RECENT DEVELOPMENTS IN THE NEW ZEALAND GEOTHERMAL INDUSTRY

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ABSTRACT

Geothermal energy is used mainly for generation of electricity in New Zealand, and provides about 6% of that generated. Major changes have occurred within the geothermal sector as a result of deregulation of the electricity generation and supply industry. A new power station, Poihipi (55 MW installed capacity) on the Wairakei field has been built and the plant tested. This station will be operated on a load following basis. Construction of another new station, at Rotokawa field, is due to start in 1997. Many small scale (<100 MW) developments involving private companies and local suppliers are now applying for environmental permits. It is predicted that geothermal energy will, in future, provide an increasing proportion of the electricity generation, rising to about 11% by the year 2020.

RECENT INDUSTRY CHANGES

Major changes have occurred within the geothermal sector over the last few years, as a result of deregulation of the electrical generation and supply industry which is the main user of geothermal resources in New Zealand. The government no longer maintains a monopoly on the generation and transmission of electricity. This freeing from state control was given to the domestic and small commercial (<0.5 MW) sector on 1 April 1993, and extended to the remainder on 1 April 1994. The deregulation has followed a similar path to that taken by the United Kingdom in 1990. Before this deregulation the generation of electricity was mainly (95%) provided by Electricity Corporation of New Zealand (ECNZ), a State-Owned Enterprise (SOE). Generation is now open to any company which has the necessary Resource Consents, access to the land, and finance. Transmission on the National Grid is the responsibility of Transpower, also a SOE, which was separated from ECNZ on 1 July 1995. Supply to consumers (both industrial and private) is currently in the hands of 36 supply companies, many formed from previous state- or local-body owned organisations. At present many of these supply companies are merging or being taken over through share purchases, both on and off the New Zealand Stock Market. The electricity supply industry is now market driven and there is wide diversification of the supply side.

Important market factors at present are:

- a future short-fall in supply due to increased demand - between now and 2005 it is estimated demand will rise by about 700-800 GWh per year (assuming no efficiency gains);

- a risk of partial supply failure - this is a result of government removing the responsibility for complete supply by ECNZ;

- transmission costs - there has been a move towards embedded generation to avoid transmission (wheeling) charges made by Transpower (still a monopoly);

- strong competition from the natural gas industry - aggressive marketing by several suppliers and cheap price ($11/GJ for residential, c.f. about $25/GJ for electricity);

- strong environmental laws - the Resource Management Act requires minimum environmental impact and consultation with Maori;

- increasing use of long-term direct generator-consumer contracts;

- low price of electricity - currently (1995) the average price is 5.8 c/kWh for industrial consumers and 10.2 c/kWh for domestic consumers; this is the 4th lowest in IEA member countries: only Mexico (4.0/6.3), Norway (5.4/11.7) and Canada (5.7/8.9) have lower prices (MOC, 1995). Such low prices, and consequent low profit margins, do not encourage small developments (Thain and Freeston, 1995).

PERMITTING

All new geothermal developers, and existing developers at regular intervals, need to obtain Resource Consents (permits) under environmental regulations contained in the Resource Management Act 1991. Important requirements are that the proposed development must have low environmental impact and be sustainable. Resource Consents, for taking and discharging fluids, are granted (or denied) by Regional Authorities (regional government) after public submissions (in particular from Maori people) and public meeting. Development of a field generally involves obtaining about 15 such consents.

All high-temperature fields in New Zealand, except one (Ngawha), lie in the Taupo Volcanic Zone (Fig. 1) and thus within the jurisdiction of two authorities: Environment Waikato (formerly Waikato Regional Council), and Environment Bay of Plenty (formerly Bay of Plenty Regional Council). Appeals against decisions of these authorities are heard by the Environment Court (formerly the Planning Tribunal), a judicial body.

Environment Waikato, whose responsibilities cover most of the high-temperature fields, has adopted the policy of managing the geothermal resources in its region as a total resource rather than managing individual systems. Certain geothermal systems containing unique features are protected, such as Waiotapu and Orakei Korako, which are designated as reserves and managed by the Department of Conservation. The remainder are open for development. Environment Waikato favours unitization of development with a "single-tapper", but multiple users (McLeod, 1995).

WELL OWNERSHIP

Prior to the recent changes in the electricity industry (above), all deep wells in New Zealand were drilled and financed by government. After the recent deregulation, the government is now wishing to sell these wells on undeveloped fields. However, there has been a period of uncertainty about ownership of the wells which has delayed several developments. This uncertainty now appears to have been resolved, and many of these wells form the basis of some of the developments described below.

NEW GEOTHERMAL DEVELOPERS

Bay of Plenty Electricity, a Whakatane-based supply company, has developed a 5.5 MW binary plant on the Kawerau Field.

Carter Holt Harvey, a large forestry company, is planning to develop the Maraetai Field.

Contact Energy. The Electricity Corporation of New Zealand (Electricorp, ECNZ) has been divided (February 1996) into 2 competing generation companies: ECNZ and Contact Energy, both at present remaining as state-owned companies. Contact Energy has inherited the two geothermal generation stations at Wairakei and Ohaaki (Broadlands) fields, together with several thermal- and hydro-stations. Contact Energy Ltd has about 30% of the generating capacity of the former ECNZ.

Downer Energy Services. Works Geothermal Ltd, an SOE previously owned by the New Zealand Government, was privatised and transferred to Downer Construction (NZ) Ltd on 16 August 1996. Downer Construction is a subsidiary of Paul Y-ITC, a publicly listed Hong Kong company. The new company is now a 100% stand alone subsidiary of Downer Construction, known as Downer Energy Services Ltd.

Fletcher Energy (formerly part of Fletcher Challenge, a major forestry company), a large New Zealand oil and gas development company with interests in Canada, is planning development of the western side of the Kawerau field.

Mercury-Geotherm, a joint venture between Mercury Energy Ltd (an Auckland-based supply company) and Geotherm Energy Ltd, is constructing a 55 MW station on the southwestern part of the Wairakei field. Recently, Mercury-Geotherm has also applied for a Resource Consent to develop a 110 MW station on the Tauhara Field.

Power New Zealand, another Auckland-based electricity supply company, is developing a 24 MW station at Rotokawa, and has an interest in Taheke and Tikitere fields, and Rotoma.

Top Energy, a Kaikohe-based electricity supply company, is planning to develop the Ngawha field.

TrustPower, a Tauranga-based supply company, which has recently acquired two other supply companies (Taupo Electricity and Rotorua Electricity), has shown interest in developing several fields. It has applied for Resource Consents to test drill at Reporoa and at Tauhara.

Tuaropaki Power Company has been formed by a land-owning, Maori Tribal Trust to develop the Mokai field.

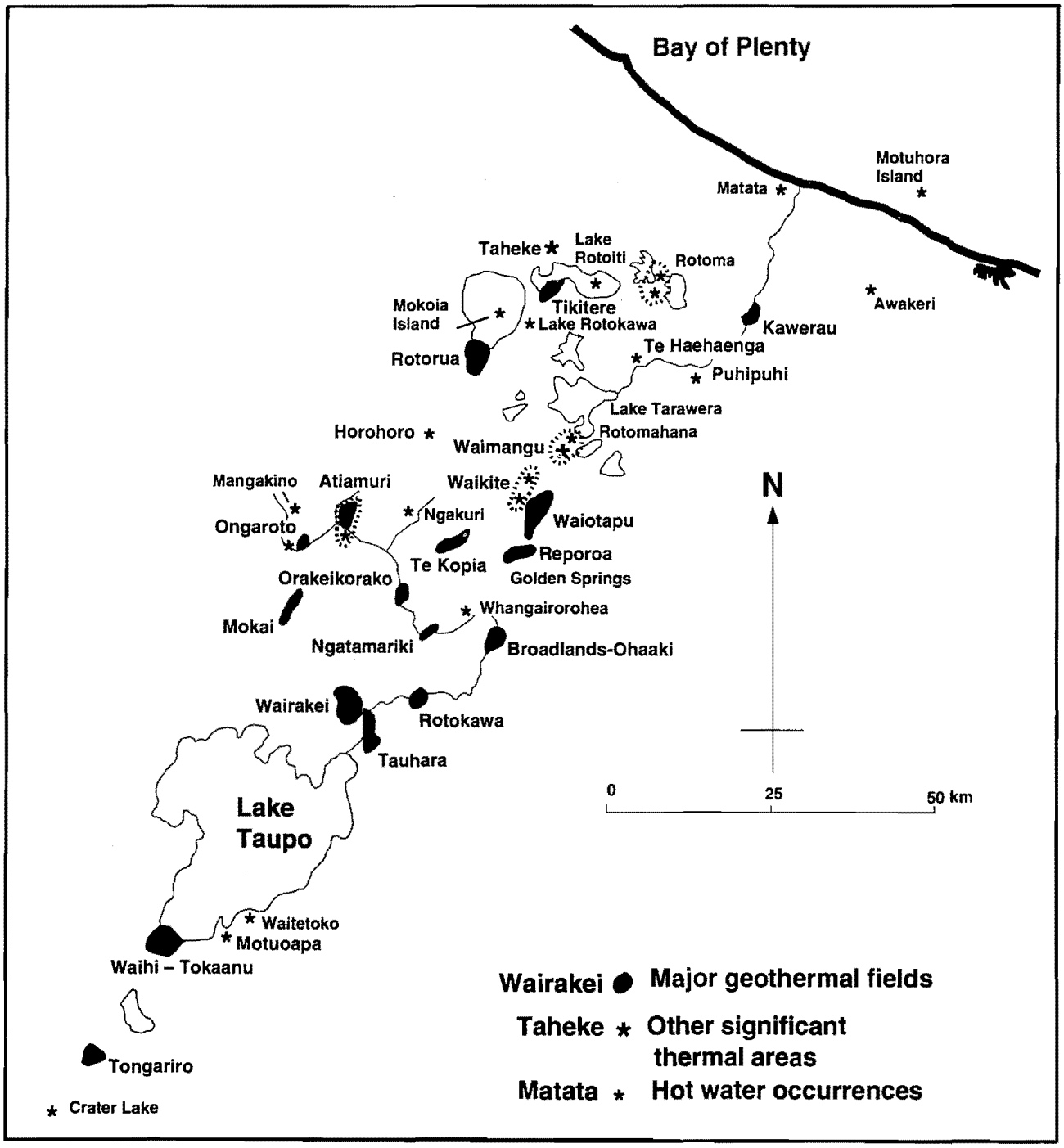

Figure 1: Geothermal fields in the Taupo Volcanic Zone of New Zealand (taken from Cave *et al*,1993).

RECENT FIELD DEVELOPMENTS

Kawerau

The field is owned by the New Zealand Government (Energy Division, Ministry of Commerce), and is operated by Downer Energy Services Ltd. Geothermal steam provides about 5% of the electrical energy from an 8 MW turbo alternator, and about 30% of process steam required by a pulp and paper mill operated by Tasman Pulp and Paper Company Ltd. Separated water is also supplied to two Ormat binary stations (1 x 3.8 MW, 1 x 2.6 MW), owned by Bay of Plenty Electricity Ltd. The Opal Trust, a joint venture between the Savage Trust (a local Maori landowner) and Fletcher Energy Ltd, plans to develop a 4 MW plant on the western side of the field, using an existing well (KA-24).

Maraetai - Mangakino

A 600 m deep exploration hole was drilled in this small field by the government in 1985, and encountered temperatures of up to 180°C. Since then no developments have occurred. Recently, Carter Holt Harvey Ltd have made plans to drill another hole to use for generating electricity to drive a pump which supplies water to the Kinleith Mill. Further progress is waiting on finance becoming available when international pulp and paper commodity prices improve. No Resource Consent has yet been granted.

Mokai

This large field was discovered in the late 1970s and government drilled 6 exploration holes (600 - 2 600 m) in the early 1980s which encountered temperatures of up to 325°C. It is now being developed by the Tuaropaki Power Company which owns most of the land within the field. Resource Consents have been granted for the first stage (55 MW: hybrid steam and binary Ormat plant) of a multi-stage development. Mokai will be a base-load station. Long-standing bore ownership issues (with government) have recently been resolved. Equipment supply contracts are in place, and construction is scheduled to begin in 1997.

Ngatamariki

Four exploration wells (1300 - 2780 m deep) were drilled by government in 1985-86, encountering temperatures of up to 280°C (NM-3). No developments have been proposed recently.

Ngawha

This field, located in the northern part of New Zealand, was investigated by the government during the late 1960s through to early 1980s. Fifteen investigation wells (600 - 2 300 m) were drilled which encountered temperatures up to 300°C but no development was begun. Recently, Top Energy, in conjunction with the Tai Tokerau Trust, has obtained Consents to generate 8 MW from the field and is currently undertaking environmental baseline studies. Development was due to begin in 1997, however, this has been delayed by claims of some local Maori people under the Treaty of Waitangi.

Ohaaki (Broadlands)

Three new wells (BR47 - 49) were drilled in 1995 to investigate the potential for deep production from basement rocks. The wells were strongly-deviated (up to 55°) along E-W trajectories, to target major fault zones within the basement rocks. BR47 penetrated 1691 m of basement, BR48 about 100 m (abandoned prematurely due to drilling problems), and BR49 1630 m. However, the rocks encountered had poor permeability, even where cut by major faults (Wood, 1996).

Reporoa

This field was explored by government in the 1970s and one exploration well (1340 m) was drilled which encountered a maximum temperature of 240°C. In 1996, Kaimai Energy (a wholly owned subsidiary of TrustPower) applied for Resource Consents for further investigation drilling and testing (3 deep wells and several shallow wells). The application was heard at a joint hearing of Environment Waikato and Rotorua District Council. However, the Consents were denied, mainly on the basis of possible impacts on nearby hot springs and on important thermal features in the adjacent Waiotapu Field. An appeal has been lodged by TrustPower with the Environment Court and will be heard in early 1997.

Rotokawa

This field was explored by government in the 1970s; 5 deep wells and one shallow well were drilled. Temperatures of up to 335°C were measured (RK4). In 1992, Resource Consents for a power station were applied for by a consortium of Tauhara North No.2 Trust (Maori landowners), Taupo Electricity Ltd, and Works Geothermal. Since then Taupo Electricity and Works Geothermal have sold their interest in the consortium, and been replaced by Power New Zealand Ltd. Take and Discharge Consents equivalent to 18 MW have been granted. It is now planned to proceed with construction of the power station. Equipment supply contracts are in place and construction is scheduled to begin in 1997. The 24 MW installed capacity station will contain: 1 x 12 MW steam turbine, 2 x 5 MW steam binary units, and 1 x 5 MW brine Ormat Energy Converter. The station will be operated on a base-load basis.

Rotoma

Power New Zealand (formerly Waitemata Electricity Ltd) plan to establish a 50 MW power station on this field. One exploration well (RM-1) was recently drilled by Works Geothermal Ltd, and 2 more are to be drilled. At this stage the Resource Consent is only for investigations, and an active programme of environmental monitoring of surface features is underway.

Taheke

A joint venture of Bay Energy (100% subsidiary of TrustPower) and Ruahine and Kuharua Incorporation (a Maori Trust) has obtained Resource Consents for test drilling in part of the field. Two drill sites have been prepared, but drilling has not yet started. Power New Zealand and TrustPower, and another Maori Trust (Taheke 8C and others) is about to apply for an Investigation Consent to drill in another part of the field. Negotiations are underway to merge these proposals.

Tauhara

This field (at least the northern part) is connected to Wairakei, as shown by a pressure drawdown of 15 bar in response to production from Wairakei. An exploration drilling programme was begun in 1964 in which 4 deep (1200 m) wells (1964-67) and 4 monitor wells (1967-80) were drilled, reaching temperatures of up to 280°C. Recently, there has been renewed interest in developing this field (Woods, 1996). Resource Consent applications have been lodged with Environment Waikato by:

- Contact Energy, for a 50 MW steam condensing plant, and an optional 20 MW binary cycle plant to utilise waste brine.

- Mercury-Geotherm, in association with Taupo District Council, for a 110 MW steam condensing plant, with an option of 2 x 5 MW binary plants using waste condensate.

- TrustPower, in association with Tauhara Middle 15 Trust (local Maori landowners), for a 20 MW binary plant.

Another developer, Tauhara Geothermal Co-op Ltd, is expected to lodge an application soon for a 10 MW plant.

Land access, resource ownership, and environmental permitting will be the key issues deciding which developer is allowed to proceed.

Tikitere

No developments have yet taken place on this small field. However, Power New Zealand and TrustPower have formed joint ventures with the Maori landowners (Paehinahina Mourea) to undertake development. No Resource Consents have yet been applied for.

Wairakei

(a) Wairakei

At present there is no reinjection of waste fluids from Wairakei Power Scheme (Contact Energy), however, it is recognised that this is needed and a programme of investigation is underway. Since 1984, 10 exploratory reinjection holes (WK300 series) have been drilled (including 1 outside the field), mainly targeting permeable rhyolite bodies and pumice breccia formations. In the last 2 years, 7 deeper and strongly-deviated wells (WK304-310) have been drilled, and testing has commenced.

Work is in the procurement stage for construction of a binary plant to utilise waste condensate from the Power Station. Land Use Consents have been obtained, and Resource Consents are being processed by the regulatory authority (Environment Waikato). It is planned to install a 13 MW (net) plant consisting of 3 x 5 MW air-cooled units; a water-cooled option was rejected, mainly because it would have greater environmental impact. The plant (approximately NS$30M) will use about 1100 t/hr of fluid at about 130°C, and it is planned that it will be operating by the end of 1998.

A pilot silica extraction plant, with an input of 100 t/day of fluid, is now operating. Recently, a pilot arsenic extraction plant has also been completed.

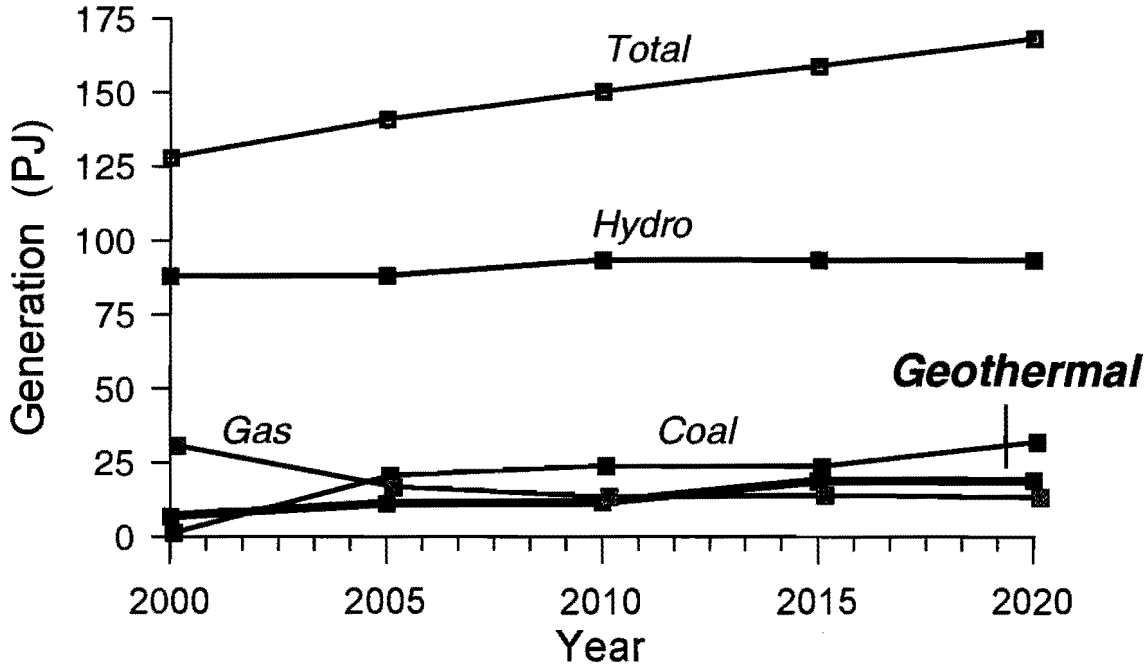

Figure 2: Predicted trends in production of electricity (taken from MOC, 1994).

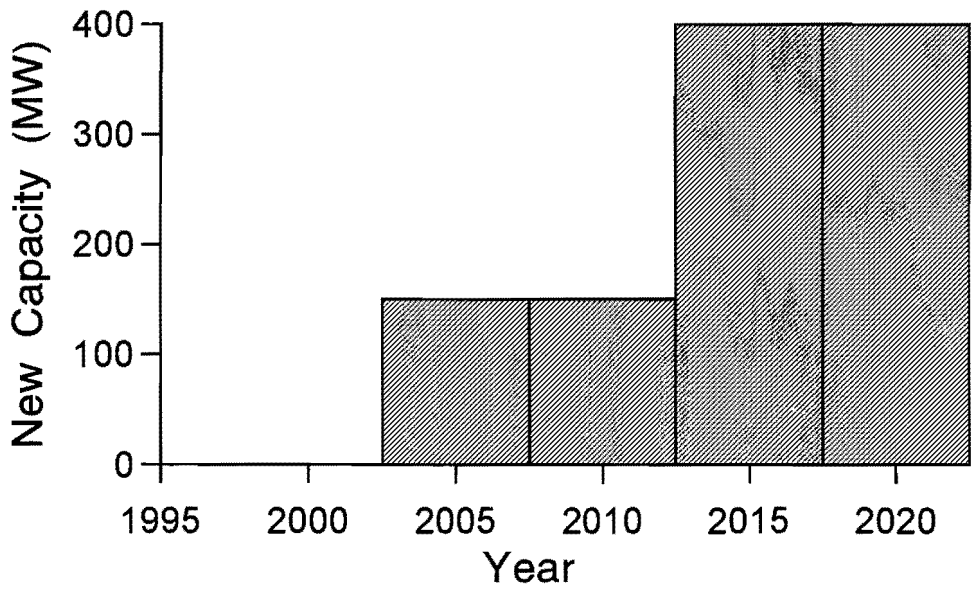

Figure 3: Predicted increases in geothermal generation capacity (taken from MOC, 1994).

Supply of waste fluid (about 40 MW t/yr) to the nearby Prawn Farm is continuing, and Contact Energy are actively seeking other cascaded uses for waste fluid.

(b) Poihipi

The Poihipi Power Project lies in the southwest part of the Wairakei field, and is being developed by Mercury-Geotherm. During 1995/96, 7 wells were drilled by Works Geothermal (now Downer Energy Services Ltd): WK604, 605, 606, 610, 620, 650 and 680. Construction of the power station and the pipeline network has been completed. A 55 MW, Fuji turbine-generator set (surface condenser) has been purchased (ex Geysers Field: moth-balled in 1986), reconditioned, installed and tested. The NZ$80M (approx. US$55M) Project was officially opened in June 1996. Negotiations are underway to purchase steam from nearby, unused wells owned by Contact Energy, to supplement supply. It is planned to operate the station in a load-following mode to meet the requirements of the Take and Discharge Consents (equivalent to 22 MW on base load), and maximise revenue.

FUTURE DIRECTIONS

Future trends predicted (MOC, 1994) for electricity generation in New Zealand include a decrease in the share provided by hydro and gas (current known reserves will be exhausted by 2017) and a rapid increase in the use of coal after 2000 (Fig. 2). However, demand will continue to rise at about 700 - 800 GWh per year and that between 2000 and 2020 an additional 2280 MW of new generation capacity will be required, a significant part of which will be provided by geothermal energy. Geothermal capacity is predicted to raise its share of total output from about 5% in 2000 to 11% by 2020, with an additional 150 MW by 2005 and a further 250 MW by 2015 (Fig. 3).

It is also predicted (MOC, 1994) that wholesale electricity prices will remain near constant at about 4.7 c/kWh until about 2005, then increase to about 8.5 c/kWh by 2020. Retail prices will remain at about 25 $/GJ until 2005, then rise to about 35 $/GJ by 2020.

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