Mapping Global Energy: Realities and Issues for the 21st Century

Chapter 1

What Binds Us All

Reality is merely an illusion, albeit a very persistent one.

Albert Einstein

A Brief Prologue

It is mid-2008, oil prices are over $140 a barrel, and there are no gas lines in America. Gas lines exist in Baghdad and Tehran, two of the most oil-rich capitals on Earth. How can we make sense of this? The price of petroleum is now higher than at any time in history, having stumbled its way in the past two years, steadily if spectacularly, to levels once thought certain to put civilization on its knees. Rather than apocalypse, however, we are besieged on all sides, in a presidential campaign year, by the call for a "green revolution," a new world order of "clean tech" that shall bring us, at last, into "energy independence." The first great oil shock in 40 years has arrived. Still more, it has arrived on the back of two other realities of epochal importance—industrialization in the developing world, and climate change. Even without an oil shock, these phenomena

would demand a different long-term approach to how we power and light the planet. The globe simply doesn't have the resources to bring billions of people, once in energy rags, fully into the era of electricity, automobiles, computers, modern life styles, using the same fuels as in the past. Thank goodness, therefore, that the oil shock is here. High prices force change. By late summer 2008, the clean tech, green tech revolution was assured, even unquestionable.

But now it is November, a mere handful of weeks later, and change has indeed come. Global economic crisis has brought stock markets everywhere into massive decline, with banks, investment firms, and now companies large and small failing in many parts of the globe. The entire U.S. auto industry—backbone of America's manufacturing sector—begs to be saved by a government that has staked its legacy on free market principles. Indeed, governments everywhere are in the midst of gigantic rescue efforts, with at least one (Iceland) on the verge of national bankruptcy. And the price of oil? Nearly in freefall, from a peak of $145 to below $45 in a mere three months. Wherefore, then, the sentiments of "green is the new red, white and blue"?(1) Whereto market solutions for a "clean tech" future when $billions are going to bail out banks and "utilities are slashing their investments in alternative energy"?(2) As the financial turmoil deepens, new questions arise. What will happen to all the progress that has been made in new energy technology to date, advances now underway with years of hope and money behind them? Will we see the end of a "green bubble"? What about economic growth in China and efforts to deal with climate change? Could it be—irony of the fates—that with energy demand dropping and fossil fuel use too, recession will prove to be the quickest "method" to lower carbon emissions and control our resource appetites?

A great deal, in other words, remains uncertain. But this is hardly the sum of what matters. The vast majority of our global energy system, from oil wells to solar panels, along with the trends and forces that make it work, will hardly weaken, break, or disappear. Indeed, to even begin to understand what impact the new financial crisis might eventually have, we need to know about the system as it exists, the specific resources and technologies it depends upon, where it has been headed in both rich and poor nations, the possibilities it has created. To those who have spent their lives in the energy industry, the ground hasn't really shifted in any profound way. "Boom and bust" and varied political winds have always been part of the geography. Yet beyond this, energy realities are also known to be dynamic, evolving, always seeking a balance. These realities are too deeply embedded in the life of individuals, cities, and nations for the case to be any different.

Whatever the outcome and uncertainty of the moment, in other words, there are bedrock issues and patterns that will not diminish. How can global civilization move forward, yet also ensure a safe future for both the human and extra-human biosphere? How can we advance modern energy, for ourselves and the billions who remain without it and who desperately need it, while mitigating what this might mean to lakes, rivers, the oceans, the atmosphere? Nations will continue to pursue their own, self-concerned anxieties about energy security—the U.S. and foreign oil; China and imports; the EU and its umbilical natural gas ties to Russia. But all are integrated deeply, irreversibly, into a global web of markets and relationships, such that the future of one can't be realistically conceived in seclusion. A so-called "green revolution" in America can't happen without causing, or depending upon, big changes elsewhere—Canada and Mexico for example,

largest suppliers of oil and gas to America, or Brazil and Holland, who rely on U.S. exports of coal, or the European companies Siemens Energy (Germany) and Vestas (Denmark), the two largest manufacturers of wind energy systems. Such is why "energy independence" is both impossible and, in the end, inadvisable. For politicians in an election year, it is a phase ripe with symbolic power. But in the real world of global relations, it is a myth—the U.S., with no less than a quarter of all world oil demand, is simply too big a consumer, too dependent on oil itself (over 90% of transportation in America is oil driven), to cut itself off in a decade or so from most of the globe's major suppliers, such as Saudi Arabia, Iran, Venezuela, and Kuwait. Moreover, cutting off such supply would mean terminating much of the influence the U.S. might still have on such nations, who also supply oil to its allies and the rest of the world. Progress, in short, will not come from energy isolationism. Come it must, however. For another bedrock truth is that the developing world now drives the larger part of our global system. It accounts for eight out of every ten units of new energy (be they barrels or Btus) called for worldwide—an astounding change from a decade ago. If we are concerned about fossil fuels, how much of them may be left or what their use might bring, we must turn our gaze to nations other than those in North America and Europe. Many of the greatest triumphs and also tribulations of the decades ahead—from securing food and clean water to battling disease and ensuring the vitality of cities and the security of nations—will return, sooner or later, directly or subtly, to how this fact is dealt with in a global way.

For now, energy is a word on many lips, as well it should be. The economic crisis hasn't removed any of the urgency about our energy future—on the contrary. The recent oil shock, whether it may be fully over or not (is $40 per bbl really cheap?), wasn't like

those of the 1970s, when actions by the Organization of Petroleum Exporting Countries (OPEC) created shortages and price spikes. Today, there are real problems of demand and supply, the one having grown too fast, the other too slowly. Too little new production capacity was developed in the 1990s and 2000s, and there were too few refineries. In the first decade of the new century, the world of oil was caught unready for the surge of appetite from developing nations. And with things so tight, there appeared threats to supply that never really mattered on a big scale before—hurricanes, sabotage, oil workers strikes. Even the loss of a few refineries or supply from a single country was enough to make everything tremble. The global financial crisis thus ironically arrived to help loosen everything up, cooling off consumption and demand—for the moment. What happens when the global economy recovers?

America had no gas lines in 2008, because it wasn't 1973. Policies had changed. It had large fuel stocks and no price controls: prices were allowed to rise this time, and people responded by cutting back on driving. Iran, meanwhile, had gas lines for exactly the same reason in reverse, because it subsidizes gasoline to a huge degree, keeping it extraordinarily cheap (about 25 cents/gal in 2008) and demand therefore extremely high. A nation of over 65 million people with 15 million vehicles and growing car sales, Iran in 2008 was the second largest importer of gasoline after the U.S. and had even begun rationing. Still more, its demand for crude oil, which it uses to generate electricity as well as transport fuels, is also soaring. Yet its oil fields are rapidly depleting, by 8%-10% a year. Instead of slowing this bleed, by investing today's profits in enhanced recovery and upgrades to a decrepit supply system, Iran prefers to pour its cash into social welfare, to keep its people "happy."(3) What does this mean? With rising demand for oil and

falling production capability, future exports will inevitably suffer. At current rates, they could even disappear before long. Thus Iran's claim that it needs nuclear power for electricity may indeed, in some part, have validity.(4) But rather than contemplate the implications of this for U.S. security, let us consider Baghdad. Here, gas lines in 2008 come from sabotage, theft, and corruption in the wake of the U.S. invasion of 2003. Again, we don't need a full accounting to tell us that it isn't 1973 or 1979

There are differences of scale, too. Earlier oil shocks delivered considerable new income to petroleum-rich states. From 2006 to 2008, however, we witnessed the greatest transfer of wealth since Genghis Khan appropriated the fertile lands and shining cities of Asia and the Near East. Literally trillions of dollars from oil-consuming to oil-exporting nations like OPEC and Russia. In 2008, oil revenues for Saudi Arabia and Russia, the world's two largest suppliers, reached $1 billion per day. Import levels, meanwhile, were near 60% in America, higher in Europe, and in Japan and Korea, over 90%. Despite these very basic and well-advertised facts, however, many people continue to speak of the "end of the fossil fuel era" and the "greed and evil" of international oil companies.

Energy matters are critical to understand because they are fundamental to our way of life and because they are the subject of endless misconception, misrepresentation, and, as already noted, myth. Several years ago, the journalist Paul Roberts wrote of Americans as "energy illiterates," conveying a feeling (based in frustration, to be sure) widely shared among experts in the industry.(4) The term, potent and suggestive, is well-deserved, and yet it doesn't seem to capture things entirely. People in the U.S. do have a certain working vocabulary about energy. Yet it is one that is incomplete and often imbalanced, full of notions from a range of sources that have been absorbed "along the

way." Unfortunately, there are very few options to learn about energy in a non-partisan setting, whether online or in school, especially when it comes to real world contexts. That people are left to fend for themselves in this critical area of understanding is perhaps the real issue, a matter less of illiteracy than absence of curriculum. There are big reasons for a book such as this one, in other words.

Definition: What are We Really Taking About?

How should we think about energy then, in realistic terms? Consider the volume you hold in your hand. How was it made? By the author at a computer, using electricity from a hydro-station (Washington state), in a room warmed by natural gas. There are lights in this room, a radio playing, a printer, a cup of coffee. Thus, the beginning. In other rooms there are editors, also with computers, phones, printers, and more, powered, say, by coal or nuclear energy. Next comes the paper mill (more electricity and heat, plus petroleum fuels); the chemical plant, where ink is born (more electricity, heat); the printer's shop and bindery (still more); delivery of the final product by air and truck; and, of course, its final transport home, to warm and lighted rooms, perhaps with a concluding mug of java to make the circle complete.

A book, in short, is no static object but a kind of social container, bursting with resources, processes. The same, indeed, can be said for any other *objet d'art,* whether made of stone, canvas, film, or text. We may speak of genius and inspiration, higher pleasures and heavenly beauty, yet it is the things of this Earth--coal, petroleum, gas,

water, wind—that give such brilliance a material reality. A simple truth, conveniently (and understandably) left out of courses on the humanities.

The average American house uses somewhere around 30 kiloWatt-hours per day (in Europe and Japan, the figure is half or less). But this leaves out entirely all the consumed energy embodied in building the house, and in its contents—all the resources and electricity and labor too that went into the making and transporting of each item of furniture, clothing, appliance, kitchenware, toy. We are, in a wholly literal way, utterly immersed at every moment in the things that energy consumption brings. To be free of all this would mean a life like that of the painters of the Lascaux and Altamira caves.

So how to understand "energy," in real terms, for our purposes? Scientifically, it is defined as "the capacity to do work." This is a textbook, mathematical definition with a specific type of meaning (work = force x distance). Certainly it's helpful, if we paint a mental picture, but still abstract and only partly useful. Interestingly, more help, and some rich implications, can be derived from a source usually thought to be even more technical in nature—the three laws of thermodynamics. But when looked at simply, these prove to be powerful ideas that underlie everything we do with energy. C.P. Snow, the well-known English scientist and novelist (author of the famous book on the "Two Cultures"), once came up with a nice way of understanding and remembering these laws. I paraphrase his "translation" as follows:

First Law: You can't get something for nothing (the conservation rule—energy can be transferred from one system to another but never created or destroyed; it is always conserved).

Second Law: You can't break even, either (energy transfer is an irreversible process and always involves some losses, expressed by an increase in the disorder, or entropy, of a system).

Third Law: You can't get out of the game (there is such a thing as absolute zero, where all atomic movement ceases, but it's unattainable).

Together, these principles, among the most basic in all of science, keep our feet on the ground. They apply to what are called "closed systems," which don't really exist in the real world but are approximated by many energy processes we use, like a power plant or motor. What these laws tell us is that energy, as we conceive it in society, is about transformation—creating, building, altering, moving, and even demolishing things—and that the processes involved in such actions have inevitable limits. These limits can never be avoided and should never be ignored; no process can ever be 100% efficient (energy out equals energy in), and precious few ever get anywhere close. We can't, for example, burn natural gas to make high-pressure steam, use this steam to spin a turbine, and have the turbine generate electricity, without giving up a lot of the original energy content, more than half in fact, to "waste" heat and friction. The first law says that what you start with is all you've got. The second law says you'll be giving up parts of it all along the way, at every step, to the merciless god of entropy. Yet there are positive implications, too. We can raise the performance of any system by improving the efficiency in any one of its steps; if we improve all of them, even a little, we will gain much, especially over

time and especially if the process is used on a massive scale in society. Thermodynamics also tells us, therefore, that some of what we lose today we can possibly stop losing tomorrow—if we are willing to put in the hard work and imagination necessary.

These sound like moral lessons from the lap of science. They aren't. Energy in our world has a material basis. We don't import or trade "energy," after all. Homes, businesses, and vehicles do not consume mathematical formula, the ineffable. They burn natural gas in stoves and gasoline or diesel in engines, use electricity to create light and wind to create electricity. Energy, therefore, always involves the use of some substance—fossil fuels, flowing water or air, enriched uranium, sunlight, volcanic fluids. It means, first of all, specific resources.

Resources, however, bring with them the issues of availability, access, and sustainability. Unlike the Greeks, we worry that the energy materials on which our society has been built—coal, oil, and natural gas, above all—cannot last a great deal longer at the rate we are using them. And yet the global reach of fossil fuel dependence has not yet peaked. As we noted in the opening to this chapter, many parts of the world remain without the touch of modern fuels, but are desperate to have them. China, India, and Brazil have set goals for development that, while not yet met for all their own people, have nonetheless been adopted in part or in whole by large portions of Southeast Asia, Latin America, and Africa. In the meantime, the fuels at the base of such development, oil most of all, are implicated today in wars and global conflicts throughout the globe—those involving Iraq, terrorism, Russian power, Central Asia, and more.

Climate change, directly related to energy use, opens up a new domain of conflict and possible cooperation. Fossil fuels belong to individual nations, yet their use has

effects on the entire world community, on *future* world communities, and on nature as well. "We all breath each other's air," notes atmospheric chemist Daniel Jacob.(5) There are security questions, too: climate impacts, such as extreme weather or drought, may be capable of destabilizing cities, causing migrations, intensifying border conflicts, damaging life-support systems, and even—as suggested by the monstrous effects of an event like the 2008 cyclone in Burma—leading to international incidents. For these and other reasons, climate concerns have begun to influence the direction of energy policy. Over the long-term, this newest of priorities may well turn out to be a determining factor in compelling a future different from what we have been led to expect.

A Bit of Context

What, then, does our energy landscape look like today? Where do we stand, as a world, with regard to resources and options, politics and policy? In what directions are we headed and what, exactly, is driving us there? Such are the questions underlying this book, among the great questions of the present. For the U.S., they appear especially urgent, and they are—unless we consider all the other nations of the globe, for whom energy questions are no less pressing.

Yet, as I will stress throughout this book, the early years of the 21st century do place us at a special historical moment. We've noted three factors already that contribute to this: the new oil shock, modernization in developing countries, and climate change. There are other issues, too—the role of technology, new concerns over energy security, the possibility of resource exhaustion, energy poverty in poor nations—and we will

discuss them also. Together, however, they appear to be pointing us in a particular set of directions. Briefly put, the era of fossil fuels, while still very much dominant and likely to expand, is nonetheless in transition. This transition is being urged not merely by geopolitics and market changes—the visible and invisible hands of government and economics—but also by human beings' combined understanding of resource limitations, the deadly effects of poor management, and concern for the Earth—what all this means, in real terms, for the long-term welfare of society.

The nature of the changes at issue—toward greater energy diversity, multiple and flexible sources, backed by advanced technology and the climate debate—is not simple, and progress will not come smoothly. But it is already underway, has been underway for more than a decade, and, despite the recent financial meltdown, gaining momentum over time. A major decision facing the world today is how much to take charge of this historic transition, or, under a different outlook and ideology, how much to let it happen on its own, probably through a series of crises, minor or major. Thirty years ago, the Arab Oil Embargo of 1973 taught the advanced nations a hard, if vital, lesson. Energy resources concentrated in a few hands are no mere commodities, but instead political and cultural capital of the highest order. More than three decades later, has the situation become any more stable or forgiving? The answer should be obvious. Our globe spins today with more shudder and tremble than ever before, and energy relations are at the axis. It is a distinct irony of the present that, despite enormous strides in technology and a deepened appreciation for geopolitical complexities, the world continues to rely overwhelmingly on the same fuels that it did a century ago.

I have said that the use of fossil fuels will likely expand a good deal further, even if prices are high. What evidence might there be for this? Here are a few facts to contemplate. Between 2000 and 2007, car ownership in China grew by 300% and oil demand by more than half, making the country second only to the U.S. in total volume imported. By early 2008, a thousand new cars were hitting the streets of Beijing every day, with the country planning to build over 60,000 miles of new highways. Oil shock or no, the Chinese auto market was the fastest growing in the world, with luxury as well as small and mini cars pouring out in unprecedented numbers from brand-name partnerships such as Geely, Chang'an Ford, Guangzhou Honda, and Shanghai Volkswagen. Symbol of status, freedom, and a modern life-style, each new car on the road is a new mouth to feed by future oil use. That China has been lowering its fuel subsidies, letting the price of gasoline rise, made little difference in the level of car buying until the global financial crisis hit. Since then, new vehicle purchases have dropped considerably, as effects of the crisis have impacted consumers. Yet psychologically, the demand for new cars remains enormous—a mere 4% or so of households in China own a vehicle.

Studies that compare car buying over time for different nations suggest there is a dramatic "take off" point when yearly household income reaches about $5,000. Beyond this level, that is, auto buying increases by a factor of two or even three. Fuel prices do not affect this pattern very much, though they do influence the size of the autos bought. Based on this metric, however, China is poised for a future explosion in car buying like the world has never seen. The financial crisis may merely prove to be the dam that temporarily holds back the deepening waters of demand. Given the pace of rising incomes in the so-called BRIC economies (Brazil, Russia, India, and China), and other

emerging car markets, economists project that by 2050 the number of cars in the world could expand a staggering 2.3 *billion* units.(6) Now, these are projections based on income growth levels that no longer exist (as of late 2008). Yet we should understand that China, Brazil, and other developing nations are not going to turn back the clock, abandon their cities, return to bicycles, and embrace the joys of subsistence farming (China, of course, tried this under Mao, with devastating consequences). History shows, again and again, that even the worst economic hard times merely postpone development. Moreover, recession or not, all of the BRICs (plus a host of other populous nations like Indonesia, Egypt, and Iran) still had fuel subsidies in place in 2008. New car buying in these countries matched that in the U.S.(about 14 million) for the first time, helping bringing the global total to nearly 60 million for the year.(7)

If even half of the 2.3 billion figure given above is realized by mid-century, this would mean over a billion new cars (in addition to those that would replace what now exists in the West), more than doubling today's global fleet, which is estimated at around 700-800 million(8). Without some potent incentives that would convince car makers to ditch their existing capital stock and retool entirely for a new technology, it is a good bet that a sizeable portion of this coming expansion in the global auto fleet will continue to rely, to some degree, on hydrocarbon fuels (all the more likely in emerging markets, if new auto technologies, like battery- or fuel-cell vehicles are more expensive).

In short, fossil fuel use will not merely expand. It will move its center to the developing world. These nations, with 75% of humanity inside their borders, are only at the threshold of major petroleum demand. A person in China used 2 barrels of oil on average in 2007, compared with 13 bbls in Europe and 26 bbls in the U.S.(9) Still larger

differences exist for natural gas, which is at an even earlier phase of global use. World markets for these fuels, in other words, *are not yet mature*—a sobering thought, if we are interested in a "new energy" future. This seems doubtful in the extreme, even scary to contemplate, given known reserves and environmental effects. China alone, at such levels, would require as much oil as the world produces today, around 85 million bbls/day. But such facts do not seem to have persuaded either of these nations to reduce the upward trend of their demand.

Change: In the Air, On the Ground

Are anxiety and a sense of coming ruin, then, the only justified response to the current energy situation? Not in the least. Even a very brief accounting would help balance such a response. Much, in fact, exists to draw our enthusiasm for real progress. The advanced world has been moving toward less polluting fuels, better technologies, and a desire to share these with poor and emerging nations. To counter, in part, the dire figures given above, we might take heart from the fact that the average car lasts no longer than about 10-12 years, and people often buy new vehicles at half this time—thus, a large part of any nation's auto fleet could theoretically be turned over to new technology in a single generation.

This is just what has been happening in Europe. Over a 20-year period, from the late 1980s to the late 2000s, diesel vehicles with up to a third better mileage than their gasoline cousins went from a small fraction to over half of the entire European new car market. Moreover, this occurred not by magic or pure market forces. Rather, with a

view to improving carbon emissions, governments negotiated directly with auto-makers, who voluntarily agreed to expand production of low-emission diesel engines in exchange for preferential fuel and vehicle taxes, as well as air pollutant policies that favored diesels over gasoline cars. The shift took advantage of major advances in diesel technology, while stimulating much new R&D in turn. Better mileage pleased consumers, who pay some of the highest fuel prices in the world. Just two decades, therefore, were needed for Europe to embrace a different auto.(10)

True enough, diesel cars are not exactly a radical departure from conventional technology. What if all-electric vehicles had been involved? Yet the lesson here is that the motive for change not only exists, but is actively being implemented into daily life. Alternative sources of electricity, such as wind power, have also progressed enormously, and there is every sign that this will continue, despite the economic downturn. Resources for the more distant future, such as hydrogen fuel cells and fusion power, are moving ahead through long-term international cooperation. Meantime, we do not yet appear to be facing a real crisis of scarcity in oil or gas; the problems here have much more to do with politics and investment (exporting countries not having built enough new production capacity). The governments of China and India do recognize the terrible toll that fossil fuel pollution is taking on their people, and on the image of effective leadership, and are taking the first steps in policy to do something about it. In other words, fear and gloom and even loathing may abound when it comes to thinking about the global energy situation, but by no means as justified universals. The landscape of energy is not that of apocalypse. It is a geography ripe with problems but also possibilities. There is much to be concerned about, yet much to anticipate.

On a recent trip to southern Germany, I had occasion to ride in a small-model Mercedes that burns biodiesel fuel at an efficiency of nearly 40 miles per gallon (16 km/liter). Traveling along the autobahn through the rolling countryside of central Franconia, with its storybook red-roofed towns on forested hillsides and meadowed valleys, I passed ridges capped by wind turbines spinning in tandem, a nuclear power plant with steam drifting from its curving towers, a local coal-fired plant pouring out smoke and power, a solar-powered neighborhood on the outskirts of Frankfurt.

Focus, for a moment, on the vehicle. It is a Mercedes 220 CDI diesel, model year 2006, employing an advanced, low-emission engine. It produces very little particulate matter (unlike those sooty, shuddering, smelly Mercedes in the late '70s), and is able to use low-sulfur biofuels derived largely, if not entirely, from locally grown rapeseed. Yet this vehicle, "cleaner" and "greener" as it seems, is still made in a factory that uses electricity from conventional power stations. If it consumes biodiesel, it employs a fuel refined from vegetable oils, yet through processes that still depend on petroleum—and, in some part, may have come from palm oil plantations in Malaysia or Indonesia, where rainforest is cleared and burnt for that purpose. Thus any "green" advantages become suspect when we account for all life-cycle inputs. Moreover, biodiesel is itself a carbon-based source; it may reduce emissions overall, but it certainly doesn't eliminate them and is therefore seen by some as an impediment, not a bridge, to a truly low-carbon future.

Now consider the other aspect to my brief sojourn across Franconia. Nuclear power, wind power, coal power, solar power, all sources with a single purpose—not industrial power but electric power. Indeed, we in the advanced world have seen our energy options, especially for electricity (primal carrier of modern life) grow on the back

of another momentous change. Between the 1960s and 1990s, westernized nations moved from economies based largely on heavy industry to those centered on services related to knowledge and information. "The coming of post-industrial society," as Daniel Bell presciently (if a bit turgidly) called it in 1973, has happened.(10) This society has arrived, on the wings of high technology, the info-revolution, and all this has involved.

Our brave new computer-based world is no less energy-hungry than before. And, as the E- in "e-commerce" or "e-mail" suggests, it is most insatiable for electricity. In Europe, Japan, the U.S., but also large parts of the developing world that are now entering the electricity age, there has been nothing short of a boom in the demand for power, outpacing increases in every other area of energy use. It is here where big advances in new forms of energy production have been made. Most renewable energy, we might recall—wind, solar, geothermal, hydrogen, biomass (in part)—is for generating electricity. The one primary energy source added during the 20th century, nuclear power, is also in this camp. So is its 21st century relation, fusion power, a hope for the future.

Advanced societies, in short, have a greater array of energy options today than at any other time in history—and (the crucial point) they know it. More options mean more responsibility of choice. More responsibility means faith in the idea that human beings can control their own destiny, at least in part. The leaders of developed societies, our leaders, are struggling with this epochal reality. The fundamental task is to create an adaptable balance among a host of aggressively competing options, and to do so in a manner that permits, nay that leads, a movement toward a more secure and low-impact energy future, while furthering economic growth and also pleasing the voting public. A challenging task, to be sure. But one that is obviously crucial to the world's future.

Make no mistake, however. The policy roads ahead, once paved, will touch every aspect of our lives. The economy, our global alliances, our workplaces, homes, the very climate we inhabit, will all be affected by how we decide to employ sources of energy. Many experts considered it a watershed moment when President George W. Bush, the "oil man in the White House," gave his imprimatur in a 2005 State of the Union Address for funding hydrogen cars—and then, a year later, in a second such address, admitted to the world that "America is addicted to oil." Symbolic gestures these may have been, but history reveals that symbols are critical fuel to the psychology of change and progress.

Caveat Lector: A Note to the Reader

Few topics are more highly charged than energy. Prognostications about related matters have long drawn the favor of prophets, detractors, and evangelicals of varied stripe and competence. Partisanship is endemic, advocacy frequent, bias expected.

Why is this so? Energy issues, because of everything mentioned above, evoke some of the most fundamental questions about the nature of society. Name any related subject—the place of nuclear energy, the power of OPEC, a plan for a carbon tax, the need for public transport—and in the timbre of discussion you will hear close by views about whether our civilization has been progressive or regressive, whether it is a bringer of treasures or Pandora's boxes, and whether it now requires revision or revolution.

Today, perhaps more than ever before, a stance on energy implies a philosophical, even an ethical, outlook. Beyond the often crude and misleading opposition between "green" and "brown", there lies a broad rainbow of opinion. Certainly there are deep

differences between those who favor government action and those who prefer that the free market determine the shape of things to come. But it is not all about eco-vegans, who think western society is an unmitigated disaster, battling cigar-smoking capitalists who prefer Hummers to hybrids. A majority of those in the petroleum industry, for example, understand only too well that fossil energy, despite its many historic benefits, has decided limits and drawbacks. Complexities are endemic to positions on energy.

This book will not resolve such complexities, but it will delineate them. As an author, I am old-fashioned enough to think that some basic knowledge of the real world is a good thing before opinions are allowed to harden. If it is difficult to speak about the future of civilization and remain entirely neutral, I hope, as a result of reading this book, no one will feel that I have babbled too many low confidences to high companions. This being said, however, I need to make warning of several important choices.

First, this book does *not* employ, routinely, the opposition between so-called "dirty" and "clean" energy sources. These terms are ordinary, I realize. But there is a price to be paid for their use. "Dirty" and "clean" put us in the realm of hygiene—what H.L. Mencken once referred to as "the corruption of medicine with morality." Demonizing one realm while reserving sanctimony for another is a means of providing shallow certainties. Moreover, it is often inaccurate. Fossil fuels help build and transport renewable sources and keep our economy vibrant enough to develop such alternatives further. Even more, *every* type of source, without exception, has an impact on the environment: making solar panels generates CO_2 and toxic waste; wind turbines are industrial installations that alter the skyline, biofuels (as noted) have led to the destruction of rainforest. Accuracy demands that we not oversimplify.

Second, because this book is concerned with realism, there is little support in it for the belief that renewable energy is ready *now* to change the world, top to bottom, if only governments and a few special interests didn't stand in the way. My task, as I understand it, is not to soothe a romanticism that may be living before its time. There are many reasons why renewable sources—which, by the way, have made spectacular progress—can't run society today, just as there are reasons to wish that they could. Progress will continue; a great deal remains to be invented.

Finally (as you may gather from the opening prologue), there is no great sympathy in these pages for the idea of Big Oil as the Great Satan. Yes, this notion does form a tradition in America, going back to the days of Ida Tarbell and the Standard Oil monopoly. Today, however, monopoly lies elsewhere. The vast majority of the world's oil rests not with ExxonMobil and friends, who control less than 10% of global reserves, but with the national oil companies of OPEC and Russia, who own nearly 80%. The largest oil company in the world is Saudi Aramco, responsible for all of the desert kingdom's petroleum: no private firm can compete with that.(11) Americans, meanwhile, may love to rant at Big Oil, even as they help guarantee its profits by driving the largest, most fuel inefficient vehicles on the planet and voting down measures that would lower consumption. Then there is the matter of who owns ExxonMobil et al. In 2007, three-quarters of the stock in these companies was held by pension and mutual funds, IRAs, and similar investments.(12) Simply put, the U.S. petroleum industry is owned by the American public. When it comes to energy, in other words, many beloved accusations come back to haunt us with the mirror.

Notes

1. The phrase is from Thomas Friedman's article "The Power of Green," *New York Times Magazine*, April 15, 2007.

2. "Gathering clouds: clean technology in the downturn," *The Economist*, November 6, 2008. Online at: http://www.economist.com/business/displaystory.cfm?story_id=12562281

3. U.S. Energy Information Administration (EIA), "Country Analysis Brief" on Iran, available at: http://www.eia.doe.gov/cabs/Iran/Full.html

4. Stern, R., 2007. "The Iranian Petroleum Crisis and United States National Security." *Proceedings of the National Academy of Sciences*. 104:1 p. 377-382.

5. Paul Roberts, 2005, *The End of Oil*. (New York: Mariner Books).

6. Pottinger, Matt, Stecklow, Steve, and John J. Fialka, "A Hidden Cost of China's Growth: Mercury Migration, " *Wall Street Journal*, December 17, 2004.

7. The main study cited here is by Chamon, Marcos, Mauro, Paolo, and Yohei Okawa, 2008, "Mass Car Ownership in the Emerging Market Giants." *Economic Policy* 23:54, p. 243-296. Other figures specific to car buying patterns in China and India can be found in the International Energy Agency's *World Energy Outlook 2007: China and India Insights* (Paris: International Energy Agency).

8. "A Global Love Affair," *The Economist*, November 15 2008, Special Report on Cars in Emerging Markets. Chamon, Mauro, and Okawa ("Mass Car Ownership") represent the higher end of this common range of estimates, stating in their article that an increase of 2.3 billion new vehicles equals growth of 350% over 2008 (= 805 million cars).

9. International Energy Agency (IEA), 2007, *World Energy Outlook 2007* (Paris: International Energy Agency).

10. National Automobile Dealers Association (NADA), 2007. *Economic Impact of America's New-Car and New-Truck Dealers*. Washington, D.C.: NADA. See chapter "Vehicles in Operation and Scrappage" (no page numbers). Available online at: http://www.nada.org/Publications/NADADATA/

11. For a more thorough discussion of this historic shift, see. Chen, B. and D. Sperling, 2004. "Case Study of Light-Duty Diesel Vehicles in Europe." Final

Report, Contract 02-310, prepared for the California Air Resources Board and California Environmental Protection Agency, 19 p.

12. Bell, Daniel, 1973, *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (New York: Basic Books).

13. The growing market power of national oil companies (NOCs) has been much discussed by analysts of the energy industry. See, for example, the report dated November 2007 by Amy Myers Jaffe and Ronald Soligo, "The International Oil Companies," published by the James A. Baker Institute for Public Policy at Rice University. Online at: http://www.rice.edu/energy/publications/nocs.html

14. Shapiro, R.J. and N.D. Pham, 2007, "The Distribution of Ownership of U.S. Oil and Natural Gas Companies," a report prepared by SONECON, LLC. Available online at: http://www.sonecon.com/studies.php