ENERGY

In late June the Coalition for Open Government released a report, Electricity in New Zealand – is there a surplus to sell? Its authors, Geoffrey Bertram and Keith Johnston submitted the following paper, which is a summarised version of the report. The Department of Trade and Industry – which has been involved in negotiations for the sale of electricity – and the Ministry of Energy's electricity division, declined to comment on this article.

Where has all the power gone?

The New Zealand Government's development strategy for the next couple of decades is based on the belief that there exists a "surplus" of electricity which can be offered at concessional rates to attract new large-scale industries.

While the magnitude of the supposed surplus has not yet been precisely identified, the figure of 5000 gigawatt-hours per year has been mentioned frequently in Government statements, and in publications such as the *Growth Opportunities in New Zealand* booklet which appeared earlier this year.

In this paper we shall argue that the true surplus is a great deal less than 5000 GWh per year; that by the mid-1980s there will be no surplus left; and that long-term sales of electricity contracted now must be on the basis of a steep escalation of the price in the early 1990s.

In developing these points we first discuss the nature and size of the surplus, and then explore the consequences of a long-term sale of a 5000 GWh block of electricity.

For nearly three decades following World War II, New Zealand's electricity planners struggled to keep up with growing demand and avoid shortages and blackouts. In the mid-1970s the picture was transformed, with generating capacity expanding more rapidly than demand.

In response to the new situation electricity forecasts began to be scaled down; some proposed new power stations were dropped from the power plan; and the Government started to talk of a "surplus" of electricity which could be made available at cheap rates to encourage new industries in New Zealand.

Unfortunately, initial estimates of the amount of "surplus" electricity available were made rather crudely, by comparing aggregate national demand with aggregate national generating capacity, and supposing the difference between the two to be a surplus of freely-available electricity. There are three main sources of error in this approach:

1. The fact that excess generating plant has been installed and paid for does not necessarily mean that electricity can be produced at low cost up to the full capacity of that plant. Only in the case of hydro-electric stations is the marginal cost of power very close to zero, up to the maximum plant factor permitted by river flows. Fuel-burning power stations, which make up the bulk of our present excess capacity, may be subject to physical constraints (especially on fuel supply) which prevent full-capacity operation; and operating these stations within their feasible range requires purchases of fuel, so that electricity from such stations is certainly not costless. Coal-fired stations such as Huntly produce electricity at a marginal cost of at least 1.2 cents per kilowatt-hour, while oil-fired stations such as Marsden A cost over 5 cents per kWh.
2. There is a clear regional pattern to our excess capacity which is concealed by aggregate figures. Excess hydro capacity is concentrated in the southern half of the South Island, while excess fuel-burning capacity is in the northern half of the North Island. The Cook Strait cable, with a maximum capacity of 4200 GWh per year, imposes a constraint on the amount of (cheap) South Island hydro power that can be taken north to substitute for (more expensive) North Island thermal power. It is only the existence of this constraint that makes **any** of the South Island's generating capacity "surplus" to current national needs.
3. Use of simple aggregate figures such as "5000 GWh per year" is inadequate for long-term analysis because it fails to take into account the time profile of surpluses and/or deficits in the system. Our "surplus" is not expected to last forever; in fact, much of it will disappear during the next 10 years. Plans and contracts drawn up to cover periods longer than this must take account of the fact that long-term commitments – which may be supplied from excess capacity in the short term – will in the longer term force us into the construction of new and costly power stations.

In Table 1 we use 14-year aggregate energy flows to illustrate the first two of these points. Assuming all years to be mean years, and comparing the resulting generating capacity with the central official projection of demand, we find that between 1980/81 and 1993/94 there would be a total of 17,823 GWh of hy-

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dro-electricity "spilled to waste" in the South Island.

This energy, which can be recovered simply by channelling water through turbines instead of over spillways, is the true low-cost surplus available to us during the next 14 years, equivalent to 1273 GWh per year on average.

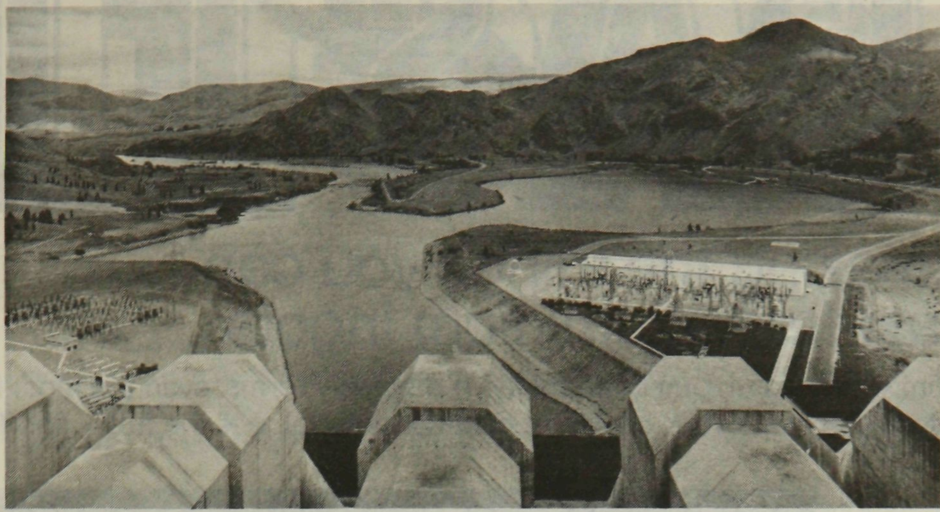
In the North Island, demand and supply will be kept in balance by varying the amount of fuel burned in thermal power stations. Our table shows 60,272 GWh of power required from this source during the 14 years, equivalent to 4305 GWh per year on average.

This leaves about three-quarters of installed fuel-burning capacity unused in the mean-year situation shown. This idle capacity, however, should not be confused with "surplus" electricity, because of the cost of purchasing fuel to run the plants and because some installed fuel-burning plants face constraints during the next decade (gas shortages will restrict New Plymouth and Stratford, while Huntly may face difficulties with hot-water discharge into the Waikato River).

In addition, it must be remembered that part of the installed fuel-burning capacity must always be held in reserve to provide dry-year firming for the national grid in years when river flows fall significantly below normal levels.

If all years are mean years and demand follows the central forecast, then our total surplus of virtually-costless electricity is 17,823 GWh spread over 14 years.

This should be compared with the Government's apparent intention to enter into long-term commitments to supply smelters and other energy-intensive industries with up to 5000 GWh per year.



A total of 17,823 GWh hydro-electricity "spilled to waste" in the South Island.

In Figure 1 we show the time profile of this supply commitment, assuming that the first 2000 GWh per year of power would be taken up in 1983/84 and the remaining 3000 GWh per year would be drawn from the grid beginning in 1986/87. (These appear to be reasonable start-up times for large-scale industries such as those now proposed).

Between 1980/81 and 1993/94, bulk sales made on this basis would require us to supply a total of 46,000 GWh at concessional rates (this is the area under the bulk-sales curve for those years).

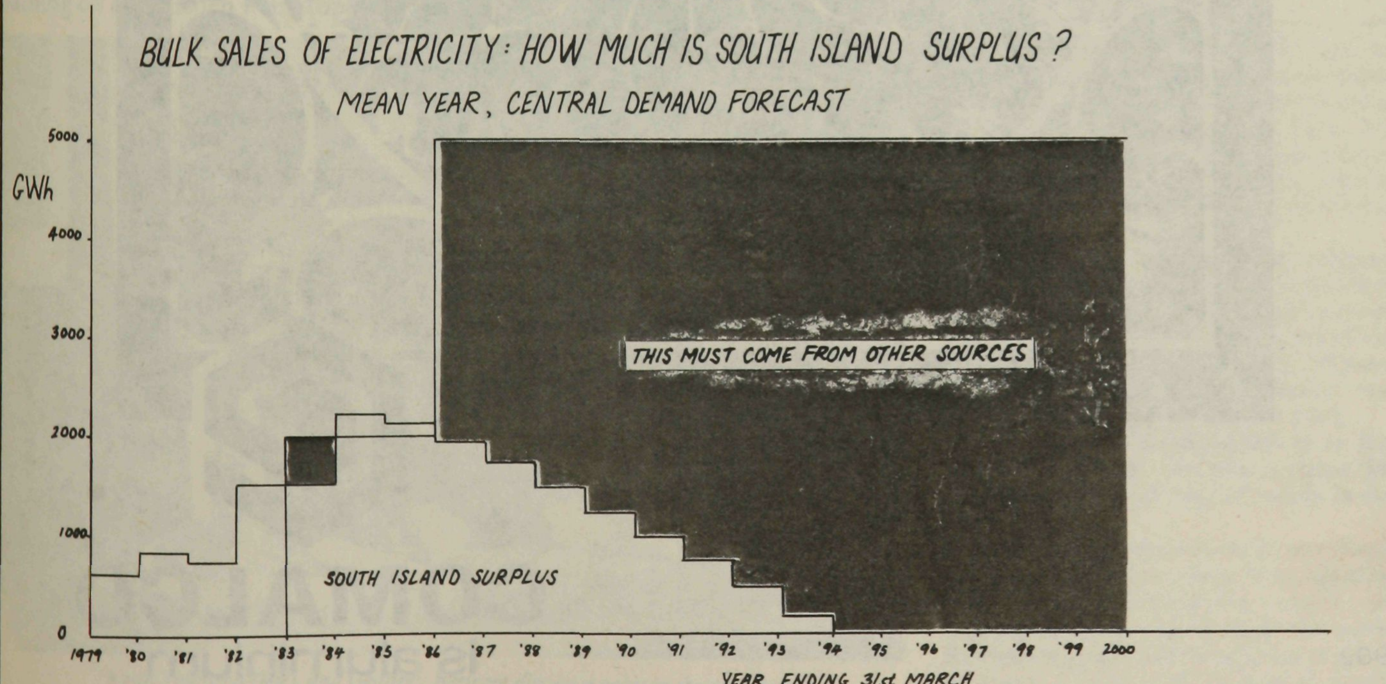
South Island surplus hydro power will total 17,823 GWh over the period — but 3669 GWh of this will already have spilled over the dams by the time the first bulk user starts up, leaving only 14,154 GWh of surplus electricity to help supply the new users' requirements.

The remainder of the bulk commitment up to 1993/94 — and all of it thereafter — would have to be supplied from sources other than the costless South Island surplus. (As Figure 1 shows, the South Island surplus will have disappeared by 1995 even if no new bulk users enter the scene).

There are two other possible sources of supply for the power to run smelters (which we shall assume to be located in the South Island): namely, existing fuel-burning stations in the North Island, and new power stations yet to be built.

Existing gas-fired and coal-fired plants will not be able to fill all of the gap in Figure 1. This means that in agreeing to

FIGURE 1



the proposed bulk sales the Government will be committing itself either to burning imported oil in existing stations, or to building a series of large new stations, or both.

It is impossible to predict exactly what combination of possible sources of supply the Government would choose, but it is possible to make a very clear prediction about the cost of supplying the bulk sale shown in Figure 1.

In the mid-1980s, with only 2000 GWh per year being drawn by the new industries, the marginal cost of supply would be very low – consisting almost entirely of the cost of providing the national grid with insurance against the occurrence of dry years. (There will be no surplus hydro-electricity at all in dry years).

By 1995 the cheap hydro surplus will no longer be available, and present coal-burning capacity in the North Island will also be fully committed to supplying projected local demand.

Possible sources of supply for the 5000 GWh bulk sale would then be Clutha (at 3.1 cent per kWh); oil-fired power from Marsden (at 5 cents plus per kWh); and a possible new coal-burning station (producing electricity at a minimum of 2.5 cents per kWh).

We have explored various combinations of these possibilities, the most likely of which are costed in Table 2. In all cases we assume that the Government proceeds with the Clutha scheme (which significantly increases costs in options 1 and 2), either on the planned timetable (option 1) or on an accelerated construction schedule (options 2 and 3). Power from this source is supplemented either by construction of a new baseload coal-burning station (options 1 and 2) or by burning oil at Marsden Point (option 3).

TABLE 1

South Island	**GWh fourteen year totals 1980/81 to 1993/94**
South Island mean-year generating capacity (all renewable)*	198,823
minus South Island projected demand (without new smelters) central forecast	122,200
Gives total South Island excess supply	76,623
minus exports to the North Island via the Cook Strait cable @4.200 per annum	58,800
gives UNCOMMITTED SOUTH ISLAND SURPLUS	17,823

*Excluding Clutha, since this is yet to be finally approved, but including the Upper Waitaki stations.

North Island	**GWh fourteen year totals 1980/81 to 1993/94**
North Island mean-year generation from renewable sources (hydro and geothermal)	122,608
plus imports from South Island via Cook Strait cable (minus 10% transmission loss)	52,920
gives total electricity from renewable sources available for North Island	175,528
Compare this with projected North Island demand, which is:	235,800
and we have the **deficit** of power from renewable sources (that is the amount that must come from fuel-burning stations)	60,272

Source: All data is drawn from the 1979 Report of the Planning Committee on Electric Power Development, with North and South Island demand dis-aggregated on the basis of information supplied by NZED.

Keith Johnston (left), and Geoffrey Bertram discuss a point in their report.

Our figures make allowance for the gains to the national grid from transmission savings as long-distance transfers of power over the Cook Strait cable are reduced; and we have included also an allowance for the cost, year by year, of providing for dry-year firming of the national system.

The results are simple and striking. During the next 10 years, New Zealand can supply up to 5000 GWh per year of extra electricity at a marginal cost of less than one cent per kWh. Between 1989 and 1995, however, the cost trebles in real terms, to about three cents per kWh.

Any supply contract which is to last beyond 1990 must take into account this trebling of the real cost of supply in the early 1990s.

The leading contenders for our cheap electricity at present seem to be aluminium smelting companies, which are signing contracts elsewhere in the world for long-term electricity supplies at prices of about 1.5 cent per kWh, with no escalation.

Our figures in Table 2 suggest that New Zealand cannot afford to offer long-term supply contracts which would be competitive with this, unless a conscious decision is made to pay very large subsidies to induce smelting companies to locate here.

Long-term sales at 1.5 cents per kWh would imply that from 1990 on we would be paying an electricity subsidy which would be over one cent per kWh by 1995, and could be as high as two cents per kWh. On a 5000 GWh annual sale this implies an annual subsidy of over $50 million.

Perhaps surprisingly, similar conclusions apply to smaller bulk sales aimed to mop up the "surplus". Power for a third pot-line at the Bluff smelter, for example, would have virtually the same cost profile as the larger sales shown in Table 2.

What we are saying in essence is that the New Zealand electricity surplus is a finite and rapidly-depleting resource, and that plans for its utilisation should take this into account. Long-term cut-rate supply contracts are unlikely to prove an appropriate use.

TABLE 2

Cost of Supplying Extra 2000 GWh and 5000 GWh
cents/kWh

	Option 1 Clyde & New Baseload Coal Station	**Option 2** Advance Clutha & Baseload Coal	**Option 3** Advance Clutha & Oil
2000 GWh sold			
1983/84	0.89	0.89	0.89
1984/85	0.62	0.62	0.62
1985/86	0.64	0.64	0.64
5000 GWh sold			
1986/87	0.87	0.87	0.87
1987/88	0.90	0.90	0.90
1988/89	0.96	0.96	0.96
1989/90	1.33	1.58	1.58
1990/91	1.61	2.25	2.25
1991/92	2.13	2.66	2.66
1992/93	2.45	2.54	3.40
1993/94	2.50	2.67	3.58
1994/95	2.59	2.82	3.77

Option 1: Assumes that a new Waikato coal-fired station would be commissioned by 1989/90 and the Clyde dam would be commissioned in 1991/92. The feasibility of the coal station is uncertain. This casts doubt on the realism of this option.

Option 2: Assumes that the Government advances the Clyde dam completion date to 1989/90 and the Luggate dam is commissioned in 1991/92. A Waikato coal-fired station is commissioned in 1992/93. Some oil-fired generation is required in mean years in 1990/91 and 1991/92.

Option 3: As for option 2, without a Waikato coal-fired station. Oil is burnt in mean years from 1990 onwards. Recent Government statements appear to favour this option. □

Load shedding

From our Political Correspondent

The Government is once again finding Comalco a tough customer when it comes to getting a "fair and reasonable" price for South Island electricity.

The price has been agreed upon by both parties, after months of negotiations, but a signing ceremony is still some time away because of difficulty with final details.

New Zealand Engineering understands the hitch involves the question of load shedding – the system whereby the Electricity Division of the Ministry of Energy or the local electricity authority shuts down power to a big industrial consumer because of an emergency or some other reason.

The final price for power that Comalco pays for the third potline may never be made public, but it is expected to be dearer than the power for the first and second potlines.

Negotiations are continuing on the price Comalco should pay for power when load is shed.

Comalco has an arrangement in its contract for shedding load on the two existing potlines.

The current exercise between Comalco and government officials is to decide the best and fairest way of apportioning the cost of the electricity Comalco loses.

Comalco naturally would want to shed the dearest load factor, but the Electricity Division wants to grab the best price it can get for the electricity.

If the Government load sheds because of some emergency, such as a generator or station breaking down, the question is how much does Comalco pay for the electricity it gets if that emergency puts one of its potlines out of commission.

Planners revising estimates

Energy planners appear to be revising original estimates about how much power New Zealand will have for the likes of Comalco.

The original estimate of 5000 GWh has been revised downwards to 2000 GWh. This is the amount they believe can be made available on the basis of future demand over the next 15 years.

Much depends on the weather. A dry summer could disrupt the electricity flow from the hydro plants and force a reduction in the "surplus" available to industry.

Peaks and lows

One reason aluminium smelters get power at a lower price than other industries is because of their constant demand, without the peaks and lows. The smelter runs 24 hours a day.

The interesting thing about setting an electricity price is that the company or officials don't know the demand until the demand is set.

Consequently, they have been analysing the whole question of power for big, new projects in the South Island much more closely than originally intended.

Energy savings

Energy savings of 10 percent could be made by improving the operational efficiency in New Zealand's food manufacturing industry without any major plant alterations.

This is one conclusion of *Report 54, Energy Use in the Food Manufacturing Industry*, which was recently released by the New Zealand Energy Research and Development Committee.

The survey, carried out by the Food Technology Research Centre at Massey University, was conducted, firstly, by a postal questionnaire being sent to 437 factories. Detailed energy surveys were then made of 74 factories.

The report also found that, in the longer term, further energy savings of 15-20 percent may be possible by replacing old equipment with more efficient, modern plant, better matching of factory services to the energy needs of processing equipment, installation of heat recovery plant, and greater use of direct-fired plant to replace indirectly-heated equipment.