OUTLOOK FOR ENERGY AND NUCLEAR POWER

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Since the first oil shock hit in October of 1973, the world has begun to recognize, albeit reluctantly and belatedly, the importance of the role that energy plays in economic activity. Energy is the capacity to do work. Without work there can be no production of goods and services. The recent series of oil crises has demonstrated that no longer can abundant supplies of easily accessible energy at low prices be relied upon as in the past.

The economic instability, evidenced by intractable inflation, erratic currency movements and high unemployment, that so characterizes our era has been caused in large measure by changing energy supply dynamics, the most apparent of which are oil price rises and the consequent massive transfer of wealth from the oil importing to the oil exporting nations.

International tensions have been heightened by anxieties over continued access to Middle East oil reserves which account for approximately 40% of the world's ultimate recoverable conventional petroleum resources. Further social and political disintegration in Iran is likely, causing an indefinite elimination of its potential 4 million barrels per day production. There is a growing possiblilty of social unrest in Saudi Arabia which would threaten its 10 million barrel per day production capacity. And the spectre has arisen of the Soviet Union pressing southward from Afghanistan in a quest for oil. Soviet pressures on this volatile and socially fragile part of the world can only be expected to increase as the traditional low cost oil supplies in European Russia are depleted. Since the Siberian oil resources are difficult and costly to recover and transport due to their remoteness, geological structure and climate, the temptation to exploit alternative sources must be very alluring to the Kremlin.

At present the energy troubles appear to stem from an overdependence on oil whose supply is shrinking and which is situated to an inconvenient degree in unreliable territories. But the problem is deeper and broader than this. It is really the failure of societies and their politicians to get the energy source mix right.

Within the scope of present technology, there are a limited number of sources from which primary energy is derived. They are hydrocarbons (oil and gas) which today provide 60% of the world primary energy, coal which contributes 30% hydro (including geothermal, solar and biomass) which supplies 7% and nuclear which accounts for 3%. It is the mix of these sources that is causing the trouble. Until 1973, the existing mix appeared to work satisfactorily. Now a transition is occurring. The nature and speed of the change in the mix that takes place will dictate the extent of the dislocation which the world will have to suffer before the adjusting phase is completed and a new, sustainable equilibrium established. A shift from dependence on oil to an increased reliance on coal and particularly nuclear is essential. The urgency of this need is heightened by a look into future energy requirements.

All predictions about future energy demand have two things in common. They are invariably wrong and they depend on assumptions of economic growth.

The postwar period of rapid economic growth (which was a function to a large extent of recovery from the Second World War) ended by the early seventies. The annual average rate of growth in the Gross Domestic Product of the OECD countries of just under 5% that characterized the 15 year period prior to 1973 dropped to 2.7% in the period 1973–79. The reasons for this slowdown are likely to persist and to result in a growth scenario (at least until the end of the century) lower than in the postwar years.

In composing a world economic growth forecast it is necessary to calculate individual rates for the three main components of the world's economy, the developed nations (e.g. OECD countries), the centrally planned economics and the lesser developed countries (LDCs). Most forecasters postulate a 1% per annum greater rate of growth for the LDCs than for the developed nations and a growth rate somewhere in between that of the LDCs and that of the developed nations for the centrally planned economies. The average annual rate of economic growth assumed for the world until the turn of the century by many

forecasters is about 3% for the low case and about 4% for the high case. This means that the rate for the developed nations will be no more than it was in the last 7 years if the low case is right and only a little better if the high case is right. It is interesting to note that no official forecast postulates a zero or negative economic growth rate.

Energy demand is related to economic growth. However it is not a straight line relationship. Apparently the ratio of energy use to GDP declines as the overall economy matures. Thus in industrialized countries the ratio is less than one: this means that a 1% increase in the GDP results in a smaller percentage increase in energy consumption. The reverse is the case for the LDCs. But as their economies mature the ratio will decline through one. Today these income elasticities are approximately 0.8 for OECD countries and 1.3 for LDCs.

Demographic factors also contribute to the rate of growth in energy demand. The rapid population increase in the developing world is not expected to level off before the end of the century. By the year 2000 the Third World is expected to represent 4 billion people or more than 60% of the world's total population. In addition it is likely that the current massive urbanization process will continue. At present 60% of the world's people live in rural areas. By 2020 this will be reversed, with 60% living in urban areas. Urbanization has a major impact on energy consumption for urbanized people in developing countries use almost 10 times as much energy per capita as do their rural brethren.

Expectations on the part of the LDCs for rapidly improving living standards for their people, together with the desire on the part of industrialized nations for expanded markets support an economic and energy growth scenario higher than that for the rest of the world.

The rate of increase in the use of energy has accelerated over the last 100 or so years. During the period 1860–1975 according to the report by the Conservation Commission of the World Energy Conference (WEC) the annual world consumption of energy increased by 2%. In the period 1925–1975 the rate of increase had risen to 3.3% and in the period 1960–1975 it moved to 4.3%.

Because energy demand depends on the rate of economic growth, the nature of economic development in the Third World and the GDP elasticities applied, official forecasters are reluctant to do more than predict a range within which they expect the energy demand will fall. The broadest range that has been taken is that obtained from an extrapolation of the long term average growth rate of 2% and the faster rate of 4.3% experienced in modern times. Within this envelope fall other forecasts based on the postulated economic growth rate of 3–4% multiplied by an elasticity factor close to 1. Given the wide range of uncertainty in any projections, the precise arithmetic rate of growth is not important. It is rather in the general nature of the trend that the significance lies. To put these figures into perspective, if the annual consumption of energy grows at a rate of 3% (the rate adopted by the WEC), by the year 2000 the world will be consuming twice the amount of energy that it does today. By 2020 energy consumption will have tripled.

Approximately 60% of the primary energy used today is in the form of conventional oil and gas. If other forms of energy which make up the 40% supplied today do not increase and substitutes are not found in the next 20 years, oil and gas would have to be relied on for 80% of all primary energy supply by the end of the century. Such an expectation is obviously unrealistic in the face of presently known or expected oil and gas reserves. On the contrary, it is expected that conventional oil and gas production will level off in the period 1990–2000. Accordingly their combined market share should decrease, probably to 45% by 2000 and to less than 30% by 2020. The gap thus left must be filled by other energy materials, almost entirely by coal and nuclear. Renewable sources of energy, such as solar power cannot be expected to contribute more than 10% by 2020. We don't have very much time. If we are going to succeed in filling the gap we must start now, given the lead times involved and the magnitude of the coal and nuclear capacity that is required to be put into place. The combined energy supplied by coal and nuclear must grow by 3 times within the critical 20 years left in this century. Clearly such a rate of increase could not be expected to be sustained by coal alone due to constraints on the amount of coal that can be produced, transported and burned. Therefore nuclear will be required to grow at a much faster rate than coal if their combined capacity is to be tripled.

The need for vitality in the nuclear area has been exacerbated by the delays in expanding nuclear capacity occurring over the past 2–3 years. During this period, the forecasts for nuclear power growth have been revised sharply downwards in virtually every nation in the developed world except in Belgium, France and the Soviet Bloc. The reason for this is partly the slower economic growth following on the 1973 oil crisis resulting in less electricity usage

than expected, but it is due mainly to social opposition to nuclear power, lack of political will and stultifying licensing procedures. The world is going to have to pay a high price for this folly. Delays that occurred in the U.S. during the 70's in building nuclear reactors represent a loss equivalent to as much as 6–9 million barrels of oil per day in the 1990's.

The recent events in Iran and Afghanistan should however encourage greater public acceptance of nuclear power. The new recognition of the vulnerability of nations to interruptions of energy supply is taking expression in a perception of energy not only as a function of economics but also as a matter of national security. If public sentiment does build in favour of nuclear power as expected, some lead time will be required before it is translated into political will and bureaucratic action. This, coupled with the fact that 1980 is an election year in the U.S. and Germany, two of the most important users of nuclear power, will probably mean that no material acceleration is likely for at least two or three years. However, as pro nuclear sentiment grows, utilities will sense a change in the direction of the wind and can be expected to review their long range plans for nuclear power in a more positive frame of reference.

Notwithstanding the recent disappointments in new plant construction, nuclear power is already supplying a significant and growing proportion of energy. About 4% of the world's electricity requirements are provided by nuclear power. In the developed countries this proportion is higher. For instance, in 1978 nuclear generated 13% of electricity in the U.S., U.K., France and West Germany and 12% in Japan and South Korea. Environmentally conscious Sweden produced 25% of its electrical requirements from nuclear. Most long term predictions indicate that by the year 2000 nuclear will be providing 45% of electrical capacity and 60–65% by 2020 throughout the world. This will result in a worldwide increase in nuclear capacity from about 150 GW $_{(e)}$ at present to 1540 GW $_{(e)}$ by 2000 and 5000 GW $_{(e)}$ by 2020, a 33 fold increase in 40 years.

In many regions of the world electricity is now regarded as a preferred energy carrier on account of its general applicability and environmentally neutral character. The growth in use of this source of secondary energy depends largely on the increasing availability of nuclear power as the primary energy. Oil and gas are too expensive and scarce to be burned. In any event they are more usefully employed in transportation and the petro-chemical industry. Coal, while appropriate has a limited capacity for the purpose due to the massive requirements of mining, transportation and pollution control.

Global electricity capacity is expected to grow from 1400 GW $_{(e)}$ in 1978 to about 11,000 GW $_{(e)}$ by the year 2020. This amounts to an increase of 8 times in just over 40 years. It equates to an annual growth rate of 4.4% which is, in the opinion of many forecasters very conservative. In the period 1960–1973, the electricity growth rate for most of the developed world was approximately 7% per annum. Current indications are that, after experiencing a slowdown, the growth in electricity usage is now accelerating and could result in an average rate per annum somewhere between the historical 7% and the 4.4% projected by many experts. Even at the lower growth rate, the electrification of the world will produce a dramatic impact on the picture of the world's primary energy usage. By 2020 even with a low growth scenario about half the world's primary energy will be channelled into generating electricity. This trend has profound implications for nuclear power which by that time is expected to be contributing 60%–65% of primary energy for electricity generation.

In order to supply this level of nuclear capacity, the world's requirements for uranium will increase dramatically, from about 30,000 tonnes per annum in 1980 to 260,000 tonnes by the turn of the century and to over 500,000 tonnes per annum by 2020, even assuming fast reactors are installed. These figures include the demand from the centrally planned economies. It is expected that by 2020 the centrally planned, developed and the developing countries will produce roughly equal proportions of electricity from nuclear power.

These requirements offer a challenge to the mining industry. The WEC estimates that over 300 new uranium orebodies will need to be discovered by 2015 in order to provide levels of production required by 2020 (assuming a 5 year average lead time). Total discovery cost was estimated to be $50 billion supported by development capital costs of $30–$40 billion.

Australia, with its large resources has an exciting opportunity, and indeed a serious responsibility to supply in increasing quantities the world's growing requirements of uranium. At the present time, the total uranium resources of Australia in the Reasonably Assured and Estimated Additional Resources Categories are approximately 350,000 metric tons of contained uranium. Approximately 83% of these resources are located in the Northern Territory and are of high grade by world standards. This resource figure does not include the potential uranium ore in Roxby Downs which could be material. Neither does

it include the likely additional reserves within the existing Northern Territory orebodies. The potential for the discovery of more uranium orebodies in Australia is significant, particularly in the Northern Territory, Western Australia and South Australia.

Australian production will start coming onto the market in the 1980's and is expected to grow throughout this decade and the next. By the 1990's Australia should be producing 14,000 to 17,000 MTU per annum, with potential for substantial increases thereafter.

The advantages of Australia in the uranium market place are considerable, particularly in the early years of its development as a major uranium supplier. It is just as well that these advantages are available because, due to the delays in government approvals for projects, Australia has missed the optimum part of the current uranium cycle and is introducing itself to the market when conditions are softer than they have been in the past few years. Nevertheless, the main advantage, which is the offer of a new source into which utilities can diversify, coupled with a reputation as a politically stable nation that honors its commitments (despite a bit of sabre rattling by the alternative government) will provide a competitive edge over other suppliers.

A new factor has developed in the market place recently which will assist Australia in its attempts to penetrate the world market in uranium. Due to the drop in spot prices for uranium that has occurred in the past few months, largely due to the liquidating of inventory by U.S. utilities in response to the financial pressures of high interest rates, U.S. domestic production of uranium is expected to be considerably less than had hitherto been forecast. This will provide an additional window into the market for Australian uranium which, because of its cost structure is somewhat less sensitive to a price drop than the high cost American producers. Nevertheless Australia should expedite the development of its uranium industry more vigorously than in the past. The excessive delays in bringing orebodies into production have played into the hands of our competitors, particularly South Africa. A significant part of the market in the past few years has been taken by South Africa only because Australian uranium was kept in the ground; and it was taken at higher prices than might be obtainable by producers for some time. If we do not get moving we will lose further sales to the South Africans and, now that Saskatchewan ore bodies are being brought into production, to Canada. It is a competitive market place, and there are no prizes handed out to those who stand idly on the sidelines waiting for optimum conditions to develop.

Conclusion

The international energy scenario for the future appears threatening but it does afford Australia a unique opportunity, as a nation rich in energy resources through its abundant supplies of coal and uranium, to create significant new wealth and at the same time provide an essential service to the world.

The challenge to Australia will lie not so much in the market place or in the field of technology required for exploration and production but in the socio-political arena. The delays and perturbations that have impeded the development of Australia's natural resources over the last 8 years (which take perhaps their most extreme form in uranium but are not limited to it) make it imperative that some basic changes be made in the relationship of the mining industry to the political and social structure of the Australian society. The following are some suggestions for change in this relationship.

1. Government and Opposition should move progressively toward a bipartisan approach to fundamental matters affecting natural resource development. Examples of this would be a common policy on uranium development and foreign investment.
2. An accommodation should be reached between the objectives of reasonable environmental protection and economic development of natural resources within a sensible time frame.
3. An arrangement should be achieved between legitimate Aboriginal interests and mining companies consistent with appropriate preservation of Aboriginal sacred sites, and environmental and social impact control on the one hand and avoidance of excessive development delays and uncertainties on the other. To this end the Aboriginal Land Rights Act should be made workable.
4. Progress in reducing the degree and impact of industrial disputes should be made.
5. And finally a greater acceptance and appreciation by the Australian public of the natural resource industy should be created.

If it is possible to make substantial progress in these areas, considerable optimism about the future of the natural resource industry in Australia would be justified, particularly in the energy field. The resources are there, the demand in the market place is there, capital can be mobilized, and skilled labor is available. All that is needed is the will to develop.