The Oil Future – A Very Different View

*By Roger W. Bentley**

At a recent BIEE two-day Academic Meeting in Oxford the opening speech was given by Lord Lawson, former UK Secretary of State for Energy, and subsequently Chancellor of the Exchequer. In his speech Lord Lawson dismissed the current predictions of oil shortage as scare-mongering. The meeting's closing summary appeared to go further, drawing on the work of Lynch and others to wonder if energy resource scarcity was itself a valid concept.

A group of us at the University of Reading hold a very different view. This letter explains why, and indicates how the use of public-domain data can illustrate the reasons for concern.

The key current prediction is that by the IEA, of a resource-limited decline in the production of non-OPEC oil in the near-term. We have looked at the underlying model and data for this prediction in some detail, and think that it is correct. If OPEC decide not to raise production significantly, as may be the case, the threat of oil shortage looks certain.

Lord Lawson argued strongly against such 'gloom & doom' forecasts, and Mike Lynch lent credence to this position by showing a wide collection of forecasts that had badly underestimated oil supply. What his work did not show, however, is how these forecasts were made. Some forecasts have been deliberately conservative, perhaps to predict minimum income streams, etc., while others almost certainly have extrapolated from proved rather than probable reserves.

A technique that does give good predictions of peak is that by Hubbert, where this predicts decline from the mid-point of the resource. Our appraisal of this model, both theoretically and in terms of its past performance, has shown it to be a good approximation. However, with public domain reserves generally low and unreliable, industry data are required; estimating the remaining resource base by adding yet-to-find (derived from the probable find history) to the probable reserves. Lynch, perhaps unintentionally, brought out this need for good data, quoting Campbell's 1991 prediction for the UK, but omitting to mention this was skewed by the use of the UK proved reserves of 4 Gb, rather than the probable reserves which were twice this.

Some analysts, understandably, are unhappy with a model for oil peaking that does not explicitly include price or technology. This view is reasonable, but has two answers.

The first is that price and technology are in the model, if only implicitly. The resource estimate includes all oil found to date, and thus includes that discovered during the years of high prices following the '73 shock. And the yet-to-find is based on the assumption that the price will be high enough to generate large numbers of new exploratory wells. From the point of view of technology, experience shows that once fields have seen secondary recovery, the *rate* at which oil recovered by tertiary techniques can be brought on-stream has little effect on peaking date.

The second answer supporting a simple model lies in the recognition that the main hindrance to accurate world oil modelling is the unreliability of the basic data, rather than the subtlety of the model. Poor data, for example, applies to the United States, bedevilled by reserves growth confusions; and to the FSU and the Middle East where the oil mostly lies, but where the data are especially problematic. Good modelling requires both a consistent data set, and calibration of the peaking point against the historical data.

Of course, if one is looking at a region where the data, including costs, are good, one would chose to make predictions of peak using the sort of detailed model reported by Professor Kemp for the UK. But even with this level of detail, the results show that while changing the variables significantly changes the shape of the decline, the *date* of UK peaking varies little as a function of the assumptions.

We can illustrate the different oil forecasting techniques by looking at the case of the UK.

Oil production forecasts for the UK, made between 1981 to 1993, have been quoted elsewhere by Lynch. The earlier of these were certainly on the conservative side, missing completely the major upturn in the early '90's. (Later forecasts also appear conservative, but this may yet have more to do with the timing of production, than the total production forecast.) At the BIEE meeting, the failure of these early forecasts seems to have convinced many analysts of the impossibility of forecasting oil production.

But how would a mid-point resources model have predicted production ? The UK government's 'Brown Book' contains contemporary estimates of the total original oil resource, and if probable estimates are used, at no point over the period would a mid-point calculation have shown a resource-limited peak to be at hand. For example, in 1986 which looked as if it might be peak, the probable resource stood at 29 Gb, while cumulative production was 7 Gb. On this basis, not only was 1986 clearly not the peak, but the mid-point argument would have indicated that peak would not come until nearly the year 2000. Today, with the Brown Book mean resource estimate at 38 Gb and cumulative production at 17 Gb, the peak looks imminent.

For countries that have gone over peak the general validity of the mid-point approach can be demonstrated by simply plotting their production histories. The classic 'single-peak' countries to look at are Austria, Germany, Trinidad, and, of course, the United States. The plot of the latter indicates that the United States has now burnt about three-quarters of its conventional oil, underlining the seriousness of the problem.

For more complicated 'multi-peak' countries, a history of when the major fields were found is needed. With this available, it becomes clear that groups of oil finds lead to later oil peaks. Indeed, it is this fact that the bulk of the oil is always found well before peak that makes predicting the peak largely deterministic. For example, the bulk of U.S. oil was found by 1930, with peak not occurring until 1971; while in the UK the majority of the oil was found before production even started.

Conversations at the BIEE showed that most analysts understand that the UK is a mature province, where peak is not far off, and where higher price and better technology will undoubtedly help the decline, but cannot shift the peak date by much. What is missing, at least with these analysts, seems to be an appreciation that *most of the world is just like the UK*,

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mature places where peaking is not far off. One has to talk to the geologists to understand that most of the world has now been explored, and most of the, at least medium-term, oil already identified. And while no one is going to defend the Hubbert technique as absolutely precise, in terms of predicting the future from the information to hand, it is an immensely powerful tool. Without it, one wanders blindly in a country inhabited by those for whom R/P ratios, and the view that it is all 'too difficult to model', are the only perspectives.

Now let us turn to the IEA's specific prediction: that non-OPEC output is close to decline.

Here again we can start with the presentation by Lynch. This included the observation, originally by Mitchell, that oil output from the 'Rest of the World' (RoW), i.e., the world excluding OPEC, the United States and the FSU, has risen steadily for many years. This is certainly correct; RoW output has grown from about 10% of world output at the first oil shock to about 40% today. Lynch's implication, however, is that RoW output will continue to grow for a long time to come.

Once again the answer can be illustrated with simple production data, for example from the BP-Amoco *Statistical Review* diskette. Production data, since 1965, should be plotted by country or group on an 'area' graph, plotting vertically up the page: United States, Canada, China, Mexico, UK, Norway, other RoW, FSU, OPEC outside Middle-East, and OPEC Middle East. It helps to use thick lines to visually group: USA + Canada, RoW, FSU, and OPEC.

The growth in RoW output, mentioned above, at once becomes apparent. And one is then in a position to enter predictions for future trends in the world's oil sources and sinks. The USGS confirms that the U.S.'s downward trend will continue; Professor Kemp (or UKOOA, or the DTI) can be asked about the UK trend, the NPD about Norway, and Pemex about Mexico; while China is already an increasing sink. This exercise, of course, does not *prove* that the whole of non-OPEC will soon go over peak, which depends on detailed modelling, including the FSU, but does give a picture of why this should be the case.

Finally then, we come to our views about the implications of all this.

Lord Lawson defended the philosophy that energy should be treated as a commodity. It is true that these days most analysts would support policies that remove the dead hand of government, and allow industry to show its initiative. Everyone also now recognises that there are many other sources of energy out there. The problems, therefore, as we see them, are two-fold:

- In the main, these other energies are more expensive than to-day's oil or gas, and some at least can only come to market rather slowly. Thus, as conventional oil gets scarce, and gas prices rise in sympathy, the old evils of world inflation and recession will re-appear. The effect on oil-poor developing countries will be especially severe.
- Markets do, of course, respond to signals, but oil and gas supply two-thirds of our energy; energy markets are price-volatile, and the time lags for significant structural changes are long.

As we adjust to the new realities, it looks like a very bumpy ride.■

A Debate on Global Warming Science with a Startling Conclusion on the Kyoto Protocol

*By Gerald T. Westbrook**

Although this meeting was held a year ago its subject and conclusions are still most timely. This debate[1,2] brought together seven, internationally renowned, global warming scientists and one prominent science and global warming writer, Dr. Richard Kerr of Science magazine, to discuss the science behind global warming. This group was fairly split between skeptics, neutrals and proponents as noted in Table 1.

Table 1

Scientists at the Houston Forum Global Warming Debate

Name	Affiliation and some comments
Proponents	
Dr. James Hurrell	National Center for Atmospheric Research, Boulder.
Dr. Jeffrey Kiehl	National Center for Atmospheric Research, Boulder.
Dr. Stephen Schneider	Professor, Environmental Biology and Global Change at Stanford University and a ubiquitous supporter.
Neutral	
Dr. Gerald North	Distinguished Professor of Meteorology and Oceanography; Head, Department of Meteorology Climate Research Project at Texas A & M.
Skeptics	
Dr. John Christy	U. of Alabama, Huntsville - Earth System Science lab. Key scientist for Satellite data base at NASA.
Dr. David Legates	Associate Professor, Southern Regional Climate Center, Louisiana State University.
Dr. Richard Lindzen	Alfred P. Sloan Professor, Massachusetts Institute of Technology and a pre-eminent opponent.

What follows are some highlights on the overall tone of the meeting. It was rather difficult for each scientist to make a concise and lucid presentation in the brief time available. What was achieved, however, was to see all of these individuals *in action* and to observe that a deep and complex debate on global warming exists. In the past the existence of a debate has been down-played, and skeptics have been depicted as few in number, negative, on the marginal side of the science and even a bit crazy. In contrast the skeptics came across as positive, brilliant, human and interesting. For example Dr. Richard Lindzen, of MIT, possibly the leading academician in the climate field and perhaps the world's most pronounced global warming skeptic, also teaches a course on American musical comedy. And Dr. John Christy, NASA and the University of Alabama at Huntsville, and one of the key driving forces behind the satellite based temperature data, is also a minister, a missionary in Kenya and a marathon runner. Dr Christy assured the students present that the

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current generation of climate scientists "will leave you lots of interesting problems to solve".

Although this meeting had separate segments on the measurement of temperature and on anthropogenic versus natural climate change, the audience might not have picked up that the global warming debate really centers on these two rather simple jobs – at least simple in concept. These tasks, namely the detection of a warming and an attribution of what is the source of that warming, need to be repeated over and over again along with the relative status of each task.

Temperature and Other Weather Data

Christy effectively defended the satellite based temperature record over the past ~20 years. Several adjustments have been identified. Media reports often seem to be presented in a fashion to convey that these corrections finally resolve major differences with surface based data, and as a result, we are left with the conventional wisdom that the world is warming. However, Christy was confident that the basic and major differences in temperature trends remain. These show the satellite data with a slightly negative temperature trend versus a positive trend for surface based data. This conclusion, he argues, is also supported by balloon data and a third source ... night marine air temperatures.

Christy also expressed concern on the recent flurry of reports on so-called extreme climate events as evidence of global warming. He noted that extreme weather events occur somewhere all of the time. This is a perfect situation for a politician who wants to get a photo op of his concern and involvement in this issue. As an example of this kind of hype, he cited the reports on the extreme drought in Texas this summer of 1998. He noted while Texas was very hot and dry this summer, the worst period by far was the 1930s. In that multi-year period drought existed all the way from Canada down to Mexico. He noted, in contrast, how Kansas this year has had bumper crops. In short the Texas summer of 1998 was entirely within the band of natural climate variation.

Christy concluded that climate is changing. It always has and always will. While a fraction of that change may seem to be coupled to human activities, no one knows how much.

Anthropogenic vs Natural Climate Change – the Signal-to-Noise Ratio

The problem of noise in the data and in the overall communications on this subject was noted. Dr. Lindzen commented that most of what the public knows about global warming does not come from the scientific community, but rather from advocacy groups such as the Union of Concerned Scientists, the Sierra Club and so on. And some people from such groups distort things.

Dr. Gerald North, from Texas A&M, noted that there are traps and minefields all over the detection endeavor and also political pressures in doing research on this subject. He felt that long-term climate simulations can help to understand the noise in the system. He introduced the radio analogy where you have a signal and lots of static. And that is what we have with climate research. He noted you are looking for very faint signals in a very noisy system. North commented on several climate signals as follows:

- he argued that the solar signal is not yet detectable,
- he noted that the volcanic signal is easily detected and
- he felt that the greenhouse gas and aerosol signals are detected, but each are large and are near canceling each other out so that their estimates are likely inaccurate.

He asked: "Is this status enough for use on policy analysis questions?" He answered his own question with a, "not sure ... maybe can do some things".

Lindzen noted that we are talking of very very small temperature changes. He suggested that natural climate variability needs a great deal more emphasis. He discussed four areas of natural climate variability that the large computer models do not pick up at all, or do so with insufficient details or accuracy. The El Niño is the best known example of such natural climate variability.

He reported a problem today with the testing of the large computer models of the climate. He sees a circular trap. Today we use estimates of the natural climate variability, obtained from very long term runs of a model, to test the model. He argues this approach is "on pretty shaky grounds". Lindzen also noted that the aerosol forcing may be uncertain by as much as a factor of ten.

Conclusions

The seven scientists were asked at the end of the session if they could, *would they sign the Kyoto treaty? Six of the seven scientists said no.* Dr. Stephen Schneider voted yes as did the science writer, Richard Kerr. Gerald North voted no, a change from his prior position. This change was based on a recent paper[3] by Tom Wigley, National Center for Atmospheric Research, and a noted proponent in his own right. Wigley's conclusions from his latest model runs found the Kyoto protocol, if fully implemented by all involved nations by 2010 (an event that would be extremely unlikely), *would reduce warming 0.07 ºC by 2050 and 0.2 ºC by 2100.* In short *the influence of this protocol would be undetectable for many decades.* Dr North indicated that "six months ago I would have signed". "Now, I would not put the world through all the discomfort" for such a tiny savings.

Of the several questions fielded two were of particular interest to this observer. The question was raised as to where did the money come from to conduct this research. The panelists answered, randomly, with names like EPA, DOD, NOAA and finally NASA. I kept waiting to hear the words *the American tax-payer*, but they never came. The second question was from a student seeking guidance on what his generation should do in planning for the future. Dr. Christy suggested you need to learn how to think, and also to find out why other people think the way they do. You need to ask yourself where is the data they are using coming from and what kind of agendas may be behind those sources.

Let me build on this a bit by expanding on the radio analogy, the *signal-to-noise ratio* noted earlier. Students, indeed all of us, are besieged with thousands of messages every day from TV programs, movies, video tapes, radio, TV ads, tele-marketers, newspapers, magazines, the Internet, political pitches, political spin, peers, peer groups and so on. This writer wrote a paper about 15 years ago on what was termed the emerging communications revolution. While correct on the issue and direction, the incredible magnitude of this revolution was totally missed as the traffic volume anticipated has been totally eclipsed. Further the issue of message quality wasn't even discussed. We are living in a world today of very low signal to noise ratio. Hence students,

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