Developing Geothermal Energy: Lessons & International Collaboration

Dr Mike Allen
Executive Director
Geothermal New Zealand Inc

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University of Auckland
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SUMMARY

1. Geothermal now meets some 20% of New Zealand’s electricity demand; almost 85% of our generation is from renewable resources.

2. We continue to consider new geothermal resources; innovative solutions to enhance productivity and financial returns. **On a commercial and bilateral basis we have been active globally for some 50 years.**

3. What follows touches on:
   - Our geothermal strategy
   - Lessons we have learned
   - International collaboration
   - Key issues in capability development
NEW ZEALAND ELECTRICITY SYSTEM

New Zealand’s electricity system

- Installed generation 9,800 MW
- Peak demand 6,750 MW
- Total energy supply 43,000 GWh/yr
- Connected by 700 MW HVDC link
- Power mainly transferred northwards from southern hydro systems
- Large thermal plant in north island aids peak demand and dry years
THE START OF THE JOURNEY

• Like many countries in the late 1940s New Zealand saw a steady growth in electricity demand

• Satisfied by hydro in pre war days, new and secure alternative sources were needed as concerns grew over the supply of fossil fuels
STRONG SCIENCE, A WILLINGNESS TO EXPERIMENT & EXPLORE - EARLY SUCCESS

Power from beneath the earth harnessed for electricity production
WAIRAKEI – A WORLD FIRST AND THE CORNERSTONE OF THE NZ GEOTHERMAL INDUSTRY

A reliable source of some 1200 GWh for 60 years and still delivering......
• Early commercial (private sector) opportunities identified for the use of geothermal for both process heat and electricity within the pulp and paper industry

• Progressively increasing level of captive power generation for paper and forestry processing;
A LONG TERM GEOTHERMAL STRATEGY

Over sixty years of development

Te Ahi o Maui 25 MW

1005 MW & 7,500 GWhr
PLANT ADDITIONS SINCE 2010 > $2B INVESTED

Nga Awa Puru 140MW

Ngatamariki 82MW

Te Mihi 166MW
"We will act as a beacon of hope and prosperity for our people“
Tuaropaki Trust, owners and developers of the Mokai resource
TE AHI O MAUI – 25 MW ADDITION 2019

A partnership between Eastland Generation Ltd and Kawerau A8D Ahu Whenua Trust.
KEY FEATURES OF SUCCESS

- Government funded early exploration including exploratory drilling
- Wairakei and a number of subsequent plants built by state electricity corporation
- More recent projects have been “brownfield” using existing information collected by government activities
- Geothermal is treated like water – rates of withdrawal and reinjection defined
- Development rights are controlled through land ownership
- Resource consent processes well established
- Geothermal commercially attractive within available energy mix

Utilities have invested some $2 billion over last 10 years in new plant so that geothermal now supplies almost 20% of New Zealand’s electricity:
FUTURE DRIVERS FOR GEOTHERMAL IN NZ

- Natural electricity demand increase with population growth
- Focus on electricity as transport fuel
- Potential for hydrogen using renewable energy sources – domestic and export
- Non electric uses – considerable potential, possible international cooperation
INTERNATIONAL ACTIVITIES
IN INDONESIA FOR OVER 40 YEARS

- Kamojang first plant 30 MW
- New Zealand funded; led by GENZL; team effort
- 30 years of operation
- 200MW and expanding

- Kiwi’s involved in first 1,000 MW
- Indonesia looking to 4,000 MW+
- 30,000 MW potential?
- Continue as key service providers
INDONESIA – BILATERAL AID CONTINUES

- Providing training support from surface exploration through to construction and commissioning – early parallel programme in Philippines also continues
- Involved since 1970’s with bilateral support to Kamojang - commissioned in 1982
- Providing advice at Ministry level on improving quality of field data collection, storage and dissemination
- Assisting in development of concession tendering and evaluation
- Training at all levels within technical institutes, universities, state companies and IPPs
- Running drilling engineering workshops in country; project management courses in NZ.
PHILIPPINES A KEY EARLY FOCUS

- 1976 – bilateral government agreement
- Early exploration at Leyte and Palimpinon
- New Zealand supplied rig
- Undertook early drilling
- Extensive involvement through KRTA
- 2nd largest geothermal production globally 1800 MW
- Plants privatised
- Modest future new potential
- Continuing activities, new and upgrades
KENYA THEN AND NOW..

• GENZL took up UNDP 45 MW Olkaria project in 1978
• Involved in field extensions - 200 MW
• Now adding some 1,000 MW
• Possible 5,000 MW
• New fields
• NZ consultancies and contractors playing key roles
• *Growing roles as contractors in EPC activities*
ETHIOPIA

• Development of Aluto – Langano under UNDP
• 7 MW first and only geothermal plant – 30 MW expansion now

• Considerable potential
• Hydro dominates but low annual rainfall limits production
• *Significant new projects underway*
• Full surface exploration on Comoros with GRMF support.
• Working with Govt of Comoros to secure exploration drilling funding
• Establishing New Zealand-Africa Geothermal Facility in partnership with the African Union Commission. This is a 5 year programme with a total $10m commitment.
• Already provided New Zealand Drilling Code of Practice as basis for drilling operations in East Africa.
CARIBBEAN BILATERAL ACTIVITIES

- Full surface exploration on Grenada and St Lucia
- Working with Dominica to develop first small generation facility. COO in Geothermal Co.
- Assisting CDB with GEOSmart financing facility
- Providing peer review and technical input to St Kitts/Nevis, and St Vincent
- Offers considerable potential for island nations totally dependent on diesel generation
COMMERCIAL ACTIVITIES IN OTHER MARKETS ......

Kamchatka, Greece
Poland, Iran, Colombia
**Armenia**, Turkey, Djibouti
Iceland, Japan
El Salvador, Fiji, Chile
Vanuatu, Papua New Guinea
**Nicaragua**, Mexico
Azores, **Comoros**, Rwanda

..................................................
THE GEOTHERMAL INSTITUTE IN AUCKLAND

• One of our proudest achievements – ongoing scholarships
• Trained over 1,500 scientists and engineers
• A real opportunity to share international experiences
LOOKING MORE AGGRESSIVELY OVERSEAS
NEW CHALLENGES, DIFFERENT MODELS

- Mighty River Power (Mercury) undertook greenfield development in Tolquaca, Chile

Mighty River Power (Mercury) invested in USA plant – 49.9 MW John Featherston – Imperial Valley, California
Recognise critical areas of capabilities;

- No substitute for the highest quality surface exploration and resource estimates
- Public offers of concessions must be based on best quality, reliable data
- Public sector playing renewed role in confirming resources – accepting early stage risk
- Reservoir modelling and engineering critical from exploration, through development and on into long term operations and field management
- Drilling is expensive – design and implementation must be appropriate and competently managed
- Power plant design and engineering relatively well established – EPC driven by funders
- Effective operations and management of reservoirs critical to ensure returns and longevity of resources
- National educational support at technical college, undergraduate and graduate levels to meet growing demand for qualified staff.
## WE HAVE THE TECHNICAL SKILLS

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<th>Educate &amp; Train</th>
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GLOBAL GEOTHERMAL CHALLENGES
GLOBAL GEOTHERMAL CAPACITY

TOP 10 GEOTHERMAL COUNTRIES
INSTALLED CAPACITY - MW IN TOTAL

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<td>Kenya</td>
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</tr>
<tr>
<td>Other</td>
<td>889</td>
</tr>
</tbody>
</table>

- **NZ**: -10% of our installed capacity – almost 20% of annual generation.
- **Iceland**: -26% of electricity but nearly 80% of primary energy.
- **Kenya geothermal** is 28% of installed capacity but delivers 49% of annual generation.

MOVING INTO GREENFIELDS

The Valley of Death!
RISKS

• Risks are not just those that are “geothermal”
  – Resource risk
  – Reinjection performance

*but equally important*

• Those we can influence:
  – Construction Risks – an EPC approach
  – Financial risks – appropriate financial structuring
  – Market risks – security of off take agreement
  – Management risk – choose the very best

• Those we may have less control over
  – Country and political risk – some insurance possible
WHAT’S NEEDED FOR NEW PROJECTS

• Equity for the early phases
  – Need a strong corporate balance sheet or
  – Need investors who will take appropriate risks
  – Need project returns that meet these investors needs
  – Risks are economic, financial and political
  – *This balance is never easy*

• Debt for those stages once risk is reduced
  – Resource capacity and performance defined
  – PPA in place
  – EPC committed
  – * Likely that a syndication of banks may still be required*
MARKET RESPONSE

• There is a key challenge in all markets to finance the exploration / exploratory drilling phase
• Donor / grant funding has played a key role in opening opportunities in the past
• Emerging market support is attempting to address this financing
• Debt is available but banks still see geothermal as high risk influencing the cost / tenor of debt and a need for syndication
• Private sector interests exist but few specialised facilities have been established; corporates with strong balance sheet entering market
• To attract investment the risk reward profile must be appropriate; we compete with all other investment opportunities in the energy markets, many of which are much better understood and seen as less risky.
GEOTHERMAL NEW ZEALAND INC.

- A collaboration amongst leading consultants, service providers, contractors and construction companies
- Seeking international opportunities over and above our traditional consulting support and training activities
- Indonesia, Kenya, Ethiopia, Philippines are key target markets.
- Potential opportunities in Japan post Fukushima
- Strong partnerships with international companies – manufacturers and EPC contractors
- **We still lack investment partners**
THANK YOU
MIKE.ALLEN@XTRA.CO.NZ