Report on the
World Geothermal Congress 2005

Antalya, Turkey
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REGIONAL COUNCIL

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Introduction

Every five years the International Geothermal Association holds the World Geothermal Congress in a member country. The most recent Congresses have been held in Florence (1995) and Japan (2000). This year it was held in Antalya, Turkey over the week starting 24 April 2005, with the theme "Geothermal energy: the domestic, renewable, green option." The congress's website is: http://www.wgc2005.org

All of the papers presented at the conference can be viewed on the website of the International Geothermal Association:
http://geothermal.stanford.edu/standard/search.htm

The WGC is an opportunity to keep abreast with developments in all aspects of geothermal science, engineering, use, and regulatory and environmental methods. It also enables participants to interact with leading people in geothermal resource use. An additional highlight is the opportunity to attend the Annual General Meeting of the International Geothermal Association, which is held during the conference.

For me in particular, as Geothermal Scientist for Environment Waikato (and the only geothermal scientist working for a local government organisation) there were further opportunities to develop valuable contacts with people who can assist Environment Waikato to continue to develop regulatory policies, methods, and mechanisms, and to obtain feedback from the international geothermal community on Environment Waikato's policies and methods.

Antalya

Antalya is a resort city of nearly a million people, on the Mediterranean coast. The temperatures during the conference, in their late spring, was similar to those you might expect in the same season in New Zealand, with the difference being that it did not rain during the whole time we were there, and it was clear from the amount of dust in the streets that it had not rained for some time. The beach looked picture-perfect, with palm trees and cafes, but with no offshore islands, no tide, no apparent shellfish, fish, or seaweed, and 10 km of sandy expanse with no rocky outcrops along its length, it lacked the many points of interest that you would find at a New Zealand beach. Not that we got to spend much time on the beach apart from the occasional stroll before or after the daily conference activities. Even our evenings were full, with four social events organised for us.

Traditional Turkish dance, at the Turkish cultural night

Security at the conference had the impression of being tight, with about 50 armed police to guard the venue most days, and a metal detector that had to be negotiated at each entrance. However, I never saw anyone actually being stopped and dealt with when the detector went off. We were simply waved through, in the instances where there was a guard on duty at the time. In addition, the police mostly looked like clean-cut 20 year old boys and girls, and not very scary at all. However, there was at least one benefit to someone from the police presence there. It provided an opportunity for one young couple to conduct a clandestine cell-phone relationship while standing 100 metres apart supposedly guarding the venue.

Police guard the conference venue

Security-wise, Antalya was a bit of an enigma. We had heard about travellers to Turkey having very bad experiences, and about some terrorist activities within Turkey, and about recent police brutality towards peaceful demonstrators. However, wandering around the city, and the suburb where my hotel was located, it was easy to feel safer than in a similar situation in New Zealand. There was a distinct lack of unsavoury characters, but perhaps that has something to do with the presence of an armed and well-populated police force.

The Conference

There were 1350 participants at Antalya, making it the largest WGC so far. The numbers included 44 from New Zealand. However, the New Zealand contingent was modest by comparison with such countries as Russia (100) and Indonesia (75). Turkey understandably had the largest number of attendees, almost 200.

Although the language of the conference was English, the keynote sessions were translated into Turkish and several other languages. The live translations could be obtained through wireless headphones. In addition, one of the five concurrent sessions daily was translated into Turkish. I had the privilege of presenting my paper in the room set up for this. Until we got used to it, it was a bit disconcerting having someone talking in a foreign language at the

back of the room whenever one spoke. But I am sure that this is a situation any university lecturer is well-acquainted with in these days of foreign fee-paying students.

There were 330 oral papers and 370 posters presented, from 86 countries. Because there were up to five concurrent sessions, it was impossible to attend more than about a fifth of all talks. Talks were divided into 26 categories including technical topics such as “neotectonics” and “corrosion and scaling”, as well as wider topics such as direct uses, country updates, and political and legal aspects.

I concentrated on attending country updates, direct uses, talks about New Zealand geothermal matters, and, because it was my next port of call after the conference, talks about the Iceland geothermal resource.

My Presentations

I had oral presentation of two papers accepted for the 2005 conference. One paper was on the recently released Environment Waikato geothermal policy documents (http://geothermal.stanford.edu/pdf/WGC/2005/0303.pdf), and the other was a more technical paper, presented by my co-author Professor Ron Keam of the University of Auckland, explaining the method developed for the policy documents of determining significance of geothermal features through analysis of rarity and vulnerability (http://geothermal.stanford.edu/pdf/WGC/2005/0209.pdf).

Both were well-attended, and some interesting and useful questions were asked afterwards. Some people were perplexed as to why we didn’t simply require reinjection rather than merely preferring and encouraging it. The New Zealand requirements for consultation and community participation were clearly perplexing to many people used to a more directive style of government.

World Geothermal Assessment

Valgardur Stefansson of the Iceland National Energy Authority presented an assessment of the world potential for geothermal usage (http://geothermal.stanford.edu/pdf/WGC/2005/0001.pdf). The known resource has realistic potential for electricity generation of 240 GWe. However, using Iceland and the United States of America as examples, theoretical considerations suggest that the magnitude of hidden resources is 5-10 times larger than the estimate of identified resources. If this is the case for other parts of the world, the upper limit for electricity generation from geothermal resources is in the range 1 – 2 TWe. Furthermore, the frequency distribution of the temperature of geothermal resources in Iceland and USA indicates that the magnitude of low-temperature geothermal resources in the world is about 140 EJ/year of heat. For comparison, the world energy consumption is now about 420 EJ/year. The lower limit of the world geothermal potential for electricity generation is estimated to be about 50 GWe and the corresponding value for direct use to be 1 TWth.

World Direct Uses

The international trend for geothermal use is through direct uses and the use of low-temperature geothermal resources. This contrasts strongly with New Zealand, where the largest extractive use of geothermal energy is the use of high-temperature resources for electricity production. Internationally, current growth is mainly in the areas of relatively low temperature electricity generation, co-firing for direct use, and ground source heat pumps in Europe. For most of the world, prices for electricity and other energy sources are much higher than in New Zealand, so investment in geothermal technology becomes economic, particularly when subsidised by policies promoting the use of renewable energy, many of which can be attributed directly to implementation of the Kyoto Protocol.

Derek Freeston of New Zealand, and John Lund and Tonya Boyd of USA gave an update on direct uses internationally (http://geothermal.stanford.edu/pdf/WGC/2005/0007.pdf). The number of countries reporting direct utilization of geothermal energy has risen from 28 reported in 1995 to 71 reported at the end of 2004. Direct use has doubled from the 2000 survey to 27,825 MWt in 2004. According to the report, the distribution of thermal energy used by category is approximately 33% for geothermal heat pumps, 29% for bathing and swimming (including balneology), 20% for space heating (of which 77% is for district heating), 7.5% for greenhouse and open ground heating, 4% for industrial process heat, 4% for aquaculture pond and raceway heating, <1% for agricultural drying, <1% for snow melting and cooling, and <0.5% for other uses.

Use in Turkey

According to the Turkish Geothermal Association (WGC2005 Invitation), thermal utilization started in Turkey with thermal bathing by Romans, Seljukians and Ottomans in historic times and is now a well established Turkish tradition. Today, most of the cities in Turkey have several public baths (hammams) using hot springs for bathing and curative purposes. In recent times, Turkey has achieved rapid geothermal development especially in district heating systems, electricity production and mineral recovery. Approximately 170 geothermal fields have been explored already and 57, 000 residence equivalents enjoy geothermal district heating in 11 cities. Other thermal facilities and greenhouse heating also exist in Turkey. The only active power production field in Turkey is Kizildere, started in 1968. The present plant went on-line in 1984, producing 15 MW electricity.

District Heating

It was impressive that several countries employ district heating schemes rather than houses having individual takes. District heating can confer many benefit over individual schemes in terms of cost, energy use, provision of services, and mitigation of adverse effects. It is unfortunate that New Zealand local authorities have not taken the opportunity to provide district heating in places such as Rotorua, Taupo, and Tokaanu, where the town overlies a geothermal resource and many people use individual bores, often inefficiently. It may be left up to the enterprising property developer in future, seeking to provide a point of difference for their subdivision by providing a relatively environmentally friendly source of home heating.

According to Lund *et al.*, about 77% of the annual energy use and 81% of the installed capacity used internationally for space heating is due to district heating. Iceland, Turkey, China and France are the leaders in district heating, whereas, Australia, Russia, Japan, USA and Japan dominate the individual home-heating systems use.

Ground-sourced Heat Pumps

In New Zealand all of the geothermal energy we use comes in fact from hydrothermal systems. However, to many countries, particularly Europe, there are no significant hydrothermal resources, and to them, geothermal resources are simply the Earth's natural heat gradient, which they harness through ground-based heat pumps.

According to Lund *et al.*, geothermal (ground-source) heat pumps have the largest energy use and installed capacity of direct geothermal heat applications, accounting for 33.2% of the word-wide use. Almost all of the installations occur in North American and Europe, increasing from 26 countries in 2000 to the present 32 countries. The equivalent number of installed 12-kWt units (typical of US and western European homes) is approximately 1.3 million, over double the number of units reported for 2000. The size of individual units; however, range from 5.5-kWt for residential use to large units of over 150-kWt for commercial and institution installation. In the United States, most units are sized for peak cooling load and are oversized for heating (except in the northern states) and, thus, are estimated to average only 1,000 full-load hours per year (capacity factor of 0.11). In Europe, most units are sized for the heating load and are often designed to provide the base load with peaking by fossil fuel. The cooling load was not considered as geothermal energy use, as in this case, heat is rejected to the ground or groundwater. Cooling, however, can be considered for replacing fossil fuels and reducing greenhouse gas emission.

World Electricity Generation

Ruggero Bertani from the Italian Geothermal Association provided an analysis of international geothermal electricity generation (http://geothermal.stanford.edu/pdf/WGC/2005/0008.pdf). Twenty-four countries generate power from geothermal resources. The total installed capacity is 8 900 MW, corresponding to 8 000 MW of running capacity and supplying 57 000 GWh in 2003, an increase of 12% and 15% respectively with respect to year 2000. Nineteen countries have performed significant drilling operations since 2000. Costa Rica, France, Iceland, Indonesia, Italy, Kenya, Mexico, Nicaragua, and Russia all show an important increase of relevant power plant installation activities (above 10% with respect to year 2000). New entries among the geothermal electricity community are Austria, Germany and Papua New Guinea. Plants from Argentina and Greece have been definitely dismantled. Bertani considers that the recent increases of oil prices and the natural decline of its reserves over the coming years have played their part in boosting the installation of geothermal power plant. However, this will continue to be affordable only with subsidies. The acceptance of the Kyoto Protocol could be another key factor in the trend towards more geothermal electricity production. Below I have summarised details from some of the countries either because they are places not known in the past for geothermal electricity generation, such as several European countries.

Australia has one geothermal power station, at Birdsville in SW Queensland, generating 150 kW from a binary plant using 98°C fluid. Australia also has a Hot Dry Rock Project in the Cooper Basin region of NE South Australia, with a 4.4 km deep borehole, at temperatures >250°C. The drilling of a second deep well in 2004 will be followed by a planned circulation test in early 2005. Two wells of 6 km have been drilled and a third one of 4 km is scheduled. The Mandatory Renewable Electricity Target (MRET) was introduced in 2001, requiring that by 2010 approximately 2% of the Australia's annual electricity consumption should be supplied from renewable technologies.

In **Austria**, two small binary plants are installed in the country, at Altheim and Blumau. Altheim has a production/reinjection doublet of 2,500 m depth. The fluid at 105°C is utilized

both for district heating and for electricity production using an ORC (Organic Rankine Cycle) technology plant. The net output is 500 kW, after accounting for the 350 kW parasitic load of the submersible pump. Blumau project reached the highest temperature from geothermal water in Austria: 110°C at 2 000-3 000 m depth. It is used for heating a spa facility and an ORC turbine of 180 kW net output has been in service since 2001.

In **China**, there is geothermal electricity production at Tibet, with several power stations producing a total of 28 MWe.

France has a HDR project underway at Soultz-sous-Forêts, in the Upper Rhine. The enhanced geothermal system, exploited with a three-well system in granite at a depth of 5 000 m, is expected to come into operation during year 2005.

The first geothermal plant for electrical power generation in **Germany** has been on-line since 2003. It is located at Neustadt-Glewe, with an installed capacity about 230 kWe using an Organic Rankin Cycle. In addition, 10.7 MWt are used for district and space heating. The plant uses a flow of 100 m³/h at temperature of 98°C, cooled down to 72°C. Currently six new installations for power generation are being planned in other locations.

In **Papua-New Guinea**, geothermal power development is focused on the tiny Lihir Island, located about 700 kilometres northeast of the national capital, Port Moresby. The power is used by a gold mine, displacing diesel generation, with a fuel cost savings of US$2,000,000 per year. Geothermal wells have been drilled, as well as large diameter dewatering wells used for mining purposes, and utilizes 250°C water from 1000 m depth. A 6 MW backpressure plant has been commissioned in 2003. An additional 30 MW geothermal power project is scheduled for 2005.

In **Portugal**, geothermal electricity generation has been developed successfully on the largest and most populous Azores island, São Miguel. The high enthalpy resource is used in the Ribeira Grande plant, with four binary units completed in 1998. In a second island, Terceira, a 12 MW is expected to be producing by 2008.

In **Thailand**, a small 300 kW binary plant provides electric power to the small village of Fang, using 116°C water. Hot water is used also for direct applications. The power plant replaces a diesel unit, with a saving of about US¢ 15 per kWh.

Key Linkages

During my time in Turkey I met many people, and some of these contacts could be useful to me or Environment Waikato in future. These include:

- Dr. Ingvar Fridleiffsson of the United Nations University Geothermal Programme, Iceland
- Helga Tulinius of the Iceland National Energy Authority, who was to be my host in Iceland following the conference
- Alimin Ginting, president of the Indonesian Geothermal Association
- Gabor Szita, president of the Hungarian Geothermal Association
- Dr. Feliksas Zinevicius, chairman of the Lithuanian Geothermal Association
- Dr. Vaentina Svalova, vice-president of the Russian Association of Geothermal Energy Society
- Dr. Beata Kepinska, from the Polish Geothermal Association, the International Geothermal Association, and the Polish Academy of Sciences
- Professor Roland Horne, of Stanford University
- Jochem and Dick van Amsterdam, of 4D Excavation Technology, a geothermal drilling supplies company

- Dr. Johannes Gottlieb of Montanes, a company that supplies geothermal power stations. He had some interesting comments on the relative efficiencies of different energy-transfer systems.
- Phil Hutchings, General Manager of Geodynamics, an Australian and New Zealand public company that is running the Hot Dry Rock project in Australia. His company promotes power stations using a modified Kalina cycle, reputed to be very efficient compared to other power station types. The company was instrumental in developing the Australian geothermal exploration legislation, which is similar to mineral exploration legislation in providing prospectors certainty over exploration areas. The company is interested in expanding into New Zealand, and therefore has an interest in changing the New Zealand prospecting legislation.
- Dr Alper Baba, of the Canakkale Onsekiz Mart University, Turkey. He is interested in forming a relationship between the local governments of the Gallipoli Peninsula and New Zealand links with a view to aiding development of the Gallipoli geothermal resource.

In addition, I was able to catch up with almost all of the New Zealand geothermal community attending the conference. This was an added bonus for me as in the last four and a half years I have not had time to attend the annual New Zealand Geothermal Workshop or Geothermal Association Seminar, apart from a day or two here and there.

I was also able to liaise with Karsten Pruess of the Lawrence Berkeley National Laboratory, U.S.A, and Valgardur Stefansson, Executive Director of the International Geothermal Association, Iceland, both of whom are witnesses for Environment Waikato in the forthcoming geothermal policy appeals in the Environment Court, starting in September 2005.

Conclusion

The Waikato Region contains 80% of the nation's geothermal resources, and accordingly, takes a leading position in geothermal resource management. For Environment Waikato to maintain an up-to-date knowledge of geothermal issues it was particularly useful for me to attend WGC2005 in order to catch up on technical developments, in a range of disciplines, including exploration techniques, drilling, energy transfer engineering and electricity generation, reservoir modelling and management, surface feature dynamics, and planning and policy matters.

Because of the national importance of geothermal resources as a source of electricity, a tourism resource, a haven of biodiversity, and a taonga for the Maori people, it was appropriate for my attendance at the conference to be sponsored by a national body, EECA. This shifts much of the financial burden of my attendance from the Waikato ratepayers to the taxpayer, leaving the ratepayer to shoulder the hidden costs such as time spent planning the trip, writing the papers, and attending the conference. Environment Waikato certainly appreciates the generosity of EECA in providing sponsorship for attendance.

It was instructive to see that to many countries, geothermal means not electricity production, but bathing, in a way that is deeply entrenched in the country's history and culture. And particularly in the European countries with cold winters and high energy costs, geothermal is of such importance for space heating that they are inventive in developing techniques for harnessing heat that we would not bother with. Indeed, we throw away what other people would value highly.