Developing Geothermal Energy:
Lessons & International Collaboration

Dr Mike Allen
Executive Director
Geothermal New Zealand Inc
Summer School in Energy Economics - University of Auckland
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Geothermal now meets some 20% of New Zealand’s electricity demand; almost 85% of our generation is from renewable resources.

New 32MW plant completed in Ngawha; Contact developing Tauhara – 150MW – now 168MW expected

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 60 years.

What follows touches on:
- Our geothermal strategy
- Lessons we have learned
- Beyond electricity
- International collaboration
- Key issues in capability development
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.
Geothermal Resources
The essential elements for any useful geothermal resource:

- A high **conductive** heat flow close to the earth’s surface
- The presence of water / steam that can assist the **convective** transfer of heat through the reservoir
- Permeable geological formations, porous to store water as it is heated, fractured to provide a pathway for water to flow
- An impermeable cap rock to contain pressure in the reservoir
3 G Surveys; Geology, Geochemistry & Geophysics

- Indirect methods to assess reservoir structure and scale
Conceptual Model – After initial drilling
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 New Zealand geothermal industry

A reliable source of some 1200 GWh for 60 years and still delivering......
Kawerau – largest industrial use of geothermal

• 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 operations and development

Te Ahi o Maui 25 MW / Ngawha 32 MW

1037 MW & 7,500 GWhr
Plant Additions
Since 2010 > $2 billion invested in New Zealand market

- Nga Awa Puru 140MW
- Te Mihi 166MW
- Ngatamariki 82MW
Te Ahi o Maui – 25 MW addition 2019

A partnership between Eastland Generation Ltd and Kawerau A8D Ahu Whenua Trust.
The 152 MWe installation by Contact Energy, inaugurated in June 2020, is expected to be commissioned in 2023; now projected 168MW output, adding some 3% to NZ’s annual generation.
Integrated use of geothermal resources

Miraka Dairy Factory

Glasshouses 5.5 Ha

100 MW Binary Plant

Green Hydrogen

"We will act as a beacon of hope and prosperity for our people“ Tuaropaki Trust, owners and developers of the Mokai resource
GEOTHERMAL HYDROGEN

Photo credit: www.posco.com

Net zero emission of CO₂ (Ultimate goal)

https://www.halcyonpower.nz/
Commercial Silica & Lithium Extraction

• First commercial plant commissioned in New Zealand in April 2018 with extraction of silica from geothermal fluids at the Ohaaki geothermal power plant of Contact Energy and Ngati Tahu Tribal Lands Trust this month.

• Removing silica that builds up in pipes at the plant, helping to reduce equipment maintenance cost, while also making it possible to extract more heat from geothermal fluids for more efficiency in the operation of the geothermal power plant.

• The production potential for high grade silica is estimated at up to 10,500 tonnes a year, with mostly foreign buyers.

• Ability to extract Lithium
Extremophiles

• Convert stranded gas emissions from oil/geothermal industrial waste gas streams into niche protein and carbohydrate bio-feedstocks using NZ naturally sourced non-GM microorganisms

• One Thousand Springs Project
  www.1000springs.org.nz
Geothermal operational optimisation with machine learning
Seeking Zero Carbon Emissions
Seeking zero carbon emissions
Key features of geothermal 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 New Zealand

- 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
Global geothermal capacity

Kenya geothermal is 28% of installed capacity but delivers 49% of annual generation.

Iceland -26% of electricity but nearly 80% of primary energy.

NZ -10% of our installed capacity – almost 20% of annual generation.
Global Geothermal Costs – IRENA 2020
International Activities
• Kiwi’s involved in first 1,000 MW
• Indonesia looking to 4,000 MW+
• 30,000 MW potential?
• Continue as key service providers

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

In Indonesia for over 50 years
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.
Muara Laboh Drill Site & Power Plant – challenging!
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 MTL, Jacobs, AECOM playing key roles
- *Growing roles as contractors in EPC activities*
• Considerable potential
• Hydro dominates but low annual rainfall limits production
• *Significant new projects underway*

**Ethiopia**

• Development of Aluto – Langano under UNDP
• 7 MW first and only geothermal plant – 30 MW expansion now
• Current support to Corbetti and Tole Moye developments
East Africa regional bilateral activities

• 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 drilling supervision in 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 at Auckland University

• One of our proudest achievements – ongoing scholarships
• Trained over 1,500 scientists and engineers
• A real opportunity to share international experiences
Looking overseas in the future
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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- Phase of Work: International Operations, R&D, Educate & Train, Earth Sciences, Project Mgmt, Drilling Mgmt, Rig Services, Well Services, Reservoir Eng/Software, Design, Fabricator, Precision Engineer, EPC, O&M, Special Equip, IPP

- Each company is marked with an '✓' if they are involved in the phase of work.
Moving into greenfields
• 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
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.
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