OIL & GAS MODELLING:
SOME 'PRE-DETERMINED' ELEMENTS AND BUILDING BLOCKS

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‘PROVED’ CONVENTIONAL OIL RESERVES

- **All the main sources – OGJ, IEA, OPEC, US-EIA & CIA, BP – overstate world proved conventional oil reserves.**
- **This is partly the result of five Middle East OPEC Member countries [Saudi Arabia, Kuwait, UAE, Iran & Iraq] having widened their ‘perception’ of proved oil reserves (those with a reasonable certainty of being produced – 90% or P90/1P) to probable and possible – 50% or less.**
- **These countries then grossly overstated their ‘proved’ reserves between 1983 and 1987 to secure a larger share of OPEC production quotas.**
- **These figures are unaudited, and accepted at face value.**
- **Reserves and resources data are subject to considerable uncertainty, but the standard public data sources listed above are clearly erroneous/misleading. [On the former point see John Mitchell: “Petroleum Reserves in Question”, Chatham House, 2004; on the latter Roger Bentley: “Global oil & gas depletion: and overview”, ‘Energy Policy’, 30 (2002), 189-205. The UK Energy Research Centre report: “Global Oil Depletion” (August, 2009) and its seven Technical Reports (July, 2009) are very thorough.]**

AND UNCONVENTIONAL OIL 'RESERVES' ARE THROWN IN TOO …

- Venezuela's 'proved' conventional oil reserves rose from 19,888 million barrels in 1981 to 24,900 in 1982; and then spiralled upwards to 54,454 million in 1985, to 72,667 million in 1996, to 99,377 million in 2007, to 172,323 million in 2008, and to 296,501 million in 2010.
- This increase of 276 billion barrels is far in excess of the 94 billion barrels contribution which BP, for example, notes includes the Magna Reserve Project in the Orinoco Belt – quoting OPEC's "Annual Statistical Bulletin", 2008. It is all 'heavy oil'.
- Canada's 'proved' reserves figure in successive BP Statistical Bulletins rose from 6.6 billion barrels in 2001 to 16.8 billion in 2003, to 27.7 billion in 2006, and 175.2 billion in 2011. The 2011 edition of BP's Statistical Bulletin had 32.1 billion barrels for end-2010. The 2012 edition has backdated all Canada's numbers, so for 1991 the figure is now 40 billion barrels, not the 8 billion barrels it had stood at for 20 years! The gap is explained by the inclusion of tar sands.

THE SCALE OF 'INCREASES' IN PROVED OIL RESERVES

- The five Middle East OPEC Member States have 'increased' their proved oil reserves by some 425 billion barrels since 1983.
- Venezuela and Canada, by including heavy oil and tar sands respectively, have increased their 'proved' oil reserves by some 445 billion barrels since 1981.
- Together these figures total 870 billion barrels.
- Some other OPEC Member States have increased their 'proved' oil reserves figures without firm evidence of corresponding finds and production evaluation: for example Nigeria (16 billion barrels since 1998); and Libya (19 billion barrels since 1999).
- Between January, 1984 and end-2011 OPEC Member States produced 267 billion barrels of oil.
- Few OPEC Member States reflect any historic production in reduced proved reserves.

CHANGES IN PROVED OIL RESERVES FIGURES FOR SELECTED COUNTRIES [OPEC DATA – MILLION BARRELS]

	1980	1984	1986	1988	2002	2011
Saudi Arabia	168,030	171,170	169,744	254,989	262,790	265,405
Kuwait	67,930	92,710	94,522	96,500	96,500	101,500
UAE	30,410	32,490	97,203	98,105	97,800	97,800
Iran	58,296	58,874	92,860	92,860	130,690	154,580
Iraq	30,000	65,000	72,000*	100,000	115,000	141,350
Venezuela	19,530	28,028	55,521	58,505	77,307	297,571**

* Increased to 100,000 in 1987. ** Increased from 99,377 to 172,323 in 2008.

OPEC CRUDE OIL PRODUCTION 1/1/1984 – 31/12/2011
(billion barrels)

SAUDI ARABIA	88
KUWAIT	20
UAE	25
IRAQ	20
IRAN	36
TOTAL OPEC	267

PROVED CONVENTIONAL OIL RESERVES – SOME PRELIMINARY CONCLUSIONS

- Some official figures are grossly inflated, for political/production reasons. This has been recognised by some senior former ARAMCO geologists, in PIW, and by Petroconsultants.
- The five Middle East OPEC Member countries selected increased their claimed proved conventional oil reserves figures by some 425 billion barrels between 1980 and 2011 (Libya raised its figure by 28 billion barrels in addition) with few new finds.
- Venezuela's figure explicitly now includes Magma Reserve heavy oil (over 94 billion barrels), but this fails to explain the country's claimed increase of nearly 280 billion barrels since 1980. Inclusion of Canadian tar sands pushed up the global figure from 2003 by 168 billion barrels (and the Canadian figure has been backdated -1991 now shows 40 billion barrels, not 8 billion).
- Production from the above reserves over the past 28 years for the five Middle East countries selected alone is 189 billion barrels.
- Thus the generally claimed proved reserves of conventional oil of 1,383 billion barrels at end -2010, and 1,653 billion barrels at end-2011, are likely to be overstated by over 900 billion barrels before past production not reflected in claimed proved oil reserves is deducted.

SOME IMPLICATIONS

- It is much too early to write off the 'peak oil' hypothesis as irrelevant or misleading.
- As the UK Energy Research Centre Report "Global Oil Depletion" (2009) concluded: "On the basis of current evidence we suggest that a peak of conventional oil production before 2030 appears likely and there is a significant risk of a peak before 2020." Other specialists have concluded that the peak has already passed.
- The right-hand side of the 'Hubbert' curve may well flatten as a result of non-conventional oil and gas production, and shifts in the transport sector and travel patterns, but this does not amount to a rejection of the 'peak oil' hypothesis.
- As pointed out as long ago as 1975 (and the subject of M. Al-Gamal & A. Myers Jaffe: "Oil, Dollars, Debt and Crises", 2010) oil price rises can quickly snuff out global economic recovery. The effect is non-linear (price rises have larger impacts than price falls, as James Hamilton has pointed out in "What is an oil shock?", Journal of Econometrics, 2003).
- The Energy Return on Energy Invested (EROI) has been in widespread decline in many locations, for oil and other fossil fuels, placing further pressure on availability and costs. [see David Murphy & Charles Hall, in Annals of the New York Academy of Sciences, 2011]

OIL AND GAS RECOVERABLE RESOURCES

- **There is no firm evidence that recoverable conventional oil resources exceed 2.4 billion barrels.**
- **Of this total just over 1.2 billion barrels have been used.**
- **Of the remaining 1.15 billion barrels, only 250 billion barrels can robustly be considered proved at the 90% level (not 1.38 billion).**
- **Non-conventional oil resources are huge.**
- **Heavy oil may have a 1.2 trillion barrel resource, though little more than 300 billion barrels have been judged to be recoverable. Venezuela already claims to have 278 billion barrels recoverable.**
- **Tar sands may have a 2.5 trillion barrel resource, of which little more than 300 billion barrels have been judged to be recoverable. Canada already claims to have 168 billion barrels recoverable.**
- **Oil shale may have a resource of 3.5 trillion barrels, of which some 600 billion barrels may be recoverable. As with the other forms of non-conventional oil, high costs and environmental impacts are involved.**
- **And there is gas …**

GAS RESOURCES

- Conventional and non-conventional gas resources are huge – the IEA estimates more than 300 times the current annual use of gas.
- Recent excitement over shale gas tends to obscure the fact that shale gas was first exploited in 1821, and estimates of this resource have hovered around 2 trillion barrels of oil equivalent for over a decade, with recovery some 500 billion barrels.
- There is considerable uncertainty about precise recovery because (a) there is controversy over the recoverable quantities from Bakken, and even Marcellus, shale in the USA; and (b) there appears to be widespread reluctance in many other industrialised countries to exploit their shale gas resources, with water pollution, use of hazardous chemicals, earth tremors and CH4 leakage quoted.
- There is great interest in exploring for shale gas offshore in several parts of the world.
- Coal bed methane has major supply potential (up to 250 billion barrels of oil equivalent). Gas to liquids also has interesting potential for transportation.

THE TRANSPORTATION SECTOR

- The demand for oil in the transportation sector is slowing in some industrialised countries, and in a few shows evidence of decline. Vehicle miles travelled per capita in the USA peaked in 2004, and there has been similar evidence in some European countries. Higher costs of fuel and vehicles, some policy initiatives, and possibly some lifestyle considerations are believed to underlie this.
- Electricity generated from gas may provide a boost for electric vehicles, but this will take a long time to achieve in terms of making a large impact on the stock of motor vehicles, and will require heavy infrastructural investment in recharging facilities.
- Countries outside the USA may wish to note that whereas coal accounted for 52% of electricity generated in the USA in 2006 that figure is expected to drop to 37% in 2012.
- However, petrol and diesel still account for over 92% of energy used in global transportation, and fuel efficiency has been rising in recent years.
- And although urbanisation is proceeding apace around the world, there are still large numbers of rural dwellers whose needs are unlikely to be met by public transport, or reflected in 'intelligent transport systems'. The 'municipal agenda' favoured by many present-day politicians does not go down well in the country, where 4X4s are essential under some prevailing weather/road conditions.

OTHER OPTIONS & ISSUES

- RENEWABLE ENERGY SOURCES – fashionable, should avoid carbon emissions, and are claimed to have huge potential, amply able to supply global requirements for modern energy services. In fact their low power densities (see Vaclav Smil) are a severe constraint, as is the intermittency of wind and the constraints of poor solar insolation. The performance of wind energy developments is frequently subject to gross exaggeration and false statements. Solar PV is focussed upon, whereas the huge technical potential over large sub-tropical areas is CSP + UHVDC transmission, provided socio-political stability prevails. Estuarine barrages usually destroy the local ecology (La Rance, for example). Wave power in some locations will do little harm, but also not contribute much. Tidal stream can contribute – but in only a few locations. Use of first-generation biofuel technology has had harmful consequences, and its potential very limited. Second-generation biofuel technology would also fall far short of needs – current research suggests only 3%-5% of EU needs would be met (IIASA). Policies and Planning Inspectors that back the simple burning of palm oil (as under UK 'Planning Guidance') should be stopped.
- NUCLEAR POWER – in the wake of the Fukushima hysteria (and TEPCO incompetence), Germany may not be alone in swinging from nuclear to the regeneration of coal, but why not consider thorium – which is safer and more abundant than uranium?
- FINALLY – what action will be taken on emissions "embedded" in imports, and with what implications? The UK claims to have cut carbon emissions 20% since 1990. In fact they have risen 20% if "embedded" emissions are included. Many other industrialised countries have also greatly increased their imports from China and India.

IN CONCLUSION

In modelling, as in every other activity intended to focus upon possible futures, let us acknowledge:

"Those who foretell the future lie, even when they tell the truth."

(An ancient Chinese saying)

"What shape would you like your locality to be in when petrol becomes very scarce and the renewables can't substitute for it?"

(Ted Trainer: "Renewable Energy Cannot Sustain a Consumer Society")