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Chapter 2
The End of the Easy Oil

Two miles off the coast of Azerbaijan, on a windswept strip of land called Sand Island, the former glories of the Soviet oil empire rust away beneath a relentless Eurasian sun. Twenty years ago, this three-hundred-acre island was the toast of the Soviet oil industry, with row after row of gushing wells and thick pipelines crossing the water to refineries in Baku. Then oil production hit its natural peak, the flow subsided, and Sand Island fell into the kind of profound industrial decay that Hollywood spends millions trying to replicate. Rusting pipelines line the roads. Empty buildings, some still sporting the red Soviet star, lean at odd angles. Old barrels, bits of broken machinery, and permanently parked trucks litter the grounds, while just offshore a line of gigantic rust-colored oil derricks, most of them abandoned, marches away toward the horizon. "No pollution," insists Sahib Siradjev, my translator from Azerbaijan's State Oil Company, for maybe the tenth time since we drove onto the island. "You can fish here."

Inside an old administrative building, we are met by Huseynov Vaqif, general manager of Sand Island — a big wedge of a man with a beefy face, beautifully coiffed silver hair, and a reputation in Caspian oil circles as something of a star. When he was brought to Sand Island in 1996, the easy oil was long since gone. The entire operation was producing barely 1,500 barrels a day — hardly enough to pay the salaries of its 1,600 employees. Vaqif swung into action. In booming, rapid-fire Russian, he tells me how he retrofitted old wells and sank dozens of new ones, some as deep as two miles, eventually increasing the flow on Sand Island by a factor of nearly three — and all this despite limited resources and a fraction of the technology Western oil companies take for granted. "Put me anywhere, and I can get you the last drop of oil," boasts Vaqif, standing beneath a huge, hero-of-the-people portrait of Heydar Aliyev, the former Azeri president. "Even if they put me on the moon."

Vaqif, unlike his counterparts at Western oil companies, actually seems pleased to have a media person on the island. Untroubled by the dilapidation around him, he barks out orders that I be driven around the facility, then hosts me at a sumptuous luncheon of borscht, sturgeon, and vodka. Later, over tiny glasses of sweet Azeri tea, Vaqif presents me with autographed copies of an engineering manual he himself penned and gently lectures me on the superiority of Soviet-trained oil engineers. Western oilmen are "too specialized," says Vaqif, pausing briefly to shout into his desk intercom at some distant underling. In the former Soviet Union, Vaqif continues, oilmen were trained to rely on their instincts. "You must work with an oil well as you would with a lady," he tells me. "That way, she won't refuse you."

As Vaqif walks us back to the car, bouncing along in jaunty good humor, it seems the wrong moment to point out that his "ladies" have in fact been refusing him ever since he arrived on Sand Island, and fairly assertively. Although production has indeed nearly tripled here, current output is still barely a sixth of what it was during the time of peak production, in 1986. At this rate, the flow of oil will slow to a trickle within a few years, and Sand Island will permanently enter the ranks of the abandoned fields that now surround the city of Baku, the fading former capital of the old Soviet oil empire.

Sand Island is little different from thousands of other former boomtowns in Texas, in Pennsylvania, on Borneo, and elsewhere — richly endowed oil frontiers where the industry came in, erected an enormous and expensive infrastructure, and then, when most of the oil was gone, packed up and moved on to the next big strike. At one level, Sand Island will hardly be missed. Historically, oil companies have been so adept at finding new oil fields that the loss of a single

operation is a microscopic blip in global oil production, which has surged relentlessly from half a million barrels a day in 1900 to around eighty-two million barrels today.

Yet as the unfortunate Vaqif knows quite well, what goes up must come down. Oil is a finite substance, and at some point, just as Sand Island's volumes have fallen off, all the oil being discovered around the world will no longer replace the oil that has been produced, and global production will peak. Oil companies and oil states will find it harder and harder to maintain current production levels, much less keep up with rising consumption. Demand will again outstrip supply, and prices will rise.

Worse, although the term "peak" suggests a neat curve with production rising slowly to the halfway point, then tapering off gradually to zero, in the real world, the landing will not be soft. As we approach the peak in production, soaring prices — seventy, eighty, even a hundred dollars a barrel — will encourage oil companies and oil states to scour the planet for oil. For a time, they will succeed, finding enough to keep production flat, stretching out the peak into a kind of plateau and perhaps temporarily easing fears. But in truth, this manic, postpeak production will simply deplete remaining reserves all the more quickly, thereby ensuring that the eventual decline is far steeper and far more sudden. As one U.S. geologist put it, "the edge of a plateau looks a lot like a cliff."[1]

In short, oil depletion is arguably the most serious crisis ever to face industrial society. And yet, according to Colin Campbell, a former Amoco oil geologist and currently the eminence grise of the so-called oil pessimists, "governments remain pathetically ill informed and unprepared."[2] For years, the official line of the big importing nations, the big exporting countries, and the big international oil companies, with few exceptions, has resembled that of an annoyed parent dealing with an overly curious child. Yes, yes, yes, we're told, in tones of exasperation and condescension, oil production *will* peak — eventually; but that isn't something humanity needs to worry its pretty little head about anytime soon. Not only are the known reserves of oil enormous, we're told, but oil scientists, engineers, and other clever types are getting better at finding *new* oil in unexpected places — in the North Sea (in the 1960s), for instance, or off the shore of Angola (in the 1990s).

Factor in the indescribably vast reserves of so-called unconventional oil — whether in the form of the molasseslike "heavy oil" in Venezuela, for instance, or the oil-bearing tar sands in Alberta — plus all the known reserves of natural gas (which can be processed into synthetic gasoline and diesel) — and, say optimists, the world won't reach a peak in production for fifty or sixty or a hundred years. Such a buffer, optimists say, leaves us plenty of time to develop new energy technologies and ensure an orderly transition to a post-hydrocarbon order without having to take rash or costly emergency measures, or even to upset ourselves thinking about it.

To the extent that governments and energy companies even mention long-term oil prospects publicly, it is almost entirely in a political "if only" context: we could have as much oil as we needed *if only* OPEC would stop limiting the supply; or *if only* oil companies were allowed to drill in the Arctic National Wildlife Refuge; or *if only* malcontents in Iraq would stop blowing up their own oil pipelines. According to this view, any concerns relating to long-term oil can be addressed through legislative, diplomatic, or, on occasion, military means. Long-term oil supply is, in other words, really a question of political will, of deciding how much oil we need and then going and getting it.

In truth, however, as some energy companies and government agencies tacitly acknowledge, the optimists' rosy picture is far from accurate. Though vast quantities of oil still remain in the ground, most is what might be called *theoretical* oil — it may exist, but in highly uncertain and even problematic environments: deep below the Arctic ice, for example, or in small African regimes wracked by civil war. Or, most important, inside the oil fortress known as OPEC, whose political machinations will affect long-term supply more powerfully than any geology. Thus, our ability to get at this theoretical oil, and to use it, depends on a myriad of variables — technological, economic, financial, and political — that are, at this point, hard to predict and even harder to control.

In other words, although we will not run out of oil tomorrow, we are nearing the end of what might be called the easy oil. Even in the best of circumstances, the oil that remains will be more costly to find and produce and less dependable than the oil we are using today. This fact means not only higher prices, but more volatile prices, which will make it harder to see how fast oil

supplies are being depleted, and harder still to know when we'll need to start looking for something new.

So when do we peak? In theory, the production of oil reaches a peak when half the original supply has been pumped from the ground. This holds true whether you're talking about a single oil well or the collective behavior of all oil wells on the planet: with half the supply gone, it simply gets harder and harder to maintain the same levels of production — the same number of barrels per day — and eventually, production falls.

Presumably, if we know the total volume of oil the world had to begin with, as well as the amount of oil we've already used and the amount we will use in the future (calculated from forecast energy demand), we can predict the arrival at a depletion "midpoint" and thus the production peak; but of course, we don't know the total volume. Although we are reasonably sure how much oil we've used since the dawn of the oil age — around 875 billion barrels — estimates of the amount of oil still in the ground are tremendously suspect, and therein lies the crux of the problem.

Generally, when we ask how much oil is left in the ground, we're talking about two kinds of oil — proven and undiscovered. "Proven" is the term used for oil in fields that have already been discovered but not yet pumped out. Proven reserves are essentially the inventories held by oil companies like ExxonMobil and oil states like Saudi Arabia or Norway. According to the U.S. Geological Survey (USGS), one of the most respected and widely quoted oil agencies in the world and a leader among the so-called oil optimists, the world's proven reserves stand at 1.7 trillion barrels, over half of which are in the Middle East.[3]

"Undiscovered" oil, by contrast, is oil whose existence has not yet been confirmed by the drill but is strongly indicated by various geological markers. Undiscovered oil is the exciting oil — the stuff of romantic stories about hardy John Wayne types, "wildcatters," who risk their lives searching steamy jungles and barren steppes in hopes of striking a gusher (even if oil exploration is essentially automated these days). In theory, undiscovered oil fields are scattered around the world, although certain regions appear favored — among them, Siberia, western Africa, eastern South America, and the Caspian. According to the USGS, undiscovered oil amounts to around 900 billion barrels. Adding proven and undiscovered oil deposits together, we get a total of 2.6 trillion barrels. Assuming that world oil consumption, now 80 million barrels a day, continues to grow at the rate of 2 percent per year, a 2.6 trillion-barrel reserve has us hitting our peak somewhere around 2030 — or even later if world oil consumption slows.[4]

The problem is that both numbers, those for proven and for undiscovered, are doubtful. Estimates of proven reserves, for example, are routinely exaggerated for economic and political gain. The classic case came in the late 1980s, when the six big OPEC producers — Kuwait, the United Arab Emirates, Iran, Iraq, Venezuela, and Saudi Arabia — collectively added more than 300 billion barrels to their stated reserves. The move nearly doubled reserve numbers that had been on the books for years and, in one stroke, "delayed" a peak in world production by nearly a decade. Saudi Arabia alone, owner of the largest oil reserves in the world, raised its estimate from 167 billion barrels to a breathtaking 257 billion barrels, overnight.

Why is this figure suspect? Generally speaking, oil producers revise their reserve estimates in only two situations: when discoveries are made or when some new assessment methodology reveals that they have more (or less) oil in existing reserves than previously stated. But none of the six OPEC countries had announced any significant new discoveries during the 19805 or 19905, nor had assessment technologies suddenly improved. The six countries themselves claimed to be correcting for past mistakes: the Western oil companies that founded Middle Eastern oil operations had routinely underreported the size of their reserves.[5] Yet although some correction was in order, it is worth noting that the upward revisions just happened to coincide with a 1985 OPEC edict stipulating that the higher a member's stated reserves, the more oil that country could export and thus the more revenues it could earn. Going country by country, says Campbell, the Amoco geologist-turned-pessimist, it becomes apparent that the revisions were largely bogus. "It is obviously absurd to imagine that Iraq, for example, has increased its reserves fourfold since 1980," says Campbell, "when much of the time it was at war or embargoed."[6]

This is classic "pessimist" rhetoric, and it tends to reinforce the image of the oil pessimists as conspiracy nuts who believe that the energy-industrial complex is trying to conceal the imminence of the peak in oil production. Campbell, in particular, a stout, square-faced Englishman with a serious tone and a penetrating, gloomy stare, has earned the undying enmity of oil executives everywhere by repeatedly declaring their reserve estimates to be bald-faced lies. "If you get to meet with Shell and BP," Campbell warned me once, "I recommend that you admit to no contact with myself, whom they apparently regard as a terrorist."

Yet for all their dark theories and occasional paranoia, oil pessimists are right to challenge the oil numbers being tossed around today, because in many cases those numbers simply don't make sense. Take the estimates for "undiscovered" oil. Many optimists, including the USGS, believe that a huge amount of oil remains to be found — anywhere from 1 trillion to 1.5 trillion barrels. The problem is, few places on earth remain where all that oil could be hiding but where oil companies have not already looked. Oil is not a random geological event, something that can occur just anywhere. It is the product of complex geological processes that take place only in certain quite specific conditions. As we saw in the story of Spindletop, you must first have *source rock* — the deeply buried sediments rich in organic matter. It is also necessary to have a migration pathway — cracks or porous rock through which the newly formed petroleum can escape toward the surface. Finally, a layer of impermeable stone or clay or salt is required, to trap the petroleum and create a reservoir, or field.

This three-part source-reservoir-trap configuration — "a petroleum system," in geologists' terminology — constitutes an underground hydrocarbon machine that generates, transports, and stores oil and gas. Petroleum systems exist all over the world and comprise anything from smallish entities producing just a few hundred barrels a day to the four massive systems in the Middle East that together account for half of the world's known oil reserves. Yet for all their variety, all petroleum systems operate according to a set of rigid natural rules. The source rocks, for example, must contain enough organic material to generate usable volumes of oil and gas. The migration rock must be sufficiently permeable, or the oil won't flow freely through it. The cap rock must be sufficiently impermeable, or the oil will simply leak away.

Above all, the timing must be perfect. To become oil, the organic material in the source rock must be heated to a certain temperature for a certain period of time. Typically, this happens when the source rock gets buried and, over millions of years, is pushed downward, into what oil scientists call the "kitchen" — a geological zone between ten thousand and thirteen thousand feet below sea level where temperatures are high enough (100 to 135°C) to boil organic matter into petroleum. Petroleum forms only in the kitchen. Source rock that isn't pushed low enough will not be cooked, whereas source rock that is pushed too far, past the kitchen, becomes too hot, and the petroleum is either "cracked" into gas or simply destroyed. There is no halfway: the conditions for oil either exist or they don't. Nor are there any guarantees: even if a system meets all these criteria, it may still reveal itself to be empty when oil companies pierce it with their drills. Many older petroleum systems have produced oceans of oil in the distant past, only to have it leak away millions of years before humans even knew what oil was.

Oil, in other words, is a relatively rare phenomenon, produced only in certain geological spaces, under certain conditions, and within a shallow zone just below the surface of the earth. Worldwide, there exist approximately six hundred petroleum systems capable of producing commercial volumes of oil and gas. Of these, approximately four hundred have been explored. The remainder lie in places like the Arctic or in deep offshore waters — remote, hard-to-reach areas that oil companies have turned to only after exploiting the more accessible oil.

This state of affairs helps explain why oil exploration has become so much more difficult in recent decades. Not only are the remaining "undiscovered" systems harder to reach, but they are likely to be smaller: historically, larger systems, being easier to find than smaller ones, have tended to be discovered first. What is more, oil companies prefer to develop the large discoveries first and put off exploring the smaller, less profitable fields until later. "In any region, the large fields are the biggest targets and are usually discovered first," says petroleum geologist Joseph Riva, a former oil analyst with the U.S. Congressional Research Service (CRS). "As exploration progresses, the

average size of the fields discovered decreases, as does the amount of oil found per unit of exploratory drilling."[7] Or in plain English, remaining undiscovered fields not only will be smaller but are likely to yield ever-smaller volumes of petroleum.[8]

In fact, when one charts the average volume of oil that has been discovered each year since the beginning of the century, it becomes clear that new oil is indeed getting harder to find. Year by year, the volume of newly discovered oil — that is, the number of barrels found each year and recorded in the books as known or discovered reserves — climbs steadily upward from 1860 until around 1961, when it peaks. Since then, oil companies have found, on average, a little less oil each year — with the exception of a small blip in the late 1990s, as big finds were announced in the Caspian, off the shore of West Africa, and in the Gulf of Mexico. In fact, since 1995, the world has used at least 24 billion barrels of oil a year but has found, on average, just 9.6 billion barrels of new oil annually. According to a study by Wood Mackenzie Consultants, industry is finding less than 40 percent of the new oil it needs to keep the base of known reserves from shrinking.

Barring some fairly spectacular disruption to historical patterns, there is little reason to expect anything to alter the downward trajectory of discovery. "We've been drilling holes all over the world since the early 1900s," says Les Magoon, a geologist with the USGS who has mapped world petroleum fields for three decades and does not share his employer's optimism. "Statistically, it's unlikely that there is all this 'hidden resource,' waiting to be found; [it] is pretty hard to support scientifically."[9]

Indeed, according to pessimists, when we use these more realistic forecasts of future oil discoveries, our estimates for the world's total remaining oil — proven and undiscovered — drops to a trillion barrels (not 2.6 trillion, as the USGS claims) and puts the peak at around 2010. That doesn't leave us a lot of time — certainly not enough time to prepare for the kind of consequences that a peak is expected to unleash. Even if we assume that the peak would actually be a plateau, with the "cliff" pushed out till, say, 2016, the deadline is still fairly imminent, given the size and value of the oil-based infrastructure — the tankers, the pipelines, the refineries, 7475, Greyhound buses, and, above all, cars — that would need to be upgraded or replaced outright. "The point to remember about production isn't that it peaks, but that it declines rapidly afterward, at a time when the world demand would be moving rapidly in the opposite direction," Joe Romm, former acting U.S. assistant energy secretary for the Clinton administration, told me last year. Once a decline begins, Romm says, "there is very little time for the U.S. to react."[10]

On the road back from Sand Island, crammed into the backseat of the oil ministry's tiny Lada sedan, Sahib has finally stopped reminding me about the cleanliness of the water. We are bouncing along through yet another dreary petro-landscape — treeless brown hills, rusty pipelines, oily lakes, and mile upon mile of oil derricks — interrupted periodically by an olive grove or a flock of dust-covered children. As we approach Baku, the hills sink lower, sprouting apartment blocks and refugee shantytowns, before giving way to a broad plain of oil refineries, factories, and soot known as the Black City — the heart of the old Soviet oil empire. We pass a shipyard, where a massive oil-drilling rig lies on its side, its bright new paint in stark contrast to the surrounding decrepitude. In the seat next to me, Sahib seems to revive. He taps on the window and tells me how the platform will soon be taken by barge out to the new fields in the Azeri sector of the Caspian Sea, "where the really big oil is."

In the 1990s, in what was dubbed the deal of the century, a consortium of Western oil companies paid Azerbaijan eight billion dollars for the right to look for oil in the seabed a few miles off Baku, far from Sand Island and Azerbaijan's other antiquated oil fields. Soviet engineers had long suspected the presence of huge oil reserves beneath the deep Caspian waters yet lacked the technology to prove the oil existed, to say nothing of actually pumping it out of the ground. Within a few months of signing the deal, Western operators, armed with the latest seismic technology and deep-water drills, struck pay dirt at Chirag-Azeri-Gunshali, a supergigantic formation initially believed to hold some 3 billion barrels of oil — enough to earn Azerbaijan anywhere from eighteen billion to thirty billion dollars a year in oil revenues, depending on oil prices.

The promise of such oil wealth has become a national obsession in Azerbaijan. In speeches and ads and on billboards and huge banners, Azeri politicians lose few opportunities to remind voters how bright their future is. Sahib, who worked on some of the first oil company negotiations, recalls them proudly — not least because they involved lavish trips to the United States. "I have been to Houston many times," he tells me, with the nonchalance of a world traveler. "I have stayed at the Hilton, the Hyatt. I also went to New Orleans. What a town. *'Show us your teets!'"*

Many in the oil business share Sahib's enthusiasm. Western analysts described the Azeri deal, the first of many between Western oil companies and various Caspian governments, as a geopolitical win-win: a desperate former Soviet republic gets oil revenues; the industrialized world gets an alternative to Middle Eastern OPEC oil. Thus far, Azerbaijan has been slow to build up its offshore operations, and the massive Chirag-Azeri-Gunshali and other fields have generated only a modest flow of oil — less than a million barrels a day. But officials with the State Oil Company of the Azerbaijan Republic, or SOCAR, insist that production is growing and that the "big oil" is just around the corner. By 2010,I am told, Azeri production will reach 2 million barrels a day. And in the meantime, estimates of Chirag-Azeri-Gunshali's total size are updated almost monthly, as new test wells are sunk and operators find new oil: as recently as 2003, Azeri officials claimed the field contained at least 4.7 billion barrels of oil.

To many in the oil industry, stories like this help justify the optimistic scenarios for future oil discoveries — and go a long way toward dispelling the more pessimistic predictions about the end of oil that have lingered since the oil shocks of the 19705. Thirty years ago, the world truly did seem to be running out of oil. In 1971, U.S. production had peaked. After serving as the world's oil pump for nearly a century, America could no longer cover global oil shortages, much less meet its own domestic needs, simply by opening the taps in Texas and Oklahoma. Henceforth, those taps would remain wide open pretty much twenty-four hours a day, and still it would not yield enough. America's reign as the dominant oil power was over, and newer oil producers were quick to take advantage of it. In 1973, when Arab oil states like Saudi Arabia and Iraq cut off oil shipments to America, the United States watched helplessly as oil prices tripled and the world economy plunged into deep recession.

Fearing that a similar peak might be imminent for world oil, energy analysts scrambled to assess global oil supplies. The early forecasts were not encouraging. By most estimates, the world's proven reserves stood at around 1.3 trillion barrels, which, at the then-current rate of consumption, would not last very long. Esso (later Exxon, then ExxonMobil) predicted a peak in 2000, as did Britain's Department of Energy. Royal Dutch-Shell said production would plateau by 2005."

By the time revolutionaries shut down Iran's oil fields in 1979, sending oil prices to their highest level in history, oil pessimism had become the reigning paradigm in Western political and economic circles and a fixture of popular opinion. Convinced that oil depletion was imminent, Western governments and consumers embraced energy conservation with patriotic fervor, while environmentalists and energy activists welcomed the opportunity for a new, cleaner energy order. Meanwhile, an army of experts, many of them former oil company geologists, devoted themselves to calculating the date of the peak and creating highly detailed and gruesome postpeak scenarios, most involving worldwide recession, political chaos, and the military conquest of the Middle East by desperate industrialized nations.

But as in times past, depletion anxiety was quickly replaced by a surge of oil optimism. In 1975, spurred on by the high prices caused by the Arab oil embargo, oil companies began producing enormous volumes of oil from the North Sea, a deep-sea frontier previously dismissed as too technically challenging to develop economically. Two years later, huge volumes began to flow from extensive fields on Alaska's equally inhospitable North Slope.

Optimists say that these successes and the many more since highlight a major flaw in the pessimists' theory: namely, their failure to credit the oil industry for becoming much cleverer since the gloomy 1970s. Barred from access to "easy" Middle Eastern oil, oil companies were forced to reinvent how they looked for and produced oil, and the results have been astonishing. Drills today can now reach ten miles underground, move in any direction — even horizontally — and

electronically detect oil and gas. Operators employ powerful supercomputers to create stunning three-dimensional seismic images of underground structures, showing precisely where oil- and gas-bearing rocks are and even identifying the best routes for drilling.

For the industry, this explosion of technological advances has had three major effects. First, companies can now work in nearly any climate or environment, from permanently frozen tundra to a floating platform anchored two miles above the ocean floor — places previously dismissed as technically or economically impractical, like the Caspian or even frigid Siberia, which is widely regarded as the "next" oil frontier. Thus, each year oil that was regarded as unreachable — or "unconventional" — becomes conventional. For example, new production technologies are even allowing oil companies to produce previously unusable oil, such as the molasseslike "heavy" oil of Venezuela and the massive reserves of tar sands in Alberta, Canada; indeed, the government of Alberta now claims to have "reserves" equivalent to more than a *trillion* barrels of oil.

Second, companies have dramatically increased the amount of oil they get from a given field. As recently as the 1970s, drillers were lucky to extract 30 percent of the oil from a field, while effectively leaving 70 percent in the ground as "unrecoverable."[12] Even today, in less-developed oil regions, like Saudi Arabia, recovery rates are said to average just 25 percent. But with new mapping and drilling technology, operators can see where the remaining oil lies within a reservoir, and then drop in a precisely targeted new well to reach it. Such techniques have raised recovery rates to as high as 80 percent — a success that not only has boosted yields at new fields but is allowing companies to revive declining and even abandoned fields.

Worldwide, according to the USGS, enhanced recovery technologies will add another seven hundred *billion* barrels of oil to the world's tally of remaining oil — and delay by years the peak in production. Dan Butler, an analyst at the Energy Information Administration, the very optimistic forecasting arm of the U.S. Energy Department, says some of the biggest potential for improving recovery is in the Middle East. "The Saudis have very primitive operations," says Butler. "They just let the oil gush out. But if you could get another 5 percent out of Saudi Arabia and the rest of the Middle East, you would up your reserve base by at least a hundred billion barrels."

Third, companies are much smarter at knowing where to look for oil. New geological understandings — for example, that oil can form anywhere within dozens of miles of a river delta, even in superdeep waters — have led to a welter of new discoveries in unexpected places, like the deep waters off the coast of West Africa. Deep-water oil is touted as the real frontier of the future and is the place where most oil companies and many analysts expect to find the bulk of the undiscovered oil. Excitement is particularly keen over "deltaic" prospects in the deep-water Gulf of Mexico, off the coast of Africa and Brazil, as well as in the Arctic provinces of Canada and Greenland, Norway, and Siberia, where seismic surveys reveal subterranean structures identical to those beneath the oil-rich North Sea, but far larger. "The Arctic is going to be the next big play," promises Tom Ahlbrandt, the director of the USGS world assessment project and a prominent oil optimist. "We feel that more than half of all undiscovered resources are in the deep offshore, of which half are in the Arctic. And we've looked at only seven Arctic provinces; there are twenty-eight more we need to look at. We haven't even begun to discover all the oil that is out there."[13]

But even the USGS is not the last word in oil optimism. When U.S. policymakers want the most positive energy forecast, they turn to the U.S. Energy Information Administration (EIA). Whereas USGS forecasts take into account only oil that could be extracted with today's technology and at today's oil prices, the EIA assumes substantial improvements in both — with encouraging results. So, for example, while most optimists believe that the Caspian region might hold 100 billion barrels, EIA numbers show a staggering 292 billion barrels of "ultimately recoverable reserves" in Kazakhstan, Azerbaijan, and other "-stans." The EIA further believes that newly discovered fields off West Africa and South America may, when combined, come close to rivaling those of some Middle Eastern states. "It's probably not a new Saudi Arabia," says EIA's Butler, smiling faintly, "but certainly enough to push the world production peak to 2035."[14]

Butler's comment about a "new Saudi Arabia" bears closer scrutiny. No matter how good we get at finding new oil, the world oil map remains fundamentally unchanged. We may find reserves in Africa, in Siberia, and elsewhere. Sooner or later, though, we must come back to the fact that the lion's share of world oil is in the Middle East, controlled by OPEC, a cartel of unfriendly, unstable regimes that already exercises too much control over world oil prices and will gain even more sway once oil fields outside the OPEC countries have begun running out. Thus, although it will eventually be important to know when *total* world oil production will peak, for now, when governments and oil companies and pessimists ask about a peak, what they really want to know is, When can we expect a peak in *non*-OPEC oil, the free oil, the oil we have a chance at exploiting?

This is where the depletion picture really gets ugly. Clever though we may be at finding new oil, the fact remains that there is simply less of it to be found in the regions outside OPEC control. Yes, exploration technologies have improved dramatically. The supercomputers that companies brought in during the 1980s to help map out new fields and zero in on oil did in fact yield a burst of discoveries. But neither supercomputers nor anything else has been able to halt the long-term decline in new discoveries outside OPEC, where oil producers and international oil companies alike continue to pump out more oil than they can replace through exploration.

Where the non-OPEC world's troubles are most evident is in the decline of the supergigantic oil fields — those massive, multibillion-barrel behemoths that could change a third-world nation into an oil empire but which now rarely come to light. The two largest fields exploited in the last thirty years have been Kazakhstan's Kashagan field, with an estimated fifty-five billion barrels, and Kuwait's Kra al Maru, reportedly of similar size. And while this *is* a lot of oil — enough to keep the world humming for about four years — we should note that it is not non-OPEC oil. Kra al Maru is in Kuwait, which is part of OPEC.[15] Kashagan is in Kazakhstan, which, though technically outside OPEC, was similarly off-limits to Western exploration methods until the early 19905. (When international oil companies were allowed into Kazakhstan, they found Kashagan in about thirty-six minutes.)

If we want to see the last monstrous non-OPEC fields, we have to go back all the way to South America's Canatrell, discovered in 1976, and Prudhoe Bay in Alaska, found in 1968. Giant fields are still being uncovered outside the OPEC countries, but mainly in the one-billion-to-three-billion-barrel range — again, substantial volumes, in absolute terms, but piddling by comparison with superstars of yore. The trend is clear: in places where international oil companies have been allowed to look — that is, places that OPEC does not control — the industry is finding smaller and smaller fields.

To be sure, this reality tends to get lost amid all the hullabaloo over the "next hot prospect." A decade ago, the deep-water Gulf of Mexico was supposed to be the new El Dorado, although after a string of successes, it has disappointed. British Petroleum's biggest find — the 1.5-billion-barrel Thunderhorse field[16] — barely qualifies as a supergiant, and other companies have been similarly frustrated. ExxonMobil's chairman and CEO Lee Raymond has gone so far as to complain that "the best thing ExxonMobil could have done after it drilled its first well in the Gulf was to never drill another again."[17]

Declining field size is one reason that many of the large oil companies have recently been missing their growth targets and are struggling to "replenish" reserves — that is, to discover a new barrel of oil for each one they produce. Adds analyst Fadel Gheit, "The low hanging fruit has already been picked. There *is* more fruit, but it's harder to pick."[18]

The story is the same whether we're talking about oil companies or entire oil provinces. Despite billions of dollars in investment by the industry, production in oil fields in Alaska, the Western Basin of Canada, and Britain's North Sea — once-prolific regions that provided the oil economy with a bulwark against OPEC — is today in steep decline. In the North Sea, for example, oil companies recently celebrated the discovery of the 1.1-billion-barrel Buzzard field, but it was not enough to keep the United Kingdom's production from peaking in 2002 at 2.3 million barrels a day and falling to 1.8 million barrels a day the next year.[19]

Depletion is rampant. Mexico, the sometime ally of the West and a loyal supplier to the United States, could reach its peak as early as 2005. Nigeria, which the United States is trying to woo

away from OPEC, could peak by 2007. Worse, Norway, whose state-owned oil company, Statoil, exports three million barrels a day and consequently ranks as the third-largest exporter, behind Saudi Arabia and Russia, is likely to see a production peak in 2004. Even the mighty gush of Russian oil is beginning to look temporary. Since the fall of the Iron Curtain, Russian oil production has come roaring back, and today every major Western oil company with a passport is in Moscow, bidding for a share of Russia's near-mythic petroleum riches. U.S. diplomats, meanwhile, are wooing Moscow to be America's chummiest (non-Arab) oil supplier. Yet although Russia does have a great deal of oil — perhaps as much as 200 billion barrels, according to the congenitally optimistic EIA — that is peanuts by comparison with the nearly 850 billion barrels believed to be held by Saudi Arabia and other Arab states. And whereas most OPEC states are restricting their production (in an effort to keep world supplies tight and prices high), Russian oil companies are producing at full throttle, and many experts expect a Russian peak no later than 2015.

This, then, is the final act in the oil saga. According to even optimistic projections that take Russian oil into account, non-OPEC oil production could peak by 2015 — at which point, the world's big importing nations will be forced to turn to the one supplier they trust least: OPEC. OPEC, of course, faces a peak of its own — probably sometime in 2025. Yet as long as OPEC's peak comes later, the effect is the same: world oil supply will come increasingly under the control of a cartel with a history of rash behavior and dubious sympathy for the West. By some estimates, as early as 2010, even before a non-OPEC peak, the countries of OPEC will be supplying approximately 40 percent of the world's oil, up from around 28 percent today. Presumably, its share will rise dramatically as non-OPEC oil production falls. What this will mean for the oil markets, and for energy geopolitics generally, is impossible to say. But to judge by deteriorating relations between the oil-consuming West (read: the United States) and many players in the Arab Middle East (read: Saudi Arabia), few of the possible scenarios are very encouraging. At the very least, OPEC countries would be fairly free to push prices higher than they are now, without fear of competition from non-OPEC producers. The last time OPEC had such control over oil prices, during the 1974 Arab oil embargo, Western powers came close to intervening militarily and simply *taking* the oil. By some accounts, only the threat of a counterstrike by the Soviet Union kept them from doing so, and that deterrent no longer exists.

If depletion is just around the corner and the consequences of a peak in non-OPEC supply are so grim, why then, oil optimists ask, has panic not set in? If scarcity were truly imminent — that is, if supply were showing signs of falling behind demand — then oil prices should already be much higher. Today's oil markets are hair-trigger sensitive: a single suicide bombing in Jerusalem is enough to send prices soaring, because from an oil trader's perspective violence increases the probability of war in the Middle East and thus a short-term disruption in Middle Eastern oil exports. Presumably, if traders got even a hint of a more permanent disruption in oil supplies — a peak in world oil supply, for example — they would scramble to buy up as much oil as they could, in hopes of selling it for a higher price later. Indeed, the scramble to buy would send up prices now, well in advance of an actual shortage, and the higher prices would then provide what economists call a signal to consumers and politicians, telling them to either conserve or find an alternative — as happened during the oil shocks of the 1970s. The fact that this is not happening — despite occasional spikes, oil prices have averaged twenty dollars a barrel for decades — is proof, optimists say, that a peak is by no means imminent.

There are, of course, a few flaws in this reassuring argument. First, one reason we haven't seen a price signal is that we couldn't: there has been too much slack in the oil markets. Although non-OPEC producers — the international oil companies, plus countries like the United States and Russia — have been pumping at their maximum, the situation in many OPEC countries is different. In fact, countries like Saudi Arabia, Kuwait, and Venezuela have historically held back: they have extra wells, pumps, and pipelines that are not being used but can be brought into use in fairly short order.

Until recently, OPEC had as much as three million barrels a day above world demand, and this surplus capacity has come in handy, allowing OPEC to fill in supply gaps when Iraq or Venezuela suddenly stops producing. Unfortunately, spare capacity, or "overhang," also serves to cloud the supply-depletion picture, because it muffles any signs of production difficulties. If non-OPEC production begins to fall, OPEC countries can call on their spare capacity before markets get too tight and prices rise too high. As a result, no price signal is sent. Thus, with this overhang in place, one can imagine a scenario in which non-OPEC oil could actually peak but no one would notice for some time. Or as Matt Simmons, an oil industry investment banker and depletion expert who advises the Bush administration on energy issues, puts it, "Peaking of oil and gas will occur, if it has not already happened, and we will never know when the event has happened until we see it 'in our rear view mirrors.'"[20]

Second, in order for price to reflect changes in supply accurately and thus warn us whether depletion is actually taking place, the market in question must be relatively free, which for oil is not the case. In a free oil market, where all oil was accessible to whoever could pay for it, oil companies would always produce the easiest, most accessible oil first, because it costs less to do so. As that easy oil was depleted, companies would turn to the increasingly expensive oil, which would gradually push up the price and simultaneously send a timely signal to consumers to start using less oil. For this marvelous mechanism to function, though, oil companies must have access to that cheaper oil, so they can use it up first, before moving on to the expensive stuff. In the real world, however, just the opposite occurs. Because OPEC owns most of the cheap "easy" oil and limits how much is produced (and who can produce it), Western oil companies are essentially forced to produce the *expensive* oil first, and so must charge more for it — around twenty to twenty-five dollars a barrel — to cover their higher production costs. (This dynamic in turn allows OPEC to charge the same price for its oil, even though OPEC oil is much, much cheaper to produce.)

This market inversion, according to many analysts, has effectively kept the world oil price double what it would be on the free market, a situation that not only encourages a production overhang but masks many changes in long-term supply. As a result, says Alfred Cavallo, a Princeton-based energy consultant who has studied depletion, "the price warning that consumers expect to have as resources are being exhausted is totally obscured."[21]

Ideally, when markets fail like this, governments are supposed to intervene — in this case, by giving some indication that they have doubts about long-term oil. In reality, no intervention takes place. Having witnessed the political damage and panic caused by the bleak forecasts of the 1970s, today's consuming nations tread ultracautiously when speaking officially about future supply. To suggest that something was amiss — that non-OPEC oil production might peak as early as 2015, for example — would not only spook the markets and give bargaining power to OPEC but run counter to the Western mantra of nonstop economic growth. As Joe Romm, the former U.S. assistant energy secretary, put it, "if the U.S. government even brought up the possibility that global oil production might peak in, say, 2020, not only would that have an enormous and very negative impact on the markets, but it would essentially force the United States abruptly to change its energy policy to one that emphasized energy efficiency and alternative energy."[22]

Thus, despite the widely understood fact that all oil estimates are highly speculative — statistical extrapolations based on data from known oil fields[23] — such forecasting agencies as the USGS, the EIA, and Europe's International Energy Agency are under intense political pressure to err on the side of wild optimism. And err they do. During the 1990s, for example, a USGS report giving a low figure for oil reserves in the Arctic National Wildlife Refuge was withdrawn under pressure from pro-oil lawmakers in Alaska and rewritten with a more optimistic conclusion.

According to industry and government officials, this Panglossian dynamic occurs in every forecasting bureaucracy and does little to encourage policymakers even to consider the issue of oil depletion. "It would be a huge mistake to base U.S. energy policy on what the USGS thinks about future oil supplies," says one former high-ranking U.S. energy official, "and the Energy Information Administration has put out such overblown numbers, and done it with such arrogance, that it should be statutorily barred from answering questions about oil."[24]

The State Oil Company of the Azerbaijan Republic is headquartered in a huge Georgian mansion overlooking the Baku waterfront, about an hour away from Sand Island. Built by an oil millionaire during the city's first oil boom a century ago, it's a juxtaposition of old and new that a Western oil company would have seized upon as a marketing bonanza, but which here looks to have been purely accidental. The building is rundown. The grand old roofline has been disfigured by a row of massive blue letters that spell "SOCAR," as if the Azeri oil bureaucracy were some kind of Hollywood icon. Inside, most of the spacious rooms have been chopped up into tiny offices, and the fine old parquet floors look as if they've been driven over repeatedly by tractors.

Still, this being the former Soviet Union, some elegance has been preserved for senior officers. In one especially grand corner space, with a large conference table and sweeping vistas of the refineries and tankers in Baku Harbor, Natig Aliyev, SOCAR's president, smokes a slim cigarette and dismisses the disappointing exploration results from one of the country's much-hyped offshore fields. The previous summer, ExxonMobil, the biggest and most successful of all Western oil companies, drilled a test well in a new formation called Nakhchivan, not far from the giant Chirag-Azeri-Gunshali. When the first round of drilling revealed no "commercial" volumes of oil or gas at Nakhchivan, the well was deepened. When oil was still not forthcoming, ExxonMobil again deepened the well, this time to around twenty-two thousand feet — a record in Caspian drilling. Still no oil was found, and ExxonMobil announced that the well would be "plugged and abandoned."[25]

Natig insists that the fault lies with ExxonMobil, not the field. "We have made an analysis," he tells me through a translator, "and we concluded that the well drilled by our foreign partner was outside the oil-bearing structures." In other words, ExxonMobil simply *missed* the oil. Satisfied, apparently, with this explanation, Aliyev rises and walks over to his desk to retrieve another cigarette. Slender and darkly handsome in an elegant dark gray suit, which he carefully protects from cigarette ash, he looks nothing like the traditional Soviet oilman. "Only one well was drilled," he continues. "It is impossible to judge reserves by just one well."

That may be true. But around Baku these days, at least, outside the offices of SOCAR, talk is decidedly less optimistic than it used to be. Although production from the big Chirag-Azeri-Gunshali field has increased steadily, if slowly, Azeri "big oil" otherwise has not only failed to materialize but seems to be shrinking. The Nakhchivan failure is actually the second disappointment for ExxonMobil, which recently came up short in another field, the much-touted Oguz formation. Nor is ExxonMobil the only Western partner to strike out. Despite numerous test wells throughout the Azeri sector of the Caspian, four other majors — Eni Agip of Italy, TotalFinaElf of France, ChevronTexaco, and BP — have all failed to find "commercial volumes" of hydrocarbons.[26] Firms have quietly tried to break their contracts with the government of Azerbaijan, and it is no secret that many now wish they had bet less heavily on Azeri oil and more heavily on the north Caspian, where the massive Kazakh fields are capturing all the headlines — and most of the Western oil investment. "Azerbaijan has only confirmed what people always knew," complains one senior Western oil executive. "Only a tenth of explored structures usually turn into real fields."[27] And even Kazakhstan is losing its luster. Just recently, BP, Norway's Statoil, and British Gas have sold their interest in the mighty Kashagan field. As one oil analyst quipped, "maybe they were just embarrassed at the prospect of so much wealth. Or maybe they'd begun to suspect that Kashagan wasn't the largest field ever found."

Such bad luck fits into the larger pattern of very mixed exploration results worldwide. Although the new technology is unquestionably uncovering new fields, it has not reversed the trend of declining discoveries. In 2002, for example, worldwide discoveries fell to six billion barrels of new oil — far less than the historic average and well below the twenty-seven billion barrels that the market sucked up. Most of the easy oil — the huge oil reserves in easy-to-reach fields — has already been discovered and in many cases, especially outside OPEC, pumped out. The oil that remains will be riskier to extract, and the likelihood of unexpected costs, missed production targets,

and outright failure will be greater. The more oil we produce, the greater the risks associated with what remains.

The Arctic, for example, may indeed hold huge untapped reserves. Yet as even many optimists acknowledge, drilling and producing oil in deep, ice-covered waters, thousands of miles from any tanker port, pose enormous technical challenges. Special equipment and highly trained crews must be brought in and protected in a harsh environment. Thousands of engineering and technical hurdles must be overcome simply to bring the oil to the surface — to say nothing of building the thousands of miles of pipeline that must be laid to get the oil to market. What is more, according to some geologists, once oil companies finally do tap into the Arctic, the formations are far more likely to hold gas than oil.

In addition, the Arctic is among the more fragile ecosystems on the planet, one that environmental groups have been willing to fight hard to protect. For nearly twenty years, Greens have effectively kept oil companies from tapping into a reserve estimated at fifteen billion barrels that lies beneath the Arctic National Wildlife Refuge in Alaska, despite decades of well-financed oil industry lobbying. Signs of similar resistance to exploration in Greenland and Arctic Scandinavia are already in evidence.[28] Likewise, many analysts are already raising questions about plans to produce synthetic oil from Alberta's tar sands and from other heavy oils: the refining process produces massive emissions of carbon dioxide, the main suspect in climate change.

Meanwhile, among some analysts, confidence is fading for the supplies of OPEC oil as well. After analyzing more than one hundred technical production reports written by Saudi oil engineers, Simmons, the Bush energy adviser, believes that the Saudis themselves fear that Saudi Arabia "has very likely gone over its peak. If that's true, then it's a certainty that planet earth has passed its peak of production."[29]

The picture for long-term oil is not encouraging. Even if you don't subscribe to the fear that oil will run out tomorrow, it is clearly going to become riskier by the year — technically, geologically, environmentally, and ultimately economically and politically. Yet thus far, governments, and the populations that elect them, seem to be in a state of denial about petroleum. It is true that efforts have been made to develop alternative fuels or shift the energy economy to natural gas, but such programs will cost trillions of dollars and require decades to carry out. Thus, the real question is not whether oil is going to run out (it will) but whether we have the capacity, the political will, to *see* that outcome soon enough to prepare ourselves for it. Even though the peak is probably further away than many pessimists argue, its arrival may be difficult to detect, given such masking factors as supply overhang and price manipulation. Worse, because depletion will probably *accelerate* in a postpeak environment, as companies strive to capitalize on higher prices, world markets — and the political systems that depend on those markets — could deteriorate with surprising speed once it becomes widely known that a peak has occurred. "The experts and politicians have no Plan B to fall back on," complains Simmons.[30] Adds Romm, "I do not share the alarmists' point of view [about the imminence of a peak], but I am increasingly of the opinion that when it does peak, it will be too late to do anything about it."[31]

In Azerbaijan today, two years after I visited the country, the future still lies very much with oil, at least officially. Despite new setbacks — among them, a failed test well that a Japanese oil consortium drilled in 2002 — the government continues to pin its hopes on the coming "big oil." Around town, motorists can still see banners bearing slogans like the oil industry is the power of the people. At SOCAR, talk has turned to new formations even farther offshore, in deeper water, although some outside geologists are skeptical. As the USGS's Gregory Ulmishek observes: "The source rock is there, the structures are there, the reservoirs are there. The question is whether the source rock is as good in the deep-water part of the basin, as it was in some of the shallow areas. And whatever I say, we just won't know until the first well is drilled. Until you try it with a bit, you just can't know."[32]

Back at SOCAR headquarters, Natig continues to dismiss any such skepticism. "When will the oil run out?" he says. "Thirty years is what we hear, but who knows. We have no idea where we will be in thirty years, or even twenty." He smiles. "We have only just begun. The first wells were very shallow. We will just go deeper and deeper."

Afterword

In the twelve short months since *The End of Oil* first appeared, the issues it raised about the health of the global energy economy have only become more pronounced. You can't turn on the TV, pick up a newspaper, or even drive past a gas station without being reminded that our system for producing and consuming energy worldwide is under enormous strain and that the very notion of "energy security" has become a thin fiction.

The most visible signs, of course, can be found on the world oil markets. In 2004 the price per barrel of crude topped fifty-five dollars — almost triple the three-decade average and nearly twice what it was before U.S. forces "secured" the oil fields in Iraq. True, today's oil prices haven't matched those during the energy crisis of the 1970s; in current dollars, the price then was well over eighty dollars a barrel. Yet the present cost of crude is having a profound impact nonetheless. The robust economic growth of the last several decades was possible in part because energy, especially oil, was so cheap. And if our modern economy is less affected by energy costs than its predecessors were, today's price spikes have managed to arouse that almost forgotten beast, inflation, provoking fears that the economic recovery we've all been counting on may take a long time to arrive. If we factor in the price of oil's cousin, natural gas, which has climbed recently to more than triple its historic average, it looks as if the long, blissful era of cheap energy is over.

Interestingly, even as oil companies rack up record revenues, the energy industry itself seems to have lost some of its old confidence. Although the United States and Saudi Arabia — the two bookends of the global oil order — continued to officially insist that high oil prices are an anomaly and that there is plenty of oil to go around, energy companies and the energy market as a whole seem to feel otherwise. The market is acutely aware that demand for oil is now growing far faster than anyone had anticipated — especially in countries like China, which now imports more oil than any other nation except the United States. The market knows that production is straining to keep up with this demand and that the Saudis, the Russians, and other formerly flush oil states are pumping crude at very close to their maximum. Above all, the market knows that the balance between supply and demand is now so tight that the slightest hiccup — a riot in Venezuela, a terrorist bomb in Baghdad — will send not just ripples but sharp spikes through the entire economy. Volatility has become the new market reality — not a reassuring scenario for a world that still depends on oil for 40 percent of its energy and more than 95 percent of its transportation fuel, a world that still has no real alternative to oil.

And keep in mind that this grim scenario is the short-term picture. In *The End of Oil,* I argued that in the longer term our oil-dominated global energy system was vulnerable to three major threats — depletion, environmental degradation, and geopolitical instability. If anything, these threats have become more acute during the last year. Today, for example, we find even more evidence that oil production is likely to hit a peak sooner rather than later. Western oil companies struggle to find enough new oil to replace the oil they are selling on the world markets. State-owned oil operations are also in trouble. According to a study last fall in the respected *Petroleum Review,* in Indonesia, the United Kingdom, Gabon, and fifteen other nations that together supply nearly a third of the world's daily oil needs, production is now falling by 5 percent a year — more than twice the rate of decline of the year before. Effectively, this means that other oil producers, like Saudi Arabia, Russia, and Venezuela, must pump extra oil just to keep global supplies steady, to say nothing of *raising* production to meet soaring demand. Chris Skrebowski, editor of *Petroleum Review* (and a former analyst for BP and the Saudi national oil company), put it this way: "Those producers still with expansion potential are having to work harder and harder just to

make up for the accelerating losses of the large number that have clearly peaked and are now in continuous decline."

Optimists insist that the problem here is financial, not geological: the only reason production is falling is that oil states haven't invested enough money to increase their capacity. It is true that investment has not kept pace and that the global oil industry will need to spend several trillion dollars by 2020 to meet projected oil demand, but it now seems likely that no matter how much they invest, those oil states simply do not have the massive reserves they've always claimed — and upon which our energy optimism has largely rested. At an energy conference in Houston last spring, Saudi oil officials admitted that production at their largest fields was being maintained only by the injection of massive volumes of seawater to force the oil to keep flowing out. They also admitted that Ghawar, the largest oil field ever discovered and a mainstay of the world oil business, was more than half depleted and that reserves in parts of Ghawar were down to just 40 percent of their original volume.

As stark as such admissions may seem, some U.S. experts say this new candor doesn't go nearly far enough. At the same conference, Matt Simmons, a Houston energy investor and Bush administration energy adviser who has studied trends in world oil production, made the case that Ghawar is actually closer to 90 percent depleted and that the Saudi oil kingdom is much nearer its production peak than anyone in Riyadh — or Washington — wants to believe. The Saudis quickly rejected Simmons's thesis, insisting, as they always have, that Saudi Arabia, with its wealth of untapped fields, has enough oil to fuel the world for decades to come. But many oil analysts I've spoken to since the conference are far less confident about the "big" Saudi oil reserves. Simmons makes no apologies. "We could be on the verge of seeing a collapse of 30 or 40 percent of [the Saudis'] production in the imminent future," he was later quoted as saying. "And imminent means sometime in the next three to five years — but it could even be tomorrow."

Depletion is, of course, only one threat to the modern energy system that depends on hydrocarbons. Levels of atmospheric carbon dioxide, the primary driver for climate change, continue to climb rapidly, as do signs that climate change is occurring. Polar ice is melting, as are glaciers around the world. And while parts of the world caught a break in 2004 — in the eastern United States, for example, temperatures were slightly cooler than the historic average — the warming trend continues, as do weather phenomena thought to be related to climate change. The eight named tropical storms that appeared in the Atlantic basin during August 2004 broke another record. New studies also show that crop yields are declining worldwide as temperatures rise — a trend that will be dangerously destabilizing in countries already suffering from poverty and unrest. In fact, the political ramifications of climate change are now gaining attention outside of activist circles. Early this year the U.S. Defense Department released a report stating that rising temperatures could be so destabilizing to world governments that "disruption and conflict will be endemic" and "warfare would define human life."

Just as disturbing, the prospects for relief seem even dimmer now than they did a year ago. Although Europe has embarked on a relatively aggressive policy to cut CO_2 emissions, America remains as reticent as ever. The Bush administration did concede, a few months before the election, that climate change might indeed be linked to human-caused emissions. For all that, the White House hasn't shown much interest in enacting a climate policy that could actually cut those emissions. And our climate problems will not be solved simply by persuading U.S. lawmakers to act. For better and for worse, the future of the world's climate lies more and more in the hands of China and India, both of which will probably fuel a large percentage of their much-needed economic growth with climate-killing coal.

Sadly, these concerns about oil and climate may be overtaken by developments in the third arena: energy geopolitics. Oil has always been central to global power and has been at the heart of many of the most important political events of the twentieth century. But in the last year, oil's capacity to influence and upset the balance of global power has become more starkly apparent. Continued unrest in Venezuela and armed rebellion in Nigeria have demonstrated graphically just how vulnerable the global oil system is to the smallest political perturbations. In Russia, Vladimir Putin's steady consolidation of political power — and his recent battles with oil tycoon and political

rival Mikhail Khodorkovsky — have thrown that country's oil sector into chaos and dampened Washington's hopes that a flood of new Russian oil would finally break the OPEC monopoly. Next door, China and Japan continue to spar diplomatically over access to Siberian oil. China is now so desperate for oil imports that it has stepped up efforts to forge a petro-alliance with the Middle Eastern producers that the United States is courting, effectively putting Beijing on a diplomatic collision course with Washington.

Yet perhaps the most disturbing developments in oil geopolitics have centered on Iraq, where the American-led war has already cost more than $100 billion, caused thousands of military and civilian casualties, and given radical Muslims more grist for their anti-West mill. The Bush administration continues to insist that the war wasn't "about oil." Yet in the past year, a series of high-level government investigations have steadily discredited the president's public rationales for invading Iraq — namely, that Saddam Hussein had weapons of mass destruction and that he maintained ties with Al Qaeda.

Ironically, even if the United States had hoped that a post-Saddam Iraq could be a new source of oil and a solution to America's growing oil anxieties, such hopes have proven false. The inability of the U.S. occupation forces to keep oil pipelines from being blown up, to protect civilian workers from being killed or kidnapped, or to maintain anything resembling civil order have undercut efforts to restore Iraq's oil exports, much less raise them. If anything, the war has actually made American energy security *worse:* not only is Iraq itself exporting less oil than before, but its neighbors are now less politically stable and thus less reliable as oil suppliers than they were before the war.

In fact, the greatest casualty of the Iraq war may be the very idea of energy security. Before the war, it was generally accepted by world leaders — and oil traders — that if global oil production truly did become threatened by political instability or terrorism, the United States could restore order, and exports, through some measure of diplomatic or military intervention. That confidence led George W. Bush to assure us he could use diplomatic leverage — "jawboning" — to persuade OPEC to raise production. More to the point, that confidence has given rise to an American energy strategy of projecting military force throughout the oil-producing world in order to guarantee access to oil — a Cold War-like doctrine that has seen the United States building up a military presence not only in the Middle East but in Africa, Central Asia, and South America, oil-rich regions whose exports might otherwise be vulnerable to interruption by terrorists or political unrest.

But with the continuing fiasco in Iraq, it is now clear that even the most powerful military entity in world history cannot stabilize a country at will or "make" it produce oil simply by sending in soldiers and tanks. In other words, since the Iraq invasion, the oil market now understands that the United States *cannot* guarantee the security of oil supplies — for itself or for anyone else. That new and chilling knowledge, as much as anything else, explains the high price of oil.

And what of efforts to move *beyond* oil? In *The End of Oil I* was highly skeptical of many of the more prominent energy alternatives. I was especially harsh on hydrogen fuel cells, a technology that its proponents, including the Bush administration, claim is all but imminent, yet whose real potential is still blocked by a number of technical, economic, and political obstacles. I also challenged the popular faith in renewable technologies like wind and solar power, which show great promise but which still lack the power density to easily and cost-effectively replace hydrocarbons. Many critics have taken me to task as too pessimistic; some have insisted that these and other energy alternatives are actually much closer to being cost-effective than I had suggested.

Have the past twelve months changed my mind? Perhaps. I concede that these technologies are improving rapidly — all the more because oil and natural gas prices are so high — and that governments and private companies should redouble their efforts to bring these and other energy technologies to the market. Yet I remain convinced that their time is still to come, and the most prudent course in the meantime is not to wait for the technology of tomorrow to sweep down and save us but to push *existing* technologies toward greater efficiency and lower emissions. In fact, no matter what energy technologies we end up using twenty or thirty years from now, we still won't have enough energy for everyone if we haven't found ways to use much less of it. Efficiency remains our greatest hope.

In this context, the most encouraging story of the last year has been the rising acceptance of gas-electric hybrids. These vehicles cut fuel use and emissions roughly in half, use a current technology, and have already earned respect from auto analysts and, more to the point, consumers. After the surprising success of hybrids from Toyota and Honda (waiting times are still more than a year in some markets), Ford has launched a hybrid SUV, the Escape, which gets nearly forty miles per gallon in the city, and other U.S. companies will have hybrids out soon. To be sure, hybrids will account for only a tiny piece of the enormous American auto market for some time. But given how quickly attitudes about hybrids have changed among consumers *and* automakers — and given that gasoline prices won't be coming back down very much for years — we shouldn't be surprised to see hybrids rapidly penetrate the U.S. auto market.

If the auto industry is ripe for an efficiency revolution, it's not clear whether that revolution can spread to other sectors. As *The End of Oil* argued, industrial nations currently waste an extraordinary amount of energy through poorly designed homes, office buildings, and factories — all of which could be redesigned for dramatic energy savings. Yet the daunting and hugely expensive task of reengineering such large pieces of infrastructure will require more than the kind of snappy ad campaign that has worked for hybrid cars. Improving efficiency outside of the auto sector must begin in the political sphere with a new consensus by policymakers that the energy system must change in fundamental ways — and, above all, real leadership to ensure that such change actually happens.

On this count, the prospects are still mixed. In America, local and state policymakers have begun acting as if energy mattered. California, long the leader in activist energy policy, has enacted tough new auto emission standards and is again at the forefront of policymaking and technology research. Other states are also moving toward energy and emissions policies that could eventually remake the American energy system. And, after decades of willful obliviousness, consumers seem to waking up to the possibility that the age of cheap energy is over. Not only are sales of the biggest SUVs, such as the Hummer and Ford's obscene Excursion, flagging but, according to some surveys, a growing number of consumers say that if energy prices stay high, they will seriously consider buying a more efficient car, taking mass transit, or even moving to a home that shortens their commute.

In other ways, however, energy attitudes remain unchanged. Even as businesses and consumers scramble to adjust to higher energy prices, many governmental leaders insist that the status quo needs no help. Indeed, for anyone hoping for an American energy revolution, the reelection of President Bush last fall was hardly encouraging. Bush's energy policy during his first term centered mainly on the outmoded assumption that the key to U.S. energy security was simply to find *more* hydrocarbon energy, either at home or abroad. As for creating a *new* energy economy, the president has no vision. Early on, White House officials mocked energy "alternatives" and the idea of cutting energy demand. When that approach played poorly, the White House offered up vague promises of a "hydrogen economy," yet committed only a fraction of the funding needed to bring such an economy into being and said nothing about the obvious need to aggressively cut energy demand now while we wait for the development of a brave new energy system.

The notion that the second Bush administration will be any different seems rather implausible. Although the president has the political "capital" and the credibility with the energy industry to launch a new energy policy, he seems far more likely to continue the policy of defending the status quo while denying that the current system is in need of change. Last fall, as crude oil prices sailed toward fifty-five dollars a barrel, White House officials insisted that the price rise was a "short-term phenomenon" driven by "an anomalous set of circumstances" including "the geopolitics of oil" — as if the geopolitics of oil were something that happens only once every few decades.

In many respects, the debate over energy is coming down to a single question: can the market deliver the kind of new energy economy we need, or must government step in? For the past few years the free-market argument has been dominant. Proponents, such as Alan Greenspan, the chair of the all-powerful Federal Reserve, insist that high oil prices will actually force whatever "adjustments" to the economy are necessary, without clumsy government intrusion. According to

Greenspan, we will not only use less oil, thus reducing demand (and eventually the price), but just as important, the market will be spurred to develop alternatives to oil — everything from ethanol to hydrogen — which will begin to look quite affordable compared to oil. That's what happened in the 1970s, after the Arab oil embargo. And, says Greenspan, that's what is happening today. In other words, the current high prices are simply the beginning of a natural economic process, a historic transition that will eventually produce a new, smarter, cleaner, more efficient energy economy *without* government intervention.

But if anything, the last twelve months have pointed up the flaw in this otherwise comforting bit of classical economic theory. Yes, high oil and natural gas prices will change our behavior and our technologies. And if we could count on a nice smooth price rise from now to, say, 2030, chances are that the market could indeed build us a new energy economy while avoiding any really nasty side effects, such as economic dislocation. But as we've seen during the last year, the chances of an orderly price rise are slim. Gone are the days when countries like Saudi Arabia and Russia and Nigeria had limitless reserves and scads of extra production capacity. Markets are tight and are expected to stay that way for years, which all but guarantees that we'll see not just price spikes but severe ones. In fact, many analysts say that the oil markets see the market of the future as resembling a kind of permanent wave, with per-barrel prices oscillating between thirty dollars and eighty dollars or more. And that's not even considering the possibility that oil production will hit a peak and begin to decline —a possibility that seems less and less fantastic with each passing week.

In *The End of Oil* I laid out a scenario that might follow such a production peak —a grim worst case featuring global recession, worldwide unemployment, economic chaos, and, perhaps, a dangerous and escalating competition among the big oil-importing nations over the remaining reserves in the Middle East. Nothing in the last year has made me think such a scenario is less possible. What has changed, I would argue, is our awareness. More people and policymakers now seem to understand that the energy system is in serious and growing trouble and that without a fundamentally new approach we are almost assured of a catastrophic failure. What our new awareness actually means is hard to say. It may be the first tentative step toward building a more sustainable energy economy. Or it may simply mean that when our energy system does begin to fail, and we begin to lose everything that energy once supplied, we won't be so surprised.

Chapter 2 Endnotes

1 Personal communication.

2 Personal communication.

3 This estimate includes about one trillion barrels in known reserves, plus another seven hundred billion barrels in "reserve additions" — basically, new oil discovered in existing or even abandoned fields. International Energy Agency, *World Energy Outlook,* 47.

4 Future demand depends on a variety of factors, from how fast the economy grows to how energy-efficient we become; oil price, too, is key: higher prices tend to lower demand and thus delay reaching a peak.

5 They engaged in underreporting mainly to avoid being compelled by their host governments to produce more oil and thus to pay additional taxes and royalties.

6 Nor is it merely the OPEC countries whose numbers are questionable. During Mexico's financial collapse in the mid-1990s, oil officials there reportedly exaggerated the reserves to enhance the country's collateral and borrowing power: Campbell, *The Coming Oil Crisis,* 73.

7 Riva, *World Oil Production After Year 2000: Business as Usual or Crises?*

8 In fact, this "front-loaded" pattern of discovery shows up across oil fields of all sizes. According to an analysis by USGS scientists, in any given geographical area — whether one is looking at a single oil field or a single oil-producing country, a region or an entire hemisphere — the bulk of the oil is almost always discovered during the first third of the exploration period.

9 Personal communication, October 20,2003.

10 Personal communication, October 20,2003.

11 Practically the only optimistic forecasts came from adherents of a somewhat bizarre Soviet theory that oil is created continuously deep in the bowels of the earth.

12 Recovery rates depend on a wealth of factors, from the viscosity of the oil — thicker oil tends to be harder to extract — to the size of the pores in the reservoir rock to how much gas pressure remains in the field.

13 Personal communication.

14 Personal communication, January 2002.

15 It is thus off-limits to Western companies, which, had they been allowed to look, would probably have found it decades ago, when most megagiants were discovered.

16 "BP Gushes over Treasure in Deep Water of Texas Coast," *Dallas Morning News,* August 6, 2002.

17 "Oil Majors Wonder," *Financial Times,* April 25,2002.

18 Personal communication.

19 Reuters, "UK Hails Crop of Small North Sea Oil, Gas Fields," August 5,2002; Urquhart, "North Sea Oil Output to Peak This Year."

20 Ruppert, "Interview with Matt Simmons."

21 Production, or "lifting" costs, in the Middle East are around $1.50 a barrel, compared with $4 to $6 a barrel for non-OPEC oil. Add $7 to $8 for shipping and a comfortable profit and you have a price of around $10 a barrel, which is what some analysts say oil would cost in a free market. OPEC members, however, base their oil price not on actual costs of production but on the very high level of revenue they need to keep their corrupt and inefficient governments in the black — around $22 to $28 a barrel. "The higher costs of non-OPEC oil are a classic indication that oil reserves on a global scale are being depleted, just as should be expected," says energy economist-consultant Alfred Cavallo (unpublished article).

22 Personal communication, October 20,2003.

23 Greenland, for example, is a hot prospect not because big oil has actually been found there, but, mostly, because Greenland has geological features similar to those beneath the oil-rich North Sea.

24 Personal communication.

25 Agence France Press, "ExxonMobil to Plug Azerbaijan Well," February 25, 2002.

26 Ibid.

27 Reuters, "Oil Majors Cool on Kazakh Offshore Plans," October 3,2002.

28 Environmentalists could also delay development of a host of "unconventional" oil projects, including plans to mine the huge tar-sand fields in Alberta. Technological advances now make it possible to refine tar sands into usable crude at a cost that is competitive with that of "conventional" oil, but because the refining process itself produces so many pollutants, a full-scale tar-sands industry must first overcome substantial political hurdles.

29 Personal communication.

30 Ruppert, "Interview with Matt Simmons."

31 Personal communication.

32 Personal communication.