NOTICE CONCERNING COPYRIGHT RESTRICTIONS

Converting Geothermal Plays to Projects in Australia—A National Review

B. Bendall[1], B. Goldstein[1], A. Long[1], and A. Budd[2]

[1]Primary Industries & Resources SA, Adelaide, South Australia
[2]Geoscience Australia, Canberra, Australian Capital Territory

ABSTRACT

Geothermal is new technology to Australia, and requires successful technical and commercial demonstration before gaining widespread acceptance. The Australian Commonwealth and state governments are supporting the development of the industry during this Research, Development and Deployment phase. A series of grant programs are in place with emphasis now being on the conversion of identified geothermal resources into proven reserves via proof-of-concept and demonstration projects.

Australia's geothermal projects are focused on developing both Engineered Geothermal System (EGS) (or Hot Rock systems) and Hot Sedimentary Aquifer (HSA) plays to generate electricity, power large scale air conditioning and industrial-scale direct use applications (including coal drying, mine water recycling and desalinization processes).

Nationally, over the January 2000 through March 2010 term, 55 companies have applied for 404 license areas (covering 491,000 km^2) to progress proof-of-concept amagmatic EGS and HSA projects. In the term 2002 through 2009, more than AU$468 million (US$427 million) has been spent on studies, geophysical surveys, drilling, reservoir stimulation and flow tests which comprise the work programs required to sustain tenure in geothermal licenses areas. In the term 2002-2014, investment for Australian proof-of-concept geothermal projects is forecast to exceed AU$2,104 million (US$1,922 million).

Progress towards large-scale commercial deployment of Australian geothermal resources is underpinned with more than AU$290 million (US$265 million) in Australian Commonwealth and state government grants, which meets up to half of the cost of the private sector's field efforts. This includes AU$50 million (US$45million) under the Australian Government's Geothermal Drilling Program available to support new deep drilling for proof-of-concept EGS and HSA projects and AU$188 million (US$171 million) for pre-competitive, commercial-in-scale geothermal energy demonstration projects. Additional potential grant programs might be implemented in the future.

These collateral efforts are all directed at achieving the Australian Geothermal Energy Group's (AGEG) aspirational targets of at least 10 successful research and proof-of-concept geothermal projects, and at least 3 power generation demonstration projects in distinctly different geologic settings by the end of 2013, with the results providing compelling evidence to justify investment in the development of Australia's vast EGS and HSA plays (IEA-GIA, 2008). The shared vision of Australia's peak representative organisation for the geothermal industry (the Australian Geothermal Energy Association, AGEA) and the AGEG is to see geothermal energy providing the lowest cost, emissions-free, renewable base load energy for centuries to come.

This paper summarizes: (1) proof-of-concept amagmatic EGS and HSA geothermal projects co-funded by investors and governments in Australia; and (2) policies, programs and alliances put in place to support the development of geothermal plays.

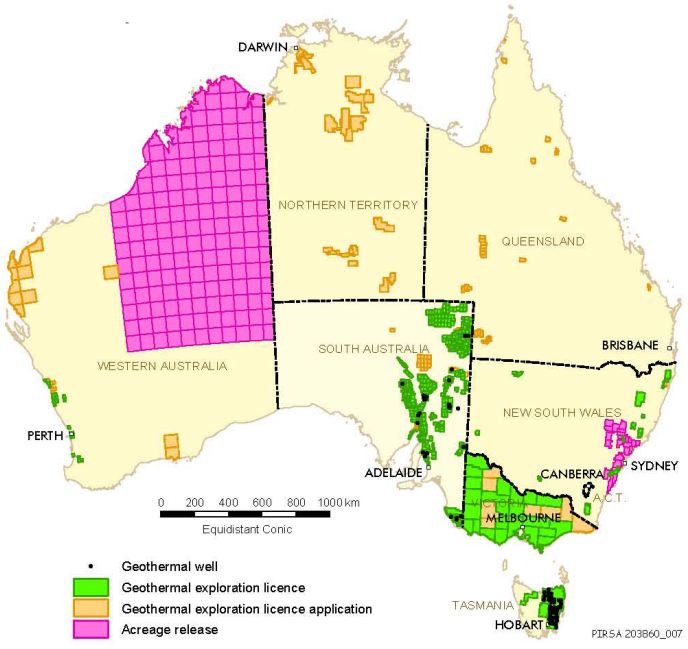

Figure 1. Australian geothermal licence areas and acreage releases at April 2010. Geothermal exploration licences are shown in green, exploration licence applications in orange and acreage releases in pink.

Success in Australia will have positive implications for similar projects, world-wide.

Vision to Deployment

In the nine years since the first Geothermal Exploration Licence (GEL) was granted in Australia, interest and activity in the geothermal sector has increased at a tremendous pace. To the first quarter of 2010, 55 companies have commenced exploration and development programs in 404 licence application areas covering ~491,000 km^2 of the Australian continent (Figure 1). This represents an estimated investment of AU$2,104 million (US$1,922 million[1]) over the period 2002-2014, in pre-competitive geothermal projects.

Table 1. Summation of the applicable legislation currently governing geothermal exploration activities in the various Australian states.

State Government Jurisdiction	Applicable Legislation for Geothermal Exploration	Comments
South Australia	*Petroleum and Geothermal Energy Act 2000*	Regulates licensing and activity approvals for upstream petroleum, geothermal, gas storage and petroleum pipeline projects. An 'over the counter' system, where explorers can apply for those areas desired. Licences can co-exist with existing or future minerals and petroleum exploration titles.
Victoria	*Geothermal Energy Resources Act 2005*	Regulates large-scale commercial and sustainable exploration and extraction of Victoria's geothermal energy resources.
New South Wales	*Mining Act 1992*	Governs geothermal exploration in New South Wales. Geothermal exploration is considered as Group 8 - Geothermal Substances. Application for a Group 8 geothermal exploration licence requires the Minister's consent.
Queensland	*Geothermal Exploration Act 2004*	Applies a competitive permit system to encourage and facilitate efficient and responsible exploration.
Tasmania	*Mineral Resources Development Act 1995*	Geothermal tenements are granted as a Category 6 mineral 'Special Exploration Licence' (SEL). An 'over the counter' system, where explorers can apply for those areas wanted to be explored. Licences can co-exist with existing or future minerals and petroleum exploration titles.
Western Australia	*Petroleum and Geothermal Energy Resources Act 1967*	Provides legislative coverage for the exploration and recovery of both conventional (hydrothermal) geothermal energy and EGS (hot dry rock) geothermal energy. Does not cover non-commercial uses or heat pumps.
Northern Territory	*Geothermal Energy Act 2009*	Intent is to reserve a relatively small region around the Katherine area for later tendered release, while providing for "over-the-counter" application for geothermal authorities over the remainder of the Territory.

Growth and activity in the sector have benefited substantially from key supporting policy and legislative frameworks and generous grant funding from the Australian governments, both at the Commonwealth and state level. In 2004, the Australian Government's Energy White Paper, Securing Australia's Energy Future (DPMC, 2004), recognised Engineered Geothermal Systems as a technology in which Australia had comparative advantages. Following from this, a number of Federal Government policy developments, including the Geothermal Industry Development Framework (GIDF) (DRET, 2008a) and the Council of Australian Governments' (CoAG) Technology Roadmap (DRET, 2008b), have been initiated to support the development of Australia's geothermal energy resources and technologies. Underpinning these is the Australian Government's goal to have at least 20 per cent of Australia's electricity supply coming from renewable energy sources by 2020 as articulated in the expanded Renewable Energy Target (RET). Policy frameworks specific to the geothermal sector are designed to;

- identify the various critical stages of project evolution toward commercialisation,
- support the sector via targeted funding mechanisms through the geothermal exploration (research), appraisal (proof-of-concept) and demonstration phases,
- identify technology and research needs for the pre-competitive demonstration and subsequent development of geothermal energy resources,
- facilitate achievement of key milestones identified by the industry.

Legislation enabling exploration for geothermal energy is now active in every Australian state and the Northern Territory, and many states also have development and production legislation emplaced (Table 1). A range of targeted grant initiatives have been initiated at both Commonwealth and state level to further promote and stimulate geothermal activities. Current Commonwealth and state government support initiatives include; Renewable Energy Certificates (RECs), the Renewable Energy Development Initiative (REDI) Program, Geothermal Drilling Program (GDP), Renewable Energy Demonstration Program (REDP), Renewable Energy Future Fund (REFF), Australian Centre For Renewable Energy (ACRE), Energy Innovation Fund (EIF), Plan for Accelerating Exploration (PACE - South Australia), Renewable Energy Support Fund (Victoria), Victorian Energy Technology Innovation Strategy (ETIS), Rediscover Victoria strategy, Western Australian Exploration Incentive Scheme and the New South Wales Climate Change Fund. To further encourage exploration, the Australian Government plans to introduce the Resource Exploration Rebate (RER) in the July 2010- June 2011 Budget, which will provide a refundable tax offset at the prevailing company tax rate, for geothermal exploration expenditure carried out in Australia.

Structuring of these various grant mechanisms can be viewed as a staged continuum, feeding in from pre-drill research studies and early exploration shallow drilling efforts, through to assistance for deep drilling, stimulation operations and extended flow tests to achieve proof of concept, and finally to pre-competitive demonstration of electricity production from a power plant (Table 2).

Also recognised in the findings of the Development Framework (DRET, 2008a) and the Technology Roadmap (DRET, 2008b), was the need for a robust, targeted and well coordinated research effort to advance collaborative investigation and solution of the various technical challenges faced by the geothermal energy industry. As such, parallel guidelines and policies and funding mechanisms designed to support geothermal research and development have also been emplaced and are discussed in an accompanying paper (Long et al., 2010).

Table 2. An overview of different grant options currently available to the Australian geothermal sector. All currency values in Australian $ (AU$) and million expressed as M.

Agency	Research & pre-drill	Shallow drilling & early exploration	Deep drilling to resource depth	Proof of Concept	Pre-competitive production demonstration	Production
Commonwealth Government (federal)	Geoscience Australia (GA) data	Resources Exploration Rebate (RER)	Energy Technology Innovation Strategy ~AU$5M awarded to date		Renewable Energy Future Fund (REF)	Renewable Energy Credits (RECs)
			REDI: ~A$100 M total at AU$5M per well	REDI+ ~AU$100 M total at AU$50k – 5M per proposal	REDI: ~AU$100 M total at AU$50k – 5M per proposal	
			GDP~ AU$50 total available at AU$7M per well		REDP~ AU$435 total available at $50 – 100M per proposal	
				Energy Innovation Fund ~AU$50M total.	Energy Innovation Fund ~AU$50M total.	
South Australian Government	SA PACE ~ AU$1.6 M total at up to $100,000 per proposal	SA PACE ~ AU$1.6 M total at up to $100,000 per well			Regional Development Infrastructure Fund	
Victorian Government		Rediscover Victoria AU$250,000 total	Energy Technology Innovation Strategy	Energy Technology Innovation Strategy	Renewable Energy Support Fund	
Western Australian Government	Exploration Incentive Scheme ~$81 total available at up to AU$200,000 per proposal.					
New South Wales Government				NSW Climate Change Fund ~AU$40M total	NSW Climate Change Fund ~AU$40M total	
Queensland Government		Qld Collaborative Drilling Initiative				Qld Renewable Energy Plan ~AU$4.3M

Play Types

Geothermal resources with considerable potential to enable power generation in Australia generally fall into two categories: (1) Engineered Geothermal Systems (EGS) and (2) Hot Sedimentary Aquifer (HSA) plays (i.e. hydrothermal groundwater resources in sedimentary basins). However at present the industry remains in a pre-competitive phase with the only geothermal energy currently produced in Australia being from a 120 kW geothermal energy plant located in Birdsville, Queensland and operated by Ergon Energy, which sources medium temperature hydrothermal waters at relatively shallow depths from the Great Artesian (Eromanga) Basin. Currently most geothermal companies are engaged in exploration, however the majority of the expenditure to date has been towards proof-of-concept and pilot phases.

Recognising the need for meaningful targets to focus the industry, the Australian Commonwealth Government and Australian geothermal sector (through AGEA and AGEG) in consultation, developed an exhaustive list of key issues, milestones and objectives, gaining strong bi-partisan support at both Commonwealth and state government levels (DRET 2008a and 2008b; IEA-GIA, 2008). Milestones captured within these planning guidelines include:

- Achieve several successful research (exploration) and proof-of-concept geothermal projects (heat energy is flowed).
- Establish several geothermal power generation demonstration projects in distinctively different geologic settings.
- Achieve compelling success with geothermal power generation and ground source heat pumps so the investment community has confidence geothermal energy is viable.
- Demonstrate safe, secure, reliable, competitively priced, renewable and emissions-free base load power from geothermal energy, which makes asubstantial contribution to Australia's long term energy supply.

Guided by these strong policy initiatives and key milestones, Commonwealth and state government grant outcomes have been aimed at supporting the development of a range of projects testing different geothermal resource concepts along the path to commercialisation. To date a total of AU$291 million (US$265 million) in Australian Commonwealth and state government grants have been committed to support Australian geothermal research, exploration and proof-of-concept projects for the period 2000 to end March 2010.

Company Activities

Supported by the rollout of government frameworks and staged funding support, Australian geothermal companies are steadily progressing along the path from early to advanced exploration and

proof-of-concept activities toward demonstration of geothermal energy projects. An overview of the progress of the following eight company projects is presented as a demonstration of the relationship between policy and funding structures initiated by Australian Commonwealth and state governments, and the progression of projects successful in leveraging off these initiatives.

Proof of Concept and Demonstration Phases (EGS) — Geodynamics Limited (ASX Code GDY)

Geodynamics is a publicly listed company on the Australian Securities Exchange (ASX) and has been highly successful in gaining support from public and private funding sources for their portfolio of geothermal projects, as well as gaining substantial funding support from both the Australian Commonwealth and relevant state governments.

Best known and most advanced is Geodynamics' Engineered Geothermal System project near Innamincka in the Cooper Basin region of South Australia, where a total of five wells have been drilled into the granite resource to depths of 3800 – 5000 metres at three separate fields, Habanero, Jolokia and Savina. These wells were intended to determine and characterise the extent of the resource present within Geodynamics' Cooper Basin licences. Proof of Concept was achieved in 2009 when circulation tests conducted at the Habanero field confirmed connection between Habanero 1 and 3. Construction of a 1MW pilot plant at Habanero was completed in April 2009 with the aim of supplying electricity to the nearby township of Innamincka, however commissioning of the plant has been postponed as a result of a loss of casing integrity in Habanero-3. Diligent investigation into the cause of this incident by the company has found that casing material failure due to hydrogen embrittlement, was caused by the presence of dissolved gases in the reservoir fluid (Geodynamics, 2009a). Further drilling is to be undertaken before confirming the location of a 25 MW Commercial Demonstration Project (CDP) which aims to demonstrate EGS technology is cost effective at a commercial scale. Commissioning of the 25 MW CDP geothermal power plant is expected to occur in mid 2015 (Geodynamics, 2009b).

Since commencement of the Cooper Basin project, Geodynamics have been awarded in the order of AU$119.3 million (US$109 million) from various federal funding programs and AU$700,000 (US$639,000) in South Australian Government grants. Initially Geodynamics received AU$5 million (US$4.5 million) under the Renewable Energy Development Initiative (REDI) for construction and operation of a high efficiency Kalina cycle generation plant. However the majority of support is via the Commonwealth Government's Renewable Energy Demonstration Program (AU$90M) toward development of their 25 MW commercial demonstration plant and AU$560,000 from the South Australian Government's Regional Development Infrastructure Fund toward construction of transmission lines between the 1MW Pilot plant and Innamincka township. This funding will be received incrementally following completion of technical milestones as the project develops.

Advanced Exploration Phase (EGS) — Petratherm Limited (ASX Code PTR)

Located adjacent to the northern Flinders Ranges in South Australia, Petratherm's Paralana project is an EGS project based on the company's Heat Exchanger Within Insulator (HEWI) concept. This model contends that creating an EGS reservoir in the insulating sedimentary rocks overlying the high heat producing basement, can result in reduced drilling costs, and aid in the successful hydraulic stimulation of a reservoir.

Petratherm are recipients of an AU$5 million (US$4.5 million) REDI grant to develop the Heat Exchanger Within Insulator (HEWI) model, an AU$7 million (US$6.39 million) GDP grant in support of the drilling of their first deep well (Paralana 2) into the Paralana resource, and an AU$62.7 million (US$57 million) REDP grant. Paralana 2, spud in June 2009, was successfully completed to a depth of 3725 metres (Petratherm, 2009a and 2009b). Planning is underway to undertake mini-fracture stimulation operations and subsequent multi-zone hydraulic stimulation in the third quarter of 2010. Contingent on the outcomes of these operations, a second deep well, Paralana 3, will be designed and drilled as a first production well, followed by construction of a 3.75 MW pilot plant planned for 2011 - 2012.

REDP funding from the Commonwealth Government will assist in completion of the second stage 'scale up' of the Paralana project to a commercial power plant of 30 MW. The longer term aim for the Paralana project is to develop a large scale, base load geothermal power station of greater than 260 MW capacity which would supply power to the National Electricity Market (NEM).

Petratherm have two significant Joint Venture partners for the Paralana Project. Beach Energy Ltd entered an agreement with Petratherm in early 2007, to contribute up to AU$30 million (US$27 million) for a 36% interest in the Paralana project, while TRUenergy (a wholly owned subsidiary of China Power and Light) agreed to pay up to AU$57 million (US$52 million) to earn 30% equity in the Paralana Project in August 2008.

Advanced Exploration Phase (HSA) — Panax Geothermal (ASX Code PAX)

Panax Geothermal Ltd's Penola Geothermal Project (part of Panax's broader Limestone Coast Geothermal Project) located in the Limestone Coast area of south-eastern South Australia, is targeting a Hot Sedimentary Aquifer resource in permeable reservoirs of the Otway Basin. The Otway Basin is a well understood existing oil and gas province with substantial information from historical petroleum exploration and production wells (28 deep petroleum wells, and extensive 2D and 3D seismic coverage) indicating that elevated temperatures are achievable within the permeable Crayfish Subgroup at depths of up to 4000 metres. In this instance, the sedimentary rocks provide both the overlying insulation and geothermal reservoir, heated by conduction from the basement rocks below.

Panax Geothermal was successful in receiving an AU$7 million (US$ 6.39 million) GDP grant from the Commonwealth Government in 2009 to assist with the drilling of the first appraisal/production well into the inferred resource as part of their proof-of-concept project stage. This well, Salamander 1, spud in January 2010, and was drilled to a total depth of 4025 metres in 44 days, making Panax Geothermal the third company in Australia to drill a deep geothermal well, and the first to test an HSA target. Early data from the well is promising with indicated non-equilibrated temperatures of 130^{o}C at 3000 metres and 171.4^{O}C at 4000 metres (Panax Geothermal, 2010a). Extended flow tests

from the well are scheduled to be carried out in June 2010 (Panax Geothermal, 2010b).

Given a successful outcome from the flow tests, Panax Geothermal will develop the project in stages, beginning with a demonstration plant based on one production well, Salamander 1, and subsequently scaling up to the commissioning of a Phase 1 plant based on a total of three production wells. Phase 2 will require drilling of further production and injection wells and commissioning of a 59 MW (net) plant (Panax Geothermal, 2009).

Advanced Exploration Phase (HSA and Direct Use) — Green Rock Energy Limited (ASX Code GRK)

Green Rock Energy has 16 exploration licences in South Australia covering 2,899 km^2 adjacent to BHP Billiton's Olympic Dam Mine, 3,834 km^2 in the Cooper Basin plus 15 geothermal licence offers covering 3,950 km^2 in the Western Australian Perth Basin, and on-going projects in Hungary.

Green Rock Energy is undertaking a project on the University of Western Australia campus to demonstrate the direct use of medium temperature geothermal resources recovered from hot sedimentary aquifers for commercial applications in the Perth metropolitan area. Geothermal energy is already being recovered to heat aquatic centres in the company's permit area held jointly with the university. The company has been awarded an AU$7M Commonwealth GDP grant (US$6.39 million) and two Western Australian Government drilling grants totalling AU$295,000 (US$ 269,000) in support of drilling of two wells to depths of three kilometres, to access target 100°C (212°F) geothermal water which will be used displace electricity to power absorption chillers for air conditioning of the university buildings. Success would see this concept replicated in metropolitan Perth with geothermal energy replacing over 50 per cent of the energy used to cool and heat numerous commercial and industrial buildings which currently use fossil fuels (Green Rock Energy, 2009).

Exploration Phase (EGS) — Torrens Energy Limited (ASX Code TEY)

Torrens Energy Ltd currently holds twenty six geothermal licences and one licence application spread across three project areas in South Australia (the Torrens, Barossa – Clare and Adelaide projects), plus one permit in Victoria.

The company has undertaken a robust exploration shallow drilling program to characterise heat flow trends throughout these project areas, publishing Australia's first inferred resource estimate in August 2008 of 780,000PJ at the flagship Parachilna Project, an EGS project located north of Port Augusta in South Australia. Torrens Energy, is expecting to drill its first deep proof-of-concept well at Parachilna toward the end of 2010, with the assistance of a AU$7 million (US$6.39 million) GDP grant awarded in December 2009 (Torrens Energy, 2009).

Previously Torrens Energy were successful in attracting an AU$3 million (US$2.7 million) Commonwealth REDI grant to develop, demonstrate and refine a 3D modelling method for the prediction of EGS plays, and an additional AU$100,000 (US$91,000) South Australian PACE grant for heat flow exploration in the Parachilna area.

Torrens Energy entered into a binding Geothermal Alliance Agreement (GAA) with AGL Energy Ltd in July 2008, which included AGL acquiring a 9.99% cornerstone position in the company. AGL is Australia's largest integrated renewable energy company and largest private owner, operator and developer of renewable generation. The agreement provides for the joint development and commercialisation of base-load geothermal projects close to the Australian National Electricity Market.

Exploration Phase (EGS and Direct Use) — Greenearth Energy Limited (ASX Code GER)

Greenearth Energy Ltd has three Geothermal Exploration Permits in the state of Victoria covering a total 18,795 km2 of the Geelong region, onshore Gippsland area and the Latrobe Valley.

Greenearth Energy's flagship project with an inferred geothermal resource of 17,000PJ, is the Geelong Geothermal Power Project (GGPP) located northwest of the Victorian coastal township of Anglesea.

The project is planned to be undertaken as a staged development. Stage 1, aimed at achieving Proof of Concept, is scheduled to commence in late 2010 and will involve drilling and flow testing of 2 deep wells into a Hot Sedimentary Aquifer resource at up to 4000 metres. In support of this work, Greenearth Energy were awarded AU$7 million (US$6.39 million) under the second round of the Commonwealth Government's Geothermal Drilling Program (Greenearth Energy, 2009).

In late August 2009, Greenearth Energy submitted a successful application for AU$20 million (US$18 million) to the Victorian Government's Energy Technology Innovation Strategy (ETIS) program for a 12 MWe geothermal demonstration energy plant utilising the inferred HSA resource in the area. The 12MWe geothermal demonstration plant development represents Stage 2 of the GGPP and is planned to commence in 2012.

The Victorian Government, also under the ETIS program, awarded a further AU$5 million (US $4.5 million) to Greenearth Energy to assist in the stage 1 Proof of Concept phase. Total Victorian Government grant contributions toward the Geelong Project total AU$25 million (US$22.8 million), with the AU$20 million (US$18 million) grant for Stage 2 being awarded upon successful completion of Stage 1. Combined Commonwealth and Victorian Government grant contributions toward Stage 1 of the Geelong Project total AU$12 million (US$10.9 million).

The GGPP is planned to be fully commercialised using a phased development approach by means of deployment of modular Organic Rankine Cycle (ORC) plant technology across the HSA geothermal resource area. Successful commercialisation has the potential to produce up to 140MWe. This phase represents Stage 3 of the project.

Exploration Phase (HSA) — Hot Rock Limited (ASX Code HRL)

Hot Rock Limited hold exploration permits covering 27,521 km^2 of the Otway Basin in Victoria and 657 km^2 west of Cairns in northern Queensland. In the Otway Basin data from existing oil and gas wells indicate temperatures of 130ºC occur at depths of about 2800 metres and water temperatures of up to 152ºC have been recorded in petroleum wells up to 3700 metres deep in permeable sedimentary sequences overlain by a mudstone insulating

blanket. The permeable sandstone reservoir rock is up to 3km thick in sub-basins located in the permits with the lower section consisting of clean coarse sandstone that is highly fractured in places producing attractive reservoir targets.

The company intends to investigate the potential for a Hot Sedimentary Aquifer resource in this area with the drilling and testing of two appraisal wells scheduled for late 2010. The licences are close to population centres and infrastructure, and Hot Rock Limited is assessing the potential for direct use applications as well as electricity generation. Progress on the Proof-of-concept phase of this project has been supported by the granting of an AU$7 million (US$6.39 million) grant by the Commonwealth Government under the second round of the GDP.

With successful results from these two deep wells, drilling will be followed by the construction of a pilot binary power plant (Hot Rock Limited, 2009).

Conclusion

The geothermal industry in Australia continues to grow at an unprecedented rate and expectations for the sector remain high. As demonstrated in this paper, strong government backing both in terms of supportive legislative and policy frameworks, and well structured generous grant funding mechanisms, have been key factors in facilitating the achievements made by the industry to date. Continued support by Australian governments and the industry's keen desire to achieve expectations will see the Australian geothermal sector continue to overcome the challenges it faces in reaching the goal of commercial production of large scale, base load geothermal energy in Australia.

References

Department of the Prime Minister and Cabinet (DPMC), (2004). Securing Australia's Energy Future. Commonwealth of Australia, Canberra. 193pp. See: http://pandora.nla.gov.au/pan/79623/20080117-2207/dpmc.gov.au/energy_future/index.html

Department of Resources Energy and Tourism (DRET), (2008a). Australian Geothermal Industry Development Framework. Commonwealth of Australia, Canberra. See: http://www.ret.gov.au/energy/clean_energy_technologies/energy_technology_framework_and_roadmaps/geothermal_industry_development_framework_and_technology_roadmap/Pages/GeothermalIndustryDevelopmentandTechnologyRoadmap.aspx

Department of Resources Energy and Tourism (DRET), (2008b). Australian Geothermal Industry Technology Roadmap. Commonwealth of Australia, Canberra. See: http://www.ret.gov.au/energy/clean_energy_technologies/energy_technology_framework_and_roadmaps/hydrogen_technology_roadmap/Documents/GEOTHERMAL%20ROADMAP.pdf

Geodynamics Limited, (2009a). 2009 Interactive Annual Report. Accessed online: http://www.geodynamics.com.au/IRM/content/OAR/index.html.

Geodynamics Limited, (2009b). ASX Announcement 06 November 2009: Federal Government Awards $90 million in Funding to Cooper Basin 25 MW Geothermal Demonstration Project. Accessed online : http://www.geodynamics.com.au/irm/Company/ShowPage.aspx?CPID=2060&EID=84470685

Greenearth Energy Limited, (2009). ASX Announcement 14 December 2009: $7M Grant Awarded to Geelong Geothermal Power Project. Accessed online: http://www.greenearthenergy.com.au/downloadfile.php?filename=files/announcements/GER%20GDP%20R2%20Announcement%20Final%2014122009%5B1%5D.pdf

Green Rock Energy Limited, (2009). ASX Announcement 14 December 2009: Green Rock Energy offered $7 million Geothermal Drilling Program Grant. Accessed online: http://www.greenrock.com.au/media/2009_12_14___GRKGDPGrant.pdf

Hot Rock Limited, (2009). ASX Announcement 14 December 2009: Hot Rock Offered $7m Government Grant. Accessed online: http://www.hotrockltd.com/IRM/Company/ShowPage.aspx?CPID=1179&PageName=Hot Rock Offered $7m Government Grant

International Energy Agency Geothermal Implementing Agreement (IEA-GIA), (2008). Chapter 7 Australia – National Activities. *In* IEA Geothermal Energy Annual Report 2007. Accessed online: http://www.iea-gia.org/documents/GIA2007AnnualReportWebcompressed31Dec08.doc

Long, A., Bendall, B., Williams, A., Budd, A., and Huddlestone-Holmes, C.,, 2010. "Australian Geothermal Research Progress and Directions." *Geothermal Resources Council Transactions,* Vol 34.

Panax Geothermal, (2009). Penola Project – Limestone Coast, South Australia: 59 MW "Stand Alone" Case, Project Evaluation. Accessed online: www.panaxgeothermal.com.au/Images/File/20090910%20PANAX%20SCALE%20UP%20CASE%20WEBSITE%20VERSION.pdf

Panax Geothermal, (2010a). ASX Announcement 20 May 2010: Triple boost for Penola Geothermal Project. Accessed online: http://clients.weblink.com.au/clients/panaxgeothermal/article.asp?asx=PAX&view=4220780

Panax Geothermal, (2010b). ASX Announcement 20 May 2010: Steam release from Salamander 1 well. Accessed online: http://clients.weblink.com.au/clients/panaxgeothermal/article.asp?asx=PAX&view=4220812

Petratherm Limited, (2009a). ASX Announcement 06 November 2009: $62.8 million grant awarded to Paralana Geothermal Energy Project. Accessed online: http://www.petratherm.com.au/LiteratureRetrieve.aspx?ID=56413

Petratherm Limited, (2009b). ASX Announcement 14 December 2009: Paralana Joint Venture Project Update. Accessed online: http://www.petratherm.com.au/_literature_59178/Paralana_Joint_Venture_Project_Update

Torrens Energy Limited, (2009). ASX Announcement 14 December 2009: $7m GDP-R2 Grant Awarded to Torrens Energy. Accessed online: http://www.torrensenergy.com/announcements/091214_grant.pdf

1US$1 = AU$0.9138 as at May 2010