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The Law and Geothermal Development in New Zealand

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ABSTRACT

While the Geothermal Energy Act 1953 provides for the control of specifically geothermal development in New Zealand, legislation dealing with the conservation of natural waters, and with orderly land development, is high on the long list of laws which must be satisfied, in common with many engineering projects.

The Act relates to all energy derived from the earth's natural heat, excluding water at temperatures up to 70°C. The sole right to exploit the energy is vested in the Crown (effectively the nation), regardless of land ownership. Furthermore, if development involves the payment of compensation to the landowner, the amount should not include any unrealized potential benefit of the energy.

Specific land areas may be reserved for use by the Crown alone. Elsewhere, the landowner or the Crown may allow exploration, including drilling, provided certain safety and administrative conditions are met.

The right to use geothermal energy (rather than merely to investigate it) is subject to the granting of a license, unless the energy is for domestic purposes and comes from wells less than 61 m deep. The many small users are also exempt from the payment of a rental amounting to about 3 US cents/GJ of energy used in excess of 10 TJ/yr.

There is legal insistence on the technical and environmental adequacy of any development, and the means for policing it.

INTRODUCTION

We may suppose that man has been bathing and cooking with natural heat since earliest times. Why, then, is it necessary, now, to legislate for its control? It seems that population pressures, and rapid advances in technology, lead to confusion in the exploitation of any resource unless there are guidelines to work to. Nature should be preserved from wasteful activities of mankind, and man desires protection from the destructive forces of nature, and from the operations of his fellow man.

This paper reviews in broad terms the main provisions and effects of the New Zealand law from the standpoint of a layman in legal matters, but a professional in geothermal engineering. For those who wish to delve more deeply into the subject, a listing of the statutes referred to is given at the end, but even that is by no means exhaustive. While emphasis will be placed on specifically geothermal legislation, it will be realized that there are many statutes applying to engineering development work in general, and a few of them will be described briefly.

In New Zealand, most of the shallow drilling has been done by private interests, while the great majority of deep hot wells have been sunk by the Ministry of Works and Development, the central government's engineering organization responsible for the administration of the Geothermal Energy Act and some others of the laws quoted. A notable private developer whose geothermal operations have expanded under the control of the legislation described is the Tasman Pulp and Paper Company at Kawerau.

GEOTHERMAL LEGISLATION

Definition

There is unlikely to be any single definition of geothermal energy which will satisfy all requirements for it. The N.Z. Geothermal Energy Act of 1953 relates to all energy derived from the earth's natural heat, excluding water at temperatures up to 70°C. This interpretation has proved to be satisfactory in a country where well temperatures have been measured up to 300°C, where it was convenient to exclude from unnecessary control those areas whose lower temperatures rendered them safe from hydrothermal eruptions.

However, there are many countries in the world where substantial use is made of lower-grade heat, and where it might be proper to set a limit of around 40°C, above which there is danger to the person, and below which relatively little energy is extracted. Higher-temperature petroleum production may need special consideration.

Ownership

To be effective, the law must designate the rightful owner or developer of the energy. Control is easiest to administer when the whole of any heat reservoir lies within the jurisdiction of one body. Unless the boundaries of all fields are defined, this can be achieved only by reserving the rights to the central government, or to a monopoly. Until the behavior of reservoirs under exploitation can be predicted with greater confidence than at present, the task of fairly allocating the resources of a single reservoir between adjacent landowners presents problems which some may wish to avoid.

In New Zealand, the sole right to geothermal energy is vested in the Crown—essentially the central government—but any competent person or body may be authorized to search for, or licensed to use, geothermal energy; so that questions arise regarding prior right and interference. There is nothing in the Act to determine how the energy should

be apportioned between rival users, except that, by inference, the first developer should not be affected by subsequent exploitation by others.

The central government has the power to have a well closed for various reasons, including that of its detrimental effect on other wells. Compensation is then payable, which gives good reason not to allow the drilling of wells too close together. However, it should be noted that while compensation is payable for certain well closures, and for the depreciation of property values due to geothermal development, none is due for the potential value of unexploited energy under a property.

In that they appear to be partly replenishing, geothermal reservoirs have some similarities to both petroleum reservoirs and to cold-water aquifers, but New Zealand legislation links them strongly to the latter.

Search and Use

Persons with appropriate land rights may be authorized to search for geothermal energy by means of surface surveys and by drilling, subject to conditions mainly governing safety.

If, however, the energy found is to be used, a license is necessary, unless the well is not more than 61 m (200 ft) deep, and its production is for domestic purposes. The law is designed to keep a measure of control, without leading to unwieldy administration of the many minor users. In the Rotorua area, where these are most common, subsurface conditions and the general standard of drilling make it unlikely that dangerous blowouts will occur from such shallow depths. There is provision for the closure of a well, or remedial work on it, if danger threatens.

Rental

When the Act was passed in 1953, the rental payable for geothermal energy applied only to industrial or commercial use, and the amount was fixed as a percentage of the savings achieved by using that energy rather than the next cheapest heat source. The concept was a fair one in theory, but proved difficult in practice when applied to a pulp and paper mill, whose energy sources included electricity, wood and liquor wastes, coal, and geothermal steam for electricity production, direct heat, and secondary steam generation. In assessing the rental it was necessary to simplify the engineering alternative and to make accounting assumptions, which may have given an unrealistic impression of the benefit accruing by using the geothermal source.

An amendment in 1966 substituted a rental based on the quantity of net heat used. Domestic consumption is excluded from payments by remitting the first 10 TJ/yr (about 10 thousand million Btu), and then charging the equivalent of 3 US cents for each GJ (or million Btu). The rate was chosen at a figure low enough to encourage geothermal exploitation in competition with alternative sources of energy such as coal, electricity, and oil. It should be noted, however, that in the nine years since its adoption the prices of all other fuels have risen considerably. The cost of coal, for instance, has almost doubled during that period.

One other important aspect of the rental is the basis of measurement, which is the energy *used* by the process. In the case of a heat exchanger it is the heat gained by the secondary fluid, with no charge being made for the amount rejected. This measure of energy is convenient, but with the greater emphasis now being placed on conservation, an attractive alternative would be the net heat extracted from the reservoir (at a correspondingly lower rental). Such a basis would also ensure that the total quantities being withdrawn from the ground were being monitored for reservoir engineering studies. One objection might be a greater difficulty in measurement—if, for instance, there is two-phase flow at the wellhead, but separated steam at the point of use.

The law requires that all practical steps be taken to avoid waste, but an economic incentive might help to reduce the policing of this clause.

Geothermal Safety

Safety above ground is covered generously by statutes having a wide application in engineering construction work as described later in this paper. The Geothermal Energy Regulations 1961, however, include specific provisions for controlling the standards of workmanship during drilling and subsequent well operation. They are directed, particularly, towards avoiding surface blowouts of uncontrolled steam flows, and recognize (1) that casing depths and strengths must be designed for the worst likely formation conditions; and (2) that it is not feasible to promulgate detailed rules applying to all circumstances.

Figure 1 shows the consequences possible when the casing program, and other control measures, are inadequate.

All casing below ground must have an adequate factor

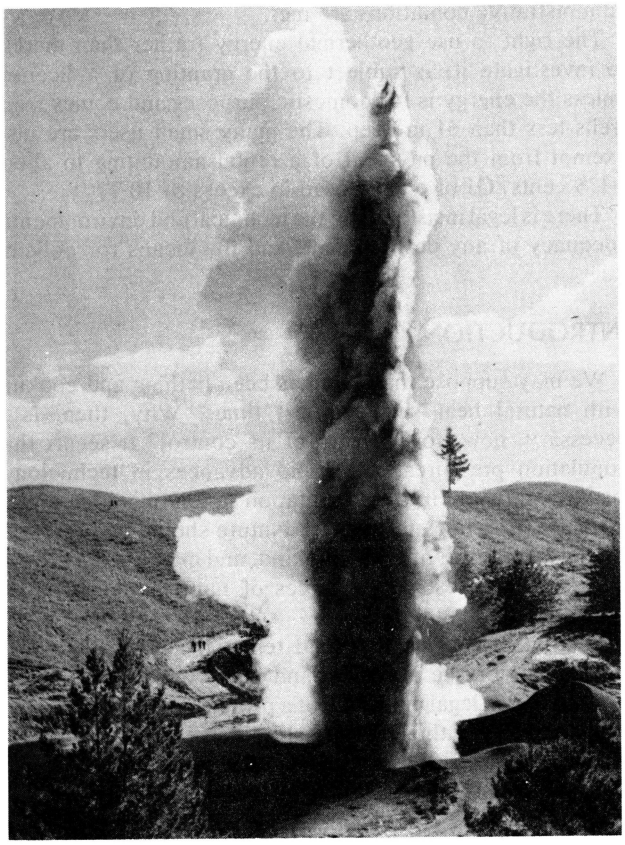

Figure 1. Geothermal well with problems: possible consequences when control measures are inadequate.

of safety against bursting, tension, and collapse. In petroleum engineering, "collapse" refers to radial failure due to excess external pressure; but in steam wells high thermal stressing can also cause axial compressive collapse, and it would be preferable to mention this separately in future legislation. The design of casing strings for geothermal service has several features not normally met in petroleum drilling, but these have been discussed elsewhere in geothermal engineering literature. Full annulus cementing is specified for all casing in wells deeper than 61 meters. The casing head and master valve are required to have a specified factor of safety, plus a 5-yr corrosion allowance on metal thickness.

The regulations require the proposer: (1) to submit his drilling program with his application to drill; (2) to employ a qualified supervisor to manage the drilling; and (3) to use appropriate equipment, materials, and methods. All of these matters are considered with the application, and the authority granted contains the conditions which must be satisfied if the work is to proceed.

During the course of the work, detailed daily logs must be kept of the operations employed, the materials used, and the conditions encountered. An inspector, appointed under the Regulations, ensures that proper standards are maintained, and has the power to suspend work if necessary. Because of his direct and constant contact with the work, the inspector exerts an important influence in determining the effectiveness of the legislation, no matter how well devised that may be. The Regulations also provide for an engineer, who provides technical steering and overall administrative control of development work.

If the operation or condition of a well presents a danger or nuisance to persons or property, or if it is to be abandoned, it may be required to be closed, or sealed if that is necessary. Where long-term corrosive deterioration of the well's structure can occur, it is proper to fill the casing with an impermeable cement grout.

Testing

Operators must take rock samples and make them available for geological inspection. There is general provision for taking specimens and testing, which would include the chemical analysis of formation fluids. Downhole temperature profiles are also included in the testing required.

Rotura City

As the largest center of population in the thermal region of New Zealand, Rotorua has more than 600 thermal wells within its 27-km^2 area. A temperature maximum occurs at a depth of about 100 m, so that most of the wells are shallow, and nonindustrial use predominates. Moreover, the natural thermal displays attract a very large tourist following.

Some years ago the City Council recognized that: (1) the common practice of individual wells serving only one or two houses was grossly inefficient in terms of heat conservation; (2) geothermal effluent disposal was inadequate; and (3) both of these problems would be reduced by larger-scale district heating schemes.

Accordingly, the Rotorua City Geothermal Energy Empowering Act 1967 was drawn up and passed, delegating to the City Council the legal authority to control geothermal prospecting and utilization within the city boundary. The council may make bylaws for a wide range of purposes, including reticulation, charging for supply, and controlling the disposal of water. It also has responsibility for licensing and inspection—in fact, in most matters, acting in the place of the central government.

GENERAL LEGISLATION

Environmental Control

Some 19 government departments administer between them more than 70 statutes which have significant environmental implications. Several of them are mentioned in this paper, and in general, they provide ample means for preserving the beauties and resources of the country.

In addition, a Commission for the Environment has been established to ensure that environmental factors are fully taken into account in Government decisions. For projects subject to Government approval or financial assistance, impact reports are required if there are significant implications for the human, physical, or biological environment. The reports are published for comment and the final decisions on the proposals are then based on all aspects—technical, economic, and environmental.

Water

The Water and Soil Conservation Act 1967 includes in its objectives the making of better provision for the conservation, allocation, use, and quality of natural water. Its interpretation of natural water includes all forms, amongst them geothermal steam, ground water, and sea water within territorial limits (also snow and ice).

The sole right to divert, take, or use natural water, or discharge into natural water, is vested in the Crown (with exceptions mainly covering domestic use and sea water). The central authorities administering the Act delegate to regional water boards their responsibilities to allocate fairly the water available, and to govern the disposition and quality of effluents discharged back into natural waters.

Applications for water rights are subject to public and official scrutiny before any decisions are made on them, and physical and chemical limits are imposed. Nine classes of water are defined, with fresh water standards ranging from Class A, which must be maintained in its natural state, to Class D, which must conform to the following (abbreviated) requirements:

1. Temperature change not more than 3°C.
2. pH between 6 and 9, except due to natural causes.
3. Color, taste, and smell not to become objectionable.
4. Retention of aquatic life.
5. Oxygen in solution not reduced below 5 mg/l.

Other factors are involved in some of the classes (particularly sea waters).

It will be realized that there may be severe limitations to the discharging of geothermal effluents into classified waters. It is also clear that geothermal waters have not been classified, as a 3°C limit on temperature change would be unrealistic in geothermal reservoirs already containing large variations in temperature, measured with instruments barely capable of that degree of accuracy. Reinjection of thermal wastes into the ground requires a water right if

into a wet formation, but interestingly, not if back into dry ground.

It will be observed that the Act embraces both water and land conservation, and it may be noted that increasingly stronger links are being made with the Town and Country Planning Act, mentioned below.

Air

Under the Clean Air Act 1972, hydrogen sulfide is likely to be the only pollutant needing attention. There is a responsibility to render its emission harmless and inoffensive, at a rate and height to be specified by the health authorities. The construction of the Wairakei power station preceded this enactment, and no subsequent applications have been made yet to necessitate the setting of suitable standards for this type of plant. Moreover, the requirements are likely to be chosen to suit local conditions at individual sites.

Town and Country Planning

The Town and Country Planning Act 1953 is designed to promote the health, safety, convenience and economic welfare of the people, encourage the wise use of resources, and coordinate public services and improvements. For these purposes it provides for the making and revision of regional and district planning schemes. The zoning of land use is a primary tool, and elaborate administrative processes are involved to ensure that schemes become operative only after comprehensive surveys of the natural resources, and exhaustive public and expert enquiry. Geothermal work must take its place alongside other development in seeking local opinion before the construction of permanent features begins.

The experience with the geothermal power plant at Wairakei has been that, in spite of a diminution of natural thermal sights—partly attributable to the well drawoff—the scheme itself has provided a counterattraction of high popularity, and development of the surrounding area has been advanced.

Industrial Safety

Most of the safeguards needed for personnel engaged in general engineering work are contained in the two statutes mentioned below.

The Construction Act 1959 provides for the safe control of excavations, scaffolding, mechanical plant, tools and explosives. Emphasis is put on inspection and preventive education, for which codes of practice and guides have been published. In thermal regions, special attention should be paid to drilling cellars and trench excavations, where boiling water may be found, and lethal concentrations of hydrogen sulfide can collect.

The Boilers, Lifts and Cranes Act 1950 has special application in the provisions of its associated Boiler Code, which lays down, in specific detail, rules for design, construction, inspection, testing, and maintenance of unfired pressure vessels. Legally applying to vessels containing steam at above atmospheric pressure, the rules have been enforced, strictly, for permanently installed steam pipework, separators, and fittings downstream of all wellhead master valves, although in the case of the state-owned Wairakei plant, the Act is not binding. Off-line inspections are made every one or two years.

CONCLUSION

General Comment

While it must be acknowledged that the process of law-making is never complete, it should be clear from this summary that the existing legislation in New Zealand provides a comprehensive framework for the development of her geothermal assets. There is ample control of operations which affect man's well-being and his treatment of natural resources. The Geothermal Energy Act, in particular, emphasizes safe practices without imposing unnecessary restraints or administrative work on small-scale domestic use.

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Note: Subsequent amendments to the statutes are understood to be included.