THE PLACE OF **TARANAKI** IN **DSIR** ENERGY STUDIES

D. KEAR
DSIR, Wellington

Abstract

New Zealand is an energy-rich country. **DSIR** research and exploration are described in defining our national resources of hydro-electricity, coal, geothermal energy and petroleum (natural gas and oil), all of which are now known to be considerably larger than was thought only a few decades ago. In Taranaki there is very limited hydro-electrical potential; only modest quantities of coal in difficult locations and no geothermal potential despite the presence of the dormant volcano Mt Egmont. However, the province does contain New Zealand's best production and future prospects for natural gas and oil. **DSIR** investigations into alternative developments for synthetic liquid fuels is also discussed.

INTRODUCTION

Taranaki is one of New Zealand's most important grassland areas, rightly famed for dairying and particularly its cheese production. Recently it has also become New Zealand's fastest growing region in energy development, so it is most appropriate that the subject of energy is included in this year's Grasslands Association Conference in New Plymouth.

Many speakers have come to New Plymouth recently to talk about Taranaki's proposed energy developments, and many technical papers and newspaper articles have described those developments in considerable detail. It would be inappropriate to present yet another contribution here giving the same information as the others. Instead, this paper describes **DSIR**'s contribution to New Zealand's energy developments adding specific notes in every instance about the appropriate situation in Taranaki.

HYDRO-ELECTRIC POWER

Prior to 1973, New Zealand's very simple energy policy was based primarily upon cheap hydro-electricity and cheap imported oil. The policy involved making electricity available to virtually every house in New Zealand.

It is perhaps not widely appreciated that only about a third of New Zealand's hydro-electric potential is being used at the present time (Ministry of Energy, 1978). Certainly, quite a proportion of the remainder is either under current development or will not be harnessed because of environmental or economic reasons; but hydro-electricity remains of key importance in the New Zealand scene.

DSIR has long been in the hydro-electrical field. Its geologists have reconnoitred sites for possible hydro-electric development, alongside New Zealand engineers, in most parts of the country; and have followed this with

detailed assessments of the quality of the rock foundations, the presence or absence of flaws such as faulting or soft rock areas, and the availability of local construction materials. DSIR geophysicists will commonly probe the depth of buried river channels, using seismic methods, to determine the depth of excavation required, or the dangers of seepage of water underneath the completed dam, and will assess the seismic risk of water impounded by the new dam(s). DSIR chemists will report on possible reactions between local aggregate materials, and available cements. Some New Zealand aggregates, and particularly volcanic rocks of which some of those in Taranaki are perhaps the best examples, may react with high alkali cements to the detriment of any concrete structure. This must be looked at very carefully to select an appropriate non-reactive cement.

Hydro-electric development has never been a major energy activity in Taranaki, but some successful small hydro-electric developments have been constructed to the north.

COAL

Coal has always played an important part in the energy scene of New Zealand. Our Maori people knew of its presence. Their word for coal, “waro”, is preserved in many place names, such as the important mining centre of Rotowaro in the Waikato.

The first pakeha settlers to New Zealand came from Victorian Britain where coal was an important element in the Industrial Revolution. The early geologists therefore naturally explored particularly for coal, and their efforts and those of DSIR geologists and geophysicists since, have identified many hundred of millions of tonnes of sub-bituminous and bituminous coal reserves. With a coal production that has remained effectively between 2 and 3 million tonnes for some long time now, these reserves represent several centuries of coal supply.

However, even greater resources were to be found. A few years ago a DSIR scientist was reviewing Southland lignite (low-grade coal) reserves. The estimates then, of about 350 million tonnes (DSIR 1976) had been based on very few drillholes and outcrops; but further information had come to hand from investigational drillholes for a power pylon route across the Southland Plains. These results convinced him that there could be substantially more coal than had been originally estimated. His provisional estimates were of perhaps 1,200 million tonnes.

His work led firstly to DSIR's drilling rig's moving to Southland for a few months, its results showing that he could well be right; and secondly to subsequent Mines Department drilling which showed more than 4000 million tonnes of lignite in-the-ground. This largest of New Zealand's coalfields was therefore “found” as a result of a few months work by one DSIR scientist followed by a few months work of our drilling rig. Accepting a value of the lignite at only 10¢ a tonne, the return for this particular research would be around \$400 million to New Zealand. It is indeed one of the characteristics of scientific research that a few projects with very satisfactory outcomes produce

financial results out of all proportion to their input costs.

Taranaki has some interesting coal resources to the north. These differ significantly from most others that have been worked extensively in New Zealand, and indeed have some similarities with the coal resources of both North America and Europe. Most coal seams worked in New Zealand have been typically very variable in thickness. At the extreme, in the Reefton area, they can increase in thickness from 0.5 to 30m over a distance of only about 500 metres, while typical Waikato seams can increase from 2 to 20m in little more than 1 km. In contrast, the coal seams of England are of constant thickness; one named the "Yard" seam would be identified by a thickness of within an inch or two of 3 ft, over an area of several counties. Like the latter, the Taranaki coal seams are of constant thickness and are continuous over wide areas. The seams seldom exceed 3m, and are more commonly up to only 2m in thickness. They are in effectively flat seams, although they are broken by relatively common faulting. They occur in the Mokau formation, the predominantly marine sandstones of that formation giving the coal a moderate sulphur content.

In some areas, close to outcrop, opencast mining methods have been used; but most Taranaki coal resources have been, and will need to be, mined underground. A major problem is that the country above the coal is very steeply eroded, and heavily bushed, making exploration very difficult. DSIR's geologists and Mines Division engineers are prospecting Taranaki's coal resources to improve on the latest estimates of 150 million tonnes of mostly inferred coal (1981 Energy Plan).

In summary, the coal of northern Taranaki is undoubtedly an important energy resource which may have a part to play in the region's development; but the thin seams of moderate-sulphur sub-bituminous, coal, in remote rugged country, are unlikely to be worked extensively in the near future.

GEOTHERMAL ENERGY

Geothermal energy has been used for a long time in some special parts of the world. Our own Maori people made grateful use of an abundant source of heat at Rotorua in particular. During this century, developments in both Iceland and Italy preceded those in New Zealand; but New Zealand developments have been among the best researched and published in the world, and among the most successful (Lawless *et al*, 1981). The development has been largely due to the combined efforts of three Government departments, the DSIR, the Ministry of Works and Development, and the Electricity Division of the Ministry of Energy. Their engineers and scientists have combined to develop a new technology, inasmuch as most overseas geothermal developments had depended on relatively dry steam as the source of energy, while New Zealand has a steam-water mixture from which the steam is "flashed" for power generation of the Wairakei Power Station.

For many years now, geothermal steam has provided around 1/6th or 1/7th of the total electrical energy of the North Island. The Ministry of Energy (1978) has estimated that the potential geothermal resource in New Zealand is

at least seven times that at Wairakei, and although there are certainly resources that will never be developed because of tourist and environmental considerations, it follows that the geothermal energy potential could be of the order of the present electrical load of the whole of the North Island. Not all will be used as electricity, however. New Zealand leads the world in the industrial use of geothermal energy — at the Tasman Pulp and Paper Mill — and industrial (non-power) uses will increase significantly in the forestry, horticultural, tourist and other industries.

New Zealand's geothermal technology has been passed on to more than two dozen countries throughout the world in New Zealand aid programmes initially, and now increasingly as a commercial export through consultancy firms. DSIR has played a major role in this overseas work.

The best geothermal occurrences in New Zealand are closely associated with rhyolitic and dacitic volcanic rocks, and with certain andesitic rocks to a lesser extent. In Taranaki, the presence of the magnificent volcanic complex of Mt Egmont might be thought to imply the possible presence of geothermal activity here too. Unfortunately this is not so. There are no hot spring areas, and indeed the drillholes for petroleum have shown that there are not rapid increases of temperature with depth that would indicate even moderate possibilities for warm water developments, such as occur in the Tauranga area. However, this is not to say that a combination of Taranaki's gas and the Volcanic Region's geothermal energy may not one day contribute to specific development projects.

WOOD

Wood is an increasingly important renewable energy resource, with new super-efficient wood stoves for homes, businesses, milking sheds, etc. being developed by DSIR etc. It is also capable of being grown widely including Taranaki.

PETROLEUM

In some ways petroleum is the most recent and one of the most exciting developments in the NZ energy scene. Like coal, however, it had a very early place in the history of New Zealand energy development. Oil wells drilled here, at Moturoa, were the first in the southern hemisphere, only shortly after the first successful oil holes anywhere in the world.

Oil and gas seeps are not uncommon in New Zealand, but only in Taranaki was there any real development of oil and gas until after the Second World War. Shallow wells at New Plymouth produced sufficient gas to be used in the town supply, and sufficient oil or condensate to be used in local buses, and, through the "Peak" petrol pumps, in the cars of a few lucky motorists.

During the War petroleum exploration was intensified, and after the War DSIR geophysicists reanalysed the exploration data and became very interested in the prospects particularly in Taranaki. Simultaneously Sir Bryan Todd travelled overseas, determined to find partners to join with him in

exploration ventures. As a result, the Shell-BP-Todd consortium drilled in Taranaki, and was successful with the first hole at Kapuni. The Kapuni field not only provided natural gas to Auckland and Wellington by 1969, but its very important condensate has proved of even greater monetary value than the gas.

Exploration continue off-shore, and, also in 1969, the same consortium struck what was then the 14th biggest gas field in the world, again with its first off-shore well into the Maui field. Of considerable importance were the facts that minor oil as well as gas and condensate was found in that drilling, and that oil alone was found to the south of Maui 4 well, which obtained oil in sufficient quantities to have been commercial had it been on-shore.

More recently in 1977-78 DSIR scientists laid out the initial programme, and provided some initial key technical staff for the Government's onshore petroleum exploration venture. This led to the formation of the New Zealand national oil company, Petrocorp, and led directly to the discovery of the first major oil accumulation in this country in Petrocorp's McKee well. The McKee deposit may be small in comparison with some overseas oil fields, but it has two important merits. Firstly it should provide New Zealand with a few percent of its oil requirements, and secondly it has increased immeasurably the interest in petroleum exploration in New Zealand (e.g. Ministry of Energy 1980) which will hopefully in turn lead to more discoveries along the lines of Kapuni, Maui and McKee. All three are in the Taranaki region, an area which remains the most prospective petroleum basin in New Zealand. Other regions have prospect too, however, and other major fields could be found.

The new dependence, of an increasing part of the North Island on Taranaki gas for use in homes, commercial buildings, and industry followed by the effect of condensate use in reducing the cost of oil imports, will be followed by other important developments based upon the large remaining quantities of Taranaki natural gas.

SYNTHETIC LIQUID FUELS — and OTHER DEVELOPMENTS

The original purpose of the development of the Maui field, which demanded a major user if any development at all was to take place, was for electric power generation. When the electrical demand decreased, and other alternatives such as geothermal steam were included in forward energy plans, a large quantity of gas became available for other purposes. Among the several possible major uses of natural gas, considered by an Interdepartmental Committee chaired by DSIR, the production of synthetic liquid fuels became of greatest importance. This development is one of several which have been subsequently planned for the Taranaki area, and which include an ammonia urea and a stand-alone methanol plant. There is no need to describe these in any further detail here, because they are well reported; but it could be useful to describe the work of DSIR scientists in looking at the use of alternative liquid fuels for New Zealand once these have been produced from one of several possible fuel plants.

The proposed Mobil synthetic fuel plant intends to produce petrol from natural gas. It yields a product which can be used directly in conventional motor cars, and therefore needs no research into this form of liquid fuel as far as New Zealand is concerned.

The Mobil plant will contain two methanol trains, and the stand-alone plant will produce chemical grade methanol for export. It is also theoretically possible to make fuel grade methanol from coal or from wood, and both possibilities are being investigated by DSIR and other research organisations.

Methanol may be used as a transport fuel in two rather different ways. Firstly, it may be used in low methanol blends in petrol typically 15% methanol and 85% petrol (M15). DSIR was involved with many other institutions, including several funded by the Liquid Fuels Trust Board, to determine the feasibility of using an M15 blend in New Zealand. There were some technical problems, but these tended to be minor. Once cars had been adequately tuned for the new mixture, and after sediment had been cleared from the fuel lines, the fuel worked well technically. The prime reason that the Liquid Fuels Trust Board eventually decided against recommending the introduction of M15 to Government was because of considerable problems with the necessary distribution system for the fuel (Liquid Fuels Trust Board, 1980).

Methanol can also be used virtually pure, or in high methanol blends (say 85% methanol and 15% petrol (M85)). Some work in New Zealand involves the test running of diesel buses on methanol, and running test of Brazilian-manufactured cars, that were designed for ethanol, on a methanol fuel. DSIR's main work has been in the area of retrofitting typical cars in New Zealand to run on M85. Technically these investigations have worked well, and the Liquid Fuels Trust Board is currently looking at other aspects of high methanol blend fuels, including the critical question of distribution. It must be emphasised, however, that retrofitting is not amendable to rapid introduction, and would be additional to, not a substitute for, synthetic petrol.

Ethanol is another potential vehicle fuel and can be produced from a variety of biomass materials through fermentation and distillation. DSIR has worked specifically to identify land on which different crops could be grown, and has advised on the use of ethanol as a motor fuel. In general ethanol will do what methanol will do, but perhaps do it a little more easily. DSIR has not, however, been involved in other major work leading to ethanol production.

CONCLUSIONS

It is clear from this paper that New Zealand is an energy rich country. DSIR has had a very important input into the definition of New Zealand's energy resources and the technology involved in their use. Energy has clearly been of considerable interest in Taranaki for a long time, and energy development has most recently become a major activity of the province. This is particularly through Taranaki's natural gas, condensate and oil, perhaps with coal

becoming of greater interest in the future. None of these developments, however, will overshadow the fact that Taranaki's grasslands dairying and cheese are rightly of world reknown.

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