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Comments on IPCC Geothermal Paper
(via e-mail; received: 21 June 2008)

ICPP Draft – Response from Panax Geothermal Ltd

1. The historic production of geothermal energy is a reflection of historic competitive price environments, and to some extent regulatory regimes. The future context will be quite different in both of these key determinants of the energy mix.

The current report focuses on the historic position and does not represent the future outlook at all adequately, especially as it has emerged over the last three to four years. There has been an enormous and accelerating response to the changing economic and regulatory outlook in response to climate change, and there is now evidence that geothermal energy will be a very material, cost competitive and timely option for many countries.

The traditional geothermal energy that makes up the historic position is characterised by relatively small scale projects (10 to 50 MW), relatively high temperature resources (>200°C) and relatively shallow resources with moderate drilling costs.

2. The new context is creating new cost and resource paradigms. This has stimulated work on:
 - Lower temperature resources with production temperatures of around 130°C to 250°C, and;
 - Deeper resources (3,500 m to 5,000 m) where drilling costs are higher but the resources are hot and large.

These new paradigms have changed the scale of geothermal projects by orders of magnitude. Focus is now on hot rock resources based on very large bodies of high heat producing granites that are amenable to engineered geothermal systems as described by Tester et al., and new approaches to more conventional porous geothermal reservoirs.

For example, in Australia:

- Individual bodies of high heat producing granites extend for 500 km² to over 1000 km². The granites of interest have been buried by insulating sediments to depths of around 2,500m to 3,500m. These granites have no practical bottom limit, as they extend typically to depths of over 12 km.
- One company, Geodynamics Limited, has announced a delineated body of thermal energy in place containing around 400,000 PJ, and with early indications that it may have the capacity to support the generation of 5,000 MW to 10,000 MW, i.e. 40 TWh to 80 TWh of base load power. Other listed hot rock companies, for example Petratherm Limited, also have significant outlooks.

While Australia does not have active volcanic regions, the potential for conventional geothermal resources is being recognised rapidly. For example, in the Otway Basin, companies such as Panax Geothermal Limited and Hot Rock Limited are in the early stages of assessing their resources. Panax Geothermal's exploration tenements have been assessed independently as having the potential to support 1500 MW for over 30 years on the basis of inferred resources.

Buried hot wet sedimentary basins occur around the world but have hardly received any serious attention to date. Collectively, these basins represent a vast potential for geothermal energy.

3. It is becoming apparent that geothermal energy will be a very cost competitive and material option. In addition to Tester's report, see a report by McLennan Magasanik Associates <http://www.mmassociates.com.au/> *The Cost of Clean Coal and Where it Fits on the Gas / Renewables / Nuclear / Energy / Efficiency Spectrum.*

Analyses by various companies show that a price on emissions of over US\$20-30/t CO₂ will see geothermal energy being competitive.

The consequence of an exciting cost and resource outlook is that Australia has a rapidly emerging geothermal industry. There are now 33 companies pursuing geothermal energy in Australia, with eight listed on the Australian Securities Exchange. These companies have committed exploration programs worth over US\$0.8bn. For a summary see: [http://www.garnautreview.org.au/CA25734E0016A131/WebObj/D0841468ResponseToIssuePaper4-AGEG/\\$File/D08%2041468%20Response%20to%20Issue%20Paper%204%20-%20AGEG.pdf](http://www.garnautreview.org.au/CA25734E0016A131/WebObj/D0841468ResponseToIssuePaper4-AGEG/$File/D08%2041468%20Response%20to%20Issue%20Paper%204%20-%20AGEG.pdf)

Although the outlook is promising, it is true that today there is negligible actual generation. However, it is clear that the resources exist. Several companies are advanced in assessing their resources and planning generation projects. For example, Geodynamics is planning to be generating by the end of 2008 and to have a generating capacity of around 500 MW by 2016. Petrathern and others have similar objectives. Various scenarios see geothermal energy meeting around 7% of Australia's electricity needs by 2030, with growth beyond that as new projects are brought on stream. This share of the new energy mix is not resource constrained but rather it is restrained by the speed with which a new industry can develop.

4. Many new geothermal resources are zero emission. While it is true that geothermal developments linked with volcanic origins often also produce CO₂, it is also true that future projects will be increasingly based on binary generation plants with the result that there will not be any gas emissions. For example:
 - The emerging hot rock geothermal projects are completely closed loop, and emit no CO₂. They are typically binary cycle, run produced geothermal fluid

through a heat exchanger before reinjecting that fluid, while a separate working fluid drives the turbines.

- Large scale lower temperature porous media geothermal resources are increasingly binary cycle and will not emit any CO₂ during generation.
5. The recent hike in the cost of oil is not a temporary 'blip', but is foreshadowing the new reality. The world at large has not yet accepted this as the implications are unpalatable, requiring major changes and adjustments as to how we operate and live. High fuel costs have major implications for communities living in remote or island bound locations as these often have no choice but to rely on costly diesel power generation. The high oil prices in previous oil crises have resulted in economic bankruptcies of many developing nations. Many of these islands, e.g. in S.E Asia, the Pacific and the Caribbean are endowed with conventional geothermal resources which could partially alleviate this grave prospect. In other words, there is more to geothermal energy than global warming issues.

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On behalf of Panax Geothermal Ltd.

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