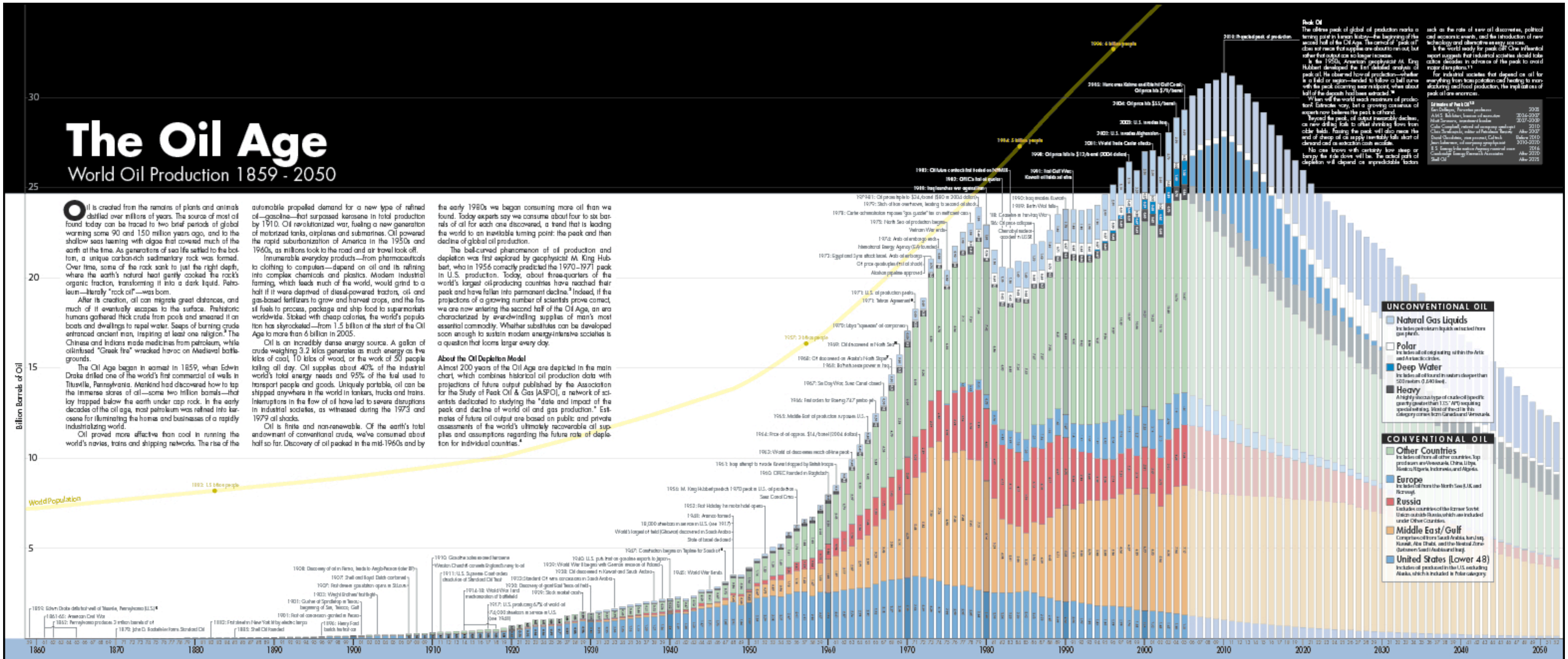
The Oil Age

World Oil Production 1859 - 2050



Oil is created from the remains of plants and animals distilled over millions of years. The source of most oil found today can be traced to two brief periods of global warming some 90 and 150 million years ago, and to the shallow seas teeming with algae that covered much of the earth at the time. As generations of sea life settled to the bottom, a unique carbon-rich sedimentary rock was formed. Over time, some of the rock sank to just the right depth, where the earth's natural heat gently cooked the rock's organic fraction, transforming it into a dark liquid. Petroleum—literally "rock oil"—was born.

After its creation, oil can migrate great distances, and much of it eventually escapes to the surface. Prehistoric humans gathered thick crude from pools and smeared it on boats and dwellings to repel water. Seeps of burning crude entranced ancient man, inspiring at least one religion.[2] The Chinese and Indians made medicines from petroleum, while oil-infused "Greek fire" wreaked havoc on Medieval battlegrounds.

The Oil Age began in earnest in 1859, when Edwin Drake drilled one of the world's first commercial oil wells in Titusville, Pennsylvania. Mankind had discovered how to tap the immense stores of oil—some two trillion barrels—that lay trapped below the earth under cap rock. In the early decades of the oil age, most petroleum was refined into kerosene for illuminating the homes and businesses of a rapidly industrializing world.

Oil proved more effective than coal in running the world's navies, trains and shipping networks. The rise of the automobile propelled demand for a new type of refined oil—gasoline—that surpassed kerosene in total production by 1910. Oil revolutionized war, fueling a new generation of motorized tanks, airplanes and submarines. Oil powered the rapid suburbanization of America in the 1950s and 1960s, as millions took to the road and air travel took off.

Innumerable everyday products—from pharmaceuticals to clothing to computers—depend on oil and its refining into complex chemicals and plastics. Modern industrial farming, which feeds much of the world, would grind to a halt if it were deprived of diesel-powered tractors, oil- and gas-based fertilizers to grow and harvest crops, and the fossil fuels to process, package and ship food to supermarkets worldwide. Stoked with cheap calories, the world's population has skyrocketed—from 1.5 billion at the start of the Oil Age to more than 6 billion in 2005.

Oil is an incredibly dense energy source. A gallon of crude weighing 3.2 kilos generates as much energy as five kilos of coal, 10 kilos of wood, or the work of 50 people toiling all day. Oil supplies about 40% of the industrial world's total energy needs and 95% of the fuel used to transport people and goods. Uniquely portable, oil can be shipped anywhere in the world in tankers, trucks and trains. Interruptions in the flow of oil have led to severe disruptions in industrial societies, as witnessed during the 1973 and 1979 oil shocks.

Oil is finite and non-renewable. Of the earth's total endowment of conventional crude, we've consumed about half so far. Discovery of oil peaked in the mid-1960s and by the early 1980s we began consuming more oil than we found. Today experts say we consume about four to six barrels of oil for each one discovered, a trend that is leading the world to an inevitable turning point: the peak and then decline of global oil production.

The bell-curved phenomenon of oil production and depletion was first explored by geophysicist M. King Hubbert, who in 1956 correctly predicted the 1970–1971 peak in U.S. production. Today, about three-quarters of the world's largest oil-producing countries have reached their peak and have fallen into permanent decline.[3] Indeed, if the projections of a growing number of scientists prove correct, we are now entering the second half of the Oil Age, an era characterized by ever-dwindling supplies of man's most essential commodity. Whether substitutes can be developed soon enough to sustain modern energy-intensive societies is a question that looms larger every day.

About the Oil Depletion Model

Almost 200 years of the Oil Age are depicted in the main chart, which combines historical oil production data with projections of future output published by the Association for the Study of Peak Oil & Gas (ASPO), a network of scientists dedicated to studying the "date and impact of the peak and decline of world oil and gas production." Estimates of future oil output are based on public and private assessments of the world's ultimately recoverable oil supplies and assumptions regarding the future rate of depletion for individual countries.[4]

Peak Oil

The all-time peak of global oil production marks a turning point in human history—the beginning of the second half of the Oil Age. The arrival of "peak oil" does not mean that supplies are about to run out, but rather that output can no longer increase.

In the 1950s, American geophysicist M. King Hubbert developed the first detailed analysis of peak oil. He observed how oil production—whether in a field or region—tended to follow a bell curve with the peak occurring near midpoint, when about half of the deposits had been extracted.[10]

When will the world reach maximum oil production? Estimates vary, but a growing consensus of experts now believes the peak is at hand.

Beyond the peak, oil output inexorably declines, as new drilling fails to offset shrinking flows from older fields. Passing the peak will also mean the end of cheap oil as supply inevitably falls short of demand and as extraction costs escalate.

No one knows with certainty how steep or bumpy the ride down will be. The actual path of depletion will depend on unpredictable factors such as the rate of new oil discoveries, political and economic events, and the introduction of new technology and alternative energy sources.

Is the world ready for peak oil? One influential report suggests that industrial societies should take action decades in advance of the peak to avoid major disruptions.[11]

For industrial societies that depend on oil for everything from transportation and heating to manufacturing and food production, the implications of peak oil are enormous.

Estimates of Peak Oil[12]

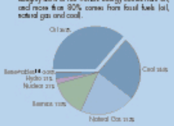
Ken Deffeyes, Princeton professor	2005
A.M.S. Bakhtiari, Iranian oil executive	2006-2007
Matt Simmons, investment banker	2007-2009
Colin Campbell, retired oil company geologist	2010
Chris Skrebowski, editor of Petroleum Review	After 2007
David Goodstein, vice provost, Caltech	Before 2010
Jean Laherrere, oil company geophysicist	2010-2020
U.S. Energy Information Agency nominal case	2016
Cambridge Energy Research Associates	After 2020
Shell Oil	After 2025

The Power of Oil

Transportation
About 55% of oil goes to power the world's autos, trucks, airplanes, trains, and ships, together numbering some 600 million. For many types of transportation—including cars, trucks and airplanes—there are few realistic alternatives to oil. Today the world depends on oil in the form of gasoline, diesel and kerosene for 95% of its transportation energy needs.

Food
It's estimated that people in the industrial world consume about 10 calories of fossil fuel for every calorie they eat. Oil powers the tractors on the farm and the trucks that ship crops and livestock to market. It runs factories that turn farm products into packaged foods. Fertilizers and herbicides are oil- and gas-based. Without these fossil fuel "inputs," farm yields could drop 50% or more, experts say.

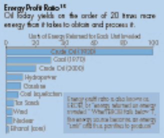
Energy Sources[13]
Roughly 40% of the world's energy comes from oil, and more than 80% comes from fossil fuels (oil, natural gas and coal).



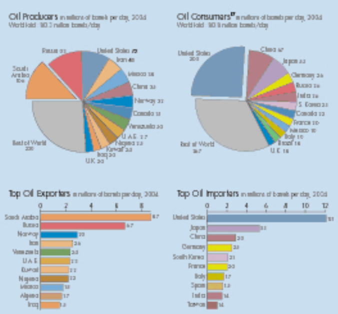
Electricity and Heat
Though it varies by country, roughly 70% of the world's electrical power comes from fossil fuels—including oil (3%), natural gas (17%) and coal (51%)—with nuclear and hydroelectric making up most of the rest. Oil distillates such as kerosene provide heat for homes and businesses, and fuel for water heaters, cook stoves, and lamps. In the Northeast U.S., about 40% of homes are heated by oil.

Chemicals and Plastics
Modern life wouldn't be the same without the wealth of petroleum byproducts like feedstock for plastics, drugs, detergents, synthetic rubber and fibers; asphalt for roads, airfields, shingles and floor coverings; solvents for paints, lacquers, and inks; lubricating oils and grease for engines and other machinery; petroleum wax and paraffin for candy making, packaging, candles, matches, and polishes.

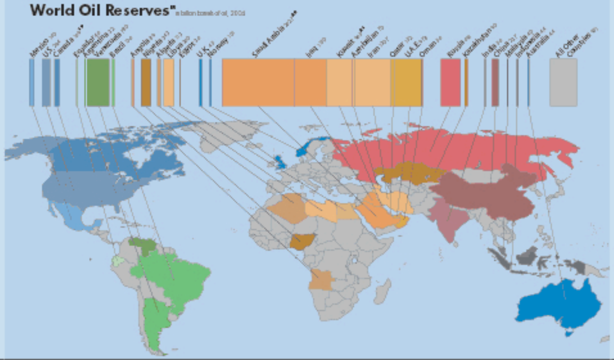
Energy Profit Ratio[15]
Oil today yields on the order of 20 times more energy than it takes to obtain and process it.



Production and Consumption[16]



World Oil Reserves[18]



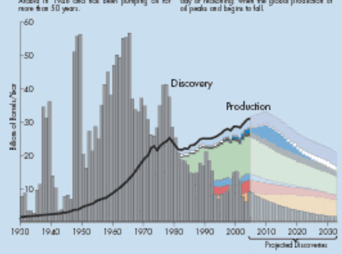
The Growing Gap[22]

For most of the 20th century, explorers discovered far more oil than industrial societies could consume. The 1930s oil boom in Texas glutted markets and led to production quotas to prevent prices from collapsing.

The big Texas finds were followed by even larger discoveries in the Middle East. The world's largest oil field, Ghawar, was discovered in Saudi Arabia in 1948 and has been pumping oil for more than 50 years.

Global oil discoveries reached an all-time peak in 1964 and have been declining ever since. In 1981, the world started to consume more oil than it discovered, and the gap has steadily widened. Today, the world consumes about four to six barrels of oil for every barrel found.

Because you have to find oil before you can extract it, the growing gap points to an inevitable day of reckoning: when the global production of oil peaks and begins to fall.



Oil's Cousins: Coal and Natural Gas

No picture of the Oil Age could be complete without taking into account the other fossil fuels—coal and natural gas. Like oil, these hydrocarbons were born of the remains of plants and animals buried millions of years ago.

Coal came into widespread use in the 18th century, rescuing Europe from an energy famine caused by centuries of deforestation. The move to coal catalyzed the industrial age, as steam engines invented to pump water out of mines were soon adapted to run trains, ships, and factories.

Even today, coal powers more than half of America's electrical grid and supplies two-thirds of China's energy needs. Coal can be converted into gas and liquid fuels, making it a potential substitute for oil. Yet it is the dirtiest of the fossil fuels and a major contributor to acid rain and global warming.

It's estimated that about 900 billion tonnes of coal remain on earth, though experts say we've already exploited much of the easily mined, high-quality bituminous coal. By one estimate, coal production could peak within 30 years if we start burning it faster to offset depleting oil supplies.

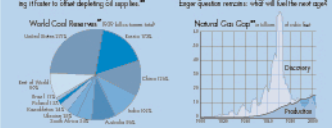
The lightest of the fossil fuels, natural gas forms deeper in the earth than oil, where intense heat and pressure reduce hydrocarbons to their simplest state—methane. Seeps of natural gas fed the ancient flames of Delphi, and the Chinese tapped underground sources as early as 500 B.C. to boil and purify salt water.

In modern times, gas was often "flared off" for lack of profitable uses. But with the construction of modern pipeline networks in the 1950s, natural gas found mass appeal as a cleaner-burning alternative to oil and coal.

Natural gas is a key ingredient in fertilizers that keep farm yields high. It has become the fuel of choice for new power plants and industrial operations such as the giant plants that turn Canadian tar sands into oil.

Like oil, natural gas has its limits. Discovery of gas peaked in the 1970s and by the 1990s, the world started consuming more gas than it discovered.

Time will tell whether gas and coal can serve as a bridge to the next energy source. And still the bigger question remains: what will fuel the next age?



Notes

Resources
Association for the Study of Peak Oil
BP Statistical Survey
Energy Bulletin
Energy Information Agency
Global Public Media
International Energy Agency

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