THE ASSOCIATION FOR THE STUDY OF PEAK OIL
&
THE OIL DEPLETION ANALYSIS CENTRE
ASPO-ODAC

NEWSLETTER No 15 – MARCH 2002

ASPO is a network of European institutions and universities with an interest in determining the date and impact of the peak and decline of world oil production, due to resource constraints, presently with members in:
Austria, Denmark, Germany, Ireland, Norway, Portugal, Sweden and the United Kingdom

ODAC is a charitable organisation in London that is dedicated to researching the subject and raising awareness of the serious consequences.

ODAC Contact:
Dr. R.W. Bentley, Co-ordinator,
Oil Depletion Analysis Centre,
305 Great Portland Street, Suite 12,
London W1W 5DA, UK.
+44 207 436 6544
e-mail : odac@btconnect.com

Newsletters on Website
These newsletters including past issues can be seen on the LBSystemstechnik website
http://www.energiekrise.de (Press the ASPONews icon at the top of the page)

CONTENTS

26. Index

At the good suggestion of John Joppling, a reader, items in the newsletters are now numbered, starting with the January issue, to provide a Table of Contents and Index.

27. ASPO Workshop in Uppsala, May 22-25th

Professor Aleklett reports that he has successfully secured enough sponsorship to be able to confirm that the Workshop will take place. A good programme of speakers is being arranged with growing interest by both the media and the Swedish government itself.
Details can be seen on the home page : www.isv.uu.se/iwood2002

The ASPO members will have a chance to meet, with time being set aside on the last day for them to formally discuss how they would like the association to progress.

28. Exploration Highlights

United Kingdom –
J.Munns of the UK Department of Trade and Industry has given a lecture in Aberdeen explaining that the Government is desperate to attract new small companies following the mergers and general loss of interest by the major companies. He admitted that oil and gas production peaked in 2000 and is set to decline. He commented that 4000 exploration and appraisal wells had found 285 fields, adding that the recent Buzzard Field with 300-400 Mb was the largest find since 1993. He quoted the official Brown Book publication, which claims that between 4 and 27 Gboe of oil and gas combined are yet-to-find. This no doubt is another example of the misleading Probability Approach, as used by the USGS, based on the subjective ranking of prospects, whereby the upper end of the range is assessed to have no more than a 5% probability. But at the same time he revealed in a slide that the range for oil is only 1.5 - 9.8 Gb (excluding the unknown and dubious Atlantic margin). With no more than 2.4 Gb having been found over the past ten years, falling to 0.85 Gb over the past five years, it sounds that our own estimate of 2 Gb is not wide of the mark.

It is evident that the United Kingdom is having the greatest difficulty in accepting that its oil production is in terminal decline, leading to a loss of revenue and soaring imports. The hyperactivity induced by the policies of Mrs Thatcher squandered the national resource in two short decades at times of low price, which it helped induce. Now, the government is forced to trawl the back streets of Houston and Calgary looking for anyone willing gamble on a late stage surprise. There may be some but not many.

Greenland
Phillips Petroleum and Statoil (the Norwegian State Company) have withdrawn from West Greenland after abortive drilling. We don't know why they preferred West to East Greenland, where the USGS claims there is 47 Gb to be found. Since the government has now decided to reduce tax to 30% as an incentive, it does not appear that the industry exactly shares the USGS view.

Australia
A 300 Mb discovery, named Enfield, has been made of Western Australia in what is claimed to be a new province.

Caspian
In April, the countries bordering the Caspian are to meet to try to decide how to divide the offshore. With the small matter of ownership unresolved it is hardly surprising that BP, Statoil and Exxon-Mobil have withdrawn from ventures there. China meanwhile is buying

into Azeri fields, with the help of funding from the European Bank of Reconstruction and Development, speaking of its desperate need to find foreign oil to offset decline at home.

Iran
Iran is inviting tenders to develop as much as 1.7 Gb in a shallow reservoir above the giant South Pars gasfield.

Iraq
Both Russian and Chinese companies have signed recent deals to drill as many as 50 wells in Iraq apparently with the agreement of the UN embargo committee, adding a further element to the consequences of the threatened US invasion.

29. Climate Change and Oil Depletion

We have commented in this newsletter about the remarkable disparity in the amount of money and effort dedicated to the extraordinarily difficult challenge of monitoring climate change compared with the infinitely easier task of determining oil depletion, which may have a greater and more immediate impact. Geologists know that there have been frequent radical changes in climate in the past, causing, for example, the tree-line to move from North Norway to southern France seventeen times in the last 100 000 years. But that is no reason to dismiss the climate research, as Dr Fleming points out in his letter. – *mea culpa*

LETTER TO THE EDITOR FROM DR DAVID FLEMING

Sir,

I have read Dr Colin Campbell's comments on the World Energy Outlook 2001, contained in his letter to Dr Fatih Birol at the IEA, as reproduced in the February Newsletter. The letter, in my view, is excellent, full of the passion, authority and burning frustration characteristic of Colin's writing. However, I believe that the letter contains one major weakness and that we who are closely engaged into oil issue ought to take a view on it and try to put it right.

The problem lies in the last paragraph, in which Colin writes, "...declining oil supply will have an impact on the emissions perceived to be causing climate change, albeit on the flimsiest of evidence". Now, this will not do. The scientific evidence for the climate change is now, unfortunately, rock solid, endorsed in detailed theoretical and empirical work by climate centres round the world. Indeed, the latest work from the Hadley Centre, which has started to model the impact of the carbon cycle, shows that the rate of warming can be expected to be double that of the best estimates that we have had so far. Similarly, there is, to my knowledge, no reputable dissent from the view that, by mid-century, the tropical forests will cease to be able to carry out the indispensable function of absorbing carbon dioxide and will, instead, release it into the atmosphere as their timber dies and their soils dry out. The salient question on climate change is not whether climate change is real, but whether it has already reached a stage at which it cannot be prevented from accelerating out of control.

There is one point on which scepticism with respect to climate change is justifiable, but this concerns the response to the problem rather than the problem itself. As Jean Laherrere has shown, the trajectories of reductions in carbon emissions being discussed in the context of the Kyoto process are grossly optimistic in the sense that they are based on assumptions about the supply of oil and gas which are well in excess of what will actually be available. In this sense, our contribution transforms the climate change issue, and the sooner this point is widely recognised the better. What we must avoid doing, however, is dismissing the climate change science lightly. Others dismiss our - far simpler and more straightforward - science of hydrocarbon supplies, and we rightly criticise this contempt for the evidence as being unscientific. If we make the same mistake of Olympian disdain for good science we ruin any chance of being taken seriously and developing a common understanding. In recognising both the supply problem and the climate problem, we are right on both these fundamental issues. The starting point for getting the climate scientists on board is to recognise that they have got at least something right, too.

I remain, yours faithfully,

David Fleming

30. Three Very Interesting Books

Three very interesting and important books have appeared. The first is entitled *Not by Money Alone – Economics as Nature Intended* by M Slessor & J.King (ISBN 1-897766 72 6), which is a marvellous counter to flat-earth economics, explaining the critical role of energy and the corresponding impact of its depletion. It proposes a radical shift in taxation from labour (income and sales taxes) to energy. The second is the *Death of the West* by Patrick Buchanan, the former American presidential candidate, who discusses the decline in western population and the consequences of massive immigration in times of economic decline. It is a remarkably erudite, courageous and outspoken account, far from the bland platitude so beloved of politicians. It is clearly relevant when considering scenarios of oil demand and the political and social reactions to the decline in supply. The third book is a racy novel *The Adjustment* by C.E.MacArthur set in aftermath of the ultimate power failure in New York. Manuscripts of two other excellent books on oil depletion and its impact have been received, and will be covered when published. It is encouraging that the subject is now receiving new attention.

31 – US Fears of Rising Oil Price

The headline says it all.

"US says economic recovery at risk without more OPEC oil"

WASHINGTON (Reuters) - OPEC must boost oil production during the second half of this year or risk slowing an economic recovery in the United States and the rest of the world, a U.S. government energy agency warned Wednesday. The Organization of Petroleum Exporting Countries' current production quota -- 21.7 million barrels per day -- stands at its lowest level since March 1991, and OPEC Secretary General Ali Rodriguez has said he does not see the cartel raising output this year. "If this quota is observed, OPEC efforts to boost (oil) prices could result in prices well exceeding their target, just as the U.S. and world economies recover," the Energy Information Administration said in its monthly update on the cartel. Because OPEC quotas are very low, world oil markets "will tighten rapidly" unless OPEC members, excluding Iraq, agree to boost daily production in the latter half of the year by one million barrels, the Energy Department's analytical agency said…….

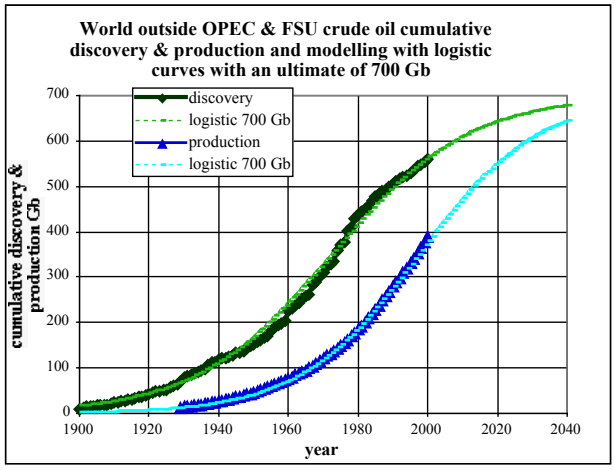
"OPEC could be faced with a repeat of 2000, when OPEC misjudged the market by over-correcting with tight quotas for too long, except that this time world economies are much weaker," EIA said. "If OPEC production does not increase as expected, prices could rise further and dampen the expected U.S. and world economic recoveries," the agency said.

32. Australia admits to depletion

John Akehurst, the Managing Director of Woodside, a major Australian oil company, points out the dire position in which Australia finds itself. Indigenous oil production is set to fall from 724 kb/d to 200-300 kb/d by 2010, by which time it will meet only 40% of demand. The present surplus of $1.2 billion is set to swing into a deficit of $7.6 billion. He comments that this should set the alarm bells ringing in the Treasury and in other arms of government concerned with managing the economy. He notes that Australia has been consuming three times more than it has been finding over the past seven years.

It is truly remarkable to find the Chief Executive of an oil company make such a frank and honest statement in the national interest. Would that his counterparts in other parts of the World were as honest, for what he says is the unadulterated truth, and the national predicament of Australia is by no means unique. Britain too has passed peak, not that anyone cares to admit it.

33. The Unconstrained World



The attached plot is taken from another beautiful set of graphs by Jean Laherrère, illustrating the robust pattern of discovery and production in the World outside OPEC and the FSU, which were artificially constrained by government policy. All the plots point to about 700 Gb for all liquids. In the current database of Conventional, circulated to ASPO members, the total comes to 612 Gb, but adding the Non-conventional brings it very close, which is welcome confirmation. All will have been produced when the production curve hits the discovery curvc, and that will come around 2050 unless consumption can be reined in radically.

34 Controversy with the Flat-Earth fraternity

The energyresources website has contained a vigorous debate in which a Mr Lynch, who is a prominent member of the flat-earth heresy, has attacked the depletion models proposed by C.J.Campbell. It attracted the following response, not to try to convert Mr Lynch, but to provide agnostics with explanations.

Misunderstandings

1. Defining what to measure

It is absolutely true that the definitions of what to measure have evolved as this study has progressed. In the early days when working with public data I took a very generalist view of the matter and, as Mr Lynch sometimes likes to point out, got quite a few things wrong. No doubt I will continue to do so although hopefully also making progress. The first step in the analysis I have tried to make was to determine the endowment of oil and gas in Nature. It soon became evident that different types of oil depleted in different ways - obviously a tar-sand is different from a Middle East flowing well. Furthermore, knowledge of some types is better than for others. The terms *Conventional* and *Non-Conventional* have no fixed definitions, but nevertheless are widely used to roughly distinguish the easy from the difficult. Perhaps mistakenly, I used these terms in a particular sense which I defined very clearly so that everyone could understand the meaning attached to them. I would add a few words of explanation about each of the categories that I treat as *Non-Conventional*

1. Oil from coal and shales (actually immature source rocks) - no particular comment
2. Bitumen - principally the tar-sands of Canada, defined by viscosity, from which synthetic oil is made
3. Extra-Heavy Oil - defined by density <10 API and mainly in Venezuela and Canada
4. Heavy Oil. This is tiresome. Canada has a cutoff at 25 API whereas Venezuela uses 22 API. I started out with a rounded 20 API. but later moved it down to an arbitrary 17.5 because there are quite a lot of fields producing happily with gravities just below 20. Any cutoff is arbitrary, but it does seem useful to distinguish heavy oils for two reasons a) production generally lasts a long time but reaches only a low peak and b) the recovery factor is low, meaning that there is particular scope for the application of enhanced recovery methods
5. Deepwater Oil - Again the cutoff is arbitrary but I use 500m water depth. I think it is useful to distinguish this category because a) the geology is very different for most of it, relying on special plate-tectonic settings and special reservoir circumstances; b) it is a hostile environment stretching technology and management to the limit, which in turn has an impact on what prospects can be handled; and c) less it is less known, so there is more scope for surprises, even good ones.
6. Polar Oil - Yet again the cutoff is arbitrary at the polar circles, but it is useful to distinguish these provinces because a) Antarctica has poor geological prospects and is closed by agreement b) the Arctic has special geology making much of it gas prone, with the exception of Alaska and parts of Siberia d) it is a hostile environment and e) it is less well known.

7 Gas Liquids are another tiresome element. There are basically two types a) that which condenses naturally called *Condensate* and b) that which is extracted by processing. Previously I excluded both from *Conventional* oil on the grounds that they would deplete in relation to gas not oil. But I have changed my mind on that, recognising that an oilfield contains hydrocarbons in both liquid and gaseous phases in proportions that can change with depletion. So I now include condensate from the gas caps of oilfields with *Conventional* oil, recognising too that it is commonly metered with oil.
8 Others - there are a few other categories such as HTHP, high sulphur, unusual reservoirs etc that could also be distinguished but I have n't done so.
I assume that all feasible enhanced recovery practices will be applied, but more could be done to smoke out the details.
I find it useful to at least define what I try to measure, even if the data at my disposal does not always allow it to be done as thoroughly as it could and should be done. In practice the boundaries are fuzzy, but the total should be about right

2. Forecasting Production
Clearly, each of the above categories can contribute differently to peak, but the contribution of all must be taken into account. It would be possible to do this more thoroughly with full access to the industry database, but I do attempt to show all production. I have spreadsheets for every country for *Conventional*, summed into Regional and World totals but add a separate global assessment for the other categories, sometimes showing all in a graph. I can easily supply anyone who is interested with the current breakdown. I won't go into all the reasons and details here, but can summarise the present assessment. I am still agonising over what Russia can supply, so there may well be revisions as new information or insight comes in.
1. *Conventional* oil production is flat at 60 Mb/d to 2010 when it begins its terminal decline at about 2%
2. Deepwater oil peaks in 2010 at 8 Mb/d
3. Polar oil declines to 0.6 by 2010
4 Heavy oil etc rises to 3.6 Mb/d by 2010 and 4.6 Mb/d by 2020
5. NGL rises to about 9 Mb/d by 2010
I also have gas rising to a plateau starting around 2015 at about 33 Tcf/a and provision for Non-Conventional gas, mainly Arctic gas and coalbed methane

In short, all liquids peak around 2010, meaning that total production need not fall below present levels for about 20 years.

3. Other Points
I do not diminish in any way the impact of technology and better geological knowledge and mapping techniques, but the study of most large fields shows a straight line decline once it sets in, lasting over many years, which implies that technology has had a negligible impact on the reserves. It evidently serves mainly to extract what is there at a higher rate. I also note that most of the known *Conventional* oil is in old giant fields, which are already efficiently exploited, so I don't think technology will have much impact on total reserves. If anything, it is likely to advance peak, by extracting the oil faster. It may however contribute more to the extraction of *Non-conventional* oil. No one can exclude the possibility of some miracle new technology but I don't make provision for it.

4. Reserve Reporting
I have abandoned the Probability ranking system, having seen the mess it got the USGS into. I conclude that *Proved Reserves* as reported for financial purposes refer mainly to what the wells at the current stage of development are expected to deliver, without necessarily saying much about what the field as a whole may provide over its life. In plain language, they are *Proved So Far*. I observe that the initially reported *Proved Reserves* of most large old fields understated what the field would ultimately yield by about one-third, simply because such fields were subject to successive phases of development, each of which added reserves. But in the case of the smaller more recent fields, reported *Proved* may indeed reflect the entire field, because there is not scope for more than the initial development scheme. It is therefore a mistake to apply the "Reserve Growth" of the past to the future. I failed to grasp the extent of this initial under-reporting in earlier studies, which explains why they underestimated both reserves and the potential for new discovery derived from the extrapolation of past discovery trends. This explains the valid criticism of Mr Lynch.

Proved Reserves, as reported in the public domain, have to be adjusted to remove any identifiable *Non-Conventional*, as herein defined, as well as any "political" component or simply the consequences of a failure to update (64 countries implausibly announced no change on 2001). The adjusted value has then to be multiplied by a factor to give a best estimate of what the fields, when fully developed, will eventually deliver.

5. Modelling Depletion
I assume that production in counties that have passed their midpoint of depletion will continue to decline at their current depletion rate, whereas it will rise to midpoint in those that have not yet got there. I also assume that the five major producers of the Middle East exercise a certain swing role around global peak making up the difference between world demand and what the other countries can supply under their depletion profiles, so modelled.

6. New discovery
It is evident that discovery of *Conventional* oil peaked in 1964, once the corrected and properly backdated reserves are applied. A smoothed trend has declined to approximately 6 Gb/y to-day although there have been occasional spikes, as occurred in 1999 and 2000 from two major discoveries in hitherto closed areas. Given that this has been the result of an industry diligently searching the world with the best technology and always deliberately testing the biggest and best prospects, it is hard to advance any evidence to suggest that it will improve in the future. The larger fields are normally found first for obvious reasons. There is scope for more discovery in the deepwater but it too is beginning to show the same eternal pattern of diminishing results. Likewise, few would dispute that the major fields of the Middle East have already been found, so stepping up exploration there would deliver results smaller by orders of magnitude

7. Economic Consequences
I am not qualified in this domain but can appeal to common sense, suggesting
a) oil price rises when demand exceeds capacity or its perceived to be about to do so
b) high prices bring on recession, reducing demand, and thereby price
c) most cheap oil lies in the Middle East and Russia (the latter due to an adverse exchange rate)
d) *Conventional* oil costs less to produce than *Non-conventional* (as here defined)
e) tax distorts the picture in many ways, giving amongst other things a subsidy to Western companies for exploration, (many spending 10c dollars)
f) the high social costs of Middle East governments with growing populations bring serious political strains if prices are low, and also limit their ability to make major investments needed to expand capacity

8. Conclusion
Today, oil provides 40% of traded energy, and energy not money drives the economy. Production is set to start declining within about ten years. Since *Hydrocarbon Man* will be virtually extinct by the end of the Century, it might be a good idea to start planning how to use less and bring in such substitutes as can be found. Given the importance of the subject, it is surprising that more serious work is not done to resolve the matter. The obstacles are primarily political, tolerating ambiguous definitions and lax reporting practices, as there are no particular technical challenges in estimating the size of an oilfield or in assessing the potential for new discovery.

35. The Nemesis Report

Another contributor from the oil industry discusses the imminent peak of production in relation to falling discovery. He is obliged to remain anonymous because expression of these well-founded concerns would be an embarrassment to the corporate image-makers. He is at the same time somewhat anxious, lest revelations of the truth may cause panic in investment circles

THE IMPACT OF FALLING DISCOVERY ON PEAK PRODUCTION

It may seem strange to make such a request, but I earnestly beg you all to find errors in the following because, if you can, then we can all sleep a little easier in our beds.

As everyone is aware, politicians when confronted with awkward or difficult questions have a tried and tested response. They answer the question that hasn't been asked or they answer the question quite literally, deliberately evading the substance of what their interrogators are trying to ask. Now, in these tricks the world's politicians are mere amateurs when compared with the professional bureaucrats. This, I believe, is the explanation for all those reassuring reports and analyses from the IEA, EIA, USGS etc. But, before tackling them, let us look at a perfect contemporary example of the 'answering the question that wasn't being asked'.

There is growing concern in the UK about future North Sea oil and gas production, and questions are starting to be asked. However, because most people view oil supplies as analogous to a pot of honey, the question they always ask is 'When is it going to run out' while what they think they're asking is 'Can production

levels be maintained'. Politicians, oil companies and bureaucrats cannot believe their luck and reply 'There's as much to produce, or more, than we've produced so far', which is a perfectly accurate but wholly misleading statement. The clear implication is that there's nothing to worry about. Even some of the analysts, who should know better, keep claiming that the decline to date (6% in 2000 and 12% in 2001) is a temporary phenomenon, an investment glitch, and a soon-to-be-reversed setback. They are plain wrong. We are past 50% depletion of the UKCS and sustained decline is now inevitable. Interestingly, a recent BP presentation in Aberdeen confirmed that the UK North Sea was past its peak, though rapidly adding that they (BP) would be able to maintain production at only a little under their peak for many years.

Turning to the global scene, careful reading of both the EIA and IEA reports establishes that they are **not saying** that particular production levels are **possible**, only that these are the **production levels necessary** to sustain a 'business as usual scenario'. It is actually quite easy to see how they generate their reports. They appear to put all the production numbers in a spreadsheet and extrapolate forward at the historic growth rate, save where they know an area is in decline, when they minimise any decline, or where they know of discovery, in which case they rev up the growth. If this isn't enough they prorate everything up to fit the required production level. Sometimes these methods produce quite amazing results. A couple of years ago, the IEA could only get to the required number (business as usual) by inventing large volumes of the quaintly named 'unidentified unconventional'. They clearly got severely reprimanded for hinting 'business as usual' might not be possible and have since reverted to earlier tried and tested number juggling techniques.
The news that the North Sea is in decline has not yet reached the EIA, who are still confidently extrapolating their spreadsheets forward to give a reassuringly impressive North Sea production of 7mn b/d in 2020. You can understand their problem. All that expanding North Sea production kept Opec in check and prices low. It is evidently not good politics to say the North Sea won't produce lots more.

Now, it is easy enough to make fun of bureaucrats but they do have a real problem. The politicians don't understand and don't want to face up to the reality. I'm not entirely convinced that even those who do understand the problem want to face up to the reality. I, myself, don't really want to face up to the devastating reality either. This is why I'm hoping someone will find great errors in what I'm saying.

Maths and Physics are clear and logical disciplines, with little room for fuzziness. I have tried to be as clear and logical as possible. I have drawn on three primary sources:

1. Colin Campbell's latest assessments as published in Newsletter 14
2. Jean Laherrère's 'Forecasting future production from past discovery'
3 .Wolfgang Schollnberger's presentation to the IP Week conference (Feb 18, 2002) and available on the Institute of Petroleum's website at www.petroleum.co.uk This can be taken as the 'industry view' from a senior BP executive who is also the Chairman of the International Association of Oil and Gas Producers (OGP).

I have tried to stand back and look at the overall picture. Wonderful detailed work has been done in many areas but sometimes the big picture gets lost in the process. However, the conclusions I reach are so startling and, in a sense, so novel that the instinctive reaction is to deny that they are possible. It is difficult to believe. I have searched in vain for an error in the logic. Hopefully I have overlooked something.
In the first part, I am only considering liquids – oil and condensates. Later on, I will show that a key alternative, namely the oils that do not flow at ambient temperatures – heavy oil and tar sands – are not a viable 'solution' as the volume likely to be produced by the critical dates is far too small.

Returning to conventional liquids, the number we have most confidence in is Cumulative Production to date. Campbell gives 873 Gb for oil only (end 2001), whereas Schollnberger gives 900 Gb for all liquids (end 2000). **So we can say with confidence that the world had used a rounded 900 Gb of liquids by end 2000.**

We also have reasonable confidence in global **demand, which has been holding steady at around 75 million barrels/day or 27 Giga barrels/yr.**

Units are an endless source of confusion and may be one of the reasons why there is so little appreciation of the imminent crisis. Measures of flow-rates in barrels/day are unhappily mixed up with measures of stock quoted in billion barrels (Gb). The easiest and most illuminating way to avoid the confusion is to work with stocks in Gb and production in Gb/year. Suddenly things become much clearer. For those trying to mislead, this makes things far too clear, which may explain the industry's enthusiasm for mixed units, mixing oil and gas by quoting reserves in barrels of oil equivalent, and other wilful obfuscations.

Perhaps most surprisingly of all, **there is an emerging consensus that the world's remaining reserves are around 1000 Gb.** Different sources arrive at this conclusion in different ways. The highly suspect public

databases, as published by API, BP Statistical Review, World Oil, Oil and Gas Journal and Opec, all have reserves reaching a plateau at around the 1000 Gb mark at the end of a long rising trend. According to Jean Laherrère's graphs, backdated reserves from the industry database have also reached the same level but at the end of a 20-year decline from a 1200 Gb peak in 1980. Campbell's latest assessment gives remaining liquids reserves as 1077 Gb (1950-873). (We should probably add some condensates into the 873 Gb produced raising it to over 900 Gb, which would then give remaining reserves of around 1000 Gb). Jean Laherrère's paper makes use of creaming curves (arguably the most accurate predictor of ultimate reserves) giving cumulative discovery of 1200 Gb outside the Middle East, 700 Gb in the Middle East and 50 Gb in deepwater. This totals 1950 Gb, which gives remaining liquids reserves of 1050 Gb after the removal of past production. We now have a truly remarkably narrow range. We can now say with some confidence that **the world's remaining liquid reserves are between 1000 and 1100 Gb.**

There remains only one area of significant disagreement – future discovery. Surprisingly, and quite counter-intuitively, this matters much less. The peaking of global oil production is likely to occur in the next 3 to 10 years. What is discovered in 2015 or 2040 may slow the rate of decline but it won't affect the peak. To illustrate with a homely example: if there is no bread and no flour available you will starve even though the farmer plans to grow a big crop of corn next year.

So what is important is the rate of discovery.
According to Petroconsultants/IHS Energy over the last decade discovery has averaged around 9 Gb/year with a couple of good years in 1999 and 2000 when levels reached 14-16 Gb/year. Figures in the Schollnberger presentation from Cambridge Energy Research Associates (CERA) show the same pattern but the decade average from CERA is, if anything, lower than the IHS numbers at around 5-7 Gb/year (excluding Russia). It also shows the 1999/2000 upturn. It is worth noting that discovery in the 1960s averaged 43.8 Gb/year. (No I have not slipped a decimal point, it averaged 43.8 Gb/year). Demand rose rapidly over that decade from just under 5 Gb/year in 1960 to just over 11Gb/year in 1969.

Returning from the industry's 'Golden decade' to the current harsh realities. The public database may be highly suspect but, as it shows essentially unchanged reserves, what it is actually saying (rather improbably) is that liquids are being found at the rate they are being consumed. But this is after 150 years of always exceeding the consumption rate. These are massaged figures but even they are hinting at the problem. Now, in fact, most serious commentators accept that net reserve growth is negative. But how negative? Returning to Jean Laherrère's graphs, we find that over the last two decades remaining reserves (backdated technical data) have declined by over 200 Gb or 10 Gb/year. However , the decline is accelerating with 170 Gb of the decline in the last 10 years, namely a decline rate of 17 Gb/year. Remember this is net of any discovery made!

Colin Campbell assesses undiscovered oil at 146 Gb, which with 10% added to give all liquids (oil +condensates) gives an undiscovered liquids of 160 Gb. Taking a 50-year view that means a little over 3 Gb/year. However Campbell sees discovery declining steadily from the current 6 Gb/year to zero. For our purposes we will take a rounded 6 Gb/year.

In sharp contrast, Schollnberger, as representative of the 'oil industry' view, anticipates discovery of a further 500 Gb (Suspend disbelief!) with improved recovery adding an additional 280Gb (Believe in miracles!). However once we take a 50-year view, this translates to 10 Gb/year of discovery and 5.6 Gb/year of enhanced recovery, namely 15.6 Gb/year in total. A highly optimistic view but not wholly absurd.

The current annual decline in the technical database of 17 Gb/year implies a discovery rate as 10 Gb/year (27-10=17). So, with some confidence, **we now know discovery is running at between 6 and 16 Gb/year with 10 Gb/year as a good working number.**

Currently liquids consumption is running at 27 Gb/year. So the pessimist Campbell predicts that the world eats into its store of discovered reserves at 27-6=21Gb/year while the optimist Schollnberger thinks the decline is only 27-15.6=11Gb/year (rounded numbers). The technical database indicates a decline of 17 Gb/year and rising. So we can confidently say the world is eating into its store of discovered liquids at between 11 Gb/year and 21 Gb/year with a 17 Gb/year decline as a good working number.

Now, the Central Limit Theorem tells us that the sum of any number of production profiles (any shape) is always a single hump curve with the peak at 50% of the total (Area under the graph). This is hard to grasp and always appears slightly mystical. However, half an hour with an Excel spreadsheet or careful viewing of those summed production profile graphs will confirm it to be true. Anyone still with doubts could look at Jean's graphs. The creaming curve for liquids discovery in the US lower 48 trends to 220 Gb. Half this is 110 Gb. US cumulative production reached 110 Gb in 1971, exactly when production peaked. UK offshore

cumulative liquids discovery is trending to 36 Gb. Cumulative production reached 18 Gb in 1999. Production peaked in November 1999. In both these examples, discovery has fallen to minimal levels and so can be effectively ignored. The creaming curve has become flat. These figures could be calculated for all countries and all areas, which would be well worth doing. Only in those areas where there is significant levels of discovery will there be any real uncertainty.

The only other area of real unpredictability is the prospect of wholly new and undiscovered provinces. Jean Laherrère believes there could be an additional 30-50Gb in deepwater. Does anyone know of anywhere else where there might be significant undiscovered reserves? If they do, rest assured that every oil company on earth would pay large sums for the knowledge.

However, in a very important sense, to get bogged down in analysing countries and regions is to miss the big picture. What applies to the countries and the regions applies to the whole. **Once the world has consumed 50% of the reserves, the production level cannot be maintained.** It seems crazy, and is wholly counterintuitive, but it is true.

Now, to determine the fateful day when liquids production can no longer be expanded is quite easy. We have used 900 Gb and we are using 27 Gb/year. There are between 1000 Gb and 1100 Gb of reserves. By deflating consumption by the **net discovery** rate, we get the rate at which we are using up the reserve store. Campbell's net reserves decline at 21 Gb/year (27-6) while Schollnberger's do so at 11Gb/year (27-16), and. the technical database indicates 17 Gb/year. Now, 50% of global discovery figure is in the range 950 (900+1000 divided by 2) and 1000 (900+1100 divided by 2).

So, we only have 50 Gb to 100 Gb left to consume before production levels become unsustainable. **At best,** it could be 10 years (100 divided by 11), namely **2011**. **At worst,** it could be under two and a half years (50 divided by 21), namely **mid 2004. The most probable date on 1000 Gb reserves and 15 Gb/year net decline is 2005.**

A major offshore field development takes around five years from discovery to production, whereas a major onshore field takes around 3 years. So there isn't much time to push out the decline date. There aren't even that many major projects or discoveries in progress.

Now, you see why I really am hoping I have made some silly mistake.

We can easily examine the sensitivity of these predictions: The decline date would be pushed out if reserves were above 1000 Gb, if there was a rapid and sustained upturn in the discovery rate or if there was some evidence that production levels could be sustained beyond the 50% of reserves depletion point. We would also get more time if demand fell steadily or, better still, collapsed. On the other hand, the date would be advanced if reserves were below 1000 Gb, or if discovery fell back to early 1990s levels, or even if demand returned to its 25-year average of 2%/year growth.

Note the working assumptions are both that any discovery goes into the reserve development chain and that the chain is long enough to allow a steady flow of new developments. There is presumably some point at which there are so few undeveloped reserves that the time between discovery and production actually impacts the ability to even partially replace production. This seems unlikely to be other than a local problem in the time frame we are discussing.

Already throughout the non-Opec world, any significant discovery is being fast-tracked to production. It is obvious that past undeveloped discoveries must be so marginal that only very high prices will get them a place in the development queue. The only significant known fields I know of that are not actively being developed are: a number of fields in Iraq (embargo); some in northern Kuwait on the Iraqi border (security fears); some very high sulphur fields in Saudi Arabia (unsaleable); some fields in Eastern Siberia (no roads, pipelines or infrastructure) and accumulations in countries where the government operates a development queue (Angola). In short, any significant discovery currently known about is in the process of development with only minimal exceptions.

A 'quick and dirty' way of looking at the problem is to look at the age of oilfields. We know that 70% of the world's producing oilfields were discovered over thirty years ago. Few fields are able to maintain production levels after 25-30 years. The early Middle East giant fields are wholly exceptional in this respect, but they too decline.

We also know that the larger accumulations are discovered first, so that 70% of known discoveries accounts for at least 80-85% of known reserves. If there are 1000 Gb of known reserves, no more than 150-200 Gb

are in fields where production could be expanded. So at best, there are 800 Gb in fields where production is static or declining, with just 200 Gb in fields where production could be developed or expanded to offset the decline and meet incremental demand. It is an area worthy of study. Reality could easily be rather worse than I am suggesting.

The fact that overall or global production levels cannot be sustained does not mean there will not be regions or areas where production is actually expanding rapidly. The most likely reason why there is so little appreciation of the imminent peaking is that people tend to focus on the areas of expansion and fail recognise the speed at which other areas will be declining. **Overall decline comes once the decline of production in fields in decline (post-peak) exceeds the production gains of fields with expansion potential (pre-peak). It is really that simple.**

So what about non-flowing oil supplies – tar sands and heavy oil? Production of these types of oil is more like mining than conventional oil production. It is the one area of the business where flat-earth economics applies. If the price is high enough more will be produced. The investment costs are huge, compounded by severe environmental problems and long lead times. Campbell's latest assessment is that Canada and Venezuela combined could provide 2.8 million b/d in 2005, 3.6 million b/d in 2010 and 4.6 million b/d in 2020. According to my calculator that's 1 Gb/year in 2005, 1.3 Gb/year in 2010 and 1.7 Gb/year in 2020. Nice to have, but its not going to save the day even if we were to double the estimates. At the moment, global gas production is being expanded very rapidly. It is not at all clear that it could be expanded more rapidly although at higher prices there might be even greater investment.

Perhaps we should start to consider what happens when liquids production can no longer be sustained.

To date, when an individual country, province or region reached this point (production decline), it simply bought from elsewhere. The economic harm was usually minimal, although it could be argued that Russia's inability to maintain production growth after 1988 denied the economy cheap fuel for its inefficient economy and led to the collapse of Communism. But what will happen when decline is a global phenomena? Initially it will be denied. There will be much lying and obfuscation. Then, prices will rise and demand will fall. The rich will outbid the poor for available supplies. The system will initially appear to rebalance. The dash for gas will become more frenzied. People will realise nuclear power stations take up to ten years to build. People will also realise wind, waves, solar and other renewables are all pretty marginal and take a lot of energy to construct. There will be a dash for more fuel-efficient vehicles and equipment. The poor will not be able to afford the investment or the fuel.

Exploration and exploitation of oil and gas will become completely frenzied. More and more countries will decide to reserve oil and later gas supplies for their own people. Air quality will be ignored as coal production and consumption expand once more. Once the decline really gets under way, liquids production will fall relentlessly by 5%/year. Energy prices will rise remorselessly. Inflation will become endemic. Resource conflicts will break out.

In 1975, the US Lower-48 produced 7 million b/d of crude. By 2000, production had fallen to just under 3.5 million b/d. Despite maximum financial incentives, the finest technology in the world and a complete openness to innovation, the US has been unable to slow, never mind reverse, this 2%/year production decline. Is there any reason to think the world will fare any better once peak is passed?

36. An Excellent Review

Dr R.W.Bentley has published an excellent review of the issues surrounding oil depletion entitled Global Oil & Gas Depletion – an Overview in *Energy Policy 30 (2002)*

The editor of the Newsletter very much welcomes contributions from members and other readers, who may wish to draw attention to items of interest or comment on the progress of their own research.

Compiled by C.J.Campbell, Staball Hill, Ballydehob, Co. Cork, Ireland