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by

C.J.Campbell

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C.J.Campbell
Association for the Study of Peak Oil & Gas Ireland
E-mail: aspotwo@eircom.net

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Abstract

The early human societies living on the Planet had to store food between harvests and keep accounts, which laid the foundations for banking and finance, but if they exhausted the fertility of their soil they either withered away or conquered other lands. Religions played an important part in controlling the societies but there were many wars as empires waxed and waned. Seen in a historical setting, the *Oil Age*, which opened only about 150 years ago, is an exceptional epoch when energy from petroleum fuelled the rapid expansion of industry, transport, trade and agriculture, allowing the human population to grow six-fold in parallel. But oil and gas are finite resources subject to depletion, meaning that the rising production of the past will be matched by a corresponding decline in the future. The status of depletion is hard to estimate as public data are unreliable but the evidence suggests that the *Second Half* of the *Oil Age* dawns. The transition threatens to be a time of great tension, especially in the oil-rich Middle East, but there is much that can be done to plan and prepare for the changed circumstances, once people and their governments come to understand that depletion is imposed by Nature.

Keyword: Oil Age, Peak oil, Oil and Petroleum production

BACKGROUND

Planet Earth has had a very long history with periodic ice ages and epochs of global warming, changing the composition of the atmosphere and the oceans in radical ways. The continents fragmented, and there were epochs of intense volcanic activity. (Walker, 2003). The species *Homo sapiens* appeared about 200 000 years ago, and settled agriculture commenced around 12 000 years ago, laying the foundations for what could be called *Modern Man*. The crops had to be stored between harvests, giving importance to those controlling the storehouse, who had to keep accounts of how much was received and returned to the farmers. Archaeologists report that the Babylonians were doing so 4000 years ago. The storekeepers could no doubt also give preference to the privileged members of their community and charge interest on food needed after a bad harvest.

These early communities flourished as they exploited the lands at their disposal, but if they depleted the fertility of their soil, they either dwindled in numbers, even to

extinction, or conquered other lands. Evidently, they needed leaders to manage their affairs, and some perceived a divine authority for doing so. Various religions took hold over time, including Judaism, Christianity and Islam, which provided a useful mechanism for controlling the behaviour of the communities. Temples were erected near the early storehouses, and priests may have had a role in their management. But the religions in turn fragmented into rival sects, often accompanied by conflict.

Someone in the early days evidently found a nugget of gold in a river bed, and was attracted by its shiny appearance. He may have shown it to a neighbour, who liked it even more, perhaps offering to exchange it for a sack of corn. Along with silver, it gradually became a medium of exchange to facilitate barter: its natural scarcity determining its value. But it was heavy stuff to carry around, leading people to deposit it in a storehouse against a receipt. Before long, an imaginative storekeeper realised that he could issue more receipts than he had gold on deposit, confident that not everyone would cash in simultaneously, laying the foundations for fractional banking.

Some communities were more successful than others, which led to the development of empires, with the Roman and the Inca Empires being notable early examples. They were run by Kings or Emperors controlling a landowning aristocracy. There were also associated mercantile empires, including the trade in slaves (Priestland, 2012). People faced many challenges as history unfolded, such as for example the Black Death pandemic in 1348-50, or the Little Ice Age which followed, lasting for about three centuries and adversely affecting agriculture. There were many wars and conflicts. For energy, people relied mainly on their own muscles and those of their horses, while wood fires kept them warm and allowed them to cook meals. The limited energy supply restrained the growth of the human population of the world, which no more than doubled over seventeen centuries from the birth of Christ.

Stone Age Man had used flints before people turned to bronze, iron and steel for better tools and weapons. These minerals had to be mined, but as the mines were deepened, they became subject to flooding on hitting the water-table. Smelting also called for more fuel, which came from wood and charcoal before coal was dug from coal-seams where they reached the surface. Gradually the pits were deepened into regular mines.

Draining the mines ushered in a remarkable technological revolution. The hand pump gave way to the steam pump, which evolved into the steam engine. It revolutionized the world, allowing the rapid expansion of industry, transport and trade. Then, a way was found to inject the fuel directly into the cylinder, leading to the *Internal Combustion Engine*, which was much more efficient. At first, it used benzene distilled from coal, before turning to petroleum refined from crude oil. The first automobiles took to the road around 1880, and the first tractor ploughed its furrow in 1907.

The windmill for its part led to the propeller, the steam turbine, and eventually the gas turbine and jet engine, having an important impact on transport, and thereby oil demand.

Electricity was generated from coal and later other sources of energy, and distribution networks were built to supply households. In recent years, that opened the door to radio, television and the internet having a huge impact on people's outlook and view of the world.

THE NATURE OF PETROLEUM

Oil and gas from surface seepages had been known from the earliest days, having been used as mortar in the construction of Babylon, but the first wells deliberately sunk before it was drilled in the mid-19th Century. Initially, the new oil supply was used as a fuel for lamps, replacing whale oil that was becoming short from over-whaling, but the advent of the *Internal Combustion Engine* led to a rapid growth in demand, ushering in the *Oil Age*.

Oil and gas were formed in the geological past under now well-understood processes. In fact, much of the world's oil comes from just two epochs of global warming, 90 and 150 million years ago, that led to the proliferation of algae and other organic matter. The remains formed chemicals, known as *kerogens,* which accumulated in the stagnant depths of lakes and seas in rifts that formed where the continents moved apart on the back of deep-seated convection currents in the Earth's Crust. They were in turn buried by sediments washed into the rifts from the neighbouring continents. When buried to a depth of about 2000m, they were heated enough to yield oil and gas. (We may confidently dismiss a theory that oil was formed deep in the Earth's crust by abiotic processes, as there is not a single oilfield in the world that cannot be readily explained in conventional ways).

Once formed, the oil tended to migrate upwards through the rocks to zones of lesser pressure. Some dissipated in the source-rocks themselves, and some escaped at the surface to be weathered and degraded, with the tar-sands of Canada being a well-known example. But, in some cases, it was trapped in a porous rock at the top of dome-like geological structures, known as anticlines, or against faults and where the reservoir pinched out, provided that such traps were capped by an effective seal of clay or salt. Various rock-types can form such reservoirs, provided that they have adequate porosity and permeability. Sandstone is the most common type, with the oil held between the grains of sand of which it is composed.

Gas was formed in a similar way from specific *kerogens*, and also from oil that was over-heated by deep burial.

There are several different types of oil and gas, each having its own costs, characteristics and depletion profile, but there is no standard classification, which is a cause of much confusion. It is therefore useful to recognise the following categories :

1. *Regular Conventional Oil and Gas*: They have supplied most to-date and will dominate all supply far into the future. (A liquid, known as *condensate*, which naturally condenses from gas, may be treated together with *Regular Conventional* oil).
2. *Heavy Oils:* with a density greater than 17.5° API, including bitumen (Degrees API is an industry measure of density, but there is no standard cut-off for the definition of Heavy. Canada has 25° API, Venezuela has 22° API but 17.5°, which is relatively low, is here seen as a useful one so that all oil that can be produced in more or less normal ways may be included as *Conventional*).
3. *Oil Shale*: oil that can be produced by heating immature source-rocks.
4. *Tight Oil and Gas (also called Shale Oil and Gas):* as derived from rocks lacking adequate natural porosity and permeability that can yield production when artificially fractured.

5. *Deepwater Oil and Gas*: in water depths greater than 500m.
6. *Polar Oil and Gas.*
7. *Natural Gas Liquids* from gas plants.
8. *Other Non-Conventional gases:* coalbed methane, hydrates etc.

It did not take the early oil geologists long to realise that finding an oilfield depended on locating a place where source, reservoir, trap and seal came together, with the relative timing also being an important additional factor. At first, they relied on field observations using no more than a hammer, hand lens and notebook to identify and map the outcropping rocks, but later developed geophysical techniques. Energy from an explosive charge, or other mechanical source, was released, and recorders measured the time taken for the echoes from rock surfaces far underground to return. In this way, it became possible to map the geology at depth in detail.

For obvious reasons, the more prolific provinces, and the larger oilfields within them, were found first, being too big to miss. Gradually, as the accessible onshore possibilities were exhausted, the industry turned its eyes offshore, developing sophisticated and more costly technology to do so in the 1960s. While oceans cover much of the Planet's surface, only relatively few areas within them have the right geological conditions to yield oil or gas. As the initial offshore finds were depleted, the industry turned to explore ever deeper waters, facing greater technological challenges and the occasional accident. It also addressed the Polar regions, where some discoveries have been made, including the giant Prudhoe Bay Field, found in Alaska in 1968. It is a difficult gas-prone geological province, because it relies mainly on relatively old and lean source-rocks that have been transported from lower latitudes by plate-tectonic processes. It has also been subject to large vertical movements of the Earth's crust under the weight of fluctuating ice-caps, which generally depressed the oil source-rocks into the gas-generating domain and adversely affected entrapment. But it is an under-explored domain which may yet yield some good surprises.

THE FIRST HALF OF THE OIL AGE

Early oilfields were found in various countries in the 19th Century. The Standard Oil Company secured a dominant position in the United States, following the discovery of oil in Pennsylvania in 1859, but the U.S. Government reacted in 1911 by breaking it up under anti-trust legislation. Even so, three of its daughters, comprising Esso, Chevron and Mobil, grew to become major companies in their own right. They were later joined by Texaco and Gulf, following the prolific discoveries in Texas in the 1930s. Shell and British Petroleum (BP) were formed in Europe in the early days, securing important positions in the Middle East, Mexico and Venezuela. Together, these major companies, known as the *Seven Sisters,* effectively controlled the world's supply of oil.

But it was not plain sailing because opening up a prolific new province could lead to a glut of oil, which depressed price with adverse financial consequences. The *Seven Sisters* reacted by having a secret meeting at the Achnacarry Castle in Scotland in 1928 to stabilise price by regulating production between themselves. A few years later, following a glut in Texas, the US Government intervened in a similar way to limit production to a given number of days a month. In those days, most oil was moved by

rail, and the Texas Railroad Commission was in a position to enforce the policy. These measures provided precedents for the main producing countries to form the Organisation of Petroleum Exporting Countries (OPEC) in 1960. They agreed to support price by limiting production, based partly on the reported reserves of its members.

Several governments, notably Russia in 1928 and Mexico ten years later, intervened by nationalising their oil industries. National companies were also established in several countries. Although privileged in some respects, they did not have the advantage that private companies enjoyed in being able to write off the cost of exploration, not to mention managerial champagne, as a charge against taxable income, which was a hidden form of subsidy, especially in countries with high tax rates.

By the 1990s, the major companies began to realise that it was easier to obtain oil by acquisition than exploration, such that the *Seven Sisters* are now reduced to four by merger. There were of course other overtones as the management of a merged company could cash in stock options, and financial institutions profited from arranging such transactions: for example, Goldman Sachs, the prominent bank, and BP came to share a Chairman. There has since been a proliferation of relatively small promotional companies.

In most countries, mineral rights are owned by the government, which leases them to oil companies as concessions or under other agreements, but in the United States they are held by the landowner. Oilfields became important financial assets, which led the Stock Exchange to impose strict rules for what could be reported as *reserves*, while smiling on under-reporting as commercial prudence. The major international companies were subject to these rules, and found it expedient to report the minimum needed for financial purposes, which gave a positive, if somewhat misleading, image of steady reserve growth to the Stock Market. Those days are, however, now substantially over as the giant fields, offering most scope for under-reporting, mature.

Another distortion came at a time of low oil prices in the 1980s when certain OPEC countries exaggerated the size of their reserves in order to raise their production quota, and thereby secure more revenue. In 1985, Kuwait increased its reported reserves from 64 to 90 Gb (billion barrels) although nothing particular had changed in its oilfields. (It is possible that it started reporting *Original Reserves* namely without deducting past production). Two years later, it announced a possibly genuine small increase to 92 Gb, but that proved too much for its rivals. Abu Dhabi countered by matching Kuwait at 92 Gb (up from 31 Gb); Iran went one better at 93 Gb (up from 49 Gb); while Iraq capped both at 100 Gb (up from 47 Gb). Venezuela for its part increased from 25 to 56 Gb, but did so by including its *non-conventional* heavy oils that had not previously counted for quota purposes. Saudi Arabia could not match Kuwait because it was already reporting more, but in 1990 announced a massive increase from 170 to 258 Gb to hold its lead.

Still another weakness in the statistics is war-loss, which was not reported at all. At least 2 Gb of oil went up in smoke in the Kuwait war, and is to be considered as production in the sense that it reduced reserves by like amount. Another difficulty relates to properly defining the different categories of oil and gas, as described above.

There are even challenges in defining an oilfield which may hold a single accumulation or be made up of several associated pools. It may also have different names if it crosses a lease boundary or frontier: for example, the world's largest gasfield is the North Field of Qatar, but is known as South Pars where it enters Iranian territory. Clearly, any revisions to the estimated size of a field have to be backdated to the original find to obtain a valid discovery trend for each productive area. Extrapolating such past trends, relating cumulative discovery against cumulative exploration drilling (*creaming curve*), and plotting the field-size distribution (*parabolic fractal*) can give an indication of the total endowment, which in turn reveals how much is left to find and produce (Laherrère, 1996).

In earlier years, it was normal to recover no more than about 30% of the oil in a reservoir, with the balance being held by capillary forces and constrictions in the rock, although there were exceptions in particular circumstances. Advances in technology and better estimates of the size of a field have now greatly increased the reported recovery factor.

Much attention is now being given to so-called *frac-king* which becomes viable with high oil prices, and deserves comment as it is having a major impact on US production. There is nothing new about artificially fracturing a reservoir to improve its production capacity. Indeed, in the early years in Texas, nitroglycerine was poured down wells to cause an explosion fracturing the reservoir, but the advent of so-called horizontal drilling has greatly increased the scope. A *horizontal* well starts vertical but is deviated at depth to run parallel with the geological formations, thereby putting it into contact with more of the productive rock. Injecting liquids under high pressure can artificially fracture oil- and gas-bearing rocks lacking adequate natural porosity and permeability, and thereby secure production. But, the well is both costly and short-lived being able to drain only the immediate vicinity of the well-bore at slow rates. The net energy yield is also low. The resource in the ground is enormous and unquantifiable, but production is subject to severe constraints, including environmental objections. Its main impact will be to ameliorate the rate of post-peak decline, having little influence on peak itself.

The fact that oil and gas are finite resources formed in the geological past, means that they are subject to depletion: for every gallon used, one less remains.. The peak of oil discovery was in the 1960s, as confirmed by an Exxon Executive (Longwell, 2002), and must inevitably deliver a corresponding peak in production. A turning-point came in 1981, when more was produced from existing fields than was found in new discoveries. While it is virtually impossible to reach a precise assessment of the status of depletion (Campbell , 1997; 2005; 2011; Campbell and Heapes, 2009), the following graph and the data in the Appendix provide a reasonable approximation of the overall situation (Fig. 1). It shows that the Peak of *Regular Conventional Oil* was passed in 2005.

World oil production from all sources, including refinery gain, which adds 2-3% to the volume of crude oil, has been fairly flat over the past five years, averaging about 85 Mb/d, and the plateau may continue for a few more years, although inevitably one year will mark the maximum. In fact, advances in technology and high prices have led to the development of several small or difficult offshore fields and extended the lives

of existing ones, especially in the North Sea. But the longer the plateau, the steeper will be the slope on the other side of it. A debate rages as to the date of Peak and the length of the plateau, but misses the point when what matters is the vision of the long decline that follows.

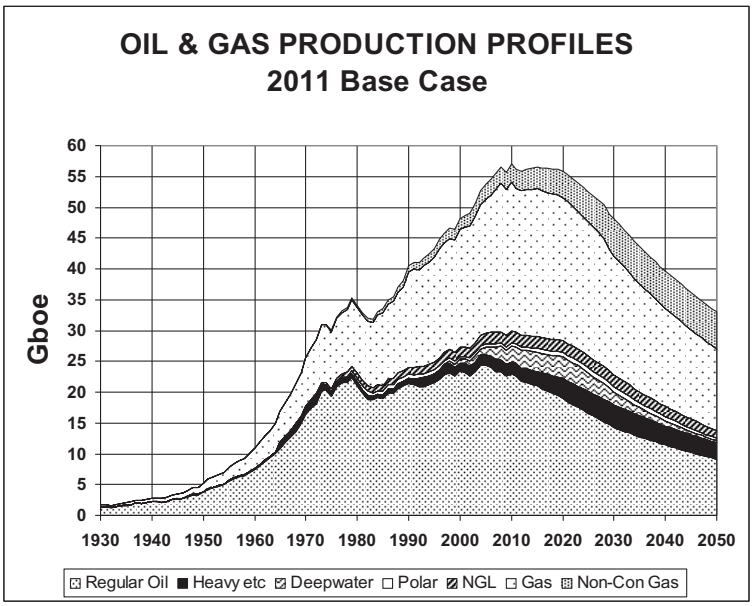

Fig. 1 Oil and gas production profiles, 2011 base case.

Gas has a different production profile with production from individual fields being constrained by pipeline capacity, which tends to give a plateau followed by a steep decline. The overall peak of production is here expected around 2020.

The *First Half* of the *Oil Age* saw the growth of oil production providing the energy for the rapid expansion of industry, transport, trade and agriculture, which allowed the human population to expand six-fold in parallel. It also saw radical social and political changes, accompanied by two world wars, partly prompted by mercantile pressures. They were of unparalleled intensity due to advances in weapons technology and transport facilities to keep the battle-lines supplied, partly relying on oil-driven transport. They were followed by the so-called Cold War when the United States and its allies opposed Communism, although actual fighting was confined to Korea and Viet Nam. NATO was established as a defensive pact, but the rules were progressively changed to allow intervention if *vital interests* were at risk: access to oil being clearly such.

The banking sector grew greatly in parallel, having a huge but unseen influence on society and political life. In earlier years, the high street banks had been mainly responsible guardians of people's savings, backed by holdings of gold, but gradually

they took on a more speculative stance. They started lending more than they had on deposit in many different complex ways, confident that *Tomorrow's Economic Expansion* was collateral for *Today's Debt*.

In earlier years, the banks of London, controlled by a few well-known names, received a huge hidden tribute from the use of the pound sterling for world trade. But the British Empire was extinguished by the Second World War, and the dollar became the dominant currency, bringing great wealth to the United States, especially as countries came to hold their financial reserves in its currency. The Federal Reserve Bank, which was formed by several prominent European Banks in 1913, continues to profitably control the country's finances. Unlike earlier empires, the US Empire is strictly a financial and commercial one as unlike earlier empires it has no responsibility for overseas territories, save for a few islands such as Hawaii under its direct control. Yet, military actions at substantial cost have been undertaken to protect its perceived commercial and financial interests.

The Stock Market too changed its structure. In earlier years, investors placed their money on a specific project, such as building a canal or a factory, having detailed knowledge and loyalty towards it. Later, their holdings were placed on a Stock Market, whose traders could have little detailed knowledge and less loyalty towards the underlying investments. Speculation and imagery replaced sound investment management. Debt even became a tradable commodity. Generally, the system worked well enough in the new expanding oil-driven economy of the last Century although the market did over-reach itself in 1929, ushering in the first Great Depression. It put about one-third of the US workforce out of work and triggered radical political changes in Europe. It may have been caused in part by excessive levels of debt arising from the First World War and its aftermath.

As the industrial countries depleted their own stocks of oil, they were increasingly forced to rely on imports, with the main current importers and exporters being listed in Table 1, showing per capita values (ignoring trade in refined product). As producing countries begin to appreciate the depletion of their oil and gas, it seems likely that they will increasingly move to limit exports to preserve as much as possible for their own future. It makes eminent national sense, although offending the principles of globalism whereby the resources of any country belong to the highest bidder. Already, Argentina has adopted such a policy, and King Abdullah of Saudi Arabia has said that he wishes to leave as much wealth as possible in the ground for his grandsons. Such moves would place increased pressure on the importers, which might in some cases trigger more geopolitical and military reactions.

Indeed, the latter years of *First Half* of the *Oil Age* have been marked by foreign military intervention in the Middle East, the world's principal supplier. The United States had enjoyed good relations with Iran until the fall of the Shah in 1979, when it shifted its support to Iraq which went to war with Iran in a border dispute, partly for oil territory. That alliance ended when Iraq invaded Kuwait over a dispute relating to the South Rumaila Oilfield that straddles the border, to be duly repulsed by US forces in the First Gulf War of 1990-91. Kuwait had had a long history of links with Iraq, being a trading port at the mouth of the Euphrates River flowing through the region, but fell under British influence in 1899, before gaining full independence in 1961.

Table 1. The main current importers and exporters in the selected countries

Exporter			Importer		
Country	**Oil Mb/a**	**Per Capita**	**Country**	**Oil Mb/a**	**Per Capita**
S.Arabia	2324	83	USA	5291	17
Russia	2128	15	China	1971	1.6
Iran	843	11	Germany	901	11
UAE	780	98	India	871	0.7
Kuwait	703	234	France	650	10.3
Iraq	682	207	Italy	512	8.4
Norway	548	110	Netherlands	357	21
Regular Conventional Oil					

Lastly, in 2001 came the 9/11 incidents in New York and Washington, which were officially attributed to Muslim terrorists based in Afghanistan, although there are many curious features that have led some analysts to cast doubt on the official explanation (Kollerstrom, 2009, Sabrosky 2011). In any case, the incidents secured enough popular support to put the United States on a war-footing, being supported by some of its allies. First, came an invasion of Afghanistan, which lies on a proposed pipeline route from the oil-rich Caspian, and that was followed by the invasion of Iraq in the heart of the Middle East oil-belt. The latter was based on unfounded claims that it had *weapons of mass destruction*, but President Bush later justified it with the words: *our energy supply was at risk*. Moreover, recently-released documents confirm that plans had been laid before the invasion to open Iraq to major oil companies (See Energy Infrastructure Planning Group 2002 report to Douglas Feith, Undersecretary for Defense). Iraq's leader, Saddam Hussein, was later executed for having authorised the suppression of a rebellion, even though the loss of life was small compared with that arising from the invasion. These conflicts have dragged on for ten long years, apparently costing the United States more than the Second World War, but now seem to be coming to an end although serious risks of a new Middle East conflagration remain. The military establishment is evidently a serious drain on the over-stretched US budget.

An important factor in all of this is the role of Israel. As mentioned above, some of the more advanced early communities, including those in the Jordan Valley, stored food between harvests, and were in a position to make loans of food if required. Even so, as revealed in the biblical book of Deuteronomy (Deuteronomy 23:20 *"Unto a stranger thou mayest lend upon usury; but unto thy brother though shalt not lend upon usury"*), they moved to prevent exploitation by condemning usury as a sin except where practiced against strangers.

In AD 135, many of the inhabitants of Jerusalem were either killed or driven into

exile by the Romans. The exiles, having no lands in their new homes, concentrated on trade and finance, and some of their descendents came to play a dominant role in world banking.

Christ had famously attacked the money-changers in the temple, and usury was later condemned as immoral by the Christian and Muslim churches, but loans were still required to fund trade and wars. This brought wealth to those whose religion allowed them to practice usury against strangers, which in turn encouraged them to maintain their separate identity. Even so, the practice prompted resentment leading to persecution, especially in Russia with the so-called pogroms, notably in 1881 (Odessa), 1881-84 (Kiev, Warsaw and Odessa), and 1903-06 (in Kishinev), and later by the National Socialists of Germany. The latter had also adopted eugenic principles, which were attracting scientific interest at the time, proposing that superior humans could be bred in the same way as can racehorses, which called for racial purity.

These pressures gave rise to Zionism whereby the victims sought to recover the original homeland from which their ancestors had been driven nearly 2000 years before. A turning point came in 1917 when the Bolshevik Revolution, which was partly funded by a New York banker reacting to the earlier persecutions, (See the role of Jacob Schiff.) ended the rule of the Czars; and Britain announced the Balfour Declaration for a *home* in Palestine. It had been negotiated a year earlier in return for dollar loans to fund the war, which the United States then entered, leading to the defeat of Germany.

The movement was finally rewarded with the creation of the State of Israel in 1948, albeit with arbitrary frontiers. It was not welcomed by the indigenous Palestinians, many of whom were forced to flee as refugees, and prompted several wars with neighbouring Arab countries. But its supporters, retaining much financial power, understandably continue to play an influential role in the United States and elsewhere.

THE SECOND HALF OF THE OIL AGE DAWNS

The peak of *Regular Conventional* oil supply in 2005 brought shortages of cheap and easy oil leading to a rise in prices as the industry had to turn increasingly to more expensive sources from deepwater fields and the tar-sands of Canada. Shrewd traders spotted the rising trend and took contracts on the Future's Market, while the industry built storage, watching it appreciate in value at little cost. The scale of speculation is illustrated by the fact that the contracts on the Future's Market exceeded actual production by factors of ten to thirty (Tolub and Erb, 2010). Prices, which had averaged $28 in the 1990s began to soar, reaching a peak of almost $150 a barrel in mid 2008 (Fig. 2). The traders spotted the limit and started selling *short*, while the industry began to drain its storage tanks, correctly anticipating that the high prices would trigger a recession, cutting demand. Prices fell back to $63 in 2009 before rebounding to $111, two years later (being quoted in terms of 2011 dollars; BP, 2012). The near doubling of oil price over this short period evidently had a major economic impact, given the central role of oil in fuelling transport and agriculture. It still costs the Middle East about $10-20 to produce a barrel, so when it is sold for over $100 that generates a flood of liquidity undermining the world financial system. It is noteworthy too that world food prices have doubled since 2005, with about one-third of US grain supply being distilled into bio-ethanol fuel for transport (Brown, 2012)

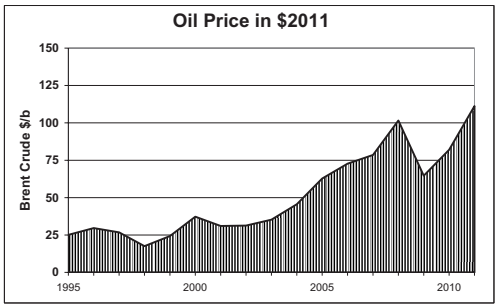

Fig. 2 Oil price in 2011 ($).

The recession soon hit the banks, especially in relation to the US housing market, and they ran into serious difficulties around the world. Their managers had come to enjoy excessive rewards : it being reported that 238 members of the senior staff of Barclays Bank in London were paying themselves as much as £4.27 million a year (Chakrabortty, 2012), which sounds like an extreme form of usury. They are also accused of manipulating financial rates to their advantage. It is noteworthy that in earlier years those guilty of counterfeiting and other forms of financial mismanagement had been subject to the death penalty.

The scale of the US financial crisis may be summarised by the following points : the Federal Reserve Bank is buying some 75% of the debt issued by the US Treasury; US interest rates are low at 1-3%; Federal debt has increased by a factor of 2.2 since 2002; the current rate of borrowing is 40% of the Federal budget; and the price of gold has increased over the past fifty years from around $300 an ounce to $1500 (World Affairs Monthly July 2012).

Europe was particularly badly affected by the recession. Efforts had been made after the Second World War to liberalise trade and remove the causes of conflict, leading to the European Union, now made up of twenty-seven countries with a combined population of 550 million, almost double that of the United States. The Economic and Monetary Union of seventeen of these countries introduced a common currency, the Euro, but left financial management to the individual countries. Some of them, including Ireland, Greece, Portugal, Spain and Italy, evidently over-exploited their new financial strength, and were seriously affected as the economic recession gathered momentum.

Governments on both sides of the Atlantic, following outdated economic principles, reacted to the recession by printing yet more money out of thin air in the hope of stimulating consumerism to restore past prosperity. The policy met with a brief success but that led to an increase in oil demand such that prices rose again to pass $110 a barrel in 2011. Logic suggests that recession may become a permanent feature matching the natural depletion of oil that plays such an important role in fuelling the economy. Oil prices may soar in the future in dollars of the day, but in real terms are unlikely to exceed say $150 (quoted in current dollars) because high price dampens demand. The scale of national debt is massive, standing at almost £20000 per

capita in the United Kingdom and at $51000 in the United States. Evidently, it cannot be re-paid in real terms, and hyperinflation may prove to be the only practical mechanism for removing it.

The tensions were not confined to Europe, but also struck North Africa and the Middle East severely, as people reacted to rising food costs and economic recession by blaming their governments in the so-called *Arab Spring*. Most of these countries had had long established dictatorial regimes, which may indeed have been the most efficient system in their circumstances, but the people rose in rebellion to demand democracy in the hope that it would improve their lot.

Oil-rich Libya was one such country. It has a relatively small population of six million, belonging to various tribes, and had been under the control of Col. Gaddafi, belonging to the al-Qadhafah tribe, for forty years. The rival Senussi tribe of the oil-rich eastern part of the country rose in rebellion, and managed to secure the support of Britain and France, which mounted a military action leading to the murder of Col. Gaddafi. The intervention was officially justified on humanitarian grounds, but there may have been other underlying reasons as the country has substantial oil reserves, needed by Europe, and was also planning to revert to the gold standard, encouraging other African countries to do likewise, which would have adverse implications for the world financial system.

A revolution broke out in Syria in 2011, with the rebels evidently being funded from abroad, and Iran is currently under threat, being accused of developing the capacity to produce nuclear weapons. It remains to be seen if a new Middle East war with foreign intervention will unfold. It would likely ignite the underlying regional tensions between the Sunni, Shi'ia and other sects of Islam, such that the region might disintegrate into many discrete communities, which might be to Israel's advantage, but would have a devastating impact on world oil supply.

The transition to the *Second Half* of the *Oil Age* threatens to remain a time of great tension, but new positive policies may be progressively adopted if people and their governments come to appreciate that the decline in the critical energy supply, fuelling the world, is imposed by Nature and is not a conspiracy by oil companies, Arabs or others. By 2050, world oil supply will have fallen to level able to support no more than about half the world's current population in its present way of life. Already, about one billion people, mainly in India and Sub-Saharan Africa, are chronically hungry and malnourished. Countries such as Saudi Arabia, China and South Korea are even buying farmlands in Africa despite the pressing needs of the indigenous people (Brown, 2012).

The religious objections to usury were abandoned during the *First Half* of the *Oil Age* as making money in the boom times became a primary aim for most people, but may return in the *Second Half* when sharing limited resources becomes the principal objective of society. Money at the end of the day has to reflect the use of energy, suggesting that dwindling oil supply in the years ahead may mean a contraction in money supply. That may be achieved by devaluing money through inflation.

It is not difficult to imagine some steps that could be adopted in order to face up to the unfolding situation:

1. Adopt the *Oil Depletion Protocol* (Heinberg, 2006): already the Portuguese

Parliament has passed a resolution urging its Government to adopt a policy for cutting consumption to match world depletion rate (*Annual* as a percentage of *Future* production), and a new political party in the Spanish province of Galicia has adopted it as part of its platform. Depletion is currently running at no more than about 2.5% a year for *Regular Conventional* oil and less than 1% for all categories. Cutting demand by such small amounts should be readily attainable.

2. Progressively disallow energy costs as a charge against corporate taxable income, which is a form of hidden subsidy. Management, facing these costs head-on, would likely react by paying more attention to energy efficiency, for which there is much scope.
3. Install smart meters so that households may be more aware of their electricity consumption, much of which is generated from gas, and impose new tariffs whereby the cost per unit rises with increasing consumption.
4. Encourage car-sharing whereby people come to give lifts, sharing the cost of the fuel, which itself might be subject to an affordable tradable ration, providing for minimal essential needs to people in different circumstances (Fleming, 2011).
5. Encourage the development of energy from tides, waves and wind, as well as that from solar and geothermal sources. Anaerobic digestion, by which urban and agricultural organic waste is used to generate methane, can also contribute. Home-owned wind- and solar-power facilities can make households largely self-sufficient, even selling a surplus back to the grid.
6. Encourage a new regionalism with local currencies, managed responsibly, whereby people may become less oil-dependant and again rely on what their particular region can support. This might prompt a new more positive democracy whereby the leaders are better linked to the people they represent, being freed from hidden financial and other pressures.
7. Above all, take measures to reduce the world population.

Coal and nuclear power can continue to supply useful energy, but are subject to constraints. Coal is also a finite natural resource subject to depletion, production having passed its peak, and nuclear power faces the risk of severe accident, as have already occurred at Chernobyl and Fukushima, as well as the problems associated with the disposal of nuclear waste. The production of prime-grade uranium has already passed its peak (Dittmar, 2009).

In conclusion, it may be said that the evolution of life on Earth has seen many changes. The simple limpet (or *Patella* to give it its scientific name) has remained little changed for over 500 million years, but other more sophisticated species proliferated when they found a niche that suited them, only to die out when the niche closed from natural causes. Few, if any, found a way to revert to simplicity. *Homo sapiens* does not necessarily face an early extinction, but *Petroleum Man* will be about gone by the end of the Century. The challenges for survival are real but can be met once the issues at stake are better appreciated. Indeed, it is promising that the subject is now attracting much interest with academic research (Aleklett, 2012) and the publication of many books and scientific papers. More than thirty countries are now represented in the

Association for the Study of Peak Oil and Gas ("ASPO").

APPENDIX

Tables 2 and 3 are based on the latest version of a depletion model that has evolved over many years. It is a large and complex subject but involves the following main steps for *Regular Conventional Oil*.

1. Plot past production and sum it to deliver the total produced to the reference date. Plot field-size distributions on a log-log scale (*parabolic fractal*), and extrapolate cumulative discovery versus exploration drilling to asymptote (*creaming curve*) to obtain an indication of the *Total* (to a convenient end-century cut-off).
2. Subtract *Past Production* from the *Total* to obtain *Future Production*, and estimate the percentage coming from known fields (*reserves*) based on the range of public and confidential information, with the balance being *Yet-to-Find*.
3. In countries past the midpoint-of-depletion (*Total*/2) assume that future production continues to decline at the current *Depletion Rate* (*Annual as a percentage of Future*). It has a certain self-adjusting feature because if actual production is below or above forecast, the balance will be correspondingly higher or lower. For the few countries not yet at midpoint assume that production remains constant to midpoint, also taking into account any political factors.
4. Estimate future exploration drilling rate, normally assuming decline at a given percentage, and attribute the *Yet-to-Find* pro rata to the future exploration wells.
5. Check the various relationships to identify anomalies and adjust accordingly. The key relationships are: *Peak Date* and percent depleted (about 50%); and Depletion Rate (normally about 5%). Also note the amount of implausible reserves in public databases that show unchanged year-on-year values.

It is important to make the evaluation for each producing country, so that the anomalies and uncertainties can be identified, before summing the results into regional and world totals. The *Non-conventional* sources have also to be modelled as well as possible based mainly on current outlook. This is not exact science, but nevertheless is capable of delivering a plausible model, to be progressively refined and improved as better information becomes available. The Total of 2000 Gb contains a negative rounding of 17 Gb.

Table 2 Regular conventional oil by country 2100.

RESOURCE BASED PRODUCTION FORECAST — **2011**

Regular Conventional Oil by Country to 2100

Region	*Sorted by production in 2010* / *Mb/d*	2000	2010	2020	2030	D.R %	Disc/ NFW	Totals Gb Past	Totals Gb Future	Percent Disc	Percent Dep	Peak Dates Expl	Peak Dates Disc	Peak Dates Prod
C	Russia	6.48	8.73	6.08	4.04	4.0	24	153	77	93	67	1988	1960	1987
F	Saudi Arabia	7.77	8.37	8.77	7.11	1.8	1582	121	179	97	40	1967	1948	1980
F	Iran	3.70	4.08	3.80	3.12	1.8	312	67	83	92	45	1967	1964	1974
C	China	3.25	4.08	2.60	1.58	4.9	26	41	29	92	58	2003	1960	2010
H	US-48	4.21	3.36	1.90	1.08	5.5	0.5	179	21	99	90	1982	1936	1970
E	Mexico	3.01	2.62	1.50	0.81	5.9	35	40	15	97	73	2003	1977	2004
F	UAE	2.37	2.42	2.74	2.33	1.8	220	31	54	94	36	1952	1972	2016
F	Iraq	2.57	2.40	3.91	3.53	1.1	598	35	80	90	30	1978	1928	2029
F	Kuwait	1.76	2.04	2.19	1.87	1.4	1592	43	57	97	43	1963	1938	1971
D	Norway	3.22	1.87	1.05	0.59	5.5	39	24	10.9	95	69	2009	1979	2001
A	Algeria	1.25	1.54	1.05	0.69	4.2	22	21	13	96	62	1961	1956	2006
A	Libya	1.41	1.65	1.22	1.03	0.1	26	28	27	95	50	1963	1961	1970
C	Kazakhstan	0.72	1.53	2.19	1.91	1.7	24	11	34	89	25	1988	2000	2026
D	Nigeria	2.17	1.25	1.23	1.03	1.7	38	28	27	96	52	1967	1968	2005
A	UK	2.28	1.23	0.64	0.38	5.2	9	25	6.9	98	78	1990	1974	1999
G	Qatar	0.74	1.13	1.23	1.17	1.8	321	10	25	96	28	1988	1940	2020
C	Azerbaijan	0.28	1.04	0.83	0.62	2.5	42	11	13	94	45	1953	1871	2010
B	Indonesia	1.43	0.94	0.62	0.41	4.1	7	24	8.1	97	75	1983	1944	2010
H	Oman	0.97	0.87	0.52	0.29	5.7	20	10	5.4	96	64	1984	1962	2000
G	Venezuela	2.47	0.83	0.82	0.72	1.4	31	51	24	95	68	1981	1914	1970
H	Canada	0.91	0.88	0.49	0.27	5.3	1	21	5.0	97	81	1980	1958	1973
E	Colombia	0.69	0.79	0.52	0.28	6.0	7	8	5.2	94	60	1988	1988	1999
B	India	0.65	0.75	0.45	0.26	5.1	6	8	5.1	98	61	1991	1974	2010
E	Argentina	0.76	0.63	0.38	0.24	4.6	3	11	4.4	96	70	1985	1962	1998
A	Angola	0.75	0.52	0.23	0.17	2.8	14	6.3	3.7	96	63	1968	1978	2000
B	Malaysia	0.69	0.55	0.37	0.25	4.0	14	7.1	4.9	98	59	1970	1971	2004
F	N.Zone	0.63	0.53	0.35	0.24	3.9	285	8.5	4.5	97	65	1962	1960	2003
A	Egypt	0.77	0.52	0.34	0.22	4.4	7	11	4.0	97	73	2008	1965	1996
A	Sudan	0.19	0.51	0.43	0.25	3.4	22	2	4.4	85	27	2002	2003	2019
E	Ecuador	0.39	0.49	0.30	0.17	5.5	23	4.9	3.1	96	61	1972	1969	2006
B	Australia	0.72	0.44	0.32	0.23	3.2	2	7.2	4.8	94	60	1985	1967	2000
G	Syria	0.52	0.37	0.20	0.12	4.8	19	5.1	2.2	95	70	1992	1966	1996
B	Vietnam	0.36	0.32	0.31	0.19	3.2	21	2.1	3.4	94	38	1994	1975	2016
A	Congo (B)	0.28	0.30	0.17	0.09	6.2	18	2.4	1.6	96	1	1992	1984	2011
G	Yemen	0.44	0.26	0.11	0.09	2.9	10	2.8	2.0	92	59	1992	1984	2001
B	Denmark	0.36	0.25	0.12	0.06	6.6	17	2.4	1.1	93	67	1985	1971	2004
D	Thailand	0.11	0.24	0.12	0.06	6.7	6	1.0	1.2	89	45	1983	1981	2011
A	Gabon	0.32	0.25	0.14	0.07	6.4	7	3.7	1.3	97	74	1989	1985	1997
E	Brasil	0.50	0.16	0.11	0.09	1.5	3	6.1	2.9	97	68	1982	1975	1990
C	Turkmenistan	0.14	0.18	0.14	0.10	3.5	10	3.5	2.0	93	64	1986	1956	1973
B	Brunei	0.19	0.14	0.09	0.05	4.6	32	3.5	1.0	98	77	1975	1929	1979
A	Chad	0.00	0.13	0.14	0.09	2.9	22	0.4	1.6	69	22	2002	1977	2015
E	Trinidad	0.12	0.10	0.07	0.05	3.4	12	3.5	1.0	99	79	1972	1959	1981
D	Italy	0.09	0.10	0.07	0.04	4.3	1	1.2	0.8	94	60	1962	1989	1997
C	Romania	0.12	0.09	0.07	0.06	2.2	8	5.6	1.4	98	80	1969	1890	1976
C	Ukraine	0.07	0.05	0.04	0.04	1.1	8	2.8	1.7	98	63	1990	1962	1970
A	Tunisia	0.08	0.08	0.06	0.04	3.7	4	1.5	0.8	95	1	1981	1964	1983
E	Peru	0.10	0.07	0.06	0.05	1.8	8	2.6	1.4	93	65	1975	1869	1982
A	Cameroon	0.08	0.07	0.04	0.02	4.7	8	1.3	0.5	94	75	1977	1977	1985
B	Pakistan	0.05	0.06	0.03	0.02	6.0	1	0.7	0.4	97	65	2003	1984	2006
G	Turkey	0.05	0.05	0.03	0.02	5.7	1	1.0	0.3	97	78	1975	1961	1991
C	Uzbekistan	0.09	0.06	0.09	0.10	1.1	3	1.1	1.9	81	36	1991	1985	2024
E	Bolivia	0.03	0.04	0.03	0.03	1.9	3	0.6	0.7	92	46	1962	1999	2005
G	Bahrain	0.04	0.04	0.02	0.01	5.5	58	1.1	0.2	99	84	1983	1932	1970
B	Papua	0.07	0.03	0.03	0.02	2.0	5	0.5	0.5	97	46	1990	1987	1993
D	Germany	0.05	0.03	0.03	0.02	2.1	1	2.0	0.5	96	79	1958	1949	1967
D	Netherlands	0.03	0.02	0.02	0.02	1.8	1	0.9	0.4	98	68	1985	1943	1986
D	France	0.03	0.02	0.01	0.01	4.0	0.5	0.8	0.2	97	84	1959	1954	1988
D	Austria	0.02	0.02	0.01	0.01	5.5	1	0.8	0.1	98	88	1975	1949	1955
C	Hungary	0.03	0.01	0.01	0.01	1.7	1	0.7	0.3	93	73	1964	1965	1979
C	Croatia	0.02	0.02	0.01	0.01	1.1	3	0.6	0.5	86	55	1985	1957	1988
C	Albania	0.01	0.01	0.01	0.01	2.3	11	0.5	0.2	94	68	2013	1928	1983
E	Chile	0.01	0.00	0.00	0.00	1.1	1	0.4	0.1	99	86	1972	1960	1982
A	Uganda	0.00	0.00	0.15	0.15	0.0	48	0.0	2.0	80	0	2010	2009	2030
	WORLD	64	63	51	38	2.5	4	1093	907	94	55	1981	1964	2004

Regular Conventional Oil by Region

Region		D.R %	2000	2010	2020	2030
			Mb/d			
F	ME.Gulf	1.5	18.8	19.8	21.8	18.2
C	Eurasia	3.5	11.2	15.8	12.1	8.5
A	Africa	2.2	7.3	6.8	5.2	3.8
E	L.America	3.5	8.1	5.7	3.8	2.4
H	N.America	5.5	5.1	4.2	2.4	1.3
D	Europe	5.8	6.1	3.5	1.9	1.1
B	Asia-Pacific	4.1	4.3	3.5	2.3	1.5
G	ME Minor	2.7	2.6	2.7	2.1	1.7
	Minor	4.5	0.5	0.8	0.5	0.3
	Non ME.Gulf		45	43	30	21
	MEGulf Share		29%	32%	42%	47%
	Total	2.4	64	63	52	39
	Non Conventional Oil					
	Heavy etc.	0.7	3.6	5.5	8.8	10.0
	Deepwater	2.9	1.6	6.7	9.4	6.0
	Polar	1.0	1.3	1.4	2.0	2.3
	Gas Liquid	1.3	6.5	8.5	8.2	8.2
	Total		13	22	28	27
	WORLD	**2.3**	**77**	**85**	**81**	**66**

Production to 2100	Regular Conventional Gb	Regular Conventional %	All Oil Gb	All Oil %
PAST	1115	56	1260	48
FUTURE	885	44	1340	52
Know	779		40	
To be foun	106		00	
Discovered	1894	95	2200	85
TOTA	**2000**		**600**	

NOTES

Regular Conventional Oil includes condensate

ME-Gulf =UAE, Iran, Iraq, Kuwait, NZ, S.Arabia.

Eurasia = FSU, E.Europe & China.

N.America = USA & Canada.

Minor refers to countries having insignificant production or possibilities

The Production Forecast assumes decline at the Current or Midpoint Depletion Rate, whichever comes first.

Depletion Rate = annual production as % of Future.

Deepwater >500m WD.

The statistics refer to Production to a cutoff at the end of the Century not Ultimate recovery.

DR = Depletion Rate (Annual/Future)

Disc/NFW = Av. Discovery in Mb per wildcat

Revised 07/04/2012

Abbreviations in Table 2:

DR – Depletion Rate (annual as a percent of estimated future production)

Disc/NFW – discovery divided by the number of exploration boreholes (*New Field Wildcats*) giving an indication of the intensity of exploration.

Percent Disc. – percentage of the *Total* endowment discovered.

Percent Dep. – percentage of the *Total* endowment depleted.

Peak Dates – Expl. – exploration

Disc – discovery

Prod – production

Table 3 Regular conventional gas by country 2100.

RESOURCE BASED PRODUCTION FORECAST															2010
Region	Regular Conventional Gas by Country to 2100														
	Sorted by production in 2010					D.R,	Disc/	Totals Tcf		Percent		Peak Dates			
	Tcf/a	2000	2010	2020	2030	%	NFW	Past	Future	Disc	Dep	Expl	Disc	Prod	
C	Russia	21	23	30	19	2.7	144	676	824	84	45	1988	1966	2014	
H	US-48	24	23	8.5	3.1	12.5	3	1181	219	98	83	1956	1996	1979	
A	Algeria	5.8	7.0	6.5	3.2	4.3	186	143	157	95	48	1961	1957	2011	
F	Iran	3.9	6.5	6.5	6.5	0.6	2217	116	1084	82	10	1967	1964	2030	
H	Canada	7.7	5.6	1.5	0.4	9.6	13	211	39	99	82	1980	1993	2001	
D	Norway	3.2	5.2	4.3	1.6	5.4	202	78	92	97	46	1997	1979	2018	
G	Qatar	1.3	3.8	6.2	10.1	0.4	9340	36	964	95	4	1991	1971	2030	
F	Saudi Arabia	1.9	3.3	5.5	5.5	1.0	1727	84	316	84	21	1967	1948	2030	
C	China	1.0	3.2	5.0	5.0	2.0	74	43	157	92	22	2003	2000	2022	
C	Turkmenistan	1.6	1.5	3.8	4.3	0.5	603	78	297	80	21	1986	1973	2030	
B	Indonesia	2.9	3.0	3.0	3.0	2.1	46	78	142	90	35	1983	1973	2020	
F	UAE	1.8	2.8	2.8	2.8	2.2	550	53	122	93	30	1952	1978	2023	
B	Malaysia	1.7	2.6	2.6	2.1	3.1	140	42	83	93	34	1970	1970	2017	
A	Nigeria	1.2	2.1	3.5	3.5	1.2	148	50	170	92	23	1966	1967	2029	
D	Netherlands	2.6	2.6	1.5	0.9	5.3	125	117	48	99	71	1985	1959	1976	
E	Venezuela	2.14	2.50	2.5	2.5	1.3	101	65	185	93	26	1981	1941	2030	
A	Egypt	0.86	2.00	2.7	1.9	2.8	42	25	70	89	26	1985	1996	2019	
C	Uzbekistan	1.99	2.20	2.2	1.3	3.4	157	68	62	93	52	1991	1974	2015	
D	UK	4.12	2.10	1.0	0.4	7.5	35	94	26	98	79	1990	1966	2000	
E	Mexico	1.51	1.70	1.4	0.8	3.9	62	58	42	96	58	2003	1977	2013	
B	Australia	1.17	1.83	4.8	5.0	1.0	37	32	188	83	15	1985	1971	2030	
E	Argentina	1.58	1.70	1.1	0.5	5.9	16	43	27	92	61	1985	1977	2004	
B	Pakistan	0.86	1.50	1.5	0.9	3.7	86	26	39	88	40	2003	1952	2014	
E	Trinidad	0.58	1.50	1.4	0.5	5.1	124	21	29	91	44	1971	1968	2012	
C	Kazakhstan	0.16	1.26	3.3	3.6	1.2	68	14	111	91	11	1988	1979	2027	
B	India	0.91	1.55	1.3	1.3	2.7	39	24	56	86	30	1991	1976	2023	
A	Libya	0.36	1.00	1.3	1.6	1.3	40	21	74	84	20	1963	1965	2027	
G	Oman	0.48	1.15	1.3	1.3	2.5	76	15	45	93	25	1991	1973	2021	
B	Thailand	0.71	1.20	0.6	0.2	7.7	101	16	14	98	52	1983	1973	2008	
C	Azerbaijan	0.49	0.91	1.3	1.3	1.7	975	16	54	85	23	1953	1999	2030	
E	Colombia	0.51	1.00	0.3	0.1	12.0	13	15	7	98	67	1988	1973	2010	
C	Ukraine	0.64	0.70	0.7	0.5	1.9	169	64	36	96	64	2000	1950	1975	
E	Bolivia	0.20	0.50	0.8	0.8	0.9	138	10	22	87	15	1962	1999	2030	
G	Yemen	0.67	0.50	0.5	0.3	3.3	53	10	15	97	42	1992	1989	2013	
F	Iraq	0.15	0.61	1.00	1.57	0.5	663	14	136	73	10	1978	1953	2030	
D	Germany	0.84	0.79	0.42	0.22	6.1	15	36	12	97	75	1958	1969	1987	
B	Brunei	0.42	0.45	0.30	0.17	4.8	178	16	9	98	64	1975	1963	2006	
E	Brasil	0.47	0.50	0.50	0.26	4.0	7	11	12	95	48	1982	2003	2011	
G	Bahrain	0.41	0.50	0.19	0.07	9.3	902	16	5	99	77	2004	1932	2009	
A	Angola	0.25	0.40	0.40	0.28	3.4	25	7	11	94	38	1968	1971	2016	
F	Kuwait	0.40	0.40	0.40	0.40	0.8	1145	21	49	97	31	1963	1938	2015	
E	Peru	0.03	0.35	0.35	0.35	1.7	46	5	20	84	19	1975	1986	2025	
C	Romania	0.49	0.31	0.09	0.03	11.6	56	45	2	99	95	1969	1954	1985	
A	Congo (B)	0.13	0.30	0.11	0.02	9.8	26	3	3	93	54	1992	1984	2012	
G	Syria	0.28	0.30	0.30	0.19	3.4	37	7	9	89	44	1992	1987	2013	
D	Italy	0.59	0.27	0.18	0.12	4.1	12	26	6	98	80	1962	1968	1994	
B	Vietnam	0.05	0.30	0.48	0.56	1.3	94	2	23	98	9	1996	1995	2030	
D	Denmark	0.42	0.27	0.09	0.03	10.3	47	7	2	97	74	1985	1968	2000	
A	Tunisia	0.08	0.15	0.12	0.05	5.2	9	2	3	94	45	1981	1974	2008	
C	Hungary	0.11	0.09	0.07	0.05	2.6	10	7.7	3.3	97	70	1964	1965	1985	
E	Chile	0.10	0.05	0.05	0.05	0.9	15	4.7	5.3	97	47	1972	1960	1992	
A	Gabon	0.08	0.06	0.01	0.00	14.1	4	2.9	0.4	98	88	1990	1965	1995	
D	Austria	0.06	0.06	0.04	0.03	3.2	6	3.4	4.9	98	67	1975	1949	1975	
A	Cameroon	0.07	0.07	0.07	0.07	1.5	30	2.0	4.6	93	30	1977	1979	2025	
E	Ecuador	0.04	0.05	0.04	0.02	5.0	5	1.0	1.0	93	52	1972	1969	2013	
D	France	0.07	0.04	0.02	0.01	9.8	6	11.4	0.4	99	97	1959	1949	1978	
F	N.Zone	0.05	0.04	0.05	0.05	0.6	229	2.7	7.3	96	27	1962	1967	2030+	
G	Turkey	0.03	0.03	0.03	0.01	4.4	1	0.5	0.6	97	45	1975	1965	2012	
A	Sudan	0.00	0.03	0.05	0.06	1.5	4	0.0	2.0	51	2	2002	2003	2030	
C	Croatia	0.06	0.08	0.06	0.03	5.0	10	1.5	1.5	90	51	1985	1974	2014	
A	Chad	0.00	0.01	0.01	0.01	2.0	5	0.0	0.5	66	2	2002	1975	2030	
A	Uganda	0.00	0.01	0.02	0.02	2.0	7	0.0	0.5	41	2	2010	2015	2023	
B	Papua-NG	0.00	0.01	0.30	0.30	0.0	102	0.1	19.9	90	0	1990	1990	2030	
C	Albania	0.00	0.00	0.01	0.01	0.3	18	0.5	0.8	91	39	1987	1977	1982	
	WORLD	106	134	129	107	2.0	18	3892	6607	87	37	1981	1971	2015	

Region	Regular Conventional Gas by Region	D.R	*Tcf/a*			
		%	2000	2010	2020	2030
C	Eurasia	2.1	27	33	47	35
H	N.America	10.2	31	29	10	3
A	Africa	2.6	8.8	13.1	15	11
F	ME.Gulf	0.8	8.1	13.6	16	17
B	Asia-Pacif	2.1	8.8	12.4	15	14
D	Europe	5.7	11.9	11.4	8	3
E	L.America	2.5	7.2	9.9	8	6
G	ME Minor	0.6	3.2	6.3	9	12
	Minor	3.5	1.2	3	2	1
	Rounding		0.0	-1.0	1.0	-2.0
	Total	2.0	108	130	130	100
	Non Conventional Gas					
	US		9.6	15.4	20	21
	Other		1.3	2.0	6	15
	Total		10.9	17.4	26	36
	WORLD		119	148	156	136

Regular Conventional World Summary		
PRODUCTION	Tcf	%
PAST	3931	38
FUTURE	6319	62
Known	5274	51
To be found	1045	10
Discovered	9205	90
TOTAL to 2100	10250	

NOTES

Regular Conventional Gas excludes gas from coal and shale; and Deepwater (>500m) and Polar areas.

ME-Gulf =UAE, Iran, Iraq, Kuwait, NZ, S.Arabia.
Eurasia = FSU, E.Europe & China.
N.America = USA-48 & Sub Arctic Canada.
An idealised depletion profile assumes a production plateau from 30% to 70% depletion.
The statistics refer to Production to a cutoff at the end of the Century not Ultimate recovery.
DR = Depletion Rate (Annual/Future)

Revised 20/03/2011

Abbreviations in Table 3:

DR – Depletion Rate (annual as a percent of estimated future production)

Disc/NFW – discovery divided by the number of exploration boreholes (*New Field Wildcats)* giving an indication of the intensity of exploration.

Percent Disc. – percentage of the *Total* endowment discovered.

Percent Dep. – percentage of the *Total* endowment depleted.

Peak Dates – Expl. – exploration

Disc – discovery

Prod – production

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