

AUSTRALIAN

# RESEARCH

INDEPENDENT INVESTMENT RESEARCH

## Leigh Creek Energy (ASX: LCK)

April 2019

## WHO IS IIR?

Independent Investment Research, "IIR", is an independent investment research house based in Australia and the United States. IIR specialises in the analysis of high quality commissioned research for Brokers, Family Offices and Fund Managers. IIR distributes its research in Asia, United States and the Americas. IIR does not participate in any corporate or capital raising activity and therefore it does not have any inherent bias that may result from research that is linked to any corporate/ capital raising activity.

IIR was established in 2004 under Aegis Equities Research Group of companies to provide investment research to a select group of retail and wholesale clients. Since March 2010, IIR (the Aegis Equities business was sold to Morningstar) has operated independently from Aegis by former Aegis senior executives/shareholders to provide clients with unparalleled research that covers listed and unlisted managed investments, listed companies, structured products, and IPOs.

IIR takes great pride in the quality and independence of our analysis, underpinned by high caliber staff and a transparent, proven and rigorous research methodology.

### INDEPENDENCE OF RESEARCH ANALYSTS

Research analysts are not directly supervised by personnel from other areas of the Firm whose interests or functions may conflict with those of the research analysts. The evaluation and appraisal of research analysts for purposes of career advancement, remuneration and promotion is structured so that non-research personnel do not exert inappropriate influence over analysts.

Supervision and reporting lines: Analysts who publish research reports are supervised by, and report to, Research Management. Research analysts do not report to, and are not supervised by, any sales personnel nor do they have dealings with Sales personnel

Evaluation and remuneration: The remuneration of research analysts is determined on the basis of a number of factors, including quality, accuracy and value of research, productivity, experience, individual reputation, and evaluations by investor clients.

### INDEPENDENCE – ACTIVITIES OF ANALYSTS

IIR restricts research analysts from performing roles that could prejudice, or appear to prejudice, the independence of their research.

Pitches: Research analysts are not permitted to participate in sales pitches for corporate mandates on behalf of a Broker and are not permitted to prepare or review materials for those pitches. Pitch materials by investor clients may not contain the promise of research coverage by IIR.

No promotion of issuers' transactions: Research analysts may not be involved in promotional or marketing activities of an issuer of a relevant investment that would reasonably be construed as representing the issuer. For this reason, analysts are not permitted to attend "road show" presentations by issuers that are corporate clients of the Firm relating to offerings of securities or any other investment banking transaction from that our clients may undertake from time to time. Analysts may, however, observe road shows remotely, without asking questions, by video link or telephone in order to help ensure that they have access to the same information as their investor clients.

Widely-attended conferences: Analysts are permitted to attend and speak at widely-attended conferences at which our firm has been invited to present our views. These widely-attended conferences may include investor presentations by corporate clients of the Firm.

Other permitted activities: Analysts may be consulted by Firm sales personnel on matters such as market and industry trends, conditions and developments and the structuring, pricing and expected market reception of securities offerings or other market operations. Analysts may also carry out preliminary due diligence and vetting of issuers that may be prospective research clients of ours.

### INDUCEMENTS AND INAPPROPRIATE INFLUENCES

IIR prohibits research analysts from soliciting or receiving any inducement in respect of their publication of research and restricts certain communications between research analysts and personnel from other business areas within the Firm including management, which might be perceived to result in inappropriate influence on analysts' views.

Remuneration and other benefits: IIR procedures prohibit analysts from accepting any remuneration or other benefit from an issuer or any other party in respect of the publication of research and from offering or accepting any inducement (including the selective disclosure by an issuer of material information not generally available) for the publication of favourable research. These restrictions do not preclude the acceptance of reasonable hospitality in accordance with the Firm's general policies on entertainment, gifts and corporate hospitality.

### DISCLAIMER

This publication has been prepared by Independent Investment Research (Aust) Pty Limited trading as Independent Investment Research ("IIR") (ABN 11 152 172 079), an corporate authorised representative of Australian Financial Services Licensee (AFSL no. 410381). IIR has been commissioned to prepare this independent research report (the "Report") and will receive fees for its preparation. Each company specified in the Report (the "Participants") has provided IIR with information about its current activities. While the information contained in this publication has been prepared with all reasonable care from sources that IIR believes are reliable, no responsibility or liability is accepted by IIR for any errors, omissions or misstatements however caused. In the event that updated or additional information is issued by the "Participants", subsequent to this publication, IIR is under no obligation to provide further research unless commissioned to do so. Any opinions, forecasts or recommendations reflects the judgment and assumptions of IIR as at the date of publication and may change without notice. IIR and each Participant in the Report, their officers, agents and employees exclude all liability whatsoever, in negligence or otherwise, for any loss or damage relating to this document to the full extent permitted by law. This publication is not and should not be construed as, an offer to sell or the solicitation of an offer to purchase or subscribe for any investment. Any opinion contained in the Report is unsolicited general information only. Neither IIR nor the Participants are aware that any recipient intends to rely on this Report or of the manner in which a recipient intends to use it. In preparing our information, it is not possible to take into consideration the investment objectives, financial situation or particular needs of any individual recipient. Investors should obtain individual financial advice from their investment advisor to determine whether opinions or recommendations (if any) contained in this publication are appropriate to their investment objectives, financial situation or particular needs before acting on such opinions or recommendations. This report is intended for the residents of Australia. It is not intended for any person(s) who is resident of any other country. This document does not constitute an offer of services in jurisdictions where IIR or its affiliates do not have the necessary licenses. IIR and/or the Participant, their officers, employees or its related bodies corporate may, from time to time hold positions in any securities included in this Report and may buy or sell such securities or engage in other transactions involving such securities. IIR and the Participant, their directors and associates declare that from time to time they may hold interests in and/or earn brokerage, fees or other benefits from the securities mentioned in this publication.

IIR, its officers, employees and its related bodies corporate have not and will not receive, whether directly or indirectly, any commission, fee, benefit or advantage, whether pecuniary or otherwise in connection with making any statements and/or recommendation (if any), contained in this Report. IIR discloses that from time to time it or its officers, employees and related bodies corporate may have an interest in the securities, directly or indirectly, which are the subject of these statements and/or recommendations (if any) and may buy or sell securities in the companies mentioned in this publication; may affect transactions which may not be consistent with the statements and/or recommendations (if any) in this publication; may have directorships in the companies mentioned in this publication; and/or may perform paid services for the companies that are the subject of such statements and/or recommendations (if any).

However, under no circumstances has IIR been influenced, either directly or indirectly, in making any statements and/or recommendations (if any) contained in this Report. The information contained in this publication must be read in conjunction with the Legal Notice that can be located at <http://www.independentresearch.com.au/Public/Disclaimer.aspx>.

### THIS IS A COMMISSIONED RESEARCH REPORT.

The research process includes the following protocols to ensure independence is maintained at all times:

- 1) The research process has complete editorial independence from the company and this included in the contract with the company;
- 2) Our analyst has independence from the firm's management, as in, management/ sales team cannot influence the research in any way;
- 3) Our research does not provide a recommendation, in that, we do not provide a "Buy, Sell or Hold" on any stocks. This is left to the Adviser who knows their client and the individual portfolio of the client.
- 4) Our research process for valuation is usually more conservative than what is adopted in Broking firms in general sense. Our firm has a conservative bias on assumptions provided by management as compared to Broking firms.
- 5) All research mandates are settled upfront so as to remove any influence on ultimate report conclusion;
- 6) All staff are not allowed to trade in any stock or accept stock options before, during and after (for a period of 6 weeks) the research process.

For more information regarding our services please refer to our website [www.independentresearch.com.au](http://www.independentresearch.com.au).

# Contents

Initial 2P Gas Reserves of 1,153 PJ Booked.....	1
Key Points.....	1
Swot Analysis .....	2
Overview .....	4
Background and Project Overview .....	4
Financial Position.....	5
Capital Structure .....	5
Project Description .....	6
Leigh Creek Energy Project - Leigh Creek 100% .....	6
Activities by Leigh Creek.....	9
Permitting.....	9
Development Studies.....	11
PCD Pre-Start Development Activities .....	11
PCD Operation and Technical Details .....	11
Planned Activities .....	14
Draft Heads of Agreement With CCCC.....	14
Heads of Agreement With Africary.....	14
Peer Group.....	15
Transactions.....	16
Valuation .....	17
Board and Management.....	18
Background - In-Situ Gasification .....	20
History .....	20
The Australian Experience.....	20
Urea and the Australian Market.....	21
What is Urea, and How is it Produced? .....	21
Cost of Production - Ramifications for Leigh Creek .....	22
Eastern Australian Gas Prices.....	23
Oil and Gas Glossary .....	24



**Note:** This report is based on information provided by the Company as of April 14, 2019.

Investment Profile	
Share Price April 12, 2019	A\$0.36
12 Month L/H	A\$0.084/ A\$0.43
Issued Capital:	
Ordinary Shares	547.7 m
Unlisted Options	42.76 m
Options - In the Money	32.76 m
Fully Diluted	590.4 m
Market Cap. Undiluted	A\$197.2 m
Cash - December 31, 2018	A\$4.26 m
Cash on Option Conversion	A\$11.67 m
Debt - December 31, 2018	A\$3.60 m
January 2019 Rights Issue	A\$3.86 m

Board and Management	
Mr Justyn Peters: Executive Chairman	
Mr Phil Staveley: Managing Director	
Mr Gregory English: Non-Executive Director	
Mr Murray Chatfield: Non-Executive Director	
Mr Zhe Wang: Non-Executive Director	
Mr Zheng Xiaojiang: Non-Executive Director	
Mr Justin Haines: Chief Technical Advisor	
Mr Christian Bolda: Operations Manager	
Mr Jordan Mehrtens: Company Secretary	

Major Shareholders	
China New Energy Group	24.89%
Crown Ascent Development	8.37%
Citic Australia	3.15%
Board	9.06%
Top 20	53.02%



**Mark Gordon - Senior Analyst**

The investment opinion in this report is current as at the date of publication. Investors and advisers should be aware that over time the circumstances of the issuer and/or product may change which may affect our investment opinion.

## INITIAL 2P GAS RESERVES OF 1,153 PJ BOOKED

Recent years have seen Eastern Australian natural gas prices more than triple to around A\$10/GJ, as well as expectations that posing a major threat to industries, particularly chemical manufacturers, that rely on natural gas as a feedstock. This provides an ideal opportunity for Leigh Creek Energy Limited ("Leigh Creek" or "the Company"), which is concentrating activities on the 100% owned Leigh Creek Energy Project ("LCEP" or "the Project"), located over the eponymously named historic coalfield, 550 km north of Adelaide in South Australia.

The LCEP is an in-situ coal gasification opportunity ("ISG", also known as underground coal gasification or "UCG"), with the Company looking to commercialise the significant, recently booked 2P Gas Reserves of 1,153 PJ, and 2C Gas Resources of 1,469 PJ, the largest uncontracted Reserves of any energy developer or producer in Eastern Australia.

The Reserves are the result of the soon to be completed Pre-Commercial Demonstration ("PCD") which has successfully produced commercial quantities of commercial quality (and high calorific value) syngas from a single gasifier operating in a 500m deep coal seam. The final phase of the PCD will be to demonstrate that the gasifier can be successfully shut down and rehabilitated, a critical part of any future commercialisation - ongoing environmental monitoring of the PCD has shown no adverse environmental impacts.

Commercialisation scenarios are being considered as part of the Definitive Feasibility Study ("DFS"), which is due for completion in 2020, with production targeted for 2023. Options include the development of an ammonia/urea plant that will use syngas produced from the ISG activities, as well as the potential to provide natural gas into the Eastern Australian market. The Company is currently seeking expressions of interest for the offtake of up to 50 PJ/annum, and for which it has had numerous responses from major gas retailers and end users.

Key advantages here for urea production are two-fold - ISG directly produces cheap syngas - chemical manufacturing traditionally cracks methane (natural gas) and combines the products with other gases to produce the required feedstock gases. Secondly, Australia imports over 80% of annual urea consumption of ~2,000 kt; urea is the key nitrogen fertiliser used in Australia. There is also a significant export market for ammonia based fertilisers in Asia.

## KEY POINTS

**Very large resource:** With 2P Reserves of 1,153 PJ augmented by 2C Resources of 1,469 PJ, the LCEP has the largest uncontracted gas inventory in Eastern Australia, with the potential to supply a long term urea and/or gas supply operation.

**Commercial quantities of commercial quality gas being produced:** The PCD has to date produced commercial grade syngas, containing around 20% methane and between 5% and 10% hydrogen, with "commercial" scale production. In their October 12 release the Company alluded that commercial design rates would be in the order of ~3 MMcf/day per gasifier, however commerciality will also be partly determined by gasifier depth and gas composition amongst others - as of February 19, 2019 peak flow rates of 7.5 MMcf/day had been achieved, more than 7 times the stated goal of producing 1 MMcf/day.

**Low cost gas production:** The LCEP has the potential to provide significant quantities of syngas at a very low cost, providing the basis for potentially good returns from chemical and gas supply operations - research in the US has indicated costs in the order of US\$1.10/Mcf for syngas from ISG for one example, and Carbon Energy, in a 2012 presentation, indicated costs (+ 50%) of A\$3.50/GJ natural gas from ISG syngas - these are not directly comparable as natural gas (mainly methane) is just one component of the syngas mix.

**Geology suitable for a low environmental risk project:** The Leigh Creek Coalfield is situated in a bowl shaped basin composed of generally impermeable rocks, with no aquifers in the target seams or overburden, no hydraulic connections to external aquifers and no critical land uses, making it suitable for ISG operations with low environmental risks - this strongly differentiates the LCEP from Linc Energy's (ASX: LNC, now liquidated) problematic Chinchilla Project. This is supported by the South Australian Government's independent assessment of the project, which recommended that the PCD could proceed. The report included the quote "the Leigh Creek site represents one of the strongest opportunities for low risk UCG anywhere in the world." Differences between Leigh Creek and Chinchilla are presented in Table 3 of this report.

**Infrastructure rich:** By virtue of the historic coal mining Leigh Creek is connected by tarred highway, standard gauge rail and grid power to Port Augusta, 250 km to the south. There is also ample accommodation and related facilities in the nearby towns of Leigh Creek and Copley.

**Valuation:** We have a base case risked valuation range of A\$0.32 to A\$0.62/share (with our preferred figure at the upper end), based on Reserve multiples of other juniors with significant gas interests - further upside potential and key price movers will include successful JV negotiations (and the terms thereof) and material progress in the DFS and statutory permitting/ approvals. Sensitivity of our valuation to the risk multiplier is shown on Page 18.

## SWOT ANALYSIS

### Strengths

- ◆ **Geology:** The geology of the Leigh Creek Coalfield is suitable for a low environmental risk ISG operation - the rocks and any fractures are “tight”; there are no aquifers in the targeted coal seams and overburden, and there are no hydraulic links to external aquifers.
- ◆ **Commercial quality, high calorific value gas produced:** The results of the PCD have been largely successful, showing that high value syngas can be produced; on the other hand the certifiers report stated that the data were not robust enough to support 1P Reserves.
- ◆ **Large reserve:** The 2P Reserve of 1,153.2 PJ, which is from the Main Series coal only, is potentially sufficient to supply a long term urea and/or gas operation; in addition we expect to see additional upgrades down the track from the Upper and Lower Series coals should trials be operated on these seams.
- ◆ **Cheap syngas production:** ISG offers a relatively cheap way to produce syngas when compared with the usual method of cracking natural gas - this is particularly so with the current very high Eastern Australian natural gas prices.
- ◆ **Experienced personnel:** Company personnel, particularly the engineering and project team, are all well qualified professionals. A number have significant experience in ISG projects in Australia, a vital factor in a field in which there is a limited pool of talent to choose from. These include, amongst others, Mr Justyn Peters, who was Investor Relations Manager at Linc Energy and Mr Justin Haines, who was Technical Manager at Carbon Energy. The Company also draws on specialised consultants across all necessary disciplines.
- ◆ **Key shareholder and alliances:** Having CITIC and the China New Energy Group (“CNEG”) on the register and a potential alliance with China Communications Construction Company (“CCCC”), with a draft Heads of Agreement provided) should prove beneficial. There may be the potential for these groups (and in particular the large SOEs, (CITIC and CCCC) to help in sourcing development funding, be involved in project development as well as aiding access to the Chinese fertiliser and gas markets.
- ◆ **Infrastructure:** Given that fertilisers are a bulk commodity infrastructure is critical - Leigh Creek satisfies the product transport infrastructure requirements with the railway linking Leigh Creek to a number of South Australian ports, including those at Whyalla and Adelaide; this is in addition to grid power, communications infrastructure, tarred road access and the nearby towns of Leigh Creek and Copley, which offer the range of facilities expected in rural communities.
- ◆ **Rigorous permitting process:** The Project has gone through a rigorous permitting process and is subject to ongoing environmental monitoring with project oversight by the relevant authorities with which the Company has a strong relationship.
- ◆ **Industry standard equipment:** The above ground facilities, including gas separators, use well understood industry standard equipment, likewise the underground equipment, including ignition lances.

### Weaknesses

- ◆ **Largely commercially unproven:** There have only been a few examples of commercial ISG operations globally; this may affect the ability to secure funding for the capex required for a large scale operation from traditional sources. The presence of large Chinese partners however may aid in sourcing any development funding required.
- ◆ **1P Reserves not booked:** Although significant 2P Reserves were booked, the certifying consultants, MHA Petroleum Consultants LLC (“MHA”) were of the view that the results of the PCD precluded the booking of 1P Proven Reserves, due to the view that the PCD data was not sufficiently robust to justify a commercial outcome for the 1P case - MHA was of the view that a longer and more stable trial would be required to justify booking of 1P Reserves. Potential ramifications of this may include making it more difficult in acquiring financing and attracting JV partners with the lower confidence of the commercial viability of 2P Reserves and having to accept less attractive terms in any agreement as more risk passes to the prospective partner. Should an additional trial be considered (which we understand is not being considered by Leigh Creek as 100% owners) additional time, cost and permitting would be required.

- ◆ **Public perception:** ISG has, by virtue of the well publicised issues at Linc Energy's Chinchilla later ISG trial, a bad perception amongst some groups of the public. This overshadows the success of the early Linc trials and Carbon Energy's (ASX: CNX, receivers and managers appointed) Bloodwood trial that was operated and rehabilitated successfully, which included producing power from a 5 MW on-site facility. It was the Queensland Government's decision to legislate for a ban on ISG in the state that ended Carbon Energy's activities. On the other hand, the rigorous permitting process for Leigh Creek and very favourable outcomes of the South Australian Government's assessment (refer Table 3) highlight the differences between Leigh Creek and Chinchilla, and a successful PCD should go some way to changing the perception of ISG.

### Opportunities

- ◆ **Production of other gas based chemical products and plastics:** With the price of natural gas forcing some gas based manufacturers out of business, there may be the potential to set up a diversified manufacturing centre at Leigh Creek should the initial urea plant prove successful. There is also the potential to provide gas into the East Coast markets.
- ◆ **Draft Heads of Agreement with CCCC:** The Company has been provided with a draft Heads of Agreement ("HoA") with CCCC, Asia's largest international contractor - this has the potential to open up development opportunities outside of gas and fertiliser production as well as leveraging off CCCC's capabilities, including networks and funding amongst others. One development opportunity may include a gas pipeline from Leigh Creek to connect to the Eastern Australian gas markets.

### Threats/Risks

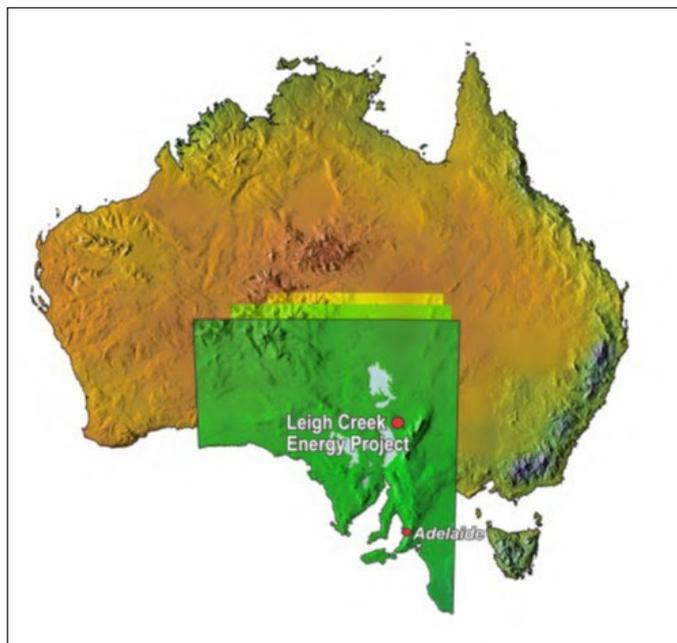
- ◆ **Political:** Given the varied public views on ISG (and other unconventional hydrocarbon sources) and it also being a "fossil" fuel, it can become a political football - although supporting the Project whilst in power before the 2018 election, the South Australian branch of the Australian Labor Party ("ALP") passed a motion at the 2018 state conference to ban ISG at Leigh Creek (as reported in "The Australian" on November 20, 2018). However, would a future state ALP Government actually carry through with this if the Project was in development or operation at the time such a Government was elected? The next state election is in April 2022, when the Project is expected to be in development.
- ◆ **Permitting:** Although the PCD was successfully permitted and operated, there is the risk that a commercial operation may not be permitted - obtaining approvals for a commercial operation is a key aspect of ongoing activities by the Company, and should be facilitated by the success of the PCD and the blemish free environmental performance to date.
- ◆ **Future gasifiers not developing and working as expected:** This is the main technical risk, however the results from the current PCD on the Main Series have largely been positive (albeit without 1P Reserves being booked which has potential ramifications as mentioned above), and the PCD has achieved all objectives as presented in the release of October 12, 2018:
  - Produce syngas, a combination of CO, CH<sub>4</sub> (the major component of natural gas piped around Australia), nitrogen and hydrogen,
  - Produce syngas at over 1 MMcfpd (commercial design rates will be up to 3 times higher),
  - Demonstrate that LCK can operate the ISG gasifier safely and in an environmentally responsible manner,
  - Provide information for the development of the commercial project; and,
  - Provide the information required for the review of the existing SPE-PRMS 2C 2,963.9 PJ resource that has resulted in the partial upgrade from Contingent Resources to Reserves.
- ◆ **Markets and funding:** This is a perennial risk for any resources stock, and particularly when it comes to funding major capital. In addition, as mentioned above, this may prove more difficult given the relatively untried commercial nature of ISG. In the shorter term, the Company may need to go to the market again in 2019, however no firm guidance has been given to cash requirements for 2019. The funding risk is partially mitigated by the presence of CITIC and CNEG on the register, the interest being shown by CCCC and the potential funds from the conversion of in the money options.

## OVERVIEW

### BACKGROUND AND PROJECT OVERVIEW

- ◆ Leigh Creek is an ASX-listed energy/fertiliser chemical developer, with activities focussed on the LCEP, located 550 km north of Adelaide in South Australia (Figure 1) and situated over the historically operated Leigh Creek Coalfield.

**Figure 1: Leigh Creek project location map**



Source: Leigh Creek

- ◆ The Company came about through the back door listing of the Project (then held by private company ARP TriEnergy) into Marathon Resources Limited (ASX: MTN), with the transaction approved at an EGM held on May 27, 2015 - following recompliance and finalisation of the acquisition Marathon relisted on the ASX on July 3, 2015, with the name subsequently being changed to Leigh Creek Energy.
- ◆ The LCEP is an ISG opportunity, with the Company close to completing the PCD operation from which data will be used in the DFS for the design of a full scale operation, with the commencement of operations slated for 2023.
- ◆ The optimal production scenario is being developed as part of the DFS, with this likely to include up to a 1 mtpa urea plant and the sales of gas into the Eastern Australian markets.
- ◆ Although final production volumes will be determined in the DFS, indicatively the Company initially plans to produce up to 50 PJ per annum of syngas from multiple gasifiers of which the planned urea plant will require 33 PJ per annum - production volumes down the track are flexible, with, due to the large Reserves and area available for operations, the potential to install additional gasifiers to supply additional sales gas.
- ◆ Previous production scenarios (now superseded) investigated included:
  - A 2 Mtpa urea plant,
  - A 2 Mtpa methanol plant,
  - A 460 MW power station; and,
  - Supply of 80 PJ/annum of syngas.
- ◆ The Company is currently seeking expressions of interest for up to 50 PJ per annum of gas sales into the market, and has received numerous responses from major gas users and retailers.
- ◆ Australia currently imports ~85% of ammonia based fertilisers, with current domestic production of ~450 ktpa of urea equivalent at risk from high east coast natural gas prices - ISG potentially provides a significantly cheaper supply of gases, which are the main inputs into ammonia and urea production - the cost of gas has been around 70% of the cost of urea production, although this is dependent of course on gas prices.
- ◆ The Company also holds five PEL applications, totalling 25,417 km<sup>2</sup> in South Australia - given that activities are focussed on the LCEP these will not be discussed further.

## FINANCIAL POSITION

- ◆ As of December 31, 2018 the Company had A\$4.265 million in the bank and debt of A\$3.60 million.
- ◆ The debt is part of a receivables facility with the Commonwealth Bank of Australia (ASX: CBA, "CBA"), predicated on the receipt of Research and Development ("R&D") refunds from the Federal Government - this facility, which reached A\$10.500 million in the September 2018 quarter is in place until December 2019, with a large part already being paid down, with the remainder expected in early 2019 and based on the FY2018 accounts.
- ◆ The Company recently completed a 1 for 15 non-renounceable rights issue which raised A\$3.86 million before costs through the issue of 32.14 million shares at A\$0.12/share - this rights issue followed a placement of 10.68 million shares to raise ~A\$1.28 million before costs.
- ◆ Extra cash may also be sourced from the recent announcement of the sale or lease of the PCD plant following completion of the PCD.
- ◆ The Company, over the past two years, has received R&D refunds totalling A\$7.227 million out of the expected total of A\$12 million.
- ◆ In the twelve months to December 31, 2018, the Company spent A\$20.766 million on exploration and evaluation, and A\$5.555 million on staff and administration; in addition the December 2018 Quarterly Report estimated expenditure of A\$3.779 million in the March 2019 quarter.
- ◆ Cash received from equity raises over the period totalled A\$10.191 million before costs from a placement and SPP at A\$0.16/share - the placement included the final tranche of China New Energy Group's ("CNEG") investment in Leigh Creek.
- ◆ The placement, which raised ~A\$8.8 million was oversubscribed, with the SPP raising A\$1.52 million, an acceptance of ~50%.
- ◆ No guidance has been provided for expenditure over the next twelve months, however we note that operating expenditure (not including R & D refunds) in CY2017 was around A\$3.2 million per quarter, although this included an amount of PCD development costs. Operating expenditure for CY2018 averaged ~A\$6.5 million/quarter, largely due to PCD activities - this is expected to significantly decrease at the end of the PCD.

## CAPITAL STRUCTURE

- ◆ Leigh Creek currently has 547.7 million shares and 42.76 million unlisted options on issue - details of the options are listed in Table 1 - 41.76 million options are in the money, with the potential to bring in A\$11.667 million if exercised.

**Table 1: Options**

Options				
Expiry Date	Number	Exercise Price	Cash on Exercise - All	Cash on Exercise - In Money
10/05/2019	1,500,000	\$0.300	\$450,000	\$450,000
14/10/2019	1,000,000	\$0.212	\$212,000	\$212,000
31/07/2020	1,000,000	\$1.500	\$1,500,000	
14/10/2020	1,000,000	\$0.250	\$250,000	\$250,000
30/11/2020	7,673,500	\$0.300	\$2,302,050	\$2,302,050
31/12/2020	4,000,000	\$0.250	\$1,000,000	\$1,000,000
8/05/2021	800,000	\$0.300	\$240,000	\$240,000
10/10/2021	4,000,000	\$0.350	\$1,400,000	\$1,400,000
31/12/2021	1,500,000	\$0.200	\$300,000	\$300,000
31/12/2021	1,500,000	\$0.220	\$330,000	\$330,000
31/12/2021	1,500,000	\$0.240	\$360,000	\$360,000
31/12/2021	1,500,000	\$0.260	\$390,000	\$390,000
3/07/2022	5,000,000	\$0.246	\$1,230,000	\$1,230,000
16/07/2022	5,790,000	\$0.251	\$1,453,290	\$1,453,290
17/04/2023	5,000,000	\$0.350	\$1,750,000	\$1,750,000
<b>Total/Av</b>	<b>42,763,500</b>	<b>\$0.308</b>	<b>\$13,167,340</b>	<b>\$11,667,340</b>

Source: Leigh Creek

- ◆ The largest shareholder is China New Energy Group, with 24.89% of the listed shares, with the second largest at 8.37% being Crown Ascent Development, for which Leigh Creek director Mr Zheng Xiaojiang is a director.
- ◆ Directors' direct and indirect interests are 9.06%, with the top 20 holding ~53%; as of March 28, 2019 the Company had 3,516 shareholders.

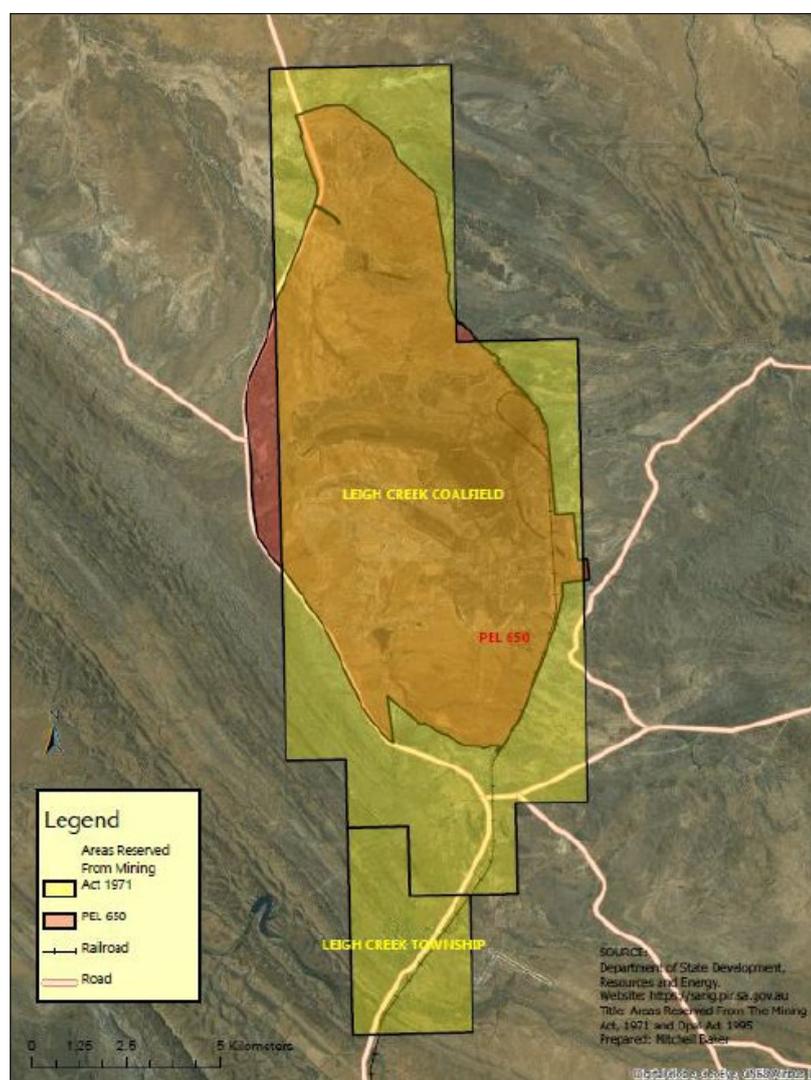
## PROJECT DESCRIPTION

### LEIGH CREEK ENERGY PROJECT - LEIGH CREEK 100%

#### Location and Tenure

- ◆ The LCEP is in PEL650, of 93.4 km<sup>2</sup> and Gas Storage Exploration Licence GSEL662 (coincident in area with PEL650) - both are in good standing, with PEL650 been granted for a period of five years on November 17, 2014 and GSEL662 for five years on April 14, 2016 (Figure 2).
- ◆ 31 km<sup>2</sup> of PEL650 will be required to be relinquished upon licence renewal.

Figure 2: LCEP tenements and exclusion zone



Source: Leigh Creek

- ◆ The crown leases and operational approvals over the Leigh Creek Coalfield are held by Flinders Power Partners ("FPP"; formerly Alinta Energy) , with Leigh Creek having granted "Notices of Entry" with FPP that cover Leigh Creek's activities on the site.
- ◆ Given the historic coal mining activities the LCEP is well served by infrastructure - this includes the nearby towns of Leigh Creek and Copley, and sealed road, rail and grid power connecting the site to Port Augusta, some 250 km to the south.

- ◆ Leigh Creek had a population of up to 2,500 during the mining activities, however the population is now ~200 following the cessation of activities, with the potential for the LCEP to bring new life to the town.

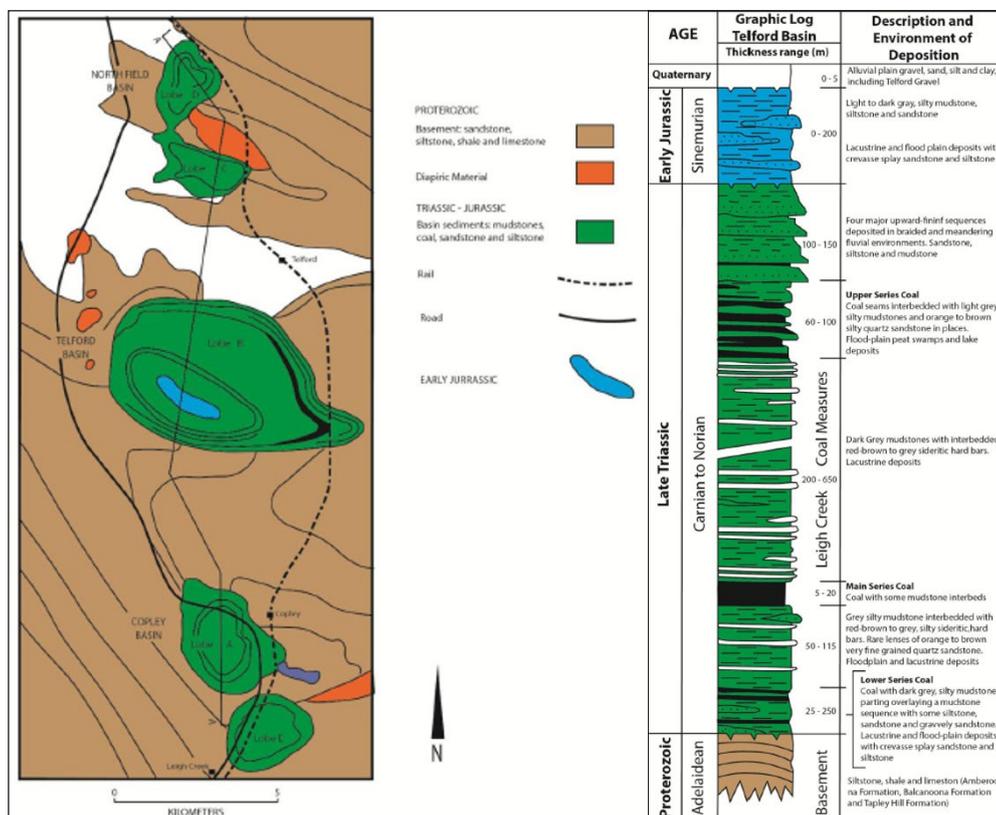
### Mining and Exploration History

- ◆ Coal was initially discovered at Leigh Creek in 1888, however only minor amounts of coal were extracted, with these initial operations ending in 1894 - coal mined during this period was assessed for the suitability for use in steam engines, with this work concluding that the coal was not fit for this purpose.
- ◆ Development of the open pit commenced during WWII, however it was not until the development of the initial Playford A Power Station at Port Augusta in the 1950's, which was designed to burn the sub-bituminous Leigh Creek coal, that large scale operations commenced - the construction of Playford A was followed by Playford B in the 1960s and the Northern Power Station in 1985.
- ◆ The mine expansion in the 1980s necessitated the moving of the Town of Leigh Creek out of the coal basin, with the current town being occupied in 1980 - peak production was 4.1 Mt in 2007, with production averaging ~3 Mtpa in the 2000s - the mine closed in 2015, with the power stations closing in 2016.
- ◆ All infrastructure is still in place, including the 4'8 $\frac{1}{2}$ " standard gauge rail connecting Leigh Creek to the Trans-Australian line at Port Augusta.
- ◆ In the 1980s the South Australian Government assessed the suitability of the Telford Basin (which hosts the coal) for ISG - the results of this work were used by Leigh Creek in their decision to apply for PEL650.

### Geology and Hydrogeology

- ◆ Coal at the LCEP is hosted in the Telford Basin (or Lobe B), one of five discrete Triassic to Jurassic Basins spread over a north south distance of 20km (Figure 3) - the Telford Basin covers an area of some 7.5 km x 4.5 km, with up to 1,500m thickness of stratigraphy being recognised (Figure 3).

Figure 3: Leigh Creek region coal basins (L) and stratigraphic column (R)

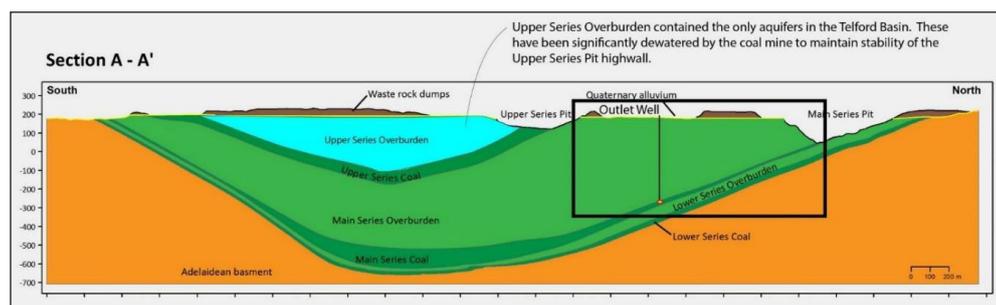


Source: Adapted from Leigh Creek

- ◆ The basins form inliers within, and unconformably overlie Proterozoic metasediments of the Adelaide Geosyncline (Figures 3 and 4).
- ◆ Coal occurs in three main groups (Figure 3), the Upper, Main and Lower series, with overburden for each being largely comprised of very low porosity fine grained sediments, including mudstones and fine sandstones - most units are considered aquitards, with the

only aquifers occurring within the Upper Series Overburden, with water flows now into the historic open pits (Figure 4).

**Figure 4: Telford Basin schematic section**



Source: Leigh Creek

- ◆ The “tight” nature of the rocks is an important consideration in the suitability of Leigh Creek as ISG site, in that it should minimise the potential of contamination of surrounding areas through transmission of harmful products by water.
- ◆ Other geological and hydrogeological aspects supporting the suitability of the site for ISG operations include:
  - The lack of aquifers in the target coals and overburden,
  - Therefore it is not a groundwater source,
  - The “dry” nature of the coal (e.g. it contains no coal seam gas),
  - It is a non-swelling coal (swelling of coal would cause pressure issues in the gasifier)
  - A relatively small, bowl shaped basin with no hydraulic connection to aquifers, including the Great Artesian Basin; and,
  - The planned depth should result in hydrostatic pressures greater than planned pressures within the gasifier, thus preventing outflows from the gasifier (except through the production well).

## Resources and Reserves

- ◆ Coal and Gas Resources/Reserves have been estimated for the LCEP - JORC 2012 Compliant Inferred Resources of 337 million tonnes for coal (ISG addressable) were announced to the market on December 8, 2015, with Contingent Gas Resources announced on January 8, 2016 and Gas Reserves announced on March 27, 2018 (Table 2).

**Table 2 - LCEP Gas Reserves and Resources**

LCEP Gas Reserves and Resources				
Area	Category	2019 Reserves and Contingent Resources (PJ)	2016 Contingent Resources (PJ)	
PEL 650, LCEP	1P Reserves	0.0	0	
PEL 650, LCEP	2P Reserves	1,153.2	0	
PEL 650, LCEP	3P Reserves	1,608.3	0	
PEL 650, LCEP	1C Contingent Resources	0.0	2,747.7	
PEL 650, LCEP	2C Contingent Resources	1,469.0	2,963.9	
PEL 650, LCEP	3C Contingent Resources	2,126.6	3,303.1	

Source: Leigh Creek

- ◆ Gas Resources and Reserves were estimated by experienced and respected US based consultants MHA Petroleum Consultants LLC (“MHA”), in accordance with the 2007 Petroleum Resources Management System (“PRMS”), as well as the 2011 Guidelines for the Application of the PRMS, approved by the Society of Petroleum Engineers.
- ◆ The Contingent Resources were based on the Coal Resource and used the same parameters, in addition to the following:
  - The energy yield of the coal was estimated to be 15.5 GJ/tonne,
  - A process recovery efficiency, which quantifies the percentage of coal in place that is gasified during the ISG process, was estimated at 80%; and,
  - A geological risk factor ranging from 40% to 80% was also applied to the estimate.

- ◆ The factor driving contingency was whether or not gas could successfully be produced from the coal - Leigh Creek has demonstrated that this can be done in the Main Series coals, and thus the Contingent Resources for these has been upgraded to Reserves.
- ◆ We note neither 1C or 1P Resources/Reserves were booked in 2019 - the view of the certifiers was that the PCD did not provide robust enough data to justify a commercial outcome for the 1P case, and that a longer and more stable trial would be required.
- ◆ The 337 Mt coal Mineral Resource Estimate ("MRE") is for coal below 200m depth that is considered suitable for ISG; no shallower coal is included; the MRE drew on a database of 6,137 historic holes.
- ◆ The Coal Resources were based on the following parameters:
  - A maximum coal seam thickness of 2m,
  - A maximum stone parting thickness of 1m,
  - A minimum depth below surface of 200m,
  - Points of observation spacing of 4km (1km past the last point) were used where the geological correlation supported such continuity; and,
  - A fixed relative coal density was used.
- ◆ It is expected that limited drilling should be able to upgrade part of this, as well as bring part of the 28.7 Mt to 31.8 Mt Exploration Target into Resources.
- ◆ The main target for operations is the 239 Mt Main series, with this having a thickness ranging from 2.0m to 18.9m, with an average of 15.97m - this is the thickest of the three series.

## ACTIVITIES BY LEIGH CREEK

- ◆ Activities by the Company have focussed on initially getting approvals for, and then undertaking the current PCD gasification - some activities, including licencing and Resource estimations are covered above.
- ◆ The purpose of the PCD is, amongst others, to determine whether commercial quality and quantities of syngas can be produced, and to demonstrate the environmental viability of the ISG process (including remediation) at Leigh Creek - all gaseous products are destroyed on site.
- ◆ Results will be used in the DFS, and also the PCD is using a commercial scale gasifier, so as scale up risk will be minimised - as mentioned previously the Company has indicated that flow rates in the order of 3 MMscf/day per gasifier could be considered commercial, however this will be contingent on a number of factors - peak production to date from the single gasifier has been 8,912 scm/hr or 7.5 MMscf/day.
- ◆ Our analysis indicates that, using an energy content of 6.6 MJ/scm, to produce 50 PJ/annum, gas flow rates of 20 MMscm/day or 716 MMscf/day will be required.

## PERMITTING

- ◆ Permitting is a vital part of the Project, with the need for a thorough and "bulletproof" process to deliver world's best practice and to help negate or ease misconceptions that some sections of the community have about ISG.
- ◆ The permitting process included three main parts:
  - Licencing, which as discussed previously was completed with the grants of PEL650 and GSEL662,
  - Preparation, review and approval of the Environmental Impact Report ("IER") and accompanying Statement of Environmental Objectives ("SEO") - the latter document details the conditions that the proponent will need to demonstrably achieve; and,
  - Notification of, and approval of commencement of activities.
- ◆ The Draft IER and SEO were submitted to the State Government Regulator in the 2017 September quarter.
- ◆ Following review, the Regulator required that three additional holes be drilled largely to confirm geological, hydrogeological and geotechnical assumptions, including permeability across the Master Fault (with the fault subsequently being shown to have the same very low permeability as the host stratigraphy).

- ◆ The revised documents were submitted in December 2017, and were released for public consultation from January 16 to February 28, 2018 - a total of 102 submissions were received from the public, with all being addressed by the Company, with the environmental approval being obtained on April 19, 2018, and final Activity Notification being received on September 3, 2018.
- ◆ The conclusions of the final assessment by the Regulator were very positive, with one comment in the assessment report including “the Leigh Creek site represents one of the strongest opportunities for low risk UCG anywhere in the world”.
- ◆ The same report presented a comparison of key factors between Leigh Creek and the Linc Energy Chinchilla Trial - this was in response to a number of public submissions showing concern that factors that affected Chinchilla would occur at Leigh Creek - a comparison of the key differences between Leigh Creek and Chinchilla is presented in Table 3.

**Table 3 - Leigh Creek vs Chinchilla**

LCK Demonstration	Chinchilla Operations
LCKE primary focus is environmental performance, demonstrated through a discrete 3 month operation with transparency to the regulator and general public.	Site operations were commercially driven, operating 5 gasifiers over a period of more than 12 years under a “black box” approach.
Regulator is closely engaged with the proponents, has developed a technical understanding of the technology and risks, and has undertaken a rigorous assessment process	Regulator considered the operations R&D, had limited engagement with the company and restricted reporting triggers to water bore quality at the boundary of the site
Site characteristics that minimise environmental risk: <ol style="list-style-type: none"> <li>1. Deep at 540m (more than 4 times Chinchilla site)</li> <li>2. Very low permeability of coal (an aquitard)</li> <li>3. Fractures and fracturing risk deemed low through comprehensive geotechnical investigations</li> <li>4. Non-gas bearing coal</li> <li>5. Aquitard has no value for groundwater users</li> </ol>	Site characteristics that contributed to environmental risk: <ol style="list-style-type: none"> <li>1. Shallow at 125m</li> <li>2. Permeable coal seam that was a local aquifer</li> <li>3. Anthropogenic fracture permeability in the coal and immediate roof material</li> <li>4. CSG bearing coal</li> <li>5. Nearby water users of the coal seam aquifer</li> </ol>
Operational actions that will reduce environmental risk: <ol style="list-style-type: none"> <li>1. Operating pressures declared by proponent based on verifiable data</li> <li>2. Operating pressures automatically set to stay below hydrostatic pressure (key safety feature)</li> <li>3. Low risk of hydraulic fracturing (known breakover pressure)</li> <li>4. Well designs aligned to industry standards</li> <li>5. Depressurisation highly localised due to low permeability</li> <li>6. Strict monitoring requirements for groundwater, air and soil in process area</li> </ol>	Operational actions that contributed to environmental risk: <ol style="list-style-type: none"> <li>1. Operating pressure was neither declared by proponent nor prescribed by regulator</li> <li>2. Operating pressures exceeded containment pressures</li> <li>3. Hydraulic fracturing – intentional and unintentional</li> <li>4. Proponents set well design standards which were largely inadequate</li> <li>5. Progressive depressurisation of coal seam water levels</li> <li>6. No monitoring requirements, triggers or actions of the process area</li> </ol>

Source: Assessment of Leigh Creek Energy UCG Trial Proposal - Department of the Premier and Cabinet, South Australia

- ◆ A 2015 paper (Camp, W, and White, J: Underground Coal Gasification: An Overview of Groundwater Contamination Hazards and Mitigation Strategies. March 2014, Lawrence Livermore National Laboratory) outlines four key parameters for meeting “world’s best practice” for ISG:
  - Minimal and manageable land use conflict,
  - Manageable groundwater resources,
  - Minimal environmental receptors and impact; and,
  - Suitable geology creates low risk for:
    - Subsidence,
    - Fugitive gas.
- ◆ The LCEP meets all of these criteria, hence confirming the low environmental risk nature of the Project and contributing to the Regulator’s assessment.
- ◆ Subsequent to the Activity Notification an application to the Supreme Court of South Australia was made against the Minister for Energy and Mining and the Company by the NSW Environmental Defenders Office (“EDO”) on behalf of the Adnyamthanha Traditional Lands Association (“ATLA”), the Traditional Owners - this application was dismissed by the Court on September 19, 2018, thus allowing the PCD to proceed.

## DEVELOPMENT STUDIES

- ◆ The initial development study was a Scoping Study with the results released to the market on January 30, 2017.
- ◆ This study investigated the potential of either natural gas production (20 PJ to 80 PJ pa) or power generation (150 MW to 550 MW installed capacity) - the conclusions were positive, and hence the Company proceeded to a Pre-Feasibility Study ("PFS").
- ◆ Ongoing work also investigated the potential to produce ammonia, urea and other chemical products that rely on gas for their production - rising natural gas prices in Eastern Australia are a significant threat to the current chemical industry, with ISG potentially providing a low cost source of syngas.
- ◆ The final conclusion of the studies to date is that the production of 1 Mtpa of fertilisers and fertiliser chemicals, including ammonia and urea makes the most commercial sense, with Leigh Creek now undertaking a Proof of Concept Study in association with Thyssenkrupp - final production volumes will be determined as part of the DFS.

## PCD PRE-START DEVELOPMENT ACTIVITIES

- ◆ Site activities have included drilling, with programmes including an initial three hole campaign with aims to collect environmental data, including:
  - Baseline environmental samples of rock and water,
  - Groundwater properties,
  - Rock formation properties including geotechnical information; and,
  - Coal and overburden samples for additional detailed gasification analysis.
- ◆ As mentioned above a second three hole programme was completed at the request of the regulator to test hydrogeological and geological factors, and in particular permeability across the Master Fault, with the results being incorporated into the updated EIR and SEO - subsequent drilling has included 18 monitoring wells and the two gasification wells.
- ◆ Design of the plant commenced in 2016, with plans initially to commence the PCD in late 2017 - this was postponed to Q4, 2018 largely due to permitting considerations and delays, possibly partly due to the state election that was held on March 17, 2018.
- ◆ Plant construction, development and contracting commenced in June quarter, 2016, with the site facilities, including the gasification wells, largely completed in the June quarter, 2018 (Figure 5).

Figure 5: Leigh Creek PCD site



Source: Leigh Creek

## PCD OPERATION AND TECHNICAL DETAILS

- ◆ Initiation of the gasifier occurred on October 10, 2018, with a three month trial planned - the first syngas was produced the following day, and the successful production of commercial quality gas (at low flow rates) announced on January 7, 2019 - this syngas included 20%

methane, with commercial quality gas flowing continuously for 13 days within a total 89 day syngas production period.

- ◆ On January 23, 2019 the Company further announced that gas production was increasing and consistently in excess of 1,000 scm/hr (0.84 MMscf/day) with methane contents of around 20% and between 5% and 10% hydrogen - as shown in Figure 6 production started to accelerate over the last two days of the data provided, with this continuing to ramp up as the gasifier developed.
- ◆ This was followed by the announcement on February 19, 2019, that peak flow rates had hit 8,913 scm/hr (7.5 MMscf/day), with these being commercial flow rates and well in excess of the targeted 1 MMscf/day.
- ◆ This compares favourably with Carbon Energy's successful Bloodwood Bore Panel 2, which produced at flow rates of up to 4,000 scm/hr, however that at Bloodwood Bore was limited by regulatory requirements.

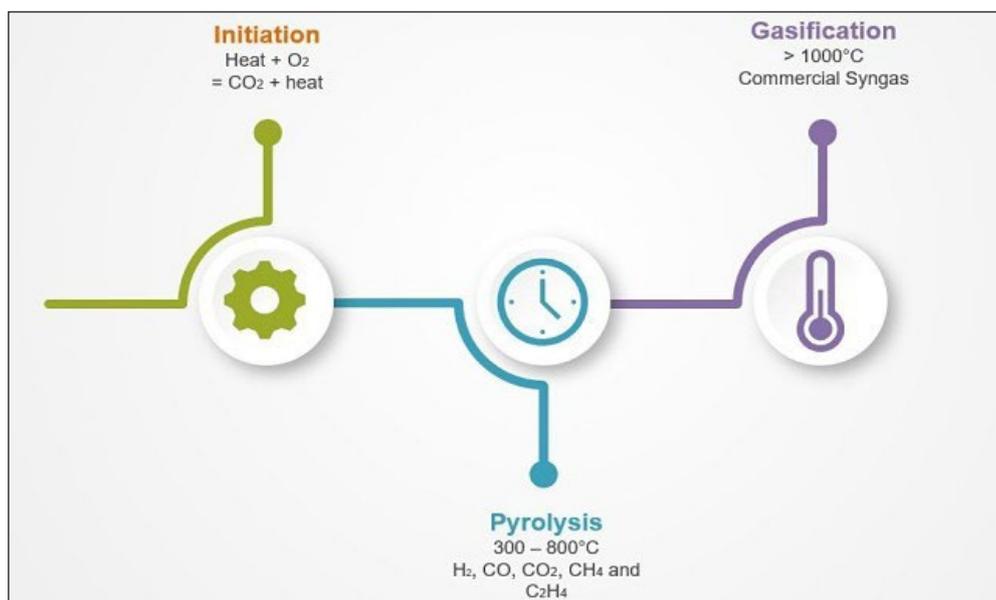
**Figure 6: LCEP syngas production - January 23, 2019**



Source: Leigh Creek

- ◆ The syngas has an energy content of 6.6 MJ/scm, which the Company has stated is one of the highest for any air-blown syngas products globally - based on these figures the peak gas flow equates to ~0.5 PJ/annum from the single gasifier, however there is considerable scope to significantly increase production from single gasifiers, including by using larger diameter piping to allow for higher gas flow rates.
- ◆ The gasification involves three stages - initiation, pyrolysis (with the production of low quality gas through removal of volatiles in the coal) and gasification, which produces the commercial grade gas (Figure 7) through more complete conversion of the coal - at no stage does the coal catch on fire - ISG does (or should) not lead to an underground fire, whether controlled or uncontrolled.

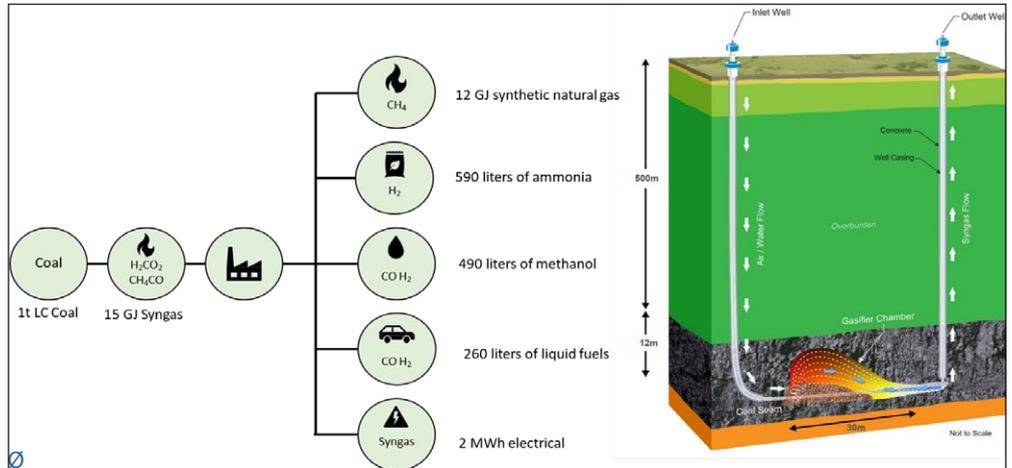
**Figure 7: Gasification stages**



Source: Leigh Creek

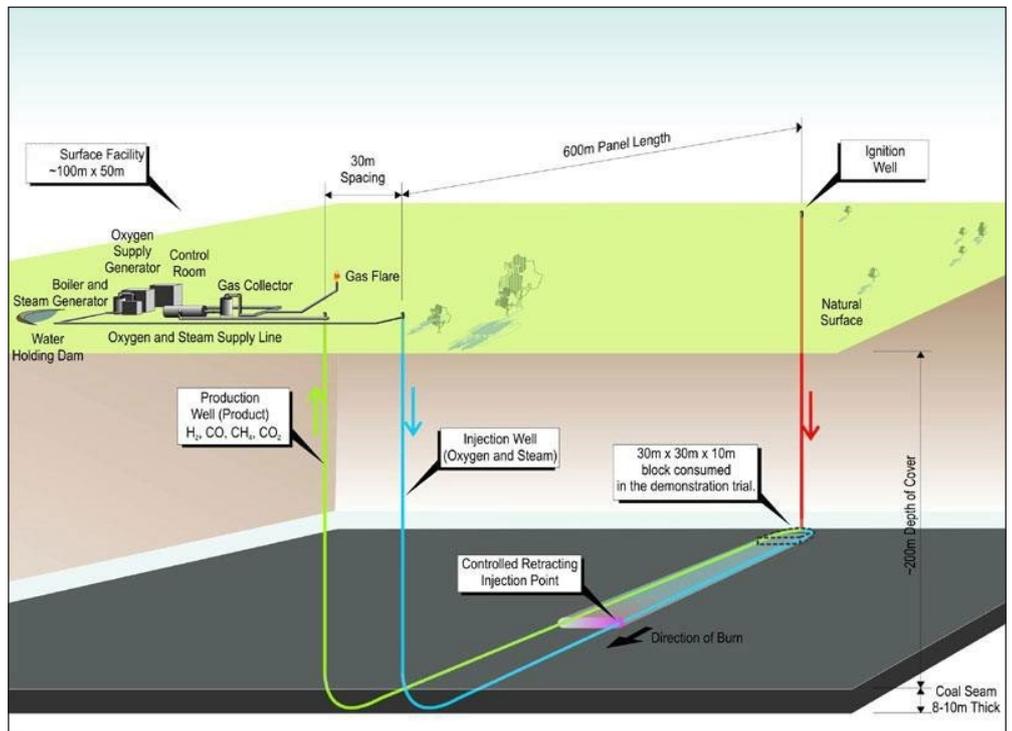
- ◆ A schematic diagram of the gasifier and products that potentially can be produced is shown in Figure 8 - as shown the PCD is using a dual Linked Vertical Well set-up.
- ◆ Another potential system that could be used in commercial operations is the two well parallel Controlled Retractable Injection Point ("CRIP") setup (Figure 9).

**Figure 8: Gasifier schematic diagram and products**



Source: Leigh Creek

**Figure 9: Parallel CRIP schematic**



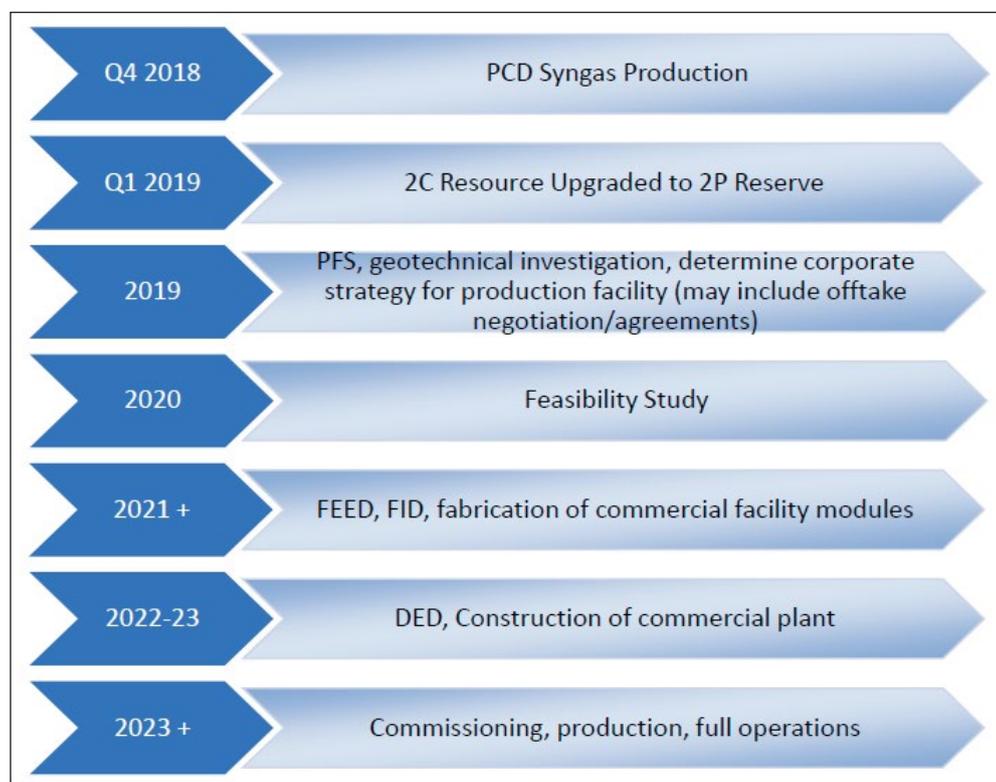
Source: Carbon Energy

- ◆ Gasification will not commence until the development of the chamber, hence there is a delay from initiation until production of syngas - timing and behaviour will vary from site to site, with this behaviour being tested by the PCD.
- ◆ Key gases produced include methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), nitrogen (N) and hydrogen (H); syngas gas compositions can be varied by the injection of different compounds into the gasifier, including water (steam), air (which contains 80% N) and pure oxygen - Leigh Creek is using a mixture of air and water.
- ◆ Ongoing environmental monitoring is critical aspect of the PCD - as of the February 19, 2019 announcement environmental performance was as per expectations, with no adverse results or reportable incidents from the monitoring - the final stage of the PCD will be to demonstrate that it can be successfully shut down and rehabilitated with no adverse environmental effects.

## PLANNED ACTIVITIES

- ◆ The planned pathway to commercial ammonia/urea production is shown in Figure 10 - note that the first two items have now been completed.
- ◆ The Company is continuing with the PCD, however the time frame will depend upon available funds.
- ◆ In addition to those activities presented in Figure 10, the Company plans to progress joint venture negotiations, and progress permitting and approvals, with the including an EIS.

**Figure 10: Proposed work programme**



Source: Leigh Creek

## DRAFT HEADS OF AGREEMENT WITH CCCC

- ◆ The Company has been sent a draft Heads of Agreement with China Communications Construction Company Ltd ("CCCC"), a major, publicly traded Chinese state-owned multinational engineering and construction company.
- ◆ Amongst others, CCCC:
  - Is the world's largest port design and engineering company, having designed and constructed seven of the world's ten largest ports by throughput capacity,
  - Has the Australian based John Holland Group as a subsidiary; and,
  - Is ranked as the largest Chinese enterprise in terms of revenue from overseas projects.
- ◆ The draft document envisages looking at joint investment and development of infrastructure projects in South Australia beyond the planned gas and fertiliser production.
- ◆ CCCC undertook a site visit to South Australia and Leigh Creek in early 2019.

## HEADS OF AGREEMENT WITH AFRICARY

- ◆ On January 16, 2019, the Company announced that it had signed a Heads of Agreement with African Carbon Energy Pty Ltd ("Africary") for the following:
  - The execution of a Sale and Lease Agreement for the PCD plant; and,
  - A service agreement between Leigh Creek and Africary whereby Leigh Creek will provide advisory services to Africary.

- ◆ Upon completion of the PCD (and signing of a binding agreement), Africary will lease the plant for use it its Theunissen ISG project in South Africa; the leasing agreement will also include an option to purchase that if executed should result in Leigh Creek recouping a significant portion of the PCD plant costs.
- ◆ The leasing and service agreements will also result in some cash flow to Leigh Creek.

## PEER GROUP

- ◆ Leigh Creek is one of a small number of independent ASX listed companies with significant gas Resources and/or Reserves operating in Australia.
- ◆ However it needs to be noted that it is the only Company currently investigating ISG and thus realistically is in a peer group of one; in addition only two other pre-production companies, Comet Ridge and Blue Energy have booked Reserves.
- ◆ These independent companies are presented in Table 4, and have been compared on the enterprise value per PJ in 2P Reserves and 3P Reserves - where companies have published Resources and/or Reserves in MMboe, these have been multiplied by 6.12 to get the PJ energy equivalent (definitions are presented in the glossary at the end of the document).

**Table 4: Leigh Creek peer group**

Leigh Creek Peer Group								
Company	Code	EV	2P PJ	3P PJ	EV/2P	EV/3P	EV/(2P+2C)	Notes
Beach Energy	BPT.ASX	A\$4,908 m	1,732	2,558	\$2.834	\$1.919	A\$1.660	Conventional gas and oil producer, Australia and NZ. Australia's 2nd largest oil producer
Cooper Energy	COE.ASX	A\$592 m	321	406	\$1.847	\$1.458	A\$1.274	Gas and oil production - Cooper, Otway and Gippsland Basins
AWE	awe.asx	A\$637 m	502	NQ	\$1.269	NQ	A\$0.590	Taken over by Mitsui in 2018, Vic, Qld and WA gas production
Comet Ridge	COI.ASX	A\$209 m	172	374	\$1.217	\$0.560	A\$0.278	Appraisal drilling, Mahalo Gas Project, Bowen Basin and others
Central Petroleum	CTP.ASX	A\$178 m	175	210	\$1.019	\$0.850	A\$0.669	Oil and gas exploration and production, central Australia
Blue Energy	BUL.ASX	A\$71 m	71	298	\$1.002	\$0.239	A\$0.067	Oil and gas exploration - conventional and unconventional, including CSG, Qld and NT
Senex Energy	SXY.ASX	A\$460 m	693	NQ	\$0.663	NQ	A\$0.634	Oil and gas producer and developer - Cooper and Surat Basins
Leigh Creek Energy	LCK.ASX	A\$181 m	1,153	1,608	\$0.157	\$0.113	A\$0.069	Leigh Creek Energy Project
Strike Energy	STX.ASX	A\$85 m	0	0	N/A	N/A	A\$0.167	Merged with UIL, Perth and Cooper Basin conventional exploration assets
Galilee Energy	GLL.ASX	A\$73 m	0	0	N/A	N/A	A\$0.029	Glenaras Gas Project, Galilee Basin Qld - CSG
Tlou Energy	TOU.ASX	A\$35 m	0	0	\$0.000	\$0.000	A\$0.145	CSG, Botswana
Icon Energy	ICN.ASX	A\$0 m	0	0	N/A	N/A	A\$0.000	Unconventional, Cooper and Victoria - affected by the Victorian onshore exploration moratorium
<b>Total/Average All</b>		<b>\$7,248</b>	<b>3,665</b>	<b>3,847</b>	<b>A\$1.497</b>	<b>A\$1.121</b>	<b>A\$1.320</b>	<b>Not including Leigh Creek</b>
<b>Total/Average - Developers</b>		<b>\$473</b>	<b>243</b>	<b>672</b>	<b>A\$1.154</b>	<b>A\$0.417</b>	<b>A\$0.071</b>	<b>Not including Leigh Creek</b>
<b>Total/Average - Producers</b>		<b>\$6,775</b>	<b>3,422</b>	<b>3,175</b>	<b>A\$1.980</b>	<b>A\$1.789</b>	<b>A\$1.234</b>	

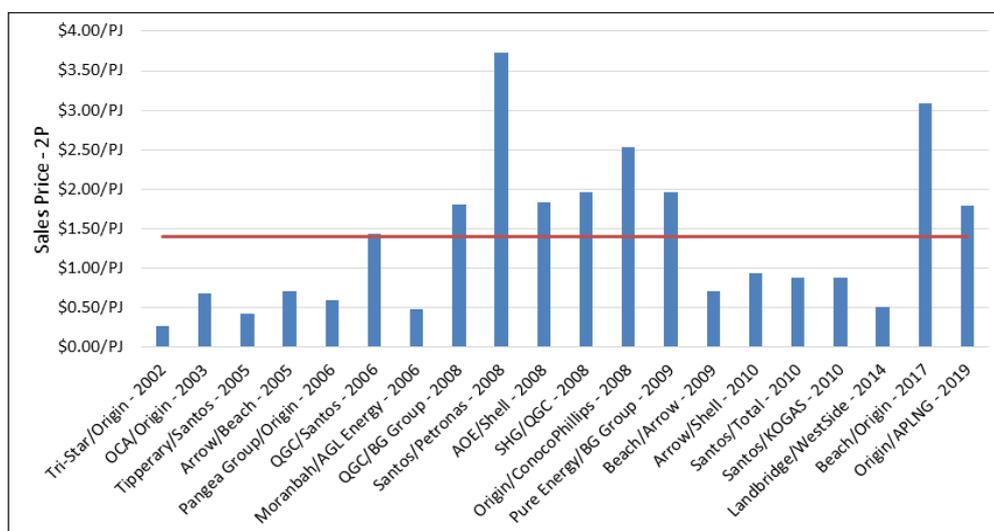
Source: IRESS (April 8, 2019), Company reports, NQ - Not quoted in reports, EV/Reserve figures calculated for only those companies with the relevant Reserves. Total EVs are the sum of all companies, therefore dividing total EV numbers by total Reserve numbers will not necessarily result in the average EV/Reserve numbers shown.

- ◆ Any comparison based on EV per unit of Resource needs to be treated with caution - this is at best an indicative comparison only, and will vary due to any number of factors - a key factor here in comparing Leigh Creek is that it is, as mentioned above, the only ISG developer in a small group of conventional and CSG gas operators.
- ◆ However as can be seen in Table 4, as expected the highest values are ascribed to producing companies, with the lowest (including Leigh Creek) being for those companies looking to develop unconventional assets - the low value for Icon Energy is at least in part due to that company holding onshore assets in Victoria, with that state have an onshore drilling moratorium in place.
- ◆ Leigh Creek has the second largest 2P Reserves (behind Beach), and the lowest EV/2P PJ - this may also reflect the large Reserve being somewhat discounted due to the relatively early stage of the Project.
- ◆ We have also added in a column listing EV/(2P + 2C) - although this is an unconventional parameter it allows to compare particularly early stage companies with either just Contingent Resources (which are yet to be upgraded) or those with Contingent Resources and some measure of Proven Reserves - a case in point is Blue Energy, which has a very high 2P multiple due to the small 2P Reserves (and is out of sync with peers), however is more indicative of the peer group when the EV/(2P + 2C) measure is used.
- ◆ In this case Blue Energy and Leigh Creek have similar multiples.
- ◆ In our view the low multiples for Icon may be due to having projects in Victoria, which currently has a moratorium on onshore gas drilling.

## TRANSACTIONS

- ◆ Figure 11 presents the 2P multiples for a number of largely coal seam gas asset sales going back to the commencement of development of the basins in Queensland to supply the LNG export terminals - these include a mix of developed and undeveloped assets.
- ◆ There was a significant period of consolidation in the mid to late 2000s, which concentrated on the Queensland coal seam gas ("CSG") fields, with this resulting in very few small players being left in the market - the latter part of this saw sales prices fall to under A\$1/PJ 2P, and only few subsequent transactions.
- ◆ The most recent transaction is Origin's sale of the Ironbark project in the Surat Basin to Australian Pacific LNG ("APLNG"), which is owned 37.5% by Origin - this has a value of A\$1.78/2P PJ.
- ◆ The average value for all transactions is A\$1.40/2P PJ (shown as the red line on the chart) with it being closer to \$2.00/2P PJ for the main consolidation phase; other averages are A\$7.11/1P PJ and A\$0.72/3P PJ

**Figure 11: Historic 2P transaction multiples**



Source: IIR Analysis

## VALUATION

- ◆ We have considered both a peer comparison and transaction based Resource/Reserve multiple approach to our valuation of Leigh Creek, with this including an assessment of historic transactions of unconventional gas assets - we have not considered the current cash position given that this is not material in the overall Company valuation.
- ◆ It needs to be noted that there have been no recent valuations, market or otherwise, of ISG properties in Australia - at the time of the Queensland trials asset valuations were generally highly inflated by the market, and thus they do not provide a reasonable basis for comparison - this makes any valuation problematical, and in our view indicative only.
- ◆ Table 5 presents a range of values based on resource multiples for both transactions and peers - this highlights a wide range of potential valuations for Leigh Creek, from A\$0.00/share to A\$6.29/share - here the peer valuations are based on the weighted average multiples for explorers and developers only; producers are not included.
- ◆ Our preference however is the peer based approach (the transactions had a mix of undeveloped and developed assets (which would tend to increase the average value above that for a Company at Leigh Creek's stage of appraisal) - this gives potential unrisks share prices of A\$0.26 to A\$2.05, with an average of A\$1.16/share - here we have not considered the market value ascribed to Icon Energy given that company's circumstances.

**Table 5: Leigh Creek valuation range**

Leigh Creek valuation range						
A\$/GJ						
Category	PJ	PJ Adjusted	Min	Weighted Ave	Max	Notes
2P	1153	923	\$0.273	\$1.397	\$3.732	Transactions
3P	1608	1287	\$0.246	\$0.717	\$2.404	Transactions
2P	1153	923	\$0.869	\$1.115	\$1.217	Peers - Pre-producers
3P	1608	1286	\$0.207	\$0.403	\$0.560	Peers - Pre-producers
2P + 2C	2622	2098	\$0.000	\$0.068	\$0.278	Peers - Pre-producers
Shares on Issue		547.7				
Total - A\$m						
Category	PJ	PJ Adjusted	Min	Weighted Ave	Max	Notes
2P	1153	923	A\$252 m	A\$1,289 m	A\$3,443 m	Transactions
3P	1608	1287	A\$316 m	A\$923 m	A\$3,093 m	Transactions
2P	1153	923	A\$802 m	A\$1,029 m	A\$1,123 m	Peers - Pre-producers
3P	1608	1286	A\$266 m	A\$519 m	A\$720 m	Peers - Pre-producers
2P + 2C	2622	2098	A\$1 m	A\$143 m	A\$582 m	Peers - Pre-producers
A\$/share Unrisks						
Category	PJ	PJ Adjusted	Min	Weighted Ave	Max	Notes
2P	1153	923	A\$0.460	A\$2.353	A\$6.287	Transactions
3P	1608	1287	A\$0.578	A\$1.685	A\$5.647	Transactions
2P	1153	923	A\$1.464	A\$1.879	A\$2.050	Peers - Pre-producers
3P	1608	1286	A\$0.486	A\$0.947	A\$1.315	Peers - Pre-producers
2P + 2C	2622	2098	A\$0.001	A\$0.261	A\$1.063	Peers - Pre-producers
A\$/share Risked						
Category	PJ	PJ Adjusted	Min	Weighted Ave	Max	Notes
2P	1153	923	A\$0.320	A\$0.706	A\$1.886	Transactions
3P	1608	1287	A\$0.320	A\$0.506	A\$1.694	Transactions
2P	1153	923	A\$0.439	A\$0.564	A\$0.615	Peers - Pre-producers
3P	1608	1286	A\$0.320	A\$0.320	A\$0.394	Peers - Pre-producers
2P + 2C	2622	2098	A\$0.320	A\$0.320	A\$0.320	Peers - Pre-producers
Risk Factor		30%				

Source: IRR analysis

1: "PJ Adjusted" is total energy content multiplied by 0.80 to reflect expected proportion of the energy in the syngas that could be used for methane production so as to compare with the other companies, for which methane is the main gas component.

- ◆ However, given that Leigh Creek is the only ISG company to be considered in recent times, we have risked the per share valuation using a conservative multiplier of 30% to reflect our view of the risk as compared to the CSG and conventional operators - risks include amongst others:
  - Uncertainty as to the commercialisation route, and hence capital/operating costs,
  - Only having 2P and 3P Reserves without 1P Reserves; and,
  - Other risks inherent in being an ISG operation as outlined in our SWOT analysis.
- ◆ On the upside there is, amongst others, the potential for a JV (for which the Company is working towards), the conditions of which may set a base valuation for the Company.
- ◆ In considering this we have also set a base price of A\$0.32/share (as shown in the outlined part of Table 5) - this is very close to the previous 10 trading day VWAP, however we note that this is under the current share price.
- ◆ Using this base price and risked peer multiple gives an indicative price range of A\$0.32 to A\$0.62/share, with our preferred value at the upper end of this range - in our view key price movers will be successful joint venture/partnership negotiations and critically, material advancement of permitting and approvals processes with the Government - success should also lead to further value upside potential with derisking and thus increasing the risk multiplier.
- ◆ Given the inherent uncertainty and the potential for uplift we have undertaken a sensitivity analysis modelling changes in the risk value used - results are shown in Table 12.

**Table 6: Leigh Creek valuation sensitivity**

Leigh Creek valuation sensitivity	Risk Multiplier				
	20%	25%	30%	35%	40%
Min share price	A\$0.320	A\$0.320	A\$0.320	A\$0.320	A\$0.320
Max share price	A\$0.410	A\$0.513	A\$0.615	A\$0.718	A\$0.820

Source: IRR analysis

## BOARD AND MANAGEMENT

- ◆ **Justyn Peters - LLB, LP, BA - Executive Chairman:** Justyn joined Leigh Creek Energy as Non-Executive Director on 28 November 2014 and was appointed Executive Chairman on 27 May 2015.

Justyn is a qualified Lawyer and has many years' experience in the ISG industry and in senior management positions. He has had over a decade of experience with investing entities based offshore, and in particular in China, investing directly into Australian mining, energy and infrastructure projects and brings with him extensive deal structuring experience and long dated contacts. Justyn's experience includes working in the mining industry, for industry representative bodies and for various state and federal environment departments and authorities.

- ◆ **Phil Staveley - CPA, BA (Acc) (Hons), Dipl Btr - Managing Director:** Phil is a qualified Accountant who has 30 years' experience working in the resources sector.

He started his career in the oil and gas sector working for Schlumberger in London, followed by a number of years with SAGASCO and SAOG (South Australian Oil and Gas Company). He spent almost ten years with Normandy Mining Ltd. Whilst with Normandy he fulfilled a number of planning, finance, M&A and commercial roles, including the establishment of a Group Supply Function and three years based in Rio de Janeiro as the CFO of TVX Normandy Americas.

Since 1998 he has been involved in mining and contracting companies in the position of CFO and more latterly, CEO roles with an emphasis on strategy and corporate finance.

- ◆ **Gregory English - LLB, BE (Mining) - Non-Executive Director:** Greg joined the Leigh Creek Energy Board as Non-Executive Director on 22 September 2015.

Greg is a qualified Mining Engineer and Lawyer. He is currently a partner of Piper Alderman Lawyers and specialises in mining, commercial and securities law. He is a qualified Mining Engineer, with experience on a wide variety of mining projects for MIM Limited, ETSA, Kalgoorlie Consolidated Gold Mines and Normandy Mining Limited. Greg is currently the

Non-Executive Chairman of Archer Exploration Limited and Core Exploration Limited and was a previous Director of ASX listed Gawler Resources Ltd.

Greg's experience in the mining industry, particularly in capital raising, tenement acquisition, project management and business development, and his industry knowledge and business relationships, will assist Leigh Creek Energy Limited to manage and develop its existing tenement portfolio and to identify and secure other high quality exploration assets.

- ◆ **Murray Chatfield - (B.Com (Ag) (Economics and Marketing) MBA (Cass University, London), AMCT, MAICD) - Non-Executive Director:** Murray joined the Leigh Creek Energy Board as a Non-Executive Director in June 2016.

Murray brings a wide area of expertise covering the financial sector, entrepreneurial, commodity, technology and service facing sectors that will ensure strategic focus and vision, together with the attention to detail to guide the creation, reorganisation and expansion of the business to achieve sustained benefits.

Murray has a diverse skill set covering finance, treasury, accounting, operational efficiency, risk management (business, market, tax and regulatory), legal and regulatory compliance and direct financial market interaction.

- ◆ **Zhe Weng - Non-Executive Director:** Zhe joined the Leigh Creek Energy Board as a Non-Executive Director on 1 July 2017.

Zhe is a Chinese based Energy and Thermal Physics Engineer, who was appointed to the Board as a nominee of China New Energy Group Limited (one of Leigh Creek Energy's major shareholders). Zhe has over 8 years executive management experience. Zhe also sits on the Board of Beijing Raise Mind Technology Ltd.

Zhe's key areas of expertise include; Coal Combustion; Renewable Energy Applications and Steel Sinter. He has a Bachelor of Thermo Dynamics, Renewable Energy Applications as well as a Masters in Energy Engineering and Thermal Physics, Coal Combustion.

- ◆ **Mr Zheng Xiaojiang - Non-Executive Director:** Zheng joined the Leigh Creek Energy Board as Non-Executive Director on 5 December 2017.

Zheng is a senior finance executive and brings wide experience in the finance sector in both Australia and China. His experience includes having been a senior official for The People's Bank of China in Australia and New Zealand.

Zheng was responsible for facilitating the investment in LCK by China New Energy, LCK's largest shareholder.

- ◆ **Justin Haines - B.App.Sci.(App.Geo.), G.Dip.Sci.(Hons), M.Min.Eng., MAusIMM - Chief Technical Advisor:** Justin has postgraduate qualifications in geology and mining engineering and broad experience across engineering and geological services for multiple commodities including coal, iron ore and uranium. Most recently, he worked as Technical Manager for Carbon Energy Ltd, an In Situ Gasification (ISG) technology developer who successfully operated a demonstration facility in Queensland under the direction of the Queensland Government's UCG Trial Policy.

In the General Manager Technical role, Justin is responsible for all technical and operational aspects of the development of the Leigh Creek Energy Project through to commercial production..

- ◆ **Cristian Bolda - Operations Manager:** Cristian has experience in delivering high-value petroleum and infrastructure projects internationally. Senior management roles in the Middle East, Wheatstone LNG project (WA), and the APLNG gas field facilities (QLD), as well as with various power station upgrades and bio-remediation plants

- ◆ **Jordan Mehrtens - LLB/LP, BCom (Fin), GDip (Planning) - Company Secretary:** Jordan is a qualified Lawyer, and has a Bachelor of Commerce (Finance) and a Graduate Diploma in Urban and Regional Planning. Jordan has worked with the Leigh Creek Energy Project since its commencement, providing regulatory, compliance and other analytical advice. Jordan is a member of the Governance Institute of Australia and Australian Mining and Petroleum Law Association.

Jordan currently performs the legal role in the Company as well as the formal Company Secretarial duties.

## BACKGROUND - IN-SITU GASIFICATION

- ◆ ISG presents a relatively clean, cheap route to gas and energy production, with some advantages including:
  - The ability to convert otherwise stranded coal resources to energy - these could be considered stranded by virtue of being uneconomical to mine due to depth, else of a quality not suitable for mining,
  - High energy conversion factor when compared to conventional burning of coal,
  - Environmental advantages including negating the requirement to mine coal (with associated environmental effects) and cleaner, with ash remaining underground and greater control on gas emissions; and,
  - Relatively low and stable costs when compared to the current natural gas market in Australia.
- ◆ Key environmental impacts can include groundwater and soil contamination as well as ground subsistence, however these can be prevented by careful site selection (taking into account geology and hydrogeology) and rigorous trials and management and monitoring of operations.

## HISTORY

- ◆ Although ISG is a relatively new technology, the production of syngas in surface gasifiers from mined coal (and other biomass) has been around since the late eighteenth century, and was widely used for street lighting in the nineteenth and early twentieth centuries - the gas was commonly termed "town gas".
- ◆ Surface gasification of coal is still a widely used process globally, particularly in the chemical industries; in recent history one of the most well known users was the South African company SASOL, which converted syngas to synthetic fuels using the Fischer-Tropf process, with development of this industry driven by the embargoes against the country during the apartheid era.
- ◆ The chemical processes and products, including those pertaining to pyrolysis and gasification are the same for both ISG and surface gasification; the difference, as the names suggest, is that one is done on mined coal in surface gasifiers and the other on the in-situ coal.
- ◆ Early developments date from the 1930s in the FSU, with the techniques developed in the FSU forming the basis of the technology developed and used in generally small scale trials that were undertaken in the US during the 1970s and 1980s, followed by a resurgence of interest from around 2004 to 2015 - to date there have been over 100 ISG trials/projects globally.
- ◆ The key triggers for the US trials included the 1970s oil embargo, and then increases in oil prices in the 2000s - subsequent increases in gas and oil supply (particular from unconventional sources, including shale) have all but ended the interest in the US.
- ◆ Activities are still underway in the FSU, with the largest commercial facility being Angren in Uzbekistan - this has operated for close to 60 years, and reportedly produces ~ 35,000 Mcf/day of syngas that is fed into the Angren power station - Angren was previously owned by Yerostigaz, a subsidiary of the now liquidated Linc Energy.
- ◆ Another example of a current ISG operation is Eskom's commercial Majuba operation in South Africa, with this providing syngas to Eskom's Majuba power station.

## THE AUSTRALIAN EXPERIENCE

- ◆ Prior to Leigh Creek, the main ISG focus in Australia was on three trials undertaken in Queensland at various times from 1999 to 2016, with these designed to test and assess the full lifecycle (from initiation to successful rehabilitation) of ISG projects.
- ◆ Key outcomes from these trials (as well as all previous work) have been used in the development and design of the LCEP, with this
- ◆ The most successful of the three trials was that operated by Carbon Energy (ASX: CNX, Receivers and Managers appointed) at Bloodwood Creek near Dalby from 2008 until the successful decommissioning and rehabilitation from 2012 - the decommissioning was in response to the recommendations of the Queensland Government appointed Independent Scientific Review Panel ("IPT") report published in 2013.

- ◆ Bloodwood Creek, which was based on a 1PJ/year module, was also the first ISG operation in Australia to generate electricity, with a 5 MW power station producing first electricity in 2011 and feeding 1.5 MW into the grid.
- ◆ Two panels were successfully operated at Bloodwood Creek, with Panel 2, which supplied the gas for the power plant, operating from March 2011 to October 2012, with an estimated 10,000 tonnes of coal being gasified - this reportedly produced syngas at up to ~4,000 scm/hour.
- ◆ Another participant in the trials was Cougar Energy (now Moreton Resources, ASX:MRV), however this was short-lived - the reported failure of a well casing five days into the trial near Kingaroy resulted in the premature cessation of operations.
- ◆ Unfortunately most media focus has been on Linc Energy and the Chinchilla trial that initially operated from 1999 until 2001 from Gasifier 1, and then again from 2007 until 2013 from Gasifiers 2 to 5 - the second phase also included a facility to produce synthetic fuels from the syngas.
- ◆ The first phase of operations ("Gasifier 1") reportedly operated well and converted >20,000 tonnes of coal to syngas, with ongoing environmental monitoring after the 2001 controlled shut down not identifying any issues.
- ◆ It was the second phase of operations (which reportedly converted ~36,500 tonnes of coal) that led to the events as widely reported in the media, and which unfortunately overshadowed the successful trials at Chinchilla and elsewhere.

## UREA AND THE AUSTRALIAN MARKET

### WHAT IS UREA, AND HOW IS IT PRODUCED?

- ◆ Urea ( $\text{CO}_2\text{-}2\text{NH}_2$ ) is a major fertiliser ingredient, being a major source of nitrogen, one of the key plant nutrients (along with potassium and phosphate), with global consumption, in 2016, of over 108 million tonnes, of which Australia consumed just over 2 million tonnes (Table 6).

**Table 6: Ammonium derived fertiliser consumption 2016**

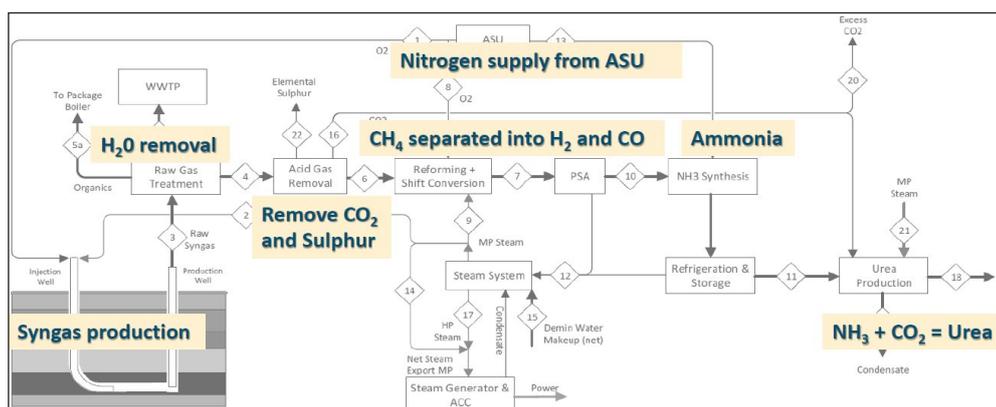
Ammonium derived fertiliser consumption 2016			
Fertiliser Type	Global Consumption (kt)	Australian Consumption (kt)	Australian % of Global
Ammonia Direct Application	4,803	55	1.14%
Ammonium Sulphate	16,668	334	2.01%
Urea	108,289	2,090	1.93%
Ammonium Nitrate	19,190	29	0.15%
Calcium Ammonium Nitrate	14,085	167	1.18%
Ammonium Phosphate	25,733	550	2.14%
<b>Total Ammonia Based Fertilisers</b>	<b>188,767</b>	<b>3,224</b>	<b>1.71%</b>

Source: Calculated from IFA data

- ◆ Urea, and other ammonia derived fertilisers comprise ~71% of total nitrogen demand (by contained nitrogen), making them the most important source of nitrogen fertilisers.
- ◆ Australia produces ~15% of its ammonia based fertilisers domestically, with the rest being imported - the only production facility is Incitec-Pivot's (ASX: IPL) Gibson Island plant near Brisbane, which produces up to 500,000t of urea equivalent fertiliser annually - products include ammonia, urea and ammonium sulphate.
- ◆ The dominant urea producer in 2016 with ~25% of production (India is also the largest consumer, and is a net importer), followed by the Russian Federation (~8%) and Indonesia (~7%); the Russian Federation, Qatar and Saudi Arabia are the top exporters, with Indian production being used domestically
- ◆ The major production route for ammonia ( $\text{NH}_3$ ) is from natural gas, with this being broken down and the resultant hydrogen being combined with nitrogen to form ammonia, commonly using the Haber-Bosch process.
- ◆ Urea is then produced by combining ammonia with carbon dioxide, with the latter being a by-product of the ammonia production - as such ammonia and urea plants are commonly produced at common facilities.

- ◆ The processing route proposed by Leigh Creek is shown in Figure 12.

**Figure 12: Schematic flowsheet - Urea production**

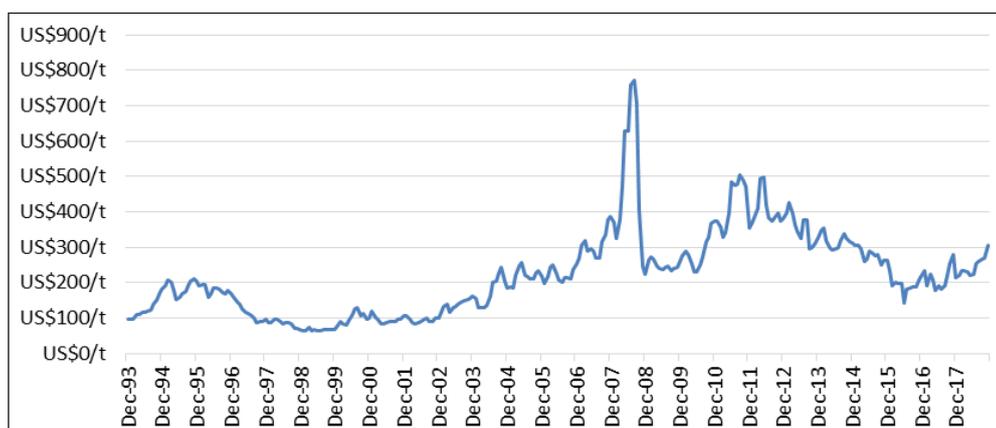


Source: Leigh Creek

## PRICING

- ◆ Figure 13 shows bulk urea prices for the past 25 years, FOB Black Sea - this highlights a recovery in prices since mid-2016.

**Figure 13: Urea price - FOB Black Sea**



Source: IndexMundi - sourced from various, including Fertiliser Week, Fertiliser International, World Bank

## COST OF PRODUCTION - RAMIFICATIONS FOR LEIGH CREEK

- ◆ The major cost input for ammonia, and hence urea production is natural gas, with this comprising up to 70% (or more) of the cost of production, and this of key concern for Incitec-Pivot, with rising east coast Australian gas prices severely affecting the economic performance of Gibson Island.
- ◆ Incitec Pivot has stated that a A\$1/GJ rise in the price of natural gas will lower annual EBIT by A\$14 million; this figure suggests that, assuming annual production of 450,000t to 500,000t of urea equivalent, ~28-31 GJ of natural gas is required to produce one tonne of urea equivalent; in addition to the cost of the natural gas, the cracking to syngas also adds an estimated A\$2-3/GJ to the cost of production.
- ◆ This clearly highlights the pressures on Gibson Island (and other Australian gas-based manufacturing industries) with gas costs now in the order of A\$10/GJ, and Incitec-Pivot competing in a global market where bulk urea costs are currently ~US300/tonne (FOB Black Sea) - IPL is looking to close Gibson Island if gas cannot be sourced beyond 2019.
- ◆ Given the current state of the eastern Australian gas market (which includes the LNG exports), a moratorium on onshore drilling (Victoria) and various other bans or moratoriums nationwide, there appears to be little chance of significant falls in natural gas prices in Australia for the foreseeable future.
- ◆ Another factor affecting the cost of production of ammonia and urea (amongst other chemicals) is that natural gas needs to be broken down into its constituent components and then be combined with other gases and reformed as ammonia.
- ◆ Cost differences between syngas derived from ISG and that derived from natural gas were investigated in a recently published paper (Pei, Peng and Korom, Scott F. and Ling, Kegang and Nasah, Junior; Cost comparison of syngas production from natural gas conversion and

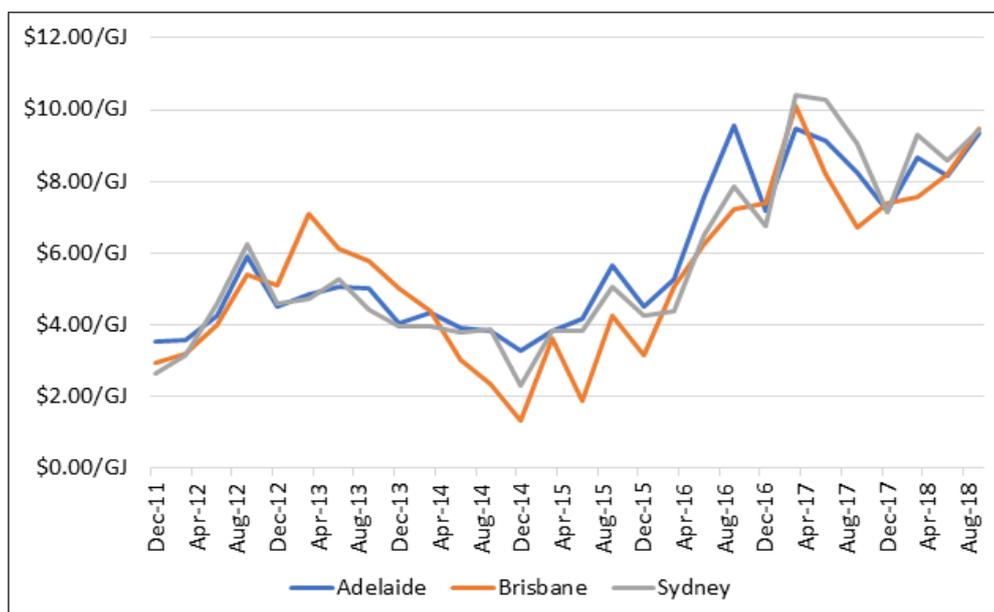
underground coal gasification. *Mitigation and Adaptation Strategies for Global Change, 2016, vol. 21, issue 4, 629-643*).

- ◆ Results of this US-focussed study indicated that costs (including amortisation of capital) of syngas from ISG were around US\$38 per thousand cubic metres (~\$US1.10/Mcf), and ranged between US\$24 to US\$90 per thousand cubic metres (US\$0.70 to US\$2.60/Mcf) for that produced from natural gas.
- ◆ Natural gas prices used in the latter ranged from US\$1.00/Mcf to US\$4.80/Mcf (significantly lower than current Australian prices), with the ISG example based on a 6m thick lignite seam at a depth of 245m below surface, about half the depth of that at Leigh Creek - the upshot of the latter is that, calculated on the same basis, production costs would be more at Leigh Creek with the requirement for deeper drilling - in the modelled example estimated drilling costs were ~35% of the total operating costs.
- ◆ As a comparison, a 2014 presentation by ISG technology providers Ergo Exergy Technologies provides an example with a cost of production of syngas from ISG of US\$2.14/Mcf, and a 2012 presentation by Carbon Energy estimated a cost of A\$3.50/GJ (+/- 50%) for producing natural gas from UCG - what needs to be noted in the latter case is the natural gas (largely methane) is just one component of and needs to be separated from the syngas, and hence the raw syngas production costs will be significantly lower than the quoted natural gas production cost.
- ◆ Our view is, that, with current Australian gas prices, the LCEP provides the potential for a cheap source of syngas that can be used as a feedstock for cost effective ammonium fertiliser production.

## EASTERN AUSTRALIAN GAS PRICES

- ◆ Figure 14 shows the considerable rise in Eastern Australian spot gas prices since late 2011.

**Figure 14: Eastern Australian spot natural gas prices**



Source: AER

- ◆ The causes of this are varied and complex (and we won't go into this in detail here), and include the effect of the international LNG markets on domestic prices, with domestic gas prices reflecting the netback gas price calculated from the international LNG price and production and transport costs from the major LNG production trains in Queensland.
- ◆ This has also led to shortages of gas for domestic supply, thus affecting prices - there is no gas reservation policy in place in the eastern states.
- ◆ Other contributing factors may also include supply restrictions, with restrictions, bans and moratoriums on unconventional gas production throughout Eastern Australia - these have generally been put in place for political reasons, and there also has been a lack of political will in addressing the price issues.
- ◆ There is little expectation of considerable falls in prices in the foreseeable future, with a number also forecasting critical domestic supply shortages within the next few years, and the possibility of LNG imports to feed domestic gas shortfalls!

## OIL AND GAS GLOSSARY

Glossary	
<b>Volumes</b>	
<b>boe</b>	Barrel of oil equivalent - based on energy content, and not monetary value
<b>bbl</b>	Barrel (= 158.987 litres)
<b>cf</b>	Cubic feet
<b>cm</b>	Cubic metre (= 35.31cf)
<b>Units</b>	
<b>M</b>	Thousand (10 <sup>3</sup> )
<b>MM</b>	Million (10 <sup>6</sup> )
<b>B</b>	Billion (10 <sup>9</sup> )
<b>T</b>	Trillion (10 <sup>12</sup> )
<b>Energy Contents</b>	
<b>KJ</b>	Kilojoule (10 <sup>3</sup> joules)
<b>MJ</b>	Megajoule (10 <sup>6</sup> joules)
<b>GJ</b>	Gigajoule (10 <sup>9</sup> joules)
<b>TJ</b>	Terajoule (10 <sup>12</sup> joules)
<b>PJ</b>	Petajoule (10 <sup>15</sup> joules)
<b>btu</b>	British thermal units
<b>Non Gas Liquids</b>	
<b>C3</b>	Propane (the number refers to the number of carbon atoms in the molecule)
<b>C4</b>	Butane
<b>C5+</b>	Pentane and heavier
<b>Energy Equivalents</b>	
<b>1 Mcf of natural gas</b>	~1.0 MMbtu / ~1.05 GJ
<b>1 boe</b>	6.12 Mcf gas
<b>1 Mcf of hydrogen</b>	~0.35 MMbtu / ~0.37 GJ
<b>Miscellaneous</b>	
<b>ISG, CSG</b>	In-Situ Gasification, Coal Seam Gasification - synonymous
<b>PSC</b>	Production Sharing Contract
<b>IOR</b>	Incremental Oil Recovery
<b>GCoS</b>	Geological Chance of Success
<b>CCoS</b>	Commercial Chance of Success
<b>TCoS</b>	Total Chance of Success
<b>pd</b>	per day
<b>pa</b>	per annum
<b>WTI</b>	West Texas Intermediate crude

Source: Various

# DISCLAIMER

## (a) Disclaimer

The information, reports, financial models, forecasts, strategies, audio broadcasts and other media (referred to as "Content" throughout this Legal Notice), provided on this web site has been prepared and issued by Altavista Research Pty Ltd trading as Independent Investment Research "IIR," Independent Investment Research Holdings Pty Ltd (ACN 155 226 074), as authorised to publish research under an Australian Financial Securities Licence (AFSL No 420170) which allows Independent Investment Research to offer financial service advice to retail and wholesale clients. Users of this web site should not act on any Content without first seeking professional advice. Whilst the Content contained on this web site has been prepared with all reasonable care from sources which we believe are reliable, no responsibility or liability is accepted by Independent Investment Research, for any errors or omissions or misstatements however caused. Any opinions, forecasts or recommendations reflect our judgement and assumptions at the date of publication or broadcast and may change without notice. Content on this web site is not and should not be construed as an offer to sell or the solicitation of an offer to purchase or subscribe for any investment. We are not aware that any user intends to rely on the Content provided or of the manner in which a user intends to use it. In preparing our Content it is not possible to take into consideration the investment objectives, financial situation or particular needs of any individual user.

Access by any user to this website does not create a client relationship between Independent Investment Research and the user. Users seeking to invest must obtain individual financial advice to determine whether recommendations are appropriate to their investment objectives, personal financial situation or particular needs, before acting on any recommendations. Any Content is not for public circulation or reproduction, whether in whole or in part and is not to be disclosed to any person other than the intended user, without the prior written consent of Independent Investment Research.

## (b) Disclosure of Interest

### General

Independent Investment Research, its officers, employees, consultants and its related bodies corporate have not and will not receive, whether directly or indirectly: any commission; fee; benefit; or advantage, whether pecuniary or otherwise, in connection with making any recommendation contained on this web site. Independent Investment Research, discloses that from time to time, it or its officers, employees and its related bodies corporate: may have an interest in the securities, directly or indirectly, which are the subject of these recommendations; may buy or sell securities in the companies mentioned in the Content; may effect transactions which may not be consistent with the recommendations in the Content; may have directorships in the companies mentioned in the Content; and/or perform paid services for the companies that are the subject of such recommendations.

However, under no circumstances, has Independent Investment Research been influenced, either directly or indirectly, in making any recommendations contained on this web site.

### Corporate Research

Independent Investment Research has or may have, received a fee either directly by a company itself or by a third party, to provide coverage and/or corporate research (the "Fee"). Where a Fee has been received, Independent Investment Research does not publish:

Buy / Hold / Sell recommendations for the security or managed investment schemes.

## (c) Copyright Protection

All Content at this web site is protected by copyright. Apart from any use permitted under the Copyright Act (Cth) 1968, you must not copy, frame, modify, transmit or distribute the material at this web site, without seeking the prior written consent of the copyright owner. Content on this web site is owned by the business Independent Investment Research. Users are prohibited from copying, distributing, transmitting, displaying, publishing, selling, licensing, creating derivative works or using any content on the web site for commercial or public purposes

Copyright 2010 Independent Investment Research. All rights reserved.

## (d) Trade Marks

The trade marks and logos displayed on this web site belong to Independent Investment Research or other parties. Such trade marks include registered trade marks and trade marks pending registration. Users are prohibited from using any of these trade marks, without seeking the prior written consent of IIR or such third party, which may own the trade mark content on this web site.

## (e) Limitation of Liability

To the fullest extent permitted by the law, Independent Investment Research and any of its officers, employees, agents, consultants or related bodies corporate disclaim any liability, whether based in contract, tort, strict liability or otherwise, for any direct, indirect, incidental, consequential or special damages arising out of or in any way connected with the use of any Content made available on this web site by any person or entity.

## (f) No Warranties

Independent Investment Research does not make any claims, promises, guarantees, representations or warranties regarding the accuracy, completeness or fitness for purpose of the Content made available on this web site. All information on this web site is provided to you on an as is basis, without warranty of any kind either express or implied. To the extent that research can be provided by third parties, Independent Investment Research makes no warranty or representation as to the accuracy or completeness of such information displayed on this site, and accepts no liability for errors or omissions arising from such third party information. To the fullest extent permitted by law, under no circumstances will Independent Investment Research be liable for any loss or damage caused by users reliance upon information obtained through this web site. It is the responsibility of the user to evaluate the accuracy, completeness or usefulness of any information, opinion, general advice or other content made available through this web site. Furthermore, Independent Investment Research does not warrant or represent that this web site is error free or free from viruses or defects. A user must do all that is necessary (including using virus checking software) to satisfy itself that accessing this website will not adversely affect its system.

For further information, please contact IIR at: [client.services@independentresearch.com.au](mailto:client.services@independentresearch.com.au)



**Independent Investment Research LLC**  
**Independent Investment Research (Aust.) Pty Limited**

**DENVER OFFICE**

200 Quebec Street  
Suite 200  
Denver Colorado 80230 USA  
Phone: +1 720 355 0446

**NEWYORK OFFICE**

Phone: +1 917 336 0818

**SYDNEY OFFICE**

Level 1, 350 George Street  
Sydney NSW 2000  
Phone: +61 2 8001 6693  
Main Fax: +61 2 8072 2170  
ABN 11 152 172 079

**MELBOURNE OFFICE**

Level 7, 20-22 Albert Road  
South Melbourne VIC 3205  
Phone: +61 3 8678 1766  
Main Fax: +61 3 8678 1826

**MAILING ADDRESS**

PO Box H297 Australia Square  
NSW 1215