Lend Lease
INFRASTRUCTURE

CSM Commercialisation

A Developer / Investor's Perspective

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Presented by
Ken Aspinall & Glen Gill
Investment Managers
Lend Lease Infrastructure

A) Introducing Lend Lease Infrastructure

Before discussing the merits of coal seam methane from an infrastructure developer and long term investor's perspective it seems appropriate, given the fact that Lend Lease is a relatively new entrant to the energy and gas industries, to first provide a brief overview of Lend Lease Infrastructure.

Lend Lease Infrastructure's parent, the Lend Lease Corporation, as a top twenty Australian listed company and an established leader in the provision of integrated property and financial services, on a domestic and international level (refer to Figures 1.0 and 2.0). Lend Lease Infrastructure is the development arm for Lend Lease Capital Services, the newest company within the Lend Lease Group. Lend Lease Capital Services has transformed its highly successful formula for project development, financing, and management

developed in the property industry to infrastructure projects, thereby offering an innovative approach, a complete range of services, and maximum benefit to all stake holders (refer to Figure 3.0). In a relatively short time, the company has through its subsidiaries involving partners who apply world's best practice in each industry sector, become a leading joint sponsor, developer, and manager of public and private sector infrastructure projects in Australia and the Asia Pacific region. Projects include Sydney's $200 million Prospect water filtration plant, several hydro electric and gas fired power projects, and the Brisbane International Airport Terminal.

Lend Lease Infrastructure is actively involved in economic infrastructure developments including airports, mining, ports, power, rail, water and waste water. Lend Lease Infrastructure specialises in the origination, sponsorship, and provision of development equity for infrastructure projects. Since other divisions within Lend Lease such as Project Finance and Development Capital are the expert financial advisers, the focus of this paper is predominantly from a developer / investor rather than a pure investor. Such a perspective, hopefully, will be of greater general interest.

The shift toward more private sector involvement in developing, owning, and operating infrastructure and the general lack of both infrastructure and well managed infrastructure in Australia has encouraged Lend Lease to draw on and apply its considerable resources and core competencies to this specialised area. Lend Lease is very comfortable competing in an open, fully contestable market and looks forward to the emerging fully competitive energy industry of Australia

B) Coal Seam Methane (CSM) - Unconventional Gas

Coal seam methane is distinctly different in many ways from the conventional natural gas which we have all grown to know and love. Unlike most conventional gas which must be searched for and found utilising sophisticated exploration technology, coal seam methane gas is akin to the low pressure methane found in vast shallow blankets of shaly sandstone structures such as those found in south east Alberta, Canada or the vast quantities of heavy oil trapped in the tar sands of the northern part of that same province. The resource, or more accurately the insitu methane desorption capability as is the case for CSM, is large and relatively easy to quantify, therefore attracting excitement throughout the energy industry. A recent overview of Australia's CSM by the AGA states that inferred CSM resources are as high as 532,000

PJ's, and that most, if not all, is in close proximity to major population centres and markets.[1] With relatively small capital expenditure the size of the resource base can be quite accurately be estimated. The same report states the following concerning the amount of recoverable CSM energy having due consideration to geological and technical factors: "In the United States, 30 percent of discovered coal seam methane is normally recoverable."[2] This statement insinuates that some 160,000 PJ's of recoverable CSM is available. The report tabulates estimates by others to be as high as 14,600 PJ's.[3] Nevertheless, there seems to be an abundance of recoverable CSM in Australia.

Clearly, the main barrier to the extensive development of CSM in Australia is economic factors which determine whether any recoverable resource at any given time is commercial or not (refer to Figure 4.0). The AGA report is silent regarding the lack of CSM commercialisation in the two countries blessed with by far the most CSM resource on a world-wide basis, namely Russia and Canada. Furthermore, the tar sands of Alberta, Canada contain more known oil resource than the oil reserves of the Middle East, yet only two relatively small tar sand recovery projects have been developed. Conversely, the shallow tight conventional methane resource of Southeast Alberta, which was once considered to be of no commercial value, has had widespread and extensive development and is a major contributor to Canada's natural gas production. The CSM industry has grown substantially in the US and contributes approximately 20% of the nation's total natural gas production. In order to achieve the highest probability of success in the development of Australia's CSM resource, we believe that it is important to understand and appreciate the commercial differences between a resource such as this and the conventional hydrocarbon resource which Australians are more accustomed to.

It is appropriate, from time to time, to revisit and perhaps challenge first principles concerning the natural gas resource base and the economics which drive supply and demand and ultimately gas reserves. Gas reserves are herein used to describe that portion of the gas resource which is commercially recoverable while gas resource refers to insitu gas including that which is either unrecoverable or non-commercial.

> *Many people think of the natural gas resource base as a 'finite volume', measurable with existing analytical yardsticks using current technology. An alternative view of the resource base is the 'Resource Pyramid', a more dynamic resource view than the*

[1] Australian Gas Association, *Coal Seam Methane in Australia: An Overview,* AGA Research Paper No. 2, April 1996, p. 7.
[2] Ibid., p. 19
[3] Ibid., p. 15

> *now dominant resource depletion theory .... The resource 'grows' with advancing knowledge and technology. ... The effect of technology improvement is to either lower extraction costs or improve accessibility. A key result of this alternative theory is that if the pace of technological improvement matches the decline in resource quality, then long term real gas prices remain constant.*[4]

This resource pyramid concept (refer to Figures 5.0 and 6.0) has for some time now replaced the 'theory of the mine' in the highly competitive and economically efficient North American gas industry. CSM is clearly a lower grade resource than much of the conventional natural gas resource base of Australia, as is evidenced by the relatively high field prices purported as necessary for projects to be economic. At any given time, one, will exploit as deeply in the resource pyramid as economics permit. Pending state or national energy strategies, occasionally economics are temporarily assisted by government policy. "Coalbed methane, gas from tight sands, and Devonian shale gas were recent beneficiaries of a government tax incentive program (Section 29). With this support, technology was developed and transferred to the field, which resulted in tremendous conversion of resources to reserves, as seen in the San Juan basin example."[5]

Although resources like CSM require relatively little capital to quantify the resource base, they often require substantial capital investment over a long time period in order to establish an acceptable level of confidence in their extraction and delivery costs; and hence commercial viability. This distinction is illustrated in Figures 7.0 and 8.0. Although exploration costs are small, production testing or pilots are typically long term in nature and capital intensive. The commercial impact of this is as follows: conventional gas reserves can generally be booked earlier in time after incurring only finding costs while CSM reserves can only be booked after rigorous and time consuming production testing. This feature is important from a commercial perspective for it drives full cycle, half cycle, and incremental costs, all of which are fundamental to producer behaviour in a competitive market. Furthermore, upon its development, CSM typically has a production profile which is uncharacteristic of conventional gas (refer to Figure 9.0). Such a production profile places new demands on the gas industry which must be met in order to overcome commercial hurdles.

[4] Enron Corp, *The Outlook for Natural Gas,* March 1993, p. 9.
[5] Ibid., p. 9

C) Lend Lease Infrastructure's Methane Energy Power Project

Lend Lease Infrastructure, in a 50% partnership with Energy Developments Ltd, participated in the development, ownership, and operation of two CSM fired power stations associated with BHP's Appin and Tower coal mines located in New South Wales, south west of Sydney. These two power stations were built at a combined cost of approximately A$100 million, have a combined output of 94 MW from two series of one megawatt state-of-the-art lean burn gas engines and became fully operational in September of 1996 (refer to Figure 10.0). As they are fuelled predominantly by CSM extracted in the process of long wall mining, they are Australia's first attempt at finding a commercial use for CSM. Whilst this extraction method differs from the conventional methods of CSM extraction when the primary product, these power plants demonstrate some of the peculiarities of CSM energy from a developer / investor's perspective.

The highest value use for the CSM by-product associated with the Appin and Tower coal mines was determined based on the following parameters:

- the product value for alternative CSM based products,
- the cost to process CSM into the desired product
- the cost of transporting the product to market

The low pressure of the extracted CSM, the distance to gas pipelines, the cost to process the CSM to pipeline quality, and the proximity of the mine site to high voltage power transmission lines all led to the selection of generation of high voltage power from low pressure CSM at the mine site as the preferred commercial option. The partnership involving gas engine specialist Energy Developments Ltd and developer / financing specialist Lend Lease Capital Services facilitated an innovative solution. A long term (15 year) electricity sale / purchase contract was established with the local electricity distribution company: Integral Energy (formerly Prospect Electricity).

The unproven nature of the CSM reserves and the variable rate of extraction associated with the mining activity had a significant impact on the commercialisation of the CSM at these two mine sites. The coal miner, namely BHP Collieries Division, had to demonstrate an acceptably high level of confidence in the CSM reserve by guaranteeing a specific level of supply. Top up gas is purchased as required from the local gas utility, AGL. The partnership proposing to develop the power station were then able to take a level of reserve risk and finance the project based on a significant amount of research and data on CSM production. These power plants are now both fully complete and operational. This project

demonstrates among other things, Lend Lease Infrastructure's flexibility in risk structuring and sharing to the extent that the commercial development of the CSM resource is possible

The Appin & Tower Methane Energy Projects won a National Energy Award in 1995 for their innovation and environmental excellence. Through the utilisation of CSM which otherwise would have been vented to the atmosphere, this project not only generates enough electricity to supply the needs of up to 60,000 Sydney homes but it also cuts greenhouse emissions by more than 100,000 tonnes per year[6] and reduce emissions of methane by 280,000 tonnes per annum.[7] The Appin & Tower Methane Energy Project is unique in that it is not only reducing greenhouse gas emissions, but utilising available energy sources in capturing the methane and burning it in high efficiency engines to produce electricity under commercial arrangements.

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D) CSM Commercialisation - General Factors of Importance

Due to the 'unconventional' nature of CSM, its commercialisation demands a different perspective and process than the traditional model familiar to Australia's gas industry. Furthermore, this new resource is seeking to enter the energy market at a time of unprecedented change; this timing creates both opportunity and uncertainty. Lend Lease believes that the commercialisation of CSM requires upstream infrastructure economies of scale unfamiliar to the Australian upstream sector to date, and an integrated perspective regarding the transportation and consumption of methane energy and its derivative products. Such a comprehensive effort, we believe, requires an unprecedented degree of collaboration and innovation by participants throughout the value chain and the participation of non-traditional players such as Lend Lease. As can be seen from Figure 11.0 there are less pro CSM factors existing in Australia today than there were in the US at the time of CSM inception.

While the technical and geological parameters associated with the extraction and production of CSM remain primarily the concern of the producer community, it is important to understand that Australia's lack of upstream service company infrastructure is a major deterrent to the development of such a resource. Service companies conduct the drilling, stimulations, completions, and testing of wells for the producer who purchases the right to extract from the resource owner - usually the government. The cost for such services to CSM developers in Australia is

[6] Australian Gas Association, *Coal Seam Methane in Australia: An Overview,* AGA Research Paper No. 2, April 1996, p. 40.
[7] Ibid., p. 39.

currently many times that of North America. Australia's service industry is sparse, reflecting the relatively low level of well activity, and is set up to predominantly provide services for high tech offshore well drilling, testing, and completions. The cost of such services could, perhaps be reduced significantly if CSM developers and other onshore producers such as Santos pooled and co-ordinated their activity. Furthermore, in aggregate it would be easier to make a substantial long term commitment to a particular service company and thereby realise lower costs.

The need for a relatively long production test or pilot period prior to confirmation that CSM is commercially recoverable at any given development project is assisted greatly if there exists a spot market for gas and the pilot is in close proximity to under-utilised gas transmission capacity. Access to a short term market under short term freight commitments allows early gas sales and associated cash flows offsetting testing costs. Temporary compression, short pipeline laterals, and the use of common facilities in this regard all assist the economics. The recent construction of two new partially utilised pipeline laterals in the Moura region by two competing CSM developers is an example of unnecessary costs. Such extreme competition among CSM projects may lead to the failure of the CSM industry. Furthermore, buyers need to appreciate why CSM producers are reluctant to make long term sale commitments prior to the completion of such prolonged testing. Since the majority of full cycle costs are incurred prior to the point at which resources become reserves, CSM producers cannot tolerate much delay in selling full production capacity once reserves are proved up. Such a delay is not as important when only exploration costs are incurred prior to the establishment of reserves, as is the case with conventional gas such as that of south west Queensland Cooper / Eromanga Basin. Santos experienced a 10 year delay between its discovery of gas reserves and the instalment of major production facilities and the commencement of gas sales to major Queensland based markets.

As is the case with any resource, proximity and access to markets is a major commercial consideration. Freight cost or pipeline tolls are often a major component of delivered prices, particularly in Australia where pipeline infrastructure is relatively immature and tolls often reflect the extraction of monopoly rent. In Queensland, PGT has been progressive in this area, both in terms of tolls and access principles. Higher cost CSM gas cannot afford to pay large pipeline transmission tolls; for Australia's emerging growth gas demand will not pay excessively high delivered prices. Since commercial CSM typically comes from shallow coal beds it's production pressure is low and its compression requirements are relatively large in order to meet the operating pressures of gas pipelines. These costs can be avoided by the development of onsite demand such as power generation at BHP's Appin and Tower coal mines or BHP's proposed ammonia plant at its Moura coal mine. The compression cost and pipeline freight savings must be more than offset by the additional transportation cost, if any, of the

derivative products, in this case electricity or ammonia. Another transportation factor to consider is the disadvantage CSM has over conventional gas due to its lower heat content. This feature does not detract from its market value, and in some cases may in fact enhance it. It may, however, lead to an increase in unit transportation cost on a per energy basis as pipelines often charge based on volume.

> *Importantly, the nature of coal seam methane production in the early years of project start-up is the greatest economic impediment, with typical coal seam methane wells involving a slow build up of production, and average well rates significantly lower than for natural gas wells. … An important characteristic of individual coal seam methane wells is their potential long life of up to about 20 years including a lengthy tail of low production.*[8]

This production profile combined with high initial water production and associated disposal cost significantly deteriorates the net present value of CSM projects from that of high deliverability initially water free conventional gas projects. As a result, it is important that CSM projects realise low cost water disposal and that gas production is not curtailed from its maximum capability. The net present value of a shut-in GJ of CSM gas approaches zero. In order to produce gas in such a manner there needs to be a buffer between market demand and production. Such a buffer can be provided to a degree by any one or a combination of the following mechanisms: market liquidity, gas storage, pipeline line pack, and fuel switchability.

Although the restructuring of the gas industry of Australia is expected to deliver some of the aforementioned mechanisms to allow the load levelling of CSM production and is expected to offer unprecedented demand growth and market access, increased gas to gas competition is also anticipated. With increased gas to gas competition, downward pressure on today's natural gas prices ex-field are expected. CSM developers / producers will have to ensure that their projects remain commercially viable under such circumstances. Furthermore, as both the gas and the electricity industries are undergoing major restructuring of the market, it is often considered imprudent for buyers of either commodity to lock in a fixed price or a CPI indexed price for any length of time. The market will generally want market sensitive floating prices; at least until price base lines are re-established for the new market conditions.

Other issues which impact the commercial viability of CSM include the uncertainty

[8] Australian Gas Association, *Coal Seam Methane in Australia: An Overview,* AGA Research Paper No. 2, April 1996, p. 33.

over the legal ground rules within which the industry operates, particularly in the state of Queensland. The rights to conduct methane drainage, evaluation, and production operations are somewhat confusing in Queensland due to the current uncertainty as to whether CSM is regarded as a 'mineral' associated with mining operations or as a 'petroleum' and therefore a stand alone hydrocarbon venture. This uncertainty has not only resulted in a conflict between petroleum producers and coal miners in Queensland, but has added a higher degree of uncertainty or risk to any commercial contracts related to the sale and purchase of CSM. In our view, it appears that Queensland's Department of Minerals and Energy has been pre-occupied somewhat with the promotion of two new gas pipelines connecting the largely dormant conventional gas found in the south west Qld Cooper / Eromanga basins to new gas markets in the greater Mt. Isa region and to the established markets and pipeline grid of east coast Qld, and have neglected its involvement in the state's CSM resource. The guiding principles adopted by the Qld government as outlined in the CSM overview released by the AGA last April offer little comfort to the investment community. The 'relative worth' of either coal or CSM to the government is a moving target pending variables such as royalty rates, commodity prices, and industry cost structures. The recently circulated position paper tabled to the industry by Queensland's Department of Mines and Energy regarding this CSM regime issue is, hopefully, close to resolving this concern.

Another issue which Lend Lease Infrastructure has faced in its involvement to date in the commercialisation of CSM revolves around the need for many investors to have an independent assessment of the CSM resource and the lack of industry expertise and consensus in this area. There are many different drainage techniques, many of which are rather experimental and CSM developers seem to relish the promotion of their unique application of such technology at the expense of that applied by their competitors. This behaviour combined with an apparent lack of competent independent appraisal firms results in a cautious and confused investment community. This hinders the use of CSM energy and prevents it from reaching its full commercial potential, as conventional gas as a reliable energy source is currently easier to evaluate.

E) Lend Lease's Capabilities Regarding CSM Commercialisation

As has been discussed and as indicated on Figure 12.0 the current structure of Australia's CSM industry does not demonstrate the ability to compete against conventional gas supplies nor perhaps sustain its own development. Slowly these factors are changing. PGT's proposed pipeline extension to Brisbane is at least one important evolution to a successful formula enabling the industry's development. A healthy industry which provides benefit to all participants is illustrated in Figure

13.0 and is one which displays less fragmentation than that of today.

Other important changes required in the CSM industry to facilitate its full commercialisation are:

- Producers becoming efficient collaborators and sharers of common infrastructure (refer to Figure 14.0);
- Buyers or end users introducing some flexibility into the procurement of gas supply and perhaps taking more supply risk in order to increase the long term depth of gas supply;
- Governments making clear policy decisions in support of open access on pipelines, the prohibition of monopoly rents for the use of such pipelines, clear rights and procedures in terms of CSM extraction and the establishment of a gas strategy which recognises the uniqueness inherent to kick-starting a CSM industry;
- A market with active involvement by non-traditional players such as wholesale marketing companies, risk management intermediaries, and developers in order to add the necessary depth to the industry to allow efficient commercial risk management and to fill the commercial gaps in the white spaces between the end users, the pipeline companies, and the producers (refer to Figure 15.0).

It is in this latter one that Lend Lease Infrastructure can and does add value to the commercialisation of CSM.

As a widespread infrastructure developer, Lend Lease is able to position itself across the CSM value chain without the biases accompanying such participants who are experts at one particular activity. Such a perspective allow optimal solutions for CSM commercialisation. Once the optimal solution is determined, Lend Lease then partners as required to import the appropriate expertise. A second advantage which Lend Lease offers is its willingness to underwrite and manage both technical and commercial risk. As the designer, constructor, developer, owner, and operator we are potentially more capable of understanding and managing the particular risk profile associated with CSM energy supply. Lend Lease have the capacity to provide commercial solutions which are only possible through an integrated risk management approach. For example, the partial funding of CSM development through a production payment vehicle is available to producers should Lend Lease be awarded a cogeneration project. Furthermore, Lend Lease is prepared to establish and price the cost of suitable contingencies such as fuel switching and backstopping gas supplies.

Lend Lease aims to participate in a range of related activities which provide flexible and seamless solutions to the gas industry in general and the CSM industry in

particular. Some of these activities are:

- energy marketing operations
- energy financial services including commodity financial derivatives and production payments
- energy physical hedges - dual fuelled power generation assets
- build, own, operate infrastructure assets
- energy procurement, trading, and commercial management
- physical and commercial risk management services

F) Conclusion

In conclusion CSM while a vast resource, is also an unconventional one and those involved in its commercialisation should beware of applying traditional business practices as quick solutions to its commercialisation. While unconventional in many ways, the challenge to commercialise substantial quantities is not an insurmountable task if those involved can collaborate in terms of sharing infrastructure and risks/rewards, and be as innovative as possible. Arriving at innovative solutions often means involving non-traditional players with diverse backgrounds and competencies. Lend Lease has been a major participant in one of Australia's first commercial uses of substantial quantities of CSM and would like to assist others in this regard. We hope that this paper not only provides some insights into the uniqueness of CSM which contribute to its commercialisation success or failure, but also demonstrates that Lend Lease Infrastructure is capable and willing to support this important initiative.