to homes, businesses and infrastructure from increasing frequency and intensity of major storms and floods; supply water to drought stricken areas; feed the world as current zones of major agricultural production become unviable; and deal with mass human migrations? This sounds too scary. It is – but we can no longer ignore these scenarios, as climate research indicates a strong likelihood that these events will happen as CO_2 levels rise above limits not seen in the last 800,000 years.

The first step in reducing our carbon footprint is to limit carbon (CO_2) emissions from current sources. This requires building "green" renewable energy power plants that do not emit CO_2 to meet rising electricity demand, and replacing and/or converting older coal fired plants to natural gas. Renewable energy resources include: hydro, biomass (wood and wood waste), wind, solar, geothermal and tidal. Nuclear has no greenhouse gas emissions; but more nuclear plants require a national repository for radioactive waste and reprocessing of spent fuel – facilities which Congress is unwilling to approve, but should. Natural gas is a fossil fuel, but because it has half the CO_2 emissions of coal when burned, and because it is so abundant and relatively inexpensive, it should be used as a transitional fuel. More than half the homes in America heat and cook with natural gas (Source: EIA).

The chart which follows shows the projected cost of a new electric power plant using different fuel sources, put into service by 2016, as determined by the EIA.

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2009 $/megawatthour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	65.5	3.9	24.5	1.2	95.1
Advanced Coal	85	74.7	7.9	25.9	1.2	109.7
Advanced Coal with CCS	85	92.9	9.2	33.3	1.2	136.5
Natural Gas-Fired						
Conventional Combined Cycle	87	17.5	1.9	44.6	1.2	65.1
Advanced Combined Cycle	87	17.9	1.9	41.2	1.2	62.2
Advanced CC with CCS	87	34.7	3.9	48.6	1.2	88.4
Conventional Combustion Turbine	30	45.8	3.7	69.9	3.5	123.0
Advanced Combustion Turbine	30	31.7	5.5	61.3	3.5	102.1
Advanced Nuclear	90	90.2	11.1	11.7	1.0	114.0
Wind	34	83.3	9.5	0.0	3.4	96.1
Wind-Offshore	34	209.7	28.1	0.0	5.9	243.7
Solar PV[1]	25	194.9	12.1	0.0	4.0	211.0
Solar Thermal	18	259.8	46.6	0.0	5.8	312.2
Geothermal	91	77.4	11.9	9.5	1.0	99.8
Biomass	83	55.4	13.7	42.3	1.3	112.6
Hydro	53	78.5	4.0	6.2	1.8	90.5

[1] Costs are expressed in terms of net AC power available to the grid for the installed capacity

Source: Energy Information Administration, Annual Energy Outlook 2011, April 2011.
DOE/EIA-0383(2011)

FIGURE 8. Estimated levelized costs for new electric power plants to go online in 2016
(Source: EIA 2011)

The data demonstrate that a new natural gas plant is now less expensive than a conventional coal plant. Onshore wind is about the same cost as a conventional coal plant, and geothermal, biomass and hydro are only slightly more expensive. Offshore wind and solar are more than twice the cost of a new coal fired power plant per the EIA estimates. Advanced (clean) coal would increase power costs by only 14%, and clean coal with carbon sequestration would increase coal power costs by as much as 43%. Nuclear is about the same as an advanced coal plant.

The International Energy Agency in Paris has prepared a study of OECD country projected energy costs with sensitivities for 5% and 10% interest rates for capital cost financing (*IEA Projected Costs of Generating Electricity: 2010 Edition*). Their data indicate that wind and solar will be two to four times more expensive per kilowatt hour than a conventional coal or gas fired power plant. Nevertheless, the Europeans have instituted comprehensive energy use and climate policies, have imposed substantial taxes on fossil fuels, and have made energy tax credits available to stimulate a transition to green energy.

Renewable energy is happening in America, spurred on primarily by tax credits, air quality regulations, state renewable energy mandates, an interest in reducing fuel acquisition and handling costs, and social conscience. However, "green" energy is a very small percent of the total energy supply equation, as shown in the graph below.

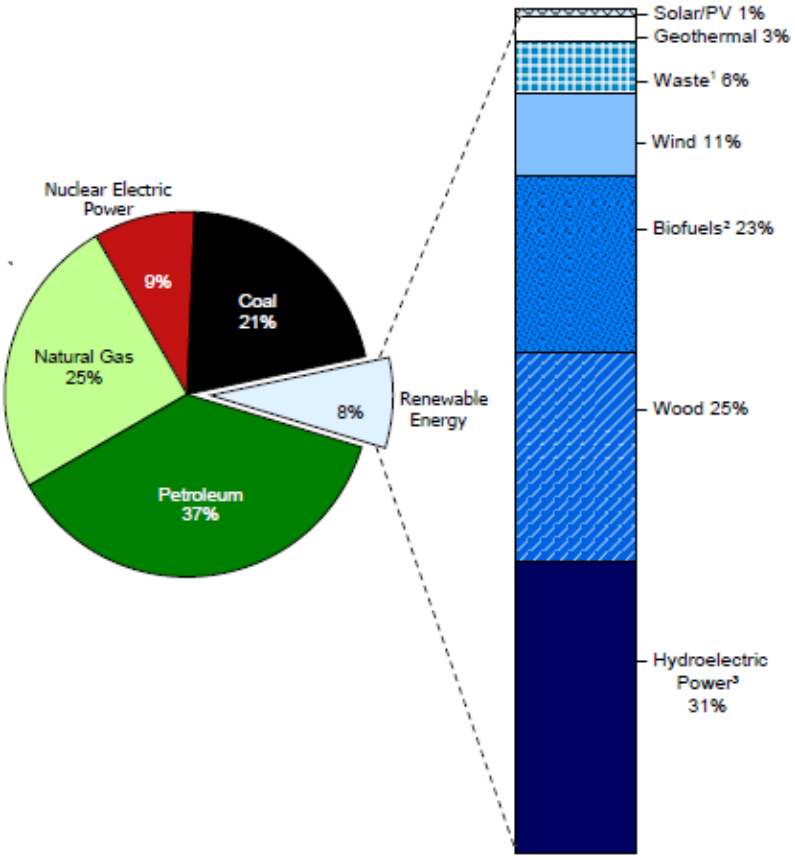

FIGURE 9. Renewable Energy as a share of total primary energy consumption in USA in 2010 (Source: EIA Annual Energy Review 2010)

Electric power generation presently accounts for 40% of total energy consumption. The breakout for fuel sources for electric power generation are : 48% coal, 21% nuclear; 19% natural gas, 10%

renewables, and 1% fuel oil (*Source: EIA*). Fossil fuels are the source of 68% of electric power generation in the United States.

Projections by the EIA for sources of primary fuel consumption through 2035 are shown in the following graph.

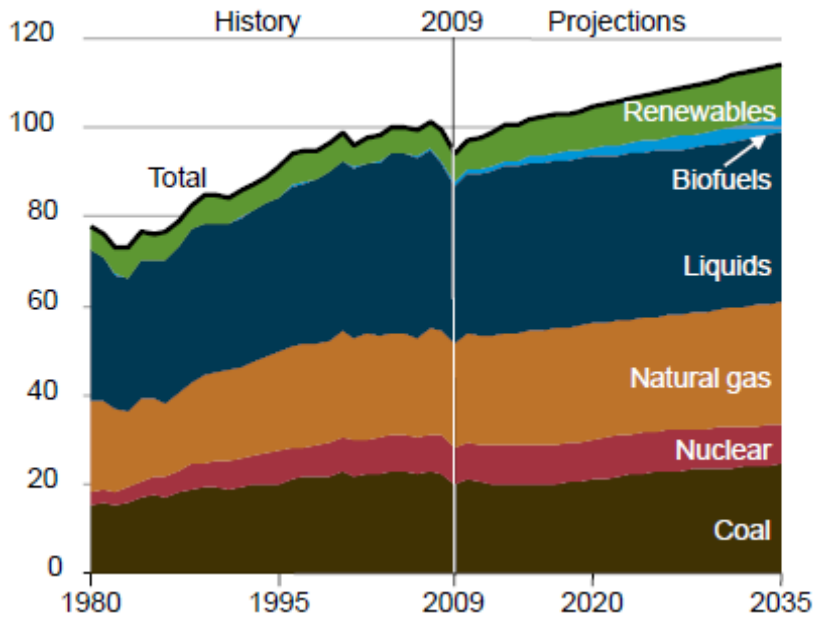

FIGURE 10. Primary energy consumption projections through 2035
Source: EIA Annual Energy Outlook 2011

Politicians and advocacy groups who tout renewable energy, and attack fossil fuels, ignore the reality of the graphs in Figures 9 and 10 above when they talk to the public about renewable energy. In 2010, renewables amounted to 8% of all primary energy, and are currently projected to meet only 13% of demand by 2035. Solar and wind represented 10% of the 8% slice of the renewable energy pie – slightly less than 1% of all primary energy in 2010. The impression is often given that we can abandon fossil fuels and run everything on solar and wind in just a few years. This is a gross misrepresentation. As reported by the US Energy Information Administration, fossil fuels supplied 83% of primary energy in the USA in 2010, and will likely supply as much as 78% by 2035. We cannot simply flick the fossil fuel switch to "off", and shut down the hundreds of billions of dollars of energy and manufacturing capital infrastructure that depend on fossil fuels, and lay off the millions of people who work in the industries and their affiliated suppliers. Hopefully we can accelerate this transition by implementing an energy policy that provides a credible roadmap to the future, certainty, and mechanisms to facilitate the financial cost of reducing our carbon footprint.

The petroleum industry has nothing to fear. Improved fuel efficiencies and conservation measures will reduce demand in the OECD nation economies, and have already reduced demand growth; but every drop of oil produced will be sold, and at a profit, due to the shear magnitude of rising global demand for transportation fuels and petrochemicals. Reductions in USA oil imports resulting from fuel efficiencies and emission mandates will not come at the expense of American oil producers.

Natural gas producers should be excited by the prospects of a new energy paradigm. Domestic prices have declined due to the abundant new gas resources emerging from shale plays, plus the economic recession. Six thousand cubic feet of natural gas have about the same heating value as one barrel of crude oil. Natural gas in the United States at $3.50 per thousand cubic feet, costs about one-fifth that of oil (at $100/barrel) on an equivalent energy basis! This reality is causing energy intensive industries to shift from coal and fuel oil to natural gas. Conversion of coal-fired power plants to natural gas, which emits half the carbon dioxide, a third of the nitrogen compounds, and practically none of the sulfur and mercury compounds per megawatt hour compared with coal, will increase demand for natural gas. Conversion of cars and trucks to natural gas, and greater use of natural gas for petrochemical feedstocks, will also increase demand for natural gas, and help displace imported oil.

Coal has been the backbone of electric power generation. It is abundant and cheap in North America; but it is also the principal source of sulfur, nitrogen and mercury emissions, and carbon dioxide. The technology currently exists to significantly reduce emissions of all types into the air. As reported in the *Wall Street Journal* on December 23rd, Duke Energy said that it plans to invest $6 billion on environmental upgrades to its new plants, and that by 2017, sulfur dioxide pollution will be reduced by two-thirds, nitrogen dioxide by half, and mercury emissions by 73% from 2011 levels. The cost to upgrade some old plants is such that they will likely have to be retired.

Reduction of carbon dioxide emissions from coal-fired power plants will be costly. We have the coal, and will be able to use it through application of clean coal emission technologies, new combustion processes such as those proposed in the Future-Gen program, coal gasification, in-situ gasification, and geological carbon sequestration. Industry should not bear the cost of emission reduction on its own. If society demands and legislates that the environment be cleaned up, then it must be prepared to help pay the expense. The best way to do this is to provide offsets such as investment tax credits, and the ability to pass costs on to consumers. Putting a price on carbon by establishing a carbon tax or a “cap and trade” mechanism would accelerate the reduction in industrial emissions.

Electric power generation with fossil fuels is the largest source of carbon dioxide emissions. However, as shown in the graph below, transportation fuels, industrial manufacturing, commercial and residential heating are also major contributors.

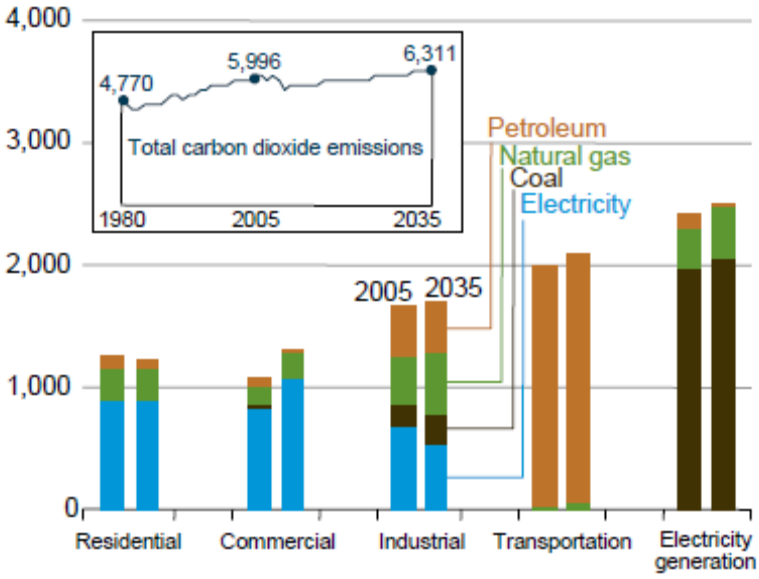

FIGURE 11. U.S. Carbon Dioxide Emissions by Sector and fuel, 2005 and 2035 (million metric tons)
(Source: EIA Energy Outlook 2011)

Reductions in CO_2 emissions in these other sectors can be achieved through improved fuel and energy efficiencies, fuel switching (i.e. - converting vehicles to natural gas and electric power); biofuels; building efficient public mass transit; installation of "smart" electric grids and smart electric control technologies in workplaces, institutions, and homes; conservation measures such as significantly improved thermal insulation, heating and cooling efficiencies, and retro-fitting old buildings, and making new buildings Leadership in Energy and Environmental Design (LEED) certified; and by recycling of metals, plastics, glass and paper, which are energy intensive to produce from primary raw materials.

Fossil fuels are significantly less expensive than green energy substitutes, and there are additional out-of-pocket costs for consumers which create financial barriers to implementing energy efficiencies. As such, normal "market forces" will not work in the near term, as end-users will continue to use cheaper fossil fuels to maximize profits, and the public will try to avoid the cost of being green. Legislative "sticks and carrots" are required to stimulate the transition to green energy. These must include increased fossil fuel energy taxes and tax credits, and subsidies for improving energy efficiencies, and developing new technologies. It is not a level playing field, which, as a fiscal conservative, I do not like. However, the cost of not facilitating the transition to green energy now through tax incentives and subsidies will be a missed opportunity compared with the cost of mitigating the impact of climate change in the future.

In June 2009, the 111th Congress passed the American Clean Energy and Security Act of 2009 (HR 2454) in the House by a vote of 219 to 212. This was the first time that Congress has passed meaningful climate legislation. The bill contained significant tax "sticks and carrots" and subsidies to reduce greenhouse gas emissions, including a "cap and trade" mechanism, and a very broad range of energy efficiency mandates. By mid-century, the bill would have reduced GHG emissions by 83% below 2005 levels. Opponents called the bill a "job killer", an "energy tax on consumers that will raise the cost of electricity and gasoline"; and as described by Rep. Joe Barton of Texas, it was "an economic disaster bill". The legislation never made it through the Senate.

In late December, 2011, a federal district court in California blocked California's Low Carbon Fuel Standard (LCFS) after declaring the regulation unconstitutional. California is trying to reduce its carbon footprint, but industry trade groups have fought the legislation tooth and nail. Consumer Energy Alliance Executive Vice-Pres. Michael Whatley commented that the court's decision will help protect consumers in other states where officials might have contemplated adopting their own LCFS. He said that "High gasoline and diesel fuel prices are a tremendous drag on the American economy which is still struggling to emerge from the ongoing effects of the recession," and that "while CEA supports the development of all energy sources it is important to do so in a responsible manner that will not have undue and unnecessary impacts on American consumers and businesses."

Wake up America - the age of cheap energy is over. Coal, electricity and gasoline will become more expensive, but that must be accepted as the tradeoff for mitigation of the potentially devastating impact of global warming, and a healthier planet. Europeans pay more than twice what we pay in America for gasoline and diesel, and Europeans and Asians pay more than three times what we pay for natural gas. Their economies have not collapsed as a result.

I do not buy the "job killer" argument. Opponents to cap and trade, carbon taxes, and increased energy efficiencies who cite the potential loss of jobs and damage to our economy should read Tom Friedman's excellent book "*Hot, Flat and Crowded*". Friedman writes that America must use its incredible reservoir of innovative skill sets to "out green" the competition, and by doing so, lead the world in the green revolution, create jobs, grow the economy, and significantly reduce our dependence on foreign oil. By dithering and delaying meaningful change, we are allowing the Chinese to ride the green wave into the future, and the USA will be buying its green technologies from Asia. Opposition to implementation of automotive fuel efficiency standards, for example, nearly destroyed the USA auto industry in the face of higher oil prices. The Clean Air Act of 1970 and Clean Water Act of 1972 did not harm the economy, despite the whining of industry and lobbyists who opposed the legislation; and a cleaner and healthier America has resulted. Why do people ignore these historic factors when they now oppose initiatives to reduce greenhouse gases, given the consequences of a "business as usual" policy?

New jobs will be created to: build, install and operate renewable energy power plants, and the equipment needed to reduce emissions; to tear down and recycle to the extent possible, obsolete plants; and to build new, efficient, and low impact coal-fired plants, gas-fired plants, and more nuclear power plants. Further jobs will be created by the manufacturers who build energy efficient automobiles (this is happening!), trucks, and public transportation systems; and energy efficient electric appliances. The construction of better intra and inter-city public transportation and smart electric grids will positively impact employment. Even more jobs will be created by the increased manufacture and installation of improved thermal insulation in homes, factories and work places, and implementing LEED certification.

The Europeans have accepted the realities of climate change and have passed legislation to reduce greenhouse gas emissions through a "cap and trade" mechanism and a targeted 20% renewable energy in the EEU by 2020. The goal is to limit global warming to $2^{o}C$ by 2050 (about 450 ppm CO_2). As reported on the European Commission website (*ec.europa.eu/clima/policies/eccp/index_en.htm*), policy makers have determined that:

A low-carbon economy would have a much greater need for renewable sources of energy, energy-efficient building materials, hybrid and electric cars, 'smart grid' equipment, low-carbon power generation and carbon capture and storage technologies.

To make the transition to a low-carbon economy and to reap its benefits such as a lower oil bill the EU would need to invest an additional €270 billion or 1.5% of its GDP annually, on average, over the next four decades. The extra investments will bring us back to investment levels from before the economic crisis and will spur growth within a wide range of manufacturing sectors and environmental services in Europe.

By stepping up climate action 1.5 million additional jobs could be created by 2020.

Commentators, politicians and others who denigrate renewables, should know that "green energy" is rapidly becoming a major global industry. According to a 2011 United Nations study, global renewable energy investments in 2010 were $210 billion, representing 18% of total 2010 energy investments of $1.2 trillion. China was #1 with a total of $48.9 billion, followed by the United States with $23.8 billion. The breakout by energy type was: wind at $95 billion; solar at $86 billion; and biomass at $11 billion. A study by Pike Research Inc., indicated that a total of 5,784 megawatts (MW) of wind power was installed in North America in 2010, and that a further $125 billion is on the order books. These are numbers that no investment banker can ignore.

The Canadian Province of Nova Scotia, for example, is forging ahead with a plan to achieve 40% renewable energy supply by 2020 through harnessing the province's abundant wind, tidal and biomass resources, and by tapping into the huge hydroelectric resources of Newfoundland and Labrador. Daewoo Industries, the Korean conglomerate, has taken over an abandoned factory in Trenton, Nova Scotia in partnership with the province and Canadian government, to launch a venture to fabricate wind turbine towers and blades. The project has an initial construction and start-up cost of $90 million, and will eventually employ over 400 people. It is now up and running, delivering its first wind towers, and will significantly strengthen the local economy and tax base.

Why must Americans be so short sighted and parochial? Let's get on with it, and introduce and pass legislation that will make a difference - now!

PART FOUR: ENERGY AND CLIMATE POLICY RECOMMENDATIONS

Energy Policy Principles

There are two major reasons why the United States must adopt a new comprehensive energy plan. The first is that long term dependence on imported oil has negative economic and security implications. We must not have our economy held hostage to crude supply disruptions due to natural or geopolitical events, or even threats of disruption from the likes of an Iran or Venezuela. Global imbalances in supply and demand have caused extreme commodity price volatility over the past decade, which hurts the economy, and makes long term investment planning difficult. America is richly endowed with conventional and renewable energy resources, and should maximize the benefit of this good fortune, and the global competitive advantage it provides. The second factor is global warming and the necessity to reduce our

carbon footprint by transitioning from fossil fuels to renewable energy. Climate and energy legislation have to be coordinated, as each impacts the other.

Good policy must lay out a road map that achieves results, provides certainty so that long term capital investments can be made, does not create policy conflicts, and stimulates the economy.

The plan should:

- Recognize and promote the development of America's abundant fossil and renewable energy resources in an environmentally and economically responsible manner.

- Reduce American dependence on imported oil, thereby reducing the hundreds of billions of dollars that are presently flowing overseas for crude and refined products.

- Stimulate the transition from fossil to renewable energy resources on a timeline that recognizes the importance of fossil fuels, the immense capital investment in existing fossil fuel infrastructure and employment; and the sheer physical and economic challenges of making the transition.

- Reduce the nation's greenhouse gas emissions in a manner that does not adversely impact the nation's vital industries.

- Make energy conservation a national priority.

- Build the "Smart Grid"

- Innovate!

Implementation of these measures will:

- create new domestic jobs.
- strengthen our economy.
- Enhance national security.
- Reduce our carbon footprint
- Improve the quality of life and secure a healthy future.

So how do we achieve these worthy goals? The first order of business is that Americans have to be educated and informed about climate change and the scientific realities of global warming; what energy options exist; and the real economic and social costs of implementing the policies that are required - and what will happen if we do nothing.

Politicians are not leading the charge. Comprehensive climate legislation was passed by the House of Representatives in 2009, but the issue has now been overwhelmed by the nation's focus on getting the economy back on track. No one is campaigning for the 2012 elections on increased energy costs and additional consumer taxes. Shrill voices, lobby money, and mis-information seem to prevail. The public is not fully informed; does not feel threatened,

and is therefore, not engaged. Objective science and reporting are missing in action. Sadly, because Americans are more reactive than proactive, it may take a string of deadly weather events, dry reservoirs and crop failures to convince the public that we need to change our ways. Before the worst happens, I recommend that federal and state environmental agencies launch public service ads to raise awareness about climate change. The active endorsement of a high-profile sports or entertainment celebrity would help. Congress is paralyzed by conflicting agendas. It will have to stop bickering and be prepared to compromise for the good of the nation.

A. Reducing Our Dependence on Foreign Oil

Politicians all seem to agree on the mantra *"reduce our dependence on foreign oil"*, but few seem to say anything other than "we need more wind and solar". In order to truly reduce American dependence on imported oil over the next decade, we must increase domestic production of oil and natural gas, and increase transportation and energy conservation efficiencies, as we transition to more renewables. Petroleum is a fossil fuel, but oil and natural gas currently make up 62% of the nation's primary energy as indicated in Figure 9, and are projected to continue to supply a similar amount through 2035 (Figure 10). In the paragraphs which follow, regulatory matters important to reducing our dependence on foreign oil are discussed.

Increased Access. Increasing access to America's petroleum resources is a necessary step for boosting production. The Eastern Gulf of Mexico, the Atlantic and Pacific offshore should be opened for leasing, as well as most of offshore Alaska. This can be done in an environmentally responsible manner. The United States is the only country with significant offshore petroleum resources that does not permit exploration on most of its continental shelf areas – yet we are the world's largest petroleum consumer. The Europeans, who generally have tighter environmental regulations than the US, permit exploration in the North Sea and on the European outer continental shelf. North Sea oil and gas development has provided an economic bonanza to the United Kingdom and Norway over the past forty years, and there have been no lasting negative environmental consequences. Oil and gas fields offshore Eastern Canada are being safely developed, and likewise, are an economic engine for Nova Scotia and Newfoundland.

The shale plays have had a dramatic impact on American natural gas and oil production, and have reversed the production decline trend of the past two decades. Tens of billions of dollars are being invested in leases, wells, pipelines and processing infrastructure, and hundreds of thousands of direct and indirect jobs are being created. North Dakota, South Texas and Pennsylvania are booming. Natural gas prices have dropped, lowering consumer energy bills and making the USA a low cost manufacturer for energy intensive products and certain petrochemicals. Shale oil production is approaching one million barrels per day (BOPD), and could reach 3 million BOPD. Additional oil production increases are coming from exploration and development in the deep waters of the Gulf of Mexico.

A typical horizontal Marcellus gas well in Pennsylvania initially produces at a rate of 5 to 6 million cubic feet of gas per day (mmcfd) - the best wells have produced as much as 30 mmcfd. The equivalent heating value of 6 million cubic feet of natural gas is about 1000 barrels of oil. At an international price of $110/barrel, a single Marcellus well can reduce oil imports by $110,000/day. Through August 2011, a total of 5,775 horizontal Marcellus wells have been permitted by the Pennsylvania Department of Conservation and Natural Resources, and this is

just the beginning of the Marcellus revolution! Marcellus gas production alone could significantly reduce imported oil and help with the country's international balance of payments deficit, and strengthen the US dollar.

Access vs. No New Leases. Oil opponents are demanding that the industry not be given greater access to new offshore and onshore federal lands as they sit on vast undrilled lease positions. Those who espouse this position have very little understanding of oil exploration and development, and how a concept in a geologist's brain works its way through a process that ultimately leads to a filled gas tank.

Exploration companies spend millions of dollars on geological studies and seismic data prior to bidding for a federal lease; bid millions for the leases; then spend more millions in maturing a lease to the point of drilling after the lease is acquired. An offshore exploration well in deep water can easily cost up to $100 million, and may have only a 25% - 30% chance of success. Because of the cost and time to define a new exploration opportunity, and the potential value of one or more discoveries, companies try to acquire as much acreage in a new exploration trend as possible. In the event of a discovery in a particular geological formation, a large lease position near the initial discovery means that they will have additional drilling opportunities in the same formation, at lower risk and front-end cost. The geological nature of a conventional oil and gas field is such that it occupies a relatively small percent of the total area of the lease. Much of the area between productive fields is structurally "low" and not where oil and gas naturally occur. It may take ten years from origination of an exploration concept to commercial production, in environmentally sensitive, harsh and/or remote operating areas.

For these reasons, and others, companies need large land inventories. All federal leases do have set terms – generally ten years, after which the lease expires and is returned to the Federal government, if oil and gas production has not been established. A very small percentage of federal lands are actually under lease. In the interest of reducing the nation's dependence on imported oil, additional leases should be made available to the petroleum industry on an annual basis.

Hydraulic Fracturing. Success of the shale plays depends on acceptance of hydraulic fracturing – (a.k.a "hydofracking" or "fracking") by the public and regulatory authorities. The public is being terrorized by the anti-shale factions such as the Sierra Club into fearing what can in fact, be safely managed. New York State imposed a hydraulic fracturing moratorium and has missed out on the huge economic stimulus that Pennsylvania is experiencing from development of the Marcellus Shale, which also underlies New York. There is always the potential for an operational mishap – planes crash, but we have not stopped flying. If a well is properly cased and completed, there is a very low probability that a fracture treatment at depths below 5,000 feet will communicate with a potable water aquifer at a depth of a few hundred feet or less. A recent multi-disciplinary study on hydraulic fracturing conducted by the Energy Institute at the University of Texas, concluded that there was no evidence of aquifer contamination from hydraulic fracturing chemicals in the subsurface resulting from fracturing operations at depth (Ref:http://energy.utexas.edu/images/ei_shale_gas_regulation120215.pdf). There have been surface spills, but this is a result of sloppy operational procedures, not the hydraulic fracturing process *per se*.

Shales are the "source rocks" for petroleum generation through natural biogenic and thermal breakdown of organic matter in the sediments. Water wells drilled into these shales will

naturally have trace amounts of a broad range of dissolved petroleum compounds. The EPA must acknowledge this fact. Methane is “swamp gas”, and everyone who has had a gurgling gut and emitted “wind”, has in fact produced methane gas! It is not a “toxic” water contaminant in low concentrations.

Fracking has been a common oilfield technique to stimulate production from low permeability reservoirs for more than sixty years. However, the hundreds of trucks, massive high pressure injection equipment, and huge volumes of water, sand and chemicals now associated with fracking shales, is a new development. Four to six million of gallons of water and millions of pounds of sand, with about 1-2% chemical additives, are required to frack a typical horizontal shale well. Prior to commercial production, a million or more gallons of introduced frack water containing low concentrations of oilfield chemicals, plus ground water with naturally occurring dissolved chemical elements such as sodium and chlorine (salt), magnesium, sulfates, and even uranium (it’s in nearly all ground water), flow back to the surface from the geological formation that was hydrofracked. The petroleum industry has the technologies and procedures to handle water supply, disposal, and now water recycling, with minimal environmental impact. However, the public needs to be reassured by “neutral” stakeholders (i.e. not the petroleum industry) that hydraulic fracturing is safe. Regulation of hydraulic fracturing under the Clean Water Act has been suggested. The oil industry strongly opposes regulation under the Clean Water Act because of the additional layer of bureaucracy, reporting requirements and cost, and the fact that hydraulic fracturing is already regulated under state law, and was specifically exempted from the Clean Water Act by the Energy Policy Act of 2005. My personal view is that regulation of hydraulic fracturing under the Clean Water Act would reassure the public that fracking is safe, and put an end to the endless hearings and litigation that is delaying shale development. The additional expense is a minor line item when added to the $5-10 million cost of a producing horizontal well. The petroleum industry needs to regain the public trust!

Tax Preferences for the Oil Industry. Oil and gas exploration is a high-risk business, where typically there is a 70-90% probability that the initial well will not find commercial hydrocarbons, and the multi-million dollar cost of a dry hole, has no salvage value. The business is not like real estate, where once a building is constructed, it might not have full occupancy, but at least there is a building with a measurable asset value. Development drilling is not risk free either. Tens of billions of dollars are currently being invested in the “lower risk” shale gas plays across North America. However, at a current low gas price of $2.50 - $3.00 per mcf, it is likely that 90% of the horizontal gas wells which have no liquids production will not recover the full cycle cost of $5-15 million to lease, drill, operate and abandon the wells on a pre-tax basis.

Oil and gas, unlike most fixed assets, are depleting resources, where the value of a producing field goes to nearly zero once the oil and gas is exhausted.

It is for these unique circumstances, that Congress established certain tax benefits for the petroleum industry. I and most other small independent oil and gas producers simply could not afford to be in the oil business if we did not have the tax benefit of expensing certain exploration and intangible drilling costs in the year in which they occur, and were not able to take the percentage depletion deduction. It is the independents who are prepared to take the risk in drilling most of the nation’s exploratory wells.

Opponents of the oil industry often cite ExxonMobil’s tens of billions of dollars of profits as justification for eliminating tax preferences for the oil industry. The company’s profits are so

large in absolute terms, because ExxonMobil is a huge company that touches so many people on a daily basis. The petroleum industry as whole should not be benchmarked against ExxonMobil – there are several hundred public oil and gas companies, and literally thousands of small independent private companies. A better measure of "profit" is return on capital employed. The oil industry returns are significantly less than many other industry sectors such as banking and communications. Is anyone complaining about Apple's multi-billion dollar profit in 2011? An analysis made by IHS Inc. in 2011 indicated that the five-year cumulative return on capitalized costs for publicly owned oil companies ranged from a high of 34% in Europe, to 25% in Africa and the Middle East, to a low of only 9% in the United States! The global five-year average return was 16%.

The Obama Administration is trying to eliminate many oil industry tax preferences. As the USA already has the lowest return on petroleum industry capitalized costs, a reduction in oil and gas tax benefits would place a significant new barrier to reducing our dependence on imported oil. As politicians call for elimination of tax preferences, they should understand that the nation cannot plan on natural gas supplanting coal and being used as a transportation fuel, if elimination of tax preferences makes the resource uneconomic to produce.

Keystone XL Pipeline. The Canadian oil sands contain an estimated 170 billion barrels of recoverable oil reserves. TransCanada Pipeline Company has proposed building the 1,661 mile Keystone XL Pipeline expansion to bring "secure" Canadian heavy oil to Gulf Coast refineries. When completed, the $7 Billion Keystone Pipeline Project will transport an incremental 830,000 bbls/day to the USA. This is a very significant source of crude supply that would displace oil imported from Venezuela, Mexico and the Middle East. President Obama has delayed approval of the pipeline permit on the grounds that oil sands are "dirty" and that the pipeline crosses environmentally sensitive areas. This is a mistake. Strategically, it is important that the US have broad access to Canadian oil sands. The Chinese will be very happy to take all the heavy oil they can get from Canada if the pipeline is built to Canada's Pacific coast instead of to Texas. The oil sands do have a significant environmental impact, which is of concern; however, this can be mitigated. In terms of greenhouse gas emissions - total GHG emissions in 2008 from the oil sands were 37.2 mega tonnes. This is equivalent to 2% of 2008 USA coal fired power emissions (*Source: Environment Canada, Canadian Association of Petroleum Producers).* There are pipelines all over the USA crossing environmentally sensitive areas. None of the oil and gas production from the Gulf of Mexico would get to consumers if pipelines did not cross sensitive coastal marshes and interior wetlands. Oil and gas pipelines criss-cross the Edwards Limestone aquifer in Texas. The environmental issues raised by the pipeline opponents have been blown out of proportion. The Keystone XL Pipeline should be approved for construction as soon as possible in the interest of creating thousands of new jobs and national security!

Improved Fuel Efficiencies. Sixty-four percent of a barrel of crude oil is refined to gasoline and diesel fuel. The quickest way to significantly reduce America's dependence on foreign oil is to increase fuel efficiency standards for all vehicles. America has an average on-the-road miles per gallon (mpg) of only 25 mpg compared with 45 mpg in the European Union. The technology is currently available to achieve 40-50 miles mpg – the Toyota Prius being "Exhibit #1". In November, President Obama proposed doubling fuel efficiency standards to 54.5 mpg by 2025, and he has the support of General Motors and Ford in this endeavor. The auto industry estimates that it will cost about $157 billion to achieve the targeted fuel efficiencies; and the Obama Administration estimates that the proposal will save consumers about $1,700 billion

at the pump, and help reduce carbon emissions. The Pew Charitable Trusts, an outspoken advocate for green energy, commented on the president's proposal as follows:

"Over the next 15 years, U.S. fuel economy standards will almost double to a fleet average of 54.5 miles per gallon, which will benefit all Americans. Once finalized, this rule will save consumers who purchase a model year 2025 vehicle more than $8,200 in fuel costs over the life of the car compared to a 2010 vehicle. It also will reduce oil imports by 12 billion barrels and avoid six billion metric tons of carbon emissions. These achievements will improve U.S. competitiveness in advanced vehicle technologies and strengthen our nation's energy security.

This is legislation that will benefit the nation. Let's get it through Congress.

Biofuels. Ethanol - an alcohol, is a clean-burning fuel. It is the principal automotive fuel in Brazil, where ethanol is manufactured from sugar cane. The concept behind the USA ethanol industry is that domestically produced ethanol can be added to gasoline to reduce imported crude oil and reduce CO_2 emissions. Corn is the principal American feedstock for ethanol production. Congress included the first ethanol subsidy in the Energy Policy Act of 1978, mandating a $0.40 per gallon tax credit. In 2004, as a stimulus for ethanol production, Congress passed the Volumetric Ethanol Excise Tax Credit, which established a federal excise tax credit of $0.45/gallon for ethanol purchased by refiners for blending with gasoline. A total of $20 billion in ethanol subsidies has been paid to refiners, including $6 billion in 2011. The Energy Policy Act of 2005 mandated production of 7.5 billion gallons annual ethanol production by 2012, such that 10% of all fuel used in cars and trucks would be ethanol. Production in 2010 was 13.2 billion barrels (*Source: Renewable Fuels Association*). Over 5 billion bushels of corn are now used for domestic ethanol production - a seven-fold increase over the past decade (*Source: USDA).*

Ethanol production has been a great opportunity for farmers in Nebraska and Iowa, but in the end, not so good for the consumer. Production of ethanol from corn has been a misguided energy and agricultural policy. Ten percent ethanol in gasoline has not provided any net energy savings, nor a reduction in CO_2 emissions, when all aspects of the corn production and its transformation into ethanol, and distribution of the ethanol to the end-user, are considered. The diversion of a significant portion of the edible corn crop to ethanol production over the past decade – now about 40%, has caused a steep increase in the cost of corn products for human consumption and animal feeds, resulting in higher costs for corn flakes, cooking oil, corn sweeteners for food and drinks, and the price of beef and chicken. The expansion of the corn crop for ethanol production has resulted in replanting of areas previously set aside for conservation purposes, and the ethanol manufacturing process is putting a strain on water resources for agriculture. Fertilizers and pesticides are washing from corn fields down to the mouth of the Mississippi River where they contribute to the pollution that has caused a 5,000 square mile "dead zone" in the Gulf of Mexico. This is an area the size of Connecticut!

Under the Renewable Fuels Standard (RFS) of the Energy Independence and Security Act of 2007, Congress increased ethanol production targets to 36 billion gallons by 2022, but mandated that 21 billion gallons must come from cellulosic ethanol and advanced biofuels.

The Volumetric Ethanol Excise Tax Credit was allowed to expire at the end of 2011, as Congress sought savings to reduce the federal budget deficit. The scale of corn ethanol is now such that it should be profitable without a subsidy. We'll see. Hopefully expiration of the subsidy

will result in a reduction in the acreage planted in corn, and reduce the costly diversion of a basic human and animal food crop to ethanol production.

I support the growth of the non-food cellulosic ethanol and biofuels industry if it can truly result in a net reduction in imported petroleum, energy use and GHG emissions. A limited amount of cellulosic ethanol, ultra clean bio-diesel, and even jet fuels are being manufactured from algae, switch grass, agricultural byproducts, wood waste and other cellulosic matter. More R&D is required, as is market scale, to make cellulosic ethanol and biofuels commercially viable. In December, the EPA used its authority to amend the RFS and dropped the cellulosic ethanol requirement for 2012 to 8.65 million gallons, which is far below the original target of 250 million gallons. Federal subsidies in the amount of $1.01/gallon for ethanol made from cellulosic feedstocks remain. This subsidy is necessary to help cellulosic biofuels reach a critical mass. Congress should re-examine the Renewable Fuels Standard and eliminate the requirement that 15 billion gallons of corn ethanol be produced by 2022.

B. Reducing Green House Gas Emissions

A "stick and carrot" approach is required to hasten the transition to a green energy economy. Emission, energy efficiency, and renewable energy standards, and a timetable to reach those standards, is required. Penalties for failing to meet these standards should be clearly defined. Unless a price is put on carbon, none of the green energy technologies will happen in a time frame or at a scale that makes a meaningful difference in reducing GHG emissions. Instead of a "cap and trade" mechanism, my recommendation is to impose a federal excise tax on fossil fuels at the point of production and consumption, and to use the tax revenue to offset the cost of tax credits and federal expenditures for emission reductions and new green technologies. Allocating a cost to carbon will significantly modify corporate and private energy use and lead to enhanced conservation and energy efficiencies; provide a strong incentive for utilities to build more renewable energy plants; and increase green energy consumption.

Since no politician up for election in 2012 is likely to campaign on a program calling for broad energy tax increases, and as I have no intention of running for public office, I will be the "villain", and propose the "**Energy and Climate Act of 2012**". The Act is comprehensive, and will include the following provisions

1. The Act will provide for a federal energy excise tax on fossil fuels at the point of initial production at the mine or wellhead, and at the final point of consumption.

    a. The excise tax will be paid by the initial purchaser for coal, oil and natural gas, condensate and natural gas liquids at the mine gate, well head (or point of sale from a field), and at the point of entry for imported fuels and refined products.

    b. The end-consumer will pay the excise tax for refined products when delivered – i.e. at the gas pump for gasoline and diesel vehicle fuels; and at the delivery point for aviation and distillate fuels, including home heating oil. Biofuels would be exempt.

    c. The end consumer of natural gas – electric power plant, factory, office, school, or residence, will have the excise tax added to the monthly bill.

d. Electric power generated by fossil fuels will be subject to the excise tax on the basis of kilowatt hours purchased, added to the consumer's monthly electric bill. Renewable and nuclear electric power will be exempted from the tax

The energy tax will be phased in over three years to mitigate the economic impact upon the consumer. In Year 1 of the Act, the energy tax will be 10% of the realized cost per ton, barrel, thousand cubic feet, gallon and kilowatt hour. In the second year, the tax will rise to 15%, and in year three and following years, the tax will be 20%.

Beyond the initial tax paid at the point of production, the energy tax will not apply to transportation, storage and trading of fossil fuels and refined products, nor to petrochemicals.

2. The EPA shall establish strict emission standards for power plants, such that CO_2 emissions will be reduced 50% from 2005 levels by 2025, and 80% by 2050. Penalties will be established for failure to meet the emission standards by certain dates. These could include loss of operating licenses.

3. The Act will establish renewable electric generation energy standards for each district in the North American Electric Reliability Council, and will establish a time frame for those standards to be met, such that by 2025, at least 25% of America's electric power will come from renewables.

4. All industrial manufacturers and transportation companies must measure and report their carbon emissions on an annual basis to the EPA, and track how the emissions have changed year-over-year. Five-year plans will be submitted to the EPA which describe what measures the company plans to take to reduce its GHG's emissions, and its progress in doing so, by the second anniversary of the Act, and every five years thereafter. This information will be public, and will be required to be included in the annual reports of public companies.

5. The EPA will establish efficiency and emission standards for all motor vehicles. The Obama Admistration's plan to achieve 54.5 mpg by 2025 will be incorporated in the Act.

6. Energy efficiency standards will be established by the Department of Energy for all industrial, office and residential buildings, such that universal LEED certification can be achieved by 2025.

7. The DOE will set increased electric efficiency standards and targets.

8. The Act will provide investment tax credits to companies and private citizens for the purchase and installation of equipment to increase energy efficiencies and reduce GHG emissions. This will include the cost to retrofit existing power plants, cement plants, refineries and chemical plants, steel and paper mills, and other industrial manufacturing sites with emission reduction technologies to meet established standards. It will include credits for bringing buildings up to LEED standards. During the initial three years of the Act the investment tax credit will be 75% of the equipment capital cost and installation; in years 4 -6, the tax credit will drop to 50%; and in years 7-10, the tax credit will be

33.3% ; and thereafter 25%. The decreasing tax credit over time will stimulate an accelerated reduction in GHG's and employment to implement the changes in the near term, rather than later.

9. The tax credits will be available for residential owners to improve the thermal insulation of their homes, and to install solar power, and ground source geothermal heating and cooling.

10. Funding will be available from the EPA and DOE to guarantee debt financing for putting major new green technological developments into production. Loan guarantees in excess of $250 million will be reviewed by an independent panel administered by the National Research Council.

11. Funding will be provided to expand and improve public transportation from the suburbs to city centers, within metropolitan areas, and for inter-city travel. Intra-city electric light rail will be encouraged. Fares will be subsidized as an incentive to get people out of their automobiles and onto public transport.

12. The Act will provide for installation of electric "smart" grid technologies, and facilitate the permitting and construction of new electric transmission corridors to bring renewable power from generation sites to the consumer.

13. Three years following passage of the Act, there will be an additional federal excise tax of 7.5 % on the purchase price of all private and commercial vehicles which use gasoline and diesel, which do not meet mpg and emission standards for the model year.

14. In order to stimulate a transition from gasoline and diesel for vehicle fuel, natural gas as a vehicle fuel will be exempt from the excise tax at the "gas pump".

15. There will be no tax credit for the purchase of electric or hybrid vehicles, or for the retrofitting of gasoline and diesel engines to natural gas. The savings to be realized from natural gas and electric powered cars should be sufficient market stimulus.

16. Increased R&D funding will be provided for improving enhanced reservoir recovery technologies for oil and natural gas; for reducing green house gases emitted during the production and transport of oil and gas from the well head to the burner tip; and for improving the efficiency of fossil fuel combustion in engines for transportation and in power generation. (We cannot abandon fossil fuels in the interim as the nation has an abundance of fossil fuels. We just have to find ways to use them more wisely).

17. Funding will be provided for continued R&D of clean coal, coal combustion, coal gasification, and coal to-liquids technologies. Tax credits and loan guaranties will be available for construction of clean coal power plants that meet or exceed the new emission standards.

18. Funding will be provided for further research into carbon capture and sequestration, and potential recycling as useful carbon compounds such as fertilizer.

19. The Act will mandate a national program for the recycling of consumer waste metal, glass, plastics, cardboard and newspapers.

20. The Act will call for the establishment of at least two national nuclear waste repositories and nuclear fuel recycling centers. Yucca Mountain will be re-opened and completed, such that nuclear waste stored there can ultimately be recovered and reprocessed.

21. The Act will include social funding mechanisms such that the poor and elderly are not unduly impacted by increased energy costs, and the cost to become compliant with national energy standards.

22. All United States Government agencies, state agencies, and the United States military are subject to the energy efficiency and emission reduction standards of the Act.

Enactment of the measures proposed in the Energy and Climate Act of 2012 will, in a very short time frame, reduce America's dependence on imported oil, significantly reduce GHG emissions and the projected growth in emissions, stimulate the economy, create new jobs, and enhance national security. Many of the energy efficiency measures I have proposed are not particularly radical, and were debated in Congress when the House of Representatives passed the American Clean Energy and Security Act of 2009. The Obama Administration, to its credit, has worked hard to implement reductions in GHG emissions, despite strong political and industry opposition.

The energy excise taxes will provide the US Treasury with substantial revenues to offset the investment tax credits for GHG reduction and energy efficiencies, and provide revenues to fund new construction of public transportation, and green technology development. In the table below, I have attempted to make a rough estimate of the potential annual revenues that would be generated by the new excise taxes at 10% in the first year. Annual consumption figures are my projections from EIA data for 2009-2015, recognizing that the 2009-2011 period was impacted by a recession, and the commodity price is an estimated average for commodities that have variable prices depending on the quality of the fossil fuel and source.

Rough Estimate of Revenues from Fossil Fuel Excise Taxes at 10% in Initial Year

Energy Source		**$ Billion Federal Revenue**
Crude Oil. condensate and NGL's at wellhead/import:		
	7 billion BO/year @ $100/BO x 10%	70.0
Gasoline:	138 billion gal. @ $3.50 x 10%	48.3
Distillate (Diesel):	58.25 billion gallons @ $3.80 x10%	22.1
LPG + jet fuel + other	65 billion gallons @$2.00 x 10%	13.0
Natural Gas at wellhead/import:	22 TCF/year @ $3.50/mcf x 10%	7.7
Natural Gas at burner tip:	22 TCF/year @ $ 7.00/mcf x 10%	15.4
Coal at Mine mouth:	1 billion tons @ $36/ton x 10%	3.6
Electricity:	4 trillion Kwh @ $0.09/Kwh x 68% fossil x 10%	24.48
	TOTAL:	**$ 204.58**

Total energy tax revenues are projected to be on the order of $200 billion in the first year, and will double by year three. Current federal tax revenues are about $2.5 trillion. The energy excise taxes will represent an increase of about 8 -10% in annual federal tax revenues. As the national GDP is on the order of $15 trillion, the energy tax will represent 1%-2% of GDP. I am not in a position to make a detailed economic analysis of the impact of the proposed energy taxes on the cost of living and the economy, and shall look forward to the analyses made by the EIA, Congressional Budget Office, and various Washington "think tanks" – both pro and con, on the issue of energy and environmental taxes.

Opponents will naturally attack the Act as a draconian hit on the US economy. There is definitely a cost to implement the GHG reduction and energy efficiency measures. As stated many times in this essay, the era of cheap energy is over, and must be so, if the public wishes to do something about climate change. Near term, the energy excise taxes will definitely increase the cost of gasoline and diesel. However, the retail cost at the pump will still be significantly less than in Europe, where the average equivalent price per gallon of gasoline is currently about US $7.00. Taxes are the primary reason for the cost differential. The retail cost of electricity will still be significantly less than in the EEU. Domestic natural gas is currently about one-fourth of the global cost. Hopefully, the long-term result of implementing the energy efficiencies and emission reductions is that people will pay more for less energy - so perhaps the ultimate out-of-pocket cost will be neutral. To this we must also add the reduction in health costs from a cleaner environment. Voters have a choice concerning the quality of life they want for their children and grandchildren. I believe they will overwhelmingly support these proposals when presented with all the facts.

C. Balancing stakeholder Interests

The energy debate ranges from shrill cries of "Drill baby, drill" to "End fossil fuels now!" Even supporters of green energy projects face the "nimby" syndrome (not in my back yard), and the "banana" syndrome (build absolutely nothing near anything!). The first offshore wind farm, proposed in Nantucket Sound offshore Massachusetts, has met stiff resistance. Onshore wind farms are now being opposed on the grounds that they will endanger bats and birds. Hydro-power from Quebec and wind farms on the Western plains are fine – but just don't build transmission lines anywhere near us. Solar is a great idea for Arizona – but what about the desert lizards and other critters?

It is important that the interests of all stake holders be heard in the debate. However, the loudest and best financed voice must not prevail, if the outcome is not for the "greater public good". Regulatory review panels must be objective, and decisions based on good science. There should be a limit to the ability of activist groups to indefinitely delay worthy projects with seemingly endless litigation and appeals. Balancing all stakeholder interests for the good of the country and Planet Earth is essential as energy and climate legislation is discussed in state capitals and in Washington.

D. Can the USA Implement a Comprehensive Energy and Climate Policy?

Washington is paralyzed by polarization on important issues, and now, an unwillingness to compromise for political gain as we approach the 2012 elections. Energy and climate have not been issues so far in the state political primaries – it's all about jobs and the economy. The

public does not feel an "energy pain", is confused over claims of global warming and climate change, and is simply not engaged on the subjects of energy and climate. As recommended in this essay, a broad public education program is required to give Americans a "wake up call" about the seriousness of climate change, and the need to do something now, to mitigate the impact of anthropogenic greenhouse gases. Strong presidential leadership and a popular champion are required to make a difference before it is too late.

Without reconciliation and enactment of a comprehensive energy and climate plan, America will muddle along the "business as usual" path. We can expect steadily rising transportation fuel costs due to increasing global demand, and future supply imbalances and price spikes resulting from geopolitical crises. Green house gas emissions will continue to rise, increasing global warming and the environmental changes that will result. The consequences will be profound for the earth's biosphere – and that includes us.

I am optimistic that the public and our elected leaders will rise to the challenge and do what is right for the nation and Planet Earth. The House passed a comprehensive energy and climate bill in 2010, but alas, it died in the Senate. **Grass roots public pressure must be mobilized to raise the issues of energy and climate policy in the 2012 campaign process.** It is unlikely that Congress will pass any comprehensive legislation this year, because the focus in Washington is now on re-election. If enough people speak up in the coming months, there will be a 2013 Energy and Climate Act. Let's get to work!

About the Author

G. Warfield "Skip" Hobbs is a consulting petroleum geologist and Founder and Managing Partner of Ammonite Resources, a firm of international petroleum geotechnical consultants that is headquartered in New Canaan, Connecticut. He holds a B.S. Degree in Geology from Yale College and a M.S. Degree in Petroleum Geology from the Royal School of Mines, Imperial College, London. Prior to forming the Ammonite Corporation in 1980, and Ammonite Resources in 1982, Hobbs worked from 1970-1980 as an international exploration geologist for Texaco and Amerada Hess in Latin America, Europe, Asia, the Middle East, and lastly in New York City. Hobbs is also the president of Ammonite Nova Scotia Corporation, the operator of two exploration licenses offshore Nova Scotia. He is a licensed professional geologist in Texas, Pennsylvania and Florida. Skip is a past national Secretary (1993-1995) of the 33,000 member American Association of Petroleum Geologists, and was President of the AAPG Division of Professional Affairs in 2000-2001. In 2005 Hobbs was awarded Honorary Membership in the AAPG. He is currently the Past-President of the American Geological Institute, a federation of 50 geoscience societies representing over 250,000 members. Hobbs is also a member of the Council of Scientific Society Presidents; was on the CSSP Executive Committee in 2011; and is currently the co-chair of the CSSP Energy and Environment Committee. Since 2000, Hobbs has been a Trustee of the New Canaan Nature Center, a not-for-profit organization that provides educational naturalist and environmental awareness programs to over 100 primary and middle schools in Fairfield County, Connecticut and Westchester County, New York. He writes and lectures frequently on domestic and international petroleum and energy issues. Hobbs may be contacted via e-mail at skiphobbs@ammoniteresources.com.

The opinions and policy recommendations herein are solely those of the author and not of the organizations of which he is associated.