FAST-TRACK SELF-SUFFICIENCY: AN ALTERNATIVE ENERGY PLAN

A discussion paper by

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FAST-TRACK SELF-SUFFICIENCY : AN ALTERNATIVE ENERGY PLAN

1. INTRODUCTION

The New Zealand Planning Act (1977) directs the Commission for the Future to have regard for prospective trends, policies and events in New Zealand and overseas which could have important consequences for the country's future. The policies outlined in the 1980 Energy Plan and their likely consequences would seem to meet this criteria.

New Zealand, along with many other countries, is presently experiencing a transport fuels crisis. Recognising this fact, the 1980 Energy Plan prepared by the Ministry of Energy provides a blueprint by which New Zealand's current 15% self-sufficiency in transport fuel can be increased to 50% self-sufficiency by 1987.

New Zealand's external oil bill for 1980 is predicted to be about $1,400 million, or 27% of total export receipts for the 1979/80 year, a figure exceeding the balance of payments deficit of $966 million for the same period. Even if all targets and assumptions implicit in the 1980 Energy Plan are achieved, the change in the external oil bill will be minimal by 1990. However, without implementation of the Plan, a continuation of the present 15% self-sufficiency in transport fuel probably would result in a drastic increase in the oil bill.

On the other hand, if key assumptions in the 1980 Energy Plan, in particular the projections for future oil prices, are not met, then the effect on the external oil bill may be equally drastic.

This paper considers the early achievement of total self-sufficiency in transport fuels as a possible option for New Zealand, and outlines an accelerated development strategy by which this aim can be met.

Sustainability

The concept of sustainability is becoming increasingly important in long-term energy planning. Sustainability is a criterion for judging the use of a resource. A sustainable strategy for the use of a resource is one which does not degrade the long-term ability of the earth to continue to produce that resource. A sustainable strategy can be continued in perpetuity.

New Zealand currently has a transport fuel crisis because the importation of foreign oil is not a sustainable strategy. Inevitably, foreign oil resources will be depleted, but long before this happens the price of foreign oil will have become unacceptably high.

None of the transport fuel developments outlined in the 1980 Energy Plan are sustainable. A reduction in New Zealand's dependence on one non-renewable resource (foreign oil) is achieved by increasing her dependence on another (indigenous natural gas). Eventually New Zealand will have to rely on renewable resources for transport fuels, but the 1980 Energy Plan does not show how the required transition is to be achieved.

Scope

'Energy Strategy 79' (published by the Ministry of Energy) gives the following breakdown of primary energy consumption (in PJ = 10^{15} joules) for 1978:

coal	imported oil	indigenous oil	natural gas	electricity	total
49PJ	166PJ	26PJ	59PJ	60PJ	360PJ
13.6%	46.1%	7.2%	16.4%	16.7%	100%

Recently, there has been debate over the commitment of surplus hydro-electricity to energy-intensive industries such as aluminium smelting. This paper does not consider electricity, because it is an indigenous resource and problems arising from its production or use are also indigenous.

In 1978, imported oil represented almost half of primary energy consumption. Problems over its availability (or price) are largely beyond New Zealand's influence, and so to the writer assume a greater importance. Although styled an alternative energy plan, this paper addresses only the issues raised by New Zealand's heavy dependence on imported oil as an energy source.

2. AN ANALYSIS OF THE 1980 LIQUID FUELS PLAN

"Would you tell me please, which way I ought to go from here?" said Alice. "That depends a great deal on where you want to get to," said the Cat. "I don't much care where - ," said Alice. "Then it doesn't matter which way you walk," said the Cat.

- Alice in Wonderland, Lewis Carroll

2.1 Summary

Even if the assumptions, targets and strategies implicit in the Plan are achieved, the effect on New Zealand's external oil bill in 1990 will be small. Without the development projects outlined in the Plan, the growth in the oil bill almost certainly would become excessive. However, if key assumptions, particularly the projections for future oil prices, are not met, the growth in the oil bill could still become excessive, even if these development projects are accomplished.

2.2 Review of Recent Decisions

To reduce New Zealand's dependence on imported oil, the following strategies have been adopted:

i. Synthetic gasoline production - a Memorandum of Understanding has been entered into with the Mobil Oil Corporation for the development of a synthetic gasoline plant to come on stream in 1985. This plant will produce 583,000 t of synthetic petrol per year from 55PJ of natural gas, about one third of petrol requirements.

ii. Refinery expansion - an expansion of the Marsden Point refinery, incorporating a hydrocracker designed to increase diesel yields, is planned to come on stream in 1984.

iii. National strategic petroleum reserve - an additional 22 day supply of diesel is being stockpiled as a contingency measure.

iv. Diesel rationing, carless days - introduced to lower diesel and petrol consumption.

v. Bulk LPG facilities - a nationwide bulk LPG (liquefied petroleum gas) distribution system is planned for completion in 1982.

vi. CNG and LPG conversions - the government has set a target for having 150,000 vehicles converted to CNG (compressed natural gas) operation by 1985. LPG targets will be established when the bulk LPG facilities are further advanced.

These strategies, especially the synthetic gasoline plant and the CNG and LPG conversions will give New Zealand 50% overall self-sufficiency in transport fuels. However, the country will still be heavily dependent on crude oil imports for production of diesel and avtur* at the extended refinery. If these distillates become in short supply (for instance, by an oil embargo or by excessive pricing) it is heavy road and rail freight and public transport systems which will be affected first. A feature of the Liquid Fuel Plan is that greatest self-sufficiency is achieved in fuel supplies for the private motoring sector.

*jet fuel

2.3 Disaggregated Demand (derived from 1980 Plan, Energy Strategy '79)

Column a below is the oil demand for the 1978/79 year. Of the total demand of 192PJ:

i. 166PJ (86%) was met from oil imports
ii. 26PJ (14%) was met from indigenous resources

The fuel component (41.3PJ) includes 5.4PJ used in oil-fired electricity generating stations.

Column b is the "expected" forecast oil demand for 1989/90. The 1980 Energy Plan includes "low, "expected" and "high" forecasts given weightings of 20%, 60% and 20% respectively. The M-gasoline component (28.6PJ) is expressed as an oil equivalent; in fact 55PJ of natural gas is converted at 53% efficiency to this quantity of synthetic gasoline. The fuel oil component (26.7PJ) excludes any oil used for electricity generation. In the context of recent commitments of surplus electricity to energy intensive industries and given a dry year, oil demand for electricity generation in 1989/90 may exceed substantially the 1978/79 demand (5.4PJ). The total demand forecast (196.4PJ) may be a low estimate.

a. 1978/79 (historical)		b. 1989/90 ("expected" forecast)	
petrol	83.5PJ	petrol	48.9PJ
		CNG/LPG	11.9PJ
		M-gasoline	28.6PJ
avtur	13.6PJ	avtur	21.9PJ
diesel	50.9PJ	diesel	56.3PJ
fuel oil	41.5PJ	fuel oil	26.7PJ
kero, avgas	2.6PJ	kero, avgas	2.2PJ
	192.0PJ		196.4PJ

2.4 Indigenous Transport Fuel Resources in 1989/90 (derived from 1980 Plan)

New Zealand's proven gas resources at 1 January 1980 are:

Maui field	5,427PJ	413PJ condensate
Kapuni field	489PJ	136PJ condensate

While further gas (and oil) finds are possible, these cannot be guaranteed. The McKee 2 oil strike (1% of present requirements, with an unknown life) has not been included in the analysis.

The government has accepted the recommendation of the Liquid Fuels Trust Board that cumulative "take or pay" quantities be accepted as the guideline for the rate of gas extraction. On this basis, the gas draw off in 1989/90 is likely to be 165PJ/y (Maui) and 15PJ/y (Kapuni) indicating an average condensate yield of:

$$\text{(Maui)} \quad 165\text{PJ/y} \times \frac{413\text{PJ}}{5{,}427\text{PJ}} = 12.5\text{PJ/y}$$

$$\text{(Kapuni)} \quad 15\text{PJ/y} \times \frac{136\text{PJ}}{489\text{PJ}} = 4.2\text{PJ/y}$$

or 16.7PJ/y total condensate. However, the 1980 Energy Plan requires 32.5PJ of condensate in 1989/90, illustrating the higher condensate yields expected during the early part of the extraction. (At 32.5PJ/y the resource would last 16.9 years, not thirty years as envisaged.) Using this higher rate of extraction, the total indigenous transport fuel resource for 1989/90 is 73.0PJ viz:

LPG and CNG	11.9PJ
M-gasoline	28.6PJ
condensate	32.5PJ
	73.0PJ

2.5 Transport Fuel Demand in 1989/90 (derived from 1980 Plan)

Excluding bunkers, the "expected" forecast for internal transport fuel demand in 1989/90 is 145.2PJ viz:

petrol	48.9PJ
LPG and CNG	11.9PJ
M-gasoline	28.6PJ
avtur	8.4PJ
diesel	47.4PJ
	145.2PJ

The indigenous transport fuel production (73.0PJ, paragraph 2.4 above) represents 50.3% of total transport fuel demand (145.2PJ), demonstrating that the 50% self sufficiency target implicit in the 1980 Energy Plan is achievable.

2.6 Required Oil Imports in 1989/90 (writer's estimate)

The total demand for oil and substitutes (excluding oil used to generate electricity) is 196.4PJ (paragraph 2.3). Indigenous resources are 73.0PJ (paragraph 2.4). The difference represents oil which has to be imported viz:

196.4PJ - 73.0PJ = 123.4PJ

This quantity has to be corrected for the refinery efficiency of 0.90 (3.62Mt input, 3.27Mt output) viz :

123.4PJ/0.90 = 136.8PJ of oil required in 1989/90.

(As a consistency check, crude imports (2.92Mt) plus net refined product imports (0.20Mt) total 3.12Mt, equivalent to 143PJ using an approximate conversion factor of 46GJ/t.)

2.7 Impact of Oil on the New Zealand Economy

Table 1 shows recent increases in the price of oil ($US/bbl for light Saudi crude), New Zealand's monthly oil costs, New Zealand's total monthly imports and exports for comparison and oil costs expressed as a percentage of both imports and exports.

Table 1

	quarter	oil price $/bbl	oil imports $x10^6/month	total imports $x10^6/month	total exports $x10^6/month	oil as % of imports	oil as % of exports
1979	1st	20	41	281	367	15	11
	2nd	28	55	346	396	16	14
	3rd	34	57	355	347	16	16
	4th	40	69	401	426	17	16
1980	1st	37	103	422	464	24	22
	2nd	36	86	413	480	21	18

A 1980 oil bill of $1,400 million quoted by several authorities is consistent with monthly oil imports of $116 million, or oil at $US37 a barrel, in broad agreement with the trends apparent in Table 1. New Zealand's export receipts over the 1979/80 year totalled $5,150 million; an oil bill of $1,400 million would consume 27% of these earnings.

2.8 New Zealand's Oil Bill in 1989/90 (writer's estimate)

$1,400 million has been quoted as New Zealand's likely oil bill for 1980, required to meet a demand of 166PJ (1979/80). The 1980 Energy Plan uses an "expected" for cost of $40/bbl for oil prices in 1989/90 (bbl = 159litres). Accordingly the 1989/90 oil bill can be derived roughly from:

$$\$1{,}400 \text{ million in } 1980 \times \frac{136.8\text{PJ in } 1989/90}{166\text{PJ in } 1979/80} \times \frac{\$40/\text{bbl in } 1989/90}{\$30/\text{bbl in } 1979/80}$$

$$= \$1{,}538 \text{ million}$$

i.e. up 9.9% on the estimated 1980 bill

This figure supports an important assertion of this paper viz that even if all targets and assumptions implicit in the 1980 Energy Plan are met, the change in the external oil bill in 1990 will be minimal. Many economists would consider this to be a remarkable achievement, given the alternatives.

3. THE FUTURE COST OF OIL

"We do not see things as they are. We see them as we are."

Margaret Pullar

3.1 Future Oil Price Estimates

The 1980 Energy Plan uses the three sets of forecasting parameters for energy demand given in Table 2:

Table 2

	"low"	"expected"	"high"
probability weighting	20%	60%	20%
growth of GDP	1%	2%	3%
real oil prices $/bbl (1980 dollars)			
March 1980	30	30	30
March 1985	44	37	33
March 1990	48	40	35
March 1995	50	42	37
The method used in paragraph 2.8 gives New Zealand's future oil bill ($x10^6) as			
1980	1400	1400	1400
1990	1846	1538	1346
change in oil bill over decade 1980/90	+31.9%	+9.9%	-3.9%

Since the 1973 oil crisis, many attempts to forecast future movement of oil prices have been made. A striking feature of most forecasts has been the tendency of the forecaster(s) to grossly underestimate the ability of the oil producing states (particularly the OPEC cartel) to raise arbitrarily the price of their oil.

In 1978, when oil was $11.50/bbl, Hughes amd Mesarovic (Futures, August 1978, p.267) predicted the 1982 oil price to be $12.20, increasing to $12.90 by 1990. Other respected futurists have fared worse.

A Ministry of Energy paper presented to a seminar on energy forecasting in November 1979 offered the predictions given in Table 3 below, based on "a delphi-type survey of expert opinion in New Zealand". The figures in parentheses are the corresponding updated values contained in the 1980 Energy Plan and given in Table 2. These were presumably prepared about six months later. "Low" and "high" in the context of the 1979 delphi survey represent 90% confidence limits viz 90% of the experts chose values between these limits.

Table 3 oil prices ($/bbl)

	"low"	"expected"	"high"
1980	19 (30)	19 (30)	19 (30)
1985	39 (40)	28 (37)	20 (33)
1990	44 (48)	31 (40)	23 (35)
1995	47 (50)	32 (42)	23 (37)

The poor performance of energy forecasters in predicting oil prices simply demonstrates that the price of oil is established by future geopolitical events rather than by historical trends. Extrapolative forecasting is singularly ineffective.

Clues to future price increases can be found by considering (i) OPEC policy on oil pricing strategy which, although widely promulgated, has been largely ignored by western nations, (ii) likely future geopolitical developments.

i. OPEC Pricing Policy

"History will record it was OPEC that first drew attention to the energy crisis by assuming responsibility for the administration of oil pricing. The OPEC message to the consuming nations underlined certain unpalatable truths:

- oil reserves belong to producer nations, not multinational oil companies;
- oil was being extracted at increasing rates, and, for many producers their only marketable asset, would soon reach exhaustion;
- oil as a non-renewable resource was underpriced.

"The emerging OPEC strategy is to extend the life of the oil resource to allow member nations to transform it into permanent assets through development and industrialisation. Some OPEC countries already are encountering difficulties in converting their oil receipts into real wealth. Consumers must accept progressive increases in the price of oil in real terms (i.e. above inflation rates) so that the price reflects replacement cost well in advance of the time when actual scarcity of oil threatens the transition to alternatives to oil.

"Consumers must accept in a responsible way the efforts of OPEC to protect its oil revenue, and its use of the oil pricing mechanism as the only incentive for the development of alternative energy sources in the longer term. Thus far, there has been little evidence of a genuine desire by consumer countries to regard OPEC other than as an adversary. OPEC, is, and must be, interested in the economic health of the consumer countries to retain the markets for its oil and gas ..." Source: OPEC Secretary-General (in OPEC Review, Vol.3, No.3 1979).

"Many member countries of OPEC are now convinced that conservation of their resource through production cutbacks is the most sensible politico-economic choice facing them. A number of factors may be cited for this attitude:

- OPEC governments (not oil companies) now decide production levels;
- oil is an exhaustible resource;
- the original hopes of rapid modernisation and industrialisation have faded, so that the life span of the oil revenues must now be extended to allow these evolutionary processes to occur;

- OPEC funds invested abroad have been eroded by inflation, and have made the concept of storing oil wealth as untapped oil more attractive;
- fears of the consequences of excessive investment, as in the case of Iran;
- OPEC countries see little being done in the way of conservation in the industrial world;
- rising OPEC domestic demand;
- a realisation that supply reduction is the key to price increases, and gives enormous political power which they can exercise to their own benefit;
- oil exporters can obtain value-added through refining and petrochemicals.

"A number of OPEC countries have publicly declared their intention to cut back production. Others, in particular Saudi Arabia, have exceeded their production ceiling as a concession to the industrialised world, but their position is likely to change because of domestic political pressures and their inability to influence the oil market in a significant way.

"The oil market of the 1980s promises to be tight, with continuous shortages in petroleum availability and pressure on oil prices, causing them to rise in real terms to perhaps around $80 per barrel in constant 1980 prices and over $140 per barrel in current prices by 1990."
Source: Dr F. Fesharaki (in OPEC Review, Vol.4, No.2, 1980).

ii. Likely Future Geopolitical Developments

"World oil production has reached its peak and will decline during the 1980s because of both technological and political restraints. This situation sets the stage for an east-west competition for mideast oil, adding another potentially destabilising ingredient to an area which already has experienced wrenching political events in the past year or so.

"Output in the Persian Gulf countries will at best remain near current levels; production in other OPEC countries will fall; OECD output will begin to drop after the mid 1980s (including both Alaskan and North Sea production); and Communist countries will shift from a net export to a net import position in oil.

"Simply put, the expected decline in oil production is the result of a rapid exhaustion of accessible deposits of conventional crude oil. In the 1970s total new oil discoveries were probably no more than half as large as depletion. Even with new technology the chance of finding new giant fields is diminishing.

"The present high rate of depletion is causing producer countries to revamp their oil production policies. They take a longer view than did the private oil companies, and see oil left in the ground as a better investment than excessive oil revenues placed in foreign money markets.

"Production in the United States probably will continue to decline despite heavy drilling activity.

"Production in the USSR is expected to peak this year and then to decline steadily through the decade.

"Under optimistic assumptions, free world oil supplies will decline slowly if there are no major disruptions. On the other hand, OPEC production cuts for whatever motive could mean a substantial drop in supplies over the decade.

"Taken together the western and Soviet outlook sets the stage for an east-west competition for mideast oil. Competition for available oil supplies not only will put added pressure on east-west relations, it will strain relations among the industrialised western nations themselves. The going will get tougher as the decade progresses.

"Politically the cardinal issue is how vicious the struggle for energy supplies will become." Source: Admiral S. Turner, Director, US Central Intelligence Agency (23 April 1980 to US Senate)

"Across borders, there is Iraq's frontier dispute with Kuwait; Iran's dormant claim to Bahrain; the old tribal rivalry between Saudi Arabia and the United Arab Emirates; South Yemen's assertive eye on Oman and North Yemen. Within borders, there is the smouldering dispute in Saudi Arabia between western-looking modernisers and inward-looking Islamic purists; the tension in Iraq and Bahrain between Sunni and Shia Moslems; the fact that at least a third of the people living in Kuwait and many of those in the small states farther south, are dispossessed Palestinians. Not all of these problems, perhaps not many of them, will erupt in ways that will interrupt the flow of oil; that one or more of them will, over the next few years, is a near-certainty." Source: The Economist, September 27 1980

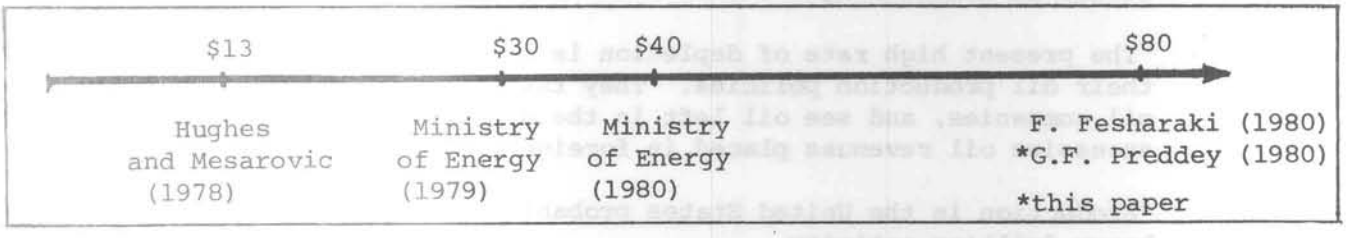
Conclusion: Real Price of Oil in 1990

Taking into consideration:

i. systematic tendency of forecasters to underestimate oil price rises;
ii. OPEC strategy viz cuts in production, increases in real cost to match that of alternatives to oil;
iii. geopolitical determinants viz east-west competition for mideast oil, declining production;
iv. OPEC's demonstrated ability and willingness, to increase arbitrarily the price of their oil;
v. OPEC - linked indications of $80/bbl by 1990;

the "expected" oil price in 1990 assumed for the 1980 Energy Plan appears unduly optimistic to the writer. A figure of $80/bbl is suggested tentatively (refer (i) above).

(A figure of $40/bbl by 1990 would require a real growth from $32/bbl in 1980 of only 2.2% per year.)



3.2 The Future Impact of Oil on the New Zealand Economy

By its use of "low", "expected" and "high" forecasting parameters, the 1980 Energy Plan encapsulates a relationship between energy demand, population growth, economic growth and the price of oil. There is no plausible way by which New Zealand's economic growth or population growth will influence the price of oil. Accordingly the price of oil must influence economic growth and population growth. Reactive/supportive planning (defined in paragraph 4) is encapsulated in the 1980 Energy Plan.

If indeed the real price of oil rises to $80/bbl by 1989/90, as explained above, then New Zealand's 1989/90 oil bill can be derived (following the method of paragraph 2.8) as:

$$\$1{,}400 \text{ million in } 1980 \times \frac{136.8 \text{PJ in } 1989/90}{166 \text{ PJ in } 1979/80} \times \frac{\$80/\text{bbl in } 1989/90}{\$30/\text{bbl in } 1979/80}$$

$$= \$3{,}077 \text{ million}$$

(i.e. about twice the 1980 bill)

On the assumption that New Zealand's exports grow proportionately with GDP at 2% ("expected" forecast), then they will rise from $5,150 million in 1979/80 to $6,278 million in 1989/90. The 1989/90 oil bill derived above will represent 49% of export receipts.

It can be argued that energy demand would react (by decreasing) if oil reached $80/bbl. Assuming "low" energy demand parameters, the 1989/90 oil bill would be about $2,730 million, or 44% of export receipts. Clearly, in the context of the 1980 Energy Plan, an oil price of $80/bbl would have considerable impact on the economy.

The remainder of this paper anticipates this eventuality by arguing for an accelerated effort to achieve total self-sufficiency in transport fuels. The argument, however, is not seriously weakened if oil prices do in fact rise only to $40/bbl, as assumed in the 1980 Energy Plan.

4. REACTIVE, SUPPORTIVE, AND ANTICIPATORY PLANNING

I add, almost to myself, "You look at where you're going and where you are and it never makes sense, but then you look back to where you've been and a pattern seems to emerge. And if you project forward from that pattern, then sometimes you can come up with something."

from Zen and the Art of Motorcycle Maintenance, R.M. Pirsig

4.1 Definitions

Harpham (1980) identifies three types of planning:

1. reactive
   - intended to produce an immediate response to events;
   - aiming to preserve the status-quo;
   - based on the assumption that the future will be like the past.

2. supportive
   - intended to support and advance the current development strategy;
   - aiming to control the future on the basis of the goals and perceptions of the majority of people today;
   - based on the assumption that the future will be like the past.

3. anticipatory
   - intended to affect the future and produce a change in the current development path;
   - giving importance to the goals and perceptions of established minority groups and pressure groups;
   - taking account of the results of long term futures research;
   - concerned with effects on the whole structure of society.

Planning in the real world may show elements of all three types, but generally the reactive and supportive approaches in the past have predominated over the anticipatory approach.

In reactive planning, events themselves are the stimulus for decisions to be made. Attention is directed towards problems of pressing concern. Attention to lesser issues is deferred. An example is New Zealand's response (by demand restraint regulations) to the oil crises of 1973 and 1979, events predicted decades ago. Another example is the intensive lobbying to maintain New Zealand's traditional lamb and butter exports in the face of mounting EEC protectionism. The creation of a national strategic petroleum reserve is reactive planning encapsulated in the 1980 Energy Plan and derives from the critical diesel shortage during 1979.

The 1980 Energy Plan also contains elements of supportive planning. For example the decision to begin synthetic gasoline production in 1985 will help to maintain the pre-eminence of the private motor car within New Zealand society. (There are 0.39 vehicles per head in New Zealand, exceeding the ratio for Western Europe (0.25 vehicles per head), but not the United States (0.51 vehicles per head). The cost of importing vehicles and parts ($300 million), and the cost of foreign oil refined to motor spirits (another $650 million) represents 20% of total imports into New Zealand in 1979/80. Including roads, motorways and service infrastructure increases the cost of the private motor car to about the expenditure on education ($1,009 million) or on health ($1,136 million) in 1979/80. These figures emphasise the influence of the private motor car in the New Zealand economy.)

An anticipatory response requires a concern to take action before an event happens, so as to minimise its possible adverse effects. In energy planning for example, the issue of whether foreign crude oil will continue to be available (at a price New Zealand can afford) might be addressed. So too might the wisdom of channelling one fifth of imports into a single mode of transport, the private motor car. The motor car, undoubtedly was an attractive option when oil was $1.20 a barrel, and for almost three decades the New Zealand subdivision was planned (reactively) around it. The private motor car may make less sense in anticipatory planning, notwithstanding the fact that any major shift in reliance on it for personal mobility would have major social consequences.

Duncan (1980) identifies essential differences between reactive and anticipatory planning in the way each balances economic costs and social costs. Reactive planning attempts to minimise immediate problems, turning them to economic advantage wherever possible. The consequential costs incurred may be overlooked, often because they are difficult to quantify (higher unemployment, environment degradation etc). Anticipatory planning may be no more successful in assessing these consequential costs. It does, however, recognise their existence and regards their solution as a prime objective. To quote Duncan: "anticipatory planning is mainly people-oriented, and is founded in an ethical sense of humanism - the concern with the total welfare of people in different ethnic, social, geographical strata of society, with these in different (and future) generations, and with harmony with nature."

4.2 Hypothetical Case Study

A small, remote country with little indigenous oil but reasonable gas and coal resources is facing a chronic balance of payments deficit caused by a growing oil bill. Conditioned by several decades of cheap oil, the citizens of this country are highly dependent on their private motor cars for mobility, so much so they spend as much on them as on health or education services. There is also considerable concern about threats of disruption to the country's oil supply.

1. reactive solution

   The price of petrol is increased steeply. Demand restraint measures, such as carless days and weekend garage closures, are introduced by regulation. A strategic petroleum reserve is created. Conservation is stressed.

   The effect is to restrain demand only slightly. Higher transport costs cause inflation and the cost of living to increase. The demand restraint measures cause some social disharmony by their uneven burden on different sections of society.

2. supportive solution

   Increased self-sufficiency through the exploitation of the country's natural gas resource becomes a priority objective. Some vehicles are converted to run on either CNG or on LPG. A synthetic petrol plant using natural gas is built, requiring imported technology. Later, to further reduce oil imports (now very expensive), a second synthetic plant using lignite as a feedstock is built.

   The synthetic gasoline plants achieve a major saving in oil imports, but at considerable capital cost (and environmental cost in the case of the lignite plant). Synthetic gasoline is freely available, but expensive. The capital-intensiveness of the synthetic fuel programme diverts resources from other areas of the economy, but creates few jobs once the plants are operating. This consequence worsens the unemployment problem.

3. anticipatory solution

A major effort is made to achieve transport fuel self-sufficiency by a critical path strategy. Initially this aim is achieved by maximising the use of natural gas derivatives viz CNG, LPG, synthetic gasoline and methanol. When self-sufficiency is largely achieved, the effort then turns to the development of sustainable energy resources which can then be substituted for natural gas. These might include biogas as a CNG substitute, methanol and ethanol from biomass and electricity in commuter vehicles.

The target of self-sufficiency requires a correction of the societal distortions created by several decades of underpriced oil viz the undue dependence on, and disparate allocation of resources to, the private motor car. Energy-saving alternatives (improved public transport and telecommunications, greater suburban self-sufficiency, bicycles etc) receive active encouragement.

Respective merits of reactive, supportive and anticipatory planning

A reactive response may be required to cope with an unforeseen event. Supportive planning may be adequate for a sustainable development strategy which has the support of the majority of people, but it requires that no major surprises occur in the future.

In a turbulent world, with major discontinuities seemingly inevitable, anticipatory planning offers some hope of minimising the impact of these. It does, however, create problems in identifying the discontinuities before they occur and in assessing changes which are required in the development path if it is to accommodate them in the future.

An apparent advantage of reactive and supportive planning is that goals and perceptions of the majority of people today are not challenged. Anticipatory planning is likely to be publicly less acceptable because it may challenge the status quo and any relative advantage awaits predicted future dislocations and so is more intangible.

References: M. Harpham 'Communications and Information Policy', internal paper for the CFF, to be published 1980

J.F. Duncan 'Trade-offs' (ibid)

4.3 Considerations Underlying the Alternative Energy Plan

1. economic

New Zealand's oil bill is a major contributor to her present economic problems - recession, inflation and balance of payments deficit. An energy strategy which reduces the external oil bill to pre-1973 proportions would remove this source of economic stress.

2. short term strategic

World oil production is predicted to decline, due both to politically-motivated cutbacks and to the depletion of the oil resources of the US, USSR and several other major producers. The continuity of supply is threatened by Middle East instability. A total cutoff of Gulf states' oil is conceivable and could be disastrous for the developed world.

Early self-sufficiency in transport fuels is an anticipatory development option which obviates the economic and strategic concerns noted above.

3. longer term strategic

An inevitable depletion of non-renewable energy resources must necessitate a shift to renewable energy resources at some time in the future. The development of alternatives to the present reliance on imported petroleum will have, by the scale of the transition, major economic and social implications. If these alternatives in themselves are not sustainable, the major dislocation of the transition to renewable resources will have been only deferred and may indeed be exacerbated by the delay.

The introduction of sustainable energy alternatives in the near future may solve the present liquid fuels crisis without planting the seeds for another one.

4. social

Unemployment is becoming one of the major issues for the future. As resources, capital and labour become more expensive, the growth of the workforce seems likely to outstrip the growth of new jobs. Capital-intensive projects which create few new jobs (e.g. aluminium smelters) are likely to worsen this trend, unless they generate downstream activity. Projects which are labour-intensive may offer real advantages for a work-short society.

5. psychological

New Zealanders may conceivably prefer to see to the development of alternative energy resources which draw heavily on indigenous enterprise and skills, rather than those which rely on the importation of foreign technology provided by multinational corporations.

6. phasing

An option for New Zealand consistent with the considerations listed above would be the development of alternative energy sources which:

i. allow self-sufficiency in transport fuels as quickly as possible;
ii. are sustainable i.e. derive from renewable energy resources;
iii. draw heavily on indigenous enterprise and skills and in so doing create significant employment.

The development of sustainable transport fuel sources has hardly begun (except in Brazil), and is likely to be a slow process. Consequently, a conflict over time scale could arise between criteria (i) and (ii). This conflict could be resolved by recognising the respite that the Maui gas field provides, and accordingly by splitting the development process into two phases:

phase 1: achievement of total self-sufficiency in transport fuels as quickly as possible by maximising the use of natural gas and its derivatives viz CNG, LPG, synthetic gasoline, methanol, but anticipating

phase 2: substitution of sustainable alternatives for (non-renewable) natural gas. These might include biogas as a direct substitute, methanol and ethanol derived from biomass by several routes, and electric commuter vehicles as a replacement for some types of liquid-fuelled vehicles.

7. anticipatory

Both phases will require anticipatory planning to succeed. For example:

i. The roles of methanol and synthetic gasoline in phase 1 (self-sufficiency) have to be reconciled with the achievement of phase 2 (sustainability).

ii. Because liquid fuels from renewable resources will not be cheap, the pattern of fuel-use established during the era of underpriced oil (ca 1950-1973) may not be viable. (It was only viable during 1973-1980 through external borrowing.) Energy-saving alternatives (e.g. improved public transport and telecommunications, greater urban self-sufficiency, bicycles) must be integrated into both phases of the plan.

iii. Anticipatory planning will be required to derive maximum social benefit from the labour-intensiveness of certain elements of the plan, for example:

- (phase 1) vehicle conversions, establishment of alternative distribution networks, construction of methanol and synthetic gasoline plants;

- (phase 2) establishment of decentralised biogas and alcohol plants, development of indigenous electric vehicle technologies;

- (both phases) upgrading of public transport and telecommunications systems, bikeways, improvements to urban self-sufficiency which reduce the requirement for cross-city travel.

8. vulnerability

The continuity of New Zealand's present oil supply is threatened by Middle East instability. This threat would be largely removed if transport-fuel self-sufficiency was achieved by the route outlined above. However, New Zealand, for a period, would then be vulnerable to an accident at the Maui offshore platform (blowout, collision, capsize etc). The 1980 Energy Plan also increases New Zealand's vulnerability to this kind of mishap, but to a lesser extent.

Energy supplies would become relatively secure when sustainable alternatives to Maui gas became available. Decentralisation of energy supplies may become an effective insurance against disruption, especially if world conflict becomes more endemic.

5. THE FUTURE OF THE MOTOR CAR

"We must run our economy on a leaner mixture of capital and a richer mixture of labour. Such a resource-conserving, full-employment, less-inflationary economy would, of course, be an environmentally benign economy also."

from Creating Alternative Futures - The End of Economics, Hazel Henderson

Futurists are generally agreed that rapid changes have placed humankind at a critical point in history, but differ in their own visions of the emerging "post-industrial" society. Some, like Herman Kahn, see a "super-industrial" society in which advanced science and technology become central pursuits. Large scale technological fixes overcome problems caused by resource depletion, energy shortages, and population growth. Other futurists, like Hazel Henderson, see the new frontiers as social rather than technological. The local community is strengthened by decentralisation. New technology is small scale, resource conserving and environmentally benign.

New Zealand citizens today place considerable value on the private motor car. Whether in the future they will continue to, or indeed be able to, is at least open to question. To explore this uncertainty further, two contrasting views of the role of the private motor car in future New Zealand are developed below.

5.1 *How future society perceives the private motor car*

anticipatory view

The private motor car is perceived as an element of a comprehensive transport and telecommunications system. Ownership derives from an individual's requirement for mobility which cannot be met by the existing system.

The former (1980) correlation between a vehicle's size and its owner's social status is no longer accepted by a society which understands and practises conservation. Vehicle durability and fuel economy are, however, highly prized, and are the criteria emphasised by a low-key media promotion. The market contraction, which resulted from both a reduction in demand and a government-led rationalisation of the assembly industry, has reduced dramatically the range of vehicle options available.

The two constraints of durability and fuel economy have accentuated the functional aspects of the motor car, as a machine for moving people. Consequently the non-functional exuberances of former (1980) designs - chromework, fins, aerofoils, fancy trim - have all but disappeared. The anticipated appeal of names like "Charger", "Falcon", and "Hunter"

reactive-supportive view

Society continues to place a high value on the private motor car. Ownership provides more than just personal mobility; it is a statement of perceived social status. This status relates directly to purchase cost and engine capacity of the chosen vehicle and inversely to fuel economy.

A high status person (usually executive and male) is attracted by large, expensive, high fuel consumption vehicles with six or more cylinders. (The extra power is required for towing a pleasure boat on annual vacation.)

A market for smaller, cheaper, more fuel-efficient cars is provided by the younger professional of above average income and by dependents (especially wives) of the high status male.

The aspirations of lower status persons are matched to their incomes by a hierarchal used-car market, wherein the victims of inflation can acquire the victims of body rust and so derive a semblance of mobility.

has proved a "Mirage", whereas the ubiquitous "Mini" survives and the "Minor" enjoys a new renaissance. Style is tailored to practicality and comfort is subservient to economy.

The new car market is conditioned by media, especially TV, promotion. Prestige is emphasised for the high status person through names like "Statesman". Perceived classic style, luxuriously appointed interior and superb comfort rectify shortcomings in fuel economy. For the young affluent, the appeal may be narcissistic, often with sexual undertones. The vehicle, doors wide open, is a beautiful object to ride, to possess, subservient yet responsive to the slightest touch.

5.2 How the private motor car affects future society

anticipatory view

The private motor car is perceived as only one part of a comprehensive transport and communication system. Rising fuel costs, plus the viability of alternatives, have encouraged many people to opt out of ownership. For example, the use of bicycles and power cycles receives official encouragement through the provision of cycle lanes. Former restrictions on cycle access to motorways, harbour bridges and road tunnels have been removed; indeed in some cases the number of lanes available to motor vehicles has been restricted to encourage cycle use. In similar vein, the use of public transport to and from city centres is encouraged by stringent parking restrictions imposed on private motor vehicles as a disincentive to their use in competition with public transport. Government funding previously allocated to motorway expansion is now used to maintain and upgrade metropolitan rail and bus services. Increased patronage in some areas has achieved a hitherto unprecedented effect - a modest operational profit.

Short range electric commuter vehicles are beginning to appear. These vehicles, which require mainly indigenous resources in their construction, which generate significant employment, and which consume indigenous hydroelectric energy, receive tax incentives to offset the cost disadvantages of a small local market. Electric vehicles find particular favour among the elderly, the disabled and those who view the bicycle as inconsistent with their self-perceived status.

reactive-supportive view

For those in the community who can afford one, the private motor vehicle continues to be the preferred mode for personal mobility. A basic ingredient of middle class suburbia is the double garage. Regrettably for some households, the second berth stores a table tennis table rather than a second car. In Remuera, Khandallah, and Fendalton the Saturday morning ritual of washing and waxing the flagship continues. The mistress competes with teenage children for the shopping basket (0 to 80 km/h in 8 s). Families on higher incomes and the young and affluent, still drive long distances regularly for their recreational pursuits.

In the poorer suburbs, an ageing private car fleet partly offsets the social dislocation of a declining public transport system. There is, however, a growing feeling of isolation, especially by the wife, housebound with young children, whose husband now requires the family car to reach the rail or bus station. Many single income families are simply not able to afford a motor car.

Inner city properties have acquired a premium value as uncertainties over petrol price and availability have grown. Motorway construction has halted, not so much as a result of pressure from environmentalists, but rather from a real decline in traffic volumes.

The occasional need for long distance recreational motoring is increasingly met by an expanded hire vehicle fleet. Most of these vehicles are now fuelled by ethanol, although some of the older ones still require synthetic petrol, produced by the single plant which came on stream in 1987.

The communications revolution of the 1980s largely removed the disadvantages that isolation previously had posed for rural communities. The consequent reversal of population drift to the larger centres has encouraged decentralised small scale industry, led by the expansion of the communication network and of microprocessor-based industries.

The increased self-sufficiency of local communities has led to a reduced requirement for private motor vehicles. The previous distinction between workplace and home has tended to weaken. Growth in craft, small scale garage-type industry and information processing has allowed many to work at home.

Inner city suburbs have been revitalised by the halting of urban sprawl. The unplanned subdivisions of the 1970s and early 1980s have either aggregated to semi-self-sufficient communities or have reverted to farmland. In extreme cases, houses have been shifted bodily to more appropriate locations within range of a transport system.

These trends are expected to reverse when additional synthetic gasoline plants come on stream in Southland, restoring confidence in the private motor car.

Regional development has tended to concentrate initially in Taranaki, but more lately in Southland as coal is substituted for declining Maui gas. The demand for capital for the synthetic fuel plants has tended to frustrate development in other regions.

The trend for rural depopulation continues, but many of those moving to the larger urban areas have not found work.

A widening gap in the distribution of incomes has increased tensions within segments of New Zealand society. These tensions have been made manifest by increases in vandalism and other antisocial behavioural patterns. In particular, motor vehicles left parked overnight have increasingly become targets for arsonists, who have, in the main, been young, Polynesian and unemployed.

5.3 How the private motor car affects future New Zealand

anticipatory view

Because a smaller fraction of the nation's resources have been allocated to the private motor vehicle, its imported oil, refineries, motorways, and service infrastructure, expenditure on other sectors (e.g. social welfare, health, education) has been sustained. This has happened in spite of global recession, declining trade and rocketing oil prices.

reactive-supportive view

The substantial investment of resources into the private motor car, charactistic of the 1970s, has continued. The 1980 goal of 50% self sufficiency in liquid fuel by 1987 was in fact met. However, as often happens with untried technologies, mass cost overruns diminished this achievement. Worse, supply shortfalls consequent upon the Saudi Arabian revolution caused the real price of oil to double ($64 a barrel) in the period between 1980 and 1987.

During the early 1980s the benefit of a diminishing requirement for imported oil was wiped out by rapid oil price rises. However, as indigenous fuels replaced imported oil, the oil bill quickly reverted to the pre-1973 level and the economy recovered accordingly.

In the transport sector, CNG and LPG from the Maui gas field made major contributions during the 1980s, but were overtaken firstly by ethanol, and more lately by electricity.

Ethanol production owes its origin to the extensive planting of pinus radiata during the 1960s and thereafter. By the turn of the century wood volume for export will increase five-fold over 1980 yields. The pulp and paper market has not shown comparable growth, mainly as a consequence of the telecommunication revolution and the resultant disappearance of newspapers and other mass-circulation literature. The embarrassment of a huge oversupply of wood suitable only for pulping was circumvented by the development of medium scale processing methods for converting whole logs to fuel ethanol. The most efficient of these methods uses geothermal heat and special high termperature strains of bacteria (thermoanaerobacter ethanolicus).

By 1995 nearly half of all transport fuel in New Zealand is ethanol derived from pinus radiata. The rest is represented by synthetic gasoline (reserved for older non-alcohol vehicles), CNG and LPG, and hydro-electricity (in commuter and delivery vehicles). Smaller quantities of ethanol are produced in farm-sized plants consuming wheat and other crops. The mounting world food crisis is focussing attention on the ethics of energy farming, however, and the future of small scale ethanol is uncertain.

The labour content of radiata ethanol and crop ethanol processes has created much employment, assisted by the increasing indigenous content of the vehicle fleet and by the multiplicity of fuels (synthetic gasoline, CNG, LPG, ethanol and electricity). Rural garages and support industries are doing very well.

Consequently, although demand remained relatively static, the strain on balance of payments was intensified by the massive capital investment without commensurate reduction in oil expenditure.

A second $1,000 million synthetic petrol plant was commissioned in Taranaki to use the 15% of Maui gas not committed in the 1980 Energy Plan. Further development is now envisaged as taking place in eastern Southland, using lignite feedstock and modified Fischer-Tropsch technology.

Very strong environmental objections have yet to be overcome, in spite of an invocation of the 1987 amendment to the National Development Act. The first is the determined opposition of Southland farmers, under whose land the lignite fields lie. An ironical twist is introduced by their self sufficiency in liquid fuel (ethanol from grain using solar stills).

The second arises from the global carbon dioxide problem. Although it is accepted that atmospheric carbon dioxide levels will have doubled between 1980 and 2010, argument still continues over the cause - whether it results from increasing use of coal, or from the massive deforestation occurring in many third world countries. Most researchers, however, are agreed that the increase in carbon dioxide levels is responsible for the spectacular expansion of desert and semi arid land (including much of central Otago) and a 10cm increase in mean sea level over the past five years.

A diversion of scarce capital to large scale energy projects (the principle ones being the liquid fuel plants) has continued the erosion of social welfare, health and education services which began in 1980. Because these energy projects in themselves have created few jobs, unemployment has remained substantially unaltered from the 1982 peak of 13% of the workforce.

Public transport too enjoys a renaissance. Electrification of the main trunk railway in both islands was completed in 1990 and electric urban rail and bus services continue to expand.

The transport revolution has opened some export opportunities. Now that the giant coal plants of the United States and Europe are proving environmental and economic disasters, renewed interest is being shown in the alcohol technologies developed in New Zealand and Brazil. In electric delivery vehicles, New Zealand leads the world, with a voice-controlled milk float being the latest innovation for export.

An exception has occurred in the Dunedin area, where downstream industry consequent upon the second aluminium smelter has created employment.

The impending depletion of Maui gas, the commitment of cheap hydro to two giant smelters, and the commitment to liquid fuel plants of the 4% of the Southland Lignite field considered recoverable, have led to the re-convening of a Royal Commission to investigate nuclear power generation in New Zealand.

5.4 The private motor car in the twenty-first century

anticipatory view

Its future appears assured, but only as one element of a comprehensive transport and telecommunication system. Many people may choose not to own a private motor car. Because its fuel supply is derived from renewable resources, evolutionary changes are unlikely to rival those which took place between 1980 and 1995. Stripped of all connotations of social status, the private motor car is unlikely to cause social divisions in the twenty first century. Indeed, the labour intensiveness of its assembly, its maintenance and its fuel production may serve usefully by distributing wealth in a work-short New Zealand. The golden age of motoring, however, has long passed.

reactive-supportive view

Its future appears assured, given the political inviolability of the rights of the private motorist. Nevertheless, its substantial economic impact is bound to attract increasing criticism, especially from non-motorists. The use of coal as an alternative to depleted Maui gas may attract even stronger opposition on both environmental and economic grounds. If public transport is allowed to decline further, social disharmony may increase as private vehicle ownership becomes harder to sustain. In a static economy, the allocation of substantial national resources to a mode of transport denied to many citizens may prove untenable.

6. PHASE ONE : ENERGY SELF SUFFICIENCY

The Piglet was sitting on the ground at the door of his house blowing happily at a dandelion and wondering whether it would be this year, next year, sometime, or never. He had just discovered it would be never, and was trying to remember what "it" was, and hoping it wasn't anything nice.

from Winnie the Pooh, A.A. Milne

6.1 Essential Elements

The aim is to achieve self-sufficiency in transport fuels as quickly as possible by maximising the use of natural gas and its derivation, but with two caveats:

i. Phase Two (achievement of sustainability) is anticipated;
ii. indigenous enterprise and skill is used wherever possible, to create significant employment opportunities.

Table 4 sets out the essential elements of Phase One. The left and centre columns derive from columns a and b on page 4, the latter giving the "expected" forecast demand for 1989/90 according to the 1980 Energy Plan. The right column, headed "Phase One" suggests an energy mix by which self-sufficiency in transport fuels could be achieved by 1989/90.

Table 4

	present	(Ministry of Energy) 1980 Plan	(Alternative) Phase One
	(1980)	(1989/90)	(1989/90)
Petrol, substitutes			
petrol (unmodified)	84PJ	49PJ	12PJ(c)
M100 (synthetic gasoline)	-	29PJ	20PJ
CNG and LPG	-	12PJ	18PJ
m85/c15	-	-	15PJ/5PJ(c)
electricity	-	-	7PJ
(totals)	(84PJ)	(90PJ)	(77PJ)
Diesel, substitutes			
diesel (unmodified)	51PJ	56PJ	12PJ
m90/c10 (or m100)	-	-	20PJ/4PJ(c)
CNG/diesel	-	-	8PJ/4PJ(c)
(totals)	(51PJ)	(56PJ)	(48PJ)

Energies are expressed in PJ of oil equivalent per year.

Abbreviations

M	Mobil gasoline	)	derived
m	methanol	)	from
c	condensate	)	Maui gas

6.2 Methanol-Hydrocarbon Blends

i. m85/c15 represents 85% methanol by volume blended with 15% hydrocarbon as a petrol substitute (in energy terms 77% methanol/ 13% hydrocarbon). Current research (P. Waring - Industrial Process Division of DSIR, N.J. Peet - University of Canterbury) indicates that simple modifications to the carburation, and sometimes to susceptible components in fuel lines, allow existing vehicles to perform satisfactorily on high methanol blends.

ii. m90/c10 represents 90% methanol used with 10% hydrocarbon as a diesel substitute (in energy terms 82%/18%). Methanol (or ethanol) can be used in the diesel engine by providing dual injection (Volvo system). The diesel fuel triggers ignition, which would otherwise not occur with the alcohol. Alternatively, the diesel can be converted to spark ignition to run on pure alcohol, either by direct injection (MAN system) or by external vapourisation (Mercedes system), although the compression ratio is also normally reduced by changing the pistons. Engines designed for pure alcohols will be available in 1981. Research at Auckland University (J. Stevenson) is looking into other alternative fuels for diesel engines, such as natural gas/diesel mixtures. (In energy terms the ratio is 70%/30%.) LPG/diesel mixtures are also technically feasible.

6.3 Electric vehicles

In its Annual Report for 1979/80 the Liquid Fuels Trust Board noted that:

"the comparative abundance of electric power in New Zealand and its modest price mean that electric propulsion systems, even in the absence of advances in battery technology, may hold some promise for selected modes of transportation."

More recently, a US company (Gulf and Western) have claimed a breakthrough in battery technology. Their zinc-chloride battery has driven a Volkswagen Gulf car for 240km at 90km/h on a single charge. Current lead-acid batteries give a range of only 80km at this speed, and hitherto have limited the acceptability of electric cars (New Scientist, 19 June 1980).

Another US company (General Motors) plans to introduce commercially an electric car powered by a zinc-nickel oxide battery for the 1984 model year.

These overseas developments indicate that an indigenous electric vehicle industry (perhaps importing only battery technology) could be an attractive option for New Zealand. Considerable local expertise already exists in motor and controller technology, with some export potential.

The 7PJ of oil equivalent allocated to electric vehicles by 1989/90 in Table 4 represents about 9% of private motor cars (presently petrol-driven). This proportion would be predominately commuter and second family cars, roles for which the electric car is more suitable. Assuming electric vehicles are three times more energy efficient than petrol vehicles, the electrical energy required would be about 1,300GWh, or 26% of the often quoted electricity surplus of 5,000GWh.

6.4 private vehicle mix

Table 5 uses the same three columns as Table 4, but compares energy sources for the private motor vehicle fleet according to the 1980 Energy Plan and to Phase One of the alternative plan.

Table 5 000's of vehicles

	present (1980)	1980 Plan (1989/90)	Phase One (1989/90)
petrol)	1,300	755)	200)
M100 } compatible	-	450)	340)
CNG and LPG	-	185	300
m85/c15	-	-	340
electricity	-	-	120
(totals)	(1,300)	(1,390)	(1,300)

Table 5 illustrates a requirement for societal change in an anticipatory solution of the oil crisis (represented by the Phase One mix), in that there is no increase in vehicle numbers over the decade. (The 1980 Energy Plan (a supportive solution) assumes an increase in vehicle numbers of 7%.) Also, this unchanged number of vehicles uses 9% less energy, requiring a commensurate improvement in vehicle efficiency.

6.5 Phase One energy production

i. condensate required for transport fuel

12PJ refined to petrol
16PJ refined to diesel*(12PJ for unmodified diesels)
5PJ refined for m85/c15 blend (petrol substitute)
4PJ refined for m90/c10 blend (diesel substitute)

37PJ total condensate/year

The take-or-pay quantity likely to be available in 1989/90 is 32PJ (page 3). The balance of 5PJ rather conveniently is represented by the uncommitted output of the Mobil synthetic gasoline plant (29PJ output less 20PJ committed as a motor fuel).

ii. Mobil synthetic gasoline plant

55PJ of Maui gas is converted to 29PJ of synthetic gasoline at 53% efficiency by a synthetic gasoline plant which comprises:

2 x 2,000t/day gas-to-methanol streams
1 methanol-to-gasoline stream

(planned to come on stream in 1985)

* 16PJ may not be available from Maui condensate, which is low in middle distillates, in which case a higher proportion of diesel engines may require conversion to methanol or CNG dual-fuel systems (the alternative plan leaves 25% unconverted). Alternatively, diesel substitutes such as rape seed oil could be used, especially in the farming sector. This is already happening.

iii. methanol plants

The methanol requirements for methanol/hydrocarbon blends are:

15PJ for m85/c15 as a petrol substitute
20PJ for m90/c10 as a diesel substitute

35PJ total methanol production/year

This could be produced from 60PJ/y of Maui gas at 58% efficiency, indicating a requirement of 4,350t/day of methanol.

Present plans provide for a 1,200t/day stand-alone plant producing methanol for export by 1983. If the entire output of this plant instead was used for blended fuels, the additional methanol capacity required is reduced to

2 x 1,575t/day gas-to-methanol streams

The gas requirement is roughly equivalent to the 15% fraction of the Maui field still available for new developments (Energy Strategy '79, p.58).

iv. electricity about 1,300 GWh/year

6.6 Capital Cost Comparisons ($ x 10^6)

Table 6	1980 Energy Plan	Phase One
Synthetic gasoline plant (Mobil)		
2 x 2,000t/day methanol streams	350	350
1 methanol to synthetic gasoline stream	150	150
Methanol plants		
1 x 1,200t/day (Petrocorp/Alberta Gas)	130	130
2 x 1,575t/day (additional requirement)	-	300
CNG and LPG bulk distribution	100	150
Conversions (interfuel)		
petrol to CNG or LPG		
185,000 vehicles x $1,200	220	-
300,000 vehicles x $1,200	-	360
petrol to methanol blend		
340,000 vehicles x $3.50 (i)	-	120
diesel to methanol blend		
200,000 vehicles x $1,000 (ii)	-	200
electric vehicles	-	nil (iii)
(totals)	(950m)	(1,760m)
The difference in capital costs is	$810m	

Notes

i. After P. Waring, Industrial Development Division, DSIR.
ii. Conversion cost unknown, consequently an arbitrary figure.
iii. Electric vehicles will substitute for liquid-fuelled vehicles. Any capital cost differential is likely to favour electric vehicles, once economies of scale are achieved. The target of 120,000 electric vehicles by 1989/90 could be met by importing 20,000 vehicles per year between 1986 and 1990, plus an indigenous production growing from zero to 10,000 vehicles per year over the same period (reaching about 20% of local vehicle assembly by 1990).

6.7 Cost Benefit Analysis

i. Economic

For the assumptions explicit in the 1980 Energy Plan, New Zealand's external oil bill is likely to remain constant, about $1,400m in 1980 dollars, for the next decade (page 6). Conceivably it could be doubled by circumstances beyond New Zealand's control (pp 7-11).

Notwithstanding the difficulty of integrating a 3-step introduction of large-scale alternative liquid fuel sources with the incremental process of vehicle conversions, the alternative strategy outlined in Phase One above could lead to self-sufficiency in transport fuels by 1990.

These considerations lead to the anticipated external oil bills tabulated below:

Table 7 external oil bill $ x 10^9

Year	1980 Energy Plan	Phase One	Plant Commissioned
1981	1.4	1.4	
1982	1.4	1.4	
1983	1.5	1.4	- methanol (Petrocorp-Alberta Gas)
1984	1.5	1.1	
1985	1.6	1.2	- synthetic gasoline (Mobil)
1986	1.2	0.8	
1987	1.2	0.7	- methanol (suggested)
1988	1.3	0.3	
1989	1.4	0.2	
1990	1.5	0.1	
(totals)	(14.0b)	(8.6)	

The saving in foreign exchange over the decade achieved by adopting the Phase One strategy is $5.4 billion, less the difference in capital cost ($0.8 billion), less the foregone methanol exports (seven years at $60m per year = $0.4 billion) i.e. $4.2 billion net.

However, if the price of oil exceeds $40/bbl by 1989/90, the net saving is increased substantially. For instance, a linear increase from $30/bbl in 1980 to $80/bbl by 1990 (for the reasons outlined in pp7-11) would indicate a revised saving of about $10 billion for the Phase One strategy.

ii. strategic

By adopting the self-sufficiency strategy embodied in the Phase One plan, New Zealand could overcome her present dependence on Middle East oil, but would instead become highly dependent on indigenous natural gas.

The respective probabilities of a cut-off of Middle East oil (or of unacceptable price increases) and of a mishap to the Maui production platform and pipeline would need to be compared very carefully. Contingency planning against the latter event might include stockpiling and the retention of the supply infrastructure based on imported oil, as some security against a protracted gas-field mishap.

iii. social

Phase One of the alternative energy plan could generate significant additional employment.

a. vehicle conversions for methanol-blends

On the assumption that the conversion cost represents mainly labour at $12/hour, the conversion of 340,000 petrol engines and 200,000 diesel engines will generate 610 and 1440 new jobs respectively over 1983-1990.

b. electric vehicles

Electric vehicles are envisaged as substitutes for petrol-fuelled vehicles, but could have a much greater indigenous content. For example, locally produced electric motors and controllers could substitute for imported internal combustion engines, gearboxes, and differentials. On the assumption that electric vehicles will take 20% of the total vehicle market in 1990 and will have twice the indigenous labour content of the liquid-fuelled vehicles they replace, up to 4,000 additional jobs could be created.

c. new fuelling and servicing infrastructures

Methanol blend motors (spark and compression ignition) and electric motors will require additional infrastructures generating perhaps 500 additional jobs.

d. liquid fuel plants

The 1,200t/day methanol plant is expected to employ 84 people (Liquid Fuel Trust Board report LF2004). The much larger synthetic gasoline and additional methanol plants each could employ twice this number, generating in total another 500 jobs.

e. public transport systems, communications systems

The alternative energy plan anticipates a reduced need for private motor cars through energy-saving alternatives. These alternatives might include improvements to public transport systems and communication systems and an increase in urban self- sufficiency. The improvement in the balance of payments (estimated above to be at least $4.2 billion) could allow diversion of adequate financial resources to these community developments. In this way, many new jobs could be created.

On the assumption that 4,000 community-development jobs are created, and that every two new jobs create one further downstream job in the service sector, an anticipated consequence of Phase One of the alternative energy plan is the creation of 16,500 additional jobs over the decade 1980 to 1990.

iv. economic

The cost per job, using the data in Table 6 is $105,000, including interfuel conversion costs which are largely internal. By considering only external costs (three fuel plants, bulk distribution system) the cost per job reduces to $65,000. Economists would consider these figures to be satisfactory.

A satisfactory export efficiency also is indicated; the reduction in the external oil bill (at least $4.2 billion) is four times the external investment required over the decade ($1.1 billion).

6.8 Marsden Point Oil Refinery

An expansion of the Marsden Point oil refinery, costing $500 million, is expected to begin before the end of 1980 (Mr Birch, reported in the Evening Post of 15 October). This development is a part of the 1980 Energy Plan strategy.

In the context of the alternative energy plan, the investment could still pay off, because a lot of imported oil (costing $8.6 billion on 'expected' forecast prices) is still required between 1980 and 1990. The refinery could also provide some additional security against a gasfield mishap.

However, some difficulties over the availability of crude feedstocks for the refinery can be expected in the longer term. Given heavy OPEC investment in refining capacity (to add value before export), refined products may tend to replace unrefined crude in the world's oil markets.

After 1990, according to the alternative energy plan, the expanded refinery would join the Marsden B power station as a silent relic of the oil crises of the seventies and eighties.

In the 1980 Energy Plan, the refinery acts as a brake on petrol substitutes, once the synthetic gasoline plant comes on stream. There is no scope for 15% methanol blends introduced nationally, and "the high-alcohol m85, although it seems technically quite attractive even as a retrofit to today's cars, would add still more to the sea of petrol unusable in New Zealand, which would probably end up being exported". (Energywatch 7/1980).

Reliance on diesel from crude oil processed by an expanded refinery may make the transition to sustainable alternatives (such as alcohols) more difficult.

7. PHASE TWO : SUSTAINABILITY

"Today we suffer from an almost universal idolatory of giantism. It is, therefore, necessary to insist on the virtues of smallness - where this applies .... What scale is appropriate? It depends on what we are trying to do."

from Small is Beautiful, E.F. Schumacher

7.1 Essential Elements

The aim is the substitution of sustainable alternatives for non-renewable natural gas. The Maui gas field is anticipated to last well into next century, but an early achievement of Phase Two would leave more of the gas in the ground for alternative uses (such as a petrochemical industry).

Assuming a successful accomplishment of Phase One, the New Zealand vehicle fleet in 1989/90 could be fuelled as follows:

	vehicle numbers	%
petrol (from condensate), synthetic gasoline	540,000	36
CNG and LPG	300,000	20
85% methanol blend (petrol substitute)	340,000	23
methanol, CNG mixes (diesel substitute)	150,000	10
diesel (from condensate)	50,000	3
electricity	120,000	8

7.2 compressed biogas

CNG can be replaced readily by compressed biogas, which is derivable by anaerobic digestion from a wide range of biomass sources (animal and human wastes, plant residues, cultivated crops). Studies by the Invermay Energy Farm (D. Stewart) consistently show biogas, even derived from cultivated crops, is an economic transport fuel. Stewart has reported that maize or kale can be grown for about 13c/L (petrol equivalent) and processed commercially to biogas for 35c/L. Sale of the digestion residues can reduce the biogas cost to 19c/L (petrol equivalent) which is competitive with imported oil in 1980 ($34/bbl = 21.4c/L, plus refining and distribution costs). As an illustration of the viability of the biogas option, Stewart has pointed out (at an Alternative Energy Conference arranged by the Department of Trade and Industry, Wellington 1980) the annual production of biogas in China now exceeds the energy content of the entire Maui gas field by a factor of seven.

7.3 methanol and ethanol

Methanol can be produced readily from the gasification of wood. Economies of scale tend to favour medium-scale plants. The NZERDC Review on energy farming (Report 46, July 1980) quotes a cost of 20c/L (petrol equivalent) for blended methanol produced by a 2500 t/day wood gasification plant. Methanol from wood, like biogas, appears to be competitive now with imported oil (costings given above).

Methanol is considered to be the liquid fuel easiest to derive from coal; this methanol-from-coal option is discussed in paragraph 7.5.

Ethanol, as an alternative to methanol, can be produced by small-scale fermentation processes or by medium-scale acid hydrolysis of wood.

Small-scale production, up to 5000L/year, has been encouraged by recent relaxation of the regulations governing the distillation of alcohol. Already, numbers of farmers are achieving self-sufficiency in their own liquid fuel requirements. A medium-scale commercial plant has commenced operation in Reporoa in 1980, using a milk bi-product (whey) as feedstock.

Recent work by the Forest Research Institute on the acid hydrolysis of pinus radiata has indicated a factory gate price for ethanol of 35c/L (petrol equivalent). Vehicles presently are being run on ethanol with only minor modifications (quoted conversion cost of $100).

In 1979, New Zealand produced 9.1 million m^3 of wood, mainly radiata pine. Trees already planted will increase this volume to 20 million m^3 by 2000. Domestic consumption is expected to increase from the present 4.3 million m^3 to about 8 million m^3, leaving 12 million m^3 for export in 2000 and 20 million m^3 in 2010. Present exports are 4.8 million m^3 per year (DFC Forest Industry Study, March 1980).

Where and in what form this wood is to be exported is less certain. A major expansion in telecommunications (data networks, electronic mail, videotext) may depress future demand for paper products, especially newsprint. While the cost of sending information by electronic means is still falling, the cost of sending hard copy (letters, invoices, newspapers, etc) is increasing as the energy crisis worsens.

The methanol yield from wood otherwise available for export in 2000 can be derived from

volume of wood 20×10^6 m^3
energy content 19GJ/ODt viz 14GJ/m^3
50% conversion efficiency (wood to methanol)

as 140 PJ (i.e. four times the 35PJ required by the alternative energy plan)

Thus the production of fuel alcohol from wood (especially the large volume of waste wood generated from sawn logs) may become an attractive future option and may indeed circumvent the embarrassment of an oversupply of pulp wood. Wood has several other advantages over alternative biomass feedstocks in that it can use lower quality land, has no seasonal constraints and can serve as a medium-term energy store.

Economics currently favour methanol production (over ethanol production), but its larger scale may be a disadvantage. Ethanol production from wood could integrate more easily with production from cultivated crops, such as fodder beet.

regional benefits

Apart from the major benefit of providing greater, perhaps total, self-sufficiency in transport fuels, energy farming provides an opportunity for employment and regional development. To keep transport distances short, processing plants will require location within 20 to 30km of the energy crops. In many regions, this could lead to the repopulation of rural towns, reversing the trend for urban drift apparent since World War 2.

Areas having potential for new energy forest developments include reverted farmland, cut-over native forests, and low productivity farmland. These fall within regions identified by the government as having development priority : King Country, East Coast, Northland, Otago, Southland, South Canterbury, and Wanganui.

In NZERDC Report 46 (p.104) it is estimated that 683 new jobs would be created by the establishment of a two stream 1000 ODt/d plant producing 6.93PJ/year of fuel grade methanol. Five equivalent plants would produce New Zealand's total requirements for methanol in the context of the alternative energy plan (P.25). A total of 3415 new jobs would be available if these five methanol plants were set up.

The same report estimates a workforce of 58 would be required for a 200 ODt/d ethanol plant utilising maize, with another 47 new jobs created in producing the required feedstock. Another 92 downstream service jobs are anticipated, indicating that, in all, 197 new jobs would be generated by the 200 ODt/d plant.

The Waikato region has more than 300,000 ha of land suitable for maize production, sufficient for 18 ethanol plants as described above. The total ethanol yield from 18 plants is estimated as 35PJ, about equivalent to the methanol required in the alternative energy plan. The new jobs created would total 3546 (NZERDC Report 46), although undoubtedly some existing jobs would be lost. There would also be an opportunity cost - the value of the maize sold as maize rather than as ethanol - equivalent to 25% of total production cost. For radiata pine grown on marginal land, the opportunity cost would be a much smaller proportion of the production cost.

Regions adopting energy farming could expect benefits from increased economic activity and stabilised populations. Existing small towns could expect to benefit from increased demands for services and from the improved productivity of the surrounding rural areas.

(NZERDC = New Zealand Energy Research and Development Committee)
(ODt/d = oven dried tonne per day)

7.4 electricity

Electric vehicles could be integrated into the existing national grid without difficulty.

7.5 coal

Strictly, the use of coal is not sustainable although the extent of the Southland lignite field could allow the production of liquid fuels for a considerable period. However, doubts have been expressed (F. Bowen, Geological Survey) whether the coal can be mined economically. Bowen told a Coal Seminar in June 1980 that only 0.1% of the potential lignite resource can be classified as minable using existing technology in New Zealand. The Southland seams are relatively thin, are covered by a considerable overburden, and lie below the water table under fertile farmland that already produces about 20% of New Zealand's agricultural exports.

Using Fischer Tropsch technology, a minimum-sized economic plant might use 500,000t of dry, ash-free lignite to produce 200,000t of synthetic gasoline (and 320,000t of waste) each year. Its environmental effect could be considerable.

A lignite plant could also have considerable economic and social implications by virtue of its capital intensiveness. A cost of $2 billion has been indicated (Mr Birch, reported in the 'Evening Post' 20 September 1980).

Biomass is preferred to coal as a sustainable energy source in the alternative energy plan because the social and environmental costs of coal are considerable, whereas the biomass option has real social benefits.

In the context of section 4 of this paper, a coal liquefaction plant appears more supportive than anticipatory, as a solution to New Zealand's liquid fuel problem.

7.6 synthetic gasoline (Mobil Process)

The operation of the planned synthetic gasoline plant is not sustainable, because Maui gas will run out some time after 2010. Other potential feedstocks for a synthetic gasoline plant are lignite and biomass.

If lignite mining proves viable, the Mobil process would have to be judged against alternative routes to liquid fuels from coal (Fischer Tropsch, Sasol etc).

Methanol production from biomass is likely to be small-to-medium scale, and the question of whether the methanol-to-gasoline (Mobil) process could be scaled down sufficiently to integrate it with a biomass-methanol plant would have to be addressed. The logistics of transporting biomass (e.g. radiata pine) to a loading point would mitigate against plants of the scale of the one planned for Taranaki.

7.7 atmospheric carbon dioxide

Concern has been expressed over possible climatic changes caused by increasing levels of carbon dioxide in the atmosphere. In 1980, the level of carbon dioxide is 336 ppmv (parts per million by volume), but this figure is expected to double by some time between 2020 and 2040, due to an increasing reliance on fossil fuels, especially coal, for energy sources. Predicted effects of a doubling of carbon dioxide include a global warming of several degrees, shifts in weather patterns, and possibly an increase in mean sea level due to a partial melting of polar ice. The problem has been reviewed in Futurewatch 2, a publication of the CFF, which presented the proceedings of a conference held in Canberra in September 1980.

More recently the writer has received further results of modelling work carried out by Dr G. Pearman of the Division of Atmospheric Physics, CSIRO, which was prompted by discussion at the conference. Specifically:

i The present trend for rapidly increasing combustion of coal will cause a doubling of atmospheric carbon dioxide levels in the next forty to sixty years, determined by the rate of introduction of biomass and nuclear alternatives to coal, which do not add carbon dioxide to the atmosphere.

ii To maintain the atmosphere carbon dioxide level at its present 336 ppmv would require a reduction in fossil fuel burning to 0.6Gt/year of carbon, about one tenth of the present rate of 5Gt/year of carbon.

iii If the present rate of 5Gt/year of carbon is maintained, the doubling time is increased to three hundred years.

Clearly it is unrealistic to anticipate a reduction in fossil fuel utilisation by a factor of ten in the foreseeable future (required by (ii) above for steady state conditions).

Stabilisation of the present combustion rate of 5Gt/year would allow three hundred years for the development of sustainable alternatives, while causing a doubling of carbon dioxide levels (see (iii) above).

The present trend for rapidly increasing combustion of coal does not appear to be sustainable. While the first doubling, by 2020-40, is predicted (tentatively) to cause climatic changes which mankind could accommodate (perhaps even profit from), the second (by 2050-70) and subsequent doublings are more disconcerting.

Participatory planning might consider possible future international agreements required to control the rate of coal utilisation, should the environmental consequences of present trends prove unacceptable. The biomass alternative would not be affected in this way, because the carbon dioxide released by the combustion of biomass-derived fuel would be taken up again by the replacement crops or trees (in a sustainable programme of energy farming).

7.8 unconventional energy sources

1. aircraft

The Boeing Corporation has recently concluded that coal and oil shale derived synthetic fuels are the only practical alternatives to conventional jet fuel. Not so, according to the Lockheed Corporation, who propose liquid hydrogen stored within insulated tanks inside the fuselage of an extended Tri-Star jet. The prime advantage of liquid hydrogen over hydrocarbon fuels is that its energy content per unit weight is 2.8 times greater (New Scientist, June 1979). Liquid hydrogen burns cleanly and may even be safer in the event of a 'survivable' crash.

2. ships

Alternatives to marine diesel fuel are receiving intensive study. The Exxon Corporation are converting some coastal tankers to run on heavy oil, while Swiss-based Sulzer are running diesels on a mixture of 50% powdered coal, 30% water and 20% diesel. A small sail-assisted tanker is undergoing trials in the Sea of Japan. The microprocessor controlled sails are expected to reduce fuel costs by 50% (Motor Ship, May 1980).

3. the problem of avtur

Liquid hydrogen could provide an answer to the problem of avtur supply, which the alternative plan does not address. Avtur (jet fuel for aircraft) like diesel, is a middle distillate and so is a small component of Maui condensate. It cannot be replaced by alcohols, CNG or LPG. However, the problem of avtur may be more social than technical. Demand for avtur (in the 1980 Energy Plan) is predicted to increase from 13.6PJ (7.0% of total demand) in 1979/80 to 21.9PJ (11.1% of total demand) in 1989/90 (see p.4). An expansion of 61% in avtur demand, in comparison with a modest 7% increase in demand for petrol and its substitutes over the decade seems anomolous, especially since air travel is already too expensive for some sections of New Zealand society. In an anticipatory solution, less energy-intensive forms of air transport may be preferred to avtur-powered jet aircraft. Airships could enjoy a renaissance, especially if New Zealand develops closer links with the islands of the Pacific Basin. The main disadvantages of liquid hydrogen (its low density) is then no longer a problem.

8. OVERVIEW

"In Japan, the stepping stones in a garden are spaced far enough apart so that each step must be taken carefully, one by one. As you look down to cross safely, you see in the water the reflections of the clouds and trees above .... When your footing is secure again you look up to find yourself in a new place."

from Stepping Stones - Appropriate Technology and Beyond, L.de Moll and G.Coe

For the assumptions underlying the 1980 Energy Plan (viz 50% self-sufficiency in transport fuels by 1987, oil prices rising to $40/bbl by 1989/90) New Zealand's oil bill will remain substantially unchanged for the next ten years - $1,400 million per annum or $14 billion for the decade (in constant 1980 dollars). A more dramatic (and likely?) increase in oil price would increase the oil bill substantially (e.g. to $3,077 million if oil rises to $80/bbl by 1989/90).

An accelerated effort for self-sufficiency, as described in the alternative energy plan outlined in this paper, could reduce the oil bill for 1980-89 from $14 billion to $8.6 billion (and thereafter to essentially nil). The net saving ($5.4 billion if oil rises to $40/bbl) is greater than the estimated additional costs of achieving self-sufficiency ($0.8 billion).

However, to conserve natural gas for other uses, sustainable alternative energy sources would be required. Biomass is proposed as an appropriate option for New Zealand, but would require vehicle conversions for alcohol or biogas operation. In addition, a change in public attitudes to the role of the private motor vehicle in society is anticipated in the alternative energy plan.

A development programme having the goal of sustainable self-sufficiency, while removing the stress of the oil bill in the economy, could also provide important strategic and social benefits. These might include insulation against future oil supply disruptions, and some major opportunities for regional development and employment.

This report was prepared as a discussion paper on New Zealand's future energy options. As such, it is bound to contain factual errors, omissions and inconsistencies. Almost certainly, the alternative plan is not an optimal solution. Neither does it consider issues such as opportunity costs, discount rates and other devices of orthodox economics, because these are seen as second-order considerations.

It is hoped that critics will address the first-order issues raised by this paper:

- are the assumptions of the 1980 Energy Plan on future oil pricing realistic?
- is 50% self-sufficiency by 1987 fast enough?
- is self-sufficiency by 1990 a feasible option?
- is sustainable self-sufficiency a preferred option?