Skills Issues and Training in the Geothermal Industry A New Zealand perspective

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Geothermal electricity generation is expanding around the globe with total global capacity expected to rise to 11 GW by 2010. Many countries are investing in research and development of EGS and low temperature resources.

In New Zealand, 135 MWe geothermal has been added to the grid since 2005, with another 155 MWe under construction, with a further 120 MWe at the resource consent stage and over 500 MWe planned or under review. Personnel levels in a professional capacity have grown from 350 in 2005 to 450 today, with a total of over 600 people solely involved in the geothermal industry based in NZ. However, there are critical shortages of trained personnel worldwide.

The New Zealand Geothermal Association has developed a 'Skills Action Plan' to address some of these issues.

- MAKE: Grow professional and trade/technical skills for new entrants to the industry;
- FIX: On-the-job up-skilling for those already in the industry;
- BUY: Immigration – source skilled labour on the world market.

The aim of this plan is to present a way forward to increase the level of participation of skilled personnel in the industry. It also has the aim of raising the profile of this energy resource which often gets ignored in the bigger discussion on renewable energy in New Zealand.

The Geothermal Institute at University of Auckland ran a very successful year-long Geothermal Diploma course from 1979 to 2002. This course has been reshaped and revitalised and is now one-semester PGCert (Post-graduate Certificate), with additional short courses tailor-made to industry needs. From 2010 the Faculty of Engineering will also offer a Masters Degree course in Energy, with a specialisation in Geothermal Energy.

The framework already exists to design non-university trade and technical courses in geothermal energy topics which can be part of a nationally recognised qualification. School and community level education is also required.

Keywords: personnel shortages, skills action plan, specialised geothermal training, education

The Global Geothermal Industry

Trends in the global geothermal industry over the last several years reflect a strong upswing in interest in renewable energy which is being driven by two key factors – a growing recognition of the reality of global warming and the contribution that fossil fuel generation with high CO_2 emissions makes to this problem, and the very high fuel costs that had prevailed up to 2008. As a result of these factors, geothermal energy has become a favoured form of renewable power generation, being suitable for long term sustainable power with low CO_2 emissions, typically at a level of less than 20 % of that for fossil fuel generation.

The New Zealand Geothermal Industry is experiencing a period of growth which is expected to continue for the coming 10 years. A number of developers have built up critical levels of skill and confidence to be able to make geothermal investments as part of a broad portfolio of energy projects. Additionally, the geothermal industry in Australia is very buoyant with capital raising, surface exploration, exploration drilling and power development planning actively undertaken by a number of commercial entities.

Traditional international markets of the Philippines and Indonesia have recently undergone restructuring of the national electricity supply networks and of associated state-owned enterprises coupled with privatisation and asset sales. This has drawn in New Zealand consultants (and potential investors) into due diligence studies on behalf of multiple investors, and subsequent feasibility studies. Consultants have also provided advice on maintenance regimes for existing facilities. Major projects may follow.

Other developments that have required and will require New Zealand personnel include the Lihir project in Papua New Guinea, the San Jacinto project in Nicaragua, and Olkaria in Kenya. There are frequent calls on geothermal experience for due diligence and feasibility studies through parts of South East Asia and in Europe, and more recently through the Caribbean. Djibouti is one of the latest places for prefeasibility studies. There is growing interest in Central and South American development, including a recent strong drive by the Chilean government to encourage development in Chile.

Until now there have been almost no inroads into the US market but that could be about to change. The WGC 2005 country update for the USA showed there were approximately 725 professional personnel involved with geothermal activities in the US in 2004 compared with 440 similarly qualified geothermal professionals in New Zealand currently.

The US DOE has recently announced an investment of up to US$350 million targeted at geothermal demonstration projects; EGS research and development; innovative exploration techniques; and a National Geothermal Data System, Resource Assessment and Classification System. One of the expected program outcomes include demonstrating the ability to create an EGS reservoir capable of producing 5MW by 2015.

Close to US$155 billion was invested in 2008 in renewable energy companies and projects worldwide, not including large hydro. Of this, $13.5 billion of new private investment went into companies developing or scaling-up new technologies alongside $117 billion of investment in renewable energy projects from geothermal and wind to solar and biofuels. The 2008 investment is more than a four-fold increase since 2004 according to *Global Trends in Sustainable Energy Investment 2009*, prepared for the UNEP Sustainable Energy Finance Initiative.

Geothermal Personnel

Throughout the energy industry worldwide there is a shortage of skilled personnel, an ageing workforce and a reduction in graduates in relevant disciplines.

In 2005 a skills survey (NZGA 2005) of the geothermal industry reported a total 350 personnel engaged in the NZ geothermal industry as professional engineers, scientists and technically qualified plant operators. Four years on, and with an additional 135 MWe added to the grid from geothermal, there are almost 450 professionals plus over 150 technical and non-technical staff involved solely in the geothermal industry (NZGA 2009). Several geothermal companies in NZ have found a need to attract skilled professionals internationally and therefore must compete with others in the internation energy sector.

Future development in NZ alone has 155 MWe under construction, with 120 MWe with resource consents. Additional to these, over 500 MW is planned and under review. In the past 20 years much of the work NZ consultants (this includes large and small companies, individuals, Crown Research Institutes (CRIs) and universities) have been involved with is offshore. The NZ based work alone was not enough to sustain them. Yet with the growth of development in NZ in the last several years, and the growth in personnel, the geothermal industry in NZ is still facing shortages. This has been critical in the drilling sector.

The expertise of many NZ geothermal consultants is being called upon by the recent 'birth' of the geothermal industry in Australia where this industry is expected to provide between 1000 and 2000 MWe by 2020 (MMA 2008).

The MMA 2008 report noted that most of the personnel involved in the emerging geothermal industry in Australia have a strong background in minerals exploration and development, but they have less experience in generating and selling electricity, with only a few having geothermal development experience. It is particularly critical in areas such as drilling and reservoir engineering.

With the expansion and investment internationally in EGS, these areas will be in even higher demand.

Skills Action Plan

To address current and ongoing skill shortages a skills action plan is proposed. The Plan was developed by the New Zealand Geothermal Association (NZGA) on behalf of the Geothermal Industry in NZ. It is based on the 'Make, Fix, Buy' model developed by the Department of Labour and aligns with the New Zealand Skills Strategy.

- MAKE Grow professional and trade/technical skills for new entrants to the industry
- FIX On-the-job up-skilling for those already in the industry.
- BUY Immigration – source skilled labour on the world market

The aim of this plan is to present a way forward in increasing the level of participation of skilled personnel in the industry. It is also has the aim in raising the profile of this energy resource which often gets ignored in the bigger discussion on renewable energy in New Zealand. See Table 1 at end of paper.

'MAKE'

Education is central to the 'MAKE' section of the action plan. This involves: raising awareness of geothermal energy at a community level; school programs in scientific and cultural aspects of geothermal energy use; promotion of renewable energy studies at University; and as a desirable career path.

Development of a package for use in the school science curriculum is recommended for schools. Environmental awareness and sustainable development is now part of the school curriculum, and direct use of geothermal energy would fit well into this particularly at primary school level. It is a straight forward concept to explain and illustrated with a multitude of uses.

The geothermal industry needs a presence at community events raising awareness, and a package for static displays suitable, for instance, for libraries and foyers of community buildings. The geothermal industry needs to work with the Industry Trainings Organisations to develop trade and technical courses and qualifications to suit industry requirements. This may involve many interested parties, from Technical Institutes and even Universities for higher level technical skills, to in-house training for school leavers directly entering the workforce.

High level jobs involving tertiary education such as engineers and geoscientists are critical to current and future geothermal exploration and development. In the 2005 report on skills capability in the geothermal industry, the most common complaint from industry was the lack of training programs available to maintain a satisfactory inflow of younger staff or for further developing experienced staff. It was recommend that the former Geothermal Institute within the University of Auckland (UoA) be re-established but with tailored training programs to the NZ geothermal operator sector. In particular, focus on resource monitoring and management, steam field and power plant operational issues was sought.

For the long term it is suggested companies must consider actively recruiting graduates and mentoring/training them over a 2-4 year period to build up necessary experience. However, this is dependent on an increase in school leavers entering these disciplines at university. Programs promoting renewable energy and the green economy as viable career paths need to be targeted at senior school leavers.

'FIX'

On-the-job up-skilling is also vital. The benefits of on-the-job training include higher standards of safety, higher productivity, less down time, and employees feeling valued. Technological advancements require on-going training as well as the need to extend /expand the knowledge of workers moving to new areas of operation and up skilling those moving to supervisory or management roles. Employees report that they value training as long as it is delivered by someone experienced and knowledgeable who can transfer that knowledge in a way that learners can relate to, and is timely and that they have the opportunity to learn in group situations.

'BUY'

The energy industry as a whole needs to address the remuneration issue urgently and consider moves towards pay parity especially with Australia which is New Zealand's major competitor for skilled resources.

As a proportion of overall demand for skilled employees, the numbers are smaller and in the short term can be recruited in the global market. Companies will however have to prepare for a longer lead-in time to source experienced personnel because of the scarcity worldwide or to seek recruits from both traditional and non-traditional sources.

A major consideration for recruiting people from overseas is remuneration. Skills scarcity coupled with escalating demand has had the effect of adding premiums to wages and salaries for those employed within the sector. The general wage pressure is however wider than the NZ market, evidenced as a continued creep towards Australasian rates of pay for some skills and in limited circumstances, global pay rates for workers prepared to work in the more lucrative international day-worker market.

Current Status of Training in NZ

Because education comprises a significant section of the skills action plan, this section of the paper discusses the current state of geothermal training in New Zealand.

In response to perceived demand, and in anticipation of future demand, a new one semester post graduate course in geothermal science and engineering is now taught annually at the University of Auckland. For those who cannot afford the time away from work, specialist professional development short courses are offered.

The framework exists for training providers to design trade and technical courses for accreditation to a nationally accepted standard. At least one geothermal company has begun to work with Industry Training Organisations (ITO's) to enable workers to obtain a drilling qualification.

However, more needs to be done at a school and community level to promote geothermal energy.

Postgraduate Geothermal courses in NZ

The Geothermal Institute at University of Auckland ran a very successful year-long Geothermal Diploma course from 1979 to 2002 (Hochstein, 2005). Unfortunately support from the New Zealand Government for the Diploma course was withdrawn at the end of 2002. This was despite the growing concern over global warming and the required development of clean energy sources, concern among professionals over the loss of momentum in geothermal research and training in New Zealand, and a potential shortage of geothermal professionals (NZGA, 2005).

In 2006 Professor Mike O'Sullivan, leader of the Geothermal Reservoir Modelling Group in the Department of Engineering Science, and Associate Professor Stuart Simmons, Director of the Geothermal Institute, assembled a group of

geothermalists to teach a one-semester Post Graduate Certificate in Geothermal Energy Technology (PGCert).

The philosophy was to provide through the PGCert the backbone for a comprehensive geothermal training program involving university level papers, short lecture courses for professionals, graduate research degree courses and academic research programs. With the exception of Assoc Prof Stuart Simmons, the people initially involved in organising the course came from the Geothermal Reservoir Modelling Group in the Department of Engineering Science.

At the time when the decision to run the course was made the University was in the process of developing a cross-faculty research group called the Institute of Earth Sciences and Engineering (IESE). Geothermal energy was considered to be an important part of the research portfolio. However because of its research-only status within the University of Auckland the IESE cannot host University degree programmes and hence the PGCert course is hosted by the Department of Engineering Science in the Faculty of Engineering.

Support for the Course

Against the background of a small initial number of enrolments and no special financial support from government bodies, running the course relied heavily on the goodwill of:

- the Department of Engineering Science which provided lecture rooms, teaching support, and computer facilities;
- the retired staff of the old Geothermal Institute (Manfred Hochstein, Pat Browne, and Arnold Watson); and
- the New Zealand geothermal industry, who responded positively and contributed lectures, site visits, and scholarships for the course.

A feature of the inherited good will from the Geothermal Institute days has been a close connection between industry and geothermal teaching. There has been very strong industry support for the PGCert in 2007 and 2008. Contact Energy Ltd has supported the PGCert with six scholarships over the two years, with a total value of NZ$120,000, and Century Resources (now MB Century) has provided two scholarships with a total value of NZ$40,000. Sinclair Knight Merz (SKM) have donated fourteen hours of lectures each year, and GNS Science Wairakei have donated 12 hours of lectures and field tuition. In addition, Contact Energy, MB Century, Tuaropaki Power, and GNS Science, have given access to borefields, power stations, and geothermal areas, with staff accompanying groups of students for informal tours, training in taking field measurements, formal lectures, and student project supervision.

Chevron Geothermal (Indonesia) provided generous funding for three aspects of the training program:

- the development of one-week short-courses on geothermal geoscience and geothermal engineering;
- the development of course material for the PGCert; and
- archiving of course material from the Geothermal Diploma.

The success of the PGCert in 2007 and 2008 and the strong support from the geothermal industry was sufficient to convince the University of Auckland to continue support geothermal training for at least the next three years.

Teaching

Geothermal teaching at the University of Auckland involves four types of courses, all directed towards post graduate and professional training:

- the one-semester Post Graduate Certificate in Geothermal Energy Technology;
- professional short courses taught in New Zealand (one-week or four-weeks). These are planned to be part of staff professional development schemes;
- research studies for ME, MSc or PhD degrees; and
- professional short courses taught in other countries (one-week).

The University of Auckland is currently planning a one-year taught Masters of Energy degree, with a target start date of 2011. It will include geothermal energy as an option but will also allow for other specialisations such as wind, solar and bio-fuels. Courses from the PGCert will be available for this degree.

Post-Graduate Certificate in Geothermal Energy Technology

This one semester course includes lectures and assignments, field visits with data collection and interpretation, and a short research project. The minimum entry qualification is a Bachelors degree, preferably in Science or Engineering, and the University of Auckland also has strict English language requirements for post graduate courses.

Both geothermal geoscience and geothermal engineering topics are covered. All students are required to complete the first two lecture courses (papers) which are an introduction to ‘Geothermal Resources and their use’, and ‘Geothermal Energy Technology’. The class then splits: students must chose between a ‘Geothermal Exploration’ paper, and a ‘Geothermal Engineering’ paper, where specialist geothermal topics are covered in more depth. The final five

weeks of the course is devoted to a short research project resulting in a ~40 page research report. During the course there are two six-day long field trips to the Taupo Volcanic Zone, which involve lectures from geothermal experts and visits to power station, natural geothermal features, geological features, and geothermal energy direct use sites.

Professional Short Courses and PGCert Papers

One of the problems of specialist training courses for professionals is that many workers cannot take 5 months leave to attend a course such as the PGCert. In view of the lack of training courses worldwide in the last decade, causing an acute shortage of trained geothermal people, it is very difficult for those currently working in the geothermal industry to take training leave for longer than a few weeks. Our response to this problem has been to allow people to attend selected parts of the PGCert course as 'professional short courses'. These students do not attain a University qualification, but are still able to participate in modules of the course.

In 2008 the uptake for these courses was high, with an extra eighteen students attending sections of the course. Thus the number of students attending part of the PGCert course increased from one in 2007 to 18 in 2008.

Geothermal short courses are run according to demand in both in New Zealand and overseas. Some of these short courses were commissioned by companies as part of their staff development programs. For instance, in October 2008 staff from the IESE and the Department of Engineering Science spent two weeks in Indonesia delivering two short courses for Chevron Geothermal – one week each on Geothermal Geoscience and Geothermal Engineering attended by a total of 31 students. Similar courses were delivered in April 2009 in Auckland, and more courses abroad are being planned for late 2009.

Trade Qualifications and Certification

Trade/Technical skills are catered for in broad disciplines applicable to the energy industry eg. electricians, fitters etc, but not specific to the geothermal industry. However, the numbers of young people choosing to enter the trades is less than desired.

Industry Training Organisations (ITOs) have the mandate of the industry that they represent to develop training standards for their industry and to register these on the National Qualifications Framework. ITOs are funded by the Tertiary Education Commission to offer training subsidies for their industry. While not directly able to engage in training the ITOs determine which providers will be accredited to award qualifications for the industry and who will be recognised as an accredited assessor.

When necessary ITOs will respond accordingly if the geothermal industry identifies other needs or will adapt qualifications to meet any specific requirements. MB Century Ltd has been in talks with Extractives ITO EXITO to enable their in-house training be accredited by New Zealand Qualifications Authority NZQA. This new certificate will take about 6 months for a trainee to pass through the various steps in order to obtain the required credits.

Conclusion

The New Zealand geothermal industry has been experiencing a shortage of trade, technical, and professional staff. The New Zealand Geothermal Association has designed an action plan based on a model developed by the Department of Labour for the New Zealand oil and gas industry, which involves educating people for working in the industry (MAKE), further training for those already involved (FIX), and recruiting from abroad (BUY).

The 'make' and 'fix' components of the plan primarily involve education. Tertiary level geothermal training courses have been run annually at the University of Auckland since 2007, comprising the Post Graduate Certificate in Geothermal Energy Technology, and professional development courses. From 2010 the Faculty of Engineering will also offer a Masters degree course in Energy, with a specialisation in geothermal energy.

The framework already exists to design non-university trade and technical courses in geothermal energy topics which can be part of a nationally recognised qualification. One company is currently developing a drilling qualification but there is potential for further course development in this area. School and community level education is also required.

Implementation of aspects of the Action Plan is currently under discussion with the NZGA and various Stakeholders.

References

Akin, J., 2008, Workforce Management. Power, vol 152, No. 4, p 74-78.

NZGA Report prepared by SKM 2005, Review of Current and Future Personnel Capability Requirements of the NZ Geothermal Industry

NZGA Report prepared by Jane Brotheridge 2009, NZ Geothermal Industry Skills Report and Action Plan.

McLennan Magasanik Associates Pty Ltd., Aug 2008 Installed capacity and generation from geothermal sources by 2020.

Hochstein M.P. 2005. 25 years Geothermal Institute, Proceedings, World Geothermal Congress 2005, Antalya, Turkey.

Massachusetts Institute of Technology (MIT), 2006. The Future of Geothermal Energy. Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century. An assessment by an MIT-led interdisciplinary panel, prepared under Idaho National Laboratory Subcontract No 63 00019 for the US Department of Energy

MAKE General community education and primary to secondary educational level *(NERI findings in italics)*	**Who**	**Output (note – underlined is output already known to occur or planned for near future)**
There appears to be a shortfall in numbers of graduates in geothermal specializations, planning, policy analysis, mining specializations, corrosion sciences, surveying, physics, geology, ICT, human resources, law, resource management and project management needed to meet energy industry demand (NERI). *A need to ensure that energy education in tertiary institutions includes sufficient focus on issue of strategic national importance (NERI).* *A need for better understanding of the stimuli external to universities that influence students' selection of courses, degree programmes and employment options (NERI).*	This appears to be part of a larger problem that extends over many engineering and science based industries. This requires long-term action from a range of educational and government organisations. The Geothermal industry should remain alert to the chance for input into relevant decisions.	Maintain a network of interested people who are in contact with regards this type of promotion – ie PR people in companies plus interested people at research and teaching organisations plus government departments/agencies.
Market to school and tertiary sectors to promote employment opportunities in the sector	Currently GNS Wairakei and Kaikohe School. Industry	Assess and collate all existing marketing material Work alongside other stakeholders to develop relevant material. <u>Some development underway with GNS Wairakei & Kaikohe school.</u>
Development of a package for use in school science curriculum - approach schools to assess interest. Funding needs to sought.	University or research company/government department/agency.	Package developed.
Target one school then extend to three schools in 2 years time	As above.	Identify a pilot school for package. Roll to more schools in future

MAKE Tertiary education (*NERI findings in italics*)	**Who**	**Output**
Increase numbers participating in university programmes relevant to the sector (note that specialisation would occur in 3rd or 4th year of Bachelor Degree). Recruit graduates for the geothermal industry. *To meet current energy industry demand, an increase is needed in the number of university graduates from engineering, commerce, science and geography entering employment in the*	Industry/NZGA/Universities	List of contact people from each University/faculty, who organise careers presentations. Company participation in career/recruitment days. Career evening presentations hosting the Geothermal Industry as a

energy sector (NERI).		whole. Geothermal research promoted for Postgraduate topics.
Development of specific qualifications, specialist papers and projects	Universities/Industry/NZGA	Courses at the University of Auckland since 2007
Build internal expertise by collaborating/developing relationships eg. universities and utilities/developers. *A desire by energy stakeholders to have more contact with universities (NERI)*	Industry/Universities/NZGA	Develop a relationship that involves: • training using real-world scenarios • encouraging students to engage with the industry • Student projects • Course support • Fund research
Support increased numbers of MSc and PhD projects	Industry/Universities	Currently Masters and PhD research in geothermal topics at several institutions. Industry is already supportive, can always provide more research topics and funding for projects. 'Real world' topics can justify paying a student to research them.
Provide work experience/mentor graduates to build industry experience. *University graduates' relevant work experience does not appear to be sufficient to meet the work experience demanded by employers in the energy industry (NERI)*	Industry	Internship programs. Already some in the industry do this, needs more coordination with students and industry
A need for understanding of iwi perspectives on tertiary level energy education (NERI).	TPK/Universities	Input to Māori Geothermal Seminars, liaise with Māori groups on Campus, for instance UoA SPIES (South Pacific Island Engineering Students), liaise with other University groups researching wider Māori Energy Development.
There appears to be a need for cross-disciplinary university education relating to energy	Universities	Currently development of a Masters in Energy course at the University of Auckland starting 2010. Organised in the Faculty of Engineering but will have the potential for cross-disciplinary study.

MAKE Trade/Technical Qualifications (NERI findings in italics)	**Who**	**Output**
Trade level roles: Disseminate information to contractors and the community including iwi, to improve understanding of the current industry training system and how it compares with the former apprenticeship system. *A need for better information about the supply of non-university graduates for employment in such roles as field technicians and maintenance engineers in the energy industry (NERI)*.	ITO's/NZGA	Liaise with the engineering and electrical sectors for joint marketing of the industry as a career option Develop a communication strategy
Develop introductory pre-qualification packages for use in secondary schools.	ITO's/NZGA	Liaise with school careers advisors, ESITO etc. Establish relationship between these groups and industry to see what the needs are, and where the gaps are
Manage the relationships between schools and industry for work experience through the Gateway programme	Industry	Assess what marketing/promotional work needs to be conducted to increase industry participation in gateway. Work alongside schools to identify potential students.
Increase the number of apprentices/industry trainees	Industry	Liaise with industry to encourage the uptake of more trainees
FIX General culture of ongoing education	**Who**	**Output**
Employers in the industry need to ensure ongoing training	This is an ongoing obligation for all employers and for the self-employed	Regular widespread attendance at seminars and workshops Employees should be continuously adding to their skill base
Provision of suitable courses and topical seminars	NZGA, universities, technical institutes	Regular targeted seminars and workshops e.g. one day overview seminars useful for managers and non-technical people
Assist IESE in developing a business plan for their courses as the basis for a New Zealand/regional geothermal training facility	Industry, NZGA with some Government funding	Active and expanding training programme including input from experienced industry professionals
Ensure employees have a minimum of paid hours of training per year	Industry	Delivery of training

BUY Preparedness for Expatriate Workers	Who	Output
Individual employers should recruit internationally	Industry	Industry members are currently recruiting internationally
Where skill shortages are identified by employers, make submissions on behalf of industry to Immigration NZ's biannual shortage lists	NZGA, Industry	Shortage lists will address broad gaps, especially in trades
Utilising an independent remuneration consultant, promote a collaborative approach to benchmarking of NZ salaries. Include an assessment of the extent to which NZ geothermal compensation and benefits are aligned internally and regionally, and with the O & G sector, which are all competitors for skilled NZ geothermal workers	Industry and Government funding of an independent consultant managed by NZGA	Report on bench marked salaries, with repeat reports showing a move toward competitive values
Use Ministerial trade shows and trade fairs and international conferences to publicise the opportunities in the NZ geothermal industry	Industry/NZGA working with Government	NZ presence at wide range of events with booths highlighting opportunities

Table 1: Geothermal Industry Skills Action Plan