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

NEWSLETTER No 16 – APRIL 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. It presently has members in:
Austria, 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.

Mission:
1. ***To evaluate the world's endowment of oil and gas;***
2. ***To model depletion, taking due account of economics, technology and politics;***
3. ***To raise awareness of the serious consequences for Mankind.***

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

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37. ASPO Workshop at Uppsala

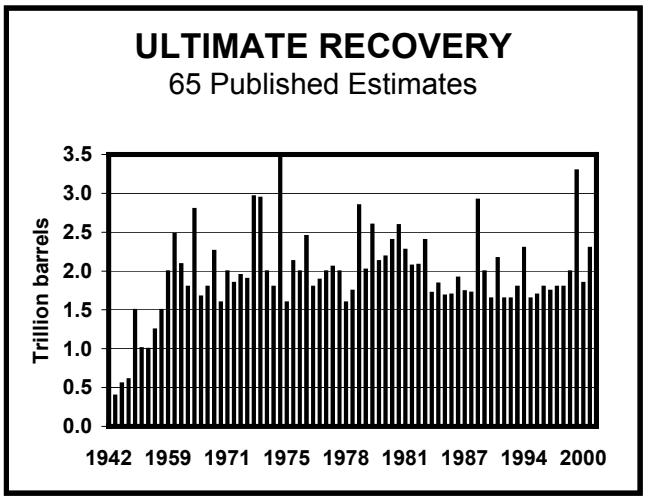
Professor Aleklett reports growing government, international and media interest in the forthcoming workshop in Uppsala from May 22-25th . The details of the programme and the abstracts can be seen on www.isv.uu.se/iwood2002.

Anyone planning to participate, who has not yet registered, is asked to do so as soon as possible on the above website. The response so far has been very promising.

A meeting of ASPO members is being convened on May 25th to consider the future of the network. An agenda will be distributed shortly.

38. Estimates of Ultimate Recovery

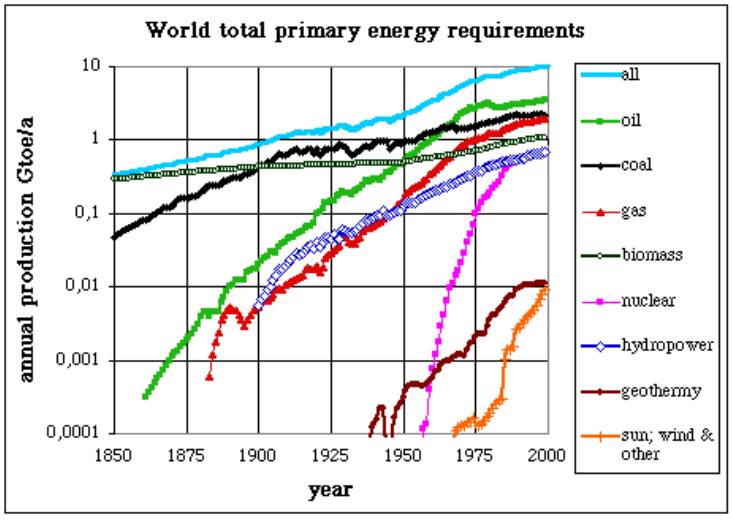
Many estimates of Ultimate Recovery have been published over the years, but we need to research the details to know where they drew the boundary between conventional and non-conventional oil, what they measured, and what their methodology was. However, the attached plot shows 65 estimates at face value, as published by oil companies, government institutions and others, including the outlandish estimates by Odell in 1973 and the USGS in 2000.



The average is 1.93 trillion, which by coincidence comes very close to the present ASPO value. Whether or not this estimate proves to be correct, we can at least say that we have the support of the consensus of qualified opinion. Accordingly, the onus rests on those with counter-views to justify their position with more than expressions of blind faith.

39. Halfway through the Industrial Revolution

Jean Laherrère has produced another useful graph plotting energy consumption over the past 150 years. The total over the first hundred years followed a straight upward trend followed by a surge from 1950 to 1975 after which it flattened, largely reflecting the levelling of oil. The most spectacular increases have been nuclear and renewables (sun, wind etc). We may speculate if the next 150 years will be the mirror image.



We may ask too what impact this will have on the "Death of the West" (lifting the term from the title of Patrick Buchanan's book). Will the energy-dependent industrial societies age and wither away in parallel with their energy supply to be replaced by immigrants and their descendants, willing to till the fields and work the coal mines from their new homes in equitable temperate climes?

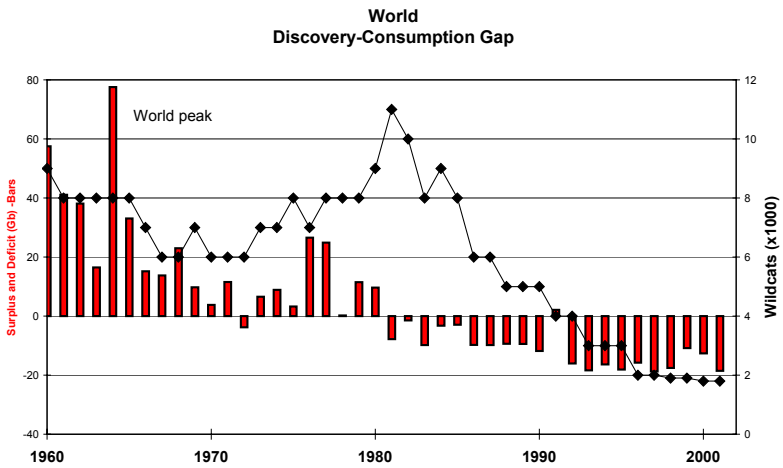
Revolutions by definition do not last for long, and there is no reason to think that the Industrial Revolution will be an exception.

40. ODAC Board of International Advisors

Dr Jim MacKenzie. Senior Associate of the Climate, Energy, and Pollution Program at the World Resources Institute of Washington, who has published some key papers on oil depletion, has joined ODAC as an International Advisor. The Board presently comprises the following members, who bring an invaluable breadth of international experience to the undertaking.

Mr A.M.S. Bahktiari – Senior Expert, Corporate Planning, National Iranian Oil Company, Teheran, Iran
Prof. R. Booth – Visiting Professor of Engineering, Oxford University, England; formerly Head of Renewable Energy, Shell Oil
Mr B.J. Fleay – Author *The Decline of the Age of Oil*, Associate of Murdoch University, Convenor of Economic Policy Working Group for the Greens of W. Australia; Perth. Australia
Mr R.F.P.Hardman – Formerly Exploration Director, Amerada Hess and President, Geological Society, London
Mr A. Ianniello – Formerly Managing Director, Agip UK, London
Dr K. Illum – Energy Consultant; formerly Professor at Aalborg University, Denmark
Mr. L.F. Ivanhoe – M.K.Hubbert Center for Petroleum Supply Studies, Colorado School of Mines; formerly Advisor to Occidental Petroleum
Mr J.H. Laherr⬟re – Formerly, Deputy Exploration Manager, Total Oil Co, France
Mr. R.C. Leonard – Vice-President of Exploration & New Ventures, Yukos Oil Company, Moscow
Dr, J. MacKenzie – Senior Associate, World Resources Institute, Washington.
Dr. S. Peters – Political Scientist, Giessen University, Germany
Mr. M.R.Simmons – President, Simmons & Co International, investment bankers; Advisor to US Government, Houston, USA
Mr C. Skrebowski – Editor, *Petroleum Review*, Institute of Petroleum, London
Mr.D. Strahan – Producer, BBC Television, London
Dr. W. Youngquist – Author of *Geodestinies*, formerly Exxon petroleum geologist and academic; Oregon
Dr W.H. Ziegler – Formerly Regional Geologist, Exxon and Sr Group Advisor, Petrofina; Switzerland.

41. Growing Gap between Oil Discovery and Consumption



It appears that total discovery in 2001 was about 8 Gb including deepwater oil, and NGL. Although there remain the eternal uncertainties about the reliability of the data, it appears that the world's oil account has been running a deficit since 1981, as it continues to eat into its inheritance from past discovery. This downward discovery trend was evidently not affected by the tax-driven surge of exploration drilling in the early 1980s, underlining that discovery depends on geology not economic incentive. Apart from two sizeable finds, the 8 Gb of 2001 came from some 300 discoveries whose average size must accordingly be approaching the lower limit of viability. It explains the continued fall in exploration drilling, as modern technology allows the companies to accurately map the size of prospects, enabling them to concentrate on the shortening list of viable opportunities. These results from the real world are compatible with the consensus estimate of the size of the endowment, discussed above, and confirm the thoroughly flawed nature of the USGS report of 2000 that has misled so many governments and international agencies. The USGS claimed (as a Mean probability estimate) that 732 Gb would be found

between 1995 and 2025, which means an average of 25 Gb a year. In fact, the average has been only 10 Gb during the first seven years of the study period, when discoveries should be above average as the larger fields are normally found first.

In the face of such easily documented evidence, it is difficult to avoid the conclusion that those who still give credence to this report must have some ulterior motive for doing so. It is surprising that the World Energy Council should provide a platform for it at its Ankara meeting. (see more in Item 44).

It is noteworthy too that Shell, which in its scenarios claims to support the USGS excessive estimates, prefers to purchase Enterprise Oil for its reserves — it having virtually no other asset of conceivable interest to Shell — rather than explore for the largesse it pretends is there to be found. Its actions speak louder than its words and scenarios. Shell's offer values the company at $6.5 billion for reserves of 1.12 Gb of oil and 2.1 Tcf. of gas, which amounts to about $6/b for the oil alone. The addition dilutes the value of Shell's existing reserve portfolio, yet is still preferable to exploration.

42. EU Fails to Support Research into the Depletion Issue

The European Union has rejected a proposal to support research into this subject that was to have been led by the responsible government agencies of France and Germany using the essential industry database. A short glance at the above plot of the growing gap between discovery and consumption should have been enough to alert them to the gravity of the situation, but instead of checking the numbers to confirm or reject the findings, they resolutely avert their gaze.

43. Response to the Nemesis Report

To the Editor

Recently I received a copy of the ASPO-ODAC Newsletter #15 from an esteemed colleague who urged, "Rich — Read the part which I have marked in red. It is dynamite - and we are right on!" The marked part was "The Nemesis Report" (Section 35. "The Impact of Falling Discovery on Peak Production") which I found comprehensive, useful, well written, and — overall — accurate.

The author ("Anon"), however, implores his readers, "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." I would like to ameliorate his slumber regarding the following paragraph.

> "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." (Anon, section 35)

We begin with a formal definition of the Central Limit Theorem (CLT):

> "**Central limit theorem**, *n.* the fundamental statistical result that if a sequence of INDEPENDENT IDENTICALLY DISTRIBUTED RANDOM VARIABLES each has finite VARIANCE, then as their number increases, their sum (or, equivalently, their arithmetic mean) approaches a NORMALLY distributed random variable. Hence, in particular, if sufficiently many samples are successively drawn from any population, the sum or mean of the sample values can be thought of, approximately, as an outcome from a normally distributed random variable." (Borowski, E.J. and Borwein, J.M., 1991)

Comparing Anon's paragraph with Borowski's definition, the former contains several errors. To wit --

1. The CLT applies to "independent identically distributed random variables," not to "production profiles (any shape)."
2. The CLT applies only to "independent variables," however the oil production in any given year is dependent upon (i.e. *not independent of*) the production from all other years. (See Duncan, 2001.)
3. The CLT applies to samples of size n taken from a population of known mean μ and standard deviation σ. However, μ and σ are not known — nay, not even defined — for the "population distribution of world oil production profiles" (whatever that means). Anyhow, the CLT does not apply.
4. The CLT depends on a large sample size (n). Is Papua New Guinea's 10 years of oil production (1992-2001) large enough? Or does it take the likes of Romania's 145 years of production (1857-2001) to qualify?
5. Anon tells us, "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." This is arm waving, not mathematics.
6. Anon writes, "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." Although my database applies to all of the US (i.e. not just the "US lower 48"), it is worth noting that the US peak occurred in 1970 when cumulative production was 104.3 billion barrels and we forecast an ultimate recovery of 264.7 billion barrels. Thus the US peak occurred when cumulative oil production was only 39% of the US EUR, not "50%".

If Anon, and others, insist on justifying the obvious fact that the sum of the oil production profiles of all nations (and basins, and regions) will eventually add up to a world oil production curve that starts at zero, rises to a peak, and then falls back to zero, then they might try the Mean-Value Theorem of Integral Calculus. However, the fact that the Earth is round is good enough for me.

The fact that I've cited some errors in Anon's otherwise superb critique stems from my observation that sloppy mathematics has, on occasion, presented the flat-earth folks with an Achilles' heel into otherwise excellent work. Let's not give them such an easy target.

References:

Borowski, E.G. & Borwein, J.M., (1991). *The Harper Collins Dictionary of Mathematics,* Harper Perennial, New.

Duncan, R.C. (2001). Energy resources—cornucopia or empty barrel?: Discussion, *AAPG Bulletin,* June, pp. 1090-1092.

Sincerely,

R. C. Duncan

44. Explaining the failure of the US Geological Survey

National geological surveys are normally staffed by serious scientists, and are not the most obvious places in which to expect to find conspiracies by sinister forces with ulterior motives to confuse and mislead. So how do we explain the flawed study of world oil discovery by the USGS that has so mislead the world's governments on this most critical of subjects?

The answer perhaps lies in mind-set and experience. The world has approximately 700 sedimentary basins having notional oil prospects, of which at a guess perhaps 200 have been found to be productive. Assessing the potential of the productive basins is a fairly straightforward task that can be achieved by extrapolating the experience to-date with the help of a series of robust statistical techniques, relating declining discovery to drilling activity, and field size distributions. Assessing the presently non-productive basins is a different challenge altogether, and can be based only on abstract geological reasoning. The USGS failed to distinguish the two categories, applying the latter technique to both, which was understandable, given that they are geologists and not practical oilmen.

The USGS proposes that, as a Mean probability estimate, as much as 732 Gb (billion barrels) will be found between 1995 and 2025, tacitly assuming that an infinite number of wildcats would be drilled to find it. It was very hard for them to categorically say that their expectation for any basin was zero, especially if it was a large one, although in Nature there are many very large and very barren basins. So, they found themselves having to hedge their bets with

probability rankings, which in no case accepted the proposition of zero discovery. Their zero ranking with 95% probability was defined to mean that there was a 95% probability of there being *more* than zero, namely at least one barrel. Then they went to the other end of the range and asked what the 5% percent probability might be. Although the very concept of a 5% *subjective* probability is almost beyond the resolution of the human mind, the question demanded an answer, and in the case of a large basin it could well be a very high one. From this wide range, they computed a Mean value, which they summed to give the world total of 732 Gb.

An oilman, doing the same job, would approach it very differently, because he would know that he had only a finite number of wildcats to find it. He would no doubt dedicate most of his effort to the established provinces, which he would rightly conclude represented the best investment. He might dedicate a small part of his budget to confirming his negative assessment of the un- or under-tested basins, recognising that they are under-tested because they are perceived to have poor chances. If his first few wells confirmed the negative assessment, he would not waste more of his precious budget with abortive drilling. So instead of asking about subjective probability, it might be better to ask how many consecutive dry holes would be drilled before abandoning the search.

If we took this more practical approach, we would not assume an infinite number of wildcats but a decidedly finite number, because as the odds lengthen, fewer and fewer investors are likely to be tempted by the lure of black gold, strong as it might be. Some idea of the scale of things may be gained by looking back to the record over the past two decades to see what has actually been achieved, although, as always, we face the eternal problem of unreliable data to know even how many such wells were drilled. For what it is worth, the information we have suggests that about 110 000 wildcats have been drilled since 1980, costing, say, 500 billion dollars, and they found approximately 300 billion barrels. This was less than the 500 billion, that the world consumed, as it ate into its inheritance from past discovery. There was evidently plenty of incentive to find more oil, but the rate of wildcat drilling declined from an average of 77 000 over the first decade to 31 000 over the second.

If we now look ahead to the next 20 years, we may expect the amount of drilling to continue to halve each decade as the list of perceived remaining viable prospects continues to shorten. With an optimistic assumption that the same rate of discovery could be held that means about 150 Gb of in the next decade and about 75 in the one after that. A more realistic assumption would expect discovery rate to continue to decline, yielding much less.

As the Nemesis Report pointed out last month, the answers we get often do not match the questions posed. We thought we were asking the USGS how much oil would be found between 1995 and 2025 in the real world, but the answer we got was that there was a Mean probability of finding 732 Gb assuming an infinite number of wildcats. It might indeed be a sound logical answer to the degree that anyone can truly grasp such a concept, but it was not the answer to the question we thought we had asked. As pointed out above, seven years into the study period, we find that the real world is indeed different to the hypothetical one that occupies the minds of the USGS. Their great mistake was to put a time-span on the estimates. Their numbers could have survived well enough if they had left the time-frame open ended, as no one can know what someone with a mop and a bucket might find a hundred years from now in some distant seepage.

45. New Study of Global Oil Supply to 2050

A new study of global oil supply has been produced by Dr M.R.Smith, giving comparable results to those proposed here. Contact address glow@lineone.net,

46 Caspian Geopolitics

The Anarchists have rather left the mainstream of politics, but an interesting account of the geopolitics of Caspian exports and US military involvement is given by Terry Clancy, who writes for the Anarchist Federation. It was tempting to reproduce it in full here, but on second thoughts and in the interests of diplomacy, it is better to be content with a reference.

http://struggle.ws/pdf/war/warterrorpam2.html

47 Newsweek contemplates a world beyond oil

Newsweek of April 15th 2002 carries an extensive article entitled Beyond Oil. It says much between the lines hinting that it perceives, but cannot quite state, the reality of the situation. It falls into the common trap of using Reserve to Production ratio, quoted in years, to deny depletion, as if it were remotely plausible that production could be held constant for a given number of years and then stop overnight when all oilfields are observed to decline gradually towards exhaustion.

It emphasises that US military adventures from Colombia to the Caspian have oil as their target, whatever the pretext. It treats the sound work of Deffeyes (author of *Hubbert's Peak – the impending world oil shortage*) with a degree of scepticism, verging on derision, yet gives prominence to it, almost as if to draw attention to it, without quite having the courage to endorse its unassailable logic.

48. The attempt to oust Venezuela's strong man

The Times of 16th April implicates the United States in the failed attempt to oust the Venezuelan President, who had taken a strong position on oil. It gives a further hint of the new US oil policy, even if the CIA does seem to lost its touch since the days when it successfully did in Allende in Chile.

49. Denmark's change of direction

The journal *Science* (v.295 of 8 March www.sciencemag.org) comments on how a prominent flat-earth economist, Lomborg, has been put in charge of a new institute for Environmental Evaluation. The appointment is receiving strong opposition from Denmark's scientific community. Lomborg, who rejects the evidence of oil depletion, may find support from Denmark's Geological Survey, which has fallen under the influence of the USGS. It remains to be seen if the Danish government, which now holds the EU Presidency, will allow itself to be misled by the flawed advice it will be receiving from these sources. It is ironic that Denmark, which has given such a lead in renewable energy, should now find itself suffering this reversal.

50. Approach to the Chief Scientific Advisor to the UK Government

ODAC has sent the following letter to the Chief Scientific Adviser to the UK government, and a meeting is being arranged

Professor D. King FRS,
Chief Scientific Advisor
Office of Science & Technology
Dept. Trade & Industry, UK.

Dear Professor King,
I write to you on a topic of some importance.

The recent UK Cabinet Office (PIU) Energy Review, published February 14th, draws seriously erroneous conclusions on the security of world hydrocarbon supply.

It has been well known for over half a century that hydrocarbon production from a region reaches a physical peak, and then declines, when roughly half the original endowment has been produced. The underlying explanation is straightforward, and reflects the depletion of individual fields, and the mathematics of adding the production from what are, generally, successively smaller fields.

The examples of this phenomenon for oil are numerous, for example the whole of the US, or US regions such as Texas and Alaska; and countries such as Germany, Austria, Trinidad and many others. Regions or countries currently at, or near, peak include the UK, the EU as a whole, the Asia-Pacific region and so on.

The PIU study understands this principle of 'mid-point peaking' for the case of the UK (see para. 2.12, which recognises: " … the imminent peaking of oil and gas production from the UKCS"); but for some reason does not apply the same principle to data for the world as a whole. Instead, for the world, the PIU study makes the elementary mistake of relying on Reserves-to-Production ('R/P') ratios of 40 years for oil and 60 years for gas, and concludes (p. 24) that: "…. for the 50-year period of the current energy review, it is possible to be …. reasonably confident about gas availability, but oil might become scarcer by mid-century."

For understanding world hydrocarbon security, the implications of correctly using logistic production curves ('mid-point peaking'), instead of R/P ratios, are very serious indeed. Logistic calculations show that the world production of non-OPEC conventional oil is just about at peak, as the IEA recognised in its '*World Energy Outlook'* in 1998. The same calculations indicate that world production of all conventional oil will peak in about 10 years.

Moreover, logistic calculations, using global endowment data for both oil and gas, and making reasonable assumptions on rates of availability of non-conventional hydrocarbons, indicate that the most likely production profile of the world's all-hydrocarbons (conventional and non-conventional oil and gas) will peak in as little as 10 to 15 years.

All technical estimates have uncertainty, but the calculations just described are some of the best in the world today. They are based on extensive analysis of the industry global oil and gas database, and the use of industry-standard analysis techniques. Though the results are primarily available through rather expensive consultancy reports, they are also available in the public domain in edited form, for example:

- C.J. Campbell and J.H. Laherrère. *The End of Cheap Oil*. Scientific American, March 1998, pp 60-65.
- R.W. Bentley, R.H. Booth, J.D. Burton, M.L. Coleman, B.W. Sellwood, G.R. Whitfield. *Perspectives on the Future of Oil*. Energy Exploration and Exploitation, Vol. 18, Nos. 2 & 3, pp 147-206, Multi-Science Publishing Co. Ltd., 2000.
- ODAC's submission to the PIU (attached.)

In essence, the PIU study does not reflect the fact that, while the world does have '40 years of proved oil supplies, and 60 years of gas', most of these reserves will only be available after peak, because of reservoir behaviour. Moreover, the PIU study seems to have been misled by historical changes in reported global proven reserves. It is easy to show that most of such changes are due to reporting conventions, 'quota wars' increases, and currently, extensive non reporting.

A key number to keep in mind is the estimate of the world's original endowment of conventional oil. Despite some 'outlier' estimates, (and those from the USGS in 2000 need especial discussion), industry-based estimates have remained close to 2,000 billion barrels (excluding NGLs) for some 40 years now, and four very recent estimates, all from respected industry sources, including BP and TOTAL, continue to support this number. With a 2,000 billion barrel endowment, and nearly 1,000 billion barrels used, global production of conventional oil is clearly close to its physical peak.

Turning to gas, there is certainly a large amount discovered but not yet used, as the current 60 years' of proven reserves show. But well-established estimates for the world's original endowment of conventional gas stand at around 11,000 Tcf, of which just over 8,000 Tcf (industry data) have been discovered so far. The world gas discovery trend over the last 20 years indicates it will take at least 50 years to find the remaining 3,000 Tcf, though large new gas finds are certainly to be expected, particularly in Northern Russia. If the 11,000 Tcf figure is used, the standard logistic peaking argument puts the global peak in gas availability around 2020.

This date is in sharp contrast with the PIU's reassuring, but naïve, calculation (para. 4.36) that: "Some two thirds of the world's global gas reserves are already within economic distance of the European gas market. These reserves are equivalent to 100 years of current European consumption level." In essence, here, the PIU's calculation pays no attention to global demand, nor to global peaking.

And, as explained above, the decline in conventional oil, following peak, offsets the rise to peak of gas, so that the overall peak in 'all hydrocarbons', including non-conventionals, precedes the peak for gas. An all-hydrocarbons peak would have an extraordinarily severe impact on the economies of the world.

I believe you have already had discussions on this topic with Mr. Richard Hardman, formerly Exploration Manager of Amerada Hess, also formerly President of the Geological Society. You may also wish to contact Professor John McMullan of the University of Ulster, Chairman of the DTI's Foresight Programme Energy Futures Task Force; Dr. Tom Huntingdon of NERC; Professor Bruce Sellwood, Head of Dept., Postgraduate Research Institute for Sedimentology at the University of Reading; or Professor Max Coleman of the same department. For an industry view you may wish to contact Mr. Francis Harper, Manager of Reserves and Resources, BP, Sunbury; Dr. Michael Smith, independent consultant; or, for an informal but informed opinion, Mr. Chris Skrebowski, Editor, *Petroleum Review*, the Institute of Petroleum.

For reference, I enclose our submission to the PIU, and a more concise submission we made recently to a committee of the House of Commons. ODAC would be happy to make a presentation to your office, if this were thought useful.

Additionally, or alternatively, your office may wish to appoint, on a temporary basis, one or two competent people, preferably a scientist and a petroleum geologist (where it would perhaps be better if the latter were drawn from one of the UK independents, or a technical consultancy) to examine the various analyses that exist, both from the exploration geologists, and from the economists. A good initial technical understanding of these analyses could be obtained in just few days.

The misunderstanding on security of supply in the PIU Energy Review is very serious, and needs correction. It is too late to influence what is in the report, so, in our view, it is essential that the forthcoming Energy White Paper include provision for assembling a qualified group to examine the serious near-term risks to global hydrocarbon supply in a sound and quantitative manner.

Yours sincerely,

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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