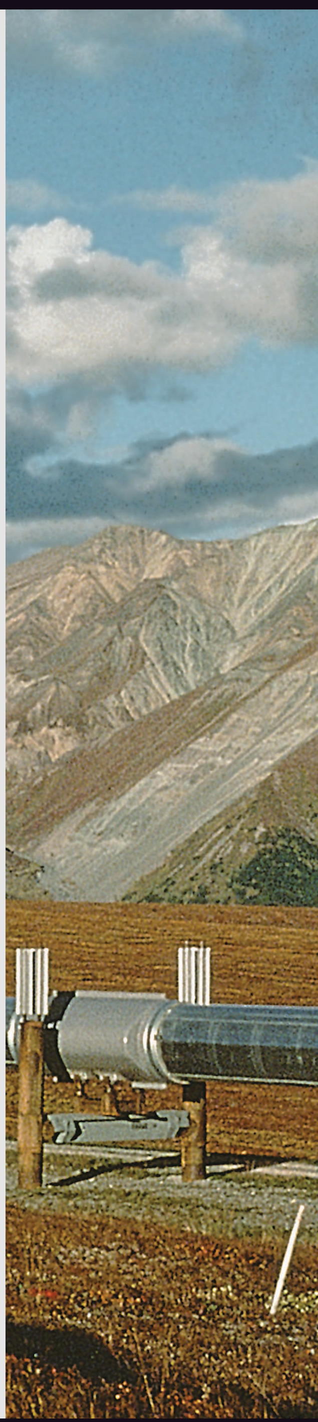
PETROLEUM Possibilities

in the Pipeline



One of the Bush administration's defining goals on energy policy is to reduce U.S. dependence on foreign sources of oil. Despite being the world's second largest producer after Saudi Arabia, the United States now imports 56% of its oil from overseas, with a quarter coming from politically and economically volatile countries in the Middle East, according to the Energy Information Administration (EIA) of the U.S. Department of Energy. As the U.S. economy grows, imports could reach 70% by 2020—a level administration officials worry could have serious implications for national and economic security. In a speech given on 17 May 2001, the day a task force headed by U.S. vice president Dick Cheney released its long-awaited and controversial national energy policy, Bush said, "Overdependence on any one source of energy, especially a foreign source, leaves us open to price shocks and blackmail."

An Elusive Goal

That petroleum is a nonrenewable resource is an undeniable fact. Even so, advances in technology have continually enabled geologists to find new oil and natural gas deposits, and extract them economically from hard-to-reach places. So estimates of the amounts of recoverable petroleum are rising.

Today, these figures are half again as large as they were in 1970, when some experts predicted the United States would be out of crude oil by the year 2000 or shortly thereafter. That prediction can be tossed into the recycling bin. According to 2001 figures from the EIA, 1.016 trillion barrels of recoverable oil are still underground, enough to fuel the world economy well into the next century, if not beyond.

But can the United States actually reduce its foreign dependence by increasing its own domestic output? Not completely, experts say. The United States has only 3% of the world's recoverable crude oil but consumes nearly 25% of its annual oil production. Roughly two-thirds of the world's proven crude oil reserves (volumes that are known to exist based on

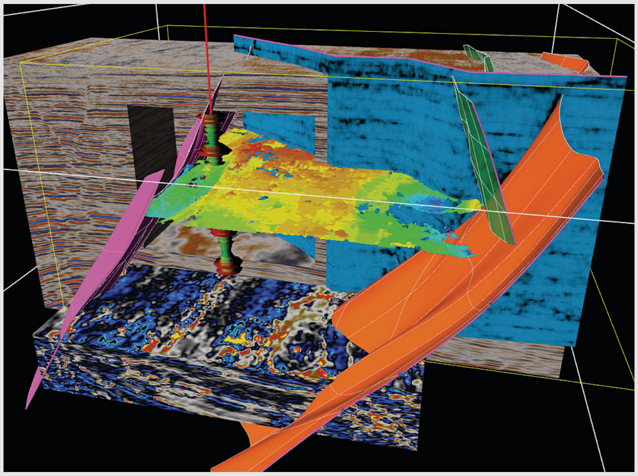
Far left: PhotoDisc; left and far right: ANWR.org; insets (left to right): ANWR.org; Matt Orendorff/U.S. Coast Guard; Image Vault; ANWR.org detailed geologic investigations) lie in countries that belong to the Organization of the Petroleum Exporting Countries (OPEC), including Saudi Arabia, Iraq, the United Arab Emirates, Kuwait, Iran, and Venezuela.

About the best that could be hoped for, says William Fisher, a professor of geological sciences at the University of Texas at Austin, is that increased domestic yield could hold foreign imports at bay, or perhaps reduce them "a little bit" as the economy grows. Bill Hederman, vice president of the Energy Group at the Fairfax, Virginia–based ICF Consulting, which provides natural, economic, and physical resource management assistance, suggests that the United States could become independent of "dangerous" foreign suppliers (whom he declined to identify), but only if "all the available tools on supply and demand options are applied." Such tools would include reduced usage, alternative sources, and increased domestic production.

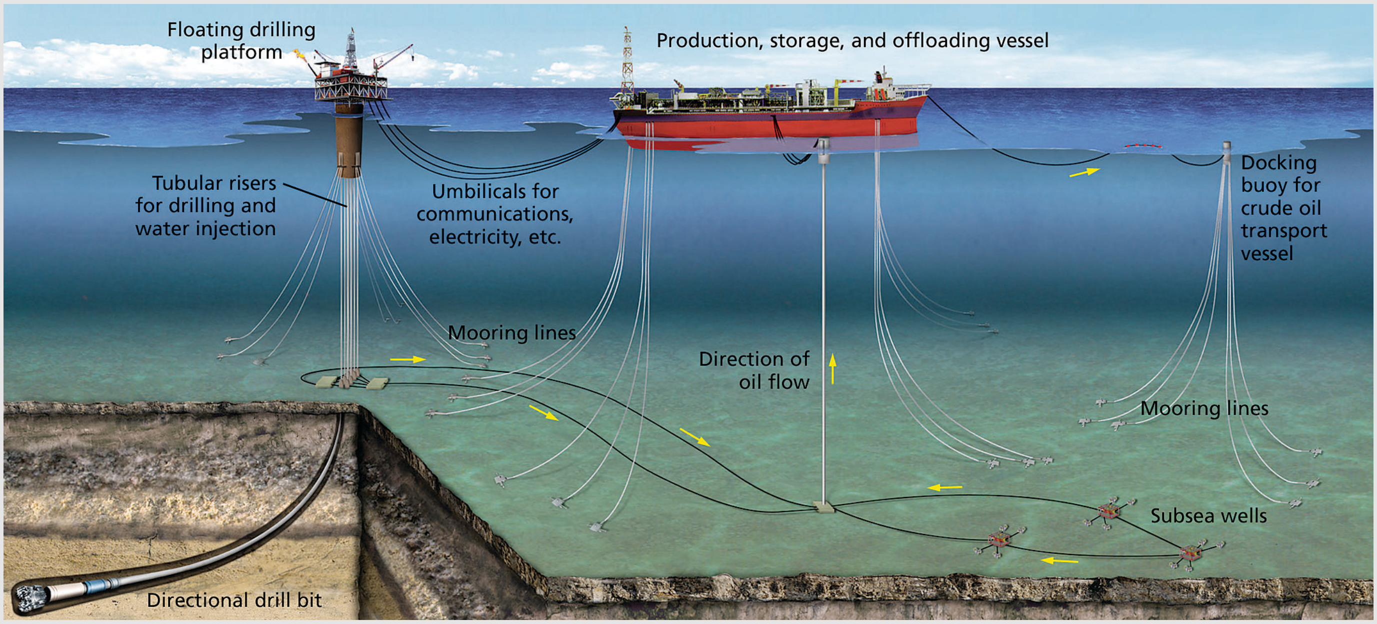
Efforts to narrow the gap between imports and domestic supplies are further challenged by the reality that domestic oil output has been declining for years, from a high of 3.5 billion barrels in 1970 to just 1.9 billion barrels in 2000, according to the EIA. "The U.S. oil industry is very old," says Paul Holtberg, a senior operations researcher with The RAND Corporation in Arlington, Virginia. "There's no question that the resource here has been drilled more heavily than anywhere else in the world." The Trans-Alaska Pipeline System that connects the 89,000-square-mile North Slope to the port town of Valdez is running at less than half its capacity. The East Texas Oil Field, which is the second largest field after Prudhoe Bay in the North Slope, has been online since 1930 and has already given up nearly 98% of its recoverable reserves. Shallow offshore regions of the Gulf of Mexico, dotted with roughly 10,000 wells after half a century of production have, says Holtberg, "been drilled practically to death."

To increase its domestic output, the U.S. oil industry is proceeding along two fronts. First, companies are pushing the limits of technology to locate and extract as much oil from existing fields as possible. Second, the industry is targeting new sources, many of them located in remote and often environmentally pristine areas. These include portions of the Overthrust Belt (a subterranean feature rich in natural gas that extends along the eastern flank of the Rocky Mountains into Canada); vast, previously untargeted regions in the North Slope, including Alaska's wildly controversial Arctic National Wildlife Refuge (ANWR, pronounced "anwar"); and deep (1,000–5,000 feet) and ultradeep (5,000-plus feet) offshore regions in the Gulf of Mexico.

The amount of oil in any of these locations varies according to whether one is referring to proven reserves or "resources," which are highly preliminary estimates. To be proven, reserves must also be economically viable, meaning that their value is greater than the cost of production. Reserves are precisely measured in areas where drilling is an ongoing activity. Resource estimates are huge by comparison, exceeding



The rainbow in an oil slick. Geoscientists are using 3-D seismic imaging to locate oil deep under the ground. In this image, three subsurface faults are indicated by the pink, green, and orange patches. A well is indicated by a red line and surrounded by a lathe column representing well data such as changes in rock porosity and rock density. This information is collected by sending a machine down the bore hole of a well to test rock properties—possible indicators of oil.



Deep-sea drilling platfom. New technologies allow oil companies to tap deposits that were previously inaccessible. In ExxonMobil's setup (above), a floating platform allows new wells to be drilled economically. The wells are then tapped by the production, storage, and offloading vessel, which also processes the crude oil. The ability to send this oil to a docked tanker (not pictured) eliminates the need for an underwater pipeline to the shore. Directional drill bits can reach remote oil deposits, and water found in these deposits is separated from the oil and injected back into the earth.

Top to bottom: Magic Earth; ExxonMobil

reserve values by 10 times, if not more. That's because resources are only roughly estimated by comparison of vast, unexplored regions where the geologic features are similar to those where oil and gas deposits have been found in the past.

A Technologic Transformation

In the early days, prospectors relied on their senses and their luck to find oil, often drilling where it seeped from the ground or where the surface features resembled those around prior discoveries. Even when new reserves were found, the ability to extract them was highly limited. Early producers, relying on natural pressure and primitive pumps, recovered only about 10% of the oil in a given field. Today, new technologies make it possible to pump more than 50% of the oil and 75% of the natural gas from a typical reservoir.

Driving the higher yields is three-dimensional (3-D) seismic imaging. Geologists using the technology set off "booms" or "pings" underground, then analyze returning echoes with computers to infer the nature and location of the surface that reflected them. This technology can be used to characterize subsurface formations in broad, unexplored areas, thereby enabling geologists to estimate volumes of untapped resources.

Plumbing the depths. The future of oil drilling is headed downward—which is to say, deeper under water. The Deep Draft Caisson Vessel (above), at 75 stories tall and moored in 4,800 feet of water in the Gulf of Mexico, is the world's deepest drilling and production platform. It is owned by ExxonMobil.

Top to bottom: Brian Moore/U.S. Coast Guard; Image Vault

It can also be used to find fresh reserves in old fields, additions that account for 90% of the new oil and gas found in the United States during the last decade, according to Michael J. Zeitlin, president and CEO of Magic Earth, a software consultancy to the oil industry in Houston, Texas. "With seismic technology, we can go in and image new zones with better clarity and hit pressurized pockets in the existing field," he says. "It's like going back and hearing music you didn't hear before."

But 3-D seismic technology isn't new. It's been commercially available in the oil industry since 1975. Until the mid-1980s, however, computers weren't powerful enough to handle the huge volumes of geophysical data generated by the typical survey. An explosion in computer processing power changed all that. Today, Zeitlin says, analysis of a kilometer's worth of seismic data that would have taken 800 minutes to complete in 1985 can be performed in 10 minutes. In 1980, the cost of analyzing an 80-square-kilometer survey was $8 million. Now it's around $90,000.

But finding the oil is only one part of the story—extracting it economically from hard-to-reach depositories is quite another. Here again, technologic advancements are driving reserve values ever higher. Unlike early drill heads that could only bore downward, modern directional drills can approach a reservoir from whichever angle geologists deem most promising, often regardless of the various twists and turns it takes to get there. So-called measurement-while-drilling technology has transformed the typical oil well into a high-tech marvel, equipped with sensors and computer processors residing behind a drill squashed under miles of rock and mud. These electronic components can be linked to the Internet, allowing geologists to track the well's trajectory from thousands of miles away.

The oil industry claims these technologies have ushered in a new era of "environmentally friendly" drilling and exploration. In the North Slope, for example, the size of the typical drill platform has shrunk from 65 acres to 10, under which multiple wells fan out like the arms of an octopus. "Fewer than half as many wells are needed to achieve the same yield as two decades ago," says Robert Kripowicz, acting assistant secretary for fossil energy at the Department of Energy. "With current technology, we've been able to reduce the number of dry holes while at the same time increasing our yield."

Toward the Deep Water

Advanced technology is luring oil companies toward what could be the biggest reservoir of oil and gas in the United States: deep and ultradeep regions of the outer continental shelf (OCS) in the Gulf of Mexico. After 53 years of drilling in the gulf, deepwater wells finally began to account for almost 50% of total U.S. production in 2000. Millions of offshore acres in the gulf are now being opened for leasing by the U.S. Department of the Interior, including a 1.5-million-acre tract known as Lease Sale 181, located off the Florida coast, which was opened up in December 2001. (This tract was reduced from more than 5 million acres in July 2001 so that oil operations would not be any closer than 100 miles from the Florida coastline, in part to appease the environmental concerns of the President's brother, Florida governor Jeb Bush.) At least two more deepwater eastern gulf sales are scheduled between 2003 and 2005, according to Barney Congdon, a public affairs officer with the Minerals Management Service (MMS) in New Orleans, Louisiana.

No one is really sure how big the deepwater payoff in the gulf might ultimately be. The proven oil reserves, according to the most recent EIA figures, are roughly 2.8 billion barrels. However, resource estimates in the deepwater gulf, for which the existence and recoverability are much less certain, are estimated by the MMS to range as high as 37 billion barrels. According to Congdon, the MMS predicts that the exploitation of these deepwater resources (some of which have colorful names such as Crazy Horse and Mad Dog) could allow gulf production to continue at rates more than a third greater than they are today for the next 50 years.

To drill in deep and ultradeep waters, oil companies must work in a high-pressure, low-temperature environment so challenging and remote it's often compared to the moon. Too deep for divers, the hard work of constructing and monitoring undersea oil rigs is performed by robots and remotely operated submersibles. Managing thousands of meters of drilling muds (composites of clay, water, and additives used in the extraction process) in each well is also extremely difficult. And water in crude oil often crystallizes into waxy formations of ice and methane called hydrates that clog well pipes and slow the flow of oil to the surface.

The combined technical challenges make deepwater development roughly nine times more expensive than coastal shallow water development, according to Jim Longbottom, an associate professor of chemical engineering at the University of Houston and a specialist in oil industry economics. Longbottom suggests that before the potential of the deep gulf can be fully realized, production costs must drop by 50%.

This need has spurred an intense level of federal- and industry-funded research on deepwater technology development. Most recently, $900 million was targeted for government-sponsored research on deepwater oil production through the Natural Gas and Other Petroleum Research, Development, and Demonstration Act of 2001. This bill was passed by the House of Representatives on 2 August 2001 and is expected to be taken up by the Senate in early 2002.

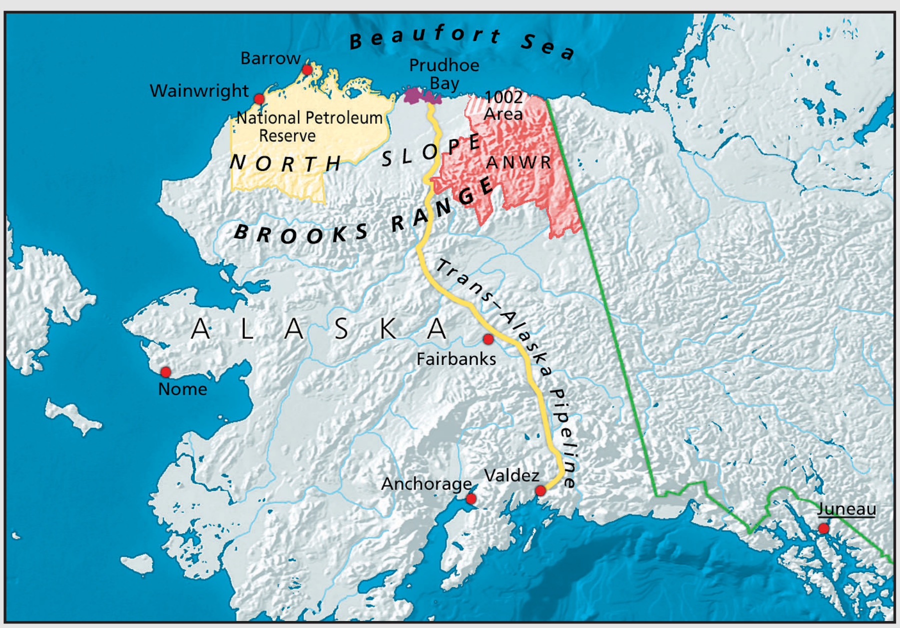
In addition to the technical challenges, oil companies working in the deep must also contend with a range of unique environmental hazards. Richard Charter, a marine conservation specialist with Environmental Defense's Oceans Program in Oakland, California, says a worrisome scenario might arise if methane hydrates are destabilized by human activity. Methane hydrates are often seen as a virtually inexhaustible fuel for the future—if they can be safely harvested. The U.S. Geological Survey (USGS) estimates that beneath U.S. sediments alone, methane hydrates hold some 200 trillion cubic feet of natural gas, enough to supply all the nation's energy needs for more than 2,000 years. But the hydrates form within a very specific range of temperature and pressure. If either of these are perturbed, for example by warm oil gushing up from a well, the hydrates can become unstable and cause a variety of problems, including uncontrolled gas releases and surface fires. For this reason, the MMS specifically forbids oil companies from drilling in areas where methane hydrates have been shown to exist.

Big footprints. An ice road being constructed in the North Slope region is an example of the types of industrial "footprints" created by oil extraction that concern environmentalists and others.

The specter of a major deep-sea oil spill terrifies the oil industry, not only because of the potential for environmental harm, but also the heavy regulatory burden that would be sure to follow, says William P. Dillon, project chief for the USGS Gas Hydrate Project located at the Woods Hole Oceanographic Institution in Massachusetts. Deep-sea oil spills are unique in ways that make cleanup extremely difficult, if not impossible, adds Charter. "A conventional spill coalesces into mats of oil that you can contain. The problem with a deep spill is that what you wind up with isn't a slick, it's more like a sheen that doesn't hang together and spreads over a much broader area," he says. "Studies have shown that deep spills can surface days later, miles away, in an uncorrectable form."

The Alaskan Frontier

Another major cache of offshore oil—described in the Bush administration's energy policy as 22.5 billion barrels of oil and 92 trillion cubic feet of natural gas—may lie under the Arctic OCS in a region known as the Beaufort Sea planning area. Currently, only 5% of this area is actively being pursued for development and production.



The Alaska office of the MMS is planning three lease sales that could open up the entire Beaufort Sea planning area, 65 million acres in all, for oil drilling and exploration, according to spokesperson Robin Cacy. In addition, the MMS is proposing to lease large areas of the adjoining Chukchi Sea, which lies to the west, far from the North Slope infrastructure and the Trans-Alaska Pipeline, within the next five years. "The Chukchi Sea is a frontier for the oil industry, and there's a lot more economic risk," says Cacy. "But we're making it available, and our hope is that oil companies will come, lease, and explore."

Expansion in Alaska is by no means limited to offshore areas, however. Hoping to boost the flow of oil in the Trans-Alaska Pipeline, North Slope companies including Phillips Petroleum and ExxonMobil are either moving or planning to move into tens of millions of acres adjacent to existing fields on the North Slope. This remarkable growth is largely passing under the media radar, barely noticed by a public preoccupied almost entirely with ANWR. According to Mark Meyers, director of the Division of Oil and Gas in the Alaska Department of Natural Resources, 3-D seismic technology is uncovering additional proven reserves of untapped oil on the North Slope—not including ANWR—that could range as high as 14 billion barrels. ANWR resources, concentrated in a 1.5-million-acre portion of the refuge called the ANWR 1002 area, were estimated by the USGS in 1998 to range from 11.6 to 31.5 billion barrels of oil—enough to supply total U.S. energy needs for roughly 26 years at current rates of consumption.

New Technology but Old Problems

Industry officials say they are maximizing the use of environmentally friendly technologies as they seek to extract these resources. "When you compare the Prudhoe Bay facilities, which have never had a blowout or catastrophic failure of any kind, to the next-generation oil fields in the North Slope—for example, the more recently developed Alpine Field, which is undergoing a major expansion—you see some important changes," says Meyers. "All the exploration is done off the ice. The footprint of the Alpine

Top to bottom: http://www.ANWR.org/; Mountain High Maps, Christopher G. Reuther/EHP

Field is just ninety-six acres, but it drains a forty-thousand-acre area. And the facility is stand-alone, it has no connecting roads."

Even the environmental community concedes that the new development has come a long way. "They've reduced the size of the gravel footprint needed to support production facilities, they're using ice roads instead of gravel roads when possible, and they're no longer dumping reserve pit waste directly on the tundra," says Lisa Speer, a senior policy analyst with the Natural Resources Defense Council (NRDC) in New York City. She adds, however, that although these are important improvements, "they are occurring at the margins of a huge industrial complex sprawling over an area the size of Rhode Island."

The real environmental problems on the North Slope may derive not so much from the newly expanded operations as from decaying infrastructure that's already been in place for decades, particularly in Prudhoe Bay. "Some of these facilities are nearing the end of their intended thirty- to fifty-year life spans," says Susan Harvey, a spill prevention program manager with the Alaska Department of Environmental Conservation (ADEC). "It remains to be seen how they're going to hold up over time. They're aging, and we're starting to see problems. This is when you would expect maintenance issues to really show up."

ADEC investigations turned up an average of 400 spills a year from 1995 to 2001 from North Slope industry operations, totaling nearly 1.5 million gallons of diesel, crude, and hydraulic oil, as well as other substances. According to the ADEC, most of these spills are the result of corroded infrastructure. The oil industry claims the spills fall on gravel pads, not directly on tundra, implying the environmental consequences are minimal. However, according to Pamela A. Miller, president of the Anchorage, Alaska–based environmental group Arctic Connections, this information isn't systematically collected by either the industry or ADEC, so it's impossible to confirm.

Some studies have shown dramatic environmental effects, however. A 1987 study of diesel spills in the Alaskan Arctic showed that 28 years later there were still substantial toxic hydrocarbons in the soil and little vegetation recovery. In 1990, a crude and diesel spill was rediscovered at an exploratory well site drilled 20 years earlier. Oil had permeated the gravel pad and flowed onto the tundra. It was cleaned up in 1991, but even after 20 years benzene and other toxic compounds were still present. And studies following the *Exxon Valdez* oil spill found that North Slope crude oil hydrocarbons pose higher risks to fish and wildlife than previously known and that there is long-lasting ecologic damage.

Also, says Speer, "There is no debate about whether the industry can clean up oil spills in broken ice—they can't. No one disputes this, not even the industry and certainly not the State of Alaska, which has supervised the conduct of a number of spill drills, most recently last spring, that were complete failures."

In the last year, a series of articles published by *The Wall Street Journal*, beginning with a front-page story on 13 April 2001, essentially portrayed the Prudhoe Bay infrastructure as a ticking time bomb. Relying on testimony from 300 anonymous employees of BP, which operates the Prudhoe Bay Field on behalf of the oil consortium that runs it, the newspaper described myriad problems associated with aging infrastructure including corroded pipes, systems failures, leaking hydraulic valves, and spills. According to the BP employees, the problems derive largely from poor maintenance and insufficient, overworked staff. In a widely cited quote, independent oil broker and activist Charles Hamel said, "A major spill or fire at one of our [processing centers] will exit the piping at high pressure and leave a half-mile-wide oil slick on the white snow all the way to ANWR [about 30 miles away]." None of this bodes well for a political constituency hoping to capitalize on "environmentally friendly technology" as a way to justify opening ANWR to drilling and exploration.

Controversy over ANWR drilling dates to the oil crisis of the early 1970s, when Alaskan politicians—mindful that oil provides a majority of the state's general revenue—began arguing that oil and gas deposits under the frozen tundra could significantly offset reliance on foreign energy sources. Meanwhile, environmentalists in both the United States and Canada, which share protected wildlife such as elk and caribou, countered that drilling would irreparably harm what they see as a crown jewel of the American wilderness.

The amount of oil that can be economically extracted from ANWR is also hotly contested: Senator Frank Murkowksi (R–Alaska) often refers to USGS resource estimates, which range up to 30 billion barrels, to draw support for opening the refuge for oil exploration. Also citing USGS estimates, the NRDC counters that only 3.2 billion barrels (assuming $20 per barrel) can be economically extracted from the refuge, largely because the oil is concentrated in discrete pockets instead of large contiguous deposits. This volume would sustain U.S. energy needs for roughly six months at current rates of consumption.

The debate—which peaked as a divisive issue during the 2000 U.S. presidential campaign, pitting then-governor Bush and

http://www.ANWR.org/

Seeking refuge. Bears, birds, and other wildlife must contend with the encroachment of human activities on their habitat. This is a major point of contention in the debate over opening up the Arctic National Wildlife Refuge to oil exploration and drilling.

Corroding safety. Decaying oil production infrastructure creates an environment ripe for leaks and spills, such as the May 2001 leak into Swanson Creek, Maryland, from the Pepco Power Generating Station. A Coast Guard response crewman (right) wades through a marshy area where oil from the spill collected.

Top to bottom: PhotoDisc; Angel Dellmer/U.S. Coast Guard

his oil industry backers against opponent Al Gore—persists without resolution in the Congress today.

At the request of Representative John D. Dingell (D–Michigan), the ranking member on the House Energy and Commerce Committee, who was alarmed at *The Wall Street Journal*'s allegations, BP recently completed a review of its Prudhoe Bay facilities. At press time, this report had not been completed. However, sources indicate the BP investigators discovered "large and growing" maintenance backlogs on fire- and gas-detection systems and pressure-safety valves.

Harvey supports these allegations based on her own investigations of the BP facilities. She says BP is currently under a number of compliance orders by the ADEC, directing the company to correct numerous spill-response and prevention deficiencies. Harvey acknowledges that BP has responded in a timely fashion to problems when identified by state inspectors. But like other stakeholders, she wonders whether "the largest oil company in the world couldn't be more proactive and ahead of the curve on these problems."

A Pipeline in Peril?

With domestic oil production expected to rise in the coming years, stakeholders are concerned about its impact on another related problem: the ability of the U.S. pipeline infrastructure to accommodate the additional load. Richard Kuprewicz, a pipeline expert and president of the Redmond, Washington–based consulting firm Accufacts, says the nation's pipelines, including the liquid pipelines (which carry crude oil, jet fuel, and diesel fuel) and the natural gas pipelines (which carry methane), are "in a very sad state of affairs, with countless failures." In 2000 alone, pipeline spills totaling 1.8 million gallons contaminated drinking water supplies in Dallas, Texas; Lexington, Kentucky; and Richmond, Virginia; and forced the evacuation of 500 homes west of Detroit, Michigan. On 19 August 2000, 11 people camping near Carlsbad, New Mexico, were killed by the explosion of a 50-year-old pipeline so corroded that its wall thickness had shrunk by 50%.

Exacerbating the problem, says Kuprewicz, is that regulatory management of the pipeline system is "at its weakest point in history, ironically at a time that the need for regulation is higher than it ever has been before" because more gas is being pumped through the existing system than ever before. According to a 15 May 2000 report on pipeline safety by the General Accounting Office, the number of pipeline accidents increased by 4% annually between 1989 and 1998, killing 226 people. Furthermore, the Department of Transportation's Office of Pipeline Safety (OPS) virtually eliminated the use of fines as an enforcement tool, did not collect comprehensive information on the cause of pipeline accidents, and did not comply with the law by failing to implement 22 of 49 requirements mandated by Congress since 1988 to improve pipeline safety. Despite repeated attempts over a period of several weeks, the OPS, which is widely recognized as being overworked and understaffed, declined to answer phone calls during the preparation of this article.

The Bush administration is well aware of the problems and has called for construction of 38,000 miles of new pipeline to augment the aging infrastructure and to "match supply and demand." However, the safety record is so bad that local resistance to new pipeline construction has become a serious problem. For example, a proposed 422-mile natural gas pipeline that would stretch from Lake Erie across the southern tier of New York to Westchester County has come under fierce opposition by hundreds of local residents, who denounce the plan at hearings and flood local officials with angry letters.

Whether the thousands of miles of new infrastructure can be built fast enough to accommodate the heightened oil and gas production envisioned by the Bush administration remains to be seen. Fisher suggests that optimally the combined additional output from the OCS, Alaska's North Slope, and the Overthrust Belt could amount to 1 billion barrels a year. Kuprewicz suspects that the bulk of increased gas must come through the existing gas pipeline infrastructure. He says, "The vast majority of this pipeline infrastructure is going to be stressed. You increase throughput on existing gas transmission pipelines by raising the pressure [which stresses the pipes]. And the majority of this existing gas infrastructure is over forty years old."

Corrosion and poor regulatory oversight aren't the only threats to the pipeline system. In the post–September 11 world, terrorist attacks on pipeline infrastructure—and on most other structural components of the U.S. energy system—have become a serious concern. In response, the OPS has begun to limit Internet access to pipeline mapping information and other data to selected individuals, while federal officials have increased security near vulnerable points in the system.

However, the extent to which the pipeline system is an attractive target for terrorists is debatable. Kuprewicz, for one, downplays the destructive potential of deliberate attacks on the pipeline system. "I'd estimate that only about five percent of the pipeline infrastructure poses a real vulnerability problem for the United States," he says. "In most places, even if you blow the pipeline up, it can be quickly repaired and cleaned up. I can understand the concern, but for the most part the terrorist effect in these cases is basically nil."

Toward the Future

Moving forward, the Bush administration will continue to face challenges from environmentalists who insist that demand-side reforms such as increased conservation and development of renewable energy sources could reduce foreign dependence faster, more efficiently, and with less environmental impact than would heightened production of domestic oil. Most comparisons are concentrated in the transportation sector, which is nearly 100% dependent on gasoline derived from crude oil, in contrast to electricity, which is supplied mainly by coal, natural gas, nuclear power, and renewable energy sources.

For instance, Therese Langer, transportation program director for the Washington, DC–based American Council for an Energy Efficient Economy, says, "Raising CAFE [Corporate Average Fuel Economy] standards for mileage in the auto industry to forty miles per gallon would reduce dependence on foreign oil by two million barrels a day, or more than twice the amount we now import from Saudi Arabia." Langer also points out that these savings could be realized within a decade, which is roughly the amount of time it would take to get the ANWR wells up and running. Replacement tires that are as fuel-efficient as original equipment tires could also produce major oil savings, estimated by the NRDC at 5.4 billion barrels over 50 years.

Another critical factor playing into the future of domestic oil production, particularly in remote locations like the deep gulf and ANWR, is economics. Currently, a barrel of oil costs $18, about half the cost of an earlier peak this year of $35. Oil prices, which are driven mainly by the state of the world economy and production quotas from OPEC and non-OPEC countries, determine how much industry money is available for exploration and production. To illustrate the influence of pricing, consider the impact on drilling and exploration in ANWR. As noted previously, 3.2 billion barrels of oil are economically available for extraction in ANWR if one assumes a price of $20. Should the price drop to $15 per barrel, the ANWR reserve would be "nothing," according to Kenneth Bird, chief of the North Alaskan Petroleum Studies project at the USGS offices in Menlo Park, California. Just three years ago, the price of oil dropped to an all-time low of $13 per barrel.

Clearly, then, efforts to advance domestic production are a gamble. If oil prices fall—a variable no one can predict with absolute certainty—the U.S. oil industry may ultimately pursue easier and more accessible deposits elsewhere throughout the world.

Charles W. Schmidt

Nuclear Resurgence

During the last several decades, the U.S. nuclear energy industry has endured a prolonged slump. The last permit for a new nuclear power plant was issued in 1979; the last new plant to be built, the Watts Bar Nuclear Plant near Spring City, Tennessee, finally went online in 1996 after being commissioned in 1970. Because of attrition, 10% of the nation's aging reactors have been removed from service in the last 10 years. But nuclear energy still supplies 20% of the nation's electricity, and the tide appears to be turning back in its favor.

The Washington, DC–based Nuclear Energy Institute (NEI), the industry's leading trade group, recently unveiled a plan to add 50,000 megawatts of nuclear capacity to the electrical grid by 2020. The plan is supported at least in principle by the Bush administration, which has made increased use of nuclear power a high priority in its energy policies.

According to Mitchell Singer, a spokesperson for the NEI, the additional wattage could be supplied by 50 new reactors, most of which could be installed in existing plants where the requisite infrastructure and public support are already in place. Additional wattage can also be supplied by "uprating" a plant's power-generating capacity by making certain structural changes. According to the NEI, uprates completed since the 1970s have allowed nuclear energy's contribution to the power grid to rise, even as the number of active reactors has declined.

And what of the health and environmental concerns that once made nuclear power such a hot issue? Stakeholders acknowledge that the industry's safety record has been very good since 1979, when a reactor meltdown at the Three Mile Island Nuclear Station near Harrisburg, Pennsylvania, was narrowly averted. Also to their environmental credit, nuclear power plants don't release greenhouse gases to the atmosphere.

But the key problems—and the resulting criticisms—haven't gone away, says David Lochbaum, a nuclear safety engineer with the Union of Concerned Scientists in Washington, DC. "The risk of a catastrophic accident has always been a low-probability, high-consequence event, and it's still in the same category," he says. Terrorist attacks on nuclear infrastracture—an acute concern in the wake of September 11—have raised the stakes even higher. Nuclear reactors are potential targets, as is what the NEI estimates to be 44,000 tons of radioactive waste spread throughout the country (the total produced by all nuclear industry activities in the United States to date), much of it under water in so called spent fuel pools. Arjun Makhijani, president of the Institute for Energy and Environmental Research, a nonprofit group located in Takoma Park, Maryland [see EHPnet, p. A19], says some pools "contain even more radioactivity than the reactors," adding that a deliberate attack on these temporary repositories could be "comparable to a reactor accident."

A suitable option for permanently storing radioactive waste remains elusive and highly controversial. Only Yucca Mountain, located in a remote rocky region in Nevada, is currently under federal review. Singer says that if approved by the U.S. Department of Energy (DOE), 77,000 tons of nuclear waste could be stored deep in the mountain's core. But any decision to go ahead with the project risks a huge public backlash. Critics charge that Yucca Mountain is vulnerable to earthquakes, and according to Makhijani, the site has poor natural containment for radionucleides. [See *EHP* 107:A68–A73 (1999) for more information on Yucca Mountain.] Lochbaum insists, however, that DOE studies on these issues show that earthquake effects are most profound on the surface and would have little impact on the 1,000-foot-deep repository, which could be designed to reduce risk from fault displacement. Also, he adds that DOE assessments show that any radionucleides would represent a very small portion of the overall background exposure levels for radiation. Still, problems with the site remain contentious and unresolved, as illustrated by the DOE's long-inconclusive studies and review, which have been ongoing since 1982.

Lochbaum acknowledges that nuclear power may be a suitable alternative for the short term and agrees that even the expansion called for by the NEI may be appropriate. But he adds that alternative energy sources must be developed to handle the nation's long-term energy needs. "There are more attractive options," he says. "Conservation and renewable fuels could provide the same environmental benefits and then some, without the risk of a catastrophic accident."
–Charles W. Schmidt

PhotoDisc