Energy Update for South Australia
What’s new and enabling?

Bio-fuel vehicle on E-Bay

Caveat Emptor: Don’t step in exhaust

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Minerals & Energy Resources Group
Australia in the Context of World Markets:

- World’s largest exporter of coal
- Amongst largest uranium exporters (SA leads)
- 6th largest exporter of LNG (SA has prospects)
- Only 0.3 % of world oil reserves.
- Net imports of liquid fuels account for ~50% of consumption
- 20th largest consumer of energy
- 15th largest consumer of energy per capita

...and it is sunny, windy in places & hot down under
• Gas is less emissive than coal
• Gas plants are flexible (fast start) for electricity
• Australia has huge gas resources
  ✓ Discovered conventional gas offsh. NW Australia is huge
  ✓ Discovered unconventional gas onsh. Australia is very large and expected to be huge (in SA, too)
  ✓ The Australian domestic gas market is relatively small
  ✓ Otherwise stranded conventional and unconventional gas is being monetised as feedstock for LNG exports
  ✓ International net-back price for gas as feedstock for LNG at least twice eastern Australia’s domestic price for gas
• Expect gas market share to grow in coming decades
• Gas can become a significant transport fuel
• Question: At what oil price is the use of gas as feedstock for synfuel more valuable than as feedstock for LNG?
**Competition is wonderful for consumers!**

**Eastern Australia:** $3.20-$4.10 / GJ

**West Australia:** twice the price.
- Reflects less competition.
- Informed demand is backing exploration to add to supply-side competition.

Remaining eastern Australian 2P gas is > 32,000 PJ (75% Coal Seam Gas)

Australia’s gas pipeline industry is nimble and competitive

Source: Core Energy Group 2010
STOCKTAKE - conclusions re: gas

• Eastern Australian gas reserves > demand beyond 2020

• Price increases expected from 2016-2017 as Eastern Australian contracts expire

• Unconventional gas opportunities are expected to sustain supply-side competition vital for robust gas markets (more on this next)

• Domestic gas price drivers: supply-side competition; gas banked for LNG and/or synfuel contracts; emerging links between the price of gas with the price of oil; and the price of carbon in the cost of energy

• Reservation of gas from proven plays can stymie exploration and future play-on-play competition—careful what you wish for
SA’s Energy Portfolio
– proven to prospective plays;
– trusted investment settings

Proven plays:
1. Uranium for export
2. Oil & gas Cooper-Eromanga & Otway
3. Leigh Creek Coal

Prospective plays in the mix:
1. Oil & gas - Officer and Arckaringa basins
2. Oil & gas - offshore Bight Basin
3. Oil & gas - offshore Otway Basin
4. Shale gas - Cooper and other basins
5. Low K reservoir (tight) gas - Cooper Basin
6. Coal seam gas - Eromanga Basin
7. Underground coal gasification – Arckaringa, Walloway and other basins
8. Coals mining - Arckaringa & Tertiary basins for power generation, syngas and synfuel
9. Hot rock engineered geothermal systems (EGS) - eastern South Australia
10. Hot (geothermal) sedimentary aquifers - eastern South Australia

Technology options: CNG, LNG, GTL, CTL, bio-fuel blending, car battery supply-chains, gas storage
SA Cooper Basin Oil Success Rate

World class success rates
Discovery $\Rightarrow$ production in months
Existing infrastructure minimises CAPEX up-front
Productive play trends extended
New unconventional gas plays
Serial underpinning for IPOs

SA Cooper Basin Gas Success Rate

New giant gas plays under construction

Modest 500k bbl oil discovery worth $\sim$50 Mln in gross sales

www.petroleum.pir.sa.gov.au
Cooper-Eromanga Petroleum Bid Blocks

• Bids on 3 blocks offered in 2010 closed 10 March 2011

• 11 bids from 6 companies

• Winners – SAPEX Blocks A and B, Ambassador Block C

• Bids total $52.7m

• $48.3m guaranteed for:
  12 wells
  1,300 km 2D seismic
  200 sq km 3D seismic

Expiry year

- 2010 – 2011
- 2012 – 2013
- 2014 – 2015
- 2016 – 2017

Relinquishment upon renewal

- Half
- Third
- All
Vast Opportunities for Unconventional Gas

✓ Shale Gas
Santos Annual Report 2009, “An audit of the Cooper Basin has shown vast amounts of unconventional shale gas and tight gas resources. Already, the company is producing shale gas from one of its wells.”

✓ Tight Gas
Beach Energy, “Cooper Basin….huge resource potential…comparable to combined NSW and Queensland coal seam gas combined”

✓ Coal Seam Gas to LNG
not so unconventional now!

✓ Underground Coal Gasification (UCG) to synfuel

✓ Coal to Gas to Liquid Transport Fuel

✓ Micro LNG

Santos Annual Report 2009, “An audit of the Cooper Basin has shown vast amounts of unconventional shale gas and tight gas resources. Already, the company is producing shale gas from one of its wells.”

Beach Energy, “Cooper Basin….huge resource potential…comparable to combined NSW and Queensland coal seam gas combined”

“Coal seam gas explorer, Icon Energy Ltd … signed a Memorandum of Understanding for an exclusive 20-year gas sale contract with a subsidiary of … SinoGas. The Gas Sale Agreement …. would position Icon as the exclusive supplier of 40 million metric tonnes of LNG. Stuart’s (Senex) Cooper Basin tenements have potential to contain in excess of 20 trillion cubic feet coal-hosted gas-in-place,

Linc Energy: 1.0 to 1.3 billion tonne coal … UCG to GTL commercial location now confirmed at Orroroo…It is anticipated that the 20,000 barrels per day of synthetic fuels produced at Orroroo can be supplied into … Adelaide and South Australian regional markets

Altona Energy: 7.8 billion tonne sub-bituminous coal resource in the Arckaringa Basin…. Base case features a 10 million barrel per year coal to liquid plant and 560MW co-generation power facility
Competitive supply portfolios are GREAT!

Average Individual Play Chance for Success

Chance portfolio will yield at least one play success

1% 5% 10% 15% 20%

0% 5% 10% 15% 20% 25%

15 plays
10 plays
5 plays

Coin toss chance
Roundtable for Unconventional Gas
Objective, Strategy and Intended Outcomes

Objective: Inform industry strategies and government policies to underpin optimum life-cycle upstream-downstream planning for the deployment of technologies and infrastructure for exporting unconventional petroleum gas and liquids.

Strategy:
- Convene a Roundtable (government and Industry) focused on unconventional petroleum gas and liquids with this forum ranking opportunities and threats in the context of a roadmap for the development of unconventional gas.

Intended Outcomes (via roadmap):
- Informed industry investment strategies
- Informed government legislation, policies and programs
### Roundtable for Unconventional Gas Participants (more coming)

1. Ahava Energy Pty Ltd
2. Altona Energy
3. Australian Energy Market Operator (AEMO)
4. APPEA
5. Australian Pipeline Industry Assoc. (APIA)
6. Beach Energy Ltd
7. CNOOC New Energy International (Australia)
8. Core Energy Group
9. Dept. of Planning & Local Government
10. Drillsearch Gas Pty Ltd
11. Dept. of Transport, Energy & Infrastructure
12. Energy Exploration Ltd
13. Energy Quest
14. Energy World Corporation
15. Epic Energy
16. Greenpower Energy Ltd
17. Liberty Resources Ltd
18. Linc Energy Ltd
19. Liquefied Natural Gas Ltd
20. PIRSA (includes RESIC)
21. RISC Pty
22. Santos Ltd
23. SEA Gas Pty Ltd
24. Somerton Energy
25. SACOME
26. Strike Energy Ltd
27. Stuart / Senex
28. Sundance Energy Australia
29. Syngas Ltd
30. Transfield Services
31. University of Adelaide
32. Worley Parsons
Terms of Reference for a Roundtable (Interest Group) to Consider
Supply Chain Infrastructure & Technologies for Syngas, Synfuel, CNG & LNG

Likelihood of occurrence
Materiality of consequence
Magnitude of Impact:
Low priority for risk management
Upper med. priority for risk management
High priority for risk management
Less material - less likely
Lower med. priority for risk management

Risk Mitigation Goals (ex. SAFETY!)

First things first by design

Opportunities
Roundtable to define and rank for materiality and do’ability

Threats (Risks)
Roundtable to define and rank for materiality and do’ability

Ranking Opportunities by Priority (ex Infrastructure)

Ex. Risk management required for low chance but potentially catastrophic ‘bang’
Ex. Sharing wharf or GTL plants
SHIFT GEARS
Great Expectations for Geothermal Energy


Stage 1: This design makes walking impossible

Stage 2: Yeah, possible but impractical

Stage 3: Told you this would work!

www.petroleum.pir.sa.gov.au

Government of South Australia
Primary Industries and Resources SA
Geothermal Play Ingredients:
1. heat source,
2. insulating cover, and
3. reservoir
   combine to provide adequate heat flow rates to economically meet markets

Where natural permeability in sedimentary reservoirs is sufficient to support economic flow rates, the geothermal plays are called ‘HOT SEDIMENTARY AQUIFERS’

Where reservoir quality needs be enhanced with either physical or chemical stimulation methods to support economic flow rates, the geothermal plays are called ‘ENGINEERED GEOTHERMAL SYSTEMS’ (EGS)
Why Geothermal in Australia?

Below Ground Factors
- Extensive radiogenic basement at modest depths (heat source)
- Australia converging with New Guinea – giving rise to horizontal compression and common naturally occurring horizontal fractures (reservoir)
- Sedimentary cover (insulators) for hot sedimentary aquifer & hot rock EGS targets

Above Ground Factors
- Land access and title to resources
- Government stimulus for R, D, D & D
- Market recognition of comparative advantages – extensive, exploitable hot rocks
- Political will to attain energy security & mitigate risks of climate change
- Investors perceptions of risk: reward
- Growth in energy demand

>200°C @ < 3,500m in some locations in Australia

278°C @ 4,900 metres in Jolokia 1
Evidence of comparative advantage in the South Australian Cooper Basin: natural horizontal fractures susceptible to fracture stimulation

Areal distribution of ground movement (~reservoir creation) during fracture stimulation

- Initial phase stimulation, P-wave arrivals – Habanero
- Main phase stimulation, P-wave arrivals – Habanero
- Last phase stimulation, P-wave arrivals – Habanero

Plan View EGS @ Habanero

Cross – Section View @ Habanero

Max 3.7 Mag. induced event

 Courtesy of Geodynamics
Geothermal Energy Plays & Projects in South Australia

Play ingredients:

- Amagmatic conductive heat source
- Sub-horizontally fractured Hot Rocks and/or Hot Sedimentary Aquifer reservoir(s)
- Insulating cover

Investment

- 27 companies in 248 licences covering 131,343 km²
- 87% of investment ($584Mln) to YE ’10
- SA projects attracted 85% ($200 Mln) of Fed. Grants to date
Converting Australian Geothermal Plays to Projects – National Review

- Precompetitive – no large scale production
- Total 7 deep wells to date by 3 companies. ALL IN SOUTH AUSTRALIA
- 6 EGS (4 frac’d) & 1 HSA to date
- More to come
## Australian Geothermal Projects
### Progress is Measurable (Even through the GFC)

<table>
<thead>
<tr>
<th>Metrics</th>
<th>31 December 2007</th>
<th>31 Dec-2010</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal Licences</td>
<td>232 in Australia (198,000 km²)</td>
<td>418 in Australia (477,522 km²)</td>
<td>78% ↑</td>
</tr>
<tr>
<td></td>
<td>190 in South Australia (90,000 km²)</td>
<td>248 in South Australia (131,343 km²)</td>
<td>31% ↑</td>
</tr>
<tr>
<td>Companies</td>
<td>31 Australia-wide</td>
<td>57 Australia-wide</td>
<td>84% ↑</td>
</tr>
<tr>
<td></td>
<td>21 in South Australia</td>
<td>27 in South Australia</td>
<td>38% ↑</td>
</tr>
<tr>
<td>Geothermal Licence holders listed on ASX</td>
<td>9 Australia-wide</td>
<td>24 Australia-wide (more expected)</td>
<td>177% ↑</td>
</tr>
<tr>
<td></td>
<td>6 in South Australian Licences</td>
<td>14 in South Australian Licences</td>
<td>133% ↑</td>
</tr>
<tr>
<td>Aus$ Invested</td>
<td>$209 Mln in Australia (to YE 07)</td>
<td>$671.7 Mln in Australia (to YE 10)</td>
<td>118% ↑</td>
</tr>
<tr>
<td></td>
<td>$207 Mln (99%) in South Australia</td>
<td>$583.6 Mln in South Australia</td>
<td>107% ↑</td>
</tr>
<tr>
<td>F’cast Aus$ 2002-15</td>
<td>$851 Mln Australia-wide</td>
<td>$3,227 Mln Australia-wide</td>
<td>243% ↑</td>
</tr>
<tr>
<td></td>
<td>$681 Mln in South Australia</td>
<td>$1,384 Mln in South Australia</td>
<td>81% ↑</td>
</tr>
<tr>
<td>Government Grants</td>
<td>$46.4 Mln Australia-wide</td>
<td>$296 Mln Australia-wide</td>
<td>539% ↑</td>
</tr>
<tr>
<td></td>
<td>$27.3 Mln in South Australia</td>
<td>$204 Mln in South Australia</td>
<td>647% ↑</td>
</tr>
<tr>
<td>Federal Grants</td>
<td>$30.3 Mln Australia-wide</td>
<td>$235 Mln Australia-wide Projects</td>
<td>676% ↑</td>
</tr>
<tr>
<td></td>
<td>$20.5 Mln for South Australian projects</td>
<td>$200 Mln for South Australian Projects</td>
<td>876% ↑</td>
</tr>
</tbody>
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Download AGEG-AGEA Geothermal Reserve & Resource Code:  
### Australian Geothermal Energy Group (AGEG) Members

**ASX-Listed (Code)**  
International company

#### AGEG’S VISION:
Geothermal resources to provide the lowest cost emissions-free, renewable base load and direct-use energy for centuries to come.

<table>
<thead>
<tr>
<th>Company Members</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. AGEA (Industry Group)</td>
<td>37. Google (NASDAQ) - RE&lt;C Team</td>
</tr>
<tr>
<td>2. 3-D Geo</td>
<td>38. Golder Associates</td>
</tr>
<tr>
<td>3. AAA Energy</td>
<td>39. Gradient Energy – Planet Gas subsidiary (PGS)</td>
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<tr>
<td>4. ACIL Tasman</td>
<td>40. Granite Power</td>
</tr>
<tr>
<td>5. Activated Logic</td>
<td>41. Greennearth Energy (GER)</td>
</tr>
<tr>
<td>6. AGL (AGL)</td>
<td>42. Greenrock Energy (GRK)</td>
</tr>
<tr>
<td>7. Air International - Thermal Systems</td>
<td>43. Halliburton (NYSE listed)</td>
</tr>
<tr>
<td>8. APA Group (APA)</td>
<td>44. Hitachi HIPPO</td>
</tr>
<tr>
<td>10. Beach Petroleum (BPT)</td>
<td>46. Hot Rock Ltd (HRL)</td>
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<tr>
<td>11. Buddina Project</td>
<td>47. Hot Rocks Tasmania</td>
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<tr>
<td>12. BurnVoir Corporate Finance</td>
<td>48. Hydro Aluminiun</td>
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<td>13. Callabonna Energy</td>
<td>49. Icon Energy (ICN)</td>
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<td>16. Direct Energy</td>
<td>52. KPMG</td>
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<tr>
<td>17. Earth Heat Resources (EHR)</td>
<td>53. KTM Capital</td>
</tr>
<tr>
<td>18. Earthinsite</td>
<td>54. KUTh Energy (KCN)</td>
</tr>
<tr>
<td>20. Earth to Air Systems (Australia) Pty Ltd</td>
<td>56. Marubeni-Itochu Tubulars (Japan)</td>
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<tr>
<td>21. Eden Energy (EDE) (Terratherma is a subsid.)</td>
<td>57. Mitsubishi Heavy Industries (Japan)</td>
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<tr>
<td>22. Electranet</td>
<td>58. Monaro</td>
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<tr>
<td>24. Environmental Systems and Services</td>
<td>60. New Energy Finance (Blimberg subsid.)</td>
</tr>
<tr>
<td>25. Ergon Energy - owned by the Qld G’mnt</td>
<td>61. New World Energy</td>
</tr>
<tr>
<td>27. Ernst &amp; Young</td>
<td>63. Pacific Hydro (Australian Infrastructure Fund subsid.)</td>
</tr>
<tr>
<td>28. Finlaysons</td>
<td>64. Pacific Sensor Technologies</td>
</tr>
<tr>
<td>29. FrOGTech</td>
<td>65. Panax (PAX)</td>
</tr>
<tr>
<td>30. Geodynamics (GDY)</td>
<td>66. Petratherm (PTR)</td>
</tr>
<tr>
<td>32. Geopower</td>
<td>68. Rockwater</td>
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<tr>
<td>33. Geothermal Advisory Pty Ltd</td>
<td>69. RPS Energy</td>
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<tr>
<td>34. Geothermal Power Pty Ltd</td>
<td>70. Schlumberger (NYSE)</td>
</tr>
<tr>
<td>35. Geothermal Resources (GHT)</td>
<td>71. Senergy (+ Senergy Econnect)</td>
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<tr>
<td>36. GHD</td>
<td>72. Sinclair, Knight, Merz</td>
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<td>37. Golder Associates</td>
<td>73. Snowy Mountain Engineering</td>
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<td>38. Gradient Energy – Planet Gas subsidiary (PGS)</td>
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<td>39. Granite Power</td>
<td>75. Stuart Petroleum (STU)</td>
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<td>42. Halliburton (NYSE listed)</td>
<td>78. Teck Cominco (Toronto Exch)</td>
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<td>43. Hitachi HIPPO</td>
<td>79. Terra Therm</td>
</tr>
<tr>
<td>44. Hot Dry Rocks Pty Ltd</td>
<td>80. ThermaSource</td>
</tr>
<tr>
<td>45. Hot Rock Ltd (HRL)</td>
<td>81. Torrens Energy (TEY)</td>
</tr>
<tr>
<td>46. Hot Rocks Tasmania</td>
<td>82. Tri-Star Energy</td>
</tr>
<tr>
<td>47. Hydro Aluminiun</td>
<td>83. TRUenergy (Owned by China Light &amp; Power, HK)</td>
</tr>
<tr>
<td>48. Icon Energy (ICN)</td>
<td>84. VEMTEC</td>
</tr>
<tr>
<td>49. KPMG</td>
<td>85. Weatherford (NYSE)</td>
</tr>
<tr>
<td>50. Infinera Resources - Southern Gold subsid., (SAU)</td>
<td>86. Worley Parsons (WOR)</td>
</tr>
</tbody>
</table>

**Research Institution Members**

1. Curtin  
2. James Cook University (Economic Geology Research Unit)  
3. Monash  
4. University of Melbourne  
5. University of Adelaide  
6. University of Newcastle  
7. University of NSW  
8. University of Queensland  
9. University of South Australia  
10. University of Sydney  
11. University of West Australia  
12. University of Tasmania  
13. University of Auckland

**Government Members**

1. GA  
2. CSIRO  
3. South Australia (Chair)  
4. Victoria  
5. Western Australia  
6. Queensland  
7. Tasmania  
8. Northern Territories  
9. New South Wales

Other government agencies are at least ‘friends’ of the AGEGL - Including: RET EWH&A, CC, others
Aligned International Geothermal Research Priorities

- Share knowledge & drive complementary research
- Standard geothermal resource & reserve definitions
- Predictive production modelling
- Predictive reservoir and stress field characterisation
- Mitigate induced seismicity / other HAZOPS
- Cooling condensers for hot, dry climates
- Use of CO₂ as a working fluid for heat exchange
- Improve power system efficiency
- Education / training
- Technologies & methods to minimise water use
- Exploration technologies to predict heat flow and reservoirs ahead of the drill bit

High-T: high temperature & high pressure

Also R&D priorities for petroleum industry

- Improved / revolutionary High-T hard rock drilling equipment
- Improved High-T zonal isolation
- Reliable High-T / High Rate pumps for modest hole diameter
- Enable well longevity (20-30 year life for casing, cement, etc)
- Optimum High-T fracture stimulation methods
- High-T logging tools and sensors
- High-T flow survey tools
- High-T fluid flow tracers
- Mitigation of formation damage, scale and corrosion
“It’s only when the tide goes out that you can see who’s swimming naked” (Warren Buffet)

At least local transport fuel gap-fillers based on Australia’s comparative advantages:
- CNG
- LNG for large vehicles
- Coal-to-syngas-to-synfuel
- Gas-to-synfuel
- Hybrid fuel
- Electric transport (reap economies of scale for grid)
- Vehicle efficiency

New supply-chains required

From: 12 April 2004  Oil & Gas Journal (pp 28-30) article
‘Study: World oil forecast beset with reserves shortfalls.’
Wrap-up: South Australia has a tremendous undeveloped energy resource portfolio including and not limited to:

- unconventional gas incl. coal seam gas, underground coal gasification; fractured shales; low permeability reservoirs and the conversion of mined coal to syngas;
- conventional oil and gas in frontier plays ex. onshore Officer Basin Precambrian sub-salt plays and offshore deep water Bight & Otway Basins
- LNG and CNG from unconventional and conventional gas feedstock
- synfuels from unconventional & conventional gas feedstock
- geothermal (full spectrum from high temperature engineered geothermal systems, hot sedimentary aquifers and shallow heat resources);
- nuclear fuel;
- Gas storage and disposal in the subsurface

The delivery of salient precompetitive information, leverage from national and international fora, attractive investment settings and efficient/trustworthy regulation combine to attract investment in a portfolio of energy supplies – with supply-side competition a key targeted outcome
Go to South Australia

DRILL A WELL

BINGO

SORTED

I can't help feeling you may have over simplified our objectives somewhat...