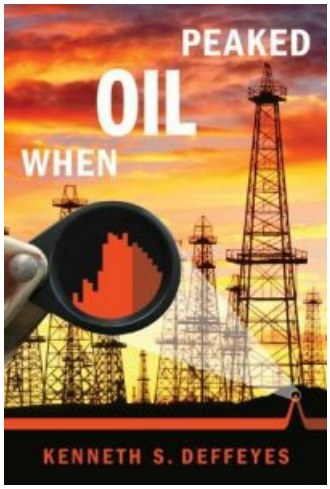

Book When Oil Peaked

Kenneth S. Deffeyes
Hill and Wang, 2010
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Recommendation

Forecasting the date of peak oil production is serious business, and this short book tackles the predictive methodology, geology, economics and mathematics head-on. Princeton professor emeritus Kenneth Deffeyes presents the techniques used by petroleum geologist M. King Hubbert to validate his prediction as to when oil production would peak. Deffeyes, who worked with Hubbert, further validates Hubbert's work, as he did in his earlier book, *Hubbert's Peak*. He presents the pros and cons of various alternative energy sources, how oil prices contributed to the recent global recession and the status of the oil industry today. This is a technical book; Deffeyes is an engineer, geologist and oil heavyweight, and he makes detailed presentations requiring advanced knowledge not provided in the text. *BooksInShort* considers this an important text and recommends it to people interested in the most rigorous assessment of future energy trends and climate change.

Take-Aways

- History credits American geologist M. King Hubbert (1903-1989) with recognizing when world oil production would peak: in 2005.
- Tar sand deposits in Canada potentially could release a trillion barrels of oil, an amount equal to all the oil produced so far, but processing it is very expensive.
- Today, natural gas sells for 100 times its cost in 1970.
- The globe has enough coal and uranium to last 100 years.
- When society consumes all the coal and uranium, it will rely on solar, wind, biomass, wave and hydroelectric energy.
- Coal gasification is a viable but expensive future energy process.
- The US uses some 20% of the world's oil supply for transportation.
- When the Earth's carbon dioxide level doubles, the average world temperature rises by three degrees Celsius.
- The Earth's current population may be greater than the planet's capacity to sustain life.
- The most difficult future challenge will be balancing population and economy.

Summary

No Horn of Plenty

Experts widely credit American geologist M. King Hubbert (1903-1989) with analyzing when the world's oil production would peak. Hubbert's acolytes ("Hubbertians") follow his methods and now believe global oil production peaked in 2005. Data shows that, since 2005, there has been no increase in world oil production.

> "It seems obvious to me that the oil problem is the disease and the financial recession is a symptom."

In May 2005, crude oil cost $44 a barrel; by July 2008, it cost $147 per barrel. Despite dramatically higher prices, oil supplies did not increase. This focused attention

on Hubbert's early analysis. He began his research in 1956 when he set out to calculate recoverable US oil reserves. Using estimates from two other petroleum geologists, Hubert theorized that a graph of US oil production would show 100 years of early, fast growth to the peak, followed by another 100 years of decreasing production.

"On a time scale somewhere between one hundred and three hundred years, our civilization has to come around to sustainable and renewable resources."

Hubbert theorized that finding oil was dependent on the amount of undiscovered oil. Richard Nehring, a Hubbert critic, wrote a series of articles in 2006 asserting that Hubbert had utilized a flawed model. One problem concerned the definition of "discovery" and its meaning within the oil industry. Hubbert used this term to mean the total amount of oil produced in a given year combined with the known underground reserves in that same year. But in oil industry jargon, a "discovery" is the date of the first successful well – the "discovery well" – sunk in a known field.

"We have to admit that we simply do not know how much natural gas has been produced."

Since Hubbert's death, the process of reporting oil reserves has become more politicized because of changes in production reporting rate by the Organization of Petroleum Exporting Countries (OPEC). The reporting calculation once depended on production capacity, but now it depends on reserves. In response, the Securities and Exchange Commission (SEC) changed its definition of reported reserves. Thus, today's estimates of international reserves are not that revealing. "The bottom line is that national reserve estimates contain very little useful information."

"Sometimes a piece of knowledge in one field expands into an adjacent realm that initially did not seem to be related."

Today, oil reserve calculations are closely guarded secrets. While industry data are available from the *Oil & Gas Journal*, the US Energy Information Agency, the International Energy Agency, private agencies and oil companies, industry participants use the information carefully. These data sets define key terms differently, and might include results from exploratory drills.

"Buried plant debris has a reputation for producing lots of natural gas and almost no oil."

Crude oil forms from heated organic material about 7,500 to 15,000 feet under the Earth's surface. The temperatures are high enough to break down these materials into oil molecules. At depths greater than 15,000 feet, the heat reduces the organic material to methane gas. When oil develops – which might take 15 million years – it rises to the surface or into submerged layers under the Earth.

"A potential flaw in dealing with the global oil shortage is fixing one part of the problem and then congratulating ourselves on having 'done something'."

One promising area is rediscovering untapped oil inside existing fields by using electrical conductivity techniques developed in 1920 by Schlumberger Inc. This well-based technique measures the electrical conductivity of rock saturated with water, oil and gas. Since oil and gas-saturated rock conduct electricity poorly, their presence suggests that more oil or gas await in productive layers.

Poor Quality Data

When monthly US expenditures for crude oil increase dramatically, the rise causes inflation without an accompanying increase in economic productivity. This happened in the 1980s, when the economy suffered a period of "stagflation." The subprime mortgage crisis triggered the recession that began in 2008, but other contributors include reliance on foreign oil, trade deficits, a service economy dependent on imports and the outsourcing of US jobs overseas. Without new oil discoveries, the aviation, auto and agricultural industries are at risk because they rely on fossil fuels and nitrogen.

The Changing Oil Industry

The last known available source for liquid oil is in the tar sands located in the provinces of Saskatchewan and Alberta, Canada. These deposits possibly could release a trillion barrels of oil, an amount equal to all the oil produced since the beginning of the oil industry. But current extraction methods use large amounts of water and natural gas, and require skilled workers who can brave temperatures of 40 degrees below zero. Processing the oil is difficult. Operators have used steam to separate the tar and solvents, and considered using a nuclear reactor. Operating a tar-sand mine can cost $1 billion.

"The oil business is 150 years old, it is huge, and its character is changing."

"The major international oil companies are gradually becoming engineering teams with a merchant bank attached." While the oil industry's current economic situation is changing, it remains a profitable business. Before 1980, its return on invested capital was the highest of any business segment. To maintain this return, the largest oil companies expanded into exploration and production. After 1980, oil companies decreased their research budgets and exploration activities.

New Alternatives

Any discussion of new alternatives to oil starts from trying to find a plentiful source. The most important questions are: What is the available supply, and how much will it cost? Many new oil-replacement fuel options compete for attention and development funding. Will ethanol, coal gasification, natural gas, oil shale, solar, hydroelectric, geothermal or nuclear energy be sufficient to replace oil? Focusing a national effort on just one source is not easy.

"The message...all around the oil patch is 'There are no good drilling prospects out there'."

Today, the planet contains 100 years' worth of coal and uranium. When that's gone, people will rely on solar, wind, biomass, wave and hydroelectric energy. These sources are not available in equal amounts globally, and transferring all that energy will require new infrastructure.

Easy access to energy sources matters. The US and Northern Europe were the main beneficiaries when coal fueled the Industrial Revolution in the late 1700s. Coal

provides cheap energy, but has produced major environmental problems and remains the dirtiest fossil fuel. Half the weight of coal is carbon, which converts to carbon dioxide when burned. Coal also produces sulfur dioxide, which combines with water to produce sulfuric acid or, when it is released into the atmosphere, acid rain.

"Burning fossil fuels—coal, natural gas and oil—has increased the carbon dioxide content of the Earth's atmosphere."

One alternative is coal gasification, which dates to the late 1800s. This process burns coal using a limited amount of air combined with steam. One variation calls for injecting air (to produce carbon dioxide) followed by infusing steam (to retain the hydrogen and carbon monoxide). The process also allows for converting hydrogen and carbon monoxide into gasoline. Hydrogen has been used as an additive in the petroleum refining process and to turn nitrogen into fertilizer. Coal gasification enables the separation of other destructive chemicals (such as sulfur and mercury) during the process.

"Finding additional oil in our existing oil fields is likely to be much more rewarding than grassroots exploration for new fields."

Coal gasification requires large capital expenditures and more stable energy prices. Yet even with these constraints, it remains a viable future energy source.

Going Nuclear

Nuclear power poses problems and solutions, and remains controversial. The last nuclear plant built in the US was finished in 1996. One of the largest uranium deposits in the US is on the Colorado Plateau, which spans Utah, Arizona, New Mexico and Colorado.

"Here's a warning: The conventional peak-oil story points to a grim and unhappy future."

Storing radioactive waste is the critical problem associated with nuclear plants. Straightforward technological fixes exist, but the politics involved in selecting storage locations complicate the issue. The safest storage sites are located deep in salt or calcium sulfate rock layers. These two rocks form a tight layer, which also keeps oil coming from the surface. One of the ways to make nuclear power more attractive politically involves reusing fissile materials from military nuclear weapons to produce electric power from new nuclear plants.

Global Warming

Readings taken from Hawaii's Mauna Kea volcano since 1958 demonstrate that carbon dioxide levels in the atmosphere are increasing. Other calculations show that the burning of fossil fuels contributes to the higher levels.

"The geological good news is that we have deposits of energy sources to last us for at least one hundred years."

Carbon dioxide traps outgoing infrared radiation and heats the Earth, affecting rainfall, temperature and winds. Using carbon dioxide data going back to 1967, one scientist discovered that a doubling of carbon dioxide would produce a three-degree Celsius increase in the average global temperature.

"Regardless of the model, a sustainable Earth is going to support only a finite number of people."

Ocean water salinity, which affects climate, is another key component in global temperature change. The interactions among the world's oceans, salinities, currents and temperatures affect the oceans' heat transfers and, over time, glacial development. Glaciers build slowly and retreat quickly. Glacial cycles take tens of thousands of years to develop, and affect both the Earth's climate and its orbit. The Earth's most recent glaciation cycle of advance and retreat lasted more than 100,000 years. It takes 100,000 years for the world's rivers to replace all the dissolved carbon dioxide in the world's oceans.

The Earth's continental glaciers retreated beginning about 12,000 years ago. Ice caps in Greenland and Antarctica are remnants of this period. The glacial retreat allowed humanity to develop agriculture and to domesticate animals, starting about 10,000 years ago. More recently, from AD 900 to AD 1300, the Earth was warmer; records show 46 vineyards in the south of England during that time. The warm weather also provided additional food for the workers who built Europe's great cathedrals during this same era.

Natural Gas and Improved Efficiency

Before 1970, the oil market did not consider natural gas valuable; it sold for three cents per thousand cubic feet, and people often burned it as a waste product. Today, gas sells for $3 per thousand cubic feet, but little detailed information about natural gas supplies is available. Data shows that hydrofracturing – drilling horizontal wells through shale – is increasing gas production rates. This is welcome news since natural gas can fuel bus fleets and cars, manufacture nitrogen fertilizers, and upgrade heavy oil. It also is possible to convert natural gas into liquid fuel.

The world can achieve energy savings by improving transportation systems and logistics. The US uses some 20% of the world's oil supply for transportation. The most energy-efficient transportation vehicles in the US are oil tankers, bulk cargo carriers, barges and freight trains. The cheapest way to transport goods from the East Coast to the Upper Midwest is through the Erie Canal, which was completed in 1823.

While various models of how future populations will manage their energy needs are available, population growth remains a key concern. The Earth's current population already may be greater than the planet's capacity to sustain it. Balancing population growth and economic stability within the Earth's capacity to sustain life remains society's greatest challenge.

About the Author

Kenneth S. Deffeyes, a former researcher for Shell Oil, is professor emeritus of geology at Princeton University.