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Why We'll Never Run Out of Oil

Back in 1973, some experts were predicting $100-a-barrel oil prices by the year 2000. What happened?

By Curtis Rist | Tuesday, June 01, 1999

American civilization as we know it appeared to be in grave peril a quarter century ago. When Arab nations cut off oil shipments to the United States during the 1973 war in the Middle East, gasoline prices abruptly rose 40 percent and panic ensued. Motorists idled in long lines at gas stations, where creeping tensions led to fights and even occasional shootings. Automakers scrambled to retool their assembly lines to manufacture miserly compacts rather than gas-guzzling behemoths. Entrepreneurs poured millions into upstart solar-energy and wind-power companies. Politicians pontificated about the need for collective belt-tightening and offered income tax credits to homeowners for energy-saving insulation. Meanwhile, doomsday scenarios predicted ever-increasing shortages of fossil fuels and $100-a-barrel oil prices by the year 2000.

Surprise. Doomsday is nigh and oil has been selling at $10 to $15 a barrel, not $100. Adjusting for inflation, gasoline is cheaper today than it was before the Arab oil embargo. Indeed, the world seems to be awash in oil.

This year, wells around the world—from the sands of Saudi Arabia to the deep continental trench off the coast of Brazil—will pump some 75 million barrels of oil each day to satisfy demand. That's about 25 billion barrels a year, and the number is climbing at a rate between 2 and 3 percent a year. Barring a worldwide recession, the U.S. Energy Information Administration believes the world will be consuming around 110 million barrels a day by the year 2020. And it looks as though we won't be running short by then either. "It's hard for people who remember the seventies to accept this, but I believe we'll never 'run out' of oil the way the pessimists used to think," says Michael Lynch, a political scientist at MIT.

"People think of the Earth as having a certain amount of oil the way you might have a certain amount of money in your bank account," adds Daniel Yergin, chairman of Cambridge Energy Research Associates, who wrote the The Prize, a history of oil, and The Commanding Heights, a study of market forces and the energy industry. "But in reality, the ultimate amount available to us is determined both by economics and technology." So even though the United States has already spent more than half its domestic oil reserves on its energy-hungry economy, the gloom-and-doom predictions of the seventies were averted because of advances in oil technology and colossal new oil finds in West Africa, Colombia, and Russia. And Roger Anderson, director of the energy research center at Columbia University's Lamont-Doherty Earth Observatory, expects the future will hold more of the same. "If you pay smart people enough money," he says, "they'll figure out all sorts of ways to get the oil you need."

These days a host of innovators is probing for new sources of oil underwater. Geologists have perfected seismic imaging of seafloor geology, with the hope of tapping into vast new oil fields like the one that lies beneath the Caspian Sea in Kazakhstan. That region could harbor a staggering 200 billion barrels—making it one of the largest oil basins ever discovered. And drilling companies can now venture well over a mile into the seafloor. Unmanned submarines make the descent, fitted with robotic arms that guide the drill into the seafloor. The Gulf of Mexico could produce a total of 15 billion barrels, the coast of Brazil 30 billion, and the coast of Angola and elsewhere along West Africa another 30 billion—totaling some 75 billion barrels. "This ultra-deepwater drilling moves into the realm of science fiction; it's something no one ever believed would be possible," says Lynch. By the year 2005, a fifth of the world's oil could be recovered from such deepwater drilling.

That prize has prompted oil companies to spread the risk of discovery among themselves. Chevron, working with a consortium of other oil companies, recently drilled an exploration well in the Gulf of Mexico in waters 7,718 feet deep, a distance five times the height of the Empire State Building. The 618-foot Glomar Explorer, a former CIA vessel built during the Nixon administration to recover a Soviet nuclear submarine that sank deep in the Pacific, was converted into a deepwater-drill ship. And instead of dropping anchor—which is impossible in such depths—the ship hovered over the spot with the help of the global positioning satellite system, which identified the latitude and longitude. First the crew lowered the pipe—21 inches wide and weighing a million pounds—into the water through a hole in the ship. Once the drill bit reached the seafloor, it bored another 10,000 feet until it had reached down 17,000 feet—more than three miles.

But, after $20 million in work, the well is said to have come up dry. If so, that's not unusual: about half of all prospective wells do. "But there's lots of oil to be found at that depth," predicts Anderson. "The big news is that it can be pulled out at a profit." And crews should soon be able to drill in even deeper water. The Glomar Explorer can't be used in water much deeper than 8,000 feet, because it doesn't remain stable against the million-pound pipe. But new, larger ships are under construction, and they could lower pipe down to 10,000 feet, maybe more.

THE ORIGIN OF OIL

Unlike coal, which is widely distributed throughout the world, petroleum is more difficult to find and extract. Coal forms wherever plants were buried in sediments in ancient swamps, but several conditions must exist for petroleum—which includes oil and natural gas—to form.

The first is an accumulation of algae and other microorganisms in shallow seas, like those that periodically formed as the continents drifted apart and moved together again over hundreds of millions of years. Second, these microorganisms must get trapped in silt, which can happen wherever giant rivers emptied into shallow seas. "There wouldn't be much oxygen, so they were preserved instead of rotting away," says Roger Anderson, a researcher at the Lamont-Doherty Earth Observatory of Columbia University. Finally, these pools of dead microorganisms must be subjected to the right conditions—say, a temperature of about 150 degrees, under pressure for a few million years. That prolonged pressure-cooking causes chemical reactions that convert proteins, carbohydrates, and other compounds in the material into crude oil. If the temperature rises to about 200 degrees, the result will be natural gas.

No matter where oil is found, it is always a sign that the area once lay at the bottom of a stagnant sea. And in places like the Salt Lake in Utah and the Black Sea, oil continues to be formed today. In the Gulf of California, near the Colorado River delta, researchers pulled up a mud sample and found it laced with petroleum—a sure indication that, somewhere down below, oil is now being formed. That may prove to be an oil-rich province someday, but don't rush just yet to bid for exploration rights, says Anderson. "It'll take about 10 million years before its ready." —Curtis Rist

Even the most inhospitable locations are being made drill-friendly. A decade ago, oil was discovered in just over 200 feet of water off the coast of Newfoundland. Because icebergs flow through the area, no ordinary oil platform would work. Then engineers hired by a group of oil companies designed an iceberg-proof goliath. Its base is a huge 16-pointed star made of 650,000 tons of concrete and steel. (The points, which are supposed to deflect and break up icebergs, have not yet actually collided with one.) The price: $4 billion. The platform, called the Hibernia, is expected to recover 615 million barrels of oil over 15 to 20 years. That's not much compared with, say, the 200 billion barrels that Saudi Arabia holds in its oil fields. But it's a good example of how oil companies are branching out and squeezing oil from improbable places.

KNOW YOUR HYDROCARBONS

Fossil fuels—the hydrocarbons known as peat, coal, oil, and natural gas—are formed from the constituents of deeply buried and preserved organic matter. They make good fuels because the energy stored in the bonds between carbon and hydrogen is abundant and easy to release in combustion with oxygen.

Some hydrocarbons are simpler than others. Coal, for example, is mostly carbon, while petroleum—which includes oil and natural gas—is mostly carbon and hydrogen. Still, crude oil is anything but simple. It's made up of carbon molecules of many different sizes. The lightest—those with the shortest carbon chains—make good motor fuels because they are easily vaporized in engines. The heaviest hydrocarbons form viscous oil, paraffin, and asphalt. But even the longer carbon chains can be broken up chemically—in a process called cracking—to create fuels made of lighter molecules. Here are some better known hydrocarbons found in crude oil:

Methane	CH_4	(gas)
Ethane	C_2H_6	(gas)
Propane	C_3H_8	(gas)
Butane	C_4H_{10}	(gas)
Pentane	C_5H_{12}	(liquid, found in gasoline)
Hexane	C_6H_{14}	(liquid, found in gasoline)
Heptane	C_7H_{16}	(liquid, found in gasoline)
Octane	C_8H_{18}	(liquid, found in gasoline)
Pentadecane	$C_{15}H_{32}$	(liquid, found in kerosene and jet fuel)
Tetracosane	$C_{24}H_{50}$	(liquid, found in lubricating oil)

"People think of the oil industry as this backward, nineteenth-century industry with people randomly drilling holes," says Yergin. "But in fact, next to the military, it's emerged as probably the biggest consumer of computer technology in the world." Because of the way oil is distributed throughout cracks and pores in the Earth, as much as 70 percent of the oil from a typical well used to remain trapped in the ground. So anything that increases a single well's yield can have a huge impact on production. All the big oil companies are beginning to tap hard-to-reach deposits by using 3-D seismic imaging and computer-controlled sensors to detect where pockets of oil are located in a well. Once the well is bored, drill bits can be steered sideways through the ground in search of oil.

"There's no specific technology, no silver bullet to extend the oil supplies," says Lynch. "But there are sure an awful lot of copper bullets lying around."

He most promising copper bullet is new technology for turning natural gas into fuels like gasoline and diesel. For years, natural gas has been used mostly for generating electricity and fueling kitchen stoves and some home furnaces. In the Alaskan oil fields it's pumped back into the ground to maintain pressure in the oil wells. In Nigeria and the Middle East, it's simply flared. But such waste is soon to become a thing of the past.

Chemical engineers long ago figured out how to convert natural gas into liquid fuel (see "Miles of Methane," page 86), but the process was never cost-effective. "The Nazis did it in the final days of World War II because they had to," says Anderson. The South Africans followed suit during the international boycott through the apartheid years. "No one would sell them any oil," he notes. "They had to figure out how to make it themselves." There was one significant drawback, however: the exorbitant cost. Twenty years ago, a natural gas plant that produced 100,000 barrels of liquid fuel per day would have cost about $100 billion to build, says Anderson. But now that companies are doing it on a large scale and with better technology, the cost of building a natural gas plant has come way, way down. Today a natural gas plant can be constructed for as little as $10 billion, bringing the total expense of producing a barrel of fuel from natural gas down to under $20.

"That will effectively put a ceiling on the price that anyone can charge for a barrel of oil—which is something that has never existed in history," says Anderson. "The moment anyone tries to charge above that amount, people will switch to fuels derived from natural gas."

By most estimates, there's enough natural gas to produce about 1.6 trillion barrels of oil. Most of that gas probably will not be converted to oil. Still, the figure offers a hint at the extent of the world's reserves: more than all the petroleum ever consumed—roughly 830 billion barrels—and enough to fuel the world for some 60 years at current rates of consumption. And there may be far more. John Edwards, a former Shell geologist and now an adjunct geology professor at the University of Colorado, believes that underwater deposits of another form of natural gas could raise the total to 5 trillion barrels.

In many parts of the world, the seafloor contains natural gas trapped inside ice crystals called hydrates. The hydrates can be extracted by lowering a pipe into the ground and drawing up a core of mud and crystals. The problem is that unless the core is properly contained, the change in pressure and temperature at the surface can cause it to explode, says Edwards. But that isn't stopping the Japanese, who plan to drill and see if it is feasible to extract the fuel. The payoff could be huge. "There's at least again as much natural gas trapped in hydrates as has already been discovered, and probably more," he says.

MILES OF METHANE

The abundance of natural gas could keep the car culture rolling for years. Oil companies are coming up with strategies to convert natural gas into liquid fuels like gasoline and home heating oil—at prices below $20 a barrel.

Chemically known as methane, natural gas is among the simplest molecules on Earth: a single carbon atom surrounded by four hydrogen atoms. Turning it into a liquid requires some coaxing. First, the chemists release the hydrogen from its bonds with carbon by mixing methane with oxygen, throwing in a catalyst, and turning up the heat. The carbon atoms then form new bonds with the electron-hungry oxygen, creating a mixture of carbon monoxide and hydrogen, called synthesis gas. That gas becomes a building block for the larger molecules of liquid fuels.

The next step involves another chemical process to combine the carbon monoxide and hydrogen of the synthesis gas into a complex fuel like gasoline (which contains hydrocarbons with as many as eight carbon atoms) or heavier products such as kerosene, diesel, and lubricating oil. The goal is to create strings of carbon that are just the right length and reactive enough to burn easily in engines. Because these larger molecules have a higher boiling point than natural gas, they exist as a liquid. “The trick is to adjust the process so you don’t get a lot of waxes, which have many carbon atoms per molecule and are very, very heavy,” says Safaa Fouda, a chemical engineer of the CANMET Energy Technology Center in Ontario, Canada.

Fuels derived from natural gas burn more cleanly than those derived from crude oil because they don’t contain components like nitrogen, sulfur, or carbon arranged in rings, which are notorious air pollutants. The only thing that can’t be produced from natural gas is asphalt, which is the heavy residue left at the end of the crude-oil refining process.—Curtis Rist

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When and if supplies of natural gas begin to run out, the oil companies will focus on squeezing usable fuels out of even more difficult prospects. Already, the Canadians are starting to mine the tar sands of Alberta, where an estimated 300 billion barrels of oil are trapped. And Venezuelans are beginning to excavate the solid tarry deposits of the Oronoco sludge belt, which contains as much as 1 trillion barrels of oil. If those supplies run out, there’s always coal—the most abundant and environmentally damaging of all fuels. Ninety percent of the world’s fossil fuels are contained in these remnants of swamps. Tapping it and converting it to liquid fuels (a process nobody has fully mastered yet) could yield a supply lasting a millennium.

This parade of unending innovation makes any worries about impending oil shortages sound unduly pessimistic. Still, not everyone is buying the idea. Among the doubters is oil geologist Colin Campbell, a consultant with Geneva-based Petroconsultant and the author of The Coming Oil Crisis. Sure, we can figure out new ways to extract oil and other fuels, argues Campbell, but the payoff for such technology is a long way off. As he sees it, the age of oil abundance may soon come to a close.

“I’ve traveled the world over in my career to study oil fields, and it’s the limits that strike you wherever you go,” he says. “At each oil field it’s the same story again and again. The oil runs out.” Oil wells churn out black gold according to a rough bell curve, with production rising during the first half of the well’s 30-year life span, then sliding back to zero during the second half. Already, the massive oil discoveries of the 1970s—from Alaska to the North Sea—are nearing their crest of production. Worse still, he argues, the number of oil finds peaked in the 1960s. Today, one new barrel of oil is found for every four produced. “By now, the whole world has been thoroughly explored so it has become clear that no new provinces comparable with the North Sea and Alaska await discovery," he says, except the Caspian Sea. Within four years, he believes, the world's entire oil production will peak and then decline, resulting in local shortages.

At that point, boosting production among the countries in the Middle East can fill the gap—leaving the world vulnerable once more to an oil embargo. This spring, Saudi Arabia, Iran, Mexico, Algeria, and Norway banded together to shore up prices by slight cuts in oil production. Campbell argues that these countries could eventually gain a greater control of the market and impose whatever price they please. "I picture an oil price shock within a couple of years," says Campbell. "It seems a strange thing to say when today's oil prices have never been lower. But they could easily double."

Campbell's predictions may be gloomier than most, but even those who believe that oil will remain abundant foresee a different doomsday. An oil-devouring economy has not been good for the planet. The so-called greenhouse gases—mainly water vapor and carbon dioxide—make the planet warm and habitable by trapping solar heat as it radiates back off the Earth. When humans burn hydrocarbons, or fossil fuels, the carbon reacts with oxygen. The result: more heat-trapping carbon dioxide in the air. Since the beginning of industrialization around 1850, the levels of carbon dioxide have increased from 280 parts per million to about 365 today, says Pieter Tans, of the National Oceanic and Atmospheric Administration. No one can precisely predict the effects of this addition to the atmosphere, but global warming, rising sea levels and changing climates are among the troubling possibilities. As more fuels are burned, the problem may become more obvious. And if all our oil, natural gas, and coal resources are burned, "that could raise CO_2 levels by a factor of ten," says Tans. "We sure wouldn't be arguing about subtleties at that point."

Environmentalists once hoped for oil shortages to cut carbon dioxide emissions, but that no longer seems likely. Only voluntary restrictions or, more likely, taxes on fossil-fuel consumption and incentives for developing alternative fuels will reduce emissions. The 1997 Kyoto Conference—a world meeting on fossil-fuel use—produced an agreement by a handful of highly industrialized countries to reduce carbon emissions to 1990 levels by 2010. What it did not produce was how exactly this was to be achieved. Of course, some see encouraging growth in renewable energy sources such as solar, wind, and even geothermal power. And if oil prices start to rise, these alternatives could eventually become competitive with conventional energy sources. But with the price of oil dropping—by an average of 2 percent a year since the peak in 1980— "that could push off the date for economic feasibility by as much as 25 years," says Lynch.

Indeed, the perfect solution already exists: a carbon-free fuel cell that strips combustible hydrogen from a molecule like water or alcohol and yields only water when it is burned. But the cost of the technology remains prohibitive. And in a world swimming in oil, few companies and governments bother to spend big on alternative fuel technologies. Even if they did, the addiction to cheap oil would most likely persist.

"We could make the switch in fuels quite easily, but the switch in infrastructure would be far more difficult," says Edwards. The world is wired for oil. "We've got hundreds of thousands of petrol stations around the world. The switch, when it comes, is going to be slow. And it's sure not going to be voluntary." With fossil-fuel consumption projected to grow, and grow, and grow, the question isn't when are we going to run out of oil, says Arthur T. Andersen, a former director of the division of energy and international analysis at the U.S. Department of Energy. "It's what are we going to do about the greenhouse effect?"

In light of this, the gravest prediction yet regarding the future of oil may not be its impending shortfall but its unimaginable bounty.