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THE SUSTAINABILITY PRINCIPLE IN SUSTAINABLE ENERGY

Irma S. Russell*

I. INTRODUCTION

Sustainable energy is at the center of any discussion of the "sustainable development"—both from the economic perspective and from the larger perspective of society’s interest in continued survival. Energy is crucial to all aspects of the economy, and energy production and use are central to the issue of global climate change. Reliable energy has always been recognized as the backbone of the economic activity. In addition to powering the world economy, energy and control of energy resources influence government.

The continued existence of civilization, including the continued existence of the species Homo sapiens, is an implicit goal of any kind of "sustainable development." Thus, instrumental goals of reliable and sustainable energy are inextricably linked to each other and to the public interest, making it difficult to overstate the importance of these topics. Energy’s impact on all areas of the economy, the environment, and the sustainability of the planet make it "the single most important problem facing humanity today."2

The term, "sustainability" has a range of meanings. Perhaps the most common use of the term today is within the context of "sustainable development." The term "sustainable development" typically refers to the ability to develop economically while sustaining the physical integrity of the planet. Recent concerns about global climate change have led many to focus on energy as an integral part of the sustainability challenge. Whether the governmental controls on greenhouse gases ("GHG") are presented as a cap-and-trade program, auctioned rights for the discharge of GHG, direct taxation of carbon emissions, or technological controls, all levels of control should reflect a comprehensive approach and a self-conscious evaluation of the role that

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1. The national economy is inextricably linked with energy policy. "No highly industrialized society can survive at present without substantial supplies of oil, and so any significant threat to the continued availability of this resource will prove a cause of crisis and, in extreme cases, provoke the use of military force." Michael T. Klare, Resource Wars: The New Landscape of Global Conflict 27 (Metro. Bks. 2001).

government energy incentives and initiatives play as part of the solution or part of the problem in global climate change. The American public has experienced the growing realization that energy is crucial, not only to markets and the economy but also to national security and, now, to the continued existence of life on the planet. The call for change has arisen in many different sectors of the American public. T. Boone Pickens declares, “America is in a hole and it’s getting deeper every day. We import 70% of our oil at a cost of $700 billion a year—four times the annual cost of the Iraq war.”³ Private investors and other private entities have also taken up the challenge to tackle the global climate change challenge. Former U.S. Vice-President Al Gore, arguably the most notable global warming activist, established an investment firm whereby companies or individuals can buy carbon offsets to become “carbon neutral” (despite the fact that the offset purchasers do nothing to curb their current activities).⁴ In announcing his change of view of global climate change, Thomas Friedman stated the response of the common-sense man on the street: “There have been many warning signs telling us that we have entered a new era in climate terms. Scientists point to new data—changes in global average temperature, rising sea levels, and quickening glacial melt. For me, the most telling sign was that I had started asking new questions. Two in particular: ‘Who made it hot?’ and ‘Doesn’t Al Gore owe us all an apology?’”⁵ European public opinion registers an even stronger concern for global climate issues.⁶ Growing demands of industry and individual consumers throughout the world, the need to respond to global climate change, and the risks of disruption of the energy supply by foreign conflicts, mean that governments must be involved in incentivizing renewable energy to secure reliable and sustainable energy. Addressing the topic of sustainability is essential to a serious response to current environmental and public health threats posed by global climate change and other environmental hazards.

This Article considers energy policy through the lens of sustainability and the public interest, focusing on the need for incentives for the protection of the public health and the environment. Its purpose is to assess the concept of sustainability from the ground up, acknowledging the vast terrain of the concept and casting a spotlight on the

³. T. Boone Pickens, PickensPlan, http://www.pickensplan.com/index.php (accessed Sept. 11, 2008) (the website has since been updated and this quote is no longer posted).
⁵. Thomas L. Friedman, Hot, Flat, and Crowded: Why We Need a Green Revolution—and How It Can Renew America 111 (Farrar, Straus & Giroux 2008).
⁶. The response of a jury in the United Kingdom prosecution of six Greenpeace volunteers may suggest the growing concern of the public. The Greenpeace volunteers were charged with attempting to disrupt the operations of a Kent coal-burning station last year. The result of their trial, announced September 10, 2008, captured the attention of NGOs and others focused on climate issues. The defendants scaled and painted “Gordon” (referencing UK Prime Minister Gordon Brown) down the side of a chimney. A Crown Court jury acquitted the Greenpeace volunteers on “lawful excuse” grounds, persuaded by the defendants’ defense that they acted in the “greater good to protect the climate.” The willingness of jurors to recognize this defense may force the UK to reconsider plans of building at least seven new coal-burning power stations and review recent reports suggesting their energy demands may be met without coal through cleaner energy solutions. Greenpeace Intl., Court Deals Major Blow to UK Coal-Fired Power Plans: Verdict Marks a ‘tipping point’ for the climate change movement, http://www.greenpeace.org/international/press/releases/court-major-blow-to-uk-coal-10092008# (Sept. 10, 2008).
importance of energy policy in addressing the challenges of sustainability. Government regulation is inevitable in the pivotal issue of energy. Without reliable energy, the world economy and world institutions would devolve to chaos.\textsuperscript{7} Scrutiny of the U.S. energy policy provides a starting place for assessing the concept of sustainability itself. The Article's central thesis is that government incentives, which have always animated energy production, must now respond to global climate change while sustaining the global economy. Part II of the Article examines the concept of sustainability itself, reporting early recognition of the concept detailing the place of the concept in the current global climate debate. Part III provides a picture of the current state of energy supply and demand in domestic and world markets. Part IV considers the role of government incentives in stimulating change in the energy market. This part presents examples of government policies and initiatives of the United States and other countries relevant to climate change and energy. Part V compares available resources for incentivizing a multiple-source approach to energy policy as a way of fostering a sustainable energy plan. Part VI concludes with observations about the need for a carefully tailored energy policy with an explicit and methodical comparison of initiatives in order to respond to the challenge of providing a reliable and sustainable source of energy for a sustainable society and a sustainable environment.

II. THE SUSTAINABILITY CONCEPT

The concept of sustainability presents many dimensions and definitions. In 1987, the United Nations' Brundtland Report defined "sustainable development" as "development . . . that . . . meets the needs of the present without compromising the ability of future generations to meet their own needs."\textsuperscript{8} The Brundtland Report, entitled \textit{Our Common Future}, mobilized public interest in ecology and sustainability and stimulated a wave of scholarly and popular works on the dangers facing the environment. Since that time, a stream of best sellers has kept the topic of sustainability near the surface of public debate, although without comprehensive legislation.\textsuperscript{9} The 1992 Earth Summit in Rio de Janeiro, Brazil, focused the world's attention on sustainability, leading to the Convention on Biological Diversity ("CBD"), which entered into force in 1993. The Convention was the first global agreement to treat biological diversity in a

\textsuperscript{7} Michael Klare's assertion that "[n]o highly industrialized society can survive at present without substantial supplies of oil . . ." has equal or greater force when the subject is energy rather than any single energy source. Klare, \textit{supra} n. 1, at 27.


comprehensive manner, calling for sustainable use of biological and genetic resources. Article 10, entitled “Sustainable Use of Components of Biological Diversity” of the Convention creates the obligation for all nation parties to the agreement to “[i]ntegrate consideration of the conservation and sustainable use of biological resources into national decision-making.” The CBD requires nations signed on to the agreement to create procedures to require environmental impact assessments for proposed projects. The Report of the World Summit on Sustainable Development in Johannesburg, South Africa declared that “[g]ood governance within each country and at the international level is essential for sustainable development.” Because governance is based largely on law, sustainable development raises profound challenges—and opportunities—for the rule of law.

Although the focus of this Article is sustainability from an energy perspective, it is important to note that the concept of “sustainability” is not restricted in application to energy supply only. Sustainability of human civilization and life in general is naturally central to our concern. Today, the possibility that humans could inadvertently alter the natural fluctuations of the climate in dramatic ways seems increasingly real. The United States’ demand for electricity is projected to increase dramatically in coming years. While estimates of the future of energy demand vary, all projections agree that demand will continue to increase. The U.S. supply continues to focus on fossil fuel. For example, the U.S. Department of Energy projections on natural gas consumption in the United States predict an increase of 62 percent by 2020.

The basic notion of sustainability is easily understood: Use it, but don’t use it up. The idea is not new. The concept is embodied in principles as intuitive as the Golden Rule and as evocative as the Native American respect for nature. Leave the campsite as you found it. Use the interest income of the gift of life, but don’t invade the principal. Early writings on the population explosion and destructive technologies brought attention to the issue of sustainability of the planet long before the current crisis.

10. Conv. on Biological Diversity, Article 10. Sustainable Use of Components of Biological Diversity, http://www.cbd.int/convention/articles.shtml?a=cbd-10 (accessed Apr. 14, 2009). Article 10 also includes the following additional obligations: “(b) Adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity; (c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements; (d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and (e) Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources. Id.


13. “[A]ll available information suggests that the worldwide demand for petroleum will rise at a steady rate of approximately 2 percent per year between now and 2020.” Klare, supra n. 1, at 35.


fact, today’s debate about the current threats to sustainability has been around long enough to produce a wide variety of views and debate. In 1994, in *The Ecology of Commerce*, Paul Hawken argued for an ethic of restoration rather than sustainability, finding the concept of sustainability rhetorical. “The dirty secret in environmentalism is that there is no such thing as sustainability. Habitats can endure over millennia, but it’s practically impossible to calculate the sustainability of specific fisheries, tracts of land, and actual forests.”\(^{17}\) Hawken pinpointed a major disjuncture between the typical views of business about the expanding nature of the economy and environmentalists, finding in American business “a deep-seated unwillingness to face the necessary reconstruction of our commercial institutions,”\(^{18}\) in opposition to ecologists’ view “that if business continues its unabated expansion it will destroy the world around it.”\(^{19}\) Ultimately, Hawken viewed restoration as the only realistic concept for change:

> We have also probably already passed the point where present planetary resources can be relied on to support the population of the next forty years. Any viable economic program must turn back the resource clock and devote itself actively to restoring damaged and deteriorating systems—restoration is far more compelling than the algebra of sustainability.\(^{20}\)

Today a wide range of conventions, statutes, and corporate publications pledge sustainability as a goal or a responsibility.\(^{21}\) Political rhetoric alleging or disputing a connection between GHGs, primarily carbon dioxide (“CO\(_2\)”), global warming, and the effects thereof, are being used dramatically by both proponents and opponents alike to further their position.\(^{22}\) Emotions are running high because there are still many unknowns and the consequences for being wrong could be much higher—environmentally on the one hand and financially (or politically) on the other.

The problems that can arise when the principle of sustainability is compromised for other values or needs appear in the visible effects of global climate change. Devastating effects of global climate change are appearing in the news with alarming regularity. “The environmental changes resulting from global warming have devastating effects on the Inuit, indigenous peoples inhabiting the Arctic regions of northern and

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18. *Id.* at 9.
19. *Id.*
20. *Id.* at xv.
western Alaska, northern Canada, Greenland and Chukotka in the eastern Russian Federation.\textsuperscript{23} Affected communities and people harmed by climate change have begun to take legal action.\textsuperscript{24} The Inuit people and the people of the village of Kevalina have sued the United States for the devastating effects they have suffered as a result of climate change. They seek an injunction to require the mandatory GHG emission targets, as well as a commitment to investigate climate change impacts on the Arctic.\textsuperscript{25}

III. THE ENERGY PICTURE AND GLOBAL CLIMATE CHANGE

As a matter of its history and philosophical base, energy has been at the heart of American economic development. The national economy is necessarily interwoven with energy policy. In today's world, however, energy sustainability issues reach beyond traditional economic analysis. Reliable energy is essential to sustaining the economy, maintaining organized and productive markets, and protecting individual survival. Today, sustainability is often linked with the issue of global climate change. Until 2007, the debate about global climate change focused on whether climate change was in actuality the significant issue that Intergovernmental Panel on Climate Change ("IPCC") found it to be,\textsuperscript{26} and whether human activities or natural phenomena such as volcanic eruptions play the primary role in creating the problem. The IPCC expressed "very high confidence that the global average net effect of human activities since 1750 has been one of warming."\textsuperscript{27} Recent reports have quelled debate about whether increases in GHG increase ocean and atmosphere temperatures or whether GHG is contributing to the destruction of the polar ice cap and examples of dramatic harm such as that in the Kilvalina and Inuit cases. Climate change is not the only risk implicated by GHG. Impacts on the environment and human health, national security, and a host of related issues are relevant as well. The IPCC and virtually all policy makers recognize that both natural and anthropogenic causes are resulting in dire effects on the earth's climate.\textsuperscript{28} Thus, the debate has shifted from the significance of the problem and issues of causation to questions regarding what can be done to address the problem.\textsuperscript{29} Opinion among legislators has brought new focus to adaptation techniques.\textsuperscript{30} Model simulations and

\textsuperscript{23} Marguerite E. Middaugh, Student Author, Linking Global Warming to Inuit Human Rights, 8 San Diego Intl. L.J. 179, 184 (2006).
\textsuperscript{25} Middaugh, supra n. 23, at 186; see also Arnold & Porter LLP, Climate Case Chart (2009) (available at http://www.climatecaselchart.com/).
\textsuperscript{27} Id.
\textsuperscript{28} Id.
\textsuperscript{29} In his latest book, Thomas Friedman notes the urgency of moving forward rather than continuing to debate cause and effect. Friedman, supra n. 5, at 116 (noting that the "debate has diverted way too much public discussion from the current reality—which is that not only is the climate changing because of human activities, but there is also mounting evidence that it is changing considerably faster than even the most worried climatologists were predicting just three or four years ago, and it may unfold in an even more unmanageable and disruptive manner than they expected").
\textsuperscript{30} Notes of author of conversations with legislators and legislative aides during meetings of April 17, 2008. See also Intergovernmental Panel on Climate Change, supra n. 26, at 56.
other scientific measures may implement changes in agricultural, settlement patterns, and other activities rather than making fundamental changes in the types of energy sources we utilize. Carbon capture and storage is one adaptation mechanism that has received significant attention. The feasibility of capturing and storing carbon raises legal issues such as questions of ownership and liability from the practice.

Breathing alone (something that all humans must do to remain alive) accounts for over 2.4 billion metric tons of CO$_2$ each year. Of course, the “breathing” component is virtually the same for every person. The “living” component and expectation varies dramatically, however, and it appears that the level of anthropogenic GHG emissions may be directly related to the standard of living. The average American requires the production and emission of more than five and one-half times the GHGs into the atmosphere than what is required to sustain the average “living” world inhabitant. The disproportion is even greater when comparing the United States to undeveloped or developing countries such as non-members of the Organisation for Economic Co-Operation and Development (“OECD”). For example, in 2004, Americans emitted CO$_2$ per capita nearly eight times that of inhabitants of non-OECD countries.

Carbon dioxide creates threats to human health not reflected in the issue of climate change. For example, CO$_2$ concentrations affect human and animal pulmonary

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Carbon dioxide equivalent: The amount of carbon dioxide by weight emitted into the atmosphere that would produce the same estimated radiative forcing as a given weight of another radiatively active gas. Carbon dioxide equivalents are computed by multiplying the weight of the gas being measured (for example, methane) by its estimated global warming potential (which is 21 for methane). “Carbon equivalent units” are defined as carbon dioxide equivalents multiplied by the carbon content of carbon dioxide (i.e., 12/44).

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34. See Organisation for Econ. Co-Operation and Dev., About OECD, http://www.oecd.org/pages/0,3417,en_36734052_36734103_1_1_1_1_1_0,00.html (accessed Apr. 15, 2009) (“OECD brings together the governments of countries committed to democracy and the market economy from around the world to: [s]upport sustainable economic growth, [b]oost employment, raise living standards, [m]aintain financial stability, [a]ssist other countries’ economic development [and] [c]ontribute to growth in world trade.”); Organisation for Econ. Co-Operation and Dev., Members and Partners, http://www.oecd.org/pages/0,3417,en_36734052_36761800_1_1_1_1_1_0,00.html (accessed Apr. 15, 2009) (“The 30 member countries of OECD are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.”).

physiology. "[A] recent medical study indicates a causal link between CO₂ and air pollution mortality." The study demonstrates that increases in atmospheric CO₂ are directly related to increases in surface ozone, carcinogens, and particulate matter, thereby increasing death, asthma, hospitalization, and cancer rates. "The study predicts the United States may experience an additional 1000 air pollution-related deaths and 20 to 30 incidents of cancer for every one degree C[elsius] rise in temperature due to atmospheric CO₂ or an additional 21,000 deaths worldwide." Therefore, it is reasonable to assume that as the world population continues to increase, so too will the number of atmospheric CO₂-related deaths.

All living organisms exchange necessary and vital gases with toxic and waste gases across its cellular membranes.

In humans and animals, gases move across alveolar membranes in the lungs according to their partial pressures from areas of high pressure to low pressure. This constant pressure gradient and movement of gases between the lungs and bloodstream facilitates the exchange of waste CO₂... for essential oxygen (O₂) in every breath.

If atmospheric concentrations of CO₂ were to continue to increase as is suggested by recent reports, significant populations of humans and animals would suffer severe effects, including death in some cases. Whether concentrations will result in acute toxic effects depends on the level of increases of CO₂. Although, death by asphyxiation is unlikely, contemporary scientific data documenting the deleterious health effects of chronic exposure to elevated levels of CO₂ are disquieting.

37. Id. at 26 (citing Mark Z. Jacobson, On the Causal Link between Carbon Dioxide and Air Pollution Mortality 35 Geophysical Research Ltrs. L03809 at 4 (Feb. 2008)).
38. Id.
39. Id. (citing Jacobson, supra n. 37, at 1).
40. Id. at 25.

O₂ diffuses from the alveoli in the lungs and into capillaries of the bloodstream in order to oxygenate the blood which carries O₂ to all parts of the organism. Similarly in the lungs, CO₂ diffuses out of the capillaries and into the alveoli where it is subsequently exhaled to the atmosphere. At sea level, ambient air currently contains approximately 383 parts per million (ppm) CO₂, thus resulting in an atmospheric partial pressure of CO₂ (PACO₂) around 28.7 millimeters of mercury (mm Hg). At sea level a healthy adult has reference values for partial pressure of CO₂ in venous blood (PvCO₂), ranging from 42-50 mm Hg. The higher PvCO₂ enables CO₂ to cross from the bloodstream and into the lower [atmospheric partial pressure of CO₂] in the alveoli of the lungs where it is exhaled by breathing.

Musick, supra n. 36, at 25–26 (footnotes omitted).
41. Id. at 26; Intergovernmental Panel on Climate Change, supra n. 26, at 44 fig. 3.1.

An increase in atmospheric CO₂ by 25 percent to 479 ppm would yield a PACO₂ of 35.9 mm Hg and a concomitant decrease in the difference between the PvCO₂ reference value and PACO₂ by approximately 54 percent. Similarly, a 50 percent increase in atmospheric CO₂ to 575 ppm would yield an PACO₂ of 43.1 mm Hg and would be within the lower range of PvCO₂ reference values. According to Henry's Law, atmospheric CO₂ at this concentration would be sufficient to effectively prevent gaseous diffusion across the alveolar membranes at the lower range PvCO₂ reference values. Fortunately, the human body has many fail-safe systems to ensure that asphyxia, respiratory acidosis, and ultimate death would not immediately ensue, including hyperventilation and the conversion of the excess CO₂ to HCO₃⁻ via carbonic anhydrase and its subsequent excretion through the kidneys.

Musick, supra n. 36, at 26.
The Clean Air Act ("CAA") "criteria pollutants" category presents a separate basis for regulating CO₂. "The CAA requires the establishment of national ambient air quality standards for a particular pollutant that has been added to the 'criteria pollutant' list and the preparation of an 'air quality criteria' document that provides 'the scientific basis for promulgation of air quality standards for the pollutant.'" The Environmental Protection Agency ("EPA") lacked the scientific evidence regarding the health effects of increased atmospheric CO₂ concentrations at the time the CAA was promulgated. "However, the CAA does allow for revisions of the 'criteria pollutant' list at the discretion of the EPA Administrator 'which may reasonably be anticipated to endanger public health or welfare.'" The legislative history of the Act suggests that Congress expected the EPA to greatly expand the list of criteria pollutants rather quickly. One commentator argues that the EPA failed to live up to that expectation because of concern over its ability to carry out the mandate of the Act for the six pollutants for which listing was mandatory.

Like many issues surrounding global climate change, the current state of energy supply and demand is subject to debate. Indeed, some commentators suggest that the debate may be moot because the planet has passed the point of no return. Some points of agreement do exist. Approximately 55 percent of global climate change is attributable to CO₂ emissions, in large part resulting from coal and petroleum use. Absent a dramatic shift in energy use or energy resources, increased CO₂ emissions are inevitable in an economy built on expanding growth. The EPA recognizes the link between climate change and energy use, particularly with regard to transportation and power plants. The Energy Information Administration ("EIA") estimates that since 2003, prices for energy for all sectors of the economy have increased approximately 30 percent.

As the world's largest consumer of energy, U.S. policy is of crucial importance in affecting the environment and in serving as a model for change for other nations. China has recently surpassed the United States as the leading generator of GHG in the

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42. Id. at 27 (citing Lead Indus. Assn., Inc. v. EPA, 647 F.2d 1130, 1136–1137 (D.C. Cir. 1980)).
43. Id. (citing Lead Indus. Assn., 647 F.2d at 1137 (quoting 42 U.S.C. § 7408(a)(2) (2000))).
44. Id. at 27–28 (quoting 42 U.S.C. § 7408(a)(1)(A) (2000)).
47. "[A]ll available information suggests that the worldwide demand for petroleum will rise at a steady rate of approximately 2 percent per year between now and 2020." Klare, supra n. 1, at 35.
electric power sector. However, the United States continues to produce the highest GHG on a per capita basis in absolute terms, although China is expected to claim that title as well within the next few years. The United States, for now, is also the largest importer and the largest consumer of energy.

Scientists, political leaders, and citizens have reached a consensus on the need to change the way we manufacture and consume energy. This consensus on the significance of the issue of global climate change and the need to act has not developed, however, into a consensus on the way to address this need in the energy policy of the government. Some think we should focus on renewable energy sources; however, others believe we should focus on the improving efficiency and cleanliness of our existing technologies. It seems unlikely that any single idea, technology, or energy source will emerge as the panacea to solve existing and future energy needs and cure the problem of global climate change.

The world is at a crossroad where political will, ecological concern, public outcry, and technical ability have all converged to force a serious examination of the future of energy. Even without considering global climate change, strong economic reasons exist for reducing fossil fuel use as much as possible and developing renewable energy sources. Renewable energy sources are not subject to rising fossil fuel prices because they can be provided on a smaller scale basis, allowing a less regional approach to electricity supply and making our overall system less vulnerable to terrorism. The operation of power plants based on renewable energy resources (solar, wind, hydro, geothermal) produce electric energy without combustion, and, thus, without pollutants or GHGs. Renewable technologies “are emissions-free, renewable energy.” To date, in marked contrast to implicit optimism about the ability of science to address the dangers of storage of hazardous nuclear waste, leaders have expressed a pessimistic view of the power of science to solve the storage problems associated with solar and wind power. Although promising, the development of large-scale production of energy from the inexhaustible sources of sun and wind and renewable technologies are more than ten years away.

The symbiotic nature of sustainability in the political sphere emphasizes the dilemma of sustainability. From an individual perspective, the “sustainability” of elected government officials depends on providing energy and getting the message of a candidate to the public. In today’s political landscape, any realistic hope for election depends on significant contributions to each official’s campaign. Moreover, stability of governments is crucial to the ability to maintain stable energy sources and protect the public from the risks created by the effects of energy, such as long-term storage of nuclear waste. From the perspective of managed risks associated with different power sources, such as nuclear power, depends on the continued existence of a stable government with the monetary resources sufficient to manage energy threats and the

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52. See e.g. Stansberry & Reimbold, supra n. 14, at 57 (asserting that America must find new and environmentally friendly technologies).
53. Ferrey, supra n. 2, at 134.
long-term storage needs of radioactive waste.\textsuperscript{55} Thus, political power in government is a vital link to managing energy and energy is necessary for maintaining political power.

Whether the sustainability of the planet in the sense of addressing global climate change concerns has captured the attention of government to a sufficient degree to make renewable resources a priority remains an open question. Congressional leaders and the President have explicitly recognized the issue of global climate change as an issue of immediate importance. On the other hand, it is unclear whether the issue of global climate change, as a stand-alone issue, has gained the momentum necessary to result in significant policy change. While the United States has acknowledged global climate change as a serious problem for years,\textsuperscript{56} it has delayed substantive changes and has rejected the international community’s call for joint commitment in the Kyoto Protocol.\textsuperscript{57} The actions taken by the United States in both the United Nations Framework Convention on Climate Change and the United States’ position on the Kyoto Protocol suggest that the United States recognizes the effects of anthropogenic emissions on global climate change but does not regard global climate change and its effects as significant to its interests or of immediate concern at the level of issues such as the economy or national security.\textsuperscript{58} The high stakes involved in today’s climate change regulation mean that government action is necessary to change corporate and individual action. The risk of self-dealing is real, whether the decision making power resides in private industry or in the government.\textsuperscript{59} Unregulated production and use of fossil fuel will inevitably increase GHG emissions as a global matter. The gap between energy use in developed and developing countries will narrow as markets in Africa, India, and Asia gain the standard of living that has been available in the U.S. for generations. The Department of Energy estimates that the world-marketed energy consumption will increase by 50 percent during the years 2005 to 2030.\textsuperscript{60}

Energy consumption by member nations that are parties to the OECD is predicted to increase at a slower rate than the recent past.\textsuperscript{61} Estimates are that non-OECD countries will experience significant increases in energy consumption,\textsuperscript{62} however, obviously heightening concerns about climate change. Without implementing GHG emission restrictions, the fossil fuel-based technologies in the developing world will significantly outpace the current levels of GHG emissions, even if the developed world succeeded in implementing restrictions such as those incorporated in the Kyoto Protocol.

\textsuperscript{56} See infra the discussion of the United Nations Framework Convention on Climate Change.
\textsuperscript{57} Continuing Dumping and Subsidy Offset Act, 19 U.S.C. § 1675c (repealed 2006) (also known as the “Byrd Amendment”).
\textsuperscript{59} Associated Press, Government Officials Probed About Illicit Sex, Gifts, http://www.foxnews.com/story/0,2933,420541,00.html (Sept. 10, 2008) (reporting that 13 U.S. Department of Interior employees involved in distribution of royalties for oil produced on federal lands that are alleged to have engaged in inappropriate behavior with energy company employees).
\textsuperscript{61} Id.
\textsuperscript{62} Id.
Even if OECD countries reach their GHG emissions reduction goals in the year 2030 (a very optimistic hypothetical), the non-OECD may essentially nullify the progress.\footnote{Id.}

In his State of the Union speech of January 2006, President Bush famously diagnosed the addiction of the American people to oil as a problem.\footnote{Elisabeth Bumiller, Bush’s Goals on Energy Quickly Find Obstacles, N.Y. Times A1 (Feb. 2, 2006).} The administration’s energy policy since the 2006 State of the Union speech has projected increased respect and regard for renewable energy sources. The link between national security and energy policy has become apparent in recent years. The war in Iraq has intensified the public interest in domestic production of fossil fuel, and the Bush administration has noted the danger of dependency on foreign oil.

[S]ince we import about 60 percent of the crude oil we use, it causes our price to go up, as well, which means the economy becomes less competitive. And then, of course, there’s the national security concern for oil. Why? Well, we get oil from some countries who don’t particularly care for us. They don’t like what we stand for.\footnote{The White House, President Bush Discusses Energy at Renewable Energy Conference, http://georgewbush-whitehouse.archives.gov/news/releases/2006/10/20061012-4.html (Oct. 12, 2006).}

The recent governmental response to concerns about purchasing oil from foreign or hostile sources has focused on a reconsideration of exploration of pristine areas protected by legislation for decades.\footnote{See Carl Hulse, Democrats Reluctantly Embrace Offshore Drilling, but Link Bill to Clean Energy, N.Y. Times A17 (Sep. 17, 2008).} President Bush has praised alternative resources and promised development of alternatives in numerous presentations.\footnote{See e.g. The White House, President Commends Congress for Passage of Outer Continental Shelf Legislation, http://georgewbush-whitehouse.archives.gov/news/releases/2006/12/20061209-2.html (Dec. 9, 2006) (stating that “Developing these reliable domestic resources in an environmentally sound manner will help address high energy prices, strengthen our energy security and protect manufacturing jobs.”).} Government incentives for energy production continue to provide greater support for fossil fuel production than for alternative fuels, however.

Personal choice plays an undeniable role in energy consumption.\footnote{John C. Dembach, Harnessing Individual Behavior to Address Climate Change: Options for Congress, 26 Va. Envtl. L.J. 107 (2008).} Nevertheless, there are limits to what individual choice can accomplish given the market choices and market limitations. Recognition of the power of the collective also requires recognition of the difficulty of marshalling collective action in a market that presents limited choices. “[C]onsumers can ‘vote’ with their pocketbooks and switch to power products consisting of non-polluting renewable energy sources.”\footnote{Power Scorecard, Air Quality Issues of Electricity Production: Ozone (Smog) and Fine Particulates, http://www.powerscorecard.org/issue_detail.cfm?issue_id=3 (modified Aug. 2004).}

While power plants and transportation account for the major portion of energy usage, changes in life styles of individual consumers obviously influence the mix of energy demand. Consumers can reject high-consumption vehicles. They can make small changes in the patterns of living such as hanging out wash to dry and living close to their work places. Like the perennial question of “nature versus nurture” in human development, the debate regarding whether consumer choice drives the market or market availability controls consumer choice is a debate that will not be solved in the foreseeable future. Regulation and incentives can
provide a powerful nudge to stimulate individual action. Indeed, government policy choices have a far greater and more immediate impact than individual choice in a limited market. When fuel-efficient cars are not readily available on the market, the move toward fuel efficiency in transportation is delayed if not defeated.

At times, the complexity of the sustainability issue appears to be dwarfed by the complexity of devising a remedy to the situation. Untying this Gordian knot of individual action versus market stimulus is not required to address the problem. The interaction of markets and individuals is essentially an academic exercise of blame and rationalization. No matter which cause predominates the remedy is the same: government action through regulation and incentives. Whether the American consumer or government policy is seen as the causal force behind the problem of GHG, global climate change demands action. Issues of supply are also subject to debate and distrust. There is significant disagreement about oil and natural gas reserves. “In 1956, geophysicist Dr. M. King Hubbert proposed that oil production follows a bell-shaped curve; thus, a new discovery brought on an exponential increase in production. However, upon reaching the point at which half of the reserves have been produced, the production declines precipitously; this is the Peak Oil theory.” Whether or not fossil fuel production has reached or passed its peak, it is clear that oil supplies are diminishing at a significant pace, and depletion of fossil fuel reserves as we now know them is inevitable. Fossil fuels are, after all, a non-renewable resource, eventually requiring alternative strategies. “Even if we had ample oil, in the long run we’d need to switch to renewables, anyway.” As reserves are depleted, the energy required for exploration, production and transportation of fossil fuels also increases. “Price distortions include the unequal subsidies for research and development between fossil fuels and renewable energy, the lower tax burden for conventional power generators, and the failure of the market to take into account the environmental costs of fossil fuels.” On a related topic, Professor Steven Ferry detailed incentives and disincentives for major energy consumers to use renewable energy generated on-site, concluding that industrial users could improve their profits by generating renewable energy rather than purchasing it from utility companies. “The economics, reliability, and predictability of on-site renewable energy can be compelling.” Nevertheless, on-site energy generation for large-scale operations has not developed in this country because the regulator structure discourages the move. “The impediments are regulatory, rather than technical. The problem manifests in disincentives such as high stand-by power rates, interconnection difficulties, and exit fees.”

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71. Stansberry & Reimbold, supra n. 14, at 19.
75. Id.
IV. GOVERNMENTAL POLICY INITIATIVES IMPACTING ENERGY

Clearly, government policy has emphatic impacts on the economy and on the environment. News reports of the dramatic effects of global climate change and government responses to these effects appear daily. Governments create and incentivize markets by tax policy, research grants, low interest loans, and other market mechanisms.

Scrutiny of particular incentives raises questions regarding the effectiveness of individual programs. To understand the functioning of the incentives it is necessary to consider the entire structure of incentives available to investors and regulators. The fact that the government provides incentives—even sizable incentives—will not necessarily provide stimulus if other competing incentives encourage contrary action. Allocating billions in subsidies for renewable energy may not attract the necessary investors and inventors when their efforts could be more successful in other, less risky enterprises. Moreover, the patchwork of legislation and regulation at various levels of government calls into question the effectiveness of multiple authorities. Certainly all levels of government need to be involved in the push toward renewable energy use, but coordination between governmental entities is essential.

Even well-intentioned regulations sometimes fail to incentivize the desired conduct as a result of counter-incentives. For example, provisions that cap the amount of the incentive payment for production in excess of a specified amount make it difficult for a business to produce at a competitive rate in the market. Similarly, complexity of regulation is a brake on the conduct the government seeks to incentivize. Making it hard to hit the exact mark of production to reap the best tax incentive may discourage investment in less than secure ventures. Conditioning eligibility for tax credits or other incentives on job-creation requirements or other requirements reduces the likelihood of investment in alternative fuels. No common system of GHG regulation currently exists, and no accepted method of valuing the impacts of GHG emissions has been developed. This does not mean, of course, that incentives are not at work in the GHG market. The Clean Air Act 1990 Amendments included incentives intended to stimulate conservation and development of renewable energy sources. However, subsidies to traditional energy sources, including nuclear plants, far outstrip such incentives. The interrelation

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76. Daily news reports reveal the importance of government decision making to the energy landscape and the environmental impacts that accompany such decision making. For example, the current debate about offshore drilling reflects an on-going policy debate that is decades old. E.g. Hulse, supra n. 66 (noting that “[f]or decades, opposition to new offshore oil drilling has been a core principle of Congressional Democrats, ranking in the party pantheon somewhere just below protecting Social Security and increasing the minimum wage”).


of “sustainability” in the sense of “political sustainability” with the general topic of energy sustainability should be clear. Energy use underlies our modern civilization, disruption of energy can disrupt government as well as industry and the connections of power relate to political power as well as energy. Sustainability of political power is intimately connected to the power structure and a politically stable government is necessary to foster the organization and policy to support a sophisticated energy structure. Despite the strengths of a free market, coordinated effort is not an attribute of private enterprise. Indeed, leaving the issue of energy to the private sector may be no more realistic than it would have been to leave the Manhattan project to private markets. Under an umbrella of government incentives, private markets can flourish and private enterprise should have a broad range of opportunity for inventive strategies. For example, in Corporate Governance and Rational Energy Choices, Professor Steven Ferrey demonstrates the potential for cogeneration technologies operated by private businesses as a part of a rational energy plan for business. Private investors and other private entities have taken up the challenge to tackle the global climate change challenge. The T. Boone Pickens Plan presents a remarkable commitment to wind energy. Wal-Mart has made noteworthy strides in reducing that company’s carbon footprint while enhancing its profitability. Many more such plans seem to be on the horizon.

Although arguments against government involvement in energy markets continue to influence energy policy, subsidies and incentives have always been a prominent feature in the energy picture in the U.S., as well as in every other industrialized nation. Currently, “[h]alf of the world’s population enjoys fuel subsidies.” Whatever the state of a peak in oil production, recognition of “excessive” profits of the oil companies may be at a peak in today’s political world. Many would say that oil companies are not in need of subsidies given the record profits of the last few years. For example, ExxonMobil reported a record profit of $40.6 billion in 2007. Collectively, the “big five” oil companies (British Petroleum, Chevron, Conoco Phillips, ExxonMobil, and Royal Dutch Shell) posted a staggering $123 billion in profits in 2007. It is remarkable that the “big five” oil companies made campaign contributions to U.S. Senators in favor of maintaining the oil subsidies nearly three times that of those opposed. Furthermore, “big five” payments to oil lobbyists are more than three times the total campaign contributions to the Senators. Total contributions and payments by the “big five” oil companies approached $50 million in 2007. Significant support now exists for the repeal of oil-related subsidies as evidenced by H.R. 6 as passed by the U.S. House of

79. Ferrey, supra n. 74.
83. Id.
84. Id.
86. Id.
Representatives on January 18, 2007. However, by the time the H.R. 6 was amended by the Senate and enacted into law, the resulting Energy Independence and Security Act of 2007 bore little resemblance to the demand for curtailment of subsidies as recommended by the lower house.

Subsidies represent the important benefit in the context of developing countries in that subsidies can "help propel industrialization and shield poorer segments of the population from high global oil prices." Nevertheless, many economists see those supports as primarily benefiting well-off consumers and delaying the development of more efficient and renewable energy sources. Others argue that repealing aid to the oil industry would create more problems than it solves in a time when the energy resources of the U.S. are stretched beyond ordinary demands.

The federal government has not moved to regulate GHG, however, even after the U.S. Supreme Court issued an order in Massachusetts v. EPA, requiring that the EPA render a decision of harm or no harm. Federal climate legislation is needed to integrate state and federal authority to additional standards and technology-based limitations to address global climate change. The Supreme Court's decision in Massachusetts v. EPA seemed to make such legislation imminent. In the vacuum left by federal inaction on climate change, subunits of government such as state, local, and regional governments have responded with programs aimed at reducing GHG emissions. The Regional Greenhouse Gas Initiative ("RGGI") is an organization of seven northeastern states agreeing to work together to reduce GHG emissions. In 2006, California enacted the Global Warming Solutions Act. Numerous state statutes now provide incentives for renewable fuels and vehicles that use renewable fuels. Local governments are also seeking to address global climate change by a variety of mechanisms. For example, mayors from 884 cities have signed the United States Conference of Mayors "Climate Protection Agreement," pledging to take steps to reduce the emissions of greenhouse gases. The agreement was initiated by Mayor Greg Nickels of Seattle, Washington on

87. H.R. 6, 110th Cong. (Jan. 18, 2007).
90. Id.
95. See e.g. West Coast Global Warming Initiative (announced Sept. 2003, superseded by Western Climate Initiative); United States Mayors Climate Protection Agreement (initiated Feb. 16, 2005, continually signed); Southwest Climate Change Initiative (agreed to and entered into force Feb. 28, 2006); California-U.K. Global Warming Pact (agreed to July 31, 2006); Western Climate Initiative (announced Feb. 24, 2007, entered into force Feb. 26, 2007).
February 16, 2005, the day the Kyoto Protocol took effect in the 141 nations that ratified it. The mayors who have signed this non-binding agreement pledge that their cities will meet or exceed the reduction plan of Kyoto by 2012. California Governor Arnold Schwarzenegger has taken a strong stance on the need to combat global climate change: "If ninety-eight doctors say my son is ill and needs medication and two say "No, he doesn't, he is fine," I will go with the ninety-eight. It's common sense—the same with global warming. We go with the majority, the large majority."  

Although climate change is a global phenomenon, the policies of individual nations play a dramatic role in addressing the issue. Additionally, all levels of government have been involved in global climate change issues. One way governments support environmental values is by facilitating entry of environmental technology into the marketplace. Indeed, technology has been the Bush Administration's focus in recent years. Nevertheless, many countries have outpaced the U.S. in developing renewable energy resources and facilitating consumer acquisition of those resources. Some countries have supplemented the energy policy with tax incentives and other measures such as grants, preferred grid access, low-interest loans, and research and development funding. Government incentives have been the catalyst for many countries that have reduced their dependence on fossil fuels. 

A sampling of government policy initiatives can give insights into the ability of governments to influence consumer choices and to impact energy use. While the U.S. has focused its comments and policy initiatives on technological advancements, other countries have moved toward sustainable energy by encouraging production and use of renewable energy sources. 

The government-created incentives that stimulated the use of biomass fuels in Brazil provide a useful example of the use of incentives. Today, even though the United States has outpaced Brazil as the largest producer of ethanol, the majority of cars on the road in Brazil run on a fuel containing 85 percent ethanol. Recent estimates suggest that nearly 80 percent of the cars in Brazil run on ethanol. GM and other car manufacturers that provide vehicles for the U.S. market make the cars used in Brazil. Beginning in 

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99. Friedman, supra n. 5, at 138.  
100. Involvement of all levels of government may not be a good thing in all respects. Having more than one authority involved in regulating GHG inevitably complicates the picture for businesses. In seeking to comply with regulations from a variety of governmental entities, businesses face differing mandates and differing forms. "The overlap of state, federal and local authority over environmental, economic and regulatory matters affecting electric power complicates this equation." Ferrey, supra n. 74, at 135–36.  
103. E.g. Thomas L. Friedman, Flush with Energy, N.Y. Times (Aug. 9, 2008) (available at http://www.nytimes.com/2008/08/10/opinion/10friedmanl.html) (noting that roughly 50 percent of Danes commute to work by biking, leading to "less traffic, less pollution and less obesity" and the sustained, focused and systematic way that Denmark gained energy independence).
1975, in the wake of an international petroleum industry crisis, Brazil required all gasoline to contain 25 percent alcohol.\textsuperscript{104} It formed the Alcohol Program—Pró Álcool. The program included incentives to reduce Brazil’s dependence on foreign petroleum and to encourage renewable fuels. The Brazilian government guaranteed a market for biofuels by mandating that all gasoline be blended with renewable fuel.\textsuperscript{105} Brazil has incorporated renewable energy in transportation and other energy consumption. By 2002, it got “sixty percent of its primary energy requirements from renewable energy sources, thirty-seven percent from hydro, and 23 percent from biomass under programs sponsored by the government.”\textsuperscript{106} The national government provided credits and loans to stimulate the expansion of sugarcane cultivation and processing capacity, even when market conditions did not.\textsuperscript{107} The use of ethanol saved approximately $40 billion in oil imports between 1975 and 1998.\textsuperscript{108} Brazil also provided tax credits to consumers who purchased cars fueled by ethanol.\textsuperscript{109} The Brazilian government stimulated the expansion of sugarcane cultivation and processing capacity with credits and loans.\textsuperscript{110} Brazil continued to enhance ethanol markets despite stabilization in the international petroleum market in the 1980s and 1990s. After stopping direct subsidies in the 1990s, the government continues to “foster the public/private partnerships required to make ethanol competitive at the pump.”\textsuperscript{111} Today Brazil is the world’s second largest producer and leading exporter of ethanol.\textsuperscript{112} Brazilian consumers who purchase ethanol-fueled vehicles benefit by a tax savings in income tax and road taxes.\textsuperscript{113} Brazilian law requires that all gasoline contain a minimum of 25 percent alcohol (although alcohol actually accounts for 40 percent of all vehicle fuel).\textsuperscript{114}

This is not to say that Brazil has found the “magic bullet” to energy conservation and GHG. In fact, strong concerns have emerged about the effect of the loss of Brazil’s rainforest to the growing need for sugar cane to supply Brazil’s ethanol industry. Significant concerns have arisen about the effects of biofuels on food prices. The production of biofuels may drive up food prices and cause environmental harm, including deforestation.\textsuperscript{115} Significant concerns also exist concerning the possibility that

\begin{itemize}
  \item \textsuperscript{106} Ottinger & Williams, supra n. 101, at 361.
  \item \textsuperscript{107} \textit{Id.}
  \item \textsuperscript{108} \textit{Id.}
  \item \textsuperscript{109} \textit{Id.}
  \item \textsuperscript{110} Mark S. Langevin, \textit{supra} n. 105.
  \item \textsuperscript{111} \textit{Id.}
  \item \textsuperscript{113} Ottinger & Williams, \textit{supra} n. 101, at 361.
  \item \textsuperscript{114} David Morris, \textit{The Future of Ethanol}, Star Tribune (Minneapolis, Minn.) (April 17, 2005) (available at http://www.commondreams.org/views05/0417-23.htm).
  \item \textsuperscript{115} Law 360, \textit{EU Committee Votes To Scale Back On Biofuels} (Sept. 11, 2008) (reporting that in September 2008, the European Union Parliament’s industry committee voted 50-2 to recommend to the EU an amendment to a draft directive on renewable energies to scale back plans to expand the use of biofuels).  
\end{itemize}
increases in U.S. production of ethanol will cause an increase in the size of the dead zone in the Gulf of Mexico. Carbon sequestration is lost along with other environmental values when forests are destroyed. Thus, rather than illustrating the cure for the GHG problem, Brazil’s ethanol incentives stand as an example of the power of government incentives to motivate markets.

Turkey provides another example of the success of incentives at the individual level. It has become a leader in the use of solar collectors for domestic hot water systems, facilitating the installation of over 30,000 solar roofing panels in Turkish homes since the 1980s. Turkey’s Forest Authority showed significant results without large investments. Turkey launched a pilot program to encourage three villages in forest regions to switch from wood-burning water heating systems to solar systems. The government provided residents with interest-free credit of up to $900.00 to install solar-operated water heating systems. The Forest Authority extended the program to cover 15 villages and plans to spread the program to all 588 villages in Turkey’s Bursa forest region. Similarly, Japan has successfully used government subsidies to create a market for renewable energy. Since 1994, Japan has spent several billion yen to subsidize residential use of photovoltaic (“PV”) systems in Japanese homes. Demand for PV systems has increased dramatically in Japan. The solar manufacturing industry in Japan is now the largest in the world, and there are over 70,000 PV systems in Japanese homes. Now that the price of PV systems on the Japanese market has fallen nearly 75 percent, Japan is considering discontinuing the use of market incentives on this product and expects half of all new homes built by 2010 will include PV systems.

V. COMPARATIVE INCENTIVES AND A MULTI-STRATEGY APPROACH

An approach to global climate change limited to controlling the rates of GHG is likely to prove unworkable and ineffective. The need to transition to renewable energy sources is clear. A crucial first step in transition to renewable energy use is identification and comparison of the costs of the possible energy sources and the costs

122. Id.
123. Id. at 6.
associated with each. However, how that transition will be effectuated is open to question. Developing the metric for comparing energy choices is complicated by points of uncertainty relating to supply and legal rights as well as the science of carbon production and technologies for harnessing power. For example, the question of whether the abundance of natural gas is at a level to allow it to be tapped as a primary source of energy is a continuing point of debate. Just as with oil, some experts believe that natural gas production is at its peak in the U.S. Price increases for natural gas also play into the picture of whether it can provide an alternative to oil. Some scientists assert that natural gas is more abundant than oil. The most recent estimates for proved reserves in the U.S. are approximately 211 trillion cubic feet. This is an increase of three percent from 2005.

Relevant factors that must be considered in the transition to non-carbon sources of energy include future availability of fuel sources, costs associated with each fuel source, and the environmental impact of each source. The cost of transportation and the relative difficulty of setting up the infrastructure needed for transportation are part of the costs that can be difficult to quantify as a planning matter. Consideration of natural gas and nuclear energy as fuel for electricity generation and biofuels and natural gas for transportation should include consideration of the need to reduce GHG and other harmful emissions. Although every burden can be expressed as a cost (including time), the difficulties involved as a practical matter are not necessarily fully captured in references to monetary costs. For example, the time and cost involved in constructing and maintaining pipelines to transport natural gas represent years or even decades of intense work. The recent focus on the Alaska pipeline for natural gas has revealed a good example. The costs and time involved in constructing other transportation infrastructure can equal the natural gas transportation phenomenon, and the complexity is increased by the regional scope of the electricity grid. For example, the proposed Alaska pipeline would stretch "more than 1,700 miles" and "deliver natural gas from the North Slope of Alaska to the lower 48 states and be the largest private-sector infrastructure project on the continent." Infrastructure commitments on this level obviously involve an element of risk and even a gamble. Technology and infrastructure issues abound in the challenge of converting renewable power to the grid. Renewable energy looks like the long-term solution from both a supply and environmental standpoint; however, it is not the short-term solution. Consideration of the use of available fuel sources during the transition to renewable fuels must apply a


126. Id.

127. See Serge F. Kovaleski and Mike McIntire, Palin's Pipeline Is Years from Being a Reality, N. Y. Times A1 (Sept. 11, 2008).

128. Id. (noting that "The pipeline exists only on paper. The first section has yet to be laid, federal approvals are years away and the pipeline will not be completed for at least a decade. . . . [T]he pipeline might never be built, and under a worst-case scenario, the state could lose up to $500 million it committed to defray regulatory and other costs.").
metric of the factors noted above to the usual suspects of coal, natural gas, and nuclear fuel, in addition to encouraging a move to solar and wind energy.

A. Inexhaustible Resources

Currently, renewable energy resources provide a fraction of reliable base-load electricity needs. Commitment to the essentially inexhaustible sources of wind power, solar power, geothermal power, and wave technology has increased significantly within just the past few years. Private industry has accounted for a significant portion of the research and development in this area. Total electricity generated by wind power in the United States is currently at 16,904 megawatts. The United States now ranks second only behind Germany in wind power. The Energy Policy Act of 2005 provides subsidies for both traditional and renewable energy sources but at vastly different rates. For example, Congress appropriated $4.8 billion for coal technologies and $2.5 billion for fossil fuel conservation efforts as well as $1.25 billion for a new Generation IV nuclear reactor. Renewable energy was allocated $3.5 billion in subsidies out of the bill’s $14.5 billion total.

The disparity in funding was even greater in the past. The U.S. Department of Energy estimated that in 1999 the federal government gave $2.3 billion in tax credits and subsidies for conventional fuels whereas renewable resources received only $15 million in such incentives. For example, in the 2007 budget, President Bush proposed $44 million for wind energy research and $150 million for developing solar energy. While government incentives for fossil fuel, coal, and nuclear energy continue to outpace those for clean energy sources in the U.S., additional funding is available for research and development of renewable energy sources. Obviously national and international commitments by private industry and government are required to mobilize the vision of renewable and clean energy. The minute-by-minute availability of renewable energy, such as sun and wind, depends on external factors beyond human control. Nevertheless, infrastructure development could flip the current default of energy, allowing sun power and wind power when they are available and a backup from power plants using extracted resources when these inexhaustible power resources are not available. Moreover, research is currently underway to harness solar power after sunset. For the near term and perhaps over a decade, reliable conventional power generation will be needed to supplement renewable energy sources such as wind and sun. Reliable renewable energy technologies harnessing wind and solar energy are available today to supply electric

132. Sherman, supra n. 73, at 234–38.
133. Id. at 229.
power that do not contribute significantly to global warming. "On choice of technology, the good news is that a variety of proven and reliable renewable energy technologies are available today to supply electric power that do not contribute significantly to global warming." 137

Unlike in-place and extracted resources, which are limited to a particular locale and, thus, are subject to terrific costs of identifying, extracting, and transporting the resources, renewable resources are readily available. "As indigenous resources, [renewable energy sources] encourage both local control and economic growth." 138 The sun shines on all, making extracted resources necessary only as a backup in all locales. With a serious commitment to solar and wind power generation, nearly all nations could achieve greater energy self-determination. Such local control of energy may seem fanciful until one compares this concept with the costs of continued commitment to a course of extractive resources. New nuclear power plants, coal-fired plants, and the regasification facilities and tankers for liquidified natural gas also present significant capital commitments. "For all nations, diversification of generating technologies is a cornerstone of sound energy policy, national energy security, and policy regarding global warming." 139

B. Coal

Coal is the dominant resource for generation of electricity in the world today. While coal reserves are found on every continent and in over 70 countries, the biggest reserves are in the U.S., Russia, China and India, 140 with the United States holding the largest reserves. 141 With one quarter of the earth's coal located within its borders, the United States is the Saudi Arabia of coal. 142 Moreover, the energy in U.S. coal reserves exceeds the amount of energy found in the oil reserves of the entire world. 143 The dominance of coal as the major source of electricity seems inevitable in the short term given its abundance in the U.S. It is by far the cheapest form of energy from a profitability standpoint (excluding environmental costs), and it is likely that its dominance will continue for the foreseeable future. Indeed, coal is the reason why the United States has some of the lowest electricity rates of any free-market economy. 144

This level of coal reserves means that at current demand levels coal would last the world over 130 years. 145 Because of the abundance of coal reserves and the extremely low financial cost of using it to produce electricity, the burden of convincing the energy consumers in the United States, much less the world, that more costly and less abundant

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137. Ferrey, supra n. 2, at 133.
138. Id. at 143.
139. Id. at 160.
141. Id.
143. Id.
145. World Coal Institute, supra n. 140.
energy source should be used presents a challenge. Just as coal plays a dominant role in
energy security in the U.S., it also plays a major role in the global climate change issue.
"About forty percent of U.S. carbon emissions contributing to climate change are
attributed to coal-fired power generation. This percentage can be reduced by focusing on
how we produce and use energy, particularly in the corporate sector."\textsuperscript{146} Attempts to
conform coal usage to address the global climate change issue to date have been largely
futile. Even assuming the quest for "clean coal" is ultimately successful, a
comprehensive energy program will need to incorporate solar and wind power to
supplement coal powered plants.

C. Natural Gas

Natural gas lowers GHG and other harmful emissions. It presents approximately
70 percent lower GHG emissions than standard coal-fired power plants of the same
power output and up to 50 percent lower emissions than even the cleanest coal plants.\textsuperscript{147}
Natural gas power plants utilize combined cycle technology where combustion of natural
gas is simultaneously used to generate electricity, providing more efficient energy than
coal and other power plants. In the multiple cycle production process, natural gas is
burned and its exhaust is used to turn a turbine and generate electricity. The electricity is
generated by two different turbines using two different methods from the same source of
energy. The heat in this exhaust gas is captured and used to make steam, turning another
turbine to generate additional electricity. These combined cycle plants present
significant energy efficiencies.\textsuperscript{148}

Natural gas can be integrated with renewable resource technology. For example,
California has recently permitted the city of Victorville to construct two hybrid power
plants.\textsuperscript{149} These plants will generate 563 megawatts of electricity, exploiting natural gas
combined cycle turbines and solar energy.\textsuperscript{150} This is one technique for using natural gas
as a transition to renewable resources, but it is far from costless and development of this
infrastructure will require political will as well as money. The combination of natural
gas and renewable resources produces lower levels of pollution and, thus, buys time to
develop and implement the technology necessary for increased use of renewable energy.
This step carries its own significant costs but may also buy time for solidification of the
power interests behind this new and improved form of fossil fuel. This is not necessarily
bad unless the predicted danger of global climate change turns out to be as dire as some
scientists suggest. The metric for considering and comparing these relative costs without
giving disproportionate weight to choices that would continue to the existing power

\textsuperscript{146} Ferrey, supra n. 24, at 451.
\textsuperscript{148} Dept. of Energy, Natural Gas, http://www.eia.doe.gov/oiaf/archive/ieo00/nat_gas.html (accessed May
13, 2009).
\textsuperscript{149} Cal. Energy Commn., Victorville 2 Hybrid Power Project Power Plant Licensing Case,
\textsuperscript{150} Victorville 2 Hybrid Power Project to Undergo Licensing Review (April 14, 2007) (available at http://
structure. For example, in the case of natural gas, issues of uncertainty abound in relation to the Alaska natural gas pipeline because of the opposition of major oil companies to the project. The rational self-interest of the oil companies may point toward fully developing the oil reserves in the area rather than switching focus to untapped natural gas reserves. Such opposition has impact on the ability of the nation’s energy plan to switch to natural gas because those companies control Alaska’s untapped gas reserves.\textsuperscript{151}

Natural gas power plants can lower GHG emissions significantly compared with standard coal fired power plants of the same power output.\textsuperscript{152} Natural gas is also a more efficient fuel. Coal power plants only convert about 33 percent of the potential energy in coal into electricity. By comparison, natural gas power plants convert up to 60 percent of the potential energy in natural gas into electricity. More technology is available for converting natural gas into energy than for any other fuel. The extraction process of natural gas is more environmentally friendly than coal. A natural gas well will often take up less than a half acre of land and, once in place, has far fewer environmental effects than coal mining. Coal mining often requires strip mining thousands of acres and has a lingering environmental impact. Natural gas can be transported via pipeline, allowing for many small plants to be built. This creates greater efficiency in responding to fluctuating and localized power needs, less energy lost due to transmitting power over long distances, and a more reliable power grid.

As global energy demand grows, the need for multiple sources of energy becomes crucial. However, natural gas is abundant enough to gain a larger market share than it currently has in the U.S. energy supply. Natural gas appears to be a viable candidate as a transition to renewable energy. Natural gas currently supplies 20 percent of electricity. It heats 57 percent of households. It supplies more than 90 percent of the new electricity capacity constructed in the last five years,\textsuperscript{153} and 900 of the next 1000 power plants to be built are going to be natural gas.\textsuperscript{154} Natural gas also supplies the raw materials for many chemicals, fertilizers, plastics, and hydrogen for fuel cells.

\textbf{D. Nuclear Energy}

The most significant movement toward a new fuel source is actually toward an alternative fuel of the past: nuclear. The emphasis on development of nuclear power in recent legislation shows that nuclear power is a priority for the federal government. The 2005 Energy Policy Act, the most recent comprehensive energy policy act, included expansion of funding and incentives for nuclear power, including loan incentives, production tax credits, and risk insurance for builders in the nuclear industry.\textsuperscript{155} Nuclear

\begin{footnotes}
\item[151] See Kovaleski & McIntire, \textit{supra} n. 127.
\item[152] Gas v. Coal, \textit{supra} n. 147.
\item[155] See Marla E. Mansfield, \textit{Prospects for Nuclear Generation}, 38 \textit{Trends} (newslnr. of the ABA Sec. Env., Energy, and Resources) 1, 13 (Nov.–Dec. 2006); Sherman, \textit{supra} n. 73, at 236 (criticizing the focus of the Energy Policy Act of 2005 on maintaining subsidies for status quo reliance on fossil fuels and failing to correct
\end{footnotes}
energy is integrated into the existing energy framework of the U.S. The technology is mature and fits into the current system, making it possible to increase the percentage of nuclear energy with relatively low costs of hooking into the grid and power structure.

New interest has focused on nuclear energy as a result of the recent spike in oil prices and concerns about dependency on foreign markets for energy. Nuclear power has continued as a major player in U.S. power despite public concerns. It is the nation’s second largest producer of electricity—behind coal. It accounts for 20 percent of the power supply of the U.S. An advantage of nuclear power is the fact that it provides reliable electricity without carbon emissions. Despite its dominance in the U.S. energy market, nuclear power continues to be a controversial solution. In fact, the idea of a reinvigorated nuclear energy program has evoked strong emotion from the public. Concerns relating to nuclear power as an expanded source of energy include the fear of a possibility of catastrophic events, including a major melt down such as the Chernobyl event and the danger of migration or release of nuclear waste.

VI. CONCLUSION

Effectively decreasing GHG will require the commitment and cooperation of all levels of government, including international, national, state, local, and regional authorities, and it will require ingenuity of businesses, cities, non-governmental organizations, and academic institutions as well as governments. “Under even the most optimistic scenarios to redirect the infrastructure of energy use to more sustainable technologies, if one does not begin such redirection in earnest now, our global ‘boat’ cannot be turned in time should global warming predictions prove true.”

Sustainable energy is at the center of any discussion of “sustainable development.” Government regulation is inevitable on the pivotal issue of energy. Without reliable energy, the world economy and world institutions would devolve to chaos. Accordingly, it is not surprising that governments have provided incentives for energy production sources since the beginnings of the significant broad-based energy sector represented by the electricity market. In all likelihood, the United States will continue to consume energy on a massive scale and consumption will continue to rise world-wide. Together the increasing demand for energy and the growing recognition of the risks associated with energy production and use provide a mandate for action. The need for

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158. Some commentators dismiss concerns about nuclear energy as over reactions to manageable risk. See e.g. Cass R. Sunstein, Precautions against What? The Availability Heuristic and Cross-Cultural Risk Perception, 57 Ala. L. Rev. 75, 82, 82 n. 49 (2005) (noting difficulties of comparing risks and the possibility of renewable energy sources, but concluding that “alternatives pose feasibility and expense problems of their own”).
159. Ferrey, supra n. 2, at 119.
160. Michael Klare’s assertion that “[n]o highly industrialized society can survive at present without substantial supplies of oil,” has equal or greater force when the subject is energy rather than any single energy source. Klare, supra n. 1, at 27.
energy and the problems associated with production and consumption of energy present compelling issues. The production of clean fuel for transportation and power may be the most significant environmental challenge today. The remedy for the GHG problem, at least in the near term, is a reconfiguration of the mix of energy resources. A policy embracing multiple strategies and multiple energy sources is crucial to both short-term and long-term sustainability. Petroleum is likely to continue as a primary energy source for transportation, at least for individual automobile transportation. Shifting energy sources to make up a larger percentage of the power from renewable resources is the key to adaptation to global climate change.

The goal of protecting the environment while achieving economic development is a challenge of spectacular proportions. Energy consumption drives all facets of the modern economy, presenting profound risks, crucial benefits, and persistent questions of cause and effect. Harmonizing economic development with sustainable use of the resources and public safety is the challenge for today’s policy makers. In short, the power that controls energy controls the modern world as well as the modern market place. The world modern economy depends on reliable and affordable energy. Addressing the challenge of sustainability is essential to a serious response to current environmental and public health threats posed by global climate change and other hazards.161 Reliable energy is essential to sustaining the economy, an organized and productive market, and individual survival. The recent concerns about global climate change have lead many to refocus on energy as an integral part of the sustainability challenge. Strong public sentiment, particularly among environmentalists, favors repealing all subsidies to the petroleum and coal industries. Such dramatic change is unlikely however, given political realities and the need to retool to change the existing power structure.

Incentives without comparison are no more than a shot in the dark at the target of carbon reduction and environmental protection. Nevertheless, rebalancing incentives can provide valuable nudges toward sustainability. The government role in developing sustainable energy requires detailed choices as well as an overarching policy of sustainability. Energy source incentives are necessary. By careful tailoring, energy policy can explicitly and methodically compare initiatives and incentives and provide coordination among the different levels of government to respond to the challenge of providing reliable and sustainable energy and a sustainable environment.

161. Motor vehicles powered by fossil fuel produce toxic emissions in addition to GHG. Lowell Rothschild & Margaret N. Strand, Mobile Source Air Toxics: What’s Known, Not Known, and What To Do About It, 21 Nat. Res. & Env. 10, 10 (Fall 2006).