Geothermal Development in New Zealand

Thomas King

WORKS Geothermal Limited, Wairakei, New Zealand

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ABSTRACT

Depending on climatic conditions, New Zealand faces a shortage of electricity due to recent increased demand as tlie economy expands. Geothermal energy currently supplies 7% of electricity from 285MW of plant. Geothermal could supply between 2000 and 5000MW of generating capacity. Current low electricity prices. the relatively small size of projects which are approved and competing interests for geothermal resources are likely to limit the contrihution which geothermal will make to overcoming any electricity shortfalls.

INTRODUCTION

An overview is given of the role geothermal could play in New Zealand's impending electricity shortage and the constraints which may limit geothermal's role in meeting this shortfall.

CURRENT GENERATION CAPACITY

Electricity Corporation of New Zealand (ECNZ) owns 7711 MW (96%) oi'the generation capacity available for public supply in New Zealand with the remaining 333 MW owned hy supply companies. A further 167 MW of capacity is operated by private companies (ECNZ 1994). Hydro generation provides 66% of the capacity hut 75% oftlie output. Geothermal provides 3 4% ofthe capacity hut 7% of the output.

New Zealand currently consumes approximately 32.000 gWh of electricity. For a 1 in 60 dry year operating standard, the physical limit of New Zealand's installed capacity is approximately 38,000 gWh (ECNZ 1994).

FORECAST ELECTRICITY REQUIREMENT

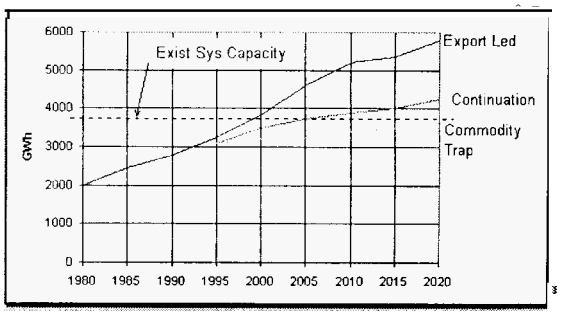
New Zealand has undergone economic restructuring sincc the Labour Government was elected to govern in 1984. Over the last 10 years New Zealand has experienced only modest economic growth until quite recently when growth rates in excess of 5% p.a have heen achieved.

With the increased economic growth. demand for electricity is beginning to increasc.

A numher of predictions on the growth in electricity have been made In particular, ECNZ have suggested three Scenarios (ECNZ 1994).

Export Led	GDP Growth 2.9%
Continuation	GDP Growth 1.8%
Commodity Trap	GDP Growth 0.6%

These predictions generally cover tlie range suggested by others.



In summary, given the predictions it is generally accepted in the industry that New Zealand now faces the prospects of power shortages from as early as 1996

The question is, can the geothermal industry in New Zealand contribute to overcoming this predicted shortfall

NEW ZEALAND'S GEOTHERMAL POTENTIAL

Estimates of New Zealand's current geothermal potential, based on current conventional generating systems vary from around 2000 MW(e) to 5000 MW(e).

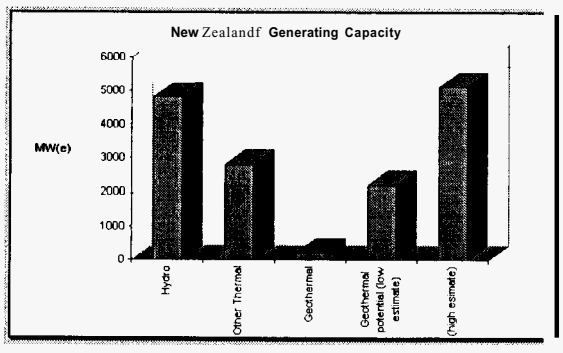
There are over 20 currently identified fields, 12 having been explored by deep drilling, with a proven potential of 1000 MW(e). Some 200MW(e) is availahle from existing wells. The fields arc limited to particular geographic areas - primarily the Taupo Volcanic Zone, that is, Ruapehu, through Taupo, to Rotorua and Kawerau in tlie Bay of Plenty. One tield has been identified outside tlie Taupo Volcanic Zone, Ngawha east of Kaikohe in Northland.

Geothermal System	Region	Reservoir temp [°C]		Area [sp km]		Inferred available Heat [PJ]		Electricity Generation Capacity Est. [Mwe]	
		Min	Max	Min	Max	Min	Max	Min	Max
Atiamuri	‡ Waikato		165		6		100		10
Broadlands/Ohaaki	* Waikato	265	307	5	11	600	1900	60	210
Horohoro	‡§ Waikato	150	220	5	5	150	400	10	40
Mangakino	‡ Waikato	220		5		400			40
Matahana Basin	§ Waikato		150		16	300	800	20	70
Mokai	* Waikato	280	326	12	16	1700	3200	180	340
Ngatamariki	* Waikato	270	280	6	12	700	1700	80	180
Orakei Korako	* Waikato	230	280	10	12	700	1700	70	180
Reporoa	* Waikato		240		12	1000	1000	110	110
Rotokawa	* Waikato	300	330	15	18	2500	3700	280	400
Taupo-Tauhara	* Waikato	265	289	18	22	2200	3100	230	330
Taupo-Wairakei	* Waikato	250	271		25	2100	2800	260	340
Te Kopia	* Waikato	240		6		500		50	50
Tokaanu/Waihi	* Waikato	250		8		800		80	80
Tongariro	* Waikato		280	15	20	1700	2800	180	300
Waikite/Puakohurea	‡§ Waikato	200	230	5	5	200	500	20	50
Waiotapu	* Waikato	220	295	16	18	900	2900	90	310
Kawerau	* Ray of Plenty	250	310	6	12	600	2200	60	230
Lake Rotoiti	¤ Bay of Plenty		130		2		<100		<10
Puhipuhi	‡ Bay of Plenty		180		38		1300		110
Rotoma	¥ Bay of Plenty	200			12	500	2200	40	180
Rotorua	* Bay of Plenty		250	10	15	1000	1500	100	160
Taheke	‡§ Bay of Plenty	200	230	30	5	100	500	10	50
Tikitere	‡§ Bay of Plenty	200	230	12	10	300	900	30	90
Waimangu/Rotomahana	* Bay of Plenty		260	22	30	2500	3400	260	360
Ngawha	* Northland	225	320	25	50	1600	9800	70	1040
			Wairakei					155	155
			Ohaaki					105	105
Σ Waikato			Waikato Region available					1490	2780
			Kawerau					25	25
			Bay of Plenty Region available					475	1155
Σ Other Regions			Other Regions available					70	1040
						TOTAL		2310	5260

* Source: "Geothermal Resources of NZ", (High temperature fields), Ministry of Commerce 1993.
‡ Source: "Geothermal Resources of NZ", (Intermediate temperature fields), Ministry of Commerce 1993.
¥ Source: Allis RG, Speden IG, 1991. (Average values).
§ Low value from Ministry of Commerce, high value from Allis RG, Speden IG, 1991.

Table: New Zealand Geothermal Resource Potential

The potential geothermal resources can be related to existing generating potential. including geothermal production, as follows:



As can be seen, geothermal can make a significant contrihution to New Zealand's future electricity capacity needs.

It is relevant to note New Zealand's gas reserves are unlikely to he available for electricity generation beyond 2008 unless significant new finds are made in the interim period. ECNZ (400MW) and Mercury Energy Auckland (110MW) have proposed gas fired stations.

ELECTRICITY PRICING

Source	cost US cents/kWh
Wind (2nd Generation)	6.8
Solar Thermal	6.3
Hydro	6.0
Geothermal	5.7
Coal	5.0
Gas	4.5
Wind (3rd Generation)	4.2

However, the significant difference between the current wholesale price and costs of new generation is a major political issue for the New Zealand industry and political system to solve.

Geothermal turbine units can be installed for less than US$1200/kW. Steamfield costs can vary considerably depending on enthalpy, well locations, terrain, environmental constraints, and reinjection costs.

Generally speaking, larger units are more economical because costs of monitoring and connection of the station to the national grid are relatively fixed. Also, larger plants are generally more efficient.

It is considered preferable to develop geothermal resources in stages, say 10 to 50 MW(e). This allows information on the resource to be gained, while avoiding the risk of over exploiting a reservoir. This concept is encouraged by the Regional Councils, who issue the necessary resource consents.

Operating costs are higher initially when monitoring is more comprehensive. Stations can however be operated remotely. Currently new developments do not incur any resource royalty payments. Allowance needs to be made for new wells in the future as individual wells generally suffer output or injectivity run-down, perhaps of the order of 2 or 4% on average.

Operating and maintenance costs can be expected to be in the range of US$30 - 50 per kW.

With total installed costs less than $1500/kW and allowing for operation and maintenance costs, electricity costs of around US 3¢/kWh are possible for New Zealand's most exploitable geothermal fields, probably only Mokai, Rotokawa and Tauhara.

Obviously as less attractive fields are developed. steamfield costs will increase significantly and hence electricity prices.

Opportunities also exist for the supply of direct use steam, particularly in three areas:

- timber industry at Kawerau
- dairy industry at Reporoa.
- timber industry at Tauhara.

ENVIRONMENTAL ISSUES

RESOURCE MANAGEMENT ACT (RMA) AND ROYALTIES

The Geothermal Energy Act 1953 vested ownership of the geothermal resources in the Crown. With the repeal of this Act and the enactment of the Resource Management Act 1991 ownership of the resources is now unclear. Claims have been made by Maori to the Waitangi Tribunal requesting that it be confirmed that Maori own the geothermal resources.

The outcome is not certain. However, there are two possible solutions. Firstly, Maori can be involved in the development. Secondly, Maori can receive a royalty payment for the use of the resource. A useful publication by the Ministry of Energy in 1989 details a range of royalty options. The simplest equates to US0.15 cents per kW/hr. At this magnitude this should not hinder development. However, if the resource owners' expectations are too high then geothermal developments will not be economically viable.

The Crown currently do not require a royalty payment

A major issue with resources tinder the Resource Management Act is the issue of sustainahility. A sustainable resource is not necessarily one which is completely renewable, but ensures that resource is used at a rate which meets society's current needs while sustaining the potential to meet the reasonably foreseeable needs of fiiture generations. Current concepts of sustainability, as applied to the geothermal resource, are to develop only some of the available fields, and development of these will be at a rate which may be sustained from each field for a period of say 30 years or longer.

LAND OWNERSHIP

Arguably, this issue is more complex than the resource issue. Large geothermal resources may underlie land which is held in a number of separate titles. If all owners wish to develop the resource, allocation'of the resource is an issue which has not been satisfactorily resolved.

Interested parties are working towards developing a solution where more than one party wishes to develop. Called a Steamfield Management Organisation (SMO) details have yet to be resolved.

GEOTHERMAL FIELD STATUS

At the end of 1994 resource consents were held for exploration at Rotoma and for development at Rotokawa (20 MW), Mokai (50 MW), Kawerau (6 MW), Wairakei (20 MW) and Ngawha (8 MW). Development is contemplated at Tikitere, Taheke, Tauhara, Mangakino and Reporoa.

SUMMARY

In conclusion the following points can be made:

- New Zealand faces an impending electricity shortfall as early as 1996, due to the recent high growth rates in electricity. This generation system is limited by fuel, not capacity.
- Whilst geothermal represents only 3.4% of the 8200 MW currently installed capacity, it produces 7% of the electrical output. Ultimately, geothermal could contribute between 2000 MW(e) and 5000 MW(e)
- New Zealand faces a major political issue in that the current wholesale price of electricity is around US 3 cents/kWh, significantly less than cost of new generation which will cost more than US 4 cents/kWh.
- Geothermal energy has a real opportunity to contribute to the impending shortage of electrical energy. However, a number of constraints including the relatively small size of projects which Regional Councils are prepared to approve, and competing interests on each geothermal resource are likely to limit this contribution.
- In the longer term, New Zealand's impending gas shortages are likely to provide an opportunity for direct supply of heat in specific areas.

REFERENCES

Electricity Corporation of NZ Ltd (1994) - "Electricity Supply and Demand in New Zealand"