

Draft 3 4/2/09 For a chpt in a Handbook of Global Warming. Other chpts will deal with the science, renewables, and more extensively with public opinion. **Comments most welcome.**

INTRODUCTION

This essay examines the two biggest environmental polluters, the oil and coal industries, and the possibilities of renewable energy that could replace them. I see the masters of these organizations, CEOs and top officials in the case of corporations, and state leaders in the case of command economies such as China or Saudi Arabia, as responding to near-term demands and interests at the expense of long-term ones, thus endangering the planet. In the case of democratic nations, the firms seek to manipulate public opinion to downgrade their impact upon our environment, and to manipulate government representatives and officials to forestall changes that would threaten their interests. Meanwhile, because of their success in the areas of public opinion and legislation, there is insufficient funding for promising energy alternatives that are carbon-free.

The challenge is unprecedented: to stabilize pollution by 2030 or even 2050, private organizations such as oil and gas producers that account for most of our green house gases are expected to reduce the profit goals of executives and shareholders, raise their prices for consumers, and lower the standard of living for citizens, by no longer freely dumping their pollutants into the atmosphere. National organizations that pollute (national oil and coal companies in China for example) are to reduce the standard of living of their citizens, and risk disorder, insurgencies and political revolts. Curtailing their freedom to pollute in order to save the planet from a distant catastrophe is not likely. The prospects for greatly increased efficiency and renewable, non-polluting energy, are distant and slim. In two or three decades we may reach the tipping point where irreversible changes cascade in an ecological calamity, and even with extraordinary determination, doing away with the major polluting energy sources in such a short time does not seem possible.

There are less dire scenerios. For example, in a 2008 testimony before two congressional committees, Thomas Fingar, Chairman of the National Intelligence Council, summarizes expert testimony that estimates a minimal impact on global economic growth out to 2030, and the U.S. in particular “on balance will benefit slightly from climate change over the next few decades, largely due to increased agricultural yields.”(Fingar 2008) Predictions from economist William Nordhaus, who has written books on the subject, are similar; the U.S. will cope over the next 100 years, though many poor nations will suffer greatly. The current “social cost” of our emissions he estimates to be only \$150.00 per person per year; a carbon tax of \$30 a ton would raise gas prices in the U.S. by only 9 cents a gallon, and involve only a 10% increase in electric utility costs. Presumably the market will then exist for developing and using non-emitting energy sources. Since a carbon tax would generate \$50 billion of revenue in the U.S. it could fund the R&D necessary for reducing emissions.(Nordhaus 2009) Many others dispute such claims, but this essay will not discuss the issue of competing models and predictions, but look at the role of organizations under any scheme.

Formal organizations, public and private, are at the heart of this problem. In rich, democratic nations, we will see how they shape public attitudes towards global warming and the need to minimize the degree of their contribution to global warming, and how

their governmental influence leads to weak governmental policies. Their influence in non-democratic nations is obvious; the state controls the polluting organizations. This is a “power” and a “materialist” view of organizations that recognizes, but gives second-place to, “neo-institutionalist” and “cultural” views of organizations.¹

An emphasis upon the role of organizations is different from some other explanations of our failure to even slow emissions. One is the complexity/manageability issue. It is true that the complexity of the problem (and the environment) is enormous and may be beyond our capacities. But I hold that when there is widespread agreement on the cause of major problems and general agreement on remedies, societies have *sometimes* responded remarkably well; even Jared Diamond’s *Collapse* has a few examples. Citizens willingly make sacrifices, as in wartime; even some corporations have foregone maximum profits in the national interest, as in the U.S. during World War II. Thus mammoth projects of great complexity and uncertainty have succeeded (e.g. putting a man on the moon; the acceptance by U.S. citizens of the costs and hardships of their role in World War II). While the complexity of the climate change problem is unprecedented and managing it will be an unprecedented managerial challenge, I do not think that this is the most important impediment. If the political and economic power of the major polluters were substantially diminished, democratic states would emerge stronger and could impose the necessary hardships. It is possible that command economies could be cajoled, or forced with economic weapons, to follow suit.

Another viewpoint is that not enough is known about the dynamics of atmospheric pollution, and even whether it threatens us. I will not bother to dispute this view; the evidence of the human source of global warming is overwhelming and well presented in other chapters. More persuasive is the view that the public is simply uninformed about the magnitude of the threat and what must be done to protect future generations, but I will suggest that, while true, it is not necessarily decisive and not inevitable. The lack of information, or correct information, I will argue is at least partly the result of the efforts of large polluting organizations. The ignorance, at least in the U.S., is constructed rather than generic. (Other chapters discuss this more fully.)

The problem also defies a “national culture” explanation; the cultures involved in inaction are simply too diverse, and the differences among them in their approach to climate change cannot be fully explained on cultural grounds. Nor is the cultural explanation of “post-materialist” values convincing, where only rich nations can afford an environmental concern. Concern with environmental quality is not limited to the rich

¹ My views are based upon the following writings: for organizations as the major environmental destroyers see Perrow, Charles. 1997. "Organizing for environmental destruction." *Organizations and Environment* 10:66 - 72. For a power view see—. 1986. *Complex Organizations: a Critical Essay*. New York: Random House. For a view of how organizations shape society see—. 1991. "A Society of Organizations." *Theory and Society* 20:725-762. and—. 2002. *Organizing America: Wealth, Power, and the Origins of Corporate Capitalism*. Princeton, N.J.: Princeton University Press. For a view of the organizational bases of major catastrophes see Perrow, C. 1999. *Normal Accidents: Living with High Risk Technologies*. Princeton, N. J.: Princeton University Press. and—. 2007. *The Next Catastrophe: Reducing Our Vulnerabilities to Natural, Industrial, and Terrorist Disasters*. Princeton NJ: Princeton University Press.

countries with “post-materialist” values. Even a political structure viewpoint, while useful in contrasting efforts of Europe and the U.S., does not illuminate the inaction of command economies such as China, or even a democracy such as Norway, which is not likely to internalize the pollution costs of its major source of its substantial prosperity. Finally, while it is tempting to cite self-interest on everyone’s part as the cause, self-interest (or greed) arguments cannot be disproved; most behavior is motivated, so even sacrifices can be seen as another form of self-interest. Social structures shape interests, and it is these that should be examined. A key part of social structure is large, for-profit or government controlled organizations. Even the outlier case of Norway, where there is widespread social responsibility built into their social structure, can be seen as having a social structure that does not preclude a massive denial of their large contribution to global warming.(Editors 2009; Norgaard 2006)

What does an organizational perspective entail that makes the other perspectives dependent variables? To be brief and superficial, in modern societies formal organizations, public and private, shape every step of our life course. We live in a society of organization; organizations shape our culture, our politics, and even our cognitive processes.(Perrow 1991) No significant endeavor by individuals or groups can proceed independent of formal organizations that will organize the efforts. Organizations are more or less, but always to some degree, centralized. Thus leaders, even if they are elected or are rotated, will have an interest in maintaining and increasing the power of the organization over other organizations and citizens, and an interest in maintaining their individual power. We use the benign term “leadership” to characterize this behavior. Organizations are tools in the hands of their masters, imperfect and recalcitrant tools to be sure, but nevertheless tools.(Perrow 1986) In the U.S. corporations are increasingly shaped by demands of large shareholders, but they too are organizations, such as mutual funds and pension funds. They can shape the incentives of the CEOs that head corporations in favor of short-term stock prices at the expense of other stakeholders.

The characteristics of organizational structure have been related to toxic emissions, though not to greenhouse gases per se. Donald Grant and colleagues have found that toxic emissions in the chemical industry increase with the size of the corporation and with the number of subsidiaries.(Grant and Jones 2003; Grant, Jones and Bergesen 2002) Prechel et al examine the changes in regulations in the 1990s that brought about changes in organizational structure that encouraged corporate pollution in a number of industries that are required to self-report their toxic emissions. The multi-layered subsidiary organizational form that became popular and allowed new sources of financing through stock issues, contributions to political action committees which can influence legislation, a low rate of return on equity (a disincenitive to installing pollution controls), large payouts to stockholders and large stock options for managers, all were associated with higher rates of toxic emissions. The imposition of penalties had no effect. [cite]

There are at least two exceptions to privileging organizations in the global warming debacle. First, millions of small farmers in the world have cattle for milk and beef, and pigs. They contribute greatly to the methane gas that pollutes the atmosphere. Second, the values of property rights and individual autonomy in democratic nations can destroy the common good. To take just one example, this is evident in the difficulty of repairing the bayous of Louisiana to reduce hurricane damage. Thousands of private

owners would have to give up their property to create the water-diversion systems and natural growth that would protect cities such as New Orleans. But even here, large oil and gas companies have contributed most to the destruction. Organizations other than oil and coal companies contribute also, e.g. the entrepreneurs who organize rain forest destruction and the wood products industry that buy the wood, but we will focus upon oil and coal companies.

It is organizations that do most of the polluting, not governments or politics or culture or economics or our psychology.(Perrow 1997) But to understand what organizations can do we have to examine their effects upon the public and upon government. Organizations are not all-powerful; they need some acquiescence from the public, even in command economies. If the public in democratic nations minimizes or denies the threat, it will be much harder to find representatives in government that will support mitigation legislation and support state investments in alternative energy forms.

THE PUBLIC

The influence of oil companies upon public attitudes is covered in other chapters in detail; just the highlights will be mentioned here. First, surveys have indicated that it is not just the rich nations that have the “post-materialist” view of being more concerned with the environment because they are no longer preoccupied with basic needs; citizens of poor nations are also alarmed about environmental destruction in general and global warming in particular. Indeed, one study found the citizens of poor nations more willing to make economic sacrifices for environmental protection; the poor seemed richer in spirit than the rich! (Brechin 1999) Contrast this with the view of the Chief Economist of the World Bank in 1991, Lawrence Summers. He recommended that there be more migration of dirty industries to the less developed countries because the health costs of pollution for workers in the dirty industries will be less (low-paid, their value is less); that the environmental effects will be less because these nations are “under-polluted;” and because the demand for a clean environment only rises with a nation’s wealth (poverty can keep the demand low).(Dunlap and York 2008, 530).

Public attitudes in the rich nations show a rising concern with global warming, but the polls can be deceptive. Their sponsors craft questions to fit their preferences. For example, a poll by Zogby taken for the National Wildlife Federation, which has a vested interest in showing there is public concern, asked about concern for global warming (it was high) but failed to ask if the respondents thought humans caused it. A non-sponsored poll by the Pew Foundation was more careful. Asked how important they saw 19 issues, the U.S., the largest contributor to global warming, had the lowest concern with global warming among 15 industrialized nations (only 19% were very concerned). Even China was higher! Perhaps most alarming, the poll asked something that most polls do not ask. Among those that say there is solid evidence of global warming, *only 41% attribute the warming to human activity*. (Twenty-one percent chose “natural patterns” and 8% did not know.) (Center, 2006) This means that only 29% of those polled believed both that there was warming and that humans were responsible. Given this result, the prospects for an aroused citizenry demanding things like the carbon taxes that will reduce their present wealth are dim.

Since the mid 1990s, oil and gas corporations have funded expensive public relations programs that deny that humans cause global warming. For example the

American Enterprise Institute (AEI), an ExxonMobil-funded think tank with close links to the Bush administration, offered payments of \$10,000 for articles that emphasize the shortcomings of an alarming report from the UN's Intergovernmental Panel on Climate Change (IPCC). (Sample 2007) Their efforts appear to have been successful among Republican voters. In 1997 the difference between self-identified Democrats and Republican respondents to a Gallup poll asking whether global warming was happening was only four percentage points; 52% of Democrats and 48% of Republicans thought it was happening. By 2008 the four point difference increased to 34%. Concern with global warming among Republicans has actually *declined* over the last decade, and their belief that it was being exaggerated rose from 37% to 59%. This was a key message of the conservative think tanks, in part funded by oil and coal interests, their efforts widely represented in the mass media. The role of corporations in shaping public opinion and the influence of conservative think tanks funded by large corporations has been well studied. (McCright and Dunlap 2003) (Jacques, Dunlap and Freeman 2008) The consequences for global warming are discouraging.

BIG OIL

The US leads the world in carbon dioxide emissions and 44% of emissions in the U.S. are from the burning of petroleum products in gasoline, heating oil, kerosene, diesel products, aviation fuels, and heavy fuels. The contributors to this large amount of pollution deserve some examination. Coal emissions are a bigger problem, but since more is known about the oil industry, it will reveal more of the organizational dynamics that drive them both.

When we think of big oil companies and global warming we think of Exxon, BP, Shell and so on. They are responsible for a significant proportion of our contribution to global warming. But 77% of the world's proven reserves are in the hands of national oil companies (NOCs), not independent oil companies (IOCs) that are privately owned, such as Exxon and Shell. Western oil companies now control less than 10% of the world's oil and gas resource base. (Jaffe and Soligo 2007) The "Big Five" IOCs (BP, Chevron, ConocoPhillips, ExxonMobil, and Royal Dutch Shell) represent only about 20% of the world production that is not OPEC. Big polluters that they are, they are no match for the OPEC and other non-OPEC countries. There is no evidence that these others are ready to even acknowledge their responsibility for global warming. (Jaffe and Soligo 2007, 3, 11)

But the Independent Oil Companies are in states with democratic governance where their responsibility for pollution can be assessed and steps taken to reduce oil consumption, increase the efficiency of its use, and at the very least, increase exploration until our reliance upon it can be reduced through alternative energy sources. What have the oil companies done?

They have consolidated in recent decades; cut back upon exploration; contributed to price rises; used their extravagant profits to increase shareholder value; and spent almost nothing upon renewables even in the face of projected declines in availability, and have managed to increase government subsidies.

Concentration. The production and distribution of petroleum products by IOCs has become highly concentrated. In 1993 the largest oil refiners controlled one third of the American market, by 2005 they controlled 55%, and the largest 10 refiners controlled 81.4%. (Editors 2007) A report by the James Baker III Institute of Public Policy at Rice

University in Houston Texas examines the exploration issue. “Several of the world’s largest oil companies merged in 1998, arguing for the need to cut costs, enhance efficiency and grow capital strength to tackle the massive spending requirements for multibillion dollar mega projects in places like Russia, Venezuela, and Saudi Arabia. However, spending patterns of these companies since the mergers failed to show any appreciable increase in exploration spending from the previous levels of their premerger entities.” Since the smaller publicly traded American oil firms have a superior record for reserve replacement and exploration activity, “there appears to be a level of consolidation that suggests that firms can become too large to exploit effectively the kinds of reserves currently available for private capital.” (Jaffe and Soligo 2007 17)

The report also noted “This is in contrast to the 1970s and 1980s when strong IOC exploration spending spurred a large increase in non-OPEC production, promoting diversity of supply and enhancing U.S. energy security for two decades.” (13) A report by a congressional staff committee was similarly concerned. Between 2003 and 2006, a period of record profits, Exxon increased its buybacks of stock 500% while increasing its explorations expenditures by only 30%. Oil companies are producing oil on only 20% of the continental shelf, and only 28% of the federal land for which they have drilling rights. But in 2006, the big five, while repurchasing stock for \$60 billion, spent only \$10 billion on exploration of new oil fields.(Staff 2008)

Price rises. Consolidation and the decline in the exploration have contributed to the rise in the price of gasoline (speculation in deregulated markets has probably been more important in the last five years). But another contribution has been their decision to not increase refining capacity, and their ability to increase the profits on refining. Margins for U.S. oil refiners have been at record highs. In 1999, U.S. oil refiners enjoyed a 18.9 cent margin for every gallon refined from crude oil. By 2005, they posted a 48.8 cent margin for every gallon of gasoline refined, a 158 percent jump. (Editors 2007) Exxon estimates that the market for oil will peak in 2020, and therefore it says it would not be wise to invest in new refining capacity. (Slocum 2006) The capacity shortage drives up prices and profits.

Where the profits go. How large are the profits, and if they do not go to exploration refinery capacity, where do they go? Exxon Mobile is the world’s largest publicly traded company and the most profitable; in 2005 it netted \$36 billion.(Editors 2007) Upon the recent retirement of CEO Lee Raymond, who helped the profit picture through acquisitions and divesting the company of nearly all of its alternative energy holdings, he was lavishly rewarded with over \$686 million in compensation, and his retirement package was worth nearly \$400 million. (Editors 2007) Despite the huge profits of Exxon and the other majors, the stock market has not been all that sanguine about the Independent Oil Companies despite their increase of 113% between 2002 and 2007. The National Oil Companies rose fully 513%.(Jaffe and Soligo 2007 32)

What did the world’s most profitable publicly traded company do with its profits? The same thing that the other four giant oil companies did with theirs: paid huge dividends and repurchased their stock. Profits can be invested internally to further the growth of company (oil exploration, alternative energy sources) or to make the company more efficient. But it can be used instead to repurchase shares in the open market, thus increasing shareholder value, and this is what Exxon and the other major oil companies have done. (Making shareholder value the primary goal of executives and the major

stockholders, such as pension funds, is only about 20 years old. For a brief review of its development and citations to the literature, see (Perrow forthcoming)) Buybacks for the five major oil companies went from under \$10 billion a year in 2003 to nearly \$60 billion a year in 2006. (As noted, only \$10 billion went to exploration.) Exxon was the biggest repurchaser in 2007, totaling \$31.8 billion in buybacks.

Subsidies. One of the reasons for their profitability of US oil firms is the generosity of the US government, where the oil lobby is very powerful. In 2005 President George W. Bush signed a new energy bill that included \$5 billion in *new* financial subsidies for the oil companies. Legislation passed in 2008 will provide \$18.5 billion in subsidies over the next 10 years for this fabulously rich industry.(Staff 2008) In addition to the new subsidies in the 2005 energy bill, the U.S. Government allocated \$150 billion of the 2008 \$700 billion bailout money to extracting oil from the shale in the Rocky Mountains, a hugely water intensive program that one critic said would use all the water currently being used by Colorado.(Slocum 2006)

Renewable energy. And what about renewable energy? European-headquartered British Petroleum, along with Royal Dutch Shell are praised for their efforts in this direction. But BP also put most of its profits into buybacks and dividends, reserving 2% for research on solar, wind, hydrogen, and natural gas. (It is rich in natural gas, so its investments there and in hydrogen are not in renewable energy, making the 2% figure even less impressive.) Small as 2% of profits is, it is much greater than Exxon, whose only significant contribution to renewable energy is a grant announced in 2008 of \$10 million a year for 10 years to Stanford University; this is \$100 million out of its \$60 billion in profits. Its expenditures on renewable energy are less than three hundredths of one percent of its annual profits. Its current renewable energy advertising campaign costs ten times as much as its investment in renewable energy.(Staff 2008)

The oil strategy. David Levy and Ans Kolk in a 2002 article on oil multinationals' response to climate change dutifully note the minor – one could say trivial – renewable energy response of the big oil firms and conclude with the following observations. The big oil companies no longer perceive climate change as a serious business threat. Exxon is more explicit about regulations. “Several U.S. managers acknowledged that adopting an adversarial stance concerning climate change did not cost them much credibility with regulators; one Exxon manager stated “they cannot ignore us anyway; we are the big elephant at the table.”(Levy and Kolk 2002 291) They do not expect renewables to pose a threat before mid-century because of the high cost and the inability of the existing infrastructure to cope with renewables. The outlook for core oil and gas businesses will be strong in the next decades and oil will remain the primary fuel for transportation. “Any improvements in fuel efficiency would be more than offset by growth in vehicle sales and miles traveled, particularly in developing countries, while radical technologies such as fuel cells still faced many costs and technical barriers.”(Levy and Kolk 2002, 295) Air transportation is also growing rapidly. All this reduces the stakes and removes the need for more aggressive conservative political action or investments in technological advances. Big oil feels that the highly flexible Kyoto mechanisms provide only weak constraints on emissions. “As a result, there are few rewards for proactively taking the risk of being a technological first mover, and a resistant strategy that aggressively challenges policy may not be worth the cost in political and social legitimacy.” (296)

Of course it is depressing to find that the oil companies, at least according to this article, do not feel threatened. Given their power and their continued pollution, their mammoth externality is likely to go on well beyond the possible tipping point.

COAL

For all of the concern about oil and global warming, ecologist Kenneth Calderia of Stanford University, speaking at the 2008 annual meeting of the American Geophysical Union, said that coal is the real problem. If the world stopped using oil it would buy us only about 10 years before coal emissions warmed the planet to dangerous levels. Oil is only a bit player; burning coal to generate electricity is the real global warming culprit. Even replacing oil with liquefied coal – one of the “solutions” offered by coal companies – would only make a two year difference, he said. (Madrigal 2008) Since 44% of U.S. emissions – and we are the biggest polluters – are from petroleum products, this seems hard to believe. Nevertheless, coal is the most carbon intensive of all fossil fuels, emitting more than twice as much carbon dioxide per unit of energy as natural gas. (Goodell 2006) If we are to have any limits on CO₂, coal will be the largest target. The industry argues that the consequences of global warming will be modest and more importantly, we have plenty of time to reduce emissions. Meanwhile anything that delays action will benefit the industry. The industry’s argument is that we are running out of oil and gas, but the US has coal supplies that should last for at least 250 years, and we should not be dependent upon foreign oil. Meanwhile, the industry that is the greatest threat to our atmosphere is growing and prospering.

Coal generates about 50% of the electricity used in the U.S. but accounts for 93% of the CO₂ from electric power, which in turn is one-third of all of our CO₂ emissions. A spokesman for the Natural Resources Defense Council testified that takes 10 years and around \$1 billion to build a one Gigawatt plant. (Hawkins 2005) We have not been building coal plants; natural gas has been cheap and accounts for most of the new power plants built in the US in the last 20 years. (Staff 2007) The increase in energy demands and the high price of natural gas prompted plans to build 151 coal-fired plants in the U.S. (However In the last 2 ½ years, plans for 83 plants in the United States have either been voluntarily withdrawn or denied permits by state regulators. (Warner 2009)) China is building two a week. The Department of Energy estimates that by 2030 electricity demand in the US will increase by approximately 40% and much of this will be met by coal. New plants will have a lifespan of 40 to 60 years. Any carbon tax that we enact, unlikely as that is, will probably have to grandfather them, exempting them from emission taxes, given our demand for power, and the power of the coal industry and their shareholders. They will be, even with the best current technology (scrubbers, gasification, etc.) high CO₂ emitters for decades.

The politics of big coal. For a brief moment after George W. Bush’s election in 2000 things looked bad for the coal industry. President Bush had campaigned on a promise to reduce CO₂ emissions, and he appointed Christie Whitman as the EPA administrator. In the first month of the new presidency she gave interviews saying that the president declared that the science is good on global warming and that reducing CO₂ had to be introduced into the discussion of energy. (Goodell, 2006,192). She might be

forgiven for this misstatement of the view of the new Republican president since many of America's landmark environmental laws have been passed by Republicans – the Clean Air Act, Endangered Species Act, Toxic Substances Control Act, and the acid rain and amendments to the Clean Air Act. (186) But it was a misstatement. These legislative acts did not strike at the heart of the energy sector, as reducing CO₂ would.

Coal had been identified as a major environmental threat as early as 1977 in a National Academy of Science report, and a worldwide coal industry conference seventeen years ago, in 1993, warned its members of a coming crackdown on CO₂ emissions. (It has yet to materialize.) A coal industry association, the Western Fuels Association, began a public-relations campaign about this time. This, along with that sponsored by oil companies, must have helped reduce the percentage of U.S. citizens who worried about global warming “a great deal” from 35% in 1991 to 22% in 1997, the year the US Senate voted 95 -0 against joining the Kyoto Protocol. So in 2001 Christie Whitman should not have been surprised that the industry demanded that the pledge to reduce CO₂ be revoked. All the heavies weighed in, including the Edison Electric Institute, and Vice President Richard Cheney and his energy committee in the White House. It worked.

Peabody Energy According to Jeff Goodell, the author of *Big Coal*, “The reversal of Bush's campaign pledge removed the most significant obstacle to the coal industry's future, and to Peabody's.” (Goodell 2006, 200). Peabody Energy is the world's largest private sector coal company. In the 2000 election Peabody's holding company gave \$846,000 to federal campaigns, 98% of which went to the Republican Party. Five days after the administration's energy plan was released in 2001 Peabody went public with an initial public offering that raised more than \$430 million for the company, and announced plans to build a new 1500 MW coal-fired power plant. Construction started in 2005 in Illinois. Despite using the latest technology available, it will have only a marginal impact upon emissions compared to a similar size plant built 30 years before.

According to its web site accessed in February 2009, Peabody Energy had revenues in 2008 of \$6.59 billion and unprecedented profits of nearly one billion dollars. With all this money it doubled its shares-buyback goal to \$1 billion, just as oil companies were doing. (It was a good time to do so; its shares were cheap, having declined 55% in 2008 with the recession.) It received 5 awards related to environmental stewardship and sustainability. These awards are often suspect. For example, it gave universities a tiny \$10 million for research and development, having previously given only one million over five years. Numbers such as million and billion are so large that we forget that the difference between one million and one billion is enormous. One million seconds is less than 12 days; a billion seconds is almost 32 years! A contribution of one million dollars over five years is infinitesimally small compared to a nearly one billion dollars in profit in just one year.

Clean coal? An industry-financed group, the American Coalition for Clean Coal Electricity, spent \$38 million in 2008 informing Americans that there is the promise of “clean,” or carbon-free, coal. Environmental groups call this “the dirty lie.” The newest, unproven technology is known as Carbon Capture and Storage (CCS). It could double the cost of electricity generated from coal. CO₂ is compressed to a supercritical liquid and piped to a suitable geological site, perhaps hundreds of miles away, to an injection well. After injection it seeps into the surrounding rock; a caprock or impermeable layer

prevents its escape. Piping and sequestering has been used extensively in small amounts to improve recovery of oil and gas fields. But as yet there has been no demonstration project that links what are called IGCC plants to sequestering facilities. The Integrated Gasification Combined Cycle (IGCC) plants (one is being built) cost 20% to 25% more to build than conventional state-of-the-art coal plants using supercritical pulverized coal technology. In addition, add-on capture technology will add another 25% to 40% in cost compared to plants without CCS capability.(Berlin and Sussman 2007) An MIT study estimates that the cost of testing sequestration at five large experimental plants to be “under” \$1 billion, and take ten years. Later the study calls for three experimental IGCC plants that would each cost (not including acquisition of CO₂) about \$15 million/year for a ten year period.(Katzner 2007)

Neither IGCC nor other coal technologies have been demonstrated with CCS. Another promising technology uses the captured CO₂ to feed algae, 70% of which can be turned into oil and the rest into fertilizer or drugs. But it needs sunlight, so only 40% of the CO₂ can be captured, and the demonstration on a large scale seems decades away.(Schrag 2008) Because of the diversity of coal characteristics, e.g. heat, sulfur, water, and ash content, multiple technologies may have to be deployed for CCS, and the geology must be suitable. As yet, there is no operational experience with carbon capture from coal plants and certainly not with an integrated sequestration operation. There is no economic incentive for private firms to undertake such projects. The technological uncertainty is a barrier, but more important, there is no carbon tax or assurance of government assistance. The 2005 Energy Act did not require that federal assistance be limited to plants with CCS, so, in the absence of charges on CO₂ emissions, they turned to pulverized coal plants since the cost is lower than IGCC. If a carbon tax comes in, however, all these plants would have to be retrofitted at huge, perhaps unsustainable costs.

Optimism rules. Nevertheless, the Center for American Progress report claims that experts are confident that large-scale sequestration will be safe, feasible and cost-effective, and cite the MIT study as evidence.(Berlin and Sussman 2007 13) I do not read the MIT report that way. Feasibility is not guaranteed, nor is the permanence of sequestration in suitable sites. (Escaping CO₂ would be deadly.) Cost-effectiveness is questionable, and it takes 10 to 15 years, and even more with integrated CCS facilities, to cover the return on investments and start making profits. Will executives and shareholders tolerate this delay? Organizations count.

Duke Energy. It appears to be hard to even get the best current technology installed, as the case of Duke Energy indicates. Duke Energy in N. Carolina is a poster-child for responsible actions by a coal company. It calls for mandatory greenhouse gas reductions from power plants, advocates a cap-and-trade system, is building the nation’s largest solar farm, and has bought a wind power company. But an advocacy group, Environmental Defense sued it when it balked at installing modern air pollution controls on old coal-fired plants. According to Environmental Defense:

“Our suit against Duke Energy, the country's third-largest power company, centered on its costly renovations to 30 coal-fired electric generating units at eight power plants in North Carolina and South Carolina. Many of these facilities had been operated sporadically or not at all and were due to be retired and replaced. Instead, Duke Energy extensively rebuilt them, resulting in significant increases

in particulate- and smog-forming pollution, but did not obtain permits nor install pollution control equipment as required by law.” (Staff 2007)

The U.S. Supreme Court agreed with them, reversing a lower court ruling that was in favor of Duke. In a 9-0 ruling in 2007, it sent the issue back to the lower courts. Duke Energy also planned to build two huge coal plants in southwestern North Carolina, but the courts allowed only one, and environmentalists are still protesting that. The estimated 240 million tons of carbon dioxide that will be generated over the 40-year life of the 800 megawatt plant, known as Cliffside, will probably never be captured, when or if injection technology becomes viable. In North and South Carolina, where Duke operates, the underground rock is too porous to contain any gas.

The future of coal. Organizations count in the new Obama presidency as well. President Obama, who has pledged to spend \$150 billion over 10 years to combat climate change and create “green” jobs, hasn’t said how much of that should go to clean-coal technology. It would take a substantial percentage. (Just to upgrade our power grid to incorporate the additional energy sources that we need will cost an estimated \$100 billion, experts estimate!) Obama’s Energy Secretary Steven Chu had called coal his “worst nightmare” in a 2007 speech when he was professor at the University of California, Berkeley campus. At his Senate confirmation hearing on Jan. 13, 2009, Chu said coal is a “great natural resource” that the “the U.S., with its great technological leadership, should rise to the occasion to develop it.”(Whitten 2009) It appears that the government will have to commit so many billions to get clean coal, that efficiency in energy production and use, and renewable energy sources seem like the more reasonable alternatives. But as we will now see, renewables too have dismal prospects. Energy efficiency is more promising, since it increases profits while reducing harm, but its returns are dwarfed by the prospect of increasing energy demand and usage in growing world economies.

RENEWABLES AND EFFICIENCY

The world has a very long way to go. According to a MIT study, only 0.4% of global energy demand is met by geothermal, solar and wind.(Katzner 2007) (Hydroelectric is not included.) Increasing that ten-fold would only make a hardly discernable impact upon the global problem, and even a ten-fold increase in the percentage of energy from renewals appears to be beyond our grasp. (Statistics vary, but it is estimated that renewables, including hydroelectric, account for about seven percent of U.S. energy.) But for a number of groups and experts, efficiency and renewables are a mantra.

Andrew Hoffman, the author of a book on how the chemical industry bowed to public pressures regarding pollution and poisons and cleaned up its act (Hoffman 1997), is busy writing books and pamphlets on the economic opportunities for business and industry in adaptation to climate change.(Hoffman 2006; Hoffman and Woody 2008) Management guru Michael Porter headed up a special section of the *Harvard Business Review*, warning firms that if they do not seize the opportunity to cash in on the renewable energy field they will lose their businesses. “Companies that persist in treating climate change solely as a corporate social responsibility issue, rather than a business problem, will risk the greatest consequences... the effects of climate on companies’ operations are now so tangible and certain that the issue is best addressed with the tools

of the strategist, not the philanthropist.” (Porter and Reinhardt 2007 22) A Yale scholar claims the U.S. is in the midst of a “revolution” where business is embracing the profit potential of a burgeoning green consumer movement. Society’s desire for action will create a huge demand for reducing carbon-content products. (Conroy 2007) The Environmental Defense Fund and other liberal non-profit organizations are trumpeting the potential of a variety of renewable energy sources. (Krupp and Horn 2008)

There are thrilling accounts of breakthroughs in every conceivable area of renewable energy sources, from algae to tides, to laser-bombarded hydrogen pellets. There are new discoveries in the wind and solar energy promising more efficiency, and there are small wind and solar farms in operation in the world. But the projects lack scale and lack funds. As we have seen with the two biggest polluters, oil and coal, their announced energy-saving and renewable energy plans and advances are a trivial part of their profits or their investments. Channeling dividends and stock buy-backs into renewable energy would have a sizeable impact upon the renewable field, but an unfortunate one on their stock prices and our U.S. 401k plans.

A key to innovations in the U.S. is the interest of venture capital firms in efficiency and renewables; they can finance the thousands of inventors with the promising ideas more efficiently than government grants and the showcase projects of oil and coal firms. But as fascinating and exciting as the projects are, a book that enthusiastically reviews dozens of nascent ventures also notes that the biggest obstacle is inadequate funding. Until there is a carbon tax imposed, these investments are too risky for scaling up with private capital. (Krupp and Horn 2008) Even a glossy master plan for competitive business strategies in this area notes that U.S. venture capitalist firms spent only 9% of their investments on clean-energy projects in 2006, a mere \$2.4 billion, the cost of two state-of-the-art coal plants. (Hoffman and Woody 2008 88)

Perhaps a carbon tax is not the essential strategy; all governments affect energy prices through taxes. The U.S. could greatly raise the tax on gasoline, well beyond even European levels, and use some of the proceeds to give tax breaks to low income families to soften their transportation burden, and use most of it as tax credits for renewable energy. One member of a venture capital firm emailed me in 2008 that the issue for venture capital is “certainty” in revenues, which can be either from long-term contracts or from tax benefits. “The economics of alternative energy don’t make it competitive with \$40 oil and probably not even \$100 oil. So it is up to the Government to put in place some set of tax credits or price guarantees to get users of energy sufficiently comfortable with long-term prices to enter into a long-term contract. Combining those revenues with tax credits can then make an investment economic, and of course as you built more the unit cost comes down.”

Most social scientists are more optimistic and less materialistic. Social movements, for example, could capitalize upon the public opinion support for renewables, and encourage entrepreneurial activity in that area. A study of the early U.S. wind power sector from 1978 to 1992, claims to find just that. The authors conclude that environmental groups directly increased entrepreneurial activity, and the groups also increased the likelihood that states would have regulative structures that supported wind power. The social movements changed cognitive frameworks, and norms and values. (Sine and Lee forthcoming) It surely is possible, but is hardly demonstrated by the study,

which only showed that in states where the Sierra Club was strong, more firms qualified as wind power vendors.

There is distinct caressing of the lucky rabbit's foot in much of the organizational response to climate change literature. In an editorial to a special issue of the *European Management Journal* the editors offer a sunny conclusion: "Taken as a whole, the articles in this special issue clearly show that companies have dramatically transformed their attitudes and reactions towards climate change compared to 1997." (Kolk and Hoffmann 2007, 414) But their own summary of the articles shows something quite different. The articles, they say, speak of "slow and fragmented results with respect to mitigating climate change;" companies "conform to a fragmented and weak policy regime;" the "indicators expose highly ambiguous responses of businesses towards climate change;" and business attempts to "counter climate change is limited," especially considering the planned investment in large-scale power plants.

The problem does not appear to be self-interest or short term shareholder value for these scholars, but "a weak policy framework and regulatory and market uncertainty." In conclusion, the editors write: "they seem to struggle finding appropriate responses, with some of them questioning whether the changes under way are sufficient and adequate." The articles are unfailingly, if sometimes only guardedly, optimistic. But they offer no evidence for the "dramatic transformation" that companies in Australia, North America, and Europe are advertised to have underway. Climate change skeptic Roger Pielke calls these "dangerous assumptions." (Pielke Jr., Wigley and Green 2008)

The Energy Department's R&D expenditures have declined dramatically. Adjusting for inflation, in 2008 the energy department spent less than a quarter than it did 30 years before on R&D for oil, coal, nuclear energy, and renewable energy, according to an editorial in *Nature* .(Editors 2008) Presidential leadership will have to do more than the Sierra Club, wind farm entrepreneurs, and corporate "transformations" have done to reverse this decline in government investment, and the initial moves of the Obama administration are certainly encouraging, but the 75% budget increase comes to a understaffed, marginalized Energy Department primarily concerned with nuclear weapons and their toxic legacy.(Alvarez 2009)

It is interesting that the U.S. renewable industry has a significant competitor from the oil-rich Gulf States. With vastly more profits than even Western oil and coal companies, they are investing heavily in renewables, often by funding U.S. universities that cannot get grant money from our venture capitalists or our government. (Rosenthal 2009) Major polluters themselves as nations, they too see what Michael Porter sees – a vast economic opportunity should the world get serious about taxing or capping greenhouse gas emissions. Will it?

CARBON TAX, CAP AND TRADE

Under the Kyoto treaty the wealthier nations of Europe and Japan have to stay within government limits for admitting polluting gases. They can buy credits for offsetting their own pollution if they pay poorer nations to reduce their pollution, which is supposedly cheaper to do than to reduce their own. This is the "cap and trade" option used in the Kyoto treaty and the European union treaty, and some small nascent ones in North America. Here is an example of its dysfunctionality:

A large rusting chemical factory in southeastern China has emissions of just one of its waste gases in a year that are equivalent to the emissions from a million American cars driven 12,000 miles.(Bradsher 2005) It can be cleaned up with an incinerator that costs \$5 million, much less than the cost of cleaning up emissions from a million cars or other sources of pollution. But foreign companies will pay China 100 times this cost -- \$500 million – because this high price is set in a market in Europe. “The huge profits from that will be divided by the chemical factory's owners, a Chinese government energy fund, and the consultants and bankers who put together the deal from a mansion in the wealthy Mayfair district of London.”(Bradsher 2005)

It gets worse. The plant produces a refrigerant that is about to be banned in the US and other industrial nations because it depletes the ozone layer. The chemical company in China, state-owned, will use the money it gets from European firms to expand existing factories that make the refrigerant and even build new ones. The refrigerant is used in old-style air-conditioners that are cheap to make but are not efficient users of electricity. In November, 2005, European delegates to a conference suggested that the new factories being built in developing countries should get the millions in credits to retool for the production of more modern refrigerants that do not deplete the ozone layer, but the Chinese government blocked the initiative. Payments, they said, should go into the government’s own clean energy fund, to be used in China.

China is doing well with the emissions trading funds, collecting almost half of them, with India, Brazil and South Korea getting most of the rest. Countries in sub-Saharan Africa were supposed to be the big beneficiaries of emissions trading, but are receiving almost nothing. Another party that benefits, the companies arranging these omissions deals, defends these perverse actions. An official of one of them, a firm in Washington DC, said that since an outright ban on admissions or regulations alone might never happen, at least some disposal of the waste gas is taking place despite the admittedly high administrative costs, so it is better than nothing. In small projects involving less than a quarter of a million dollars worth of credits, the administrative costs of such deal makers, consultants and lawyers are such that they can exceed the cost of the credits themselves. (Bradsher 2005) Organizational interests count. As Michael Porter might say, forget the humanitarian impulses, global warming is an economic opportunity.

The European Union’s experiment with cap and trade has not been successful. Started in 2004, emissions rose 0.4% in 2006 and another 0.7% in 2007. However it has generated a multibillion-dollar windfall for some of the biggest polluters. RWE, a major German power company and Europe’s largest carbon emitter received a windfall of about \$6.4 billion in the first three years of the system, and in addition raised utility rates for its customers far more than was allowable.(Kanter and Mouawad 2008)

A new program was passed on December 17, 2008. Supposedly it commits the Union’s 27 countries to reduce greenhouse gases by 20% below 1990 levels by the end of the next decade. Critics pointed out that the new program will probably reduce emissions in Europe by as little as 4% between now and 2020. The rest of the cuts are expected to take place outside of Europe, where monitoring and verification is very difficult. A Greenpeace spokesman said “haphazardly planting trees in Africa so we can continue spewing out carbon emissions in Europe is not the solution to climate change.”(Cronin 2008) An article in *Nature* points out that power companies will get “windfall profits”

because of the free allocations they will receive, meanwhile legally raising their prices to reflect what they would be were the allocations not free. (Schiermeier 2008)

A fairly scathing report by the Government Accountability Organization noted the poor performance of the European and the Kyoto cap and trade programs. Among other things they noted the lack of monitoring abilities and verification. For most programs these are based upon self-reports by the industry involved. There is a lack of accurate emissions data, and despite a “rigorous screening process” credits were awarded for projects that would have occurred without trading emission rights. Substantial wealth is being redistributed, it ominously notes.(GAO 2008)

One commentary notes a perverse incentive in the case of the European program. Germany’s renewable energy companies are very successful; 15% of the country’s electricity comes from solar, wind or biomass facilities. But this does not reduce emissions because the EU trading system sets only the total amount of CO₂ that industry and power companies can emit, regardless of how much renewable energy is produced. But the renewables generate unused certificates, which can be sold to coal companies in countries such as Poland or Slovakia, which can emit more greenhouse gases than originally planned and remain less efficient. This could be prevented if the country were required to take certificates off the market (raising the price of the rest of the certificates) every time a renewable source such as wind turbines came on line. But “if the state went back to the companies and took away the certificates they had been allotted there would be an uproar” that no politician could withstand. The promise of renewables must also be weighed against cheaper measures. It costs a lot to build wind and solar facilities, or to install scrubbers in coal plants; other measures such as renovating buildings are much cheaper.(Walderman 2009)

[paragraph on US cap and trade ventures to be added]

The biggest obstacle is rarely discussed. If renewable energy sources reduce the demand for coal and oil in a particular country it would make coal and oil prices fall worldwide. Developing nations could then afford to import more coal and oil to increase the welfare of their citizens with cheaper energy. The amount of pollution would not go down but remain about the same.(Sinn 2007) In fact, pollution could rise because there would be no incentive for the less developed nations to install expensive equipment into plants that reduces emissions. Without a worldwide accord that includes all nations of any substantial size, the establishment of renewable energy sources is not likely to reduce emissions.

CONCLUSIONS

We possess the knowledge and technology to stabilize our emissions of greenhouse gases within a few years, though it is possible that we have already passed the “tipping point.” We would need iron clad regulations in the nations that make up roughly 80% of the worlds population. These regulations would substantially lower the standard of living in the industrialized nations for at least several decades. They would also probably slow the improvements in standards of living, or perhaps even reversed them, for the poorer nations. The so-called “political will” of the populations in these nations would have to be mobilized to force their governments to invest in policies that will favor future generations at the expense of the present one. These governments then would have to drastically change the goals of private corporations where they exist in the democratic industrialized nations, as well as the nation’s own goals.

It may be too late. Most estimates of the accumulation of greenhouse gases have been too low, new data indicates. And there are examples of unexpected interactions that have grave implications. I will conclude with just one: Canada's giant boreal forests used to suck up an estimated 55 million or more tons of CO₂ annually. But the exploding beetle population, caused by global warming, is killing the trees, and their death releases up to 245 million tons of CO₂ each year. Russia's massive boreal forest expanse is also hard hit by global warming, and wildfires have risen dramatically.(Clayton 2009)

- Alvarez, Robert. 2009. "Is the Energy Department ready to reboot the country?" Bulletin of Atomic Scientists. March 27. <http://www.thebulletin.org/web-edition/features/the-energy-department-ready-to-reboot-the-country>
- Berlin, Ken, and Robert M. Sussman. 2007. "Global Warming and the Future of Coal: The Path to Carbon Capture and Storage." Center for American Progress. May. http://www.americanprogress.org/issues/2007/05/pdf/coal_report.pdf.
- Bradsher, Keith. 2005 "Outsized profits, and questions in effort to cut warming gases." New York Times. New York. December 21.
- Brechin, Steven R. 1999. "Objective problems, subjective values, and global environmentalism: evaluating the postmaterialist argument and challenging a new explanation." *Social Science Quarterly* 80:793-809.
- Clayton, Mark. 2009 "Canada's carbon sink has sprung a leak." *Christian Science Monitor*. March 10. <http://features.csmonitor.com/environment/2009/03/10/canada%E2%80%99s-carbon-sink-has-sprung-a-leak/>
- Conroy, Tom. 2007. "Sea change in public attitudes toward global warming emerge." Yale University office of public affairs. Yale University. <http://opa.yale.edu/news/article.aspx?id=4787>
- Cronin, David. 2008. "From EU, 4 percent less reduction till 2020." *IPS News*, climate change. ipsnew.net. <http://www.ipsnews.net/news.asp?idnews=45147>
- Dunlap, Riley E., and Richard York. 2008. "The globalization of environmental concern and the limits of the post-materialist explanation: evidence from four cross-national surveys." *Sociological Quarterly* 49:529-563.
- Editors. 2008. "Eyes west." *Nature* 456:838.
- . 2009. "Binge and purge." *Economist* 390:28-30.
- . 2007. "Smoke, mirrors and hot air: how Exxon Mobil uses big tobacco's tactics to manufacture uncertainty on climate science." January. Union of Concerned Scientists. http://www.ucsusa.org/news/press_release/ExxonMobil-GlobalWarming-tobacco.html

- Fingar, Thomas. National Intelligence Council. 2008. "National intelligence assessment on the national security implications of global climate change to 2030". June 25 <http://dni.gov/testimonies.htm>.
- GAO. General Accountability Office. 2008. "International climate change programs: lessons learned from the European Unions Emissions Trading Scheme and the Kyoto Protocols Clean Development Mechanism".
- Goodell, Jeff. 2006. *Big Coal: The Dirty Secret Behind America's Energy Future*. Boston: Houghton Mifflin.
- Grant, Don, and Andrew W. Jones. 2003. "Are subsidiaries more prone to pollute? New evidence from the EPA's Toxics Release Inventory." *Social Science Quarterly* 84:162-171.
- Grant, Don Sherman II, Andrew W. Jones, and Albert J. Bergesen. 2002. "Organizational size and pollution: the case of the U.S. chemical industry." *American Sociological Review* 67:389-407.
- Hawkins, David G. U.S. Senate Energy Committee. 2005. "Coal and Global Warming -- testimony of David Hawkins". Natural Resources Defense Council. February 16.
- Hoffman, Andrew. 1997. *From Heresy to Dogma: An Institutional History of Corporate Environmentalism*. San Francisco: The New Lexington Press.
- . 2006. "Getting ahead of the curve: Corporate strategies that address climate change." University of Michigan. Pew Center for Global Climate Change. October.
- Hoffman, Andrew, and John G. Woody. 2008. *Climate Change: What's Your Business Strategy*. Cambridge, Mass.: Harvard Business Press.
- Jacques, Peter J., Riley E. Dunlap, and Mark Freeman. 2008. "The organisation of denial: Conservative think tanks and environmental scepticism." *Environmental Politics* 17:349-385.
- Jaffe, Amy Myers, and Ronald Soligo. 2007. "The International Oil Companies." The James A. Baker III Institute for Public Policy. Rice University. November. http://www.bakerinstitute.org/publications/index_html/?b_start:int=60&C=.
- Kanter, James, and Jad Mouawad. 2008 "Money and lobbyists hurt your opinion efforts to curb gases." *New York Times*. New York, NY. December 11.
- Katzer, James. 2007. "The Future of Coal: Options for a Carbon-constrained World." Massachusetts Institute of Technology. MIT.
- Kolk, Ans, and Volker Hoffmann 2007. "Business, climate change and emissions trading: taking stock and looking ahead." *European Management Journal* 25:411-414.
- Krupp, Fred, and Miriam Horn. 2008. *Earth the Sequel: The Race to Reinvent Energy and Stop Global Warming*. New York: W.W. Norton.
- Levy, David L., and Ans Kolk. 2002. "Strategic responses to global climate change: conflicting pressures on multinationals in the oil industry." *Business and Politics* 4: 275-300
- Madrigal, Alexis. 2008. "Oil is not the climate change culprit -- it's all about coal." *Wired Science*. December 17. Wired Blog Network. <http://blog.wired.com/wiredscience/2008/12/oil-not-the-cli.html>
- McCright, Aaron M., and Riley E. Dunlap. 2003. "Defeating Kyoto: the conservative movement's impact on U.S. climate change policy." *Social Problems* 50:348-373.
- Nordhaus, William. 2009. *A Question of Balance: Weighing the Options: Global Warming Policies*. New Haven: Yale University Press.

- Norgaard, Kari Marie. 2006. "'We don't really want to know': Environmentla justice and socially organized denial of global warming in Norway." *Organization & Environment* 19:347, 24 pgs.
- Perrow, C. 1999. *Normal Accidents: Living with High Risk Technologies*. Princeton, N. J.: Princeton University Press.
- . 2007. *The Next Catastrophe: Reducing Our Vulnerabilities to Natural, Industrial, and Terrorist Disasters*. Princeton NJ: Princeton University Press.
- . forthcoming. "Modeling firms in the global economy: new forms, new concentrations." *Theory and Society*.
- Perrow, Charles. 1986. *Complex Organizations: a Critical Essay*. New York: Random House.
- . 1991. "A Society of Organizations." *Theory and Society* 20:725-762.
- . 1997. "Organizing for environmental destruction." *Organizations and Enviornment* 10:66 - 72.
- . 2002. *Organizing America: Wealth, Power, and the Origins of Corporate Capitalism*. Princeton, N.J.: Princeton University Press.
- Pielke Jr., Roger, Tom Wigley, and Christopher Green. 2008. "Dangerous assumptions." *Nature* 452:532-532.
- Porter, Michael E., and Forest L. Reinhardt. 2007. "A strategic approach to climate." *Harvard Business Review*:22-23+.
- Rosenthal, Elisabeth. 2009 "Gulf oil states seeking a lead in clean energy." *New York Times*. New York. January 13.
- Sample, Ian. 2007 " Scientists offered cash to dispute climate study." *Guardian*. London. February 2.
file:///Users/charlesperrow/Documents/aaaGlobal%20Warming/5bounty%20for%20denier%20articles
- Schiermeier, Quirin. 2008. "Heavy industry wins key concessions in last-minute negotiations." *Nature* 456.
- Schrag, Duane. 2008 "Large-scale algae production remains a dream, not reality." *Salinas Journal*. Salinas, CA. February 2.
- Sine, Wesley D., and Brandon Lee. forthcoming. "Tilting at windmills? The environmental movement and the emergence of the US wind energy sector." *Administrative Science Quarterly*.
- Sinn, Hans-Werner. 2007. "Public policies against global warming." in CESifo working paper No. 2087. Munich: Ifo Institute for Economic Research, University of Munich.
- Slocum, Tyson. 2006." Hot profits and global warming: how oil companies hurt consumers and the environment." *Public Citizen*. September.
www.citizen.org/publications/release.cfm?ID=7455 - 16k
- Staff. 2007."Court rules 9-0 for Environmental Defense." *Environmental Defense Fund*.
Environmental Defense Fund.
file:///Users/charlesperrow/Documents/aaaGlobal%20Warming/2Duke%20energy%20loses%20suit
- . U.S. House of Representative:: Select committee on energy. 2008. " Big oil: where have all the profits gone?". US government.
<http://www.google.com/search?client=firefox-a&rls=org.mozilla%3Aen->

[US%3Aofficial&channel=s&hl=en&q=Big+Oil%3A+Where+have+all+the+profit+gone&btnG=Google+Search.](#)

Walderman, Anselm. 2009. "Green energy not cutting Europe's carbon". Business Week. February

10.http://www.businessweek.com/globalbiz/content/feb2009/gb20090210_228781.htm?chan=globalbiz_europe+index+page_top+stories.

Warner, Melanie. 2009 "Is America ready to quit coal?" New York Times. New York.

http://www.nytimes.com/2009/02/15/business/15coal.html?_r=1&pagewanted=print

Whitten, Daniel. 2009 "Clean-coal debate pits Al Gore's group against Obama."

Bloomberg.com. February 4.

<http://www.bloombergnews.com/apps/news?pid=20601109&refer=home&sid=aqk2JyvYFwe8>