WHAT BINDS US ALL 1

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

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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, the capitals of two of the most oil-rich nations 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 to spectacular levels once thought certain to put civilization on its knees. The first great oil shock in forty years has arrived. Yet rather than chaos, 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." Such a revolution, we are told, is essential for two other reasons: economic advance in the developing world and the advent of dangerous climate change. By themselves, these phenomena 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, the riches of electricity, automobiles, and modern lifestyles 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 seems assured, even unquestionable.

But now it is November, 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 brink of bankruptcy. And the price of oil? Nearly in free-fall, from a peak of $147 to below $45 in a mere three months. How final, then, the sentiments of "green is the new red, white and blue"?[1] Whereto

market solutions for a "clean tech" future when $billions are bailing out banks. As the financial turmoil deepens, questions arise. What will happen to all the progress that has been made in new energy technologies, with years of hope and money behind them? Will the "green bubble" burst? What about economic growth in China and efforts to deal with climate change? Could it be—irony of the fates—that with demand for energy falling everywhere, economic collapse will prove to be the quickest "method" to lower carbon emissions and control our resource appetites? Have we reached such a point of desperation or cynicism?

A year later, in late 2009, the financial crisis is being declared over, though its effects are forecast to last for years. What has been learned with regard to energy? Our global energy system, from oil wells to solar panels, along with the trends and forces that make it work, did not come to death and dissolution. The world, in fact, has more oil than ever, even more natural gas, and is more interested than ever in "green tech." Dozens of proposals have come forth in the U.S. about how to change everything for the better, whether by "going all green" or opening all offshore areas to drilling. To those who have spent their lives in the energy industry, the ground hasn't shifted in any profound way. Boom and bust, varied political winds, and old ideas served in new bottles have long been part of the geography, which is dynamic, evolving, always seeking a balance.

Yet the truth is that change has begun. Whatever the uncertainty of the moment, there are bedrock issues, some already venerable, to be sure, but others lately arrived. How can global civilization move forward, yet also ensure a safe future for both the human and extrahuman biosphere? How can we advance modern energy, for ourselves and the billions who desperately need it, while mitigating what this might mean to lakes, rivers, oceans, the atmosphere? Nations will continue to pursue their own self-concerned agendas about energy security—the U.S. and foreign oil; China and imports; the EU and its umbilical natural gas ties to Russia; OPEC and global demand for petroleum. But all are integrated deeply, irreversibly, and more than ever before into a global web of markets and relationships. 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. This is why "energy independence" is both impossible and, in the end, inadvisable. For politicians in an election year, it is a phrase 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 world petroleum demand, is simply too big a consumer, too dependent on oil itself (over 90% of *all* transportation in America is oil driven), to cut itself off in a decade or two from the world's major suppliers, such as Saudi Arabia, Venezuela, and Kuwait. Moreover, ending supply entirely from these nations could well bring unwanted effects—destabilization, for example, opening the door to fundamentalism, and the loss of U.S. influence on countries that also supply oil to its allies and the rest of the world. Lest we forget, too, America imports solar equipment from Germany, wind turbines from Denmark, and hybrid vehicles from Japan. The dream of absolute energy independence is an unwanted fantasy of energy isolationism.

Progress can come only in a different manner. For another bedrock truth is that the future of energy must be a global future, not a protectionist one. It is, after all, the developing world that now drives the greater part of our global system, accounting for eight out of every ten units of new energy used (be they barrels or Btus)—an astounding change from decades past. If we are concerned about fossil fuels, how much 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—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. Economic crisis hasn't removed any of the urgency from this domain—on the contrary. The recent oil shock wasn't like those of the 1970s, when actions by the Organization of Petroleum Exporting Countries (OPEC) created shortages and price spikes. Between 2002 and 2008, there were real problems of demand and supply, the one having grown too fast, the other too slowly. Too little new production was developed in the 1990s, and too few refineries were built, so that in the first decade of the new century the world of oil was caught unready for a surge of appetite from Asia. And with things so tight, there appeared threats to supply that had never really mattered before—hurricanes, sabotage, oil worker strikes. The global financial crisis thus (again, ironically) arrived to help loosen everything up, cool 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. Some lessons had been learned. In 2008, the U.S. had large fuel stocks and no price controls; this time prices were allowed to rise, and people responded by cutting back on driving. Iran, meanwhile, had gas lines for exactly the same reason in reverse, because it subsidized gasoline

to a huge degree, keeping it extraordinarily cheap (about 25 cents/gal in 2008) and demand for it therefore extremely high. A nation of over 65 million people with growing car sales, Iran in 2008 was the second largest importer of gasoline after the U.S. Its need for crude was soaring for another reason, too, since it uses oil to generate electricity. Yet its oil fields have been rapidly depleting, by 8%–11% a year. Instead of slowing this bleed, by investing profits in better recovery and upgrades to decrepit supply infrastructure, Iran has preferred to pour its cash into social welfare, to keep its poorer people "happy." What does this mean? With rising demand and falling production capability, future exports will inevitably suffer. At current rates, they could dwindle to small digits or even disappear before long. Thus Iran's claim that it needs nuclear power for electricity may indeed, in some part, have validity—as a mark of its own mismanagement.[2] Then there is Baghdad. Gas lines in 2008 came 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 in Iraq either.

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 moved from oil-consuming to oil-exporting nations. In 2008, oil revenues for Saudi Arabia and Russia, the world's two largest suppliers, reached $1 billion per day. Import levels were at 50% in China, 60% in America, higher in Europe, and in Japan and Korea over 85%. Meanwhile, there are no clear alternatives to oil on a mass, global scale. Despite these very basic facts, however, many people continue to speak of the "end of the fossil fuel era."

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) widely shared among experts in the industry.[3] The term, potent and suggestive, is often deserved, even if it doesn't capture the reality 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 that have been absorbed "along the way." Unfortunately, it is difficult to learn about energy in a nonpartisan setting, especially when it comes to the real world. 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 book 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. When completed, the manuscript goes to reviewers in similar settings, then to editors, also with computers, phones, printers, and more, powered, perhaps, by coal or nuclear energy. Next comes the paper mill, using more electricity and heat; the chemical plant, where ink is born (more power, 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 and 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 (kWh) per day, while in Europe and Japan, where homes are much smaller, the figure is half of that or less. But this leaves out entirely all the consumed energy embodied in building the house, and in manufacturing its contents—all the resources and electricity and labor that went into the making and transporting of each item of lumber and furniture, article of clothing, appliance, dish, toy. Wherever we live, we are, in a wholly literal way, utterly immersed at every moment in the things that energy consumption brings. Energy use is what binds us most immediately to the world around us, to our style of living, and to each other as well. To be free of all this would mean a solitary life in a fireless cave.

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 × 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"),

came up with a nice way of understanding these laws. I paraphrase him as follows:

First Law: You can't get something for nothing (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. Energy in society is about transformation—creating, building, altering, moving, and even demolishing things—and that the processes involved 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 to "waste" heat and friction. If the first law says that what you start with is all you've got, the second law says you'll be giving up some 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 large 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 ineffable mathematical formulas. They burn natural gas in stoves and gasoline or diesel in engines, use electricity to create light and wind to create electricity. "Energy" always means the use of some substance—fossil fuels, flowing water or air, enriched uranium, sunlight, volcanic fluids. It entails, first of all, specific resources.

Resources, however, bring with them the issues of availability, cost, impact, and sustainability. Unlike the ancient 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 still the global reach of fossil fuel dependence has not yet peaked; many parts of the world, as already noted, are rushing towards it. 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 world community, on *future* world communities, and on nature as well. "We all breath each other's air," notes atmospheric chemist Daniel Jacob. 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. For these and other reasons, climate has begun to affect the direction of energy policy. Over the long haul, this newest of priorities may well turn out to be a determining factor in compelling a different future.

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? 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 is no less a priority concern.

As I will stress throughout this book, the early years of the twenty-first century do place us at a special historical moment. We've noted three factors already that contribute to this: the new oil shock (and what it means), modernization in developing countries, and climate change. There are other issues, too—the role of technology, new concerns over energy security, and more—and we will discuss them also. Change is thus being urged by many things at once, not least geopolitics and 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 (thus ourselves)—what all this means, in real terms, for the long-term welfare of society. Together, all this is giving the world a particular bearing. Briefly put, the era of fossil fuels, while still dominant and likely to expand, is in transition. The nature of the transition—toward greater energy diversity, multiple and flexible sources, backed by advanced technology and new forms of government debate—is not simple, and progress will not come smoothly. But it is already well underway and, despite the recent financial meltdown, gaining momentum over time. A major decision facing nations individually and collectively 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 and major.

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 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 than ever before, and energy relations are at the axis. Despite enormous strides in technology and a deepened concern for geopolitical complexity, the world continues to rely overwhelmingly on the same fuels that it did a century ago and thus remains deeply embroiled in their politics.

I have said that the use of these fuels will likely expand a good deal further. What evidence might there be for this? Here are a few facts to contemplate. Between 2000 and 2009, car ownership in China grew by 400% and oil demand by more than 55%, making the country second only to the U.S. in total volume imported. By 2008, a thousand new cars were hitting the streets of Beijing every day, and a year later China exceeded the U.S. in new car sales (a historical first for *any* nation) with the country planning to build over 60,000 miles of new highways. Oil shock or no, the Chinese auto market has been the fastest growing in the world, with luxury models 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, modernity, and even historical destiny (China's rise from a "century of humiliation"), each new car on the road at this point 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. Many Chinese suffered some income loss or even employment in 2009, though nothing close to the West. A large number will have to put off buying a car, no doubt. Yet what does this signify? Unsatisfied demand, like water behind a gateless dam. As Detroit discovered in the 1950s, after two decades of depression and war, unfavorable economics can postpone the ability but not the desire to own a vehicle. No more than 5% of Chinese households had a car by 2009.

In fact, studies that compare post–World War II 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 leaps by a factor of two or even three. Based on this metric, China is poised for a future explosion in car buying like the world has never seen. Given the pace of rising incomes in the so-called BRIC economies (Brazil, Russia, India, and China) over the past decade, as well as the efforts of carmakers in these nations to provide affordable models

(including those under $8,000), economists project that by 2050 the number of cars in the world could reach a staggering 2.3 *billion* units.[4] Now, these may be projections based on optimistic income growth. Yet even by 2008, new car buying in developing countries matched that in the U.S. (about 14 million) for the first time, helping to bring the global total to nearly 60 million for the year.[5] We should understand that China, India, et al. are not going to turn back the clock, return to bicycles, and embrace the joys of subsistence farming (Mao tried this, with devastating consequences). History shows, again and again, that even the worst economic hard times merely defer development.

If even half of the 2.3 billion figure is realized by midcentury, this would mean over a billion new cars, more than doubling today's global fleet, estimated at around 700–800 million. Without some potent incentives that would convince carmakers to ditch their existing capital stock and retool for hybrids or other new technology, it is a good bet that a sizeable portion of this coming expansion will rely on hydrocarbon fuels—all the more likely, in fact, if alternative technologies remain more expensive.

In short, fossil fuel use will not merely expand. It will continue moving its center to the developing world. These nations, with 75% of humanity, are only at the threshold of major petroleum demand. A person in China used 2 barrels (bbls) of oil on average in 2007, compared with 13 bbls in Europe and 26 bbls in the U.S.[6] 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. What if China were to strive to match the U.S. in per capita use? This seems scary to contemplate, given known reserves and environmental effects. At such levels, the Chinese would require as much oil as the entire world does today.

CHANGE: IN THE AIR, ON THE GROUND

Such questions can inspire anxiety and a sense of coming ruin. But these feelings are far from the only justified response. A fuller accounting is needed to balance the reality. 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 ten to twelve years, and people often buy new vehicles sooner than this—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 happened in Europe. Over a twenty-year period, from the late 1980s to the late 2000s, diesel vehicles with up to 30% better mileage than their gasoline cousins grew to claim over half the new car market. This occurred not by magic or pure market forces. With a view to lowering emissions, governments negotiated directly with automakers, who 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 diesel over gasoline. The shift took advantage of advances in diesel technology, while stimulating much new R&D in turn. Better mileage pleased consumers, who pay the highest fuel prices in the world. Just two decades and a few nudges, therefore, were needed for Europe to embrace a different auto.[7] True enough, diesel cars are not exactly a radical departure from conventional technology. Yet the moral here is that the motive for change is very much alive and finding a place in daily life.

On a recent trip to southern Germany, in fact, I had occasion to ride in a small-model Mercedes that burns biodiesel fuel at an efficiency of 40 mpg (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 electricity, a solar-powered neighborhood on the outskirts of Frankfurt. Such, in short, is hardly an energy landscape of Judgment Day. Change is not merely in the air, but everywhere on the ground. This does *not* mean, however, that such change comes pure and without its own complexities.

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 biofuel 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 rain forest 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.[8] This society has arrived, on the wings of high technology, the info-revolution, the transfer of heavy industry to developing nations, and all this has involved.

Yet 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 twentieth century, nuclear power, is also in this camp. So is its twenty-first-century relation, fusion power, a hope for the future.

Returning to our central point, advanced societies are taking the energy transition in hand, though perhaps with a tremble and one finger at a time. They 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 make their own destiny, forge it with ideas. 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 wholly exciting to contemplate.

CAVEAT LECTOR: A NOTE TO THE READER

Few topics are more highly charged than energy. Partisanship is endemic, advocacy frequent, bias expected. Why is this so? It is because energy issues evoke some of the most fundamental questions about the nature of society. Name any related subject—the place of nuclear power, a plan for a carbon tax, the need for public transport—and in the timbre of

discussion you will hear, close by, ideas about whether our civilization has been progressive or regressive, whether it is a bringer of treasures or tragedies, 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" lies a broad rainbow of opinion and reality. It is not all about eco-vegans, who think Western society qualifies as an unmitigated disaster, battling cigar-smoking capitalists who prefer Hummers to hybrids. Doubtless many would be shocked to learn that a majority of those in the petroleum industry accept the truth of climate change and 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 views 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. Moreover, *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 have led to the destruction of rain forest. Accuracy demands that we not oversimplify.

Second, because this book is concerned with realism, there is little support in it for the belief that oil is liquid evil and renewable energy is ready *now* to change the world, if only 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 oil is such a potent liquid and 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, 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 petroleum rests not with ExxonMobil and friends, who control less than 10% of global reserves, but with the national oil companies of OPEC and Russia, which 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. Americans, meanwhile, may love to rant at Big Oil, even as they have long driven the largest, most fuel inefficient vehicles on the planet and voted 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.[9] 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.