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Development of a Geothermal Resource Policy for Papua New Guinea

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ABSTRACT

Papua New Guinea (PNG) is located on the 'Pacific Ring of Fire' where tectonic plate movements and associated volcanic activity occurs. Geothermal resources in PNG mostly occur in isolated locations remote from large population centres. Little scientific information is held in relation to most of PNG's geothermal resources. However, the potential exists for a range of uses of geothermal resources – principally for electricity generation, but could also include other uses such as direct heat applications and the development of tourism attractions based on surface geothermal features. To date, only one geothermal power station has been developed in PNG on Lihir Island which provides electricity for a gold mining and processing operation.

A Geothermal Resource Policy has recently been developed which relates to the exploration, development, production, use and management (including preservation) of geothermal resources in PNG. The Geothermal Resource Policy for PNG was developed by Mark Chrisp (Director of Mitchell Daysh Ltd) and Marlene Oliver (a former NZ Environment Court Commissioner) as part of the NZ Aid Programme funded by the NZ Ministry of Foreign Affairs and Trade.

This paper sets out the process that was undertaken to develop the Geothermal Resource Policy including consultation with a range of key stakeholders. It sets out the key elements of the Geothermal Resource Policy and identifies some of the challenges and issues that need to be addressed associated with developing PNG's geothermal resources. The Geothermal Resource Policy seeks to promote the adoption of international best practice in relation to the management of geothermal resources tailored to local circumstances.

1. INTRODUCTION

This paper briefly describes the location of geothermal resources in Papua New Guinea (PNG) and the level of information held about those resources. It then describes the process that was undertaken to develop a Geothermal Resource Policy for PNG including consultation with a range of key stakeholders and the wider community. It identifies some of the challenges associated with developing PNG's geothermal resources, the issues that need to be addressed, and highlights the key elements of the Geothermal Resource Policy.

2. GEOTHERMAL RESOURCES IN PAPUA NEW GUINEA

PNG is located on the 'Pacific Ring of Fire' where tectonic plate movements and associated volcanic activity occurs. The northern zone extends from Mandi to New Britain, New Ireland and Bougainville, and the southern zone extends from Mt. Lamington in the Northern Province to Milne Bay Province's D'entrecasteaux islands. These two zones are areas in the country identified as having the potential for geothermal resource extraction and development.

The following map shows the locations of known geothermal areas in PNG.

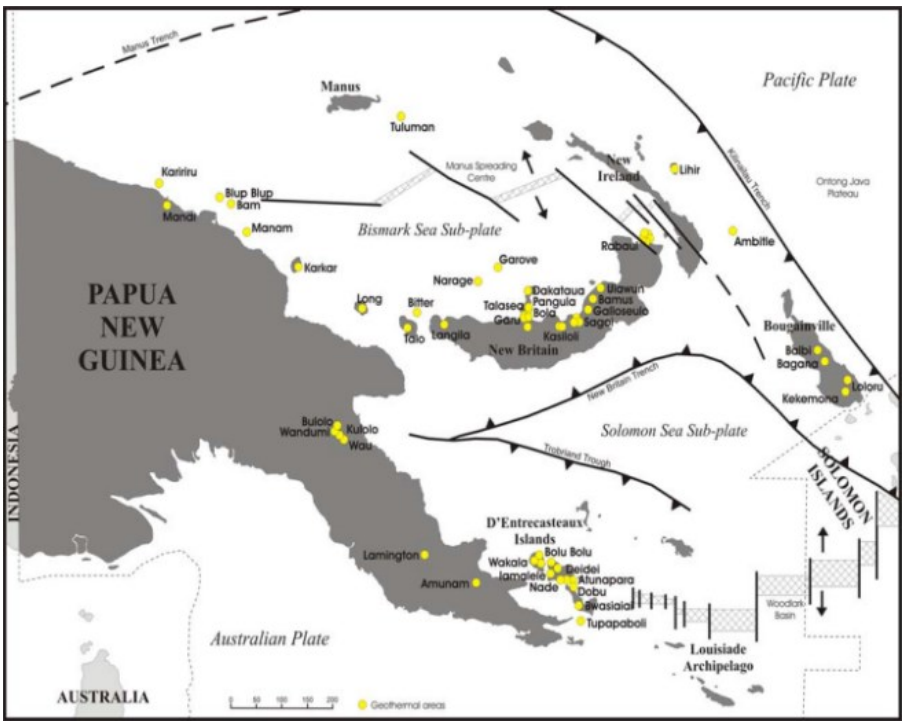

Figure 1: Map of Papua New Guinea showing the Locations of known Geothermal Areas (yellow dots) [Source: Map supplied by DMPGM from Mosusu (2008) and Heming (1969). The plate/micro-plate boundaries are modified from Williamson and Hancock (2005)].

Geothermal resources in PNG mostly occur in isolated locations remote from large population centres. Little scientific information is held in relation to most of PNG's geothermal resources. However, the potential exists for a range of uses of geothermal resources – principally for electricity generation, but could also include other uses such as direct heat applications and the development of tourism attractions based on the existence of surface geothermal features.

To date, only one geothermal power station has been developed in PNG. This is on Lihir Island (also known as Niolam Island) and provides electricity for a gold mining and processing operation. It has an installed capacity of 50 MW comprising 5 x 10 MW units (although at the time the author visited Lihir Island it only produced about 16 MW output running two of the units).

Figure 2: Geothermal Power Station on Lihir Island.

3. DEVELOPING THE GEOTHERMAL RESOURCE POLICY FOR PAPUA NEW GUINEA

The PNG Government's Department of Mineral Policy and Geohazards Management (DMPGM) is responsible for the development of government policy in relation to the management of geothermal resources. While there is some ongoing debate between various government departments, geothermal resources are classified as a mineral pursuant to the Mining Act 1992 and are to be regulated under the mining regulatory framework. This contrasts with New Zealand, for example, where rights to take geothermal water are deemed to be 'water rights' and are managed under different legislation to that relating to minerals.

DMPGM prepared a draft Geothermal Resource Policy in November 2012. The PNG Government subsequently requested assistance from the NZ Government to help DMPGM refine and complete the preparation of the Geothermal Resource Policy for PNG (the "Assignment"). To that end, Mark Chrisp (Director of Mitchell Daysh Ltd) and Marlene Oliver (a former NZ Environment Court Commissioner) were engaged as part of the NZ Aid Programme funded by the NZ Ministry of Foreign Affairs and Trade.

The Assignment Objective in the Terms of Reference was as follows:

"The Geothermal Resource Policy is expected to adequately serve the interests and aspirations of the Government and the people of PNG; and

1. Be attractive enough to draw in and retain foreign investment in the geothermal resource development and the renewable energy in PNG; and

2. Reflect international standards relating to the exploration, extraction, development, usage, decommissioning, closure and rehabilitation specifically applicable to the development of Geothermal Resources in PNG; and

3. Have practicable application and relevance to the current prevailing global practices whilst addressing the specific needs in Papua New Guinea."

The completion of the Geothermal Resource Policy was undertaken in several defined stages over a period of 11 months from August 2013 to June 2014 summarised as follows.

3.1 Study tour

Following the completion of a Detailed Work Plan, the Assignment commenced with a study tour to New Zealand by three senior DMPGM staff (the "Delegation") hosted by the author. The purpose of the study tour was for the Delegation to gain an understanding of geothermal policy in New Zealand and how it is implemented. The five-day study tour occurred in the first week of September 2013 and included:

- A meeting with Waikato Regional Council which focused on, and explained, the regulatory regime relating to the management of geothermal resources in the Waikato Region.

- A visit to Te Puia in Rotorua (http://www.tepuia.com). Te Puia is a major geothermal tourist attraction. Local Maori explained their traditional and contemporary relationship with the geothermal resource. Te Puia opened the Delegation's eyes to the prospect of geothermal resources being used for tourism purposes (rather than just for electricity generation).

- A meeting with Ngāti Tūwharetoa Settlement Trust (NTST) in Kawerau along with a site visit of the geothermal developments on the Kawerau Geothermal System. The discussions with NTST provided the Delegation with a good understanding of the experiences of a Maori landowner involved geothermal development.

- Drive by tour of geothermal tourism operations (Hells Gate and Wai-o-tapu) and geothermal power stations including those involving Maori land. Power stations observed were: Ohaaki (including a cascade use of geothermal heat – timber kilns), Mokai (including direct heat uses – glasshouses and a dairy factory), Te Mihi, and Poihipi Road. An explanation was provided as to the nature of the geothermal developments observed and the relationships between Maori interests in geothermal resources and development, including relationships with power companies.

- A meeting with representatives of Contact Energy Ltd followed by a tour of the Wairakei Steamfield, Poihipi Road Power Station, and Te Huka Power Station. The meeting with Contact Energy provided a 'reality check' in terms of the type of regulatory environment that was required for a developer of geothermal resources to invest. The site visit involved a closer look at different types of geothermal power stations.

- Lunch at the Huka Prawn Park (a cascade user of geothermal heat). The visit to the Huka Prawn Park provided another example of how geothermal resources could be used for tourism purposes.

3.2 Desktop review of Draft Geothermal Policy

A review of the Draft Geothermal Resource Policy dated November 2012 prepared by DMPGM was undertaken. A report was prepared which presented preliminary findings as to the adequacy and appropriateness of the Draft Geothermal Resource Policy compared with international best practice, and set out a list of matters that would need to be the subject of further discussion and/or consultation with the relevant parties when the author travelled to PNG.

3.3 Trip One to Papua New Guinea

The first trip to PNG was undertaken during 14 – 18 October 2013. It involved:

- Consultation with relevant agencies and/or institutions in Port Moresby; and

- Working sessions with DMPGM in Port Moresby analysing the outcomes of the consultation and ways in which the Geothermal Resource Policy should address the issues identified in a manner which is appropriate to the local circumstances in PNG.

3.4 Trip Two to Papua New Guinea

The second trip to PNG was undertaken 9 – 18 February 2014. It involved regional consultations in Madang and Kimbe, followed by a site visit to the Lihir Gold Mine (on which the only geothermal power plant in PNG is located) including a meeting with Lihir Gold Ltd (a subsidiary of Newcrest Mining Ltd).

The parties that were consulted during the second trip to PNG were invited to provide any written comments and/or feedback on the Draft Geothermal Resource Policy (dated November 2012).

A Consultation Feedback Report was prepared in March 2014 following the second trip to PNG.

3.5 Drafting of Geothermal Resource Policy

With the benefit of the feedback received during the consultation, the Geothermal Resource Policy was re-drafted. The structure and content of the Geothermal Resource Policy was amended and/or edited so as to address all relevant issues identified as part of the consultation in a manner that met the requirements of the Assignment Objective in the Terms of Reference.

A Working Draft of the Geothermal Resource Policy was completed and forwarded to DMPGM for feedback at the end of March 2014. The Working Draft was amended to address the feedback from DMPGM and a Final Draft of the Geothermal Resource Policy dated 30 April 2014 was completed and forwarded to DMPGM to circulate to the Key Stakeholders (to be discussed at the Key Stakeholder Workshop to be held in Port Moresby on 21 May 2014 – discussed below).

3.6 Trip Three to Papua New Guinea

The third trip to PNG was undertaken 20 – 22 May 2014. It involved a one-day workshop held at the offices of the Mineral Resources Authority (MRA). A presentation was made regarding the Assignment Objective, the New Zealand Study Tour, the consultation undertaken and the results of that consultation. We then worked through the Final Draft of the Geothermal Resource Policy (dated 30 April 2014) section by section and further feedback was obtained from the stakeholders present.

Following the workshop (the next day), a 'tracked changes' version and a 'clean' version of the Geothermal Resource Policy document dated 21 May 2014 was forwarded to DMPGM to circulate to the workshop participants and seek any further feedback by close of business on 28 May 2014.

3.7 Completion of Final Geothermal Resource Policy

With the benefit of the feedback received in relation to the post-workshop version of the Geothermal Resource Policy document dated 21 May 2014, the Final Version of the Geothermal Resource Policy dated 29 May 2014 was forwarded to DMPGM for any final comments or feedback. The Final Version of the Geothermal Resource Policy dated 6 June 2014 was completed and forwarded to DMPGM and MFAT.

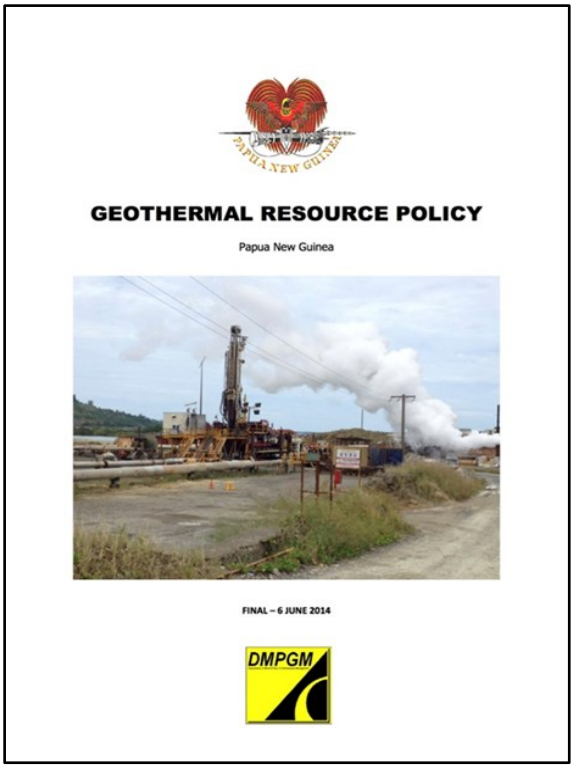

Figure 3: Front Cover of the Geothermal Resource Policy.

4. KEY ELEMENTS OF THE GEOTHERMAL RESOURCE POLICY

Consistent with the style and content of other policy documents in PNG, the Geothermal Resources Policy sets out an overall Policy Mission and Policy Objective as follows:

Policy Mission

To establish a framework that guides and promotes the exploration, development, production, use and management (including preservation) of Geothermal Resources in Papua New Guinea in a safe and sustainable manner for the benefit of the nation.

Policy Objective

To encourage, allow and facilitate the exploration, development, production, use and management (including preservation) of Geothermal Resources in Papua New Guinea in a safe and sustainable manner consistent with the policies and other provisions of this Geothermal Resource Policy.

The Policy Mission and Policy Objective are purposely enabling and encouraging, but are subject to the requirements of the various policies which require outcomes that are consistent with international best practice in relation to the sustainable management of geothermal resources. In this regard, the policies formulated for PNG are heavily influenced by New Zealand's Resource Management Act 1991 and the Geothermal Module of the Waikato Regional Plan.

The Geothermal Resource Policy includes policies under eleven headings, which are set out as follows along with a summary of the key elements of the policy imperatives.

Encourage Investment

The policy seeks to encourage investment in the exploration, development, production, use and management (including preservation) of geothermal resources, particularly as a renewable source of electricity generation, as well as for a wide range of other potentially beneficial uses including cascade uses of geothermal energy.

Identification of Landholders

Any application relating to the exploration or development of geothermal resources requires information to be provided which correctly identifies the landholders and communities potentially affected by the proposed activities which are the subject of the application.

Benefits to Local and/or Affected Landholders and Communities

In response to one of the main concerns raised during the regional consultations, the policy requires that opportunities be identified, and provided, for local and/or affected landholders and communities to be involved in projects associated with the exploration, development, production, use and management (including preservation) of geothermal resources.

The policy also requires that exploration, development, production, use and management (including preservation) of geothermal resources shall result in tangible benefits to the local and/or affected landholders and communities.

Health and Safety

This policy requires compliance with the PNG Mining (Safety) Act 1977. It also requires the adoption of best industry technology and practice, standards and codes.

Environmental Protection and the Management of Adverse Effects

The policies in this part of the Geothermal Resource Policy relate to the management of the environment and are given effect to as part of the assessment and determination of any application under the PNG Environment Act 2000 and its Regulations relating to a proposed geothermal exploration or development proposal.

The policy requires the developer to:

- Adopt best industry technology and practice, standards and codes into its environmental management regime.
- Identify geothermal features within an application area, and the values associated with those features.
- Undertake any development in a manner whereby any adverse effects on valued geothermal features are avoided, or otherwise effectively remedied or mitigated.
- Avoid, remedy or mitigate adverse effects on the natural and physical environment (including overlying buildings, structures, and important and significant features) resulting from subsidence of land and land instability, arising from the production, use and discharge of geothermal energy or water.
- Prepare a Discharge Strategy (forming part of a System Management Plan) which:
  - Has a primary focus on the sustainable management of the geothermal resource; and
  - Seeks to avoid discharges of geothermal water to fresh surface water bodies, fresh ground water, or the coastal marine environment.

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Exploration Phase - Identification and Characterisation of Geothermal Systems

This policy requires an application for an Exploration Licence in relation to geothermal resources to include in its work programme certain information including:

- Identification of the extent of the Exploration Licence area and a description of what is known about the geothermal system at the time, including an inventory and mapping of any known geothermal features and the values placed on those features.
- The objectives of the proposed exploration and a description of the nature of the proposed exploration including the extent of any well drilling.
- A description of the ways in which the proposed exploration, including any well drilling, will be managed to avoid, remedy or mitigate any adverse effects on the environment;
- A proposed Exploration Programme including timeframes and milestones; and
- An explanation as to how the proposed exploration will be undertaken in a manner that will give effect to the objectives and policies in this Geothermal Resource Policy (as applicable).

Production Management Phase - Management of Geothermal Systems

The development, production, use and management (including preservation) of Geothermal Resources shall be undertaken in a manner that allows for the controlled depletion of the energy in a geothermal system through staged production / production scheduling based on reservoir modelling that:

- Considers the capacity and sustainable yield of the geothermal system as a whole.
- Considers the reasonably foreseeable needs of present and future generations.
- Promotes the efficient management and use of the geothermal system.
- Adopts best industry technology and practice, standards and codes.

Production Management Phase - System Management Plan

Any application for a Mining Lease, Lease for Mining Purposes, or a Mining Easement in relation to Geothermal Resources involving the production of geothermal water and/or steam to a level as prescribed by MRA shall include in the proposal for development a System Management Plan which shall address the following matters:

- A description of the geothermal system including an inventory and mapping of any known geothermal features and the values placed on those features.
- A description of the proposed use and development of the geothermal system including:
  - Plans showing the location of proposed wells, pipelines, buildings and other surface infrastructure;
  - A Production Strategy and Discharge Strategy including the reinjection/injection of geothermal water; and
  - Operational flexibility and adaptive management including provision for subsequent or cascade uses;
- Reservoir modelling (demonstrating the sustainability of the proposed production and reinjection / injection regime) and subsidence modelling;
- Measures to ensure that adverse effects on the environment are avoided, minimised, remedied or mitigated;
- Mechanism(s) to ensure coordination and promote cooperation between all holders of Mineral Tenements relating to the same geothermal system;
- Research, monitoring and reporting;
- Periodic review of the System Management Plan; and
- Explanation as to how the System Management Plan gives effect to the objective and policies in the Geothermal Resource Policy.

The proposed use and development of the geothermal system is required to be undertaken in accordance with the approved System Management Plan.

A peer review panel may be established for the purpose of assisting the MRA to manage the geothermal system in accordance with the System Management Plan, as well as advising on any review of the System Management Plan.

Production Management Phase - Decommissioning of a Geothermal Power Plant and Rehabilitation

The policy requires a project developer to produce a Conceptual Decommissioning Power Plant Plan (CDPP Plan) at the time of lodging of an application for a Mining Lease associated with a development that includes a geothermal power station. This CDPP Plan should consider health and safety, socio-economic and environmental aspects of the impacted project area and incorporate effective rehabilitation measures.

Monitoring, Reporting, and Auditing

The policy requires that monitoring, reporting and auditing be undertaken as appropriate to the circumstances of any development.

Bond

In addition to an Environmental Bond that may be required under the Environment Act 2000, a bond is required as a condition of any Exploration Licence relating to geothermal resources that involves drilling a well and/or any Mining Lease for a development involving the extraction / production of geothermal water and/or steam to a level prescribed by MRA.

It is important to note that following the completion of the Geothermal Resource Policy in June 2014, it needs to advance through PNG's legislative drafting process during which the contents of the document may be subject to change. It is understood that this process has commenced but has yet to be completed, having been delayed as a result of being advanced alongside a number of other policy documents.

5. CHALLENGES AND ISSUES TO BE ADDRESSED

There are a number of challenges and issues (some of them significant) associated with the prospect of developing geothermal resources in PNG.

5.1 Remote Location of Geothermal Resources

As previously noted, most of the geothermal resources in PNG are located in isolated areas, mostly on islands some distance to the north and east of the mainland, remote from large population centres. Because of distance and topography (particularly in relation to geothermal resources on islands), the prospect of establishing any form of transmission line to larger population centres (such as the capital, Port Moresby) is generally considered to be uneconomic. Even if geothermal resources in the northern part of the mainland were developed for electricity generation, the distance (approximately 500km), topography, and landowner issues, make the prospect of transmitting electricity to Port Moresby unrealistic.

Any medium to large scale plant generating electricity using geothermal resources is most likely to be associated with a mining operation located within the same general vicinity. Any surplus generating capacity could supply local communities for commercial and domestic purposes. There are, however, population centres such as Kimbe on the Island of New Britain with a population of 20,000+ which could be a source of demand for a small-scale generation plant serving that community.

5.2 The Need to Raise Capital

As became evident during the consultation undertaken, there are a number of landowner groups that are highly motivated to develop geothermal resources for electricity generation. Some of them have already formed companies for this purpose in anticipation of a feasible project being able to be consented and developed. Their rationale is that the ability to generate electricity will not only enhance living conditions (only 13% of households in PNG have electricity) but, more importantly, they believe that the supply of electricity will attract industry which will create employment and, as a result, improve the economic and social wellbeing of their communities.

The capital-intensive nature of geothermal exploration (let alone development) makes it very difficult for landowner groups to raise money for geothermal exploration, particularly when they have little or nothing to provide in terms of security for a loan provided by a financial institution. The 'landowners' do not typically own the land in question (it is owned by the State of PNG). They are, in a legal sense, what is referred to as 'customary landowners' – being defined by historical occupation and/or use of an area.

Unless the PNG Government (or one of its agencies such as PNG Power Ltd) takes the lead in exploring and developing geothermal resources, the most likely scenario is a foreign company funding an exploration programme and a subsequent geothermal development (preferably in association with the local 'landowners'). The manner and extent to which the local landowners are involved in, and benefit from, any such project is a matter that is addressed in the Geothermal Resource Policy (discussed in the previous section of this paper).

In order to justify the investment required, any parties embarking on a programme exploration or development of geothermal resources in PNG will need to have a clear understanding as to the end use of the electricity generated (i.e. the extent of the demand) including the ability of the intended end user(s) to be able to pay for the electricity.

5.3 Lack of Capacity and Experience

The ultimate success of the Geothermal Resource Policy will lie in its implementation. In this regard, a critical issue identified as part of the Assignment was the almost complete lack of capacity within PNG in terms of expertise and experience in relation to the management of geothermal resources and associated consenting processes.

While DMPGM is responsible for the development of government policy in relation to the management of geothermal resources, MRA is responsible for the consenting of proposed geothermal developments.

DMPGM will also need to grow its capacity to be able to monitor the effectiveness of the Geothermal Resource Policy and undertake any reviews as necessary.

There also needs to be co-ordination between the various government departments and agencies with a role in the consenting, use and management of geothermal resources, e.g. MRA (both in terms of consenting and safety), Department of Environment and Conservation in relation in relation to environmental issues, and Department of Petroleum and Energy in relation to the use of energy (electricity).

As part of the Assignment, recommendations were made which sought to address the lack of capacity. Specifically, it was recommended that MRA staff who will be responsible for the processing of any application in relation to geothermal resources be

provided the opportunity to travel to New Zealand and work alongside Consent Processing Officers at the Waikato Regional Council and/or Bay of Plenty Regional Council and 'learn the ropes' in relation to the processing of applications and the manner in which the Council has an on-going role in the monitoring and management of geothermal resources. DMPGM staff could also benefit from such an experience.

It was also recommended that MRA engage appropriately qualified experts from New Zealand to assist them with the processing of the first few applications for the exploration and/or use and development of geothermal resources. This is to ensure that these applications are processed in a manner that properly takes account of, and implements, the Geothermal Resource Policy while assisting with the building of capacity by MRA learning from the experience. MRA has several applications for Exploration Licences that have been lodged and are currently 'on-hold' pending the completion of the Geothermal Resource Policy, and possibly the completion of other mining policy / legislation / regulations review processes.

6. CONCLUSION

A Geothermal Resource Policy has been developed for PNG following a consultative process with key stakeholders including government departments, agencies and land owner groups.

Overall, the Geothermal Resource Policy for PNG seeks to promote the adoption of international best practice in relation to the management of geothermal resources tailored to local circumstances.

There are a number of challenges and issues (some of them significant) associated with the prospect of developing geothermal resources in PNG. Recommendations have been made to address some of those issues.

ACKNOWLEDGEMENTS

I wish to acknowledge Marlene Oliver (a former NZ Environment Court Commissioner) who assisted with the consultation undertaken during Trip Three to PNG and was a co-author and peer reviewer of the Geothermal Resource Policy for PNG as part of the Assignment.

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