DEVELOPMENT OF AUSTRALIA'S NATURAL GAS RESOURCES

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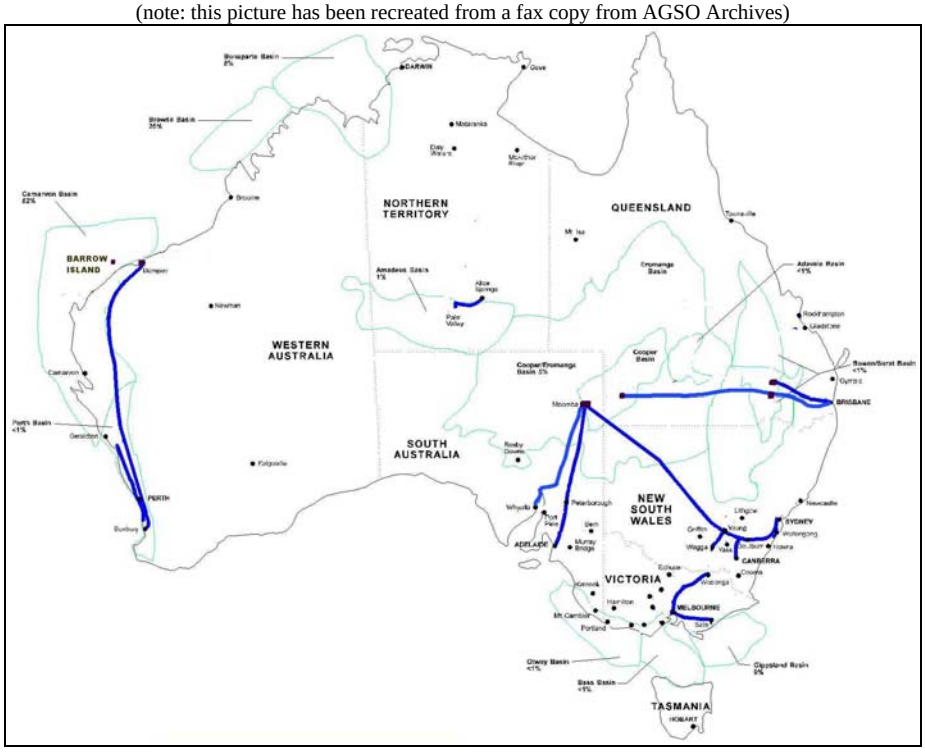
Australia's s natural gas industry began in October 1900 when gas was discovered in a water bore near the hospital in the town of Roma in Queensland (1). Encouraged by this unexpected gas find, petroleum exploration proceeded spasmodically in the Surat Basin and other basins in Australia through to the 1950s, but an oil find at Rough Range in the Carnarvon Basin in Western Australia during 1953 sparked new interest in petroleum exploration. Thereafter, petroleum accumulations were discovered in a number of basins. Table 1 lists the first significant gas and oil discoveries in each basin (2,3).

TABLE 1
Significant petroleum discoveries in Australia, 1960-1983 (see Fig. 1)

Basin	Oil/gas	Year of discovery	Discovery Well	Basin	Oil/gas	Year of discovery	Discovery Well
Surat	gas	1960	Pickanjinnie 1	Carnarvon	oil	1964	Barrow 1
	oil	1961	Moonie 1		gas	1971	North Rankin 1
Cooper	gas	1963	Gidgealpa 2	Gippsland	gas	1964	Barracouta 1
	oil	1970	Tirrawarra 1		oil	1967	Kingfish 1
Perth	gas	1964	Yardarino 1	Bonaparte	gas	1969	Petrel 1
	oil	1964	Yardarino 3		Oil	1983	Jabiru 1
Amadeus	oil/gas	1964	Mereenie 1	Browse	gas	1971	Scott Reef 1
	gas	1965	Palm Valley 1	Otway	gas	1979	N. Paaratte 1
				Canning	oil	1981	Blina 1

Figure 1. Australia: Major sedimentary basins, major pipelines, and petroleum production areas

(note: this picture has been recreated from a fax copy from AGSO Archives)



Further exploration and development drilling in the basins listed in the table revealed that the resources of natural gas far exceeded those of oil in terms of energy equivalent. Australian

sedimentary basins where petroleum accumulations have been identified are considered to be gas prone, and it is expected that the majority of this country's undiscovered resources of petroleum will be in the form of natural gas (4). If this is the case, then it is worth while considering the future of the natural gas industry in Australia to determine whether new-found and known accumulations of gas can be developed to produce a cash flow for the successful explorer.

Exploration for petroleum is normally undertaken in anticipation of rewards or profits that will result from the development of discoveries. It is therefore essential for explorers to recognize the potential for development of any discovery. A continuing sequence of discoveries and their development is necessary so that cash flows from production can finance exploration and reward investors with dividends and improve the value of the company's shares.

In the context of the development of natural gas or, for that matter, of any natural resource, four essential criteria must be met to ensure success.

(1) A market for the product of that resource must exist or be created.
(2) The product must be suitably priced.
(3) Adequate infrastructure must be available to support development.
(4) The size of the resource must be adequate to satisfy the market and recoup all costs.

As an example of the importance of these four criteria it is useful to consider the development of Australia's first petroleum accumulation in the Surat Basin in Queensland, which was referred to earlier.

For six years after its discovery, the well near the Roma hospital produced gas at a rate of about 2000 cubic metres per day, all of which was simply wasted until, in 1906, a developer perceived that the gas could be used for street lighting in the town. So the well was brought into commercial production. At first sight, this development met all four criteria. There was certainly a market, represented by the citizens of Roma who wanted gas lights, and the prices for which the gas was sold met the requirements of both the developer and the customers. The town provided the infrastructure, and since the well had produced gas for nearly six years the reserves were thought to be adequate. Unfortunately, within six days of the commencement of commercial production the last criterion failed to be satisfied. The reserves were inadequate, supply failed, and the development foundered.

In addition to the four basic criteria for development of a gas discovery there are, of course, other aspects to be considered, most of which have only incremental affects. Typically, these aspects include:

- taxation and royalties,
- environmental requirements,
- Aboriginal land claims,
- production licences,
- export licences,
- foreign ownership requirements.

Many a stalled development has been blamed on these items, but none represents an insurmountable problem, as the success of many oil and gas developers in Australia will testify.

To gain an appreciation of the way in which a developer goes about satisfying the four essential criteria, it is worth while considering the example of the development of the Cooper Basin (5).

The first discovery in the Cooper Basin was made in 1963 when the Gidgealpa 2 well produced a gas flow. A number of dry holes followed this discovery, but by 1967 the Moomba field had been discovered and evaluated. Adequate reserves of gas were identified in the Moomba and Gidgealpa fields and the fourth criterion for development was satisfied. However, the prime requirement, that of market, was not yet defined. Fortunately, the Electricity Trust of South Australia was in the final stages of the design of a 1280 MW oil-fired electricity generating station which could be modified to burn natural gas. That station, together with the use of natural gas by the South Australian Gas Company, provided a large enough market to justify investment in the necessary infrastructure, which consisted of gathering lines, a gas treatment plant to remove carbon dioxide, and a 781 km pipeline to Adelaide.

Finally, the price of the gas was determined by relating it to the price of he competing source of energy – heavy fuel oil. Since all the criteria were satisfied, the development of the Cooper Basin proceeded and it has been very successful. There will; however, be a continuing need to keep the criteria balanced. For example, the price of gas must continue to offer the developers adequate rewards, but not be such as to lure the market away to alternative fuels. This balance is perhaps not best maintained by arbitration.

The development of other gas fields in Australia proceeded along similar lines to those of the Cooper Basin, where a major customer acted as the catalyst to initiate development and then to sustain it. Table 2 lists gas developments together with an indication of how each of the four criteria was met.

Table 2 Development of gas discoveries in Australia (see Fig. 1)

Basin	Start of production	Market	Price related to	Infrastructure	Reserves
Gippsland	1968	Melbourne gas utility; power generation	fuel oil	Off-shore platforms, gas treatment, 173 km pipeline	more than adequate
Surat	1969	nitrogenous fertilizer manufacture; Brisbane gas utility	naphtha	437 km pipeline	limited
Cooper	1969	electric power generation; Adelaide gas utility	fuel oil	gas treatment, 781 km pipeline	limited
	1976	Sydney gas utility (including fertilizers, steel manufacturing)	fuel oil, coal	1300 km pipeline	
Perth	1971	alumina refinery; Perth gas utilities	fuel oil, coal	416 km pipeline	almost depleted
Amadeus	1983	electric power generation	distillate	150 km pipeline	adequate
Carnarvon	1984	alumina refineries power generation; Perth gas utilities	fuel oil, coal	off-shore platform gas treatment, 1500 km pipeline	more than adequate

The explorers who were rewarded with discoveries in the basins listed in Table 2 were fortunate in that all criteria for successful development were present or could be assembled by cooperation of customers, developers, and governments. The situation is, however, less clear for those who have already defined large reserves of gas and have few or no short-term prospects for development, and,

given the greater likelihood of finding gas in Australia, the rest of this paper addresses the possibilities for further gas project development.

Market for Natural Gas

(a) Australian markets

We can make no generalizations about the market for natural gas in Australia. There are regional supply/demand balances which need to be considered separately. There are also pricing differences, which reflect the economic conditions current at the time of the signing of a contract to supply a market. A brief summary of these regional markets follows (see also Figure 2 for graphical representation of each State's supply and demand balance).

Queensland

The Surat Basin currently supplies gas to Brisbane and a few regional centres. Reserves in the producing fields are being depleted but recent discoveries in the Denison Trough region will probably provide adequate supplies for the existing Brisbane market and perhaps for other industrial needs in Gladstone. In short, the Queensland market. is adequate to support continuing intensive exploration. There is a good balance between supply (including new discoveries) and demand without the need to augment supplies from other basins for at least 15 years, provided no new and unexpected market arises.

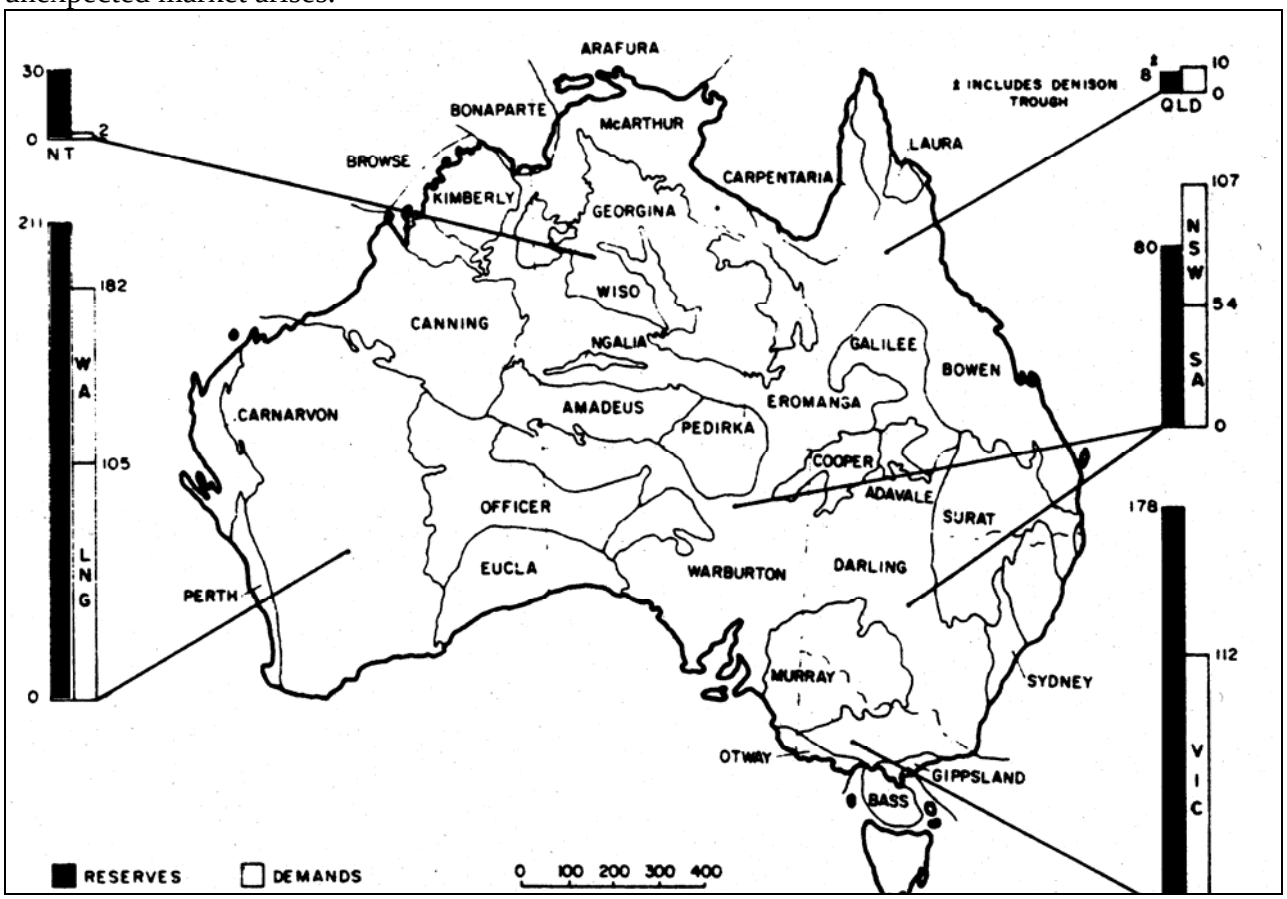


Figure 2. Australia: Natural gas demands 1983 - 2000 and reserves as at 1 January 1983

New South Wales and South Australia

New South Wales and South Australia obtain gas supplies from the Cooper Basin, and neither State has access to adequate supplies for the long term. Obviously, more exploration is required because all 'new gas' (that is, gas outside existing proven and probable reserves) discovered will find a market. Current contracts for the supply of gas are such that, given the reserves dedicated by the developers, supplies to South Australia will terminate in 1987 while supplies to New South Wales will plateau in 1984 and terminate in 2001. The New South Wales contract allows for additional reserves to be dedicated by the developers, resulting in a supply plateau in 1988 and termination in 2006. A further contract for gas supplies to South Australia gives that State rights to all future discoveries once the second requirement of the New South Wales contract is met. This situation, together with differing pricing arrangements, is not conducive to proper resource management or to orderly marketing.

The author has for many years been a proponent of a gas reserve sharing plan for the Cooper Basin. All remaining proven and probable reserves could be consolidated into a single quantity of 'old gas' and reallocated to each State on the basis of predicted demands. Current forecasts suggest that known economic reserves would be exhausted in about 1995 if shared in this manner. The price of this 'old gas' could be agreed upon at about the current price to South Australia, with an agreed modest escalation (e.g., CPI), to avoid the costly and inconvenient arbitration process.

All new finds of gas, with the exception of, say, 10% for the producers to sell at their own discretion, could be allocated to each State in proportion to its needs or by agreement. The price of new gas could be negotiated and would be applied to current supply contracts in the ratio of new gas discoveries to remaining old gas reserves. Thus explorers would begin to get immediate rewards for discoveries and consumers would be buffered against future rapid price rises.

Recently there have been a number of new and significant discoveries of gas in the Queensland portion of the Cooper Basin which have enhanced its future as a gas producing region. As can be seen from the assessment of the market for gas in Queensland, that State is quite well supplied in the short term and will not need augmentation from the Cooper Basin for about 15 years. Consequently, it would be possible for this newly found gas to be made available to the pool supplying South Australia and New South Wales, with the proviso that some proportion of the reserves, as they are progressively defined, be set aside for future use by Queensland. The early development of this portion of the Cooper Basin would provide early cash flow for the explorers and royalties for the Queensland government as well as ensuring that the infrastructure necessary for gas production was in place well in advance of Queensland’s needs.

The acceptance of this plan by producers, consumers, and the governments involved with Cooper Basin gas would result in an improved incentive to continue exploration for gas. The continued presence of an under-supplied gas market in South Australia and New South Wales provides an incentive to explore in other basins adjacent to the Cooper, such as the Pedirka and Arrowie.

Victoria

Victoria's reserves of gas are adequate for many years and are available at such a modest price that there is little incentive to explore for more. Possibly the only exception is gas for western Victoria from the Otway Basin. If gas can be produced and delivered to markets in the west of Victoria at a lower price than that from the Gippsland Basin, then such gas would find a market.

Western Australia

After the completion of the Dampier - Perth natural gas pipeline, the market for natural gas in Western Australia will be fully satisfied for many years. This implies that there is little incentive to continue exploration for gas in Western Australia.

Tasmania

No natural gas is marketed in Tasmania, but if supplies were available both Hobart and Launceston would represent modest markets. The use of natural gas in power stations using cogeneration techniques would be justified to provide a balanced mix of hydro- and thermal electricity generating stations.

The only area to have experienced any substantial exploration for petroleum is the off-shore Bass Basin north of Tasmania. Results of exploration in this area have not been very encouraging.

Northern Territory

A small market for natural gas for power generation exists in Alice Springs but this has been fully satisfied by development of the Palm Valley field. A potentially large market for gas for power station fuel existed in Darwin until last year, but the Northern Territory Government has decided to establish a coal-fired thermal power station using coal imported from the eastern States. Modest markets for fuel for mineral processing exist at Nhulunbuy (alumina) and the Alligator River area (uranium), and these could be served by discoveries in the Arafura Basin.

(b) Export markets

With the present state of the world economy and the continuing fall of oil prices in real terms, the market for liquefied natural gas (LNG) is heavily oversupplied. The existing LNG plants throughout the world are capable of supplying 60 million tonnes per year but are currently producing 46 million tonnes per year. Obviously, no new grass-roots LNG plant can be placed into operation while this surplus exists.

Japan has rearranged its fuel mix to include more coal and less LNG. The USA is importing only modest amounts of LNG, most of which serve only to satisfy current contracts since there is a surplus of gas in both the USA and Canada at the present time. Thus the medium-term market for LNG is not promising.

(c) Manufacture of methanol, gasoline, and octane extenders

One promising market for natural gas is for the manufacture of methanol or gasoline. The manufacture of methanol is well proven but its market as a motor vehicle fuel will be limited until it is accepted by motor vehicle manufacturers and fuel distributors as a viable alternative fuel to conventional petroleum products, either as straight methanol or a blend with gasoline. If, however, natural gas can be converted to gasoline, its market potential is significant. Explorers for petroleum would do well to monitor the progress of the Mobil gas to gasoline process currently being developed on a commercial scale in New Zealand(6). If this project is successful, then previously unusable large deposits of natural gas may be able to be developed and processed on site. It is conceivable that gas to gasoline plants could be accommodated on large barges moored directly over off-shore fields such as those in the Carnarvon and Bonaparte basins off north-west Australia.

Recent reports indicate that octane extenders can be made from natural gas and LPG. The demand for octane extenders could increase in the near future because of new requirements for lead-free

gasoline. Refiners may opt for intensive use of extenders rather than invest large amounts of capital in new reforming facilities.

(d) Mineral processing

Despite a downturn in Australia's exports of iron ore, alumina, nickel, and other mineral products, an export market for semi-finished metals could be developed as a result of cooperative ventures between mineral and petroleum companies that have access to large gas reserves without any prospect of development for many years. Markets for gas for the production of iron from iron ore in the Pilbara and South Australia and the metals from the ore from Roxby Downs could be substantial and should be investigated.

(e) Fertilizer manufacture

The Australian nitrogenous fertilizer industry (ammonia, urea, ammonium sulphate/nitrate) is at present under threat from low-priced imported products. Most of the nitrogenous fertilizer is manufactured using natural gas as the major feedstock, and its selling price and competitiveness are heavily dependent upon the price of gas. Australia's agricultural industry represents a very large and growing market that should be supplied from this country's resources. This is yet another area in which the possibility exists for cooperation and joint development and in which petroleum companies could become involved.

Price

The price of natural gas varies from State to State. Readers are referred to a paper read by McCaul at the 1981 APEA Conference(7), which gives a good summary of the mechanisms that have determined the present prices of natural gas in the various States.

On the matter of gas prices in the future, close consideration must be given by gas explorers and producers to the opportunity cost of gas in a competitive energy market. The price of oil is falling, as is the price of coal. Recent coal price negotiations with Japan have reduced the export price of coal, and there is at present an over-supply of the market. Reductions in the domestic price of coal are sure to follow as suppliers endeavour to maintain mine operations.

Coal technology developed between 1973 and 1981 will now allow coal to be burned more efficiently and cleanly, and it can be used for many more processes than earlier techniques allowed. For example, there are now field-proven processes that use coal as the source of synthesis gas for nitrogenous fertilizer manufacture and as fuel for gas turbines. Coal is thus becoming more of a competitor for gas and its price will have an increasing effect on gas prices.

Infrastructure

Geological misfortune resulted in most of Australia’s petroleum accumulations being long distances from markets. As a result, the infrastructure (roads, railways, communications, pipelines, treatment plants, towns) necessary to support the development of discoveries is seldom available. The developers are faced with the large cost of providing all the necessary facilities. In some cases they may be able to take advantage of facilities already provided by earlier developers. For example, oil and gas finds in the Surat, Cooper, and Gippsland basins can be easily developed by utilizing existing gathering, treatment and transmission systems. One of the barriers to this approach could be the fact that many pipelines are not classified as common carriers, and pipeline operators could either refuse to transport a competitor's product or charge an unacceptably high haulage tariff.

Reserves

It is self-evident that the developer of a gas resource must ensure that the reserves dedicated to a particular market are adequate to fulfil his obligations at reasonable production costs right to the end of the life of the reserves. The Bureau of Mineral Resources has prepared a programme to determine. minimum economic reservoir size, which could assist gas field developers in this area (8).

The developer must carry out detailed reservoir engineering and production testing to determine the amount of economically recoverable reserves and their optimum rate of production. Unfortunately, extensive production testing is seldom possible in the absence of a market because of the need to flare gas for a sufficient length of time for reservoir conditions to reach equilibrium. If long-term production testing is not possible the developer has to base his reserve estimates and production rate on the best available geological information.

The Future

The discovery of a petroleum accumulation is of no value to a company (except perhaps on the share market) unless that discovery can be developed and placed in production. This can only be done if the company takes into account the basic parameters for development market, price, infrastructure, and reserves. Through consideration of those criteria it becomes clear where a company should concentrate exploration effort.

A discovery in the Surat or Cooper or Gippsland basins would be more profitable to develop than one of equal size in the Bonaparte Basin. Explorers should be encouraged to look for gas in the basins well served by infrastructure, including areas adjacent to pipelines in South Australia and Queensland - these must include the Arrowie Pedirka, Adavale, and Eromanga basins.

On the other hand, there is little to be gained by finding more gas in Western Australia, where both the local and the export markets are currently oversupplied and will probably remain so for many years. Gas finds in the Cooper Basin and adjacent areas can be developed quickly if the reserve-sharing plan outlined earlier is adopted. Gas to gasoline, octane extenders, fertilizer production, or mineral processing on a large scale are seen to offer the best possibilities for future development of additional gas finds in the Perth, Carnarvon, Canning, Browse, Bonaparte, Arafura, and Gippsland basins.

Trans-Continental Pipeline

There have been suggestions that the construction of a trans-continental pipeline from Dampier or the Bonaparte Gulf in Western Australia to Moomba in South Australia would solve the north-west gas surplus problems and overcome shortfalls in the eastern states. This proposal must be examined in the context of gas supplies and demands throughout Australia.

Firstly, no such pipeline should be built until it can be shown to be economically viable - to repay its current cost of about $2500 million and to show a reasonable rate of return would require a large throughput over a long period of time. Secondly, sufficient incremental gas (i.e., in addition to supplies from existing producing basins including the Gippsland Basin) must be able to be marketed as soon as the pipeline is built in order to maintain a high throughput. Thirdly, adequate reserves must be established to maintain that throughput for 20 to 25 years.

Finally, such a pipeline should only be built when incremental gas from the Eromanga, Cooper, and Pedirka basins costs more than the delivery of gas from the north-west. This implies a field price for gas in those basins of about $5 per gigajoule (1984). At this price, fields much smaller than

those currently producing in the Cooper Basin could be developed, and enhanced recovery techniques could be used.

Amadeus Basin-Moomba Pipeline

The argument applying to a transcontinental pipeline applies equally to the proposed construction of an Amadeus Basin to Moomba pipeline, the only proviso being that, because the capital cost would be lower, throughputs and dedicated reserves could be much more modest.

Summary

Our exploration history shows that Australia's sedimentary basins are gas-prone, and the market for natural gas is quite poor when compared with that for oil. However, exploration for oil and gas must continue to ensure our self-sufficiency in petroleum in the long term.

McKay's paper to APEA in 1983 (4) suggests that Australia's undiscovered hydrocarbon resource base is quite encouraging but, given the greater likelihood of gas discoveries, consideration must be given to a more aggressive and innovative gas marketing policy. Companies engaged in gas production must be market-oriented and must recognize that they are only one part of a competitive energy market. Traditional industrial markets will find alternative fuels or simply go out of business if gas prices are not in step with prevailing community expectations and prices of other sources of energy. For some time in the future gas has to be considered as an abundant resource and not looked upon as a premium fuel or reserved for use as a petrochemical feedstock. The future for the development of new finds of natural gas in areas remote from existing production facilities is not assured, but could be improved by innovative marketing and pricing coupled with a cooperative approach with mineral extraction and processing or chemical industries.

References

1. *Roma Gas Project*. AAR Ltd, (1979)

2. Beddoes L. R. (1973). *Oil and gas fields of Australia, Papua New Guinea and New Zealand*.

3. *Location Index Exploration Wells and Permits.* APEA.

4. McKay B. G. (1983). *The undiscovered oil and gas potential of Australia.* APEA Journal. 23 (1), 27-32.

5. Hudson H. R. (1980) *Cooper Basin Exploration, development and pricing issues*. Centre of Policy Studies, Monash University (Conference on Natural Gas in Australia).

6. Maiden C. J. (1983). *New Zealand gas to gasoline plant.* APEA Journal, 23 (1), 33-43.

7. McCaul B. P. (1981). *City gate natural gas pricing in Australia* APEA Journal, 21 (1), 33-40.

8. Bureau of Mineral Resources (1980). *Minimum economic reservoir size project*. BMR Record 1980/31 (unpublished).