
The Oil Age in an Historical Perspective

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Abstract: *Astronomers study the Universe that came into existence 13 billion years ago. Geologists study the rocks composing Planet Earth while palaeontologists study the record of life provided by fossils. Homo sapiens evolved from earlier forms of life and so-called modern man appeared on the scene some 250 000 years ago, which is comparatively recently in geological time. Historians concentrate on tracking the more recent history of modern man over the past 2000 years.*

Different communities developed and exploited the land and natural resources at their disposal. Frontiers had to be drawn, which called for leadership, and there were many conflicts between rival communities. They exploited their resources as well as they could relying on muscle power, and used timber from fallen trees to heat their homes and cook their food. Accounts had to be kept of the food produced and consumed. Gold and silver came to be used as a medium of exchange to facilitate trade. Religions developed to help communities run their lives, but different sects arose, leading to more conflict.

For most of history, muscle power both from man himself and his horses provided the energy needed to support communities, but then coal followed by oil and gas were exploited leading to radical changes in human life and population. But these are finite resources formed in the geological past, meaning that they are therefore subject to depletion.

Determining the status of depletion is a complex issue subject to complex commercial and political pressures. Naturally, the larger and more accessible resources were tapped first having a major impact on the overall depletion profile. The evidence suggests that the world is close to the peak of oil and gas production. This will mark the dawn of the Second Half of the Oil Age, when this critical source of energy supporting mankind declines. The transition threatens to be a time of great tension, as countries find that they can no longer support their populations. The economic and financial systems, which are premised on economic growth based on expanding fuel consumption, are under increasing pressures, as already witnessed.

It is not necessarily a doomsday message as there is much that communities can do to successfully adapt to

the changing circumstances, provided that they are informed of the underlying situation. There is much that the scientific community can do to evaluate the situation and provide the necessary insights.

1. INTRODUCTION

Astronomers study the Universe, which they conclude came into existence after the so-called *Big Bang* about 13 billion years ago. Planet Earth is apparently unique insofar as it has a thin coating of water and air, supporting life. Its oceans and continents have moved around over time on the back of deep-seated convection currents beneath the Earth's crust. Mountains formed where continents collided, and rifts developed where they parted. The mountains have been subject to erosion, giving sands, clays and other sediments that came to rest on the floors of seas and lakes. Volcanoes locally erupted bringing molten rocks from the Earth's interior to the surface. The climate has changed many times in the past in response to volcanic eruptions and the changing distribution of continents and oceans in the geological past.

Geologists study these rocks to piece together the record of the Earth's history, being helped by palaeontologists, who study the fossil record. The limpet, or *Patella* to give it its scientific name, lived in the early seas, some 500 million years ago, and has not changed much since, but other species evolved into more sophisticated beings when they found an environmental niche that suited them, only to die out when they exhausted the resources it had to offer. There were periodic catastrophic events from earthquakes, meteor impacts and massive volcanic eruptions. So-called *Modern Man* appeared on the scene, some 250,000 years ago, and lived at first by hunting wild animals and eating fruit from trees. Some even came to occupy caves to live in. It is interesting to note that the survivors of the Punan tribe in the remote interior of Borneo continue to live in similar circumstances, although much of their land has now been taken by logging companies.

Historians concentrate on relatively recent history when human communities formed in particular areas, growing their own crops and raising cattle for food.

These communities often found themselves in competition with each other, which led them to define their borders and appoint leaders to control their circumstances. If a community exhausted the fertility of the soil at its disposal, as many did, it either died out or conquered other lands. There have been many wars and conflicts, with the more successful communities forming nations and empires.

2. EARLY ENERGY

For most of his history, Man has relied on muscle power to support his life, much coming from his own body as well as that from his horses and mules. He also found out how to make fires from fallen trees with which to cook his food and heat his home in winter. At a certain point, someone came across a lump of coal washed up on a beach and found that it was inflammable. It prompted the search for more, leading to the discovery of outcropping seams, which were duly dug up in open pits.

He also learned how to tap energy with wind and water mills to grind his corn and provide an early form of power for crafts that in turn evolved with the smelting of minerals to provide metals for better tools and weapons. These advances allowed the human population to grow gradually, but it no more than doubled over the first seventeen centuries of the last Millennium.

3. POLITICS, TRADE, AND MONEY

Barter developed in early societies as someone might for example exchange a sheep for a sack of corn. There was furthermore the need for community storehouses to hold the food from an annual harvest for the remainder of the year. It saw the development of an early form of accounting to record the amounts deposited by farmers and withdrawn, which in the days before paper was written on clay tablets.

At a certain point someone probably spotted a nugget of gold on a sand bank in a river, and was attracted by its unusual shiny appearance. He may have shown it to a neighbour, who liked it even more, offering to swap it for some other asset such as a sack of corn. More nuggets were searched for, and gold gradually became the medium of exchange, followed in turn by silver, another rare mineral. It became convenient to hold these valuable assets in a storehouse against a receipt, which became an early form of money. At a certain point, an imaginative storekeeper realised that he could issue more receipts than he had gold and silver on

deposit, assuming that not everyone would cash in simultaneously, laying the foundations for modern banking. But money ultimately has to reflect the amount of energy available, being so to speak the blood stream of the world.

Trade developed, ranging from the basic exchange of food to the sale of property and manufactured goods. In many cases, it gave rise to a demand for debt as people wanted to expand their businesses or simply cover their needs when they found themselves short of cash. Furthermore, wars and conflicts often called for debt, giving the lenders of money a political influence. They came to charge a fee for any loans made, such being termed *usury*, which was widely seen as unfair as it did not reflect work.

The early communities needed some form of management to control their affairs and lead them in conflicts. At first, probably someone with an appropriate personality arose to power. In some cases he managed to pass on power to his son, leading to a dynasty that might last for centuries, but in other cases there was some form of election. Some of these early leaders abused their position by extorting excessive wealth from their community, which in turn bred resentment. Some built castles in which to live and defend their property. The development of nations helped reduce the conflict between the individual communities of which they were composed, but in many cases the national frontiers were open to dispute. Britain was fortunate in being an island with boundaries imposed by Nature although in earlier years Scotland and Wales maintained their independent identities. As an island, it also developed maritime skills, which facilitated trade, leading to a worldwide empire. Considering the world as a whole, it seems that most members of the communities lived in earlier years on a barely subsistence level and had short lives. They expanded as they exploited their lands but then faced famine and contraction as they cut down their forests and exhausted the fertility of their soil.

The early communities came to make astronomical observations, noting how the sun changed its position in the sky from summer to winter, which was significant in telling them when to plant and harvest their crops. Some early observatories in the form of stone circles, such as Stonehenge in England, were constructed. The people may have come to believe that the Earth, Sun, Moon and Stars were controlled in some manner comparable to that of their own community,

which in turn prompted the notion of a divine power. Some communities even worshiped the sun. Looking at the natural world of animals and plants around them, each of which had an order to its existence, may have confirmed the view that there was an external power, termed *God*. It was exploited by some of the leaders who claimed that they had a so-called *Divine Right*. The first to do so was Hammurabi, the King of the Babylonians, in the 18th Century BC. Various religions, including Christianity, Judaism and the Muslim Faith, developed, each claiming closer links with an *Almighty*. There were of course many political overtones. Christ, when still a baby, was identified as being the *Son-of-God*. The government resented the claim prompting his family to flee. The government reacted by ordering the execution of all young male children, which confirms the role of some political faction behind the divine recognition, as a baby lying in a manger poses no threat to anyone. His family managed to escape but he later returned and was duly crucified, having successfully built up a following. It is now said that Christ is better described as a Palestinian as his teachings undermined the role of Judaism insofar as he said that all humans had access to God. The religions later subdivided into separate sects, which no doubt had political overtones.

Significantly, usury was condemned as a sin by the main religions, although Judaism allowed it to be practiced against *strangers* outside their community, as revealed in the biblical Book of Deuteronomy, which may explain the prominent role that Jews have played in banking. Jerusalem was sacked by the Romans in AD 135, prompting the survivors to flee to foreign lands, where, having no land, they had to concentrate on trade and finance. Venice in the Middle Ages was an important trading port and gave a disused iron factory (*ghetto* in Italian) to Jewish money-lenders, allowing Christian traders to lend and borrow money without religious condemnation. There were consequential outbursts of anti-Semitism that erupted from time to time, notably in Russia and later in NAZI Germany where millions lost their lives in the so-called *holocaust*. Apart from financial resentment, the German government had a desire to recognise and improve the Aryan race, which may have been a response to losing the First World War and the economic collapse that followed it. Germany was a relatively new country having been formed from various principalities following the defeat of Napoleon in the Franco-Prussian war of 1870. The government may therefore have felt the need to encourage a sense of greater national identity, partly on racial grounds.

4. ENERGY

Trade and manufacturing gradually expanded, causing more people to live in cities, which led to an increase in the demand for energy. The *Coal Age* opened in the 18th Century. The surface pits were deepened into regular mines. However, mines flood when deepened into the water-table, which prompted a remarkable technological development. The miners at first used hand pumps, but that led to the development of a steam pump to drain tin mines in Cornwall, which evolved into the steam engine, changing the world in radical ways. It in turn led to the *Internal Combustion Engine* when a way was found in 1876 to insert the fuel directly into the cylinder, making it much more efficient. At first, it used benzene distilled from coal but then turned to petroleum refined from crude oil. The first automobile took to the road in 1882 and the first oil-powered tractor ploughed its field in 1907. This is not so long ago as it might seem, having been witnessed by the parents or grandparents of an old man living today. The steamer gradually replaced the sailing ship and opened up worldwide trade. Aviation later took off, and had a particularly important role in military engagements. The oil industry was born and came to provide a flood of easy energy that has changed the world in remarkable ways. It has been calculated that a drop of oil contains 10000 calories, which is about what a manual worker can deliver in a day.

5. THE BIRTH OF THE OIL AGE

Oil from surface seepages has been known since the earliest days and was used for various purposes, including caulking wooden boats. Various small deposits were exploited: for example, one at Pechelbronn in France was tapped in around 1800 by shallow wells. A more significant development came when a well was drilled in 1859 in Titusville, Pennsylvania, hitting oil at a depth of only 69 feet. It opened the US oil industry. Initially, the refined product was used to illuminate lamps, replacing whale oil that was becoming scarce from over-whaling. But the development of the *Internal Combustion Engine* provided a new market, leading to the growth of the oil industry, which expanded rapidly providing an amazing new source of energy that has changed the world in radical ways, allowing its population to expand seven-fold. The oil industry came to be dominated by seven major oil companies, known as the *Seven Sisters*, which explored the world, finding several major new productive provinces, dominated by the Middle East.

6. PETROLEUM GEOLOGY

The oil industry came to understand the geological conditions responsible for the formation and entrapment of oil and gas. Successful exploratory drilling depends on finding a place having a source, reservoir, trap and seal to hold an accumulation, as briefly described below.

Source : oil is formed from algae that accumulated at the bottom of stagnant lakes and seas, where a hot climate warmed the surface waters reducing circulation. That gave anoxic conditions at depth, which preserved the organic material. The bulk of the world's oil comes from just two epochs of global warming, 90 and 150 million years ago, but there were many other local sources of lesser importance. The organic material, termed *kerogen*, was progressively covered by sediment washed into the sea or lake. When buried to a depth of some 3000 meters it was heated enough to be converted into oil. Gas was formed in a similar way, but from more carbonaceous material as found in the deltas of tropical rivers. Liquid petroleum also condenses from gas as its pressure falls on being brought to the surface, being known as *condensate*. Oil was also converted into gas where overheated on deep burial.

Reservoir : once formed, the oil and gas migrated upwards to zones of lesser pressure, provided that there were fractures or sufficiently permeable rocks through which it could move. In the course of its upward movement, it locally encountered a permeable and porous sandstone that acted as a reservoir, with the oil and gas filling the pore space between the grains of sand, replacing the water that previously did so. Fractured limestone and some other rock types also provide reservoirs. The water underlying the oil and gas in the pore space of the reservoir rock progressively rises as the oil and gas are extracted. Most oil deposits are overlain by gas, which expands as the oil is extracted. They are under high initial pressures, and flow naturally to the surface but later have to be pumped as the pressure declines.

Trap : some of the upward migrating oil escaped at the surface, where it was degraded, with the tar sands of Canada being a classic example, but locally it was trapped in dome-like geological structures, called anticlines, or against faults and in places where the reservoir rock pinched out laterally.

Seal : the reservoir rock also needed to be capped by a seal of clay or salt to prevent the oil and gas escaping.

At first, exploration relied on no more than geologists mapping rocks exposed at the surface, but later came geophysics whereby an explosive charge was released and recorders measured the time taken for the echoes from deeply buried rock surfaces to return, allowing them to be mapped in detail. It has become ever more sophisticated, even identifying oil-water contacts. Geochemistry too made advances permitting the more accurate identification of source rocks. Despite all these considerable technological advances no more than about one in seven exploration wells currently makes a commercial discovery. Obviously, the more prospective areas were found first, as were the larger fields within them, being too big to miss.

7. OIL WELL

The technology of drilling oil wells is a very complex process, which has made great advances. At first, the wells were sunk simply by a heavy weight on the end of a cable hanging from a derrick. It was lifted and then dropped to punch its way into the earth. Later, came the more efficient rotary rig. It starts by drilling a hole with a diameter of about 36 inches, which is then sealed by metal tubing, being cemented into the earth. The well is then deepened in progressively narrower boreholes, each being duly sealed off. A liquid, made up mainly of mud, water and the heavy mineral, barytes, is pumped down the well to bring the cuttings to the surface and hold back any oil and gas found. The samples are examined to interpret the geology of the section being penetrated. Later, sophisticated electronic methods were developed to track the nature of the rocks penetrated by the well and to spot any oil and gas-bearing intervals. Once found, holes are drilled in the side of the well casing to allow the oil and gas to enter the well and flow upwards to the surface. Drilling oil wells is a costly and sophisticated process.

8. DEPLETION

It follows from the foregoing summary description that oil and gas are finite natural resources, formed in the geological past, which means that they are subject to depletion. The pattern of depletion ranges widely, being much influenced by commercial and political pressures, but logic suggests that the peak of production in any country comes when about half of its total recoverable resource has been extracted. More than forty countries are now producing less than at some date in the past. Recognising the finite nature of the resource implies that the more used today means that less is left for tomorrow.

It sounds a relatively simple task to evaluate the status of depletion of an individual field, which could be summed to give the status of a producing country and the world as a whole, but in reality there are many serious obstacles, as summarised below.

9. THE DIFFERENT CATEGORIES OF OIL AND GAS

There are several different categories of oil and gas, distinguished as *Conventional* and *Non-Conventional (or Unconventional)*, having a wide range of different depletion profiles, but unfortunately there is no standard classification, which is a cause of much confusion in the statistics. The following classification is adopted here:

Regular Conventional Oil and Gas

Non-Conventional Oil and Gas comprising

Heavy Oil (10° -17.5° API - a measure of density)

Extra Heavy Oil (<10° API) including that from tarsands

Tight Oil and Gas (obtained by fracturing rocks lacking adequate natural porosity and permeability.)

Oil Shale (obtained by heating kerogen)

Deepwater Oil and Gas (>500m water depth)

Polar Oil and Gas

Coalbed methane, hydrates and certain other insignificant categories of gas

Tight Oil and Gas are difficult categories to define. *Fracking* has long been undertaken to a limited degree on some conventional reservoirs in order to improve permeability, but the term *Tight Oil and Gas* here refers to that from fields dependent upon it. So far, only the United States has seen a major boom in production when prices were high, although Argentina is also exploiting it from the so-called *Vaca Muerta* ("Dead Cow") *Formation* in the north of the country. Other regions around the world will no doubt increasingly turn to it in the future. The resource in the ground is considerable, but the wells have short lives, tapping no more than the immediate vicinity of the wellbore, and most require an oil price of more than about \$70 a barrel to be commercially viable.

10. PRODUCTION AND RESERVE DATA

The oil companies naturally meter the production of oil and gas from a field, and also estimate the amount left to come from its producing wells, such being termed

Reserves, provided that it is commercially viable. Scientists tend to think of reported reserves as a physical measurement, but in fact the estimates have been subject to many internal pressures related to oil price forecasts, development costs, tax, profitability and government controls. So-called *Proved Reserves* are the most confident estimate of that coming from producing wells but also recognised are so-called *Probable* and *Possible Reserves* for additions that may be tapped in fields with the degree of uncertainty the terms imply. There are strict Stock Exchange rules to prevent fraudulent exaggeration, and in general the petroleum engineers making such estimates have been, quite rightly, cautious, with the result that reported reserves have tended to increase over time. The engineers are less concerned with estimating the amount of oil in the ground than in designing optimal methods of extraction to secure good profits. Much depends on oil price and the forecasts thereof. Obviously, the higher the oil price forecast, the higher the reserves estimate, and vice versa, having a major impact on what is reported. In earlier years it was the industry's practice to estimate the size of a field on the basis of its *Proved Reserves* in full plus two-thirds of the *Probable* and one-third of the *Possible* estimates, but later statistical methods were introduced. The companies are naturally under all manner of internal pressures as different affiliates around the world vie with each other for funding. Oil price forecasts clearly have an important impact on what is reported as *Reserves*. In earlier years, prices were relatively stable, but that is no longer the case, and no doubt has a major impact on the validity of recent reserve reports.

The oil companies also like to track what each other are doing in a competitive market, and in earlier years did use an independent database, run by Petroconsultants in Geneva, through which they informally exchanged valid information. There are now several industry databases, but they might not be quite so accurate, being also costly to access and subject to strict rules of confidentiality on what becomes an increasingly sensitive subject.

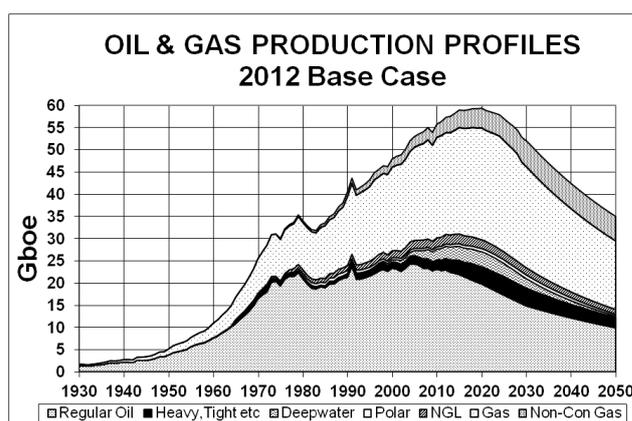
There are so-called *fallow fields*, namely discoveries that have not been developed for commercial or political reasons. Developing an oilfield involves addressing many complex economic and financial factors, including interest rates, that vary from place to place and over time. There must now be many *fallow fields* in Libya and the Middle East as the political situation there stands in the way of the investment needed to develop discoveries.

Furthermore, assessing the reserves of the ever smaller and geologically complex structures becomes progressively more difficult and sensitive to oil price forecasts. As the industry lost control of major supplies from the Middle East and the accessible onshore supplies were depleted, it was forced to move offshore, even into deep waters, which called for very sophisticated and costly new technology. Such fields are naturally very sensitive to falls in oil price and forecasts thereof. Oceans cover much of the Planet's surface, but relatively few areas within them have the right combination of geological conditions to contain oil and gas.

In 1928, following a surge of new discovery in the United States, the major oil companies had a meeting at the Achnacarry Castle in Scotland, at which they agreed to support price by restricting production between themselves. This set a precedent for the main producing countries, which in 1959 formed the *Organisation of Oil Producing Countries* (OPEC) whose members agreed to set production limits based on reported reserves.

It became subject to pressures at a time of low oil prices in the mid 1980s. In 1970, Kuwait had reported reserves of 67 Gb (billion barrels), which had reasonably fallen to 64 Gb by 1984 as a result of production and the absence of major new finds. But in the following year, it announced an anomalous increase to 90 Gb, although nothing particular had changed in its oilfields. Then in 1987, it announced a possibly genuine small increase to 92 Gb, but that proved too much for the other OPEC countries wishing to hold their quotas. In 1988, Abu Dhabi matched Kuwait at 92 Gb (up from 31 Gb); Iran went one better at 93 Gb (up from 49 Gb); and Iraq capped both at 100 Gb (up from 47 Gb). Venezuela increased from 25 to 56 Gb, but did so by including its *Heavy Oil* that had not previously qualified for OPEC quota purposes. Saudi Arabia did not react immediately but in 1990 increased its reported reserves from 170 to 258 Gb. The numbers suggest that Kuwait may have changed to reporting *Original* rather than *Remaining Reserves*, namely by not subtracting past production, as indeed is normal industry practice in determining the relative ownership of a field that straddles a lease boundary or frontier. Kuwait may have become aware of it in the dispute with Iraq over the relative ownership of the South Rumalia Field that straddles the frontier and was one of the factors prompting the First Gulf War.

The foregoing emphasises the difficulties faced by an analyst trying to determine the status of world depletion. The author has been working on this subject for many years in retirement after a career in the oil business. The following graph is reproduced from a resulting book (Campbell 2013). The preface states that the only correct numbers in the book are the page numbers, such is the unreliable nature of the country data being used, but that said, the overall picture seems reasonable. The book addresses the situation by country, including its geography, history and evolving political situation, and also contains an extensive bibliography.



11. THE FIRST HALF OF THE OIL AGE

This has been a remarkable chapter in history when a flood of easy and cheap oil-based energy had a major impact on the world. The social structure changed as people in all walks of life increased their consumption of goods and services. They also came to assume that their living conditions were set to improve over time, and became resentful if there were delays or reversals. Women had previously seen their role as wives and mothers living on their spouses' income, but especially those in the *Western World* came to build successful careers for themselves, which allowed them to earn and spend more.

Stavanger, which is the oil capital of Norway, if not Europe, is a good example of the impact of a flood of oil-based money during the latter part of the *First Half* of the *Oil Age*. Previously, it had been a charming small town, with a long-established harbour supporting fishing and some minor shipping companies. But today it has supermarkets almost the size of airports, a wide range of business premises, and extensive suburban areas supporting a massive increase in population, many of whom evidently come from distant lands. It is even building a lengthy tunnel under the town and the

adjoining fjord to reduce traffic congestion, evidently not appreciating that the level of traffic is set to decline in the years ahead as oil depletes. But now it faces a high level of unemployment, as the oil industry contracts after a peak of production in 2001, facing the decline in the country's production due to natural depletion and the recent fall in oil prices.

The flood of oil-based energy also changed the financial structure of the world with the rapid development of stock markets, which were largely speculative in nature. In earlier years, investors had put their money on a specific project such as building a canal or factory for which they had knowledge and a sense of loyalty, but then they placed it with traders who made money by tracking short-term movements on a stock market. Their skills lay in identifying market movements without having any detailed knowledge of, or commitment to, the individual underlying investments. It was not however plain sailing as the market collapsed in the Great Depression of 1929-30, which may have partly reflected the excessive debt incurred both in the First World War and in helping rebuild the German economy after its defeat. Another serious economic recession followed in 2008, prompted by a surge in oil price in 2005.

The two world wars were of unprecedented proportions and consumed vast amounts of energy, costing the lives of millions under gruelling conditions. At root, they were probably triggered by competition between trading empires. But with hindsight seem to reflect a certain political ineptitude, as governments had failed to realise that advances in technology and oil-based energy supply had changed the nature of war.

At its peak in 1922, the British Empire held dominion over one-fifth of the world's population, but it was disbanded after the Second World War, as its territories were progressively granted independence. Its place as a leading world power was effectively taken by the United States, but it is primarily a financial empire in that it takes no administrative responsibility for the people in the countries it indirectly controls. The dollar became the world's premier currency as countries held their savings in it, which in turn allowed the US Treasury to issue more bonds, stimulating the home market. There were far-reaching implications. In a sense, the country secured its oil imports for free, as their cost was matched by financial gains from foreign dollar holdings. Although primarily financial, the United States maintains by far the world's largest

military establishment with an annual budget of \$612 trillion dollars, compared with for example that of the United Kingdom, standing at \$53 trillion dollars. It appears to reflect a colossal amount of wasted money and energy for the various engagements, such as the wars in Iraq and Afghanistan, appear to have served no useful purpose. No doubt the military industry is very profitable, and there were of course domestic political overtones as conflict strengthens the role of government. It is well said that good advice for a politician is : *if you don't have an enemy, make one*, as a perceived threat tends to strengthen the support of followers. Donald Trump, who was recently elected to be President, announced in his inaugural address that he planned radical changes, aiming to isolate the US economy for the benefit of its own economy and people, reducing immigration. It speaks of a new regionalism, comparable with that expressed by Britain in its decision to leave the European Union. There is even a movement in California, named Calexit, with a similar policy.

The *First Half* of the *Oil Age* saw the expansion of democracies around the world, which were depicted as the best form of government to reflect the wishes and objectives of the people. But in fact it may not be such a good system as the people at large lack the qualifications to assess the real situation they face: most simply hoping maintain their present circumstances and increase their wealth with which to spend more. The politicians have to raise huge amounts of money to support their campaigns, and many have made fortunes. The Clintons, for example, have raised \$3 billion over 41 years in the United States, and Tony Blair, the former leader of the Labour Party in Britain, has likewise made a fortune, despite representing a party with socialist foundations. It is virtually impossible for them to recognise the onset of economic contraction marking the *Second Half* of the *Oil Age*, as discussed below.

The so-called *Cold War* dominated the post-war years. Russia had formerly been an extremely aristocratic society with privileged landlords owning vast estates, operated by serfs, who were effectively slaves. The liberation of the serfs in 1861 led to a popular rising known as the Bolshevik Movement, seeking a fairer State-controlled distribution of wealth. Ironically, it was supported by some New York bankers in response to a degree of anti-Semitism that had been imposed in 1791 by the then Czar, Catherine the Great, who had imposed the so-called *Pale*, restricting Jewish

residence. The resulting Communist Government became dictatorial in style, facing strong opposition from the United States and its allies, who supported the capitalist ethic. Changes in the Russian government eventually brought the *Cold War* to an end. But now there seem to be growing tensions between Russia and the NATO countries for obscure reasons, perhaps partly linked to a civil war in the Ukraine, where some elements seek to restore their Russian ties while others want to strengthen relations with Europe. Some commentators even say that the risks of a *Third World War* are growing.

It is noteworthy that one remarkable development of recent years has been the so-called *Digital Age*, whereby people come to own computers linked to the Internet, which allows them to secure an amazing amount of information from all over the world. Television, with its often less than erudite programmes, has evidently had a radical impact on society changing attitudes around the world at the expense of sustainable localism.

12. THE SECOND HALF OF THE OIL AGE

The world peak of *Regular Conventional Oil* production in 2005, which is now widely accepted, led to the surge in oil prices to almost \$150 a barrel by 2008. The average price over the past century had been no more than \$35, as quoted in 2016 dollars to take into account inflation. The radical increase caused the onset of an economic recession and financial crisis that cut demand and led to the failure of several major banks. The high prices also prompted a surge in the production of *Non-Conventional* categories of oil and gas, especially *Tight Oil* and *Gas* in the United States.

A debate rages as to the date of peak production of all categories of oil, which is imminent or may indeed have been passed recently, but misses the point when what matters is the vision of the long decline that comes into sight on the other side of it. Despite the uncertainties of detail, there can be no doubt that we now face the dawn of the *Second Half of the Oil Age*, when the production of this critical supply of energy declines from natural depletion. The transition threatens to be a time of great tension as discussed below.

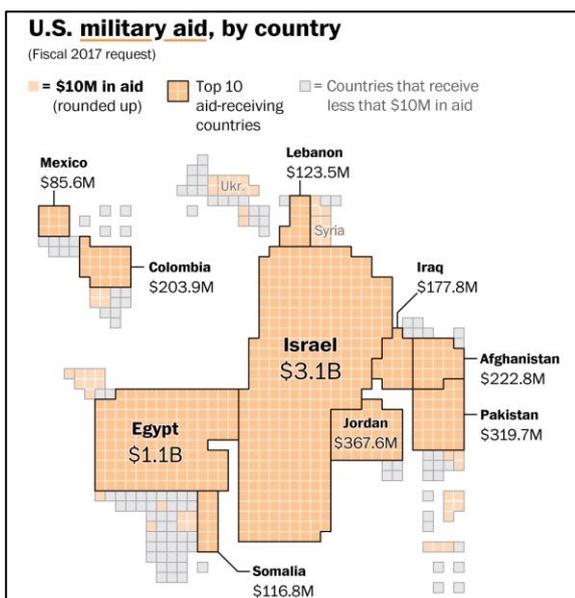
Serious political unrest has already broken out in the Middle East. It has had a long history with many rival factions, some claiming divine authority. The Judaic, Christian and Muslim faiths originated there and carried political overtones. Significantly, it holds about

half of the world's remaining *Regular Conventional Oil*, giving it a special global importance. The countries are barren lands with little to support their populations save for oil-related wealth. Probably, oil production was one of the factors leading to the political tensions over the past century as different factions sought access to the money it yielded.

With the exception of Iran, it was previously part of the Ottoman Empire of Turkey, which once was a major power even extending its control over Egypt and parts of Europe. It supported Germany in the First World War and was defeated. Britain and France then divided its empire up into new countries, but faced many challenges in setting the frontiers, which were somewhat arbitrary and did not fully reflect the divisions of different communities, religions and political factions. One group that did not receive recognition were the Kurds, who are descended from the ancient Medes and number about 30 million occupying a tract of territory through parts of Syria, Iraq, Turkey and Iran. They have been in conflict with Turkey for many years seeking independence, and are responsible for various recent terrorist attacks. They already control much of northern Iraq having gained access to the revenue from oilfields in that territory, and are participating in the Syrian civil war. Turkey faced a *coup d'etat* in 2016, but the government of Recep Erdogan managed to survive, imposing a draconian response. He now seems to be trying to strengthen ties with Russia.

The State of Israel is a somewhat anomalous country. The Zionist Movement was formed in 1897 as a reaction to anti-Semitism, mainly in Russia. In 1917, Britain responded with the so-called *Balfour Declaration* that granted Jews the right to live in Palestine, which was then administered by Britain, but the numbers were limited to those that could be readily absorbed. Britain's motives are unclear but may reflect the need to secure dollar loans to support it in the First World War. Further pressures developed after the Second World War leading to recognition of the State of Israel in 1948. It then had a population of one million, which has since increased eight-fold, receiving substantial funding from the United States. It has engaged in several wars with neighbouring countries and seeks to occupy more of Palestine. The so-called Yinon Plan of 1982, which was endorsed by the US Government according to Hillary Clinton's now released e-mails, proposed that the best way for Israel to strengthen its position was to encourage the people

of Syria to rise against the regime of Bashar Assad, the father of the present leader. It is significant that there are now new movements of anti-Zionist Jews in several other countries who are opposed to the policies of the State of Israel, which they see as threatening. These developments have led to anti-Zionism, even by people having great respect for Jews, who are generally very intelligent and friendly. The Syrian Civil War seems to be attracting wider political pressures as Russia and Iran support the Government of Bashar al-Assad prompting counter pressures by the United States, which may of course be under Israeli influence. This seems to be confirmed by the disproportionate amount of military aid sent to Israel as illustrated in the above graph.



Iraq was previously at war with both Iran and Kuwait over disputed frontiers in oil-rich territory, which prompted an invasion in 1990 by the United States and its allies in the so-called First Gulf War. A second war followed on what proved to be false accusations that Iraq was building *weapons of mass destruction*, being subsequently justified by President Bush with the words : *our energy supply was at risk*. The former British Prime Minister, Tony Blair, supported President Bush in this campaign, but the Chilcot Enquiry, which has now been published after many years of study, explains that it was an utterly mistaken strategy, especially as no plans were made on how to rebuild Iraq after the loss of its leader, Saddam Hussein, who was executed after the war. Blair was backed and funded by Israeli interests, and it turns out that the first document about *weapons of mass destruction* was drawn up in Jerusalem.

Of particular significance was the recent decision by the Saudi royal family to ignore its OPEC obligations to cut production to support price, which led to a precipitate fall in world oil price to around \$30 in 2015. Its motives are unclear but may have included the following:

- i) to counter the *Tight Oil* boom in the United States that was triggered by the price surge to almost \$150 in 2008;
- ii) to reduce the oil revenue going to other Middle East countries with which it is in conflict, and which are more dependent on such revenue;
- iii) to help the world stock markets recover, and thereby the substantial foreign holdings of the royal family;
- iv) to allow the royal family to benefit financially from advanced knowledge of radical price movements including both the present collapse and a later recovery. If they had bought stocks in foreign oil companies when prices collapsed if they might now be reaping a fortune as prices rise above \$50.

It is significant that Mohammed bin Salman, who is a power behind the throne, recently stated that the country planned to launch a Public Investment Fund of \$2 trillion, and convert Aramco, the State Oil Company, into an industrial conglomerate. Such a policy might have been built on out-dated economic principles that fail to recognise that the industrial world is driven by oil-based energy, which is in decline due to natural depletion. On the other hand, a Saudi industry would enjoy a remarkable advantage if it had preferential access to the country's remaining oil at far below world market prices. King Abdullah, who was formerly on the throne, once obliquely recognised depletion when he said that he wanted to leave as much oil as possible in the ground for his grandsons. It is worth noting that Saudi Arabia's oil is itself now about 46% depleted meaning that its production will start to decline at about 2.5% a year by around 2020. So, its potential influence on controlling price will soon fall.

There are also serious tensions in North Africa, especially oil-rich Libya, and the other OPEC countries, notably Nigeria and Venezuela, face severe economic recessions due to loss of oil revenue, which carry serious political consequences.

The recent extreme collapse in oil price was short-lived, as prices are rising, having now passed \$55 but it has already prompted the premature abandonment of

aging fields, especially in the North Sea, that are no longer profitable. It has also led the oil companies and their contractors to shed staff. Such actions make a bad unfolding situation worse. A once abandoned field cannot be profitably re-developed, even at higher oil prices. The seven major oil companies are now reduced to four by merger as they evidently found it easier to access more oil supply by merger than by conducting their own exploration.

But there are now moves to rebuild OPEC, and possibly win the support of Russia, which is also suffering from the low oil prices. It is significant too that Russia has come to an accord with China to build a new financial empire and try to reduce the power of the dollar.

In fact, OPEC carries a strong responsibility for the current situation because, had it not been formed, the industry would probably have developed the large and easy fields first, making a reasonable profit at low prices. As those fields were depleted, it would have gradually turned to more difficult and costly fields and progressively increased prices to cover rising costs while making normal profits. The gradual move to dwindling supplies and consequential soaring prices would have alerted the world to the changing circumstances under normal market conditions.

One interesting aspect of the surge in oil prices in 2008 is to recognise how inflationary it was. It costs Saudi Arabia about \$20 to produce a barrel, so when they sold it for almost \$150 that represented a flood of what could be described as unearned income. Much of it no doubt found its way to Wall Street and the London property market, and was inflationary. It could be said that money should, at the end of the day, reflect human labour as it did in earlier times. There is evidently a close relationship between the price of oil and the value of the dollar.

The Second Half of the Oil Age will unfold in the years ahead. It is of course difficult to forecast the turn of events, but logic suggests that it will see a general economic contraction matching the expansion of the *First Half*. The subject begins to attract attention with for example a notable article by Walter Youngquist. Both coal and uranium are also finite resources offering no long-term equivalent sources of energy. By all means, various forms of renewable energy from wind, wave, tide, solar, hydropower and geothermal sources can be tapped but these supplies cannot match the easy oil-based energy of the past. Many have low net energy yields, such for example as an offshore wind farm that

takes a lot of energy to build and service. There will no doubt be a turn to more *Non-Conventional Oil*, including *Tight Oil* as well as that from the tarsands of Canada and elsewhere. The resource in the ground is considerable, but the net energy yield is low.

Agriculture has been described as a process that turns oil into food, as it has come to depend heavily on this resource to plough and harvest the fields, transport the food to markets and provide synthetic nutrients. It is noteworthy, as Youngquist points out, that fresh-water supplies and soil fertility are also being depleted as a result of expanding agriculture. As a result, it seems logical to suggest that the world will be able to support no more than about half its current population by the end of the century. It is significant that both Europe and the United States face increasing immigration pressure as mentioned people in other lands find life at home unsupportable.

As Clugston explains, the financial system evolved over *the First Half* of the Oil Age to be one where money was created by the banks and government agencies to encourage economic growth. That in turn led to the increasing depletion of finite natural resources, ranging from oil to forests. In effect this excessive consumption means that pressures mount during the *Second Half* to reduce the level of world human population, as present numbers are not sustainable. It involves a radical shift of human attitude to aim at contraction not expansion, which will not be easily achieved and will probably prompt extreme tensions.

An important recent development has been a referendum in Britain in which 52% of the voters supported leaving the European Union. As a result, the Prime Minister, who urged the country to remain, resigned and has been replaced by Theresa May. Although a member of the Conservative Party, she speaks of trying to introduce more socialist principles aiming at a fairer distribution of wealth.

One of the factors for the change of government was the scale of immigration. Perhaps the new government will finally be able to come to terms with the evolving situation imposed by the depletion of petroleum-based energy. It could begin by introducing draconian birth control measures, stopping immigration and rationing food and fuel. It might also impose graded tariffs so that the more electricity a household uses, the more expensive it becomes. New meters readily showing the rate of consumption could be introduced.

The country supported a population of no more than about 20 million prior to the *Oil Age*, since when it has

tripled. Logic suggests that it will have to decline radically in the years ahead. Britain's action may prompt several other European countries, facing similar pressures, to withdraw from the Union, heralding a new chapter of localism. There are already such movements in Spain, Italy, Greece and Holland. Even the United States also sees increasing moves for the component states to recover greater independence, with strong such movements in Texas and California. It partly reflects the deteriorating economic conditions and the widening gap between the rich and the poor. The challenge will be to maintain good relations between the different communities.

It is a large and complex subject that needs to command more attention. It is noteworthy in this connection that a new quarterly journal entitled *The Oil Age* (Bentley) has come out. The transition to the *Second Half* will likely be a time of great social tension: there seem to be an increasing number of extreme acts, such as for example a massacre at a night club in Orlando, the assassination of a British Member of Parliament, or fights between football spectators, not to mention various atrocities in France, Belgium and Germany, apparently committed by Muslim extremists. It even seems that various eccentrics with mental problems have taken to committing such killings of innocent people.

There is much that can be done to reduce the massive waste of energy that currently characterises many places, especially large cities. Apparently 17% of the world's population is aged between 10 and 24 years of age, which certainly speaks of growing tensions, as people will find it increasingly difficult to support themselves in the years ahead. There may be a return to regionalism as communities come to realise that they will have to depend on whatever their particular area can support. In financial terms, they need to manage their own affairs, having their own currencies and responsibly limit debt to that having solid collateral. It is significant in this connection that Europe is already seeing such pressures, as mentioned above.

It is difficult for governments to come to terms with what unfolds as politicians in democracies only win elections by telling voters what they want to hear, and in many cases are backed by wealthy supporters whose attitudes are built on their experience in the *First Half* of the *Oil Age*. The banks had been lending more than they had on deposit confident that *Tomorrow's*

Economic Growth was collateral for *To-day's Debt*, but the unfolding economic contraction due to dwindling critical energy supply, means that that assumption is no longer valid, as is now being increasingly recognised. It has even prompted the introduction of negative interest rates in several countries, aimed no doubt at reducing the amount of debt that lacks any valid collateral in a declining economy.

There are many excesses in the way we live, and some of them will face increasing pressures from the looming economic contraction. For example, international sport consumes vast amounts of energy transporting the spectators to watch, not to mention the excessive payments made to professional sportsmen. Think too of the *Space Age*, which contributes to science, but consumes a massive amount of energy and delivers little that is useful to society. Another is international tourism, which involves flying large numbers of people to distant beaches, or building massive cruise liners containing huge amounts of embedded energy. These are simply examples of the excesses that the abundant supply of cheap energy during the *First Half* of the *Oil Age* made possible.

The inevitable conclusion is that oil-driven traffic on the roads, ships on the sea and aviation will have virtually ceased to operate by the end of the century. The oil companies too will have run out of business. That is not as far away as it might seem, being no more than the years passed since the First World War. There is nothing new about such a radical change as civilisations have waxed and waned throughout history, as described by Ponting in his book.

It is not necessarily a doomsday message as there is much that people and their governments can do to adapt to the changing circumstances once they come to realise and accept what they are.

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AUTHOR'S BIOGRAPHY

Colin Campbell was born in 1931 to British parents living in Germany where his father worked as an architect. They returned to their homeland shortly afterwards in the face of the Great Depression. Colin spent his childhood living on a remote promontory in Cornwall in the west of England where his father was building what he hoped would be a model village, but the Second World War brought that project to an end. The wartime years were spent living near London in his grandmother's house and at various boarding schools.

In 1951, after an indifferent school record, he succeeded in getting into Oxford University to read geology, an interest that perhaps reflected his childhood on the rocky cliffs of Cornwall. He successfully secured a good degree and was invited to stay on to do a D.Phil, which was awarded in 1957. It was based on mapping the hills of Connemara in the west of Ireland and the results of a survey of the remote Usun Apau area in the interior of Borneo to which he went on a university expedition.

He then joined the oil industry as a field geologist, working in Trinidad, before being transferred to Colombia, where he had many colourful experiences mapping remote Andean areas. He married a beautiful British girl he had met in Trinidad and they were blessed with two children.

In 1966, he was transferred to Australia and undertook a field survey in the highlands of Papua, where he witnessed several massacres, arising from tribal conflicts. He missed his time in South America, and especially his study of its geology, which fascinated him.

Accordingly in 1967, he joined another oil company based in New York as regional geologist for South America, which involved many trips to that region and

a move from strict geology to the more political and commercial issues of securing concessions. He also was involved in a world study of oil reserves, which opened his eyes to their limits and the status of depletion, which became a major interest.

In 1969, he was transferred to Ecuador as Chief Geologist, but since he spoke some Spanish, he found himself engaged in many complex but fascinating negotiations.

In 1971 he accepted an offer to be General Manager of a small Texas company, which was opening an office in London from which to explore the North Sea and other overseas countries. His children needed better education and his aging mother in England needed help, so he decided to go home. Next year, he moved to open an office in London and had many interesting experiences negotiating oil rights in Britain, Holland, Portugal, Ireland and Turkey.

In 1975, he moved to Dublin in Ireland managing the Irish venture with major company partners, but no discoveries were made and his company went out of business.

In 1978, the company that had employed him in the United States reengaged him as a regional geologist in their London office before posting him as Exploration Manager of their Norwegian enterprise, where he had a very interesting time building up a new office staff and evaluating a wide range of prospects in the North Sea and the Norwegian shelf. He also had particular responsibilities for the development of the Valhall Field. One of his staff pioneered the evaluation of North Sea oil and gas source rocks, which proved a remarkable pioneering insight.

In 1984, he faced a transfer to the company's Houston Office, but decided instead to remain in Norway, and joined one of the company's partners as Exploration Vice-President, where he had more colourful experiences, building a new office and securing oil rights from the government. But in 1989 he fell from grace following a change of head office management, and had six months before being granted "early retirement". He spent the time evaluating the world's oil depletion, publishing the results in a book *The Golden Century of Oil*. It attracted the interest of the Norwegian Petroleum Directorate that began a comparable study, and also led Petroconsultants, which maintained the industry's database in Geneva, to ask him to make a comparable study based on better data.

This was completed with the help of Jean Laherrere, a French expert, and briefly marketed at \$50 000 a copy before being suppressed under pressure from an oil company.

In 1989, he retired to live in southern France but continued his studies of oil and gas depletion. They led to many press interviews, publications and presentations, including those to government departments. One was at the Uppsala University in Sweden, which led to the formation of the Association for the Study of Peak Oil ("ASPO"), which came to have

members in more than thirty counties. He wrote them a monthly newsletter.

In 1990, he and his wife moved to a village in the West of Ireland to be near their daughter and family. He continued to work on the subject, and several more books were published. They include Campbell's Atlas of Oil and Gas Depletion (ISBN 978-1-4614-3575-4), which was published in 2013. He continues to track developments although no longer has access to confidential industry data.