ENERGY — A PERSPECTIVE

by
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Introduction

In my youth I once received the Annual Prize for the aggregate of the year's essays. I had developed a style of commencing my essays with a quotation from Shakespeare and concluding them with a quotation from the Bible. As the essays were marked by a classics English scholar, who was an ordained minister, I guess what happened in the middle was incidental to the choice of the starting and finishing quotations! I thought I might use the same device here today and I would introduce my subject with Lord Bardolph in Act 1, Scene 3 of Henry IV:—

> "When we mean to build, we first survey the plot, then draw the model, and when we see the figure of the house, then must we rate the cost of the erection which, if we find outweighs ability what do we then, but draw anew the model — in fewer offices or at last desist to build at all?

There have been so many Symposia, papers and learned studies about the energy problem of the future, that I am probably unwise in choosing this subject. Over recent years there has been an enormous amount of research and an enormous amount of work and an enormous amount of thought and vast amounts published — some extraordinarily good, but an awful lot of it is superficial, futile or simply axe grinding.

As an aside, one of the things that has troubled me in discussions with so many people who want to have public debates on matters of great importance, there are very few people who want to have these public debates who are prepared to do their homework, and are prepared, in fact, to read through and weigh up as they read, the basic information available to them. For the greater part these so-called public debates are expressions of unsubstantiated and unsupported opinions. I am deeply concerned about the enormous delays in the decision-making process in the United States by the American Debating Society style and I think the classic was the case of the Three-Mile incident and I quote from a recent statement of the Nuclear Regulatory Commission:—

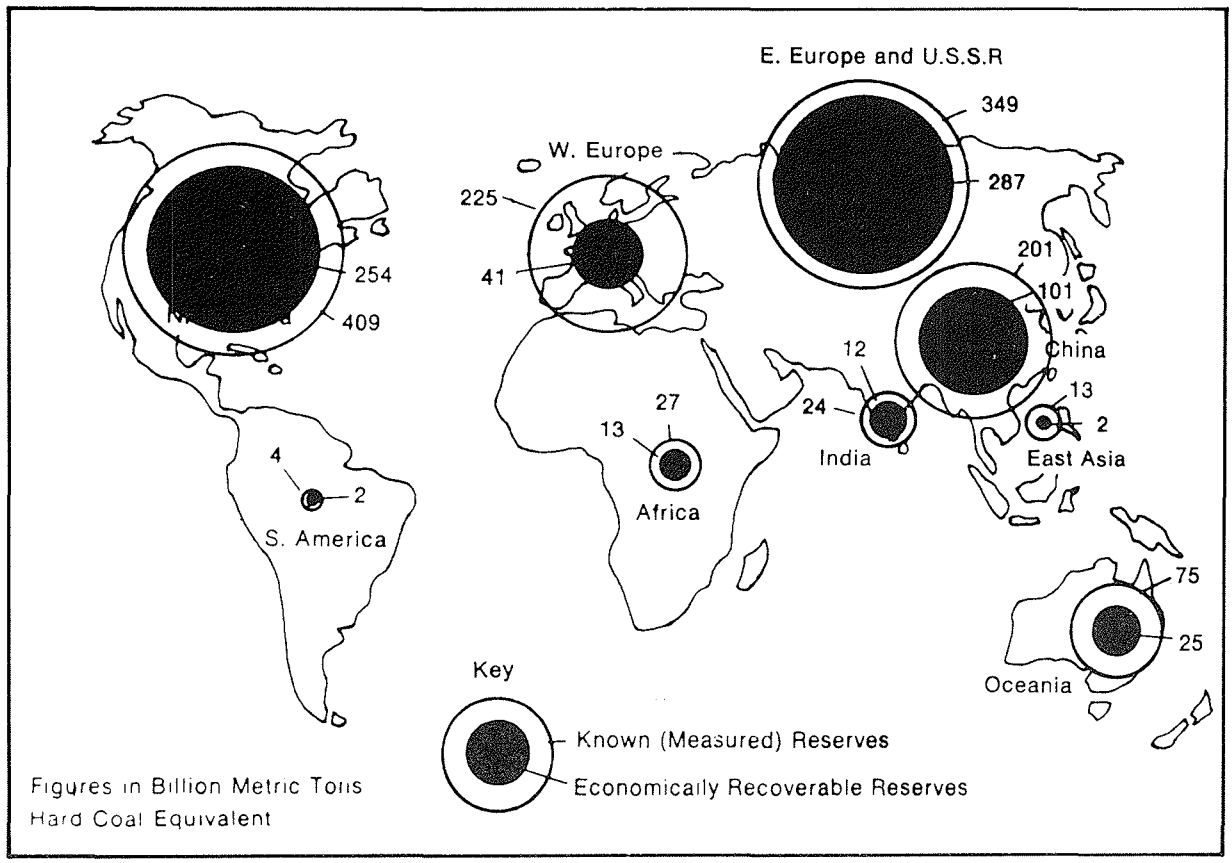
> "The five commissioners agree on very little, but they were unanimous in separate interview on one point: their debating society style of decision-making is no way to run a crisis. In debating society style, however, they have yet to begin discussing what to do about it."

However, I had better get off that topic.

The matter I want to draw to your attention today is the implications of the energy "policies" that are being bandied around in terms of their capital requirements, in terms of their use of resources, which are themselves finite, like engineering manpower; like manufacturing capacity; like raw materials; and indeed, (and it must be underlined) like the amount of energy that is going to be *consumed* in meeting the programmes for the energy of the future!

Let us first start with the thing that recently got some limited publicity — in my view not nearly enough — that the North-west Shelf Development, which is a significant energy resource in the Australian scene and in the export market, requires the application of more capacity in construction, in manufacture and in bringing it to fruition than, in fact, is available within Australian resources. So where are the physical resources for our coal — our ports — our infrastructure etc.?

Before taking that theme any further at this point, I think it's worth having a quick review of the distribution of the world's energy resources within the best guesses one can make as at the year 2000, because it raises a very salutory situation. At the 1977 World Energy Conference, estimates which are considered to be highly authoritative by Professors Peters and Schilling, showed North America, predominantly U.S.A., to have 25% of the technically and economically recoverable reserves of coal in the world, while Siberia had 17%, the Peoples Republic of China 20%, Western Europe 14% and Australia and New Zealand at just under 4%.



In the brown coals, sub-bituminous and lignite categories, the U.S.A. has 45% of the world's technically and economically recoverable reserves, Eastern Europe 15%, Siberia has 19%. Australia has possibly 7% of the world's total.

These brown coal figures, unfortunately, have no information on the availability of brown coals and lignites in China. Figures just simply aren't known, but it is reasonable to expect that the brown coal occurrences in China will be somewhat parallel to their hard coal figures and one would, therefore, expect to find China has major resources of brown coals in the future. Of course, it is to be remembered that brown coals are even less transportable than the hard coals.

When one considers North America as a unit, that is Mexico, Canada and the United States, it has the dominant position in the world, round the year 2000, as to coal, oil and oil potential, (in the Arctic Circle areas, and offshore) natural gas, oil shales, tar sands and uranium.

In a recent comment made by Mr. McAfee, Chairman and Chief Executive of Gulf Oil, I quote:—

> "In fact it has been said, without too much overstatement, that if the U.S.A. were to develop the full range of its energy potential, it could be the OPEC of the 21st Century."

Perhaps it is because of this reason that the United States is feeling able to indulge in the luxury of seemingly endless debate on its energy policy. Other countries are not so fortunately placed and cannot afford the delays in decision making. Even for the United States, time is rapidly running out.

The only geographic area that goes anywhere near rating in the same league, is the Asian/Siberia/China area and particularly as the potential for oil and gas, and indeed for coal as well in the Northern Siberia and Arctic areas, has yet to be understood. There is every reason to believe that the potential in those areas is high.

One of the most authoritative studies on global energy prospects in the time frame 1985-2000, was that done by the Workshop

on Alternative Energy strategies under the sponsorship of the Massachusetts Institute of Technology and directed by Carol Wilson of that organisation. This was published in 1977. Events since that date have not changed the basic validity of the work which was done — indeed they have tended to emphasise the urgency. I would like to quote from Carol Wilson's foreword to the particular document:—

> "We don't have much time to learn how to replace or to decrease our dependence on the fuel that for three decades has fed the expansion of Western living standards and the hopes of all nations for material betterment. Time is our most precious resource. It must be used as wisely as energy."

To illustrate the points I now wish to make, I have chosen Scenario C1 from the Workshop Study. I should make it clear that this Scenario C1 was based on a 6% growth rate in the World economy and such a level would, in the present context, be considered to be on the high side. However, there is one tremendously important corollary to all the assumptions as to growth rates of economies, be they national, or on a World scale. If energy is *not* available in adequate supply, then the question of growth simply does not arise — for the availability of energy is the first essential in economic growth.

To illustrate the magnitude of the task which was the earlier theme I touched upon, I am taking their Scenario C1 which was accenting coal and postulating modest growth in nuclear, because it so happens that that is the one on which I have available data to illustrate the magnitude of the task. Incidentally, this scenario projects a trebling of the United States domestic nuclear power generation between the year 1985 and the year 2000, and that was considered by the task force as a modest nuclear scenario.

Now, in this particular case the production of coal in the United States was projected to grow from around 750 million tons per annum in circa 1978 to 2000 million tons per annum at the turn of the century. Bechtel Power Corporation of the U.S. did a study for the Workshop which showed that in order to meet this target the U.S. would need to open 377 new 2,000,000 tons a year underground mines in the Eastern part of the United States — that is 18 per year from the year 1980 to the year 2000, or 1½ each month; 75 surface mines of 4,000,000 tons a year each in the eastern part; 232 surface mines in the western coal measures of the United States, rated at 6,000,000 tons a year — that is 1 a month — new 6,000,000 tons a year mines opening from the year 1980 to the year 2000; as well as new underground mines in the western measures. The total cost of those mines in 1975 dollars would be 32 billion dollars, but more significantly, the investment required in transportation facilities to carry the coal to consumers, would be much higher at 86 billion dollars; and these estimates do not make any provision for what would undoubtedly be necessary in upgrading rail systems, signalling, terminals and all the rest of the other infrastructure to back-up the transportation side. Included in the transportation calculations, were 9 coal slurry pipelines, each pipeline with a capacity of 25 million tons a year, so they were taking advantage of the best technology foreseeable for this purpose.

Let's add on top of that — taking President Carter's lower limit on synthetic fuel from coal and shale at 1.5 million barrels per day by 1990. Assuming that just 2/3 of that, 1 million barrels a day, come from coal, we get the situation that if they were to use the Sasol-type plant, which is the only established production equipment extant today, the requirement will be for 20 such plants costing in 1979 dollars something of the order of 3.5 billion each — 70 billion dollars to be spent between 1980 and 1990 just on these plants alone. I know that the actual number of dollars doesn't really seem to matter very much these days. To convert those dollars into something more recognisable, Fluor did a recent study based on their experience in constructing Sasol plants, and estimated that the manufacture of these synthetic fuel plants (and the 500,000 barrels a day shale oil plants by 1990) in the United States would absorb about 35% of the total American manufacturing capacity for compressors, about 30% of the total capacity for pumps, for heaters and boilers, for shell and tube heat exchangers and for valves, and that's just for the synthetic fuel plants alone.

When you remember that the coal mines which we've just talked about will use this same sort of equipment, and we haven't even yet discussed the construction of the electrical generating power stations them-

selves, you will see that the energy programme, which is required in the United States, is projected to be beyond the capacity of American industry to support and provide. So we need major investment in heavy engineering capacity to underpin those programs which should have started on a lead time of at least 3 years!

Suppose we now turn to that great saver of all, solar energy, and have a look at that. Nobody authoritative has ever come up with a figure higher than the Harvard Business School Energy Project, which supported President Carter's energy target of 20% of the energy from solar sources by the year 2000.

Now I think it is, first of all, necessary to see what this 20% by the year 2000 really means. In fact, it was a figure set to cover all energy from renewable source, for which the sun could be held responsible, even indirectly. Within this definition of solar energy, to provide 20% of the power is included hydro-electric power; it includes the so-called biomass energy sources; it includes wind power; and, of course, it includes the direct solar bit.

The actual direct solar applications are likely to make up as an absolute maximum 35% of the 20% which is 7% of the power. That in itself is a pretty significant figure. The cost of this must also be borne in mind, because although the cost is expressed in dollars, these must be measured in terms of copper, and aluminium, and pumps, and glass, and reflectors, and bits and pieces, and manhours.

They are just not dollar bills you put on the roof, they are materials which themselves have an energy content in their manufacture. Working on an analysis of this 7% of the energy from solar sources — and that's for heating and cooling and mostly domestic, and so on — it requires some 200 billion dollars worth of solar collectors, which is a capital investment in their production, equivalent to 10 billion dollars a year on solar collectors! When one sees the way in which American industry can, in fact, get going and organise itself to do all sorts of dramatic things, this is, of course, possible but one has got to look at it as being possible in the context of all the other things that have got to be done by American industry at the same time.

To add these together brings us to an interesting conclusion. The Mining capital expenditure over the last decade or so appears (on my limited statistics) to run at around 4 per cent of the Gross Private non-residential Capital Expenditure and the energy component of mining capital at around 2.7 per cent. What we are talking about here, in summation of the previous activities, is about 13 per cent and if you add the shale mining and other related activities it is about 15 per cent — or six times the proportion of recent history!

Now you may think I am drawing a long bow — but let me quote from a quite independent assessment made by the Chairman of the Committee for Economic Development in the U.S.A., Mr. Fletcher Byrom, who is also Chairman of Koppers, on 11 April, 1979 at a C.E.D.A. meeting in Sydney:—

> "After you've made all the corrections for reduction in consumption in the United States, and if you assume energy independence as being 15% importation of your energy, and you go through all the requirements that you can think of you can use, and then exploit coal, solar energy, geothermal technology, windmills, oil, shale, natural gas, you name it, you come up with an astounding fact that in order to meet energy needs in the year 2000 in the U.S. we have to build a 1000 megawatt nuclear plant every ten days from now until the year 2000."

Interestingly the so-called cheap energy sources aren't all that cheap, for we must realise that the capital invested isn't for "free", and a study which was done quite recently by Bechtel puts things very much into perspective.

I think we can then go on to the Australian scene. I have made some comments, on which I haven't got precise data, on the problems that the North-west Shelf is going to pose to Australian industry and I suggest that we should now superimpose on top of that the "policies" which we have had talked about so freely and so glibly and let's look at this business of steaming coal.

Certainly, there is considerable scope for the export of Australian steaming coal to nearby countries who have need for it. One thing that's got to be certainly borne clearly in

mind is that as the costs of transporation fuels increase — and increase they certainly will — so the costs of sea freight become an increasingly onerous burden. After all the end-user is buying BTU's at his furnace and if the transportation costs get exceedingly high, the pressure will be on the minimising of the F.O.B. cost. In the Australian scene with the internal transportation and shipping costs, this inevitably means that the pressures are going to continue to be on the miner himself.

If the potential export markets for Australian coal are to be properly availed, and the returns from those exports are to at least be the sorts of earnings required for progressive re-investment on the development of mines, then the transportation internally will have to be the subject of considerable investment. Examine the differences in costs between those great operations in the Pilbara, the iron ore mining operations, which, for their very survival require really efficient internal transport, and the costs that are being levied against the coal miners in New South Wales and Queensland — the difference is enormous. The Pilbara iron ore miners at Hamersley and Newman are hauling, in 1979, from mine stockpile to port stockpile for cost, all in — including servicing of capital; maintenance of the permanent way; and all operating expenses; these costs are about one cent per tonne km.

A typical figure in New South Wales Railways systems charge at something between 4 and 7½ cents a tonne km and the Queensland Railways operations from the Bowen Basin coal mines to the seaports, when corrected to a comparable basis with my Pilbara figures, equate to something of the order of 5 to 10 cents a tonne km also. Those who say "Ah but, these are very specialised systems hauling a single product" are losing the point of the argument.

In fact we should have specialised railways hauling at the maximum possible level of efficiency, the products we sell. The presence of such a railway would enormously enhance the economics of hauling other products as well, but they must direct their attention to the maximum of technical competence which means, in turn, a very high order of investment and as has been shown in the Pilbara case this investment is adequately serviced by the sheer efficiency of the operation. The parochialism of state railway systems and the parochialism of our port operations is going to be one of the greatest deterrents to the development of a really economic coal mining activity of the order of size that our Premiers, Deputy Prime Ministers and others like to talk about.

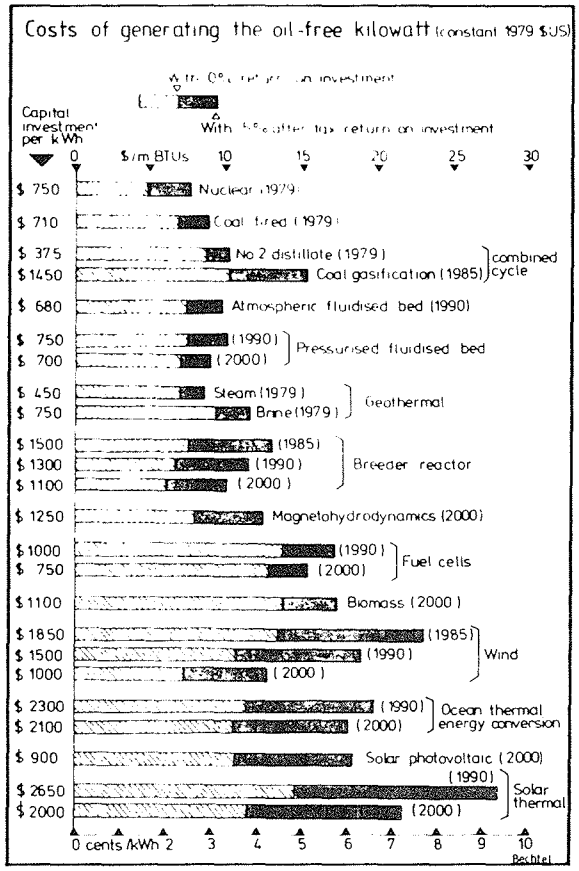
Developing further this theme of the transportation cost of energy fuels, we do have to remember that the transportation and handling costs of oil have been one of the main contributing factors to the very low cost of oil as a source of energy, and, of course, the same thing applies to natural gas.

The relative logistics of nuclear fuel vis-a-vis coal, illustrates dramatically the advantages of "nuclear" in this regard. The currently planned Ranger Operation, with its open cut pits, waste dumps and plant occupies an area roughly equivalent to that of Mascot or Tullamarine Airports.

The total resource we are mining — some 120,000 tonnes of U_3O_8 would, if used in Breeder Reactors, equate to a coal seam 5 metres thick and ten kilometers wide stretching from Sydney to Ayers Rock and then to Perth.

On present day P.W.R.'s, which use so much less of the energy available, a seam 5 meters thick and 170 meters wide for the same distance equates. However, do remember that the energy not used is available after reprocessing for use in Breeders later, and is not necessarily lost.

I would like to return again to the perspectives so far as power generation is concerned and a recent study by Bechtel produced a tabulation of the price of an oil-free kilowatt and the capital investment in respect of that power generation system. There are some considerable reservations as to how this particular chart should be read. First of all it relates to centralised power generation on a large scale and secondly it is specific to the United States, continental United States, and doesn't take into account some of the logistics costs or like factors in respect of other countries, which would affect the overall costs of the table. What it does present, I think, is an interesting first-cut guide and it shows quite clearly, I believe, that many of the options which are being toted round at the moment are not real options in terms of their capital costs and in terms of the costs in dollars per million BTU in production. As American technology



in breeder reactors has, in fact, fallen substantially behind the developed technology in Europe, I think they may be pessimistic in their assessment of the breeder and I believe there is absolutely no doubt that the breeder reactor will form an ever-increasing proportion of the total power generating capacity throughout the World, but particularly in energy short areas such as Western Europe, Japan and other industrial countries significantly earlier than people are currently postulating.

Now let me see if I can put all of these scattered bits and pieces together in a final sort of summary. The magnitude of the task, in terms of capital, of meeting the challenge of diminishing quantities and availability of petroleum and substituting other fuels and other technologies to produce transportation and transportable fuels, is vast. The longer the delays encountered in all the present debating society approaches to decision making, the more difficult the task becomes because the whole gets no smaller, the time-scale is diminishing.

There is a very large measure of pie in the sky in respect of many of the apparently easy solutions and the abundance of coal throughout the World is blinding people to the very uneven distribution of coal throughout the World and the enormity of the logistics problem and the cost of transportation from the haves to the have-nots.

Only the United States of America with 50% of the non-communist world coal, 50% of the non-communist world uranium and — coupled with Alaska, Canada and Mexico, probably more than 25% of the non-communist world oil in the year 2000, can afford to continue to debate and vacillate and has, by virtue of its enormous industrial capacity, any real chance of retrieving the situation when calamity is finally at the doorstep. The rest of the world, the energy-poor remainder, if it is to stand any chance of survival, must proceed to make decisions — as indeed France; as indeed Japan; as indeed other European countries are being more and more required to make their own decisions on the basis of the facts that lie before them; and to make those decisions in a positive and direct way; and proceed to the solution of the over-all problem so far as it affects them.

It is no exaggeration to say that, already, America is committed to a greater reliance on imported petroleum in the 1990's than it is now. This will create for the rest of the free world, economic pressures and growth constraints of an intolerable order — unless the rest of the free world recognises that the High School Debating Society is no substitute for pragmatic decision making.

Let me now conclude with a translation from the "living Bible" — Proverbs 3-21:—

> "Have two goals — wisdom, that is knowing and doing right — and common sense. Don't let them slip away, for they fill you with living energy (and a feather in your cap.)