NEW ZEALAND ENGINEERING CAPABILITIES SUPPORTING NEW GEOTHERMAL ENERGY DEVELOPMENTS

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Summary
A recent New Zealand geothermal power plant development showed that close to 50% of the total project cost is made up of local content, including some 20% of mechanical and electrical installation and plant contracts. An assessment of the imported packages showed that there is potential for further increase in local content. However, this will not happen by itself. Coordinated actions by the end users and those involved in the delivery chain are required. Some recommendations are outlined regarding how this could be achieved.

1 Introduction

1.1 HERA

HERA is the Research Association of the NZ Metals Engineering Industry, established in 1978 as a not for profit, membership based organization. It is a national organization, fully industry owned and governed, and has over 650 members across New Zealand. However, HERA not only services its members in the heavy engineering sector, it operates as the leading technical resource centre for a wide cross section of the NZ metals and construction industry.
HERA's mission statement is "To provide a platform for the NZ Metals Engineering Industry to explore new technologies and growth by accelerating innovation and strengthening combined opportunities through technical and marketing research, careers education, information technology and product R&D".
HERA maintains several technical divisions - the NZ Welding Centre, the Structural Division, and the Inspection and Quality Control Centre - as well as general support functions such as the HERA Information Centre and the Industry Development Division. One of the key functions of the HERA Industry Development Division is to ensure that members can obtain the maximum benefit from any project that is planned for New Zealand and use HERA experience to identify and promote NZ engineering industry attributes to offshore opportunities that arise.

1.2 Objectives of the Presentation

The presentation has two main objectives. The first is to build confidence within the geothermal industry that New Zealand Engineering companies can accomplish future work both in New Zealand and overseas. In this context HERA will endeavour to present member companies' previous experience in this and related fields.

The second is to discuss factors which may have an influence on increasing local engineering participation and from this discussion derive some recommendations on how this could be achieved.

1.3 NZ Geothermal Power Generation Trends

Geothermal energy is a relatively low-cost and indigenous generation option that can contribute to New Zealand's growing demand for electricity. It is uniquely reliable, with geothermal power stations typically achieving load factors of 95%, compared to typical load factors of 30 - 50% for hydro and wind power stations. The Wairakei power station has operated at a load factor of more than 90% for over 40 years with low operating costs. This inherent reliability makes geothermal generation a valuable component in a diverse electricity supply system such as New Zealand's.

With the government's commitment to renewable energy the scene is set for considerable growth in geothermal energy. Quoting from the draft NZ Energy Strategy[i], 2,700GWh of energy was supplied in 2005 in New Zealand. However the draft strategy estimates the economic potential of the technology to be on the order of 11,000 GWh/year, or about 4 times the currently installed capacity.

The current small Kawerau geothermal development planned to go on stream in October 2008 adds 90 MW to the system which, with an assumed availability of 90%, would add up to around 710 GWh/year. In other words, there is room for 15 of these stations. We also understand that a major upgrade of the Wairakei geothermal area, which currently produces 1550 GWh/year, is planned (Te Mihi, followed closely by Tauhara – see table 1).

Table 1: Projected Geothermal Installation in New Zealand (from NZ Geothermal Association and other Sources)

Plant Name	Size (MW)	Assumed Commissioning
MRP Kawerau	90	2008
Top Energy Ngawha	15	2009
MRP Rotokawa 2	110	2009
Contact Te Mihi	220	2010
Contact Tauhara	200	2011
Mokai 4	40	2011
MRP New Project	50	2011
MRP New Project	50	2012
MRP New Project	50	2013
MRP New Project	50	2014
MRP New Project	50	2015

2 NZ Engineering History in Geothermal Power Development

30 MW Lihir, PNG
Photo ; courtesy Robt.Stone Ltd

2.1 Engineering Companies

New Zealand is among the countries who have pioneered geothermal energy. As a result, its engineering companies have also been involved in establishing this technology and the Wairakei plant is a testimony to the quality of the design and workmanship. The Wairakei station was the second major geothermal station built in the world and is currently generating to capacity and is planned to continue until at least 2011 when Te Mihi is producing.

39 MW Mokai Geothermal
Photo ; courtesy Fitzroy Engineering

Going through the list of items which make up the most recent addition to NZ geothermal energy, the Kawerau geothermal power station, we note that there is a significant NZ contribution which adds up to nearly 50% of the total project expense. The total value of the project is between $100 to $140 million. For the Kawerau project, there have been a range of tenders bid by NZ companies such as Page & Macrae, Robt. Stone, Jensen Steel and Kawerau Engineering.

Engineering companies who to our knowledge already have had significant involvement in geothermal power station construction and maintenance are listed in Table 2 (page.10) for NZ projects;

Several NZ engineering companies have been successful with overseas contracts for geothermal work.

Table 3: NZ Engineering Companies involved in overseas projects

Company	Country	Project	Date
Robt. Stone	Lihir Island, PNG	20MW GPP	2004-2005
	Lihir Island, PNG	30MW	2005-2006
Century Resources	Indonesia Ethiopia Philippines St. Lucia Chile Azores		

2.2 Consultants

As noted above, NZ consultants have been amongst the pioneers of geothermal power generation going back as far as the 1950s.
Consultants who have already had significant involvement in geothermal construction contracts in NZ and overseas are:

Table 4: NZ consultants involved in geothermal projects

Company	Country	Project	MW
Sinclair Knight Merz	New Zealand Philippines Indonesia Kenya Iran South America		
Maunsell Ltd	New Zealand Indonesia Russia PNG Philippines Ethiopia Vanuatu	Wairakei Binary Kawerau Sarulla Wayang Windu Gunung Selak Ulumbu Mutnovsky Lihir Nasulo Aluto Langano Efate IPP	20MW 65MW 300MW 110MW 110MW 2MW 50MW 20MW 20MW 6.2MW
Century Resources	Indonesia Ethiopia Philippines St.Lucia Chile		
	Azores		
Thorburn Consultants	New Zealand	Pohipi Rd	50MW
Bechtel	New Zealand	Kawerau	90MW

2.3 Main Contractors

It appears that the main contractors with creditable expertise are the key to successful deployment of geothermal energy in New Zealand. The drivers for successful main contractors appear to be IP ownership of the relevant process technology (e.g. Ormat) or specific expertise on the power generation side (e.g. Sumitomo/Fuji).

We understand that the main contractors in NZ have been British Thomson-Houston and Ormat in Wairakei, Mitsubishi/Fuji, Ohaaki, Ormat with Mokai and Sumitomo/Fuji with the Kawerau station.

3 NZ Engineering Industry Capability Directory for Geothermal Energy

A detailed and up to date Geothermal Capability Document is being produced and maintained by HERA. This document is devoted to engineering capability to support the geothermal industry. It aims to clearly show a prospective purchaser or prime contractor which New Zealand companies have expertise in specific related areas. The Capability Directory[ii] is available from the HERA Information Centre (HERA Report R5-35:2007).

The information for this register comes from interested engineering companies with prior experience in the geothermal industry and includes companies such as Fitzroy Engineering, Century Resources, Page & Macrae and Robt.Stone which are among the largest, most well known and long established engineering companies in New Zealand. Other companies who have contributed such as Allied Industrial Engineering, A & G Price Ltd, BLM Engineering, Kawerau Engineering, South Pacific Industrial and Verissimo Engineering are well known heavy engineering companies with varying experience on the periphery of the geothermal industry. However, the Directory also contains information on some prospective newcomers who have the heavy engineering capability but are not currently working in this field.

4 Assessment of Potential to Increase NZ Content

On the back of the development of the Engineering Industry Capability Directory, much discussion arose from surveying opinions,of those involved on the potential to increase local content. These comments are summarised in the following SWOT Analyses.

4.1 Engineering Industry Opportunities SWOT Analysis

The following are some of the key points listed in the interviews. HERA welcomes further comments and will integrate those in the ongoing industry capability development strategy.

5 Factors Influencing the Potential to Increase Local Content

5.1 Government Policies

5.1.1 New Zealand Government Procurement Policy

New Zealand's government procurement policy is currently based on the commercial principle of best value for money through competition, and includes the requirement to give full and fair opportunity for domestic suppliers. The policy does not include domestic preference or discrimination against foreign suppliers[iii].

Strengths	Weakness
Local companies Investment dollar retained in NZ After sales service Existing skills Developing new technologies Supporting the engineering industry Employment opportunities for future generations by ensuring sustainability of our companies Reputable quality - less rework cost	Capacity of NZ engineering companies inconsistent Project awareness not early enough Not close enough to the prime contractors Lack of confidence in NZ manufacturing ability Financial ability to support insurance and performance bonds
Opportunity	**Threat**
To improve the operation and reliability of the station Link of manufacture capability to servicing capability To develop skills unique to geothermal generation construction Build credibility and substance to the industry Potential export opportunities Investment in new equipment Employment opportunities for the future Develop international partnerships	Not cost competitive as compared to low cost countries Delivery times often unachievable Overseas principal contractors commonly have partnership arrangements with engineering companies in their own country Lack of government support and industry cohesion to ensure long term success of industry investment

The industry support mechanism consistently volunteered by engineering companies surveyed for this study was a desire for the opportunity to bid for work for which they are qualified. The GETS, Tenderlink and Projectlink systems are used by many but they are limited in that not all projects are registered. There is no clear path to early communication with New Zealand suppliers; even the Government supported NZT&E and the ICN Network are often not aware of impending plans for projects which are sometimes involving SOEs. Encouraging the electricity SOEs and private providers to use the GETS service as an advisory method would assist industry to maximise their opportunities to bid for geothermal energy equipment supply and installation tenders. Full, fair and reasonable access to bids by local manufacturers and support by SOEs and Government Departments would significantly assist New Zealand engineering companies.

Government Policy Statement (GPS) September 2003 version[3] for electricity governance includes a requirement for it to be supplied at "*least-cost to the economy as a whole over the long term"* and is consistent with sustainable development.

However this whole-of-life cost benefit assessment concept currently has no mechanisms to include the overall benefits from local manufacture. Lowest price tendering does not necessarily meet this GPS requirement. The competing interests of purchasers, manufacturers and labour within each sector cannot be effectively balanced using only this method. To effect the Governments GPS policy would require a far broader approach, including how it can influence procurement policies, for example, by ensuring full, fair and reasonable access for local manufacturers in the planning stage.

The quality aspect of tender respondents needs to be more thoroughly examined. There are many instances of imported product failing to meet standards that New Zealand companies had strived to include in their tender price. Often the cost of complying with these standards is very high as the estimate must be for a worst case scenario, whereas the imported product that does not comply is often cheaper due to the ability to define the rework costs after the faults have been identified when installed and are then covered by the developer separately.

The term 'whole of life' has a much more serious meaning to New Zealand engineering companies who are used to products being made to last

much longer than their original life expectancy. This is a culture that may need to be addressed by tenderers and may have to be driven so that apples are compared with apples.

In line with the Tariff Act 1988, capital equipment which forms part of a geothermal power-station is subject to a tariff, typically 5 or 7% of the import value. However, in line with government policies which are aimed at reducing costs to business, and in recognition of the increasingly competitive situation faced by NZ business, duty concessions are considered for items of capital equipment[iv]. For this to take place the applicant would need to show that such equipment would have greater efficiency and higher performance and productivity than those available from NZ manufacturers. But the applicants have also to demonstrate that fair and equal opportunity was given to local industry to become involved in the project. The Act provides for local manufacturers to object if they believe they have the capability and capacity to produce similar goods. The final decision on whether an application is granted lies with the Minister of Economic Development.

HERA fulfils a tariff concession application monitoring role for the heavy engineering industry and objects on behalf of its members where proof of capability and capacity does exist. Through consequent application of the Act an excellent tool exists to encourage applicants to seek out local manufacturing input in order to gain tariff concession for goods where local capabilities don't exist. It is HERA's experience that this tool is not applied by industry and equally by government departments well enough to encourage an increase in local content. Far too often tenders are sought without any consideration given to seeking local suppliers, and as a consequence if capability does exist tariffs need to be paid where through appropriately exploring local opportunities industry would not have objected to fair concession applications.

Recommendations:

- Government should consider amending the SOE Act to encourage SOEs to investigate increasing local content in projects where this makes strategic sense and is viable from an economic point of view.
- More consideration should be put on the "least cost over whole of equipment life" requirement to give additional guidance on where service considerations may influence the original equipment purchasing decisions in favour of local fabrication.
- Government should actively support and encourage the economic use of the NZ engineering industry through vigilant application of tariffs rules. Tariff concessions should only be granted if the applicant proves as required that they have researched every opportunity to source local content.

5.1.2 Energy and Manufacturing Strategies

The Government's Energy and Manufacturing + strategies both set important directives for industry development relevant to geothermal energy.

Energy Strategy - Focus on Renewable Energy

The Government's Energy Strategy[v] responds to two major challenges that our energy sector faces. These challenges are now widely agreed to be: fighting climate change by reducing our emissions, and ensuring we have secure, clean energy at an affordable price. The NZ Government announced a target of 90 percent renewable energy generation by 2025 and in order to achieve this related policies and government programs need to follow.

Geothermal energy is classed as renewable, requires no fuel and tends to cost less than other types of renewable electricity. It can also operate at high load factors and does not depend on fluctuating energy provision such as wind, wave or tidal energy.

Due to the excellent match of energy strategy and geothermal energy it could be expected that government R&D policies will place special emphasis on this technology and put priority on local capability development.

Manufacturing + - value added and export focus

Manufacturers believe fundamentally in the intrinsic value of manufacturing to our society and economy. And they demonstrate this every day by transforming raw materials into valuable and saleable goods through their own efforts as they work closely with staff, shareholders and the wider community in a way that creates benefits for the entire country. New Zealand needs a manufacturing industry to support its social, technical and political aspirations.

NZTE's Manufacturing + Strategy development

The strategy is essentially about adding value to the offerings of the NZ manufacturing industry. HERA has been involved in contributing to the strategy from the metals engineering industry perspective and a summary document of key strategies has been compiled. This has been used in the formulation of different sector group strategies including for the Heavy Engineering industry and its contribution to the geothermal industry development. This workshop is one of the actions deriving from this strategy work.

In geothermal energy New Zealand is able to make considerable contribution to the geothermal industry product chain. We have considerable geothermal resources and are committed to increasingly exploiting them. We have a research base able to locate these resources and work out the best ways to extract them. We have a strong base of New Zealand consultants specialising in this area and supporting the developers and energy providers in realising the comprehensive geothermal power projects planned. We also have a very capable equipment and civil engineering base to implement these projects. What we seem to have to expand on in order to increase the local contributions and especially to increase our export values is saleable IP on the power conversion side.

Provided it is recognised by industry and government that NZ can become a truly international force in geothermal energy, from a Manufacturing + strategy point of view geothermal energy should find targeted support.

Recommendations:

- Based on the importance of geothermal energy for the fulfilment of the renewable energy strategy, government should consider the development of a NZ geothermal energy technology industry as a project of national importance.
- Due to the potential of the technology to add value to NZ manufacturing industry's offerings both for local and export markets, support should come from those driving the Manufacturing + vision.

5.2 Financial Ability

The significant cost of both insurance and performance bonds during the length of the contract generally prohibits many New Zealand engineering companies from taking a major part of a multi-million dollar contract such as a geothermal station build. A medium sized station such as the current Kawerau project (90MW) has a total estimated cost of between $100 and $140 million for a project spanning 2 years. Insurance costs over the duration of the project are significant and performance bonds, normally 10%, which need to be retained for 2 years after the commissioning date are also a substantial financial burden, particularly if the contractor is involved in more than one project. Therefore, if developing New Zealand capabilities in geothermal energy is considered of strategic national importance, it might be worthwhile to consider ways of minimising this barrier such as providing insurance assistance.

The legislative costs of employing a contract workforce in New Zealand (i.e. inductions and provision of safety equipment) are adding to the costs of the project from a different perspective. This investment in a worker necessitates that you must keep him on the payroll for busy periods of the contract even though there is insufficient work during parts of the contract. The remoteness of the sites or lack of suitable temporary accommodation often means that there are high costs involved in transporting workers daily from outside of the area. Although these site specific employment aspects relate to most geothermal projects with or without enhanced local content, where the projects are considered to be of national importance to New Zealand infrastructure forms of assistance from central and local Government agencies might be an incentive to get companies interested in building capabilities.

Recommendations:

- Government to consider insurance assistance scheme for projects of national importance.
- With projects in remote areas, local and central government could consider support schemes for the provision of temporary labour.

5.3 Potential Engineering Industry Actions

5.3.1 Relationship and Confidence Building

The potential for New Zealand engineering industry appears to be significant, although there are manufacturing equipment capacity limitations for companies that would prevent

meeting rapid delivery requirements for geothermal generation components. Building confidence between principal contractors and interested engineering companies will provide the incentive to invest in, e.g. more productive manufacturing machinery and to ensure that labour capacity is available.

In particular, engineering companies need to develop and foster relationships with the key contractors in the areas that they are interested in. They need to encourage visits from prospective partners to their workshops to demonstrate their capability and capacity as well as quality and safety systems. Predominantly large offshore prime contractors have policies regarding safety and quality that outrank all other company policies. New Zealand companies need to prove safety records with Lost Time Injury (LTI) statistics and also the general appearance of the workshop and working environment. This clean and tidy attitude also contributes to confidence in the quality system used backed up by audited results.

The preceding factors combined with the requirement of profitability are necessary to engender confidence with local companies to build sustainable long term relationships. Generally prime contracting companies and their subcontractors, particularly from the Asian area, place great value in and honour partnerships and loyalty. Extensive evaluation of principal companies' products need to be undertaken by New Zealand engineering companies to ensure that they are partnering with the prime contractor that has the most efficient and cost effective product for the project. Tendering needs to be approached in an international, proactive, competitive manner as opposed to the New Zealand contracting scene which often has a local attitude.

Recommendations:

- New Zealand engineering companies need to foster relationships with the major equipment suppliers.
- Focus needs to be developed on building links to main contractors and key equipment suppliers who meet criteria which foster local capability building.
- HERA/ICN/NZTE to liaise with prime equipment suppliers to ascertain their requirements and provide feedback to industry to generate appropriate response.
- Establishing and promoting of a geothermal energy capability register of NZ engineering companies via HERA, government organisations, and other bodies with geothermal interests.
- Inclusion of potential New Zealand suppliers in the early consultation process of a new project to allow sufficient notice of impending requirements and to ensure most suitable and cost effective packages are tendered by the local industry.
- NZ companies should position themselves to be available when these projects are imminent. This is a capacity issue and major NZ engineering companies should joint venture with each other to be successful or build better subcontract relationships with smaller workshops to achieve deliveries..

5.3.2 Defining Industry Focus

Building geothermal energy related engineering capabilities in New Zealand, as with any other business development, only makes sense if it is profitable in the long-term. There is no question that under the current NZ renewable energy frame work and the potential to expand energy generation via geothermal means the prospects for NZ companies to engage are encouraging. However, deciding what particular area to focus on and how to be distinguished from potential competitors requires considerable planning and maybe some gentle guidance by government and overarching industry interests via incentives and strategic policy assistance.

The local industry itself probably needs to focus on the requirements of the offshore prime contractors who have the most suitable or cost effective generation equipment for the planned project. The focus should be on being able to provide the best solution to the manpower and machinery requirements to ensure that the majority of this work stays in New Zealand providing the opportunity for sustainable growth to the industry. This solution may not always be within the core business of an engineering company but could easily form the start of a successful cluster.

Maybe in co-operation with geothermal research providers such as GNS and NIWA and NZ consultants with considerable expertise in geothermal energy, there might also be pathways to develop NZ-specific expertise to power

generation technology. In this context of this workshop it is probably worthwhile to explore whether people feel that there is potential for such NZ-specific R&D.

Recommendations:

- Local Industry must focus on the requirements of prime contractors.
- Explore possible avenues of specific NZ expertise and IP generation with relevant researchers.

Manufacturing Clusters

Examples of engineering clusters are the Taranaki based 'Centre of Applied Engineering New Zealand', and (ETC) Engineering Taranaki Consortium, the Lower Hutt 'Earthquake Engineering Technology Business Cluster' and 'The Dunedin Engineering Cluster'. Many of these clusters are located or supported with a local or regional focus. These have the potential to support research into technologies related to a single industry, however to our knowledge no cluster so far has a specific geothermal generation focus.

For geothermal construction multi-skilled clusters need to be formed. Typically needed are civil works, construction, electrical, fabricators, mechanical engineering and insulation companies. For example on the current Kawerau project there are several New Zealand companies working on different packages and it is quite conceivable that they could join in a cluster for future geothermal and thermal work. Particular attention could then be given by the cluster to areas where there are trade shortages such as electrical by bringing more companies into the cluster. In principle cluster groups with a common interest do not need to be regionally based, particularly in this era of electronic communications and data transfer.

A cluster that can offer multi-trade capabilities to a prime contractor will be in a more favourable position for these larger projects. Whilst these clusters could involve selected current members of existing clusters they should not detract from existing clusters and their targeted work. At the end of the day the more specifically a cluster can offer services and confidence to main contractors, or even become main contractors themselves for at least small stations, the more likely they will win the business. For NZTE and HERA, performing research into how best to develop and promote successful NZ capabilities may be a worthwhile effort to support specific cluster building.

There are several larger construction, engineering and electrical companies that could join as a cluster for future projects. If the project was too large the possibility of several clusters working together is an option. The number of future geothermal projects currently planned would suggest that there is room for more than one cluster. The amount of past experience that can be offered in one group must obviously help in an assessment.

Recommendations:

- Cluster formation is considered a key tool to expand local contents and built export business.
- Industry to develop one or more clusters specifically targeting geothermal projects.

5.3.3 HERA Role

Depending on industry feedback to the HERA effort to build a NZ engineering capability directory for geothermal energy, HERA is willing to explore further and aid in additional engagement.

In practical terms to aid the engagement of NZ industry, HERA Industry Development could be involved with the prime contractors in defining the skill requirements and matching them to pre-qualified companies or clusters. This activity would also assist in updating the capability directory.

HERA Industry Development will also be proactive in encouraging formation of new multi-trade clusters using the information gained from producing the Geothermal Capabilities' Register and its knowledge of possible prime contractor requirements. The final formation of a multi-trade cluster belongs with the participants. HERA focus must still remain with the heavy engineering industry but participation should be to the benefit of its members.

The inclusion of more than one multi trade cluster in the capability register would have obvious advantages for HERA to promote to possible offshore primes.

From a industry research association point of view, in the process of becoming familiar with the technology and capability requirement it appears likely that HERA in conjunction with industry and other R&D providers will become involved in the establishment of a NZ specific R&D roadmap to drive with those involved the

development of a NZ geothermal energy industry.

Recommendations:

- For the HERA membership to build business in geothermal energy area, HERA Industry Development needs to get engaged with all players in the chain and in particular with main developers and main equipment suppliers.
- HERA to assist in the development of one or more geothermal energy industry clusters.
- HERA to be a driver in developing a R&D roadmap for a growing NZ geothermal energy industry.
- HERA to assist in promoting and achieving prequalification of NZ companies with contending principal consultants and contractors.

6 Conclusion

Following the release of the New Zealand Energy strategy there will be a natural trend towards the use of renewable sources for power generation. We are already seeing the first major expansion in geothermal electricity for decades, mostly driven by the fact that it is already a cost effective energy form for New Zealand. The commitment to renewable electricity, and to reducing greenhouse gas emissions, requires a substantial increase in renewable capacity overall. The graphs in the New Zealand Energy Strategy show we expect most of this will come from geothermal and wind power in the years to come.

A logical extension to this strategy is that New Zealand engineering companies focus on this expanding market and use the opportunity to increase the local content in each new project. Benefiting from likely government support for this technology and the follow on effect of generation of local IP from this R&D should support the likelihood of this technology becoming a major contributor to New Zealand's export offerings.

HERA as an industry organisation must play an important part growing this industry by linking the interested parties together, contributing to the development of this industry and promoting awareness of a strong and cost-competitive New Zealand geothermal power generation industry.

New Zealand engineers have already been major contributors to earlier and current geothermal energy developments and now have the opportunity to participate and invest in this new challenge.

References

[i] Draft NZ Energy Efficiency and Conservation Strategy Dec 2006……
[ii] HERA Report R5-35:2007…….
[iii] URL-http://www.med.govt.nz/ers/electric/governance-gps/
[iv] Reference 99 Tariff Concession, A Guide for Applicants, Ministry for Economic Development
[v] Speech notes, Launch NZ Energy Strategy 11-10-07

Table 2: NZ Engineering Companies involved in New Zealand projects

Station	Company	Project	Date
Wairakei	Century Resources Downer Robt. Stone Fitzroy Engineering Holster Engineering Service Engineers	 Well head valves	
Ohaaki	Century Resources		
Pohipi Rd	Robt.Stone Service Engineers Century Resources	50 MW Mechanical Overhaul Pressure vessels and gates	2000
Rotokawa	Robt. Stone Century Resources	Re-injection pipeline	2005
Ngawha	Century Resources		
Wairakei Binary	Fitzroy Engineering		
Mokai	Fitzroy Engineering Century Resources		
Kawerau	Jensen Steel Robt.Stone Kawerau Engineering Century Resources	Structural steel 7 Pressure vessels	2007 2007