Developing Geothermal Energy: Lessons & International Collaboration

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Summer School in Energy Economics
University of Auckland
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GEOTHERMAL
New Zealand

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

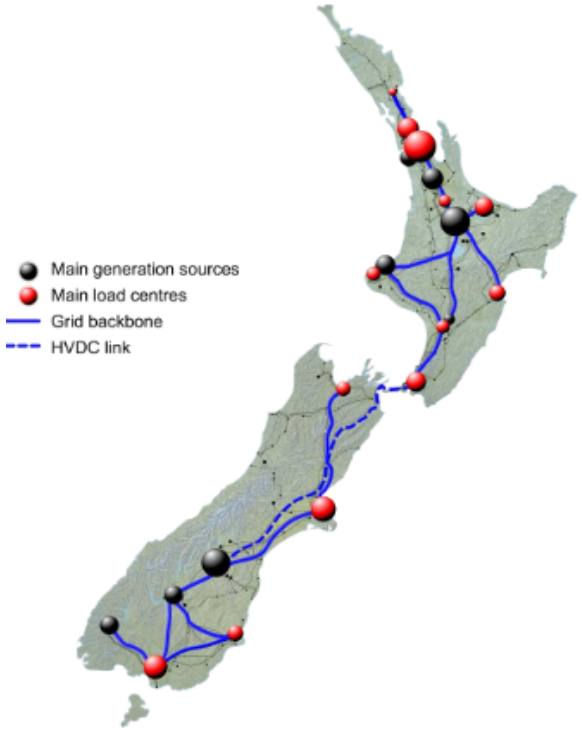
What follows touches on:

- Our geothermal strategy
- Lessons we have learned
- International collaboration
- Key issues in capability development

NEW ZEALAND

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

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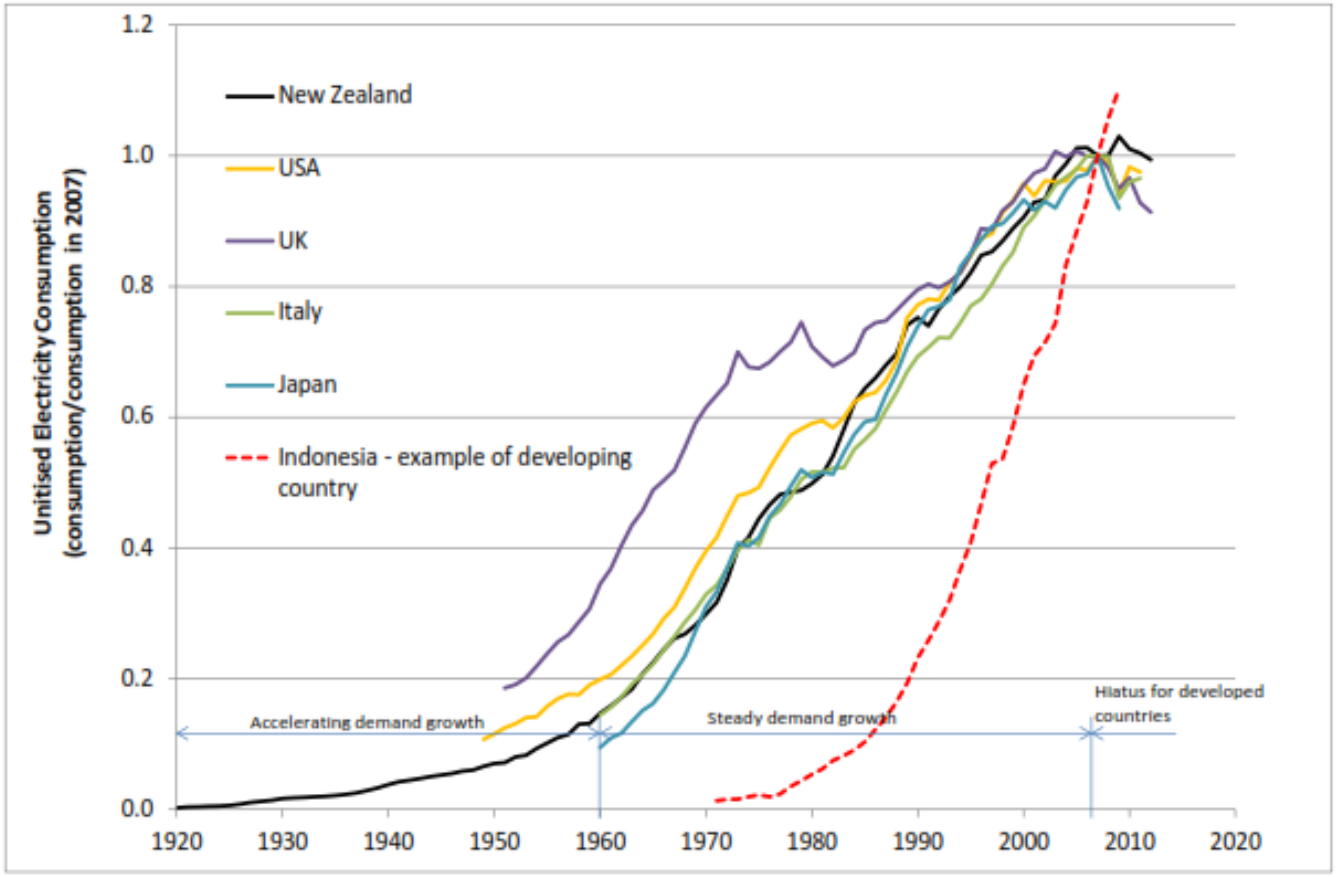
THE START OF THE JOURNEY

- 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



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STRONG SCIENCE, A WILLINGNESS TO EXPERIMENT & EXPLORE - EARLY SUCCESS

Power from beneath the earth harnessed for electricity production

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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……

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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;

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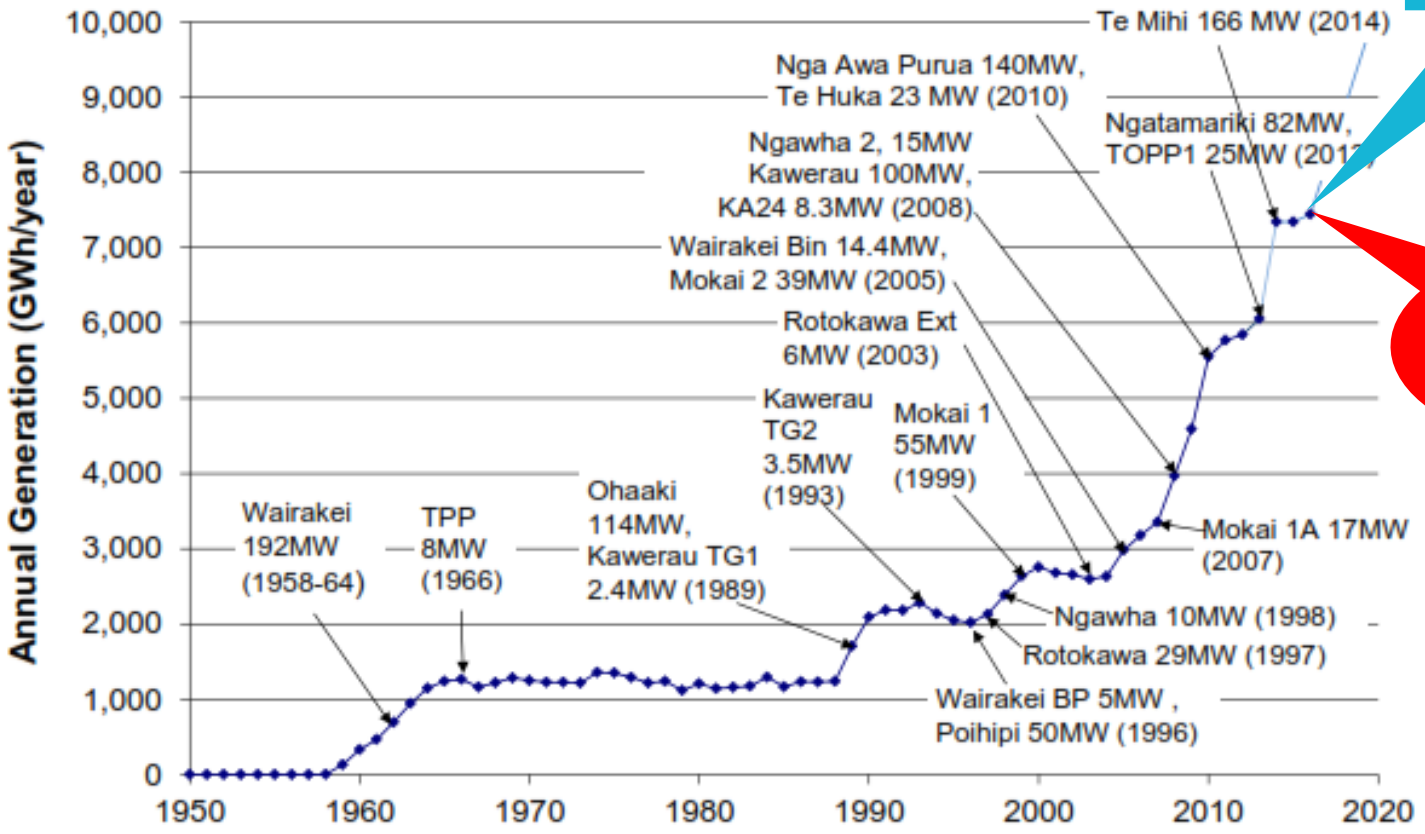
A LONG TERM GEOTHERMAL STRATEGY

Over sixty years of development



Te Ahi o Maui 25 MW

1005 MW & 7,500 GWhr

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PLANT ADDITIONS SINCE 2010 > $2B INVESTED

Nga Awa Puru 140MW

Ngatamariki 82MW

Te Mihi 166MW

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INTEGRATED USE OF GEOTHERMAL RESOURCES

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

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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:

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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

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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

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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.

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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***

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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***

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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***

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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.

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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

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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

……

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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

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LOOKING MORE AGGRESSIVELY OVERSEAS

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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

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BUILDING CAPACITY INTERNATIONALLY

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.

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WE HAVE THE TECHNICAL SKILLS

						Drilling				Design			Construction					
Phase of Work	**International Operations**	**R&D**	**Educate & Train**	**Earth Sciences**	**Project Mgmt**	**Drilling Mgmt**	**Rig Services**	**Well Services**	**Reservoir Engr / Software**	**F/S**	**S/F Design**	**Plant Design**	**Fabricator**	**Precision Engineer**	**EPC**	**O&M**	**Special Equip**	**IPP**
Company																		
Advanced Boilers																		
ARANZ GEO	√																	
AECOM New Zealand Limited	√																	
Allied Industrial Engineering Ltd (AIE)																		
AMTEC Engineering																		
Beca	√																	
Callaghan Innovation																		
Cheal Consultants Limited	√																	
Contact Energy	√																	
Eastland Generation																		
Environmental Mgmt Services (EMS)	√																	
Fitzroy Engineering Limited	√																	
Gallagher	√																	
Geothermal Consultants NZ (GCNZ)	√																	
Geothermal Energy Solutions(GES)	√																	
Geothermal Institute, Uni of Auckland	√																	
GNS Science	√																	
Heavy Engineering Research (HERA)																		
Inst of Earth Sciences & Engr (IESE)	√																	
Jacobs	√																	
Kawerau Engineering Limited																		
Mace Engineering Limited	√																	
Maskell Productions	√																	
MB Century	√																	
Mechanical Technology Limited (MTL)	√																	
Mercury Energy (Mighty River Power)	√																	
Ngati Tuwharetoa Geo Assets (NTGA)																		
Page Macrae Engineering	√																	
Plant & Platform Consultants																		
Progen Limited	√																	
RCR Energy	√																	
Switchfloat	√																	
Tauhara North No2 Trust																		
Thorndon Cook	√																	
University of Canterbury																		
Waikato Institute of Tech (WINTEC)	√																	
Western Energy Services	√																	

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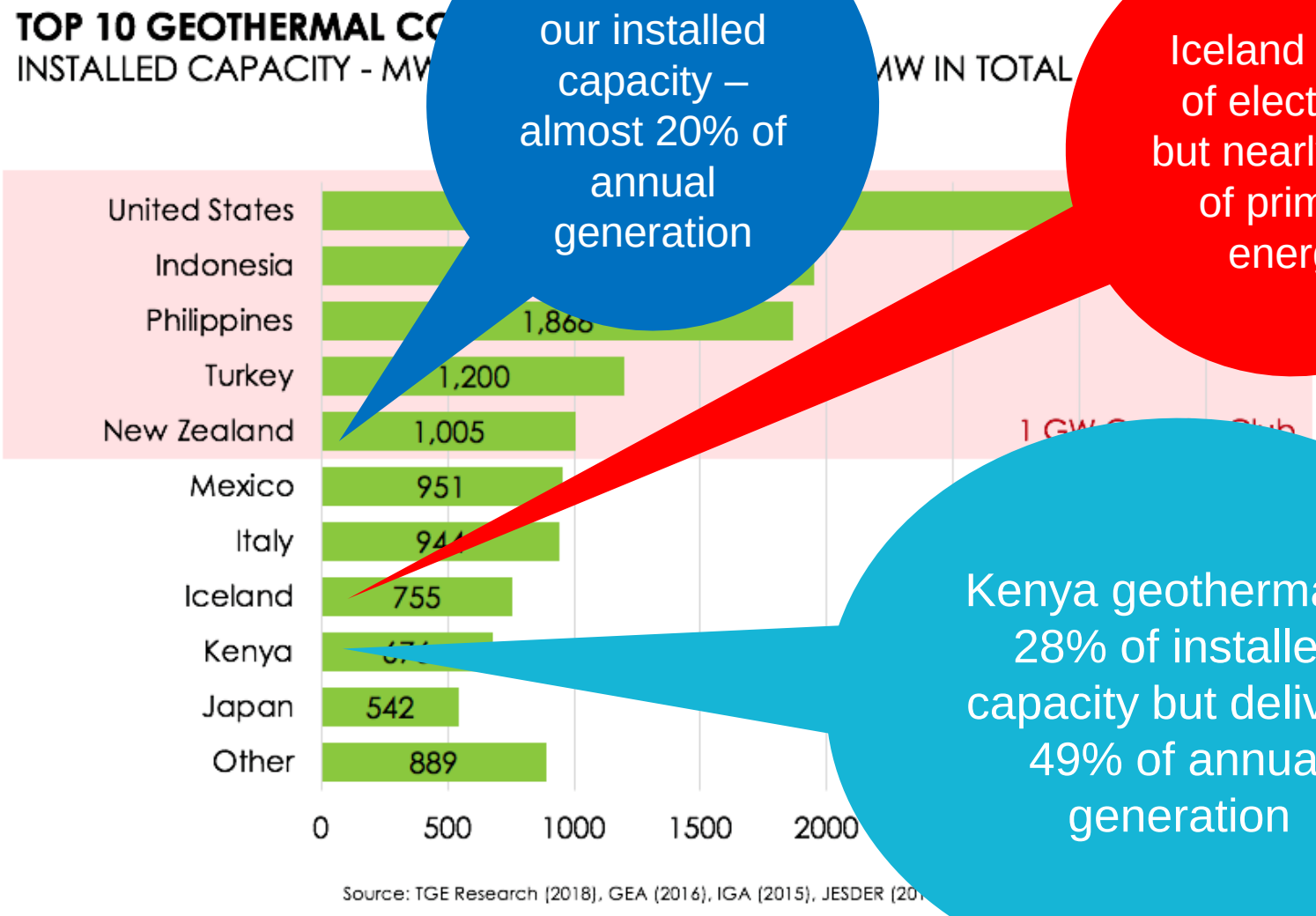
GLOBAL GEOTHERMAL CHALLENGES

GLOBAL GEOTHERMAL CAPACITY



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

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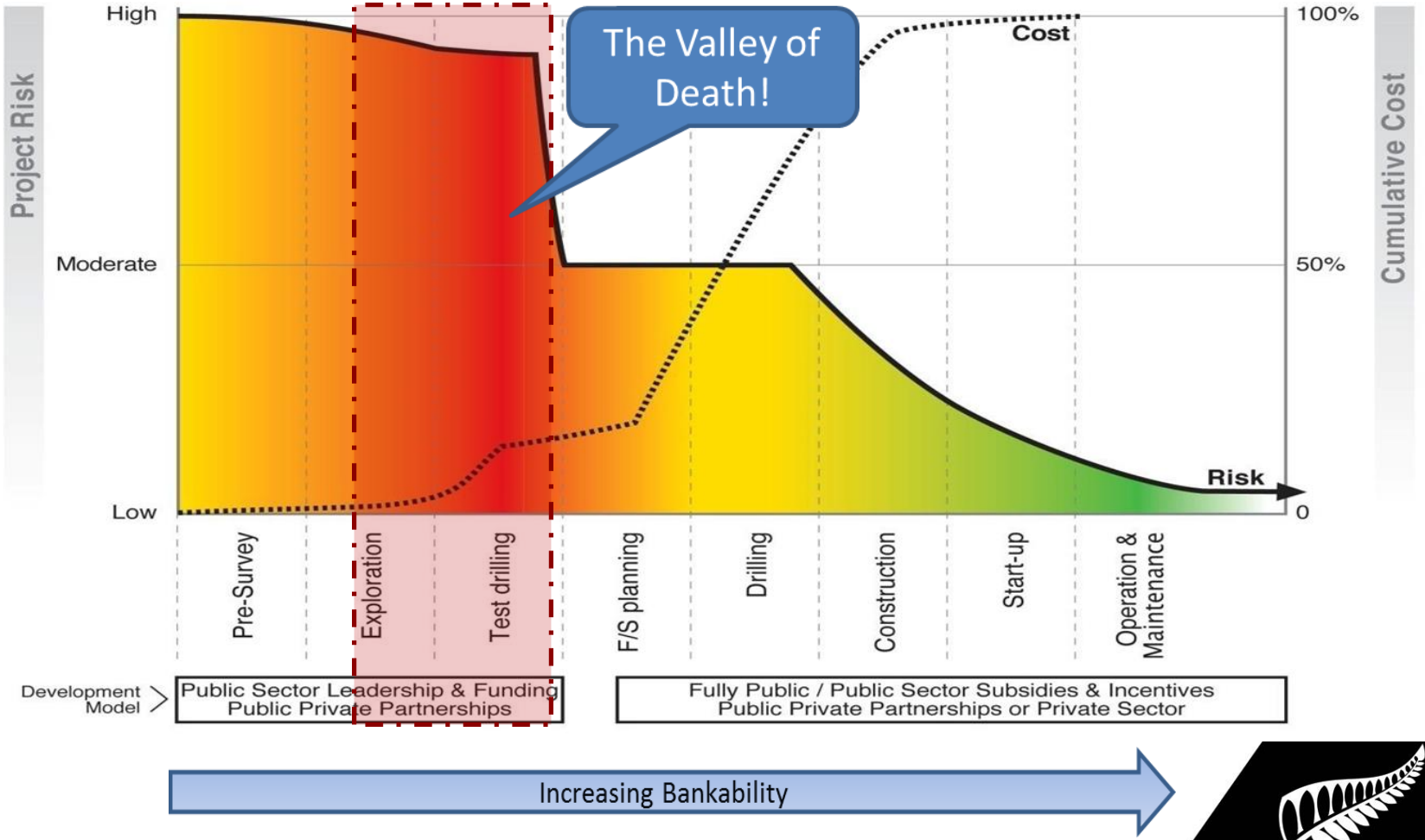
MOVING INTO GREENFIELDS



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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

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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*

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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.

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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**

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THANK YOU

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