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AUSTRALIA'S FUTURE PETROLEUM NEEDS

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WORLD OUTLOOK

World Energy Growth

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When the designation horse power literally meant what it said, the growth of energy demand increased at average compound rates of more than 2.5% to 1950, and about 5% during the period 1950-1970. In 1970 the world's primary energy consumption was 15 joules; in 1975 consumption had increased to 230,000 X 10¹⁵ joules (Australian Institute of Petroleum, Oil and Australia 1978). This rate of consumption is roughly ten times what it was at the turn of the century, and reflects not only the developments in technology that have revolutionized our modes of transport, but also the very considerable economic growth of the western world and developing countries. In particular, the comparative small population of the western world consumed the lion's share of energy, including petroleum. But it does not follow that these ever increasing rates can validly be extrapolated to arrive at a figure for energy consumption to the turn of the 21st century. Such an extrapolation would suggest that by the year 2000 the world would be consuming more than 35 times the amount of energy used in 1900. Should this occur, it would necessitate further technological development and industrial growth on a very large scale to utilize fossil deposits such as coal and oil shales for the production of liquid fuels. It would also necessitate greater use of atomic power plants for the generation of electricity; and to a minor extent the development of

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Any consideration of Australia's future petroleum needs must view the situation in context with the past and projected future world energy growth. Since the turn of the century, when the designation horse power literally meant what it said, the growth of energy demand increased at average compound annual rates of more than 2.5% to 1950, and about 5% during the period 1950-1970. In 1970 the world's primary energy consumption amounted to more than $196,000 \times 10^{15}$ joules; in 1975 consumption had increased to more than $230,000 \times 10^{15}$ joules (Australian Institute of Petroleum, Oil and Australia 1978). This rate of consumption is roughly ten times what it was at the turn of the century, and reflects not only the developments in technology that have revolutionized our modes of transport, but also the very considerable economic growth of the western world and developing countries. In particular, the comparative small population of the western world consumed the lion's share of energy, including petroleum. But it does not follow that these ever increasing rates can validly be extrapolated to arrive at a figure for energy consumption to the turn of the 21st century. Such an extrapolation would suggest that by the year 2000 the world would be consuming more than 35 times the amount of energy used in 1900. Should this occur, it would necessitate further technological development and industrial growth on a very large scale to utilize fossil deposits such as coal and oil shales for the production of liquid fuels. It would also necessitate greater use of atomic power plants for the generation of electricity; and to a minor extent the development of

solar and wind power plants in suitable regions. Other methods of developing power by tidal and ocean currents may also be used. All of these methods to utilize natural resources, in addition to massive strip mining operations to obtain coal for the generation of electric power, will probably be in operation in various parts of the world by the year 2000.

Extrapolation of the crude oil component of world energy growth is predicated on estimates of economic growth, technological developments in liquefification of coal, extraction of shale oil, and fuel consumption of mechanical transport. Annual variations in consumption may also be in part a reflection of government policies, political decisions of the OPEC countries, and costs. For example, in 1974 the average daily crude oil consumption of the non-communist countries decreased by nearly 1.5 million to about 46 million barrels. That was the year when OPEC sharply raised the price for a barrel of oil, and the beginning of the so-called 'crunch' in oil supplies. Realization dawned throughout the oil-consuming world that the days of cheap oil were over. In fact, the price of oil had, for several years previously, been falling in real terms; and the price was restored to a figure that was probably not much higher than it would have been had annual adjustments been made during previous years for depreciation of the U.S. dollar. Nevertheless, the blow was a hard one, and the average daily consumption of crude oil continued to fall during 1975 to about 44 million barrels. During the following year, no doubt as the initial shock wore off and consumers became resigned to the higher price structures for liquid fuels, consumption of crude oil began to rise again. Subsequent price rises have not had such a catastrophic impact on the economies of industrial and developing countries, but have been

a contributing factor in the slowing down of economic development in the western world, and to a more moderate increase in the annual consumption of petroleum products.

Perhaps the greatest impact on the public was felt in the U.S.A. where petrol had for years been cheap in comparison to European prices. During the oil era of the 1930s to 1950s, the U.S.A. had been the world's largest producer, and a net exporter of crude oil. In the 1960s the balance began to change, and by the 1970s the U.S.A. was a substantial net importer of oil from OPEC sources, including Venezuela. This swing occurred during a period when the industries of western Europe and Japan were expanding and consequently competing for oil.

It is of interest to look back to the years preceding the second World War when coal was the main energy source in the industrialized countries of the world; although in the U.S.A. and Canada oil and natural gas were beginning to displace coal. As both supplies and prices changed their balance in the market place, oil was in some cases displaced by gas. The result was the shutting down of many coal mines which did not revive until the post-war demand for coal by the Japanese steel industry which was able to operate collectively in a buyer's market. But this did not eventuate until the late 1950s to early 1960s, prior to which time nobody was much interested in producing coal, other than for already established overseas and domestic markets. Many coal-fueled power and other industrial plants were converted to the use of oil which was cheaper and cleaner. In the following years conversion was further encouraged by government regulations controlling the levels of air pollution, and by public relations influenced by pressure from

conservation interests. The industrial world, and the motorized public had found the answer to their dream of an ever expanding economy, an apparently inexhaustible supply of comparatively cheap fuel.

Yet the writing should have been on the wall, and the motto of the American states, 'United we stand, divided we fall', should have been seen in an industrial context with reference to the oil-producing countries of the Middle East, Africa, and elsewhere. For three to four decades before 1974 negotiations between the oil industry and the oil-producing countries of the Middle East had been carried out in a buyer's market. Bit by bit, year by year, the producer's share in the oil was raised by increasingly effective pressure from politically aware, technically trained, and business-minded nationals in Saudi Arabia and other Middle East countries. Over the years the oil companies' equity in the oil produced became eroded, and the potential of the oil-producing countries to raise the price of their share became greater. In some areas of the world the oil industry functions mainly as an agent of the government of the oil-producing country, being guaranteed a return of the costs of exploration and development, tax concessions, and interest on the investment. Whatever the terms negotiated, oil-producing countries have, for several years, been assuming a larger role as owners of their natural resources, the development of which is increasingly subject to political as well as commercial interests.

Patterns of Consumption of Fossil Fuels

During the past several decades there has been a changing pattern of consumption of fossil fuels. Before the second World War coal was the dominant source of energy. After the war the pattern changed rapidly as more homes were heated by oil, diesel fuel replaced coal in railway locomotives, and coal-burning power and other industrial plants were converted to the use of fuel oil or natural gas. The relative cheapness of oil and gas, and their comparative cleanliness and convenience of handling were major factors in decisions to convert from coal. During this period the real price of oil was either steady or tending to decline, whereas the mining of coal was faced with increasing labor costs and industrial confrontations. Added to these difficulties was the growing realization that the use of coal was causing serious problems of pollution to the environment.

The change in pattern of demand from coal to petroleum was both widespread and rapid. In 1950 about 65% of the world's energy was derived from coal. By 1960 oil and natural gas had tipped the balance and on a world-wide basis supplied slightly more energy than coal; and by 1970 they were contributing twice the energy of coal. During this period 1950-1970 the world's consumption of crude oil increased at an average compound annual rate of 8%. Since then the world's insatiable demand for crude oil has continued to grow.

Looking ahead it appears to be inevitable that the pattern of demand for fossil fuels must change again. The demand for crude oil will probably continue to grow for the next few years, but probably at a lower annual rate. During this time alternative sources for liquid

fuels, albeit more costly, will have to be developed. In this respect South Africa has already set the pattern by the establishment and planned further development of large plants for the liquefaction of coal. Natural gas can also be used in the production of methanol as an additive to liquid fuel for transport. Production of oil from oil shales and oil sands will probably also be carried out on a large scale provided technological and conservation problems, such as the large requirements for water, can be satisfactorily resolved. Also, many power and industrial plants that converted from coal to oil, years ago, may once again revert to coal, particularly in cases where technology has enabled the industry to solve the major problems relating to pollution of the environment. The building of atomic power plants, so much a public issue now, may in the future, and in the light of improved technology and maintenance safeguards, become necessary in some countries to maintain the requirements for energy. In addition, solar, wind, tidal, and wave power may in particular areas also be harnessed.

A further consideration in the changing pattern of demand for fossil fuels is the probability that conservation will become a requirement. The liberality with which petrol has been used in the past cannot be continued in the future. Years ago petrol was regarded by the oil industry as a readily available commodity that must be sold on a competitive basis to the maximum possible extent, and by the consuming public as a relatively cheap and inexhaustible necessity. Studies made in the United States of America of the driving habits of the public show that appreciable quantities of fuel are consumed in trips by car from point A to point A; in other words Sunday driving and other pointless trips are undertaken merely for the pleasure of driving. The public attitude towards cars is changing as the realities of possible future fuel supplies begin to be understood.

Conservation of fuel may be encouraged or enforced through pricing, lowering of speed limits on the highways, phasing out the manufacture of cars with higher horse power ratings, conversion of cars to the use of LPG, the addition of methanol to petrol, and the rationing of petrol. Some of these measures may not be popular, and may not come about for some years. But the public has had a rude awakening to the fact that petroleum products are no longer cheap nor always plentiful, and that insofar as they presently form a large component of the world's total energy requirements, the pattern of demand for fossil fuels will have to change.

World Energy Supply and Demand

Prognostications of Australia's and the world's future energy supply and demand are fraught with political and economic uncertainties and are at best educated guesses based largely on what is known of available proven reserves of fossil fuels, planned development of resources and industries, population growth trends, and extrapolation of curves depicting previous trends of industrial growth and of energy supply and demand. Within these constraints the validity of prognostications looking ten years ahead can probably be sustained. Further crystal ball gazing becomes increasingly clouded with uncertainty.

In 1965 oil contributed 48% of the world's energy requirements, natural gas 17%, nuclear power less than 2%, hydroelectric power 7%, and coal 28% (Esso, 1978). By 1975, and despite a reduction caused by the large price rises of 1974, the consumption of oil had risen to account for 54%, and natural gas to 18% of the world's energy requirements. Nuclear and hydroelectric power remained at 2% and 7% respectively, and coal dropped significantly to 19%. By the year 1990 it is expected that oil will have lost ground to 48%, and natural gas to 15%, the loss being taken up mainly by nuclear power to 8% and synthetic fuels to 2%. The use of

hydroelectric power and coal are expected to retain their current positions and contribute 7% and 20% respectively to the world's energy supply. In terms of actual consumption of energy, all of the contributing sources are expected to grow from 90 million barrels per day in 1975 to 150 million barrels per day of oil equivalent in 1990. The actual consumption of oil over this period is expected to rise from less than 50 to 70 million barrels per day.

The changing pattern of world energy supply and demand must take into consideration not only changes in the various sources of energy, expressed as actual or percentage changes in terms of barrels per day of oil equivalent, but also changes in the geopolitical distribution of energy consumption. These will reflect changes in the economic growth of various countries or regions. Information presented by Esso (1978) suggests that in 1975 the United States of America consumed 41% of the world's energy supply, Europe 28%, Japan 8%, and the balance of the world 23%. Extrapolation of the consumption trends indicates that by 1990 the United States of America, Europe, Japan, and the rest of the world will all consume more energy than in 1975, but in different proportions. The United States of America is expected to consume 35% of the world's energy supply, and Europe 25%, decreases of 6% and 3% respectively. Japan's consumption may rise slightly to 9% and the cumulative consumption of the rest of the world to 31%, a rise of 8%. These estimates suggest that the economies of the western world may undergo a decrease in their rates of growth during the next decade, whereas those of the rest of the world may tend to rise. This prognostication does not necessarily confirm the adage that small is beautiful, nor that economic growth for its own sake is necessarily harmful. It does suggest that economic imbalance in the world is subject to periodic readjustment and change, and that a more modest economic growth for the

industrial countries of the western world will result in a lower rate of increase in the demand for energy and in particular for oil during the next decade to 1990.

World Oil Supply and Demand

Traditional concepts of the relationships between supply and demand have in the past applied to the production and marketing of crude oil throughout the world. Annual increases in demand have, with periodic constraints, been met with increased production. This situation cannot continue indefinitely. Crude oil is a non-renewable natural resource, and the main production comes from geopolitical regions that are independent and not overly sympathetic to the aspirations of the western industrial countries. Demand for crude oil is expected to grow during the next decade to 1990, but at a lower annual rate of increase. Estimates of consumption in 1985 depend on estimates of economic growth which is viewed and interpreted variously by different economic authorities, all of whom are agreed that oil consumption is tied to the economy.

Various estimates of oil consumption for the non-Communist countries in 1985, all based on estimates of both high and low levels of economic growth, are stated by the Australian Institute of Petroleum (Petroleum Gazette, April, 1979). These estimates were made by Shell, Exxon, British Petroleum, CIA, Workshop on Alternative Energy Strategies ('comprising 70 people recruited from 15 non-Communist countries, and representing the fields of industry, commerce and government') based at the Massachusetts Institute of Technology, and the Organization for Economic Co-operation and Development. These estimates ranged from 51-68.3 million barrels of oil equivalent a day for low economic growth, and from 62.5-72.6 million barrels a day for high economic growth. The overlap of 5.8

million is considerable and probably represents different parameters in the definitions of high and low economic growth. Three estimates for low economic growth were 58.4, 58.8, and 60 million barrels of oil equivalent a day. Three other estimates for high economic growth were 71.6, 72, and 72.6 million barrels. These figures suggest that in 1985 the non-Communist world will require 60-72 million barrels of oil a day, depending on the state of the various national economies of the western industrialized countries. In 1978 these countries consumed approximately 54 million barrels of oil a day, an increase of roughly 2 million barrels over the preceding year. In view of the anticipated decrease in the growth of the economy of the United States of America during 1980 and beyond, and the effect this will probably have on the economies of the balance of the western world, it is likely that the demand for crude oil in 1985 will fall within the lower range of 62-65 million barrels a day. The upper limit of 72 million barrels may not be attained until 1990, by which time additional demand for liquid fuels may have been taken up by production of oil from oil shales and the liquefaction of coal.

It is anticipated that by 1990 the Middle East OPEC countries will contribute about 48%, other OPEC countries 14%, Europe and other non-OPEC countries 22%, and the United States of America and Canada 16% of the world's oil requirements. As already stated, oil is a non-renewable natural resource. Even the gigantic fields of the Middle East cannot be drained forever. As the reserves in producing fields decrease, so will production ultimately fall. For the OPEC countries as a whole this point may be reached between 1985 and 1995. A further consideration, quite apart from the engineering aspects of production, has been pointed out by Froggatt (1978) who has stated that production of oil from OPEC countries may be governed less by the needs of the importing countries than by the political, economic, and social objectives of the producing countries.

This aspect of trade has sometimes been referred to as resource diplomacy. It may become more apparent in the future, and may further exacerbate a possible shortfall in oil requirements before 1990. Another possibility may be a reluctance on the part of some Middle East countries to sell their oil, in view of their evident surfeit of foreign currency and problems in reinvestment. It has been pointed out by Playford (1977) that the income of Saudi Arabia, with a population of only 7 million, was some \$70 million a day. Froggatt (1978) has also stated that in 1977 the Middle East OPEC countries had an overall surplus revenue of about \$40,000 million. The resulting imbalance in future trade may place the industrialized countries in severe economic difficulties.

Having portrayed a less than optimistic outlook it must be said that most forecasts of energy supply and demand for a period of 5-10 years ahead will probably prove to be wrong, or at best to require some qualification. In this respect the most obvious possible source of error is in timing. Shortfalls in supply of oil from Iran, following the Islamic revolution of 1979, were certainly not foreseen in 1977. There are too many political and economic variables that cannot be predicted to cast the future with any degree of certainty. Outlooks tend to be an extrapolation of the present situation. When times are dark the future looks dark, yet every cloud has a silver lining from the rays of the hidden sun. Not all students of world energy problems take a dim view of the future. Some see the present situation of high oil prices as a mixed blessing, somewhat painful in the present, but encouraging the development of technology to solve our problems in the extraction of oil from oil shales and oil sands, in the liquefaction of coal, and the manufacture of other synthetic fuels. High prices also tend to encourage conservation of fuel and lower the world's demand for oil. Furthermore, high oil prices encourage exploration

for new oil fields, and enhanced recovery from old fields, the end results from which may considerably lessen the western world's dependence on OPEC oil during the latter part of the 1980's. But in this respect the oil industries and governments of the industrialized countries are painfully aware of the lead-time required to bring a new discovery into production, particularly offshore where the lag may be up to 5 years. Also, during the inevitable period of adjustment the price of oil in real terms may rise appreciably above the 1980 price to create an additional strain on the economy.

On balance, the adjustment to new world prices, supply, and demand for oil may be alleviated by the factors mentioned above, by the more efficient use of fuel, especially for transport, and by a decrease in the rate of economic growth of the western world. In which context it can be reiterated that in the world today there is no real shortage of sources of oil, only of cheap oil.

AUSTRALIAN OUTLOOK

Present Consumption of Fossil Fuels

The Australian pattern of consumption of fossil fuels is similar to that of other industrialized western countries in that a high proportion of liquid fuel is used for private and industrial transport. During the 1960s consumption of petroleum products was rising by as much as 10% a year, but has decreased to a much more modest rate of 2.5%-3% during recent years. Even so, the drain on indigenous supplies of petroleum, and the possible future requirements for imported petroleum are causes for concern. This pattern is unlikely to change much over the next decade to 1990, although by the end of that period an appreciable amount of liquid fuel may be manufactured from natural gas or derived from oil shale or the liquefaction of coal. Presently known indigenous reserves of oil and condensate in Bass Strait and elsewhere may be extended to lengthen the period of Australia's self-sufficiency to the end of the decade, provided the present annual rate of growth in the use of liquid fuel is held steady or decreased. But ultimately, unless new and economically viable oil fields are found, and provided also that alternative sources for liquid fuels are not developed for technical or economic reasons, Australia's dependency on foreign imports of oil will grow. Given the present situation of dependence on crude oil, Australia's 1977 position of 70% self-sufficiency in petroleum products (largely petrol) could decline to about 55%-60% by 1985, and to 50% by 1990 depending mainly on the performance of additional oil fields, including Fortescue and Flounder, that are brought on stream in Bass Strait. Forman (1978) states that by 1985 the figure for self-sufficiency may be 45%, if indigenous production of oil begins to decline about 1981. In this regard it has been said earlier that it may be considered technically possible to produce oil from a particular reservoir, but economically not viable. The decision

to put such a reservoir on stream may depend largely on the price received for each barrel of oil. Consequently, for economic and technological reasons it is not always possible to foresee the development of known reservoirs of oil for years ahead, and estimates of available supplies and future self-sufficiency are subject to periodic revision.

Australia relies heavily on petroleum (about 55%) and coal (about 40%) for energy supplies. Less than 2% is supplied by hydroelectric power. Of the petroleum, about 48% is provided by oil and 7% by gas. These figures are subject to annual revision, particularly as natural gas and LPG continue to displace the use of oil. The growth of hydroelectric power, especially in Tasmania, is unlikely to significantly alter the overall pattern of energy use in Australia. Analysis of this pattern shows that transport uses 57% of our oil requirements, industry 34%, domestic and commercial appliances 7%, and electricity generation 2%. Of the oil used for transport, road transport accounts for a massive 80%, sea transport 10%, and rail and air transport each 5%. A further breakdown indicates the large amounts of petrol consumed by private passenger cars which account for 70% of the fuel required for road transport. In other words, about 32% of Australia's total oil requirements is consumed by the private motorist.

Future Oil Needs

It has been estimated by Esso (1978) that by 1990 the Australian daily consumption of oil, which amounted to about 600,000 barrels in 1977, and 750,000 barrels in 1979, will have climbed to about 1 million barrels. Nearly a third of the oil consumed during 1975-78 was imported. In 1975 the cost of oil imports was \$A740 million (Eckelmann, 1977), in the period 1977-78 it was \$A1155 million (ANZ Bank Business Indicators, June 1979).

Assuming no marked decline in domestic production of oil, a stable relationship between the Australian and US dollars, the availability of oil on the world market, and an average annual price rise of 10% compounded above 1979 levels, the ANZ Bank estimates that oil imports in 1990 could cost up to \$A6000 million in terms of 1979 dollars. The cost in terms of inflated dollars may be closer to \$A8000 million. But it must be kept in mind that such figures are speculative and that although the price of imported oil will certainly rise in terms of dollars, and probably also in terms of real cost, the dates assigned to such costs may be wide of the mark. New discoveries of indigenous offshore oil, found within the years to 1985, may markedly alter prognostications for 1990 and beyond. But the inevitable time lag in developing such discoveries precludes the possibility that they may alleviate the oil supply or reduce the costs of Australia's oil requirements during the latter half of the 1980s. At some time during this period, before new discoveries can be brought on stream or alternative supplies of shale oil or synthetic liquid fuels can be brought into production, a severe shortage of oil may place further constraints on the economy of Australia.

Of the alternative possibilities for the production of synthetic liquid fuels in Australia, the liquefaction of coal appears to offer the best prospects. The way is not yet clear to operate a plant on a large, economically viable basis, and the technology of coal conversion must be further developed as rapidly as possible during the early years of the 1980s. It has been estimated by Froggatt (1978) that a plant producing 100,000 barrels of oil a day would require 10 million tonnes of coal a year. This amount of coal is approximately one third of the tonnage of brown coal mined each year for the generation of electricity in Victoria, and about one fifth of the black coal mined annually for domestic use and export in 1979. Yet it would produce only about one tenth of Australia's estimated oil requirements in 1990. Apart from consideration of the large tonnages

of coal that would have to be processed, the plant requirements for water would amount to as much as 600,000 barrels a day, some of which could probably be re-cycled. The cost for such a plant, excluding mining and transportation costs, would probably well exceed \$1000 million in terms of 1979 dollars. In terms of the cost per barrel of the fuel produced, it may continue for some years to be cheaper to import oil. Considerations other than costs, such as national security and self-sufficiency in situations of emergency will have to be weighed, and for such reasons the active technical and financial co-operation of the oil industry and the Commonwealth Government may be necessary.

Lessons to Learn

The price rises and scrambles for supplies of crude oil and petroleum products that have occurred periodically since 1974 have alarmed the industrialized countries and alerted them to the dangers of relying too heavily on particular sources of oil, despite the still higher costs of alternative supplies of liquid fuels. The lesson has not been lost on the Australian public, although there is a tendency toward panic when supplies are temporarily threatened, and on a carefree attitude of not to worry when the petrol pumps run freely. The expediency of buying oil at spot prices on the open market, or on prices negotiated with producing countries, is a stop-gap procedure that does not preclude the necessity to increase our exploration for new oil and gas fields, and to develop an improved technology for the manufacture of synthetic liquid fuels.

All this will cost money and effort, but there is no other alternative. Future energy supplies, especially those from crude oil, natural gas, shale oil, and synthetic liquid fuels will be much more expensive in real terms in the years to 1990 and beyond. It must also be realized that although new oil fields may be discovered and developed in

Australia, ultimately our dependence on such conventional sources will rapidly decrease as demand for liquid fuels outstrips the diminishing production from oil fields. It is not possible to quantify such an outlook, as no one can tell how much, if any, additional oil may be found onshore or offshore. Exploration only can provide an answer to that question, and the final analysis lies with the drill. Exploration must be encouraged and promoted by the Commonwealth and State governments. How this can be brought about most effectively is a subject variously debated according to shades of political opinion and economic views. But it must be recognized that expertise and experience lie with the oil industry which can and does operate throughout the world in various political and economic climates. Flexibility is a necessary attribute, and although hard bargaining may be involved in negotiations with government, once agreements are determined the continuation of exploration and development of production depend on the stability of the ground rules. Changes in mid-stream not only shake the confidence of the oil industry and slow the development of current projects, but deter the planning of further exploration. As mentioned in previous chapters, a great deal of money is involved in exploration which entails a large degree of risk. The willingness to assume such risks should be encouraged by legislation and the active co-operation of governments and the oil industry. Finally, it is pertinent to reiterate that the public should be aware of the long lead time necessary to bring a newly discovered offshore oil field into production.

Taking all of these factors into consideration it is clear that government policies can either encourage or inhibit the discovery or development of new sources for oil or natural gas, particularly in respect of the forward planning required by the long lead time necessary to bring such sources into production. For these reasons it is essential that government guide lines and policies be sufficiently flexible to accommodate changing economic situations and to allow room for the industries responsible for

exploration and development to make decisions and operate with a minimum of impediments and delays. This is not to say that the oil industry should be allowed to operate on a free-wheeling basis, but that mutual understanding between the industry and governments, and a sincere desire to solve common problems of vital significance to the public welfare should be energetically pursued.

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