Geothermal CRC

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Prospectus

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1. The Geothermal Opportunity

Of the world's total energy consumption since the industrial revolution, more than half has been consumed in the past two decades, with over 80% of this energy produced from non -renewable energy sources1. With an estimated half of these non renewable energy reserves now been depleted there is an imperative for alternate and more sustainable energy sources to be made available and commercially viable.

Despite advances in energy efficiency, our energy consumption continues to grow, with Australia's primary energy consumption projected to increase by 1.4 per cent per year to reach around 7715 PJ by 2029–30 2. Australia's economic growth and energy consumption, and therefore the emissions from energy production, are closely coupled. To secure our future prosperity we, need to find ways to produce energy that decouples growth from emissions.

Geothermal energy is a zero-emission power source which is reliable and is, unlike other renewable energy sources, not intermittent and capable of providing baseload electricity generation. It is one of the most environmentally friendly ways of generating electricity, occupying only small sites and does not involve mining, waste products or significant landscape impacts.

Based on Treasury's carbon price modelling, if geothermal electricity generation were technologically and commercially feasible, by 2050 it could produce around 18%, or over 81 TWh of Australia's electricity generation. However, the only operational geothermal power plant in the country is the Birdsville geothermal power station, an 80kW plant which was established in the early 1990s and owes its existence to a combination of local factors which are not replicable elsewhere. As a resource intensive, export led economy, Australia must find novel solutions to unlock our abundant geothermal energy resources if we wish to remain internationally competitive and reduce our world-leading per-capita rate of C02 emissions.

[1] IEA Key energy statistics 2010 and 2006 p 48
[2] Geoscience Australia and ABARE, 2010, Australian Energy Resource Assessment, Canberra

2. The Geothermal Challenge

There has been considerable activity in recent years toward realising at least part of the potential for geothermal power. Between 2002 to 2010, more than AU$670 million was invested by industry and government on studies, geophysical surveys, drilling, reservoir stimulation and flow tests into geothermal energy [3]. The Geothermal CRC will build on this considerable investment and the knowledge it has generated.

The large up-front cost and high degree of uncertainty about the potential to produce enough usable energy characterises most geothermal projects as too risky for investors in a post-GFC world. Usable energy is a combination of the temperature in the geothermal well and the amount of fluid produced from the well that reaches the surface. Whilst temperature at a given depth can be predicted reasonably accurately, fluid flow to the surface cannot. Unless we can develop exploration and engineering methods to achieve flow rates that are **an order of magnitude greater** than what is achieved today the economic viability of geothermal power will remain limited. Foreseeable reductions in drilling costs, increases in energy conversion efficiency, and reductions in parasitic loads **do not have as great an impact as improving flow**.

Modelling indicates that for an engineered geothermal resource at 170°C, a production flow rate of 60 kg/s will produce electricity at a cost of 16 cents/kWh. If the production flow rate increases to 90 kg/s, the cost of electricity is expected to come down to 12 cents/kWh. The best flow rate of an engineered geothermal system in Australia to date is 25 kg/s however average flow rates are well below that. Flow rates of 80-100 kg/s, which are considered achievable by the Geothermal CRC, would make the geothermal industry competitive with other energy technologies, including coal with CCS.

The goal of the Geothermal CRC is to improve the predictability of the flow rates and reduce the risk for geothermal projects in Australia, making the sector competitive with alternative energy sources and attractive for investment.

[3] Bendall et al 2011

The following Figure summarises the key aspects of the Geothermal CRC.

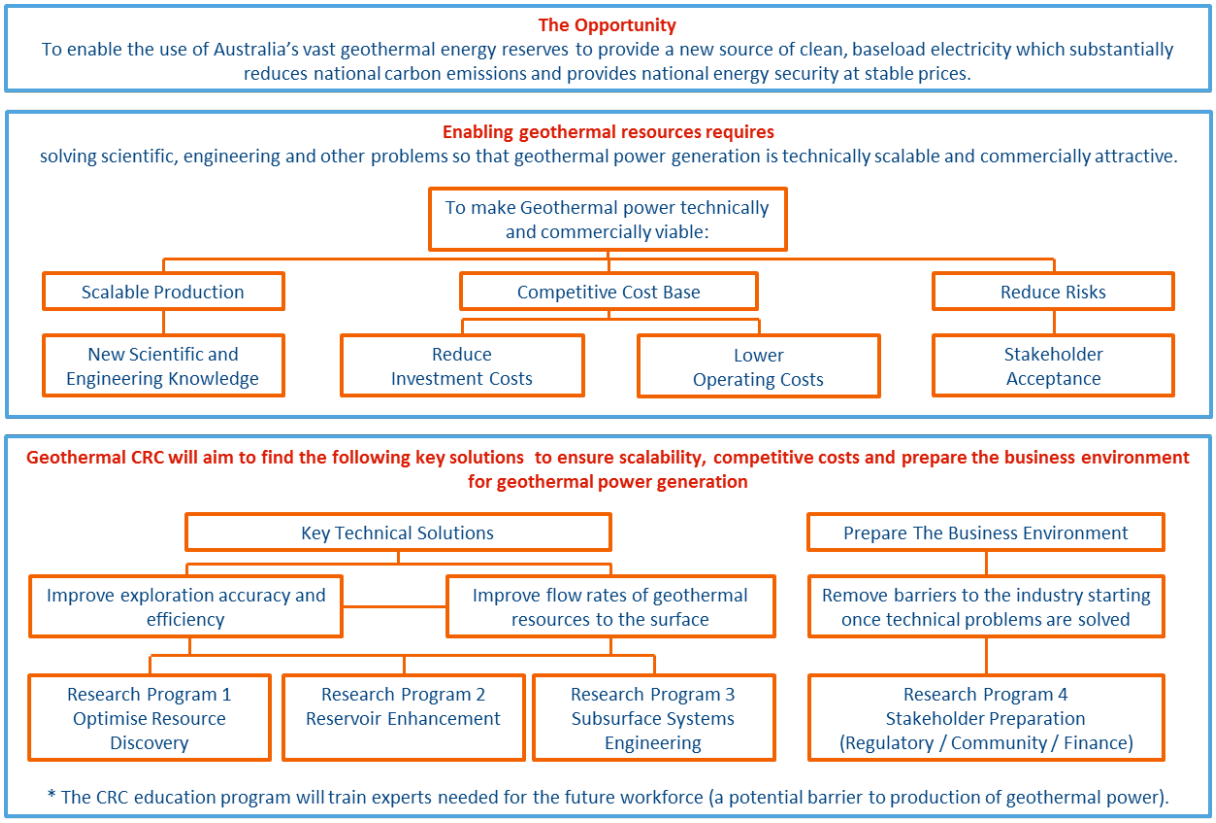

Figure 1: Overview of Geothermal CRC. Developed by Consulting & Implementation Services.

3. Why a Cooperative Research Centre?

The Geothermal CRC will be a $100m+, 7-year research joint-venture that will bring together the nation's best research minds to focus on unlocking an energy technology that can play a critical role in securing Australia's clean energy future. The CRC's research teams will be led through CSIRO, the leading Australian universities in this field and Geoscience Australia. The Geothermal CRC will coordinate its exploration efforts through Australia's geoscience agency, Geoscience Australia, and each of the relevant geological surveys in each State. Coupled with financial and in-kind commitments from the major players in the emerging geothermal industry, service companies, utilities, major base load power users and government, the CRC will accelerate the development of Australia's geothermal industry. The path from laboratory to demonstration in the field and uptake by end-users is built into the fabric of each research program. The CRC's education program will also provide fundamental skills development for the next generation energy geoscientists and engineers. Skilling our future workforce and ensuring the adoption of new Australian-led innovation in renewable energy, with application world-wide, will be key benefits of a CRC. The CRC will leverage international research through a variety of collaborations.

End user focus – This is one of the few programs that bring together Australia's leading researchers focused on end user challenges.

Value for money – This program sees end user contributions highly leveraged to make research funding now more affordable.

Networking – Participants will have access to not only the world's leading geothermal researchers but also linkages into many of the leading industry participants and key government policy makers.

4. Research Program

4.1 Introduction

The Geothermal CRC will have a science and technology focus on increasing flow rates. This focus does not mean research solely on reservoir stimulation. Rather it will provide an integrated approach from resource discovery, reservoir enhancement, ancillary engineering and community, regulation/policy and financial systems. Key to the program is the up-scaling of modelling and laboratory experiments to field scale. We will achieve this either by augmenting an Australian geothermal drilling program or through access to existing geothermal and other wells in Australia and potentially overseas. The program will:

- Develop **new technologies and work flows** to explore for the **most prospective geothermal resources**;
- Develop methods to **enhance existing** or **create new permeability** in geothermal reservoirs;
- Develop **new materials and engineering technologies** to **optimise well completions, support reservoir enhancement** and **increase well life**;
- Identify **balanced policy, regulatory and financial settings** and ensure **community concerns** can be **addressed early**.

The research plan will be structured around the following four research programs:

- **Optimising Resource Discovery:** Finding Flow
- **Reservoir Enhancement:** Fixing Flow
- **Subsurface Systems Engineering:** Making it Flow
- **Technology in Context:** Ensuring Adoption

The CRC's end-user focus will allow participants to have input into the activities completed within these four research programs.

4.2 Optimising Resource Discovery Program ("Finding Flow")

The aim of this research program is to develop the technologies and work flows required to target the most prospective areas for geothermal energy production in Australia, with an emphasis on discovering areas with characteristics that will reduce and optimise any fracture stimulation needed to achieve the desired flow rates. The program will aim to develop an understanding of the setting and key components of Australia's geothermal resource, and work on the development and improvement of methods used for exploring for resources and characterising them. These methods are applied to early exploration through to resource confirmation.

This research will increase the chances of success of the first and subsequent wells by improving the probability of finding formations with the required flow rates.

4.3 Reservoir Enhancement Program ("Fixing Flow")

This research program will develop the technologies required to enable commercial flow rates to be achieved repeatedly and reliably. The core of this program will be the design and trialling of reservoir stimulation methods at laboratory and field scales. These methods will include single and multiple zone stimulation. The program will be a mix of incremental and step change approaches. It will include further development of the numerical codes used to design and evaluate reservoir stimulation at well–to-formation, well-to-well and reservoir scales and be underpinned by fully coupled thermo-hydro-mechanical-chemical codes.

This program is intended to achieve commercial flow rates reliably through novel stimulation methods; modelling tools that will allow stimulation operations to be better planned, conducted and reviewed for their efficiency; and monitoring methods that will improve our understanding and management of stimulation activities.

4.4 Subsurface Systems Engineering Program ("Making it Flow")

The well completion, well hardware, materials and reservoir engineering technologies required to support stimulation activities and to achieve and sustain high flow rates will be developed in this research program. It will include a component to look at well completion technologies to enable long well life in conjunction with optimising well completion to support stimulation activities. A materials science stream will look at the development of new well materials, whilst another will be the development of the ability to predict the performance of reservoirs over their life.

This program will improve reservoir stimulation efficacy through optimised well completions; prolonged well life; and deliver a better understanding of reservoir performance over time, resulting in decreased operating costs over the life of a geothermal project.

4.5 Technology in Context Program ("Ensuring Adoption")

This program will look at non-technology barriers to the geothermal industry. Information will be developed to best inform policy makers, regulators, community groups, financiers and other key stakeholders in assessing their support for geothermal energy. This will help minimise the time and cost of exploiting geothermal opportunities and reduce the problems that often plague energy projects such as the coal seam gas and shale gas industries in Australia and worldwide.

The impact of this program will be to ensure the science and engineering outcomes can be applied by preparing the geothermal industry to work with stakeholders and will help ensure well balanced policy, regulatory and financial settings.

5. Participation in a CRC

The Geothermal CRC's 7 year research effort will be led by CSIRO, selected researchers from Australia's research intensive universities and Geoscience Australia who are leading the race to unlock geothermal energy in Australia. The CRC's researchers will deliver projects in partnership with government agencies and leading industry stakeholders.

Participating companies will invest cash and in-kind resources into a business model that leverages their own contributions significantly. This will provide participants with a cost effective means of developing solutions to the key challenges facing the geothermal industry. In so doing participants will gain access to Australia's leading talent, infrastructure and innovations in the field ensuring they will be at the forefront of advances in the geothermal industry. This network and knowledge typically provides a significant competitive advantage in prospecting for future geothermal opportunities.

The CRC will employ a governance model that is most suitable to deliver the proposed results. It will be a company with a predominantly independent skills based board headed by an independent Chair, and supported by appropriate advisory panels and sub committees. It will be managed in accordance with the Corporations Law and regulations set by ASIC. Board members will not be representational, but will be required to act in the best interests of the Geothermal CRC. Note that the Geothermal CRC has developed a more detailed discussion paper outlining the governance arrangements which will be made available to all participants.

End-users will have the opportunity to participate in an End-User Advisory Panel to help guide the activities of the CRC. Membership of this panel will be determined by the level of commitment of End-Users to the CRC.

The CRC program has a two stage application process. Stage 1 closes on 14 June, 2012. Prospective participants in the Geothermal CRC will need to formalise their participation no later than 23 April, 2012. Stage 1 applications invited to Stage 2 will need to prepare for an interview held in Canberra between 12th and 14th of November 2012 with the announcement of successful applicants in December 2012.

6. Contact Information

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