

Oil Innovations Pump New Life Into Old Wells

By JAD MOUAWAD Published: March 5, 2007

BAKERSFIELD, Calif. — The Kern River oil field, discovered in 1899, was revived when [Chevron](#) engineers here started injecting high-pressured steam to pump out more oil. The field, whose production had slumped to 10,000 barrels a day in the 1960s, now has a daily output of 85,000 barrels.

Multimedia Graphic Reports of Oil's Demise Are Greatly Exaggerated

In Indonesia, Chevron has applied the same technology to the giant Duri oil field, discovered in 1941, boosting production there to more than 200,000 barrels a day, up from 65,000 barrels in the mid-1980s.

And in Texas, [Exxon Mobil](#) expects to double the amount of oil it extracts from its Means field, which dates back to the 1930s. Exxon, like Chevron, will use three-dimensional imaging of the underground field and the injection of a gas — in this case, carbon dioxide — to flush out the oil.

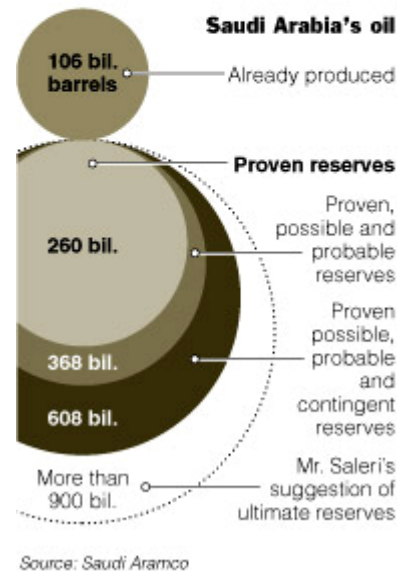
Within the last decade, technology advances have made it possible to unlock more oil from old fields, and, at the same time, higher oil prices have made it economical for companies to go after reserves that are harder to reach. With plenty of oil still left in familiar locations, forecasts that the world's reserves are drying out have given way to predictions that more oil can be found than ever before.

In a wide-ranging study published in 2000, the U.S. Geological Survey estimated that ultimately recoverable resources of conventional oil totaled about 3.3 trillion barrels, of which a third has already been produced. More recently, Cambridge Energy Research Associates, an energy consultant, estimated that the total base of recoverable oil was 4.8 trillion barrels. That higher estimate — which Cambridge Energy says is likely to grow — reflects how new technology can tap into more resources.

“It’s the fifth time to my count that we’ve gone through a period when it seemed the end of oil was near and people were talking about the exhaustion of resources,” said Daniel Yergin, the chairman of Cambridge Energy and author of a [Pulitzer Prize](#)-winning history of oil, who cited similar concerns in the 1880s, after both world wars and in the 1970s. “Back then we were going to fly off the oil mountain. Instead we had a boom and oil went to \$10 instead of \$100.”

Scratching the Surface

The most widely used estimates of Saudi Arabia's reserves show the country has extracted more than one-quarter of its oil. Dr. Nansen G. Saleri, the head of reservoir management for Saudi Aramco, says the kingdom's reserves are significantly larger.



The New York Times

There is still a minority view, held largely by a small band of retired petroleum geologists and some members of Congress, that oil production has peaked, but the theory has been fading. Equally contentious for the oil companies is the growing voice of environmentalists, who do not think that pumping and consuming an ever-increasing amount of fossil fuel is in any way desirable.

Increased projections for how much oil is extractable may become a political topic on many different fronts and in unpredictable ways. By reassuring the public that supplies will meet future demands, oil companies may also find legislators more reluctant to consider opening Alaska and other areas to new exploration.

The Reports of Oil's Demise Are Greatly Exaggerated

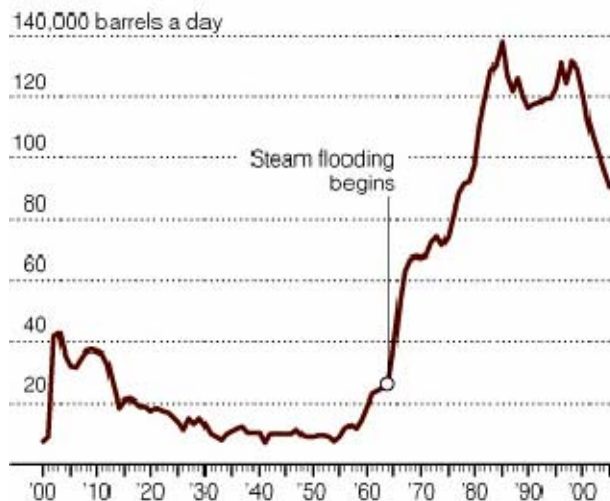
For decades, there have been warnings that oil would run out soon. But advanced technologies have made it possible to recover more oil from fields like Kern River in Bakersfield, Calif., that otherwise would have been exhausted long ago. Some experts

say that sources that are not economical to develop when oil prices are low become commercially viable as prices rise, allowing for the recovery of huge amounts of oil that are not in current estimates of conventional reserves.

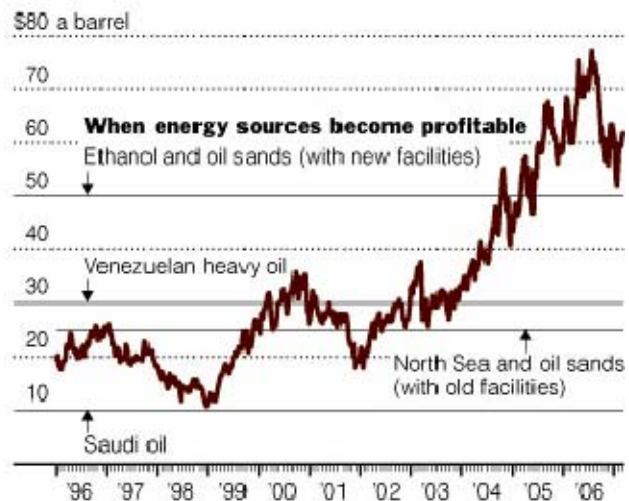
GLOBAL OIL RESERVES *Billions of barrels*

Already produced	Conventional reserves		Unconventional reserves			Exploration potential
1,078 billion	662	404	704	592	444	758
	OPEC	Other Arctic 118 Deepwater 61	Oil shale extract	Enhanced recovery	Extra heavy	

KERN RIVER FIELD OIL PRODUCTION *Bakersfield, Calif.*



OIL PRICE *Near-month contracts*



Sources: Cambridge Energy Research Associates; Chevron; Simmons & Co.; Bloomberg Financial Markets

On a global level, the Organization of the Petroleum Exporting Countries, which has coalesced around a price of \$50 a barrel for oil, will likely see its clout reinforced in coming years. The 12-country cartel, which added Angola as its newest member this year, is poised to control more than 50 percent of the oil market in coming years, up from 35 percent today, as Western oil production declines.

Oil companies say they can provide enough supplies — which might eventually lead to lower oil and gasoline prices — but that they see few alternatives to fossil fuels. Inevitably, this means that global carbon emissions used in the transportation sector will continue to increase, and so will their contribution to [global warming](#).

The oil industry is well known for seeking out new sources of fossil fuel in far-flung places, from the icy plains of Siberia to the deep waters off West Africa. But now the quest for new discoveries is taking place alongside a much less exotic search that is crucial to the world's energy supplies. Oil companies are returning to old or mature fields partly because there are few virgin places left to explore, and, of those, few are open to investors.

At Bakersfield, for example, Chevron is using steam-flooding technology and computerized three-dimensional models to boost the output of the field's heavy oil reserves. Even after a century of production, engineers say there is plenty of oil left to be pumped from Kern River. "We're still finding new opportunities here," said Steve Garrett, a geophysicist with Chevron. "It's not over until you abandon the last well, and even then it's not over."

Some forecasters, studying data on how much oil is used each year and how much is still believed to be in the ground, have argued that at some point by 2010, global oil production will peak — if it has not already — and begin to fall. That drop would usher in an uncertain era of shortages, price spikes and economic decline.

"I am very, very seriously worried about the future we are facing," said Kjell Aleklett, the president of the Association for the Study of Peak Oil and Gas. "It is clear that oil is in limited supplies."

Many oil executives say that these so-called peak-oil theorists fail to take into account the way that sophisticated technology, combined with higher prices that make searches for new oil more affordable, are opening up opportunities to develop supplies. As the industry improves its ability to draw new life from old wells and expands its forays into ever-deeper corners of the globe, it is providing a strong rebuttal in the long-running debate over when the world might run out of oil.

Typically, oil companies can only produce one barrel for every three they find. Two usually are left behind, either because they are too hard to pump out or because it would be too expensive to do so. Going after these neglected resources, energy experts say, represents a tremendous opportunity.

“Ironically, most of the oil we will discover is from oil we’ve already found,” said Lawrence Goldstein, an energy analyst at the Energy Policy Research Foundation, an industry-funded group. “What has been missing is the technology and the threshold price that will lead to a revolution in lifting that oil.”

Nansen G. Saleri, the head of reservoir management at the state-owned Saudi Aramco, said that new seismic tools giving geologists a better view of oil fields, real-time imaging software and the ability to drill horizontal wells could boost global reserves.

Mr. Saleri said that Saudi Arabia’s total reserves were almost three times higher than the kingdom’s officially published figure of 260 million barrels, or about a quarter of the world’s proven total. He estimated the kingdom’s resources at 716 billion barrels, including oil that has already been produced as well as more uncertain reserves. And thanks to more sophisticated technology, Mr. Saleri said he “wouldn’t be surprised” if ultimate reserves in Saudi Arabia eventually reached 1 trillion barrels. Even if the Saudi estimates are impossible to verify, they underline the fact that oil companies are constantly looking for new ways to unlock more oil from the ground.

At the Kern River field just outside of Bakersfield, millions of gallons of steam are injected into the field to melt the oil, which has the unusually dense consistency of very thick molasses. The steamed liquid is then drained through underground reservoirs and pumped out by about 8,500 production wells scattered around the field, which covers 20 square miles.

Initially, engineers expected to recover only 10 percent of the field’s oil. Now, thanks to decades of trial and error, Chevron believes it will be able to recover up to 80 percent of the oil from the field, more than twice the industry’s average recovery rate, which is typically around 35 percent. Each well produces about 10 barrels a day at a cost of \$16 each. That compares with production costs of only \$1 or \$2 a barrel in the Persian Gulf, home to the world’s lowest-cost producers.

Chevron hopes to use the knowledge it has obtained from this vast open-air, and underground, laboratory and apply it to similar heavy oil fields around the world. It is also planning a large pilot program to test the technology in an area between Saudi Arabia and Kuwait, for example.

Oil companies have been perfecting so-called secondary and tertiary recovery methods — injecting all sorts of exotic gases and liquids into oil fields, including water and soap, natural gas, carbon dioxide and even hydrogen sulfide, a foul-smelling and poisonous gas.

Since the dawn of the Petroleum Age more than a century ago, the world has consumed more than 1 trillion barrels of oil. Most of that was of the light, liquid kind that was easy to find, easy to pump and easy to refine. But as these light sources are depleted, a growing share of the world’s oil reserves are made out of heavier oil.

Analysts estimate there are about 1 trillion barrels of heavy oil, tar sands, and shale-oil deposits in places like Canada, Venezuela and the United States that can be turned into liquid fuel by enhanced recovery methods like steam-flooding.

“This is an industry that moves in cycles, and right now, enormous amounts of innovation, technology and investments are being unleashed,” said Mr. Yergin, the author and energy consultant.

After years of underinvestment, oil companies are now in a global race to increase supplies to catch the growth of consumption. The world consumed about 31 billion barrels of oil last year. Because of population and economic growth, especially in Asian and developing countries, oil demand is forecast to rise 40 percent by 2030 to 43 billion barrels, according to the Energy Information Administration.

Back in California, the Kern River field itself seems little changed from what it must have looked like 100 years ago. The same dusty hills are now littered with a forest of wells, with gleaming pipes running along dusty roads. Seismic technology and satellites are now used to monitor operations while sensors inside the wells record slight changes in temperature or pressure. Each year, the company drills some 850 new wells there.

Amazingly, there are very few workers in the field. Engineers in air-conditioned control rooms can get an accurate picture of the field’s underground reservoir and pinpoint with accuracy the areas they want to explore. None of that technology was available just a decade ago.

“Yes, there are finite resources in the ground, but you never get to that point,” Jeff Hatlen, an engineer with Chevron, said on a recent tour of the field.

In 1978, when he started his career here, operators believed the field would be abandoned within 15 years. “That’s why peak oil is a moving target,” Mr. Hatlen said. “Oil is always a function of price and technology.”