The Global Energy Market in the Long Term

By Peter Odell
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Theme: Oil and Energy

Global Research Editor's Note:

In the context of "Peak Oil" and with a view to encouraging debate, we bring to the attention of our readers this carefully researched analysis by Professor Peter Odell.

The geopolitical, strategic and economic implications of the US led war in the Middle East and Central Asia should be addressed in relation to the relative importance of natural gas, and gas pipeline routes.

In this regard, the former Soviet Union and the Middle East, according to figures quoted by Professor Odell has 74% of known reserves of natural gas.

The Anglo-American oil giants, supported by the US-UK military coalition vie to establish control not only over these reserves but on pipeline routes and transport corridors out of the region. BP, Chevron-Texaco, Exxon-Mobil and Shell supported by the Anglo-American military coalition are clashing with the Russian oil and gas conglomerates as well as with Europe's oil giant Total-Fina-Elf and Italy's ENI, which have sizeable interests in the region.

Michel Chossudovsky, December 2004

The Global Energy Market in the Long Term:

The Continuing Dominance of Affordable Non-Renewable Resources

Regularly recurring fears of impending scarcity of non-renewable energy have, as previously shown, all proved to be groundless. [1] Nevertheless, the issue of the world's potential supplies of coal, oil and natural gas seems to remain one of concern, reflecting humankind's continuing over-whelming dependence on them for its energy needs. This concern is, however, misplaced in the light of recent important changes on both the supply and demand sides.

The Demand for Energy

Since 1973 the rate of increase in the global use of energy has, as shown in *figure 1* , reverted back to its long-term 1860-1945 trend of only about 2 per cent per annum, compared with the +5 per cent per year growth rate which occurred from 1945-1973. The probability of a future return to the latter 28 year much higher annual rate of growth is now close to zero, given that it reflected an inherently temporary combination of a set of conditions which cannot reoccur. [2] Thus, a realistic consideration of long-term energy supply requirements has now to be orientated to a modest growth rate in use, even without taking into account the impact on non-renewable energy consumption of the recently enhanced concern for environmental questions and the now accelerating pace of growth in the use of renewable energies, emanating from rapidly evolving technologies of direct and indirect solar energy production.

Thus, the long-term future availabilities of fossil fuels must be put in the context of a maximum 2 per cent per annum growth as the highest likely requirement. Moreover, the year 2000 base from which we can now consider 21st century hydrocarbons' demand is very much lower than the conventional and widely accepted forecasts of 30 years ago indicated would be in the situation. Oil production, for example, will this year be about 3.7 Gt compared with expectations in the early 1970s of over 19 Gt. [3] Likewise, the cumulative use of oil 1971-2000 has been only a little over 100 Gt, compared with the close to 240 Gt anticipated. Thus, much more of the oil discovered before 1970 still remains to be used in the 21st century. Likewise for coal and gas, albeit to a lesser degree, so it is hardly surprising that views on the future availabilities of fossil fuels' resources and the supply potential associated with them can now be so very much morec relaxed that they were in the 1970s.[4]

Global Energy Production

Figure 2 shows a trend in the annual production of energy supplies by source through the 21st century – in response to energy demand growth that is sustained at +2 per cent per annum. Non-renewable energy sources can be seen to remain dominant until 2060. Alternatives to fossil fuels do not exceed 20 per cent of energy supplied until then, while it is 2079 before they account for 50 per cent of supply. Even cumulatively, over the century, as shown in *figure 3* – renewable energy sources supply only 35 per cent of total energy used and of this almost two-thirds is supplied in the last two decades. Unless and until the governments and peoples of the world not only accept the desirability of a much faster switch to renewable energy, but also take the necessary steps to implement the change, global energy use in the 21st century will remain heavily orientated to a combination of coal, oil and natural gas. As there are, to date, no serious signs of these conditions for change being met, global energy markets can be predicated to remain dominated by non-renewable resources for decades into the future.

Table 1. Global Rank Ordering of the Ten Leading Countries' Coal Reserves and Production, 1998. Reserves Production Country Share of Global Reserves Cumulative Reserves' Share Country Share of Global Production Cumulative Production Share USA 25.1 25.1 China 28.0 28.0 Russia 15.9 41.0 USA 26.4 54.4 China 11.6 52.6 India 6.6 61.0 Australia 9.2 61.8 Australia 6.6 67.6 India 7.6 69.4 South Africa 5.3 72.9 Germany 6.8 76.2 Russia 4.7 77.6 South Africa 5.6 81.8 Poland 3.4 81.0 Kazakhstan 3.5 85.3 Germany 2.7 83.7 Ukraine 3.5 88.8 Canada 1.8 85.5 Poland 1.4 90.2 Ukraine 1.8 87.3 Next 20 Countries 6.6 Next 20 Countries 10.2

Coal's Relative Unimportance

Nevertheless, for both economic and environmental reasons, the future pattern of non-renewable energy supplies will show marked changes from the contemporary situation, while the present quite widely-accepted conventional wisdom of constrained supplies will be seen to be based on misconceptions concerning potentially available resources. [5] These usually indicate coal resources as an order-of-magnitude greater than those of oil or gas and thus implicitly or explicitly assume that coal must become, at least, more important than oil and gas and, most likely, the dominant component in the 21st century fossil fuel supplies. [6] Given coal’s general lack of acceptability and, even more so, as shown in *table 1*, its highly geographically concentrated global patterns of both reserves (almost 53 per cent in only 3 countries and over 90 per cent in 10 countries) and production (54 per cent in merely 2 countries and 91 per cent in 10 countries) this prospect is very unlikely. Even an earlier small likelihood of coal as “the fuel of the 21st century”, in the aftermath of the oil price increases of the 1970s, [7] has now been undermined by a combination of local, regional and global environmental concerns over coal production and use. Instead, as shown in *figure 2* , coal’s share of global fossil fuel production fails to increase over the century. It makes a 21st century contribution of only just over 25 per cent to cumulative non-renewable energy use (*figure 3*).

It is thus oil and natural gas which must, between them, continue to supply the bulk of the world’s energy supply – at least until the 2060s – and consequently have to have an overall three-fold increase in their joint contribution to the annual supply of energy in the 21st century (see *figures 2 and 3*). Their relative contribution to the total hydrocarbon’s supply does, however, change very radically, as shown in *figure 4* . As will be demonstrated later in the paper, this change is, in part, a function of possible long-term constraints on oil supplies and, in part, a reflection of the inherent advantages for natural gas in respect of both supply and use considerations. Natural gas supplies are thus indicated to continue to expand to 2090, when global production is predicated output 5.5 times its year 2000 level. On the other hand, as oil’s output is anticipated to start slowly declining from the 2050s, its contribution to the total hydrocarbons supply ultimately falls from its year 2000 contribution of 65 per cent to 44 per cent by 2050 and to under 29 per cent by 2100 (see *table 2* and *figure 4*). Over the century as a whole, its share of the cumulative use of 1256 Gtoe of hydrocarbons is, at 540 Gt, only 43 per cent (see *table 3*).

Table 2. The changing contributions of oil to the total supply of hydrocarbons, 2000-2050 and 2010 (Gtoe). Period Total oil and gas supply Total oil supply Oil as a share of the total 2000 5.84 3.79 64.9 2010 6.95 4.43 63.4 2020 8.24 5.17 62.7 2030 10.58 5.76 54.4 2040 12.85 6.28 48.9 2050 14.86 6.54 44.0 2100 15.45 4.45 28.8

Table 3. The cumulative contribution of oil and natural gas to the energy supply in the 21st century. Period Cumulative oil and gas (Gtoe) Cumulative oil (Gtoe) Oil’s share of cumulative total (%) Pre- 2000 176 120 68.2 2000-2009 66 42 63.6 2000-2019 143 90 62.9 2000-2029 237 147 62.0 2000-2039 355 210 59.2 2000-2049 495 276 55.8 2000-2059 647 341 52.7 2000-2069 806 403 50.0 2000-2079 943 440 46.7 2000-2089 1108 493 44.5 2000-2099 1256 540 43.0

Natural Gas: the Fuel of the 21st Century

Natural gas will overtake coal as a global energy source in the 2020s. Its rapidly expanding production in recent years reflects the more than doubling of proven global gas reserves since 1980 and the expansion of European and other markets for gas over the period since 1990. It thus enters the 21st century with an R/P ration in excess of 60 years, so that the expansion of production in the early decades will continue to be demand limited, rather than resources-related. Indeed, the reserves of already discovered fields could in themselves serve to keep global gas production growth at 3+ per cent per annum until 2025, location and demand permitting. But the continuation of large additional discoveries is a certain prospect, given the geographically broadening base of exploration activities and the continuing opportunities of the more intensive exploitation of existing gas-rich provinces, including some hitherto thought to be well matured (eg in the Gulf of Mexico and the North Sea). The mid-point of a range of estimated additional reserves (from 197 to 303 Gtoe) indicates a volume about 30 per cent greater than that of gas used to date plus currently proven known reserves. These data, regionally defined, are set out in *table 4*. The indicated proven plus additional reserves are sufficient to support the conventional gas production curve set out in *figure 5a* .

Table 4. World Gas Reserves and Resources by Region (Gtoe). Conventional Gas Non-Conventional Resources Region Production to 1999 Remaining Proven Reserves Estimated Additional Reserves Coal-bed methane, tight formation gas, gas from shales and gas remaining after conventional production Gas Hydrates and Geopressured Gas North America 26.9 7.5 30-53 22 6,100 Central and South America 3.0 5.6 7-22 91 4.571 Europe (excluding FSU) 7.3 4.7 5-14 36 765 Former Soviet Union 16.1 51.0 95-110 159 4.208 Middle East 3.9 44.6 28-50 99 203 Africa 2.1 9.3 5-14 29 383 Asia/Pacific (excluding FSU) 3.6 9.2 25-41 203 2,528 Total 62.9 131.9 197-303 837 18,758

Source: H-H Rogner: An Assessment of World Hydrocarbon Resources, IIASA, 1996. BP Amoco: Statistical Review of World Energy, 1999. Author's estimate of 1999 production.

Superimposed on the 200 years curve of conventional gas supply shown in *figure 5b* is the complementary production curve for the supply of non-conventional natural gas. This is assumed to begin in 2020, with the shape of the curve emerging from the depletion of some 650 Gtoe of the estimated ultimately recoverable reserves of 837 Gtoe, as shown in hydrates, the energy value of which is tentatively estimated to be some 30 times greater than all other non-renewable resources taken together. [8] Even without taking any of this potential from gas hydrates into account, non-conventional gas production starting in the 2020s seems likely to become the more important component in global total gas supply within 50 years and, thereafter, its production can continue to grow beyond the end of the 21st century. Natural gas overall in 2100 is predicated to supply over 50 per cent of the year's non-renewable energy production (see *figure 2*) while, over the 21st century as a whole, it supplies about 41 per cent of the cumulative total of non-renewable energy (see *figure 3*).

Gas will thus undoubtedly be the fuel of the 21st century (as coal was of the 19th and oil of the 20th), even within the framework of the limiting assumptions on gas resources' exploitation as specified above (viz. the exploitation of only 75 per cent of ultimately recoverable non-conventional gas and no gas at all from gas hydrates). These limitations do, indeed, inhibit the ability of gas supply to grow sufficiently post-2060 so as to sustain a 2 per cent per annum expansion in overall non-renewable energy use. The "shortfall" in supply rises from zero in 2060 to 320 Gtoe in 2100 and, as can be seen in *figure 2* , it leads to a rapidly rising supply of alternative energies during the last quarter of the 21st century. There seems likely by then, however, to be a better than 50 per cent probability for additional gas supplies from the initial exploitation of gas from hydrates. Sixty more years of continuing scientific advances and engineering capabilities would seem to provide time enough to enable a small part of that massive potential source of energy in the form of the world's preferred fossil fuel for both commercial and environmental reasons, to be brought to the market; and so take care of the "shortfall", assuming, of course, that the exploitation of gas hydrates are then able to compete with the alternatives of renewable energies.

Oil's Relative Decline in Importance

The future for oil lies squeezed – to a greater or lesser extent, depending on environmental and economic considerations – between the prospective solidity of 5-8 Gtoe of annual – global coal supply, on the one hand, and the dynamics of the 21st century gas industry, on the other. Oil's future thus seems likely to be essentially demand-side limited, so that potential supply-side (= resources) limitations represent only a top-end-of the-range prospect. This is shown in *figure 6a* in which the production curves indicate most of the 200 years' period of actual and potential oil supply from 1940-2140. Conventional oil is, of course, already well into its life cycle, but nevertheless, it still has +30 years to go to reach its production zenith at ± 4.36 Gtoe in the early 2030s (compared with 3.3 Gtoe in 2000) when about 240 Gt of such oil will have been used. Thereafter, the eventual depletion of the remainder of the presently estimated ultimately recoverable reserves (URR) of conventional oil of 410 Gtoe (= 3005 × 109 barrels) will take another century. This figure of conventional oil's URR is close to the year 2000 value of the calculated upward trend, based on 33 estimates over the past 50 years, [9] of the conventional oil resource base as presented to the 1997 World Petroleum Congress. It is also very close to the mid-point of Shell's 1995 presentation of an estimated 2675 to 3275 billion barrels range for ultimately recoverable conventional oil. [10] These data are shown in *figure 7* .

By contrast, non-conventional oil production has barely started. It is now being developed more rapidly but, using a conservative assumption of only 3000 × 109 barrels of recoverable reserves (within a resource base many times larger), it will, under restraints imposed by costs, environmental and demand considerations, take 80-90 years to reach its potential peak production (see *figure 6a*) at a level which seems likely to be a little lower than that reached by conventional oil in the 2030s. As in the case of conventional and non-conventional gas, however, the two types of oil, though designated by the nature of their occurrence, are essentially complementary in respect of satisfying market demand. Customers are indifferent as to the sources of the crude oil from which their demands for products can be derived; their interests lie only in the utility to them of the oil products they need. Thus, *figure 6b* shows the production of both types of oil in an integrated way. From 2000 to 2030 conventional oil accounts for only about 12 per cent of total supply, so merely modestly supplementing increasing availabilities of conventional oil. Thereafter, its relative importance to total supply rises sharply; and by 2060 it becomes the more important component in overall supply. Oil supply in 2100 is predicated to be over 90 per cent non-conventional. The near-100 year period suggested for the full change from conventional to non-conventional oil can be interpreted as reflecting a slow, but continuing, process, based on the joint influences of economic considerations and technological developments.

The oil component in the 21st century's energy production potential is, however, by no means a small or short-lived one. The supply increase shown for the first half of the century is at a rate made possible by already known reserves, reserves appreciations and new discoveries of conventional oil, plus the steadily rising flows of non-conventional oil. Nevertheless, the peak of production in about 2060 may be seen as both later and lower than it would otherwise have been in the absence of competition from other energy sources. As a consequence of this increasing competitive tendency in the first half of the 21st century, the decline rate of oil supply after 2060 is relatively slow. Thus, even in 2100, as shown in *figure 6*, an oil industry which is still larger than that of 2000 can be predicated. By then, however, in the context of potential resources' limitations and the likelihood of intensifying competition from other energy sources, oil will contribute, as shown in *figure 2* , rather less than coal to global energy supply: while it will, of course, have become less important than natural gas since as early as the late 2030s (see *figure 4*). Oil's geopolitical importance will undoubtedly continue into the early decades of the 21st century, but, thereafter, it really will become just another energy source of steadily – decreasing importance in the world's energy demand: and, moreover, one which is available from a broader geographical diversity of locations than hitherto.

Trends in Production Costs and Prices

In this paper implicit references have been made to trends in costs and prices, but these observations do need to be brought together into an integrated overview as questions of production costs and of returns on investment constitute a central set of parameters in resource evaluations. No significant differences can emerge in the context of competitive markets between the alternative resources – or between regions – except as temporary phenomena. When such divergences do emerge they inevitably lead either to compensating changes in supply schedules, so that the equilibrium is reestablished, or to the need for subsidies or other protective measure to sustain expensive production. Contrasting transportation costs in getting production to markets (as, for example, between oil and gas) produce contrasting netbacks for different fuels in the same regions and between regions for the same fuel, but in a macrostudy of the overall global situation over a long period of time, these contrasts seem unlikely to mount to much more than fine-tuning elements in the global energy system.

The starting point of this long-term study of the future availability of coal, oil and natural gas is the declaration of proven reserves for each fuel. Such declarations are, by definition, of reserves that are economic to produce at current levels of costs and prices. As the total quantity of the reserves declared is much more than adequate to serve the world's slowly expanding energy markets, then competition will keep prices from escalating in real terms. Of course, in the past decades traumatic events, such as US oil import quotas in the 1960s and 1970s and supply limitations imposed by OPEC and others in the 1970s, 1980s and over the past year, have upset the equilibrium from time to time. Similar events will – undoubtedly occur in the future, but they cannot be forecast and, therefore, cannot be taken into account in an attempt to predict overall long-term cost and price trends.

The potential supply schedule forecast for oil – for long the price leader in the fossil fuel market – suggests little or no pressure of demand on supply for at least the next 20 years. For this period there is thus no reason why oil prices in real terms should rise much and no reason why any significant volumes of reserves of oil, gas or coal which involve higher costs should be produced. The interquartile average annual price range of $16.85 to $19.50 per barrel for internationally traded crude oil over the past 15 years seems to indicate the most likely price of oil for the medium-term future. Technological developments have already brought production costs down in many areas of production (Econ Centre for Economic Analysis, 1997), and this process can be expected to continue.

Sometime in the 2010s, however, upward price pressure on the oil market seems likely as the attempt to maintain growth in the production of conventional oil leads to a requirement for higher investment costs. An increase of 10-20 per cent in unit exploration or development costs will then be confirmed by the required new and heavy investments in the first substantial exploitation of non-conventional oil. Such cost increases will be passed through into the general level of prices. The equilibrating price of $17-20/bbl of oil in the meantime thus seems likely to be converted by 2020 to $ 19-24/bbl (in 1999 dollars). At this modestly higher real price level, the requirement for the highest cost oil producer to sell into the market and earn sufficient profits will be satisfied. Neither gas nor coal seem likely to “need” the price increase, but the producers will accept it as a means of enhancing their rate of return on investment. In the case of coal, such price rises could enable the industry to absorb the relatively higher carbon taxes to which coal by then seems certain to have become subject. Equilibrium in the global energy market will thus be maintained in a – situation in which alternative energies will, in general, still require a subsidy and so be unable to bring downward pressure to bear on prices (World Energy Council, 1997).

The next likely future price crunch, when upward pressures generated by relative scarcity again exceed the downward pressures engendered by technology, will emerge as conventional gas output approaches its period of maximum production in the 2040s. By then gas will have overtaken oil as the world’s single most important source of energy and will thus also have become the price leader in the global energy market. In order to sustain the growth of the industry into a period of the profitable exploitation of non-conventional gas, a further modest price increase (in real terms) will then be required to generate the higher level of investments in exploiting such gas. This could take the oil equivalent price to a level of $21-26/bbl (in 1999 dollars).

By that time, however, yet higher taxes on the use of coal for environmental reasons will be tending to price the fuel out of many disparate geographical markets. Technological improvements in coal production, notwithstanding, coal will not have the ability generally to influence energy prices, although it may still exercise downward pressures on energy prices in a limited number of coal-rich and coal-dependent countries. Oil will also have become largely a price taker – rather than a price maker – and the industry will be anxious to benefit from the revenue flows generated from the upward movement of gas prices, in order to secure sufficient returns for financing investments in the further expansion of non-conventional oil production. Likewise, the rapidly expanding delivery of renewable energies will benefit from the upward price movements in the market as the high prices will enable governments to reduce or even eliminate the subsidies hitherto required for sustaining the growth of the industry.

From 2040 to 2060, as the supply of fossil fuels becomes increasingly orientated towards natural gas, global energy supply seems likely to enter the age in which gas supply and users’ technologies are honed towards “perfection”, so that costs do not rise in real terms. Gas prices also seem likely to be stabilised by the sharpening competition created by the lower real costs of delivering renewable energy supplies under conditions of increasing economies of scale.

From 2060 this paper has suggested that increases in the supply of gas may fail to reach the level required to sustain an annual growth of 2 per cent in the supply of fossil fuels. Cost increases required to maintain gas production at the high global level then achieved may become a problem, with particular respect to the exploitation of gas hydrates. Whether or not such cost increases will become significant before 2100 is impossible to judge. Even if they do, there is, however, no certainty that they could be passed on in higher prices as the improving economies and technology of energy supplied by renewable energies could by then be setting the general price level. Nor is it impossible that the very large resources of relatively low cost coal remaining in 2100 may finally become a replacement fuel. This could result either from the failure of global warming to occur (so that CO2 emissions are no longer considered a problem), or from the emergence of technology which enables coal to he used in a way which is environmentally friendly. [11]

Indeed, by the end of the century, in the context of technological progress, it is a fall in the real costs of supplying renewable energy that seems more likely than a situation of increasing costs. If so, then this will bring downward pressure to bear on the prices indicated above for fossil fuels. Such a development could, conceivably accelerate their already declining contribution to world energy supply, as they become unable to compete effectively in the market-place.

Are Oil and Gas Fossil Fuels?

Finally, a word of caution on the essential fragility of a study on the very long-term future for the world's energy supply which accepts without question the validity of the original 18th century hypothesis that all oil and gas resources have been generated from biological matter in the chemical and thermodynamic environments of the earth's crust. There is an alternative theory – already 50 years old – which suggests an inorganic origin for additional oil and gas. [12] This alternative view is widely accepted in the countries of the former Soviet Union where, it is claimed, "large volumes of hydrocarbons are being produced from the pre-Cambrian crystalline basement". [13] Recent applications of the inorganic theory have, however, also led to claims for the possibility of the Middle East fields being able to produce oil "forever" [14] and to the concept of repleting oil and gas field in the gulf of Mexico. [15] More generally, it is argued, "all giant fields are most logically explained by inorganic theory because simple calculations of potential hydrocarbon contents in sediments shows that organic materials are too few to supply the volumes of petroleum involved." [16]

The significance of the alternative theory of the origin of additional oil and gas potential is self evident for the issue of the longevity of hydrocarbons' production potential and production costs in the 21st century. Instead of having to consider a stock reserve already accumulated in a finite number of so-called oil and gas plays, the possibility emerges of evaluating hydrocarbons as essentially renewable resources in the context of whatever demand developments may emerge. If fields do replete because the oil and gas extracted from them is abyssal and abiotic (based on chemical reactions under specific thermodynamic conditions deep in the earth's mantle), then extraction costs should not rise as production from such fields continues for an indefinite period. Neither do estimates of reserves, reserves-to-production ratios and annual rates of discovery and additions to reserves have any of the importance correctly attributed to them in evaluating the future supply prospects under the organic theory of oil and gas' derivation. [17] In essence, the "ball park" in which consideration of the issues relating to the future of oil and gas has hitherto been made would no longer remain relevant.

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