THE DAWN OF THE SECOND HALF OF THE AGE OF OIL

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Soaring oil prices have raised concern about the relative supply and demand of the World's premier fuel, having a central place in the modern economy. It has led people to ask: *Are we running out of oil?* A sensible short response would be : *"Yes, we started doing that when we used the first gallon"*. The World is not about to run out of oil, but what it does face is the end of the First Half of the Age of Oil. That opened 150 years ago when wells were drilled for oil on the shores of the Caspian and in Pennsylvania. The cheap, convenient and abundant energy, it supplied, led to the growth of industry, transport, trade and agriculture, accompanied by the creation of large amounts of financial capital, as banks lent more than they had on deposit, confident that *Tomorrow's Economic Expansion* was adequate collateral for *Today's Debt.* Many people came to think that it was money that made the world go round, when in reality it was an abundant supply of cheap energy, much derived from oil. It has been calculated that in energy terms a drop of oil is equivalent to a day's hard manual labour.

Knowledge of petroleum geology has made great advances in recent years, such that the conditions under which this resource was formed in Nature are now well understood. In fact, it transpires that the bulk of the World's current production comes from deposits formed in two brief epochs of extreme global warming, 90 and 150 million years ago. Algae proliferated in the warm sunlit waters providing the raw material that eventually became oil. It was preserved and trapped in places having the rare right combination of geological conditions. Virtually all the world's oil reservoirs occur in a temperature range of 60 - 120^{o}C. A glance at the oil map shows that oilfields are clustered together in such exceptional places, which are separated one from another by vast barren tracts.

Gas was formed in a similar way, save that it was derived from vegetal remains as found in the deltas of tropical rivers. Ordinary oil also broke down into gas if over-heated by excessive burial.

Oil and gas are clearly finite resources, formed in the geological past, which in turn means that they are subject to depletion. That is not a difficult process to understand, as every beer-drinker knows. The glass starts full and ends empty; the quicker he drinks it, the sooner it is gone; and every bar has a closing time. So, how far along the oil depletion curve are we? The first step in answering this question is to ask how much has been found so far and when it was found, because production has to mirror discovery after a time-lapse. It sounds simple, but as we dig into the details, we find a minefield of confusion, obfuscation and disinformation. In the past, the word *Depletion* was not one the oil companies liked to mention, fearing that it smacked of a dwindling asset, but now some of them do now begin to be more forthright[1]. The

[1] See Chevron, www.willyoujoinus.com, whose CEO deserves great credit for his frank presentation.

official institutions, for their part, continue to publish bland scenarios and half-truths, recognising that their governments are not yet ready to face bald reality.

Estimating the size of an oilfield early in its life poses no particular scientific or technical problem. The difficulty lies in the reporting. Oil in the ground is a financial asset to its owners. Accordingly, the US Securities and Exchange Commission (SEC), very properly, moved in the early days to introduce strict reporting rules. It recognised two main classes: *Proved Producing Reserves* for the expected future production of current wells; and *Proved Undevelope*d *Reserves* for the expected production of yet-to-be-drilled infill wells. The rules were designed to prevent fraudulent exaggeration but smiled on under-reporting as laudable prudence. In practice, the major international oil companies reported just as much as they needed to report in order to deliver satisfactory financial results, building for themselves a useful stock of unreported reserves to tide them over lean discovery years and cover any temporary setback around the world. As a result, they were able to revise their reported reserves upwards, giving a comforting but very misleading impression of steady growth, which was commonly attributed to technology, when in fact it was mainly an artefact of reporting practice. No trickery or conspiracy is implied: it was just good prudent management under the rules. But the luxury of under-reporting is fading fast, forcing the major companies to merge and, in some cases, revise downward their reported reserves. In part, this reflects the aging of the giant fields, holding most of the World's oil : it being clearly easier to under-report a large field than a small one. In any event, the revisions have to be backdated to the original discovery to obtain a valid discovery trend.

OPEC[2], for its part, announced enormous over-night reserve increases in the 1980s. At first, this seemed to be a correction of the under-reporting inherited from the foreign companies before their rights were nationalised, but it now transpires that they may have started reporting the total found, not the remaining reserves, explaining why the official numbers have barely changed since, despite massive subsequent production. At all events, the dataset is grossly unreliable, with as much as 300 Gb (billion barrels) being in doubt[3].

In addition, is confusion over what was measured. There are many different categories of oil, each with its own costs, characteristics and, above all, depletion profile. Producing oil from a free-flowing Middle East well is not the same as digging up a tar sand in Canada with a shovel, albeit a big one. Some types are cheap, easy and fast to produce, whereas others are the precise opposite. It is, therefore, useful to identify *Regular Conventional Oil*, defining it to exclude oil from coal and shale, bitumen and heavy oil, deepwater and polar oil, as well as the liquids that are extracted from gasfields in specialised plants. It has supplied most to-date and will dominate all supply far into the future.

Unravelling all of these confusions, so far as is possible, suggests that the status of depletion for *Regular Conventional* is as follows (to be generously rounded):

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[2] The Organisation of Petroleum Exporting Countries, representing Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Neutral Zone, Nigeria, Qatar, Saudi Arabia, UAE, and Venezuela.

[3] Reuters (Jan 20th 2006) reports that the Kuwait oil company is now casting doubt on the official numbers, saying that realistic reserves now stand at 48 Gb, not the official 99 Gb

Produced to-date (2005)		968 Gb
Future Production		882
From known fields	760	
From new finds	122	
Total		1850

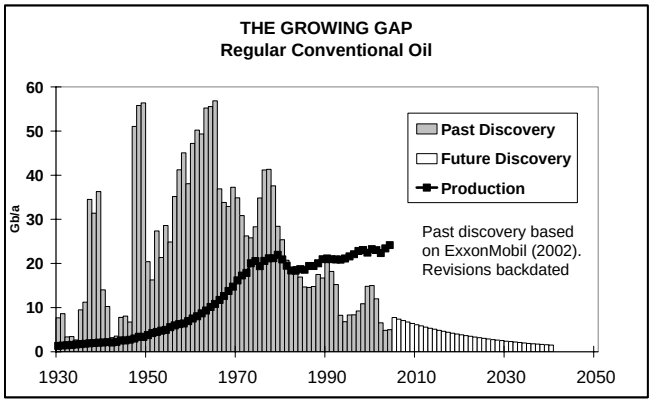
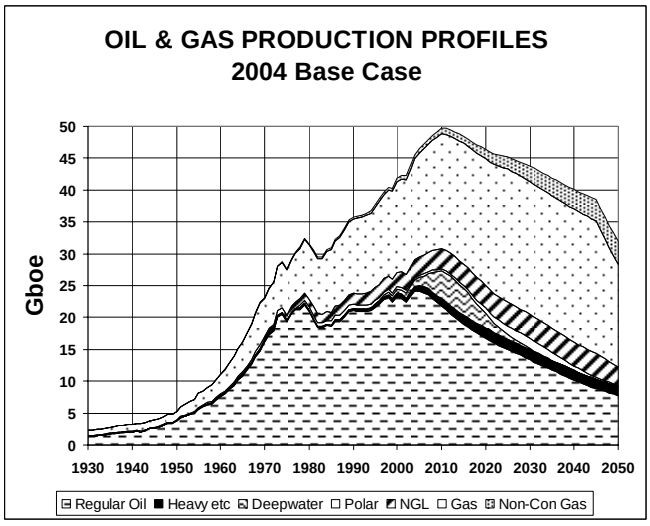


Figure 1 shows the discovery record, based on properly backdated industry data, published by ExxonMobil[4]. World discovery has evidently been in decline since 1964, despite a worldwide search always aimed at the biggest and best prospects; despite all the many advances in technology and geological knowledge; and despite a favourable economic regime whereby most of the cost of exploration was offset against taxable income. It means that there is no good reason to expect the downward trend to change direction. The World started using more than it found in 1981, and in 2005 found only about one barrel of *Regular Conventional Oil* for every five or six consumed. Oil has to be found before it can be produced, which means that production in any country, region, and eventually the World as a whole, has to mirror discovery after a time-lapse.

Although the skills of a detective are needed to collect the evidence and analyse it properly, we may be confident that the depletion profile in Figure 2 represents a realistic assessment sufficient for general planning purposes.



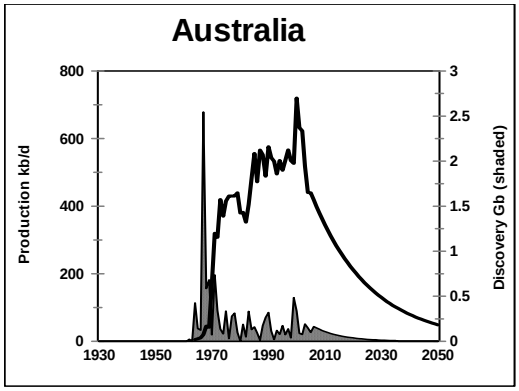
In short, the Second Half of the Age of Oil now dawns. It will be marked by the decline of oil and all that depends upon it. Gas, which has a rather different depletion profile, will also follow into steep decline.

Much study and debate has been dedicated to determining the date of peak production but this really misses the point. It is not an isolated or high peak, but merely the maximum value on a gentle curve. What matters, and matters gravely, is the vision of the long, remorseless and relentless decline that comes into sight on the other side of the peak.

[4] Longwell H.,2002, *The future of the oil and gas industry: past approaches ,new challenges*; World Energy 5/3 2002,

That said, the peak does represent an unprecedented discontinuity of magnitude, marking the shift from growth to decline. Of particular importance, is the impact on world debt whose collateral is based on the assumption of oil-based economic expansion. It runs in the face of classical economics, with its reliance on market forces. The *Stone Age* did not end for want of stones as Man found bronze, iron and steel to be better materials for tools and weapons. But the decline of oil arises from natural depletion not from the entry of better substitutes. Hopes are expressed that new technology or new investment will come to the rescue, but there is an irony about depleting a finite resource : *the better you are at doing the job, the sooner it ends.*

All countries, including Australia are affected in one way or another. Australia lies in the Southern Hemisphere, which is not richly endowed with hydrocarbon source rocks for geological reasons. Nevertheless, Australia has been thoroughly searched. Exploration commenced early stimulated by a small find in 1900. As many as 157 exploration wells had been drilled before 1930 without yielding much success. A new chapter opened in the 1960s when important discoveries were made in a Tertiary basin in the Bass Strait and on Barrow Island. The three largest finds were Kingfish (1967) with 1200 Mb; Halibut (1967) with 1090 Mb; and Mackerel (1969) with 500 Mb. Attention later turned to the huge NW. Shelf, forming the passive margin facing the Eurasia Plate. It is made up of a thick sequence of Mesozoic and Tertiary sediments. The former includes some rather lean source rocks, commonly lying below the oil-generating window, which explains the preponderance of gas-condensate finds.



Exploration is now at a mature stage. A total of about 4300 wildcats have been drilled, finding about 8 Gb of oil, of which 6.3 have been produced. Extrapolating the discovery trend and evaluating the field size-distribution suggests that about 1.4 Gb await discovery. The peak of exploration drilling was in 1985 when 184 wildcats were drilled, but has now sunk to about one-third of that number. Significant production commenced in 1964 rising to a peak of 720 kb/d in 2000, three years after the midpoint of depletion. It is now set to decline at almost 5% a year, meaning that it will have halved by around 2010. There may be some additional deepwater finds to be made but the prognosis is not very favourable.

Approximately 180 Tcf of gas has been discovered of which about 20 Tcf have been produced. Production stands at about 1 Tcf/a and as reasonable depletion profile would be for it to rise at about 10% a year to a plateau at 6 Tcf/a from 2020 for about 20 years.

Australia currently imports about 25% of its oil, which is set to double by 2015 with even static demand. The cost of imports will clearly soar given growing world shortages. Australia has every good reason to restrict immigration and turn to renewable energies as a matter of priority. The Stoney Desert has been identified as one of the world's prime sites for solar energy. The country's extensive coal deposits offer opportunities, especially for the development of coal bed methane. But the new

circumstances call for new life-styles, including the end of suburbia and a return to more sustainable practices. The transition will be difficult but the outcome might offer Australians more satisfying and fulfilling lives in rural simplicity. There might be a political case for splendid isolation to avoid the tensions deriving from global alliances and power-blocs in an increasingly tense world.

The implications for the future of the World as whole are serious. The high price of oil may trigger world economic recession because debt premised on oil-based economic expansion is losing its collateral. There are of course many other energy resources comprising coal, nuclear, and renewables from tide, wind, sun, bio-mass and geothermal sources. All have lower net energy yields than oil and gas, and some, such as coal and nuclear, carry environmental risks. There are also political risks as countries vie with each other for access to the remaining reserves, much of which lies in the Middle East. The risk of further resource wars grows[5]. Clearly, the best solution is to cut consumption and improve efficiency for which there is much scope, but it is hard to avoid the conclusion that by the end of the Century, the Planet will only be able to support fewer people, living very differently.

[5] See Klare M, 2004, *Blood and Oil;* Metropolitan Books ISBN 0-8050-7313-2