Is the world really running out of oil?

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Ever since the dawn of the petroleum era in the nineteenth century, the world has been guzzling this fuel at a steadily increasing rate. According to the BP Statistical Review of World Energy 2010, the world consumption of oil touched 29.2 billion barrels in 2009, indicating we're consuming around one thousand barrels of oil per second! That's how rapidly we're using up oil supplies. So what's the future of petroleum? How stable will the world energy situation be a decade from now? A century from now? Are we running out of oil? Petroleum geologists don't have a definite answer whereas the scientific world in general abounds in opinions about the future supply of petroleum. This article examines different aspects of the petroleum debate and what according to experts is the outlook for the future.

Oil is an energy resource and has shaped the way our world has devel oped. It defines modern society and the way we live. It has fuelled wars and is still igniting political tension in the world.

Today, the oil and gas industry is a crucial economic factor in the development of different global economies. Also, currently, we have no alternative energy source that could compete with hydrocarbons for availability in large quantities, efficient tapping, and safety. In other words, oil is a crucial resource that could bring the global population to its knees.

The birth and evolution of the petroleum industry

The modern history of petroleum is believed to have originated in the 19th century with the refining of kerosene from crude oil by the Russian scientist Ignacy £ukasiewicz in 1852 followed by the drilling of the world's first commercial oil well in Poland in 1853. But it was the drilling of what came to be known as the Drake Well in 1859 by Edwin Drake in northwestern Pennsylvania in the US that set off a burgeoning demand for kerosene and oil lamps and a global search for petroleum, ultimately leading to a drastic change in the way people lived. A few decades later, towards the end of the nineteenth century, what fuelled the clamour for oil in a big way was the birth of the automobile industry. As this industry expanded and grew there was a global surge in the consumption of oil. The de-

velopment of gasoline engines for ships and aircrafts further impacted the demand for oil.

For nearly four decades, before oil was discovered in East Texas in 1901, Pennsylvania accounted for half of the world's production of oil. Then, till World War I broke out, Oklahoma, Texas, and California were the leading production areas of oil in the world. The 1930s saw intense oil exploration activity in the Persian Gulf area. But at that time, no one had any inkling of the size of Gulf oil reserves, and despite the discovery of oil in the Middle East, the US led the world in oil production till around 1960. Today, the top three oil producing countries are Saudi Arabia, Russia, and the United States, with around 80% of the world's easily accessible reserves being located in the Middle East.

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Conflicting theories about the origins of petroleum and available reserves

Barely six years after the Colonel Drake Well was drilled in 1859, with demand exceeding supply, Pennsylvania and the surrounding states were abuzz with news reports about the country running out of oil. And ever since, for nearly one and a half century, there have been a series of predictions of humankind being on the verge of running out of available petroleum. But time has proved all those past forecasts to be wrong.

Today, most experts are debating if we have already passed the "peak oil" milestone and if from now onwards oil discoveries will start tapering off. But on the other hand, there is a smaller group of scientists who hold an exact opposite view point and insist that there are huge unexploited supplies of petroleum deep down in the Earth. Basically, the differences in opinions regarding the available reserves of petroleum on Earth all arise from a fundamental disagreement over the origins of petroleum itself.

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The theory that petroleum is formed from the decay of organic matter is known as the "biogenic or "biotic" theory of petroleum formation and is believed to have first been put forward by the Russian scientist Mikhailo Vasilyevich Lomonosov in the year 1757. Lomonosov had proposed the idea that Nature has been transforming dead life into oil for millions of years through the use of just heat, pressure and time. The advances in geophysics and geochemistry during the second half of the 20th century led to the majority of scientists rallying behind the biotic origin theory. According to this more popular theory, dead organic matter, mainly from the decay of plants and tiny marine organisms like plankton that flourished millions of years ago, accumulated and got buried at the bottom of oceans, swamps and river beds and got mixed with sand and mud. With the passage of time, more sediment piled on top of this, and due to the resulting heat and pressure the organic layer got transformed into a dark, waxy substance known as kerogen. Eventually, the kerogen molecules crack and break up into shorter molecules composed almost exclusively of carbon and hydrogen atoms. Depending on the extent of the liquid or gaseous nature of this mixture, it finally turns into either petroleum or natural gas.

But from around the 1950s, a smaller group of scientists, mostly from Russia and the Ukraine, have been questioning this traditional view, contending that oil is a primordial substance dating back to Earth's origin, that the term "fossil fuel" is a misnomer, and that petroleum is formed naturally at great depths in the Earth through a slow inorganic process. They believe this petroleum then seeps upward through cracks formed by asteroid impacts, forming underground pools in the earth's crust. Today, in addition to some Russian scientists, a small group of Western scientists too, including the late Cornell

University physicist Thomas Gold support the "abiogenic" or "abiotic" theory that propounds the inorganic origin of petroleum. In his book *The Deep Hot Biosphere* (1998), Gold argued that hydrocarbons existed at the time of the solar system's formation, and are known to be abundant on other planets like Jupiter, Saturn, and Uranus where no life is believed to have existed even in the past, proving that hydrocarbons can have an abiotic origin.

The proponents of the abiotic theory believe the Earth contains abundant, inexhaustible reserves of untapped petroleum and assert that the biotic theory that petroleum somehow evolved from biological detritus and was therefore limited in abundance is based on an archaic 18th century hypothesis and is inconsistent with modern geological and geochemical evidences. In contrast, the theory of the abiotic genesis of petroleum, they say, is backed by geological observations and the laws of chemistry and thermodynamics.

At the Euro Science Open Forum 2010 held in Turin last year which I had attended as a Fellow of the Robert Bosch Stiftung, Vladimir G. Kutcherov of the Royal Institute of Technology, Stockholm, Sweden, presented a forceful defence of the abiotic theory. During the course of his presentation titled "The end of the beginning of the petroleum era", Kutcherov argued that both laboratory experiments and geological data supported what he termed the 'modern Russian-Ukrainian theory of abyssal, abiotic petroleum origins'. Using the newly developed high pressure equipment CONAC, and materials like $CaCO_3$ or graphite, H_2O, and Fe, Russian scientists succeeded in replicating the conditions of Earth's upper mantle. Through these 'high pressure, high temperature' experiments they were able to obtain a mixture of hydrocarbons similar to that available in oil fields, thus proving that abiotic synthesis of hydrocarbons is a real physical process. They could also synthesize natural gas in the upper mantle conditions. Kutcherov also drew attention to the recent discoveries of large deep and ultra-deep deposits of oil and gas in the Gulf of Mexico.

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Oil and gas deposits at such great depths of around 8 to 10.5 kms cannot be explained on the basis of the biotic origins of petroleum. Besides, a recent study by the US Department of Energy and Lawrence Livermore Lab has suggested the existence of huge methane deposits in Earth's mantle around 60 to 120 miles deep. Kutcherov said there are no known biotic sources large enough to correspond with the gigantic sizes of such deep and ultra-deep petroleum deposits. He also referred to how studies of Saturn's orange moon "Titan" by NASA have concluded that at least one of the large lakes on its surface contains liquid hydrocarbons, indicating that hydrocarbons can be formed without any biological connection.

Science is a continuous journey in pursuit of truth, with theories being modified or rejected along the way based on the availability of newer evidence. So theories about how petroleum has formed and how much is still left in the Earth can also change with time, and no one can conclusively prove that none of the petroleum on Earth is of abiotic origin or that new reserves will never be discovered in unexpected places. Abiotic theorists like Kutcherov point out that while their more 'modern' theory has been vigorously challenged, debated, and extensively examined right from the time of its introduction, there has never been any similar critical review of the conventional hypothesis that petroleum has a biotic origin. They say the time is now right for alternative theories like theirs to be given serious consideration in scientific debates on petroleum, and for a wider discussion on the chemical genesis of hydrocarbons.

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However, though scientists today have strong disagreements over the origins of oil or how soon there will be a global oil crisis, all of them agree that the formation of petroleum requires hundreds of thousands of years and that since someday we might be confronted by demand outstripping supply we have to use oil judiciously.

The current scenario

So far, oil companies have been using the biotic theory for exploring for oil. Even as explorations are being carried out in newer areas, depletion of tens of thousands of oil and gas fields across the world is being observed with hardly any instances of refilling being noted. The abiotic theorists opine that hampered by a fallacious theory, oil companies are not drilling in the right places, otherwise they would have found much more oil than they are discovering at present.

Today we also have rising economies like China and India that are becoming increasingly dependent on oil. According to the Institute for the Analysis of Global Security, in China, the consumption of oil could increase by 7.5 % per year, while India's is likely to grow by 5.5%. In China's case, its oil production has been static since the 1980s and today, around 40% of its current oil requirements are met through imports. It's the same story in the US. Though still one of the highest producers of oil, today America imports around 60% of the oil it needs. Similarly, across the globe we see one country after another making the transition from 'oil exporter' to 'oil importer', Great Britain being amongst the latest examples of this phenomenon.

Averting a fuel crisis

At ESOF 2010, Kutcherov made some unconventional but pertinent observations. He said oil would continue to remain the main energy source for the world right through the 21st century. Currently, barely 1% of energy comes from renewable energy sources. When we have vast reserves of oil and gas, he wondered why we are not investing in developing this vital resource instead of wasting trillions of dollars on the development of other sources such as wind energy.

Some of the other suggestions he made were similar to what most scientists advocate, such as:

1. Limiting carbon dioxide pollution by developing better carbon capture technologies. In tune with his stance as an abiotic theorist, Kutcherov remarked that if we were to divert even 10% of the colossal amounts invested in the development of wind energy to developing such technologies, the objective of reduced carbon dioxide pollution could be achieved much sooner.
2. Developing advanced technologies for gas hydrate deposit exploitation.
3. Limiting the burning of oil in vehicles. Currently, 90% of the oil extracted is used to meet vehicular fuel needs. Instead more vehicles should be designed to run on fuels like liquefied natural gas.
4. Developing new types of engines and better technologies for increasing the efficiency of vehicular fuel. At present only 15 to 20% of the fuel in vehicles is used to power them.
5. Limiting the use of cars in cities and encouraging the use of public transport.
6. Introducing progressive taxes for a second or third car per family. Kutcherov said this was mainly essential in developed countries.
7. Introducing progressive taxes for households and building with low insulation efficiency, particularly in the developed world.
8. Conserving petroleum reserves by developing technologies for clean renewable sources of energy.
9. World governments should follow the example of some European countries and take steps to promote energy conservation among their citizens.

Natural Gas: The premier fuel of the future?

At the face-off held at a conference organized by the American Geophysical Union in San Francisco in 2004, scientists, academics and energy consultants hotly debated the issue of the world skidding towards an oil crisis. The majority of those present agreed that there was nothing to worry about in the short term. Stanford University geophysicist Amos Nur said that by 2060, oil production will have to triple just to meet global population growth and maintain current standards of living. Analyst Bill Fisher of the University of Texas at Austin asserted there was no reason for panic as he felt there would be plenty of

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oil for the next few decades. He said he expects the world to gradually move over to an economy based on natural gas during the first half of this century, and then to a hydrogen economy before 2100. He also drew attention to the fact that estimates of oil reserves tend to grow over time, regardless of who does the guessing.

Nowadays, many leading energy experts contend that the scenario is very optimistic for natural gas which they say will become the fuel of choice for the world economy within a decade or so. Natural gas, even excluding the enormous volume of gas hydrates, is expected to last for several centuries. Huge quantities of oil in the future are expected to come from deep to ultra-deep offshore production in the Gulf of Mexico and other parts of the world.

Some experts suggest that the world energy demand will grow by 50% by 2023, and that despite all the discussions over developing alternative energy sources, the contribution from oil and gas will increase from 61% to about 67% by then. It also reported that, with the dependence on oil diminishing, natural gas will command a market share that is practically unimaginable currently and that it is likely to account for up to 50% of energy demand.

The optimistic outlook for the transition to natural gas as the world's premier fuel within just a few years is based not just on the abundant supply around the world, but also on the fact that the supply is more diverse with many countries being legitimate potential suppliers of world-class volumes of this resource. Countries like Russia, Peru, Bolivia, Namibia and Nigeria are suddenly finding they have large gas reserves. Venezuela is believed to have more gas than oil. Consequently, the importance of OPEC and the major geopolitical vulnerabilities with respect to the Middle East is expected to reduce in future.

So are we running out of oil? The truth is no-one really knows the answer. But we could be running out of the "cheap" oil that had spawned a car-dependent society in the developed world around a century ago. Experts also predict wild fluctuations in oil prices in future with emerging economies like China and India influencing the surges and slumps in prices.

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