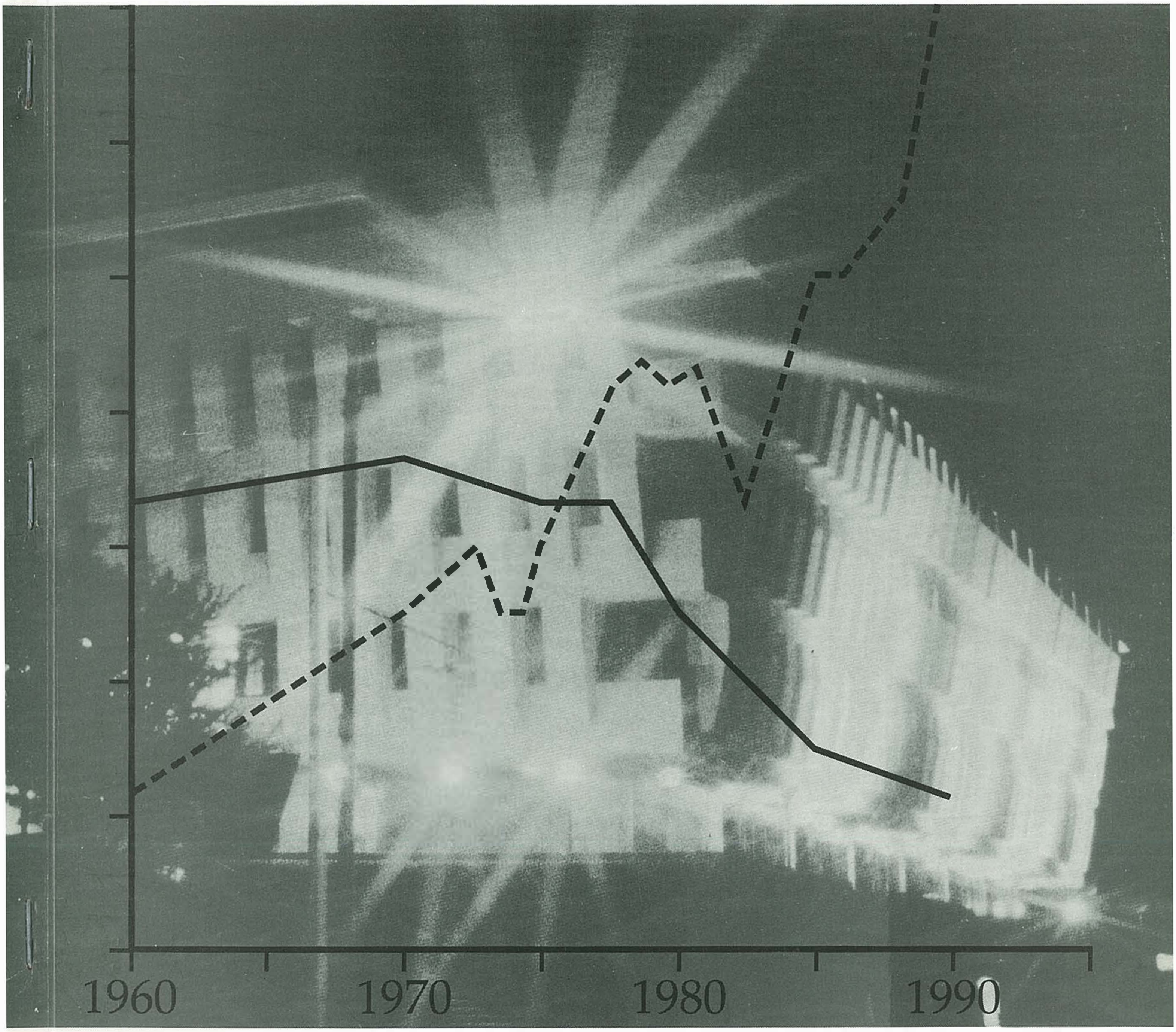
Making a Market for Energy Efficiency



NEW ZEALAND
Planning Council

Te Kaunihera Whakakaupapa Mo Aotearoa

The background picture is of the National Library which has, over recent years, reduced its annual energy bill by 52%, with savings of over half a million dollars on the electricity bill alone. The foreground is a graph measuring energy intensity over time, which shows New Zealand (broken line) rates very poorly, in comparison to the OECD average (solid line).

Making a Market for Energy Efficiency

by

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Introduction

This study looks at mechanisms which could be used to achieve a higher level of energy efficiency in New Zealand. Considerable work has already been completed, both locally and internationally, identifying opportunities for efficiency savings. But it is the mechanisms which will see these potentials taken up, which are missing.

Energy efficiency has gained prominence recently for two reasons. The first is its central role in the reduction of carbon dioxide, the dominant greenhouse gas. The second is the declining costs of energy efficiency technology which make efficiency improvements even more economic.

Some 90% of carbon dioxide emissions in New Zealand are energy-related, so that reductions in energy use are naturally the focus for achieving the Government's target of a 20% reduction on 1990 levels. But this study focuses on mechanisms for bringing about energy efficiency which can be justified on economic grounds alone: that is, mechanisms which are appropriate, independent of the need to reduce greenhouse gas emissions. Whatever policies are adopted to achieve emission reduction targets, it is desirable to first exploit mechanisms which achieve savings that are economic in their own right. The study is also confined to reforms which could be implemented without fundamentally altering existing and expected institutional and contractual arrangements.

Benefits of Energy Efficiency

Energy efficiency means using less energy to deliver the same service. It is made possible by a new device or practice which allows the same job to be done with less.

As a nation, the more efficiently New Zealand uses energy, the more cost competitive are its goods and services. At present, New Zealand ranks very poorly in terms of the amount of energy used to produce a unit of Gross Domestic Product (GDP). This international measure of energy intensity shows that while other OECD countries have reduced their energy intensity in recent years, New Zealand's has risen sharply.

Between 1970 and 1988, the average energy intensity fell by 24% while New Zealand's rose by 31%. Only Turkey has a significantly higher energy intensity. Japan, one of the best performers of the OECD, uses just 37% of the energy New Zealand does to produce a dollar of GDP. Structural adjustments in the economy are a partial explanation, but the trend has been a steady rise over 30 years, before and after the think big energy projects.

Efficiency in the use of electricity is particularly important if a steep rise in power prices is to be avoided. If present rates of growth in electricity demand are maintained, the current surplus of generating capacity will be used up in about a decade from now. The new stations which would be required would most likely be funded from increased electricity prices.

Supplies of Maui gas for electricity generation are also expected to run out about that time, in 2005. Depending on the availability of new sources of gas, considerable expense may also be incurred modifying or replacing the stations that currently use gas to generate power. One study puts the cost of building new stations as high as $22 billion over the next 15 years. The current rate of growth in demand will require the equivalent of a new Clyde dam every two years when surplus capacity is used up.

It would be a serious missallocation of resources to build new stations if energy efficiency could achieve the same service at a lower cost. Energy efficiency could at least reduce the need to build new power stations and/or delay their timing. This would limit the extent of the price rise and delay its impact. But savings of this magnitude require a well developed energy efficiency industry which will take some time to build up.

Another benefit resulting from energy efficiency is that installation of efficiency devices is employment-intensive and not confined to one geographic area.

Potential Savings

The potential for saving energy in New Zealand through efficiency improvements is not precisely known. There is considerable information from overseas research as well as a number of useful local studies, but more data are required to give an accurate picture of the potential across the economy.

This study focuses on potential electricity savings for a number of reasons. Electricity accounts for the largest share of primary energy. It also offers some of the biggest and easiest savings. A particularly important reason at this time is the role of energy efficiency in helping to avoid a steep rise in power prices with demand growth, as already described.

A rough analysis of the potential for efficiency in the electricity sector has been undertaken by Electricorp. This study estimates that 57% of the electricity currently used could be saved economically while consumers enjoyed the same level of service. The average cost of the savings is estimated at 1.6 cents a unit (kWh) as against retail prices ranging from 7 to 12 cents a unit. At 1.6 cents a unit, this is less than the cost of just burning gas used to make electricity.

There are limitations to the Electricorp study, as the estimated costs of efficiency measures are based on American experience. To test the costings, a comparison was made of the study results for the domestic sector with a limited number of similar studies based on New Zealand domestic sector costs. The comparison suggests that while the Electricorp study costs are slightly lower than would be expected, they are broadly in line when different assumptions are accounted for.

Rather than concentrating too heavily on the precise level of energy savings which is economic, the key question is whether the information to date establishes with reasonable confidence that there is a significant economic reserve of energy to be exploited. Even the limited studies completed in New Zealand suggest there is, and these are backed by a considerable depth of overseas research. The extent to which this potential is actually taken up is, in the first instance, determined by the barriers consumers face.

Barriers to Energy Efficiency

There are two basic sets of barriers: those consumers directly encounter, and wider ones which are features of the energy market in New Zealand. Barriers at the consumer level include problems of access to information and availability of energy efficiency products and services.

But the greatest barriers to consumers are probably financial ones. When making efficiency improvements, consumers must first have the money to pay for many of these. But consumers also have many competing uses for these funds. Thus only efficiency measures with a very fast payback are immediately attractive. It is recognised that commercial organisations which have the capital to pay for efficiency improvements, prefer to direct those funds into core business activities, even when they could earn a better

return on saving energy they use.

At the wider level of the energy market, there are substantial contractual and institutional barriers. The agreement covering the Maui gas field specifies minimum annual quantities of gas which must be paid for, whether or not they are used. The nature of this agreement, combined with the large volumes of gas contracted for relative to demand, means that large amounts of gas are sold quite cheaply and the biggest allocations are used very inefficiently for conversion to petrol and electricity.

The electricity and gas industries have significant monopoly characteristics. Electricorp and Petrocorp (through the Natural Gas Corporation) have highly dominant positions in the wholesale market, as well as the natural monopolies held over national transmission services. At present, both wholesalers have cost structures which encourage increased sales to profit maximise, although this will change with time.

The barriers are sufficient that efficiency currently plays a rather small role in meeting consumers' energy needs. Industry forecasts show energy efficiency as having little impact on demand growth, and the energy intensity of the economy is not expected to improve over the coming decade.

Mechanisms for Achieving Savings

American electricity utilities have pioneered many mechanisms for overcoming barriers at the consumer level. The most basic form of assistance has been utility loans, often at concessional rates. These get consumers over the problem of a shortage of money to pay for efficiency improvements. Utilities have also shared the cost of improvements through granting rebates on approved applications. To draw in those on very restricted budgets, certain efficiency devices have been given away in the hundreds of thousands.

While these methods have been successful in providing access to finance, removing risk and overcoming information barriers, they rely on the electricity utility having an interest in saving power. Historically, this has been the case in America where many regulatory authorities have offered higher rates of return to utilities for energy-savings programmes than for new power stations. But increasingly, such programmes are being undertaken because of widespread community opposition to building new power stations.

In New Zealand, however, Electricorp will not face demand sufficient to commission a new power station for about a decade. More important, the cost of producing the last few units of power (the marginal cost) is less than the price at which Electricorp sells power to supply authorities. In order to profit maximise, as directed by its shareholders, Electricorp should sell more power, not less. It has a certain incentive to promote the efficient use of electricity in order to keep electricity competitive with other fuels. But while there is surplus generating capacity, the commercial incentives for promoting substantial reductions in consumption through energy efficiency are clearly negative overall.

Electricity supply authorities are the leading industry advocate of energy efficiency. However, the supply authorities are in the process of being corporatised and will later issue shares. This restructuring will also involve the loss of franchise areas so that each will compete for customers across former boundaries. This competition will encourage energy efficiency as part of an expanded range of customer services. But the new requirement to provide an adequate return to shareholders is a disincentive to energy efficiency as energy savings would reduce the amount of power used and thus the profits on those sales. It is difficult to predict the balance of these interests, but it is far from clear that supply authorities will face sufficient incentives to pursue energy efficiency.

Although the supply of energy efficiency services is not the preserve of electricity companies alone, independent 'third party' operators would face substantial risks - at least in the short to medium term. And the commercial incentives for electricity wholesalers and retailers are largely in conflict with the work entrepreneurs would undertake. The entrepreneurs would have to compete with both for the business, where these organisation are substantial and have existing customer relationships and billing services.

It is therefore not clear that reforms currently proposed for the electricity industry will provide sufficient incentives to deliver substantial energy efficiency savings in the short to medium term. To achieve this, additional reform would probably be required. The preference would be for mechanisms which deliver the greatest amount of efficiency for the least cost and distortion. Market-based solutions used in America have already proven very successful at the consumer level. It is incentives at the institutional level that are required.

Minimal Reform

One scheme used in America to encourage energy efficiency focuses on comparing the cost of generating additional power with the cost of investing in efficiency measures. Companies producing electricity benefit financially if electricity can be saved at a lower cost than generating the equivalent amount of electricity. The cost of producing an additional unit of power which can otherwise be saved is termed the avoided cost.

Under this scheme, electricity utilities invite other parties to quote a price (in terms of cents per unit of power) for supplying either additional electricity supply, or energy savings. The utility then selects the least cost combination of bids for generation and energy savings which meets the demand for electricity.

However, this scheme again relies on the generator having an incentive to reduce power demand. Electricorp does not have this incentive. While the corporation could be required to hold such tenders, this would pose many difficulties.

A better place in the electricity system to test the avoided cost of generating more power is with supply authorities. Here, the avoided cost is higher which makes more efficiency measures economic. The supply authorities also have existing customer relationships which can be utilised.

As with the scheme above, a supply authority would tender for both power supplies (from Electricorp) and electricity savings, with the aim of selecting the best mix of sources. To make this work, the bids would need to be cast in a particular form. Initially, the supplier of efficiency equipment would pay for its installation and the consumer would keep paying the bill at the old rate. This payment more than covers the actual cost of the electricity now used and the efficiency supplier puts the surplus towards paying off the cost of the improvements and takes a profit. After a set period, the consumer returns to normal billing and gets the benefit of the improvements with lower bills.

But having made such an arrangement with a consumer, the efficiency entrepreneur can then bid in the supply authority's auction. If the bid is accepted, the consumer would continue to pay the bill at the old rate, but now it would pay the supply authority. The supply authority then passes on the amount bid by the efficiency supplier to that company. For example, say the consumer pays 7 cents a unit on the portion of demand that has been cut. If the efficiency supplier bid 4 cents a unit, then the supply authority will keep the remaining 3 cents a unit.

For the efficiency entrepreneur, sharing the profits with the supply authority reduces risk and removes much of the burden of financing the efficiency improvements. The risk is reduced because in accepting the bid, the supply authority would largely guarantee to pass on a set level of payments to the efficiency supplier. It would have

confidence to accept the bid as this would be accompanied by an independent technical audit of the efficiency potential of the improvements.

With an assured cashflow from a supply authority, finance to pay for the improvements would be much easier to arrange. Rather than having to guarantee the finance on the basis of its own capital, the firm could act simply as a broker and have a bank or finance company take on the loan.

As incentives would not necessarily exist for supply authorities to call such tenders, this would need to be required. It would also be a requirement that an independent agency vet the selection of bids and ensure that the form of the bids was in accordance with the tender objectives. Other than this, the market would provide the machinery to make the scheme operate.

Another minimal intervention option is for the Government to establish a state owned enterprise dedicated to investing in energy efficiency. This energy savings corporation would be an energy efficiency broker, arranging contracts for energy efficiency services.

However, it would be assuming the full risk of the efficiency investments and require a substantial capital base in order to make loans to customers. Finding sufficient capital is likely to prove difficult. But it is the level of risk to the Government in running such a business that would be the greater problem. The risks would be too high as the Government would find it more difficult than usual to monitor a company in a relatively undeveloped market as there are few comparable forms against which its performance could be measured.

Other mechanisms which involve substantial intervention would generally not be used as a primary tool to foster energy efficiency savings for economic gains alone. If used as a principal mechanism, it is assumed that the reduction of greenhouse emissions would be the ultimate goal.

Transferable emission permits, for example, require a total emissions limit to be set, and would be inappropriate for New Zealand to adopt in isolation as the local market would be too thin. Minimum efficiency standards are unlikely to cover existing equipment and buildings and can not practically reach many applications. However, they are a useful supplementary measure.

Subsidies and grants are not likely to be very efficient and the financial burden of using these as a principal tool would be too great. Demand ceilings too are inefficient and generate many problems.

A carbon tax is an effective means of increasing energy efficiency and reducing emissions but will compromise international competitiveness unless adopted in parallel with other countries.

Assessment and Implementation

The preferred mechanism for promoting energy efficiency is for supply authorities to conduct avoided cost tenders. This appears to be the best single step, justified on economic grounds alone, without fundamentally altering institutional and contractual frameworks.

It would be inexpensive and utilise market mechanisms to a high degree. While many of the arrangements that would need to be made are not simple, they are arrangements the market is accustomed to providing, once the requirement is made that tenders are to be called and vetted. Setting comprehensive, effective and efficient rules for the tenders would be crucial to the success of the process.

The major impact for Electricorp would be expected to be reduced gas-fired generation. The corporation has the right to onsell surplus gas, and may also negotiate provisions to defer use of the gas. If Electricorp was unable to make alternative arrangements for the gas, it would produce a reduced rate of return and electricity prices could rise slightly. Alternatively its valuation could be adjusted by the Government to reflect changed conditions.

For supply authorities, in the form of new retailing companies, the financial impact would partly depend on the ownership structure of each authority. It would also depend on the extent charges for the use of transmission lines are built into the cost of each unit of electricity consumed. This separation of charges is also very important in determining the potential for energy efficiency. If some transmission costs are not built into the cost of each unit of electricity, fewer energy efficiency improvements will be economic.

The goal in restructuring the electricity industry is greater economic efficiency in the delivery of electricity. The key reform suggested here of avoided cost tenders extends that concept by seeking economic efficiency in the delivery of, not electricity, but electrical services.

Consumers are ultimately interested in the cost of electrical services, such as heat and light, rather than the cost of electricity. Electricity is simply a means to those services, and energy efficiency can lower the overall cost. It is not clear that the current reforms will provide sufficient incentives for energy efficiency, and thus for the least cost delivery of electrical services. In particular, it is not clear which party will actually lead the provision of efficiency improvements in the short to medium term.

The tender mechanism is a means of ensuring the comparison between the value of electricity generation and energy savings is made explicitly. It establishes a market in the sense of establishing a forum for prices for both means of meeting demand.

It is difficult to estimate the costs of making the tenders a requirement in terms of the effect on economic efficiency. However, none of the costs appear to have strong structural characteristics. The level of direct benefits is also very difficult to anticipate. But the wider benefits would be increased competitiveness, improved allocation of resources and reduced greenhouse gas emissions.

Further investigation of the costs and benefits is required, and it is important that this be undertaken now rather than later. The problem with waiting to see whether sufficient incentives for energy efficiency do emerge, is that once supply authorities have been transformed into electricity retailers with shareholders, it would be much more difficult to make the reform, when it would be likely to lower the value of the shares.

The requirement to hold tenders may only be needed for a limited period while there is surplus generating capacity. The process may also be self-sustaining once initiated, so a 10 year review clause could apply. The value in speeding along those efficiency measures which the market is likely to deliver in the longer term, is the benefits that can be gained by making those energy savings earlier. The tender system would be a valuable extension of the current reforms to help achieve this.

1. Introduction

Scope of this Study

This study focuses on mechanisms for achieving greater energy efficiency in New Zealand. It looks at how an energy efficiency market could be activated.

A number of reports have already identified significant levels of energy savings that are both technically possible and economic. The role of energy efficiency as a central element in the reduction of greenhouse gas emissions has also been well described. But mechanisms for bringing about sizeable energy efficiency gains in New Zealand have yet to be seriously addressed.

This study looks briefly at the links between the greenhouse effect and energy efficiency, but is confined to those mechanisms which can be justified independently of global warming concerns. Policies for reducing global warming will require co-ordination at the international level, involving many issues beyond energy efficiency. But if energy efficient measures which are justified in their own right can be advanced now, and they lower greenhouse gas emissions as a result, this is clearly a desirable first step in any case.

The study focuses heavily on efficiency in the use of electricity, rather than other energy forms, as some of the greatest benefits are derived from saved electricity. It is also concerned with efficiency of energy use at the point of consumption, rather than efficiency in energy production which is, in general, considerably more advanced. Some analysis of the effects of proposed new institutional arrangements for the electricity industry is made, but the study does not extend to prescribing alternative structures as this would involve many other considerations. It assumes the future structures already envisaged and asks how energy efficiency can be obtained within these. It does, however, identify the features of those structures which tend to either promote or retard energy efficiency.

Background and Context

What Is Energy Efficiency?

Energy efficiency does not mean doing without. It means delivering the same service using less energy. This is made possible because a new process, device or method of use is introduced so that less energy is needed to do the same job. It is also known as energy management.

Energy conservation is related but different. It has come to mean using less energy and getting less. This may be through not using something where it otherwise would have been used, or using it less than normal, such as turning a heater down.

Why the Sudden Interest?

Energy efficiency has become a major theme in energy and environmental management because of two developments: the greenhouse effect and declining costs of energy efficiency technology. On a global basis, energy production and use account for 57% of the gases which contribute to greenhouse warming.[1] Thus the energy sector is the key place to look for reduced emissions, particularly carbon dioxide.

In New Zealand's case, the picture is not quite the same. Here, energy accounts for only 36% of greenhouse gas sources while agriculture produces 54%. However, energy remains the priority sector for reducing gas emissions. This is partly because energy efficiency can cut emissions without requiring a cut in the level of service. But especially attractive is the fact that many efficiency conversions are economic in their own right. Thus not only can existing demands be met, but significant energy savings can be made which also save consumers money.

Efficiency conversions have become increasingly economic because of many known and recent technology improvements which, put together, can deliver impressive savings. From the new compact fluorescent light bulb to better electric motors, the savings often come in small amounts but are very important contributions across the whole economy.

In relation to greenhouse gas concerns, these potential savings mean that governments can, in the short run, promote energy efficiency as a key tool through which to reduce emissions, and as a worthy programme in its own right.

New Zealand's Response

The New Zealand Government has set the target of a 20% reduction in carbon dioxide emissions (1990 levels) by the year 2000. As some 90% of the carbon dioxide produced in this country is energy-related, this will primarily involve reductions in energy use. Some carbon dioxide can be avoided through simply switching the source of the energy to one that is not a fossil fuel (renewable), or to one that emits less carbon dioxide for the same energy output (gas for coal). Some reductions can also be made by cutting back plans for new energy uses, and through conservation. But the bulk of the savings will need to come from energy efficiency measures.

Earlier this year the Ministry of Commerce's Energy Management Group produced one scenario for achievement of the target by 2005. This report, *Energy Management and the Greenhouse Effect*, is a thorough review of the technical potential for energy savings. However, it does not examine policy mechanisms for bringing these about. Responsibility for devising a carbon dioxide reduction strategy rests with the Ministry for the Environment which recently produced a scoping report for the substantive study it will co-ordinate. This sets out the work programme necessary to establish an overall carbon dioxide strategy for completion in about a year's time.

2. Current Patterns of Energy Use

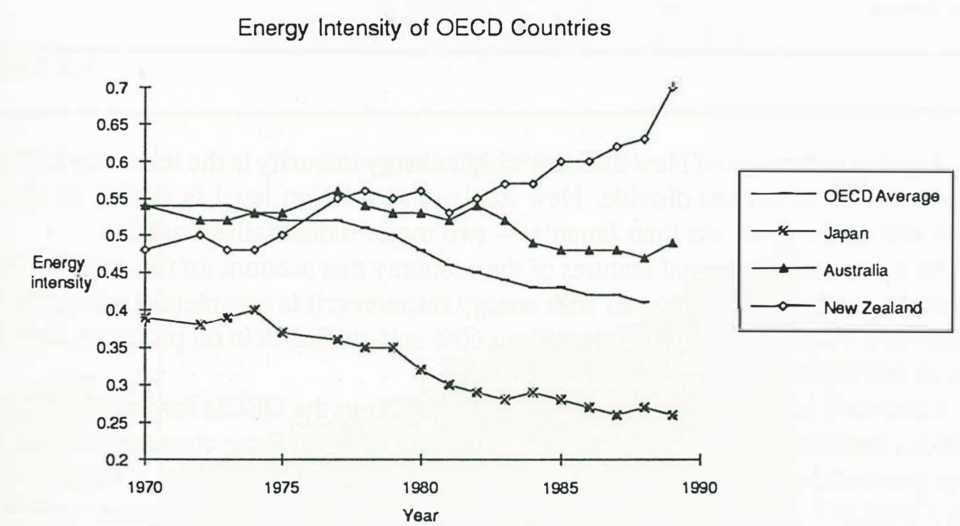
Energy Intensity

New Zealand uses proportionately more energy to run its economy than most developed countries. A measure of this intensity of use is the amount of energy needed to produce a dollar of Gross Domestic Product (GDP). New Zealand's energy intensity is 50% above the OECD average.

The major industrial economies of North America and Japan, while using far greater amounts of energy, have far lower energy intensities. North America uses only 64% of the energy we use to earn a dollar of GDP. Japan, one of the best performers of all OECD countries, uses just 37%. Australia is more in line with the United States, using 70%. Only Turkey has a significantly higher energy intensity than New Zealand.[2]

High energy intensity is not an immediate black mark for a particular industry: some simply require a lot more energy than average to make their product. But for New Zealand as a whole, even though we have a number of major energy-processing plants, the degree of disparity with other comparable nations does suggest quite poor energy use overall. The recent trend has been one of continually rising energy intensity, before and after the 'think big' projects were put in place (see Figure 2.1). Because of that poor record, there is strong potential for energy efficiency measures.

Figure 2.1



Primary energy intensity of gross domestic product;
tonnes of oil equivalent per thousand 1985 US dollars of GDP.

Source: Bertram

New Zealand has only developed its high energy-intensive status in the last 15 years. Analysis by Victoria University economist Geoff Bertram shows that before 1970, it was at a low- to mid-range position: not too far above Japan, and not too far below the

United States. However, while the OECD countries on average reduced their energy intensity by 24% between 1970 and 1988, New Zealand's increased by 31%. Other countries generally achieved considerable energy savings, following the 1973 and 1979 oil shocks, while New Zealand showed only mild and temporary adjustments before continuing to increase energy intensity. (See Figure 2.2.)

Figure 2.2

Source: Bertram

Another indication of New Zealand's high energy intensity is the relatively high per capita emission of carbon dioxide. New Zealand's emission level is similar to that of France and only a little less than Japan's — two major industrialised nations.

So are there any unusual features of the economy that account for this picture? New Zealand is certainly well endowed with energy resources: it is completely self-sufficient in electricity, natural gas and coal, and about 60% self-sufficient in oil products. But only some of this is priced lower than average.[3]

Electricity is relatively cheap — the sixth-lowest in the OECD for industry. Cheap electricity fostered the Tiwai Point aluminium smelter, which alone consumes 17% of the power generated in New Zealand. By comparison, aluminium smelting — which is very energy-intensive — consumes only 5% of America's power. The two biggest consumers of gas also pay quite low prices by international standards. On the other hand, oil product prices are about average, and natural gas a little above average. So lower prices for some energy products is a partial explanation of New Zealand's high energy intensity, but is not sufficient to account for the degree of disparity.

The dominant contributors to the rise in energy intensity during the first half of the 1980s were the 'think big' projects. This major industrial expansion included: the Motunui synthetic petrol plant; the New Zealand Steel five-fold expansion; the Marsden Point refinery expansion; the Petralgas methanol plant; a third potline for the Tiwai aluminium smelter; and electrification of the main trunk rail line. Much of this expansion arose from the abandonment of plans made in the 1970s to use most of the Maui natural gas to generate electricity. Overly high forecasts for electricity demand led to excess gas being

contracted for, to generate the power. Once the error of the forecasts was recognised, other uses had to be found for the gas, and a small electricity surplus.[4]

In the second half of the 1980s, transport deregulation was a major contributor. The effect was to shift more traffic from rail to road transport, and it also led to the expansion of commercial aviation and wider competition in the air.[5] In addition, the commercialisation, corporatisation and, in some cases privatisation, of the major state energy suppliers led to these organisations paying increased attention to sales growth with sophisticated marketing being applied to energy products.

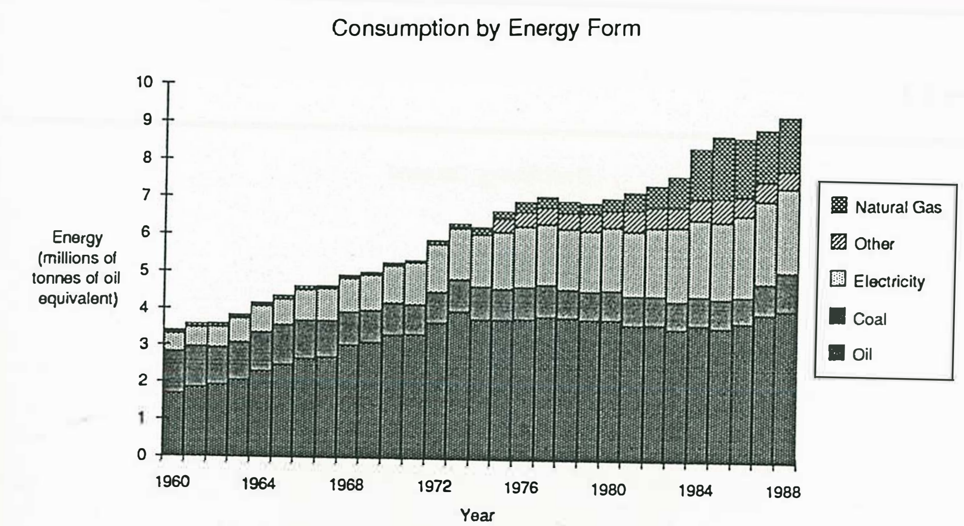
Despite the rise in energy consumption, there are also numerous examples of energy management and conservation programmes. The Government has given general support to such programmes and, at times, has initiated some quite extensive ones of its own, such as interest-free loans for insulation and alternative-fuel conversion subsidies. But notwithstanding these conservation programmes, there has been expansion of energy use at a much faster rate than the increase in GDP.

The Government no longer forecasts energy demand. But forecasts prepared by one of the major oil companies suggest no improvement in our energy intensity over the next decade.[6] Assuming an average real GDP increase of only 1% per annum, energy intensity is forecast to rise 3% by 1995, before returning to present levels by 2000.

Energy Sources and Demands

Figure 2.3 gives a breakdown of the forms in which energy is used in New Zealand. It shows that close to half (44%) of all energy is consumed as oil products while another quarter (24%) is used as electricity. Natural gas accounts for 16% and coal 11%.

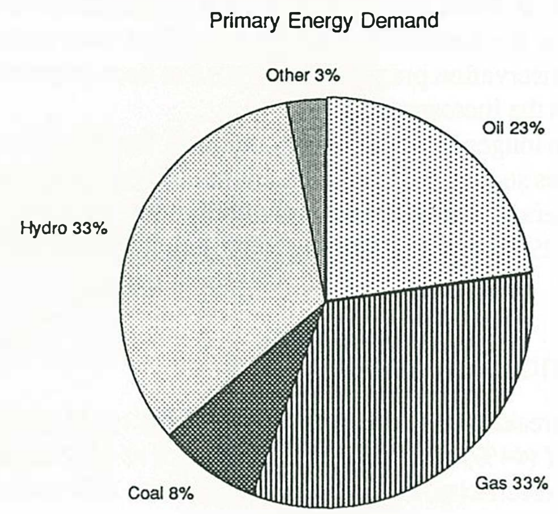
Figure 2.3



Source: Bertram

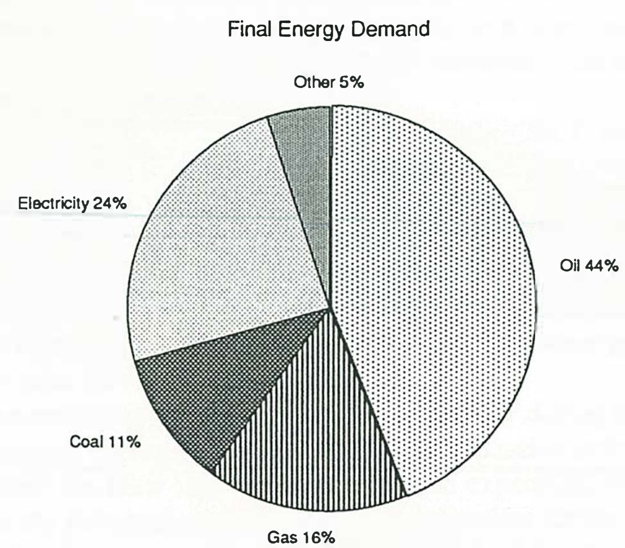
Figures 2.4 and 2.5 also break down energy consumption by form, but compare primary and final energy. Primary energy is that used before it is transformed into other energy products. Some 35% of primary energy is lost just in conversion to the form it is finally used in. Comparing the two graphs, it is electricity and gas which account for the losses while oil increases its share.

Figure 2.4



Source: Bertram, 1988 data

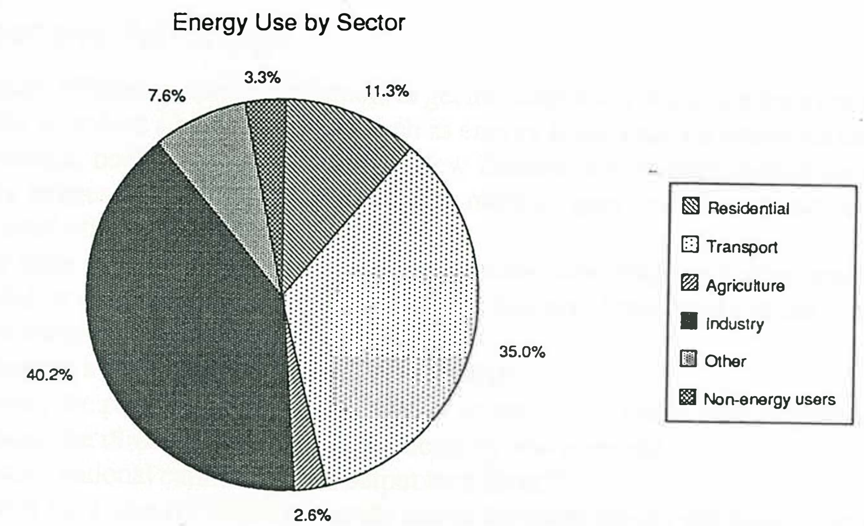
Figure 2.5



Source: Bertram, 1988 data

Figure 2.6 shows where energy is consumed within the economy. Industry and transport are the dominant users, together accounting for three-quarters of demand.

Figure 2.6



Source: Bertram, 1988 data

3. Benefits of Energy Efficiency

As well as reducing greenhouse gas emissions and saving consumers money, energy efficiency also offers a number of other very important benefits.

Competitive Advantage

Energy efficiency allows consumers to get the same level of service for a lower cost. The ability to reduce a basic cost input such as energy is obviously a source of competitive advantage, both locally and globally. New Zealand's very poor record for energy efficiency suggests local producers have even more to gain from energy savings than those in most other countries.

The links between energy efficiency, competitive advantage and other benefits are highlighted by a Swedish study. In April 1989, the Swedish State Power Board published a possible scenario for the country which:

"• supported a 50% increase in real GNP by 2010;
- allowed the phaseout of all nuclear power (representing about 40% of generation);
- reduced the direct economic cost of electricity services; and
- reduced national carbon dioxide output by a third."[7]

This is for a country which is already one of the most energy efficient in the world. The study made no special assumptions other than electricity would be used "moderately efficiently", the most efficient fuel is used to a greater extent for each purpose, and regard is paid to the environmental effects of fuels used to generate electricity.

Better Resource Allocation, Reduced Power Price Rises

Energy efficiency is crucial if New Zealand is to avoid a steep rise in electricity prices in less than a decade. The rise is expected because if present rates of growth in electricity consumption are maintained (around 3% a year), the current surplus capacity of generating plant will be used up by about 2000. That means major capital commitments for new stations, most likely funded from a rise in electricity prices.

The extent and pace of the building programme also depends on how long the giant Maui gas field can be made to last and whether replacement sources of gas become available. Maui gas is currently used to generate the bulk of Electricorp's thermal power — about 20% of its production. But the field is not expected to provide gas for generation after 2005. If no large new sources of gas become available, Electricorp will have to generate electricity by other means. This would at least entail expensive modification of gas burning plants, and possibly new stations in addition to those catering for increased demand.

A preliminary study by Alan Jenkins, strategic planner for the Electricity Supply Association, examines the high costs of continued growth in demand at an average rate of 3% a year. It shows Electricorp's spending on new stations rising in real terms from zero to around $3.5 billion a year by 2001 — more than double Electricorp's present revenue. This is part of total expenditure of more than $22 billion over the next 15 years. The study estimates that were such spending to go ahead, it would result in the average cost of generating a unit of electricity doubling over the next decade and that it would be treble three years later in 2004. This would translate into roughly a doubling in retail prices.

Building new generating capacity would be a serious misallocation of resources if power could be saved for less than the cost of building new plants. Power stations are unusually capital intensive, and large ones carry multi-billion dollar price tags. Some of the cheapest energy efficiency measures — like insulating hot water tanks and using different light bulbs — if undertaken in sufficient numbers, can make available the same amount of energy for a tiny fraction of the cost of a new station. And that is before allowing for frequent time and cost overruns because of unforeseen factors, such as volcanic heat in tunnels (Tongariro power scheme) and hillside stabilisation (Clyde dam).[8]

This also excludes the social and environmental costs of major power developments which have become increasingly important to local communities. *The Economist* reports that in America, resistance has grown to the point where "in parts of the country (such as New England and California) protest and red tape have made it virtually impossible to build new power stations".[9]

There is a serious lack of mechanisms for warning of coming power price rises. At present there are no forward contracts for power which would give the signals of price rises, and so there is no basis for a futures market in electricity. However, Electricorp chairman John Fernyhough recently announced that the corporation would begin raising prices in order to provide funds for future power station construction, and smooth coming increases over a number of years.

Energy efficiency can at least reduce the need to build new power stations and/or delay their timing. This limits the extent of the price rises, and extends the time before rises are necessary. However, it takes time to build up an energy efficiency industry. If substantial savings are sought, the industry must be activated well in advance.

Local Economic Development

Price does not affect the demand for energy as much as for other goods. If the amount of energy consumers need to buy is reduced, their discretionary spending generally rises. For cities and towns which are not major energy producers, expenditure on energy also becomes a net drain from these communities. So the more that can be saved, the greater the spending power of local people.

Such benefits were clearly shown through a study of a small rural town in the American state of Iowa. The electricity utility of the town of Osage conducted a nine-year programme of assisting the owners of local buildings to 'weatherise' their properties (stop heat losses). The result was a reduction in the utility's costs which allowed it to repay all its debt and build a multi-million dollar cash surplus, while reducing electricity charges by 32% in real terms over five years. The cheap power attracted two big factories to the town of 4,000 people, and also kept over $1,000 a year per household circulating in the local economy.[10]

Whakatane provides a similar local example — although at an earlier stage. There, the Ministry of Commerce has reported a high level of interest in energy savings, and the local council has been active in promoting the concept. In 1990 the council ran a six-month campaign involving council buildings, the local hospital, schools, farms and service stations. Much of the campaign was educational, showing how consumers could save power. The local hospital has been an early leader in energy efficiency, and has reduced its annual energy bill by a third. Bay Electricity, the local supply authority, has also assisted by developing a special thermal blanket for hot water cylinders used by dairy farmers. The blanket saves 46% of the heat energy and pays for itself in just nine months.

Energy efficiency is also good for employment. New schemes to increase energy production are obvious sources of employment. But modest budget energy retrofits

involve a high labour content, across a vast number of individual tasks, and the work is not confined to one geographic area.

A study by the New Zealand Institute of Economic Research estimates that a new company set up to implement various energy efficiency measures in the domestic sector would create over 600 permanent jobs, 78 directly and 540 indirectly. This example assumed the retrofitting of 21,196 houses (about 7% of uninsulated houses), and that the implementation work would generally be suited to semi-skilled and unskilled workers.[11]

Greenhouse and Other Environmental Benefits

As already stated, energy efficiency is the key tool for reducing greenhouse gas emissions. The most authoritative statement to date on the greenhouse effect is probably that from 700 scientists, endorsing the May 1990 report of the Intergovernmental Panel on Climate Change.

It states: "We are *certain* of the following: Emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases: carbon dioxide, methane, the chlorofluorocarbons and nitrous oxides. These increases will enhance the greenhouse effect, resulting, on average, in an additional warming of the Earth's surface."[12]

While New Zealand's contribution to the global production of greenhouse gases is tiny at 0.1%, we produce about treble the world average on a per capita basis. As noted earlier, 36% of the emissions are due to energy use and 54% are from agriculture. The high agricultural content means methane and nitrous oxides in particular make up a larger proportion of emissions than for most countries. But carbon dioxide emissions are still about double the world average. New Zealand's plantation forests absorb a significant amount of this, and additional planting is another important tool for reducing levels.[13]

Energy efficiency also brings other benefits to the environment. At present, all energy savings are ultimately saving fossil fuels. By reducing energy consumption we reduce demands on the environment, both at the points of extraction and consumption.

If there is less need to extract coal, oil or gas, then there is less disruption of the land cover, less risk of oil leaks and less impact on water sources, etc. At the consumption end, it is not just carbon dioxide which is produced as a residue of oil and coal use. Other environmentally damaging gases, including nitrous oxides and sulphur dioxide are also released, and we would benefit from a reduction.

4. Potential Electricity Savings

The technical potential for energy efficiency savings is vast. Many energy-consuming devices have been modified under laboratory conditions to the point where they can do the same job with a tiny fraction of the normal energy input.

However, not all methods of achieving savings are economic. Each also depends on factors such as the price of energy in a particular geographic area and the frequency with which the energy-consuming device is used.

The potential for savings in some types of energy use are quite startling. In America, the Rocky Mountain Institute estimates that 92% of electricity used for lighting can be saved at a profit.* Not all these measures are cost-free in themselves, but some produce such large energy savings that they more than make up for others with a positive cost. In New Zealand, lighting specialists believe that there is also a large potential for savings, with virtually every major type of lighting in use having an economic replacement system that is much more energy efficient.[14]

In the mid-1980s, the Ministry of Energy conducted a programme aimed at testing the efficiency gains that could be achieved from designing houses to make best use of solar energy. Of 33 houses built throughout the country, 23 included 'Design to the Sun' features which added between $600 and $1,000 to their construction costs. Those houses achieved savings in heating energy ranging from 40% to 90% compared to the houses without the features.[15]

Methods of Saving Energy

Before looking at overall savings potentials, the following outlines the basic pathways to energy savings. (The different measures of economic potential are described in Appendix 1.)

Energy Efficient New Products

The easiest and most cost-effective way to raise energy efficiency for a given service is at the time new investment takes place. The simplest time to secure high efficiency, with little additional effort, is when an energy-consuming device is purchased new — whether it is a machine, building or minor fitting, More importantly, the additional cost (if any) is the lowest at that time. New investment captures the full savings potential, while it is not always economic to retrofit.

Adjusting the Old

Once a less than optimally efficient device is in place, better performance may be achieved simply through non-modifying adjustments. Simple examples include turning down the temperature of hot water cylinders, and tuning cars. Timer and sensor devices which limit the operating period of the device to when it is really needed can also achieve savings without modification.

* The Rocky Mountain Institute is a resource policy research institute. It estimates the average net cost of the retrofitting to be negative.

Retrofits

Retrofits involve changes to an existing building, plant, machine or fixture, where parts are replaced or added. Obviously the more complicated and expensive the changes, the less attractive it will be. But some very simple changes — such as insulating buildings better and changing the type of light bulb used — can produce dramatic savings.

Changes in Behaviour

As well as modifying a device, changing the way people use it can also provide worthwhile savings. This may involve a different pattern of driving, or different positioning and setting of a heater. Although these are often quite simple changes, consumers are generally slow to adapt and frequently go back to old habits.

Energy Conservation

Energy conservation is a different concept to energy efficiency. It involves actively making the choice not to achieve the same level of output: a previous level of use is deliberately cut back on.

Estimates of Potential Savings in New Zealand

The potential for economy-wide energy savings through efficiency improvements is not precisely known. Any such study would be limited by a lack of primary data because many energy statistics are no longer being collected.

However, some thorough studies of specific applications, industries and sectors have been undertaken and, by themselves, confirm a considerable level of savings is available. This information base can be extended to a certain degree by comparison with international research.

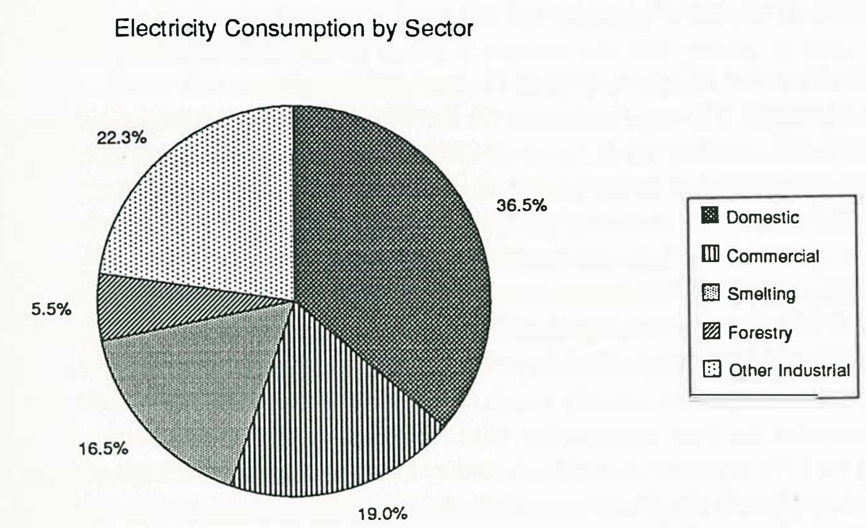
In the United States and parts of Europe, some very detailed work has been undertaken. Most of the savings identified have relied not on technical innovation, but simply the bringing together of a range of possible minor improvements to an energy-consuming device and then rigorously testing to give the best overall result. In the case of electric motors, for example, many improvements are tiny on their own but overall, they offer considerable savings.

Virtually all the systems for energy savings are transferrable between countries. The physical hardware is either compatible or adaptable. While the economics differ as a result of differing energy prices, climates and so forth, adjustments can be made for these. Thus overseas experience is a reasonable guide for what could be achieved in New Zealand.

The potential savings available from electricity are the focus of this study for a number of reasons. Electricity is the biggest source of energy (in terms of primary energy demand), and it supplies the highest share of energy to every sector except transport (see Figure 4.1).

Electricity also offers some of the biggest and easiest savings. This is partly because many of the savings are straightforward to implement. It is also because using fossil fuels to make electricity is an extremely inefficient way of delivering some services requiring energy. These non-renewable fuels are burnt to make electricity at a thermal efficiency of around 33%. If the power is then transmitted (10% loss), the ultimate efficiency of the fuel will be 30%. While roughly 80% of New Zealand's electricity is supplied from renewable sources — primarily hydro — the remaining 20% (and the marginal generation) is from fossil fuels.

Figure 4.1



Source: Electricorp, 1988 data

There are also especially strong reasons for focusing on electricity at this particular time, as outlined on pp. 15–16. Maui gas, which currently meets most of that fossil fuel generation, will soon run out. Energy efficiency would reduce the need to modify or build replacement power stations, and could avoid a sharp rise in power prices.

Finally, the information needed to understand the potential for savings in New Zealand is available for the electricity sector. Information on the oil and gas sectors is much more limited and is reviewed later in this report.

Electricity Savings Potentials — Various Studies

Energy Minister John Luxton has suggested that "The technology is now likely to be available to run New Zealand on a quarter of its existing electricity. Not all of it is cost effective, but a lot of it is."

No detailed studies of the overall potential electricity savings have been completed. But one estimate of the possible economy-wide savings has been made.

The study, by Linda Cameron for Electricorp, simply breaks down the demand for electricity in New Zealand into seven basic classes of use, and assumes that efficiency savings shown to be possible for these categories overseas, will be similar here.[16] The savings potentials in this study are adopted from work by Amory Lovins of the Rocky Mountain Institute, a leading authority on energy efficiency.

Using this rough methodology, the Electricorp study estimates that 57% of the electricity currently used could be saved economically, while consumers enjoyed the same level of service. This, of course, does not represent the savings that could actually be achieved, as not all the potential could be harnessed. Cameron states that it is more realistic to assume a 20% savings in demand could be achieved.

Naturally, there are limitations to the study, such as differing costs of savings systems when purchased in New Zealand, and differing existing standards of efficiency. But the economy of the measures was such that there is a large margin for error. It was estimated that the 57% savings could be achieved at an average cost of just 1.6 cents per unit of electricity used (kWh).* This compares with a weekly spot price for wholesale electricity which currently fluctuates in a band between 2 and 3 c/kWh, and retail prices ranging from 7 c/kWh to 12 c/kWh. As explained later, the spot price is quite close to the cost of the fuel needed to generate the last units of power. So the study is pointing to the average cost of saving half the country's needs at less than the cost of the gas which would otherwise be needed to produce much of the power.

The efficiency savings estimates for the study are taken from Lovins' work and are based on detailed bench trials, as well as the monitoring of numerous efficiency programmes run by United States power utilities. So while Electricorp stresses the limitations of the study, the technical potential is likely to be very sound. Although some observers question the cost estimates, Lovins states that these 1989 figures are now "clearly conservative".[17] He believes the technical potential for energy efficiency in New Zealand is likely to be even greater than the Electricorp study suggests, due to the relatively low emphasis on efficiency compared to the United States.

To compare this necessarily rough analysis with more detailed work, the domestic sector provides the best information base. This sector is also the single largest — accounting for 37% of power demands. A summary of the essential findings of the Electricorp study as it applies to the domestic sector, and the other domestic sector studies, follows. All assume only retrofitting changes to achieve their savings.

Electricorp Study

The study assumed that 80% of domestic demand was used for low temperature heating — such as hot water; 10% used for lights and motors; and the remaining 10% for high temperature heat — such as ovens. The efficiency savings expected from these categories were respectively: 65% for the first three-fifths of low temperature heat and 80% for the balance; 60% for lights and motors; and 10% for high temperature heat. The costs for implementing the energy efficiency changes in c/kWh were: 0.3 and 3.4; 1.2; and 1.7 (see Figure 4.3). The real discount rate used is not stated but is understood to be 5%.

The study does not generally break down results sector by sector, but a close approximation can be deduced. This shows the potential to save 64% of domestic demand at an average cost of 1.5 c/kWh.

Baines and Wright Study

This very detailed study was produced for the then Ministry of Energy in 1986, by University of Canterbury researchers James Baines and Janice Wright. It examines the potential savings available from all forms of energy, but clearly separates the electricity findings.

It estimates the level of domestic demand for the year 2000, and tries to assess what proportion of that demand could be saved by energy efficiency. The potential savings systems are described and costed individually, using a real discount rate of 10%. It estimates the potential to save 24% of projected domestic demand at an average cost of 4.5 c/kWh. It also estimates the potential to save half of domestic demand at an average cost of around 8.8 c/kWh.

* The net cost of the retrofitting work can be expressed in cents per unit of energy. This involves discounting the capital cost of the improvements over the expected life of the investment and then subtracting from this the value of the power saved as a result of the efficiency improvements.

Electricity Supply Association Study

This 1990 study looks at the potential for improving the energy efficiency of a selection of existing houses in Feilding. As in the Baines and Wright study, each potential modification is separately costed.

The study found that savings of between 23 to 85% could be achieved economically, depending on factors such as the state of the existing house, the degree to which it was occupied during the day and whether renovations were carried out. The importance of renovations is that they allow additional efficiency measures not otherwise economic to be made, as then only the margin between the work that would have to be done and the extra energy-saving work need be paid. A real discount rate of 5% was used.

For the standard all-electric house it estimates the potential to save 50% of the normal consumption at an average cost of 1.7 c/kWh. It also estimates that 66% could be saved at an average cost of 3.4 c/kWh, and savings of three-quarters of the energy were possible at a cost of 8.6 c/kWh.

Rocky Mountain Institute Study

This report was carried out for the Arkansas Power and Light Company, and looks at the potential electricity savings available from the average single family house. Again, potential modifications are costed separately, including those for air conditioning. The real discount rate used was 5%. The study estimates the potential to save 50% of the energy for an average cost of 1.2 c/kWh. It also estimates that 77% could be saved at an average cost of 2.7 c/kWh.

Comparison of the Studies

All the studies show a technical potential to save more than half the demand. The costs of achieving varying levels of savings are broadly comparable across three of the studies, but those for Baines and Wright are substantially higher.

It would be very difficult, and ultimately unnecessary, to take account of different assumptions in each study to get a truly equivalent basis for comparison. One difference which is notable with Baines and Wright, is the higher real discount rate — 10% as against 5% for the others. This has the effect of raising the cost of savings modifications and is proportionately higher for lower-cost measures.

Other important reasons for the difference are outlined in the Electricorp study which made the same comparison: "The difference may be attributed to the fact that New Zealand was a comparatively 'low-tech' country in relation to the United States in 1986 [when the Wright study was undertaken]. Since then ... the removal of tariff barriers has made it possible for New Zealand to import more efficient appliances and equipment at a lower cost. While actual costs in New Zealand may not be as low as those postulated by Lovins [for the Electricorp study] they are certainly no longer as high as the estimates produced by Baines and Wright." Lovins estimates that the cost effectiveness of these efficiency technologies has improved sixfold in the last five years.

Turning to the studies of average houses, the more recent study completed for the Electricity Supply Association (ESA) compares much more closely with the United States study. They both estimate demand can be cut by half at an average cost of between 1 and 2 cents a unit (kWh), and that another chunk of savings can be made to bring the average cost up to around 3 cents a unit.

Overall, while the cost estimates in the Electricorp study are slightly lower than comparable studies would suggest, they seem broadly in line when differing assumptions are taken into account. Thus, we can have greater confidence in the overall level of savings identified in the study.

In Summary

Determining the precise level of savings that are economic is not important. The question is whether the information to date establishes with a reasonable level of confidence that there is an economic reserve of energy to be exploited through electricity efficiency.

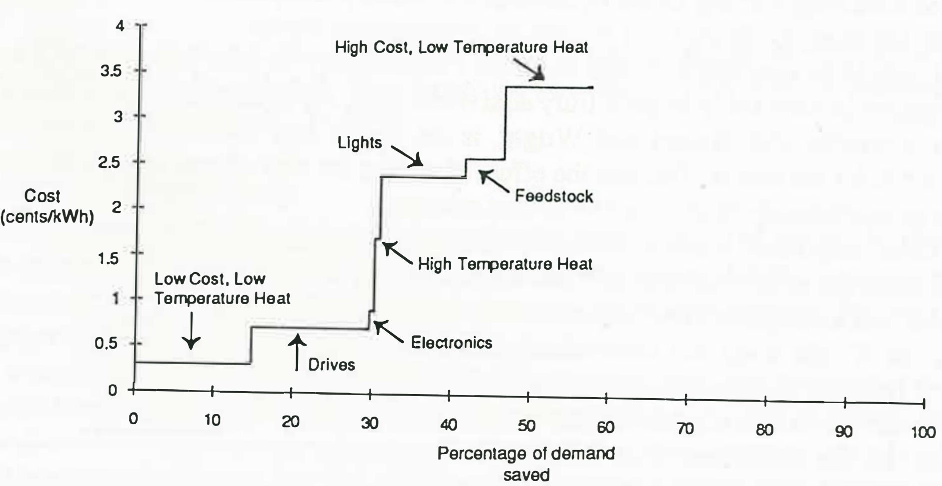
Even on their own, these limited studies suggest fairly strongly that there is. Whatever the precise potential, they all imply that there is a substantial quantity of savings that can be achieved at an average cost far below the retail price of power and the wholesale price. A first block of savings is shown as being cheaper than the marginal cost of generation. The most important limitation is that a discount rate of 5% used in three studies is probably too low.

These studies are backed by many similar ones carried out in other countries. We also have a reasonable idea of which are the really cheap means of making savings and which are the more expensive. So there is the potential to proceed cautiously if this is required, by testing the estimates for the cheap measures first. In practice, feedback from the energy-saving work will continually redefine the cost estimates.

The progressively costlier options can be shown as an energy efficiency supply curve. This shows both the cost of the option (per unit of electricity) and the amount of power that would be saved if implemented across the economy. It also notes the measures that save a lot and are cheap, as well as those which save very little and are costly. Figure 4.2 shows an efficiency supply curve derived from the Electricorp study estimates.

Figure 4.2

Electricity Efficiency Supply Curve



Source: Electricorp

What the graph is saying in more detail is that the first block of savings from low cost, low temperature heat will allow 14% of current demand to be saved at an average cost of 0.3 c/kWh. The next block of savings from improved electric motors (drives) will save another 15% at an average cost of 0.7 c/kWh. Thus it is the uses which have large horizontal components in the graph which have the big savings potentials. Further details of the figures which make up the graph are shown in Figure 4.3.

Notice that while lighting consumes only 12% of electricity demand, because 90% of the energy used can be saved, it accounts for almost 20% of the total savings identified. At the other extreme, high temperature heat accounts for 5% of current demand but savings of only 10% have been identified so its contribution to total electricity savings is less than 1%.

Figure 4.3

Electricity Efficiency Savings Potentials

	End-use GWh	Proportion of end-use %	Potential savings %	Estimated cost c/kWh	Potential savings GWh
Lights)	3,095.3	12.0	90	2.4	2,785.7
Drive)	7,738.2	30.0	50	0.7	3,869.1
Electronics)	283.7	1.1	50	0.9	141.9
LT heat	9,318.0	36.1) 3/5	65	0.3	3,634.0
		) 2/5	80	3.4	2,981.8
HT heat	1,372.5	5.3	10	1.7	137.3
Feedstock	3,944.5	15.3	30	2.6	1,183.4
Transport	52.5	0.2	n/a	n/a	n/a
Total	**25,804.7**	**100.0**	**57**	**1.6**	**14,733.1**

Source: Electricorp

5. Barriers to Energy Efficiency

The clear potential for achieving significant energy and cost savings through efficiency measures raises an obvious question: Why is there not a thriving energy efficiency industry? The answer is that it is not enough that the savings methods are technically reliable and economic. They must also be available to the consumer in a way that meets a host of other requirements. Distortions in the market which can make them uncompetitive must also be overcome. The extent of the barriers to energy efficiency determines how much of the potential savings can be realised.

There are two basic sets of barriers: those which consumers encounter directly, and those which are features of the wider energy market in New Zealand. These are considered in turn.

Barriers at the Consumer Level

Information

For consumers to adopt energy efficiency measures, they must first have the information to show that efficiency is a sound proposition. This is difficult because of the volume and complexity of the information, assuming it is readily available. Efficiency improvements typically involve a number of small changes, each requiring consideration, and there are different ways of making these changes.

Efficiency as a New Concept

Consumers have some experience of spending money to cut power bills — such as putting in Batts insulation — but they usually think of savings as doing without. The conventional assumption that using less energy means getting less needs to be overcome.

Finance

The biggest obstacle to energy efficiency is probably financial barriers. To save energy, the consumer must first have the money to buy efficiency improvements. This problem is tied to consumers wanting a fast payback on energy efficiency improvements. While electricity suppliers will typically invest in a project with a payback period of 15 years or more, consumers tend to look to a two-year payback. This difference in outlook between suppliers and consumers is known as the payback gap. So while energy suppliers may have a discount rate of 10%, the consumer's implied discount rate is around 65% for a two-year payback, given the expected life of the investment.

Risk

Because energy efficiency products are relatively new and do not have a long track record in New Zealand, the consumer perceives an element of risk. Why go through all the hassle if it does not prove to be as good as is claimed? There is also uncertainty as to the likely future prices of energy which, if they are lower, will reduce the value of the investment.

Separation of Consumer from the Investment

Sometimes the consumer will have no say as to what value to place on energy efficiency. The purchaser of a newly-built home does not choose the fittings or insulation levels, and a tenant has no incentive to upgrade a rented property when the capital outlay may not be recovered in time. Equally, a landlord has only a weak incentive to invest to reduce bills that are paid only by the tenant.

Availability of Products and Services

Many products are imported from other countries, and without an existing market to justify local agents keeping stock available, consumers may not be assured of timely delivery or the best prices. Similarly, a lack of existing demand for energy efficiency services means there are few people and organisations experienced to assess and implement improvements.

Low Priority Issue

As Electricorp notes in its 1991 Annual Report, "Commercial organisations generally prefer to invest management time and capital resources in core business activities rather than in peripheral opportunities such as energy savings, even where it is in their commercial interests to do so."

Energy Engineering reported the experience of one electricity utility in Florida, which surveyed for a nominal cost, 831 commercial and industrial consumers to audit their energy consumption. It provided a written report detailing the worthwhile changes that could be made, their cost and payback time. Though the review considered only those efficiency improvements that would pay back in under three years, and highlighted separately those which were at no cost (they paid back in less than a year), only 15 to 20% of the businesses implemented the recommendations.

Contractual and Institutional Barriers

Maui Contract

The agreement governing extraction of gas from the Maui field is the largest contractual distortion in the energy market. The sheer size of the field, when matched to typical depletion rates, helped produce a contract which requires an enormous quantity of gas to be consumed over a 30-year period, ending in 2008. The contract specifies annual quantities of gas which must be paid for by the buyer, regardless of whether the gas is actually used. (The buyer is the Crown, which has in turn onsold most of the gas to Fletcher Challenge and the balance to Electricorp.) Unused gas reverts to the field owners — a consortium of petroleum mining companies — at the end of the contract period.

While it was originally intended that 90% of the gas would be consumed in power stations, electricity demand turned out to be nowhere near the level that would require this. Current consumption is very roughly divided equally between electricity generation, the Motunui synfuel plant and other uses. Other gas fields also contribute to New Zealand's gas supply, but Maui makes up the majority of total supplies (78%) and supplies the marginal production.

The effect of the relative abundance of gas, and the contract, is that the marginal bulk consumer — Electricorp — obtains relatively cheap gas. This makes gas-fired generation cheaper than it would otherwise be, and thus promotes the inefficient use of gas to generate power, rather than for greater direct use. Further, like the original Maui contract, a number of major consumers are also on a take or pay form of contract. This can reduce the incentive for efficiency, depending on the contract conditions.

Comalco Agreement

While the Tiwai aluminium smelter is largely removed from the electricity market, the special contract Comalco holds for cheap power significantly influences the level of

energy efficiency used in the plant process. A significant block of power used by the smelter could be saved if the smelting pots were upgraded. However, as the company pays around half the South Island wholesale price for power, the incentive to upgrade is weakened.

Monopoly Characteristics

Two of the three biggest sources of energy — electricity and gas — have significant monopoly characteristics. This has, in part, arisen because New Zealand's isolation means it cannot trade economically in these resources. It is also due to the relatively small size of New Zealand in relation to the scale of projects traditionally undertaken to supply electricity and gas.

The electricity and gas industries have a section which is a natural monopoly — the grid transmission systems. It is highly uneconomic for a competitor to duplicate the main supply lines for gas or electricity once set in place. But the wholesaling of gas and electricity is not a natural monopoly, and both Electricorp and Petrocorp have highly dominant positions in their respective markets.

Depending on their cost structures, monopolies may have no incentive to encourage efficiency at the consumption end. Both gas and electricity have cost structures which, in the short to medium term, encourage increased sales in order to profit maximise. As near-monopolies, they do not face serious competition from wholesalers which may offer energy efficiency services that could reduce gas or electricity sales. Near-monopolies are also in a strong position to out-price other companies offering such services.

It is interesting to note that even between the two energy sources, monopoly force is exercised. A recent case was the North Shore Hospital's plan to construct its own small gas-fired co-generation plant. Co-generation involves the use of gas to produce heat while at the same time producing electricity, so that overall efficiency of energy use is substantially enhanced. However, as these plans emerged, the local electricity supply authority changed the charging structure for the hospital. It was changed so that while the total bill remains the same, the fixed charge component of the bill (for being connected) was much higher than before. Thus if the co-generation plant could not be relied on entirely for the hospital's needs, and power from outside was still needed, the cost of paying simply to be connected exceeded any economy to be gained from generating new power at the hospital. A number of such co-generation issues are currently under investigation by the Commerce Commission.

Energy Minister John Luxton recently confirmed details of plans to deregulate the gas industry which are designed to stimulate greater competition. These include abolition of retail franchise areas and disclosure of pipeline transmission charges. The Government is also in the process of major reform of the electricity industry (see pp. 32–3).

Lack of Independent Monitoring

Comprehensive information and independent monitoring are important to get a better understanding of energy flows in the economy. This allows better analysis of demands and prices to target energy efficiency potentials.

Barriers and Energy Efficiency Demand

Despite a healthy potential for savings, the barriers are sufficient that energy efficiency currently plays a rather small role in meeting customers' energy needs.

The extent to which energy efficiency currently reduces demand is very difficult to estimate. One study by Neil Maxwell of Ernst and Young took data from the International

Energy Agency's six biggest member countries. It suggested that between the early 1970s and 1986, electricity efficiency had resulted in demand being 10% less in 1986 than it otherwise would have been.[18] This was based on an analysis of the efficiency of electricity-consuming equipment commercially available during the two periods, 15 years apart.[19]

As noted, the Government no longer collects industry information to prepare demand forecasts. This gap is planned to be filled by both renewed government funding, and by the recently formed Energy Foundation — a grouping of major energy suppliers — which intends to produce an all-sectors co-ordinated demand forecast. In the meantime, the best indications are the forecasts of the individual energy suppliers.

Over the next decade, Electricorp expects demand for power to continue to rise quite strongly. Forecasts presented to the Wanganui water flows hearing show an increase in demand over the next decade, of around 35% in total.[20]

During that hearing the corporation also estimated the maximum substitution of electricity through energy efficiency. It considered 11% of total demand (over 15 years) to be the best achievable in the current environment, and recently reaffirmed this figure.[21]*

While Petrocorp and other gas retailers are unwilling to make their demand forecasts public due to commercial sensitivity, those prepared by Mobil Oil cover the gas and coal sectors sufficiently, as well as oil products.[22] The effect of reduced demand through efficiency has been built into these forecasts but the extent is not made explicit. (See Appendix 2 for details.) The Mobil forecasts are as follows:

- Gas consumption is forecast to rise 9.6% over present levels by 1995, but drop 2.5% by 2000 as Maui starts to run down.

- Solid fuels (essentially coal) are expected to take up the larger proportion of growth not met by gas. Demand for these is forecast to rise 10% by 1995, and 38% by 2000.

- Oil product consumption (excluding synfuel) is expected to increase 8% by 1995, and 28% by 2000.

These demand forecasts were also matched against real GDP expectations of a 4% increase by 1995 and a 15% increase by 2000. The result is that the ratio of energy to GDP (energy intensity) rises a little but is virtually equal to the current level by 2000.

Thus efficiency is certainly not expected to free up energy for new demands. The forecast envisages 14.5% more energy being used by the end of the decade with no reduction in intensity. So while some new energy-intensive industries may be matching energy efficiency gains, given normal patterns of development, energy efficiency is not expected to make a serious contribution towards meeting energy demand.

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* This study was prepared by Ernst and Young's Neil Maxwell for the corporation. Its biggest limitation is that the costs of retrofit technology have changed considerably since the study was completed. It relies on a 1986 report (Baines and Wright) for 67% of the data on which the estimate is based.

6. Mechanisms for Achieving Savings

This part of the report looks at possible mechanisms for activating a market in electricity efficiency. It examines the means to overcome the substantial barriers to greater efficiency.

In general, a good solution would involve the least reform for the least cost and administrative difficulty, to achieve the greatest potential.

A priority is to examine creative mechanisms which could be used to unblock the market without significant outside intervention. There is a wealth of overseas experience to draw on at the level of introducing services to customers; here we focus on the United States.

Electricity Savings Mechanisms in the United States

The United States has pioneered many techniques for bringing energy efficiency to the consumer. Among the 3,000 electricity utilities, California has been an early leader and continues to set even more advanced goals. Last year, three of its utilities announced a plan to spend over $US560 million on energy efficiency programmes.[23] America's largest utility, San Francisco-based Pacific Gas and Electric, is committed to energy efficiency spending of $US1.5 to 2 billion in the 1990s to meet three-quarters of its new demand for electricity.[24]

Historically, much of this activity has been stimulated by regulatory authorities offering higher rates of return (typically 4% greater) to utilities which invest in energy efficiency instead of new power stations. But increasingly, this is occurring independently of regulatory structures, due to the tremendous community opposition to construction of new power stations. The following is a summary of the principle techniques used by American utilities to overcome barriers at the consumer level.

Loans

Loans in their most basic form get the consumer over the first financial hurdle. If a company organises the loan, this saves the consumer arranging finance with a bank. In many cases, these loans have been pitched well below market levels — some interest-free. As early as the mid-1980s, over half of America's electricity consumers were being offered loans for energy efficiency improvements of one form or another. A limitation of this measure, however, is that the loans generally apply only to a selected range of improvements which can be very restrictive.

One particularly useful variation on the loan system is a scheme that only takes repayments from the consumer as savings are actually made on the power bill. The utility pays for certain improvements it believes are economic, and consumers pay their power bills on the basis of what they would have consumed before the improvements were made. The utility then takes the difference and puts this towards repayment of the loan and any interest charges. This formula thus meets the constraints of those on very limited and fixed incomes by virtually guaranteeing that their costs will not rise above what they were. It also alleviates any risks the consumer might face, while giving permanent savings once the loan is repaid. Massachusetts Electric offers such a loan scheme.

Rebates

For those unwilling to pay the full cost of certain improvements, the utilities have also developed rebating programmes. Under this scheme, selected measures or appliances qualify for a rebate so that the utility meets a proportion of the cost. This allows particularly inefficient uses or items predominant at times of peak loading to be specifically discouraged (and save the utility generating power at that time). For example, New York's Consolidated Edison Company this year offered 70,000 low wattage light bulbs, which normally sold for $US20, at the discounted price of $US5 each.[25]

While a straight rebate gives all the discount to the consumer, one variation in the case of appliances is to split this with the equipment supplier. This gives an incentive for stores to stock energy efficient equipment and promote them to customers.

Another variation for appliances, is for customers to be paid a bounty on the return of old inefficient equipment. This is similar to giving a credit for a trade-in, with the difference being that the utility scraps the appliance to ensure it is not used by another customer. A number of utilities offer $US50 for the return of inefficient refrigerators.

Pacific Gas and Electric even has a plan to spend $US9 million over the next two years giving rebates to builders who use energy-saving materials and techniques.[26]

Another phase in the development of this mechanism has been the use of generic rebates. These are used where the means of energy savings, within a class of use, is not important. The typical arrangement is that the utility offers cheaper power to consumers who can show reduced demand. The reduction in the unit price of electricity applies for a certain length of time after savings have been demonstrated by a customer, to a set level.

Gifts

For those consumers who are reluctant or unable to put up any money to improve energy efficiency, it has been economic to simply give away energy-saving devices or appliances. The Edison Company in Southern California gave away more than 500,000 compact fluorescent light bulbs to targeted customers, such as low income residential consumers and small neighbourhood stores.

Another utility targeted unemployed people, giving out relatively low-cost energy efficiency hardware that required simple labour to install, including draught prevention materials and a more efficient shower fitting.

Although these gifts can work out cheaper than some discount loans and rebates, they are not used as widely. It is felt that consumers will use the subsidies for the greatest value to the utility, as well as to the customer, if they have a stake in it.

While these methods are successful in closing the payback gap, removing risk and the need for customer expertise, they still only address the barriers at the customer interface. They also rely on the electricity utility having an interest in saving power. But the wider environment in which the electricity industry operates in New Zealand is quite different to that in the United States. Before detailing this, the following backgrounds current reforms to the industry.

Electricity Industry Reform in New Zealand

The electricity industry is now midway through a major restructuring being driven by the Government. It began with the corporatisation of the former Energy Ministry's Electricity Division, to establish Electricorp in 1986 and 1987. The industry-wide review now underway commenced with the appointment of the Electricity Industry Task Force in February 1988.

A high degree of structural change is proposed and most of the key directions seem set, even if there is still considerable work required to resolve the precise reforms. The major decisions and proposals announced to date are as follows:

- The transmission grid company Trans Power is to be split from Electricorp, and its shares probably held by a club including Electricorp, the electricity supply authorities and major users.
- The generation of electricity has been fully deregulated to promote competition.
- Consideration is being given to the breakup of Electricorp's generation assets into two or more independent companies, which may in turn be privatised. Alternatively, one or more individual stations may be sold separately, leaving the corporation largely intact, and possibly privatised.
- The electricity supply authorities which retail power — MEDs and electric power boards — are in the process of being corporatised.
- It is proposed that community trusts be established to hold shares in the supply authorities as ordinary companies. However, there may be considerable flexibility as to how the shares are ultimately distributed, and to which parties. The original proposal was that the trusts be required to sell at least 70% of the shares to private investors within three years.
- Supply authorities are to lose their area franchises entirely from January 1993.

In examining mechanisms for implementing energy efficiency, this study assumes the above as defining the broad future structure of the industry. Comment on the reforms in general is beyond the scope of this paper, but effects on the energy efficiency market are noted.

The focus of the reform has been economic efficiency rather than energy efficiency. In striving for dynamic and allocative efficiency, little consideration has been given to the likely effect of the reforms on the efficiency of energy use. In the context of such a thorough restructuring, it seems important to also examine the likely impact of the reforms on energy efficiency.

Energy Efficiency Through Electricorp

For US utilities, energy efficiency is generally in their commercial interest. For Electricorp, this is currently not the case, or it is true only in a limited sense. Due to special circumstances in New Zealand, for much of the next decade, the more power Electricorp sells, the better its commercial performance.

In America, electricity generators are benefiting from efficiency savings in two ways. One is where it saves them having to build new power stations to meet increased demand. The other is where the marginal cost of generation is higher than the wholesale price — that is, where the cost of producing the last few units of power (the marginal cost) is greater than the price at which they sell the power before transmission.

Neither of these currently apply in New Zealand. Electricorp firstly will not face demand sufficient to warrant a new power station for around a decade. As a result of power forecasting errors in the 1970s, there is an overcapacity of generating plant. More important in the short term, Electricorp's marginal cost is less than the price at which it sells power to the supply authorities.

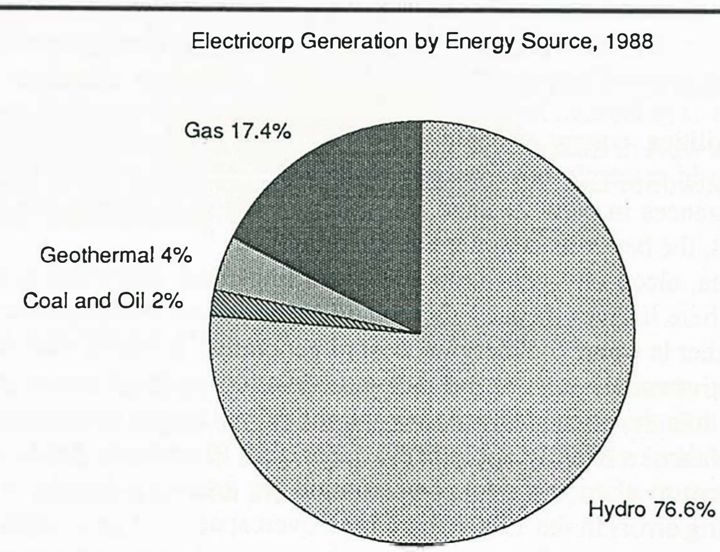
The corporation does not publish a marginal cost but it is understood to be set, for marketing purposes, quite close to the price advertised to supply authorities for power available on short notice. This spot price changes weekly, but the North Island peak charge is typically of the order of 2.7 c/kWh and the off peak around 2.2 c/kWh.[27] The marginal cost is certainly not above this price, and when compared with the average charge to supply authorities before transmission of around 4.2 c/kWh, it is clearly below this.[28]

Virtually all marginal electricity is generated using fossil fuels — mainly gas. Part of the reason the marginal cost is comparatively low is that the price of the Maui gas is also low. In fact, the contractual arrangements for the gas mean that the marginal cost could be set even lower. The costs which are avoidable if no power is produced, are essentially the cost of the gas which would be burnt. Electricorp's arrangement for the supply of Maui gas basically operates like a take or pay contract, except that Electricorp does not pay the entire cost of the gas, whether or not it is used. The corporation pays only a so-called 'reservation fee' on gas contracted for but not burnt, although the fee is a large proportion of the full price. Thus the cost of burning gas to generate another unit of power that is avoidable, can be even lower than the marginal cost used by Electricorp for pricing purposes (depending on factors described on p. 28). Further, above a certain volume of gas use, the price of the fuel becomes somewhat cheaper. (Figure 6.1 shows Electricorp's generation by energy source.)

What this means, of course, is that in order to profit maximise, as directed by its shareholders, Electricorp should sell more power, not less. It is in Electricorp's commercial interest to sell more until the marginal cost rises to equal the sale price.

However, this is not to say that all forms of energy efficiency work against Electricorp's commercial interests. The corporation has a very real interest in encouraging the development, sourcing and gradual adoption of more efficient electricity-consuming devices. This is to ensure electricity remains competitive against other energy sources. Keith Turner, then corporate development manager, told the 1988 tribunal examining the Wanganui river flows: "The corporation believes it is in its long-term advantage to promote end-use efficiency to enhance electricity's competitiveness against alternative energy forms. The promotion of [efficient] appliances such as climatisers and also efficient industrial use is crucial to meeting our commercial obligations."

Figure 6.1



Source: Electricorp and Eden Resources, 1988 data

Thus Electricorp has introduced energy efficiency appliances such as the induction hob stove and climatisers, and has promoted the use of heat pumps (which increased electricity sales overall).[29] It has also been active in encouraging higher insulation standards for hot water cylinders, and the Medallion Award for a high standard of efficiency in the all-electric house. All of these work in favour of the corporation, as they make electricity more competitive while the rate of growth in demand is reduced only a little.

Electricorp's activities also extend into retrofitting. Its subsidiary, Designpower, advertises energy surveys, technical audits and energy monitoring systems. However, the extent to which Electricorp can be expected to pursue retrofitting was also commented on by Keith Turner after giving an example of how it would lose money investing in efficiency for consumers: "This example shows that for say the next 10 years, the commercial incentives for the corporation to engage of its own initiative in ECM [demand-side energy efficiency] are not great, and I would comment that the corporation is obliged by statute and its shareholders to act as a commercially profitable business." Electricorp's forecasts project a sustained rise in demand.

In the corporation's 1991 Annual Report, chairman John Fernyhough modified the approach a little. He signalled that Electricorp could look to encouraging energy efficiency a little before the end of the 10-year period Keith Turner refers to. "The Corporation has been keen to see additional sales while it has surplus capacity, but as we now approach the time where capacity will be constrained towards the end of the century, it makes sense to consider promoting energy efficiency."

The point overall is that, at present, Electricorp has no incentive to drive a programme which would see energy efficiency substitute for a significant proportion of demand. The incentives are in the opposite direction.

If Electricorp was under pressure again to commission new power stations, as it expects to be in 10 years, things would change considerably and there would be an incentive for it to pursue demand efficiency. But in the present environment, it is unreasonable to expect Electricorp to push for substantial efficiency savings.

Energy Efficiency Through the Supply Authorities

The Electricity Supply Association is the leading industry advocate of energy efficiency in New Zealand. Under its vigorous encouragement, many of the larger and more progressive supply authorities which make up its membership have taken a strong interest in the field.

Speaking at the public launch of the Association's energy efficiency campaign in December 1990, president Murray Sweetman stressed the future impact on power prices when Maui gas ran out, along with the need for international competitiveness: "We are among the world's most wasteful energy users, regarding power the way North Americans regard petrol." Sweetman advocated the "integrated resource planning concept which means we evaluate on an equal basis, supply side options such as new power stations, alongside demand side options such as energy efficiency".

While some supply authorities have not embraced this campaign, others — such as those serving Auckland and Wellington — have set up energy efficiency units to survey premises and advise on cost-effective changes. The Rotorua Authority has gone further by conducting seminars on energy efficiency to educate its customers.

However, the reforms which are planned for the electricity supply authorities will considerably alter the commercial incentives they face. At present, they are essentially non-profit organisations with a regulated franchise area. Profits from one year are generally returned to customers in the form of rebates on next year's power prices. Thus if energy efficiency is promoted and reduces demand, this causes no commercial problems for the supply authority.

It is currently proposed to remove the franchise areas, meaning supply authorities will face competition for each customer from other authorities, as customers will be free to choose. More importantly, it is also proposed that the supply authorities become registered under the Companies Act, and issue shares. Originally it was envisaged that the new electricity retailing companies would be required to sell at least 70% of their shares into private hands over the next few years. This has since been followed by plans to allow much more flexibility in the ultimate holdings of the shares by councils and trusts, as well as private investors.

Where shares in the new power retailing companies are held by parties other than non-profit trusts, those shareholders will naturally insist on a reasonable return on their investment, and thus the supply authorities will need to make an adequate profit. However, energy efficiency will work against the commercial interests of supply authorities in two ways. Efficiency will not greatly affect profits from use of the local lines that carry electricity. But supply authorities also make a profit on each unit of power transmitted through those lines, and the less electricity sold, the lower the return. In addition, supply authorities will collectively hold a sizable shareholding in the national transmission company, Trans Power, and returns to the authorities will fall (over time) if the volume of electricity transmitted falls.

Deregulation of the generation business naturally opens the door for supply authorities to also become power producers, so would this alter the incentives? Some already own small hydro schemes built with concessional finance in the 1970s and 1980s, and others have seriously investigated new gas-fired stations. But Electricorp still produces 95% of the electricity, and no authority is anywhere near independent of it. Electricorp has also managed to contract for all the remaining sizable blocks of gas which could be used for new generation plant.

The main chance for supply authorities to secure a significant portion of generation plant would come if the Government decides to break Electricorp into two or more separate companies. It is conceivable that either such a company could buy controlling interests in a collection of retailers, or vice versa. However, such a realignment would still require government policy approval (it recently vetoed the sale of the Invercargill retailer to Electricorp). Energy Minister John Luxton said he believes supply authorities will set maximum entitlements to prevent other owners gaining a controlling interest: "I want ownership to remain in the hands of the community and the trust."[30] Ultimately, so long as there is surplus generating capacity, this will not alter the situation greatly.

However, efficiency will be encouraged by removal of franchises, as competition at the retail level will place a sharper focus on customer services, including energy efficiency. It is generally acknowledged that the administration and metering costs of competing for domestic customers would be far greater than the potential gains. Such competition awaits the introduction of a new generation of metering equipment. But for medium-sized customers, small industries and office blocks, the costs are worth it according to the Association.

There is the real threat that customers will 'migrate' to other supply authorities, and that better deals for efficiency improvements could be used as a tool for winning new market share. For example, retailers could offer a substantial energy efficiency refit of a building at reduced cost, on condition the customer signed up to take power for a set period (similar to banks offering no establishment fee on mortgages to new customers). The installation of energy efficiency equipment should also be a profitable new line of business and one that allows better utilisation of existing staff.

Another factor in the incentives equation is the smaller margin supply authorities will make on each unit of power sold.

With the removal of franchise areas, supply authorities will need to clearly distinguish between charges to their customers which are fixed, and those which vary with the amount of power consumed. At present, there is considerable mixing of the cost of the power lines which connect a building, with the cost of the power running through the lines. The tendency has been to build more of the high, fixed costs into the rate paid for each unit of power.

However, if supply authorities are to compete with one another for customers, such cross subsidisation must be removed. This will generally have the effect of lowering the cost of each unit of power consumed, particularly for smaller consumers. That in turn will make energy efficiency less economically attractive, as energy-saving devices will not save as much money if the power otherwise used is cheaper. It also means that the profit margin foregone by the supply authority not selling that extra electricity, is reduced.

Overall, supply authorities will therefore face both positive and negative incentives to promote energy efficiency. On the positive side, removal of the franchise areas will mean efficiency can be used to win new customers, and the efficiency business should also be profitable. On the other hand, the less electricity sold, the lower the return on shares held in Trans Power, and the lower the profit on sales of electricity put through wires. What the balance between this mixed set of incentives will be is difficult to predict. Much may depend on the degree of real competition for customers and how much efficiency plays a part in winning new consumers. But it is far from clear that supply authorities will face sufficient incentives to pursue energy efficiency.

Third Party Promotion of Energy Efficiency

Energy efficiency, of course, is not the preserve of electricity companies. On the face of it, there is a business opportunity to be pursued. So what are the difficulties and risks a 'third party' entrepreneur would encounter, and why is there so little third party business?

One of the main difficulties is developing a relatively new market. As already noted, spending money on new systems to save power is not a familiar concept. Getting the message across would require considerable market development. Hindering this is the relatively low level of direct experience in energy efficiency in New Zealand. Then there is the related question of building credibility for the company's new activity. Providing customers can be convinced of the merits of investing in energy efficiency, they must also be convinced the company is sound. Skilled personnel — which even the supply authorities, offering secure jobs, have difficulty in attracting — must be found.[31]

The major problem, though, is the numerous business risks involved. Let us assume that the easiest way for a company to overcome the difficulties above, is to install the energy efficiency systems at no charge and recover the money plus a margin from savings consumers make on their power bills. As for the consumer, the lack of a solid local track record for efficiency installations is also a risk to the new business. If the devices do not pay back in time, the profit margin will be cut. Then there is the problem of customers moving premises and either they or the new owner defaulting on the loan. Methods of insuring against this increase transaction costs.

But it is intervention in the market by electricity generators and retailers which is the biggest risk. This could simply occur for reasons unconnected to the presence of the new company, such as the current need to raise the fixed costs of power delivery and lower the price per unit of power, which undermines the economics of energy efficiency measures.

Whatever the commercial incentives, electricity companies will have an interest in supplying energy efficiency services where the savings are greatest (and thus the entrepreneur's profits greatest). The electricity industry can view these as inevitable and may as well make the money, rather than a competitor. In doing so, a supply authority has major advantages, including existing customer relationships which make finance options much easier.

Should new energy efficiency companies prove successful in the more marginal investments, the existing electricity company can use its competitive advantage and size to also enter that segment of the market. It may also consider ways of shutting the new company out and could use its strong position to undertake predatory pricing. Seeking redress under the Commerce Act requires both a high level of proof and considerable time to pursue. Potential new entrants point to past examples of the process having taken too long to safeguard an entrepreneur.[32]

The situation for third party involvement is different from that in the United States. There, third-party major efficiency suppliers operate in competition with electricity utilities. The difference is that, although they are competitors, the utilities are right behind what the efficiency suppliers are doing. Also, the more energy efficiency which is undertaken on a self-financing basis, the less the utilities have to subsidise programmes to get the desired level of savings. In New Zealand, a third party entrepreneur would ultimately be hostile to the commercial interests of electricity generators and suppliers. It would either be taking away electricity sales or taking away energy efficiency business.

So it would be a brave entrepreneur who would make a substantial investment in this field in the current environment. The safer path is for existing companies already in the electricity industry to start efficiency services as a side line where the investment risk is not great. An example of this is GEC's campaign for more efficient lighting. GEC is a major lighting distributor and is offering a free survey of premises as a means of boosting sales of more efficient bulbs and lowering consumers' power bills. Lighting retrofits can produce big energy savings and are one of the simplest and most impressive measures available. Thus the company has one of the best cases to present, and with little risk or investment.

Other parallel moves can be expected to a limited degree. Ultimately, a multinational company specialising in energy efficiency may well emerge, promoting services proven overseas. But overall, third party entrepreneurs face major business risks and cannot be counted on to secure substantial efficiency savings in the short to medium term.

Minimal Reform

From the above analysis, it is not at all clear that the electricity industry reforms currently proposed will provide sufficient incentives for energy efficiency, and thus the least cost delivery of electrical services — in the short to medium term. And it is electrical services, such as heat and light, which consumers ultimately seek.

Energy efficiency measures which are economic will ultimately be adopted through the market alone, but this could take considerable time and there is much to be gained in the meantime. To achieve major efficiency savings in the short to medium term, intervention is likely to be required. If this is to occur then, as before, the general preference will be for mechanisms which cause the least distortion at the least cost, for the greatest benefit.

Before reviewing the options, one point stands out so far. In America, market-based solutions have already shown their effectiveness at the interface between the consumer and the efficiency supplier. It is the incentives at the institutional level that pose difficulties.

Markets are also supremely suited for sorting out the vast range of competing efficiency savings possibilities, and their costs. They effectively ensure that those measures with the greatest benefit are implemented first. The constantly changing technologies and practices also present no problem.

Therefore, in reviewing reform options, the priority is to look to those which can assist with difficulties at the institutional level, while leaving the market to act at the consumer level — that is, the options which would facilitate a market in saved energy.

Again it is useful to examine the American experience. Even where the utilities' commercial incentives are generally in line with energy efficiency, and there are few institutional barriers such as those in New Zealand, significant interventions have been introduced to speed the process along.

Least Cost Planning

Least cost planning is the term used for power planning processes which look not just at the options for increasing the amount of electricity which may need to be supplied, but also the amount that can economically be saved.

In the state of Wisconsin, the Public Service Commission regulates electricity production and distribution, and has developed, with the utilities, a successful least cost formula. In 1975 it passed the Power Plant Siting Act which requires all power producers and distributors to submit a joint plan every two years. This sets out demand forecasts for the next 20 years, and the investment plans resulting from this for the following 15 years, while also demonstrating consideration of all alternatives.

The Commission started with the goal of countering its purely reactive role, where it had to either accept or reject power station proposals. But as the planning exercises developed, the Commission focused on "the consideration of all alternatives, including both demand-side management programmes and the supply alternatives, in a systematic and quantifiable way".[33]

Interestingly, one of the major generators in the state — Wisconsin Electric — enjoys the highest rating of all US utilities among Wall Street investment analysts, and among bond-rating agencies. Furthermore, regulatory commissions are rated in terms of their likely effect upon utilities; the Wisconsin Public Service Commission also enjoys the top ranking of Wall Street.

A number of other utilities have developed similar planning methods, including the Nevada Public Service Commission through the 1983 Utility Resource Planning Act, and the Bonneville Power Administration through the Northwest Power Act 1980.[34]

The obvious difficulty with such a system in New Zealand is that it requires the generators and/or retailers to have a guaranteed franchise. Where they face competition for customers, it would be unreasonable to expect the businesses to lay out their competing options and costings publicly. Competition has already been introduced at the generation level and removal of the franchises for the supply authorities was confirmed in December 1990.

PURPA

PURPA is the Public Utility Regulatory Policy Act of 1978. It required certain electricity utilities to buy all power offered by private generators where this worked out to be cheaper than the utility continuing to generate all its own power. The test was that the new sources of generation had to cost less than what the utility could save if it stopped producing a block of power.

This concept is based on the fact that some of the costs a utility faces are fixed even if no power is produced (finance charges, for example). Other costs — termed variable costs — are incurred only when power is actually generated (gas to fire a power station, for example). The portion of the variable costs which do not have to be paid if no power is produced is termed the avoided cost of generation. Literally, it is the expenditure which can be avoided if no power is made.

Thus PURPA required alternative sources of private generation to be accepted if they were cheaper than a utility's avoided cost — defined as the full long-run avoided cost. This is the sum of both the day-to-day costs (short-term avoided costs) and the value to the utility of not having to build new power stations in the future (the present value of the avoided new capacity).

This scheme started from a sound principle, but the way in which PURPA was framed made it badly flawed. The scheme was put on hold in the late 1980s by the Federal Energy Regulatory Commission. Much can be learned from the mistakes.

The first mistake was to offer a price for the substituting power which was just under the avoided cost. Instead of the utility and its consumers benefiting from reduced costs, generation expenses remained much the same. The second mistake was to make the offer to all suppliers who could come in under the set price, with no regard to workable limits. The result in California during the mid-1980s was that utilities were receiving serious offers for up to half their total generating capacity.

But the biggest failing was that the scheme was restricted to supply options only. Bids for the saving of power were not provided for.

All Sources Tender

A mechanism called an 'all sources tender' extends the idea of selecting alternative generation where it can be obtained at less than the avoided cost. It extends it by seeking not just alternative generation but any method that will provide the same level of service to customers, such as energy efficiency.

A generator seeking cost savings could announce that a tender was to be called for the purchase of power. It would be open to anyone who could make, save or displace electricity, however they chose, up to a certain amount of power. If the prices turned away on the first round of tendering were still good, another round could be held and so forth until the tenders brought forward no significant savings. Successful tenderers would contract for specified periods.

Similar tenders have already proved successful with a few US utilities, including the Central Maine Power Company. Energy efficiency competes well on such terms.

If such a scheme was introduced to New Zealand, how would it work? It is clear that Electricorp would not willingly initiate such a scheme: so long as the marginal cost is less than the sale price, its interest lies in selling more power. But assuming such a scheme was imposed, what would be the avoided cost and how would it be set? The following discussion focuses on Electricorp for simplicity but, in practice, the scheme would need to cover all significant wholesalers of electricity.

The avoided cost should include, at minimum, the avoidable operating costs — mainly fuel — and the present value of avoided new power station construction costs. As already noted, Electricorp's current spot prices for sale to the supply authorities are just slightly above the marginal costs set for marketing, which is understood to be very close to the cost of the fuel needed to generate an additional unit of power. Thus the North Island peak charge of around 2.7 c/kWh could be used as a base to calculate the avoidable short-term costs, and an estimate for the value of avoided new construction could be

added. Estimating the value of that avoided construction would require either examination of Electricorp's demand forecasts and estimated costs of supply, or outside estimates to be prepared.

It is clear that with normal growth in demand, major new stations will need to be ready for commissioning around the turn of the century. As it takes about six years to build a new station, the corporation will already be affected by the cost by the mid-1990s. While Electricorp discounts at 10% before tax, costs associated with such new stations will still have an effect on today's estimate of avoidable cost.[35]

As well as energy savings, there would be additional benefits from such a scheme. It would signal to consumers the degree to which new construction is going to affect electricity prices in a few years' time. At present, there is no general provision for forward contracts, and no futures market.

The major administrative difficulty with this scheme would be, who would set the avoided cost, and the bounds of the tender? Electricorp does not have the right incentives to do this at present. It would require an outside party to determine the amount of energy that would be called for, when and under what conditions. Such a scheme would also create some uncertainty for Electricorp planners. Without a very complex code to constrain the regulator, Electricorp would have difficulty knowing how much power to plan for in future years, though this would be true of any serious energy efficiency programme.

The more pragmatic argument against such a tendering scheme at present, is that there is probably a better place in the electricity system to make the avoided cost comparison. The avoided cost at the point of generation will become higher in real terms the closer it gets to the commissioning date of new power stations. But the avoided cost will not rise greatly for some years.

However, one of the important structural differences between America and New Zealand — the separation of electricity wholesalers and retailers — can be used to advantage here. Rather than looking to exploit avoided costs at the point of generation, a similar degree of intervention would be more effective at the supply authority level.

Supply Authority Avoided Cost Tender

There are two important benefits from making the avoided cost comparison at the supply authority level. The first is that the price against which efficiency options would compete is much higher. This makes more efficiency measures economic. The second advantage is that supply authorities have existing customer relationships which can be utilised.

The basic aim is to devise a system which would allow the cost of power being bought from Electricorp to be compared against the cost of saving the same amount of power through efficiency. Again, to get competitive prices, the concept of an all sources tender is attractive. The supply authority would tender for power from generators, and electricity savings from any other organisation which could offer these.

The major difference with a supply authority holding such a tender is that where a generator saves the money that would otherwise have been used to make power, the supply authority makes no such gain if it buys 'saved' power. Thus the structure of the offers for saved power has to be set to take account of this.

Those offering saved power would do so through a particular form of loan. Under this scheme, repayments are taken from the consumer only as savings are actually made on the power bill. The seller of the efficiency services pays for the installation of the equipment it believes to be economic. Consumers continue to pay their power bills on the basis of what they would have paid before the improvements were made. But the efficiency improvements mean that the amount of electricity required is lower so the consumers' payments yield a surplus. The surplus goes to the efficiency seller which uses it to pay off the cost of the improvements and the finance costs, and take a profit. At the end of a specified period, the consumers return to the regular billing system and get the benefits of the improvements.

The advantage of this form of loan in terms of the tender system is that the consumer, while getting efficiency, is still paying the normal bill. To see how this assists, it is useful to look first at the basic case.

If an energy efficiency entrepreneur makes a contract with a consumer to install improvements, the consumer could be required to pay the normal amount of the power bill to the entrepreneur. The entrepreneur would then pay the consumer's actual power bill and hold the surplus. But another way of organising the cashflow is for the consumer to pay the normal bill to the supply authority, which then passes the surplus on to the entrepreneur.

Now, back to the tender system. An entrepreneur holding this contract can offer to sell saved power to the supply authority. The entrepreneur is, at the same time, offering the payments the consumer would be making. Put simply, the supply authority pays the entrepreneur, say, 4 c/kWh for some saved power and gets the money from the consumer who is still paying, say, 7 c/kWh. The supply authority makes 3 c/kWh on the transaction in this case (see Figure 6.2 where figures in the link lines are payments).

Figure 6.2

Under this sort of arrangement, the efficiency entrepreneur could compete with power generators in a tender called by the supply authority. Supply authorities cannot necessarily be relied on to call tenders, as incentives for this may not be present. But assuming they were required to call for bids for the supply or saving of electricity, how would this work?

Bids would be submitted in the form of the cost to produce or save a unit of electricity, and the least cost mix of options would be selected. To ensure there was no bias in selection, the process would be independently vetted. The bid prices need never be made public so no confidentiality is compromised. Bidders would already have a pretty accurate estimate of any supply authority's avoided cost, as the rough wholesale price for electricity is known, and transmission charges for all segments are to be made publicly available when Trans Power is established as a separate entity.

Looking at the entrepreneur again, the question is what has such a firm to gain from selling its deals in saved power to the supply authority? Why not keep its contract with the consumer and take all the profit?

Sharing profits with the supply authority would greatly reduce risk and could also considerably reduce the burden of financing the efficiency improvements.

The entrepreneurial firm makes its money by identifying and contracting for saved power. To the extent that it has to finance the physical changes that produce efficiency, it

will be limited by its capital base. Financiers will only be willing to lend to the entrepreneur to a certain point. Beyond that limit, they can not be sure the firm has sufficient equity, should the improvements not work as well as expected or the consumer defaults. But if the entrepreneur is able to 'sell' the bulk of the package on to the supply authority, it has much greater flexibility to carry on and sign up further consumers for efficiency refits.

In selling the saved power, what the entrepreneur would effectively achieve is a guarantee that the supply authority would collect the normal amount of money from the consumer's power bill, and pass on the proportion due to the entrepreneur in terms of the bid that was accepted. That is, if the consumer is paying 7 c/kWh and the entrepreneur offered the saved power at 4 c/kWh, the supply authority would pay 4 c/kWh to the entrepreneur on the relevant portion of the consumer's bill.

With the guarantee of the supply authority that it will pass on the 4 c/kWh, and the fact that the supply authority is in a unique position to guard against default on consumer payments (it can shut off supply), finance can be much easier. Under such arrangements financiers are exposed to only a minimum of risk.

The result of the guarantee for the supply authority, of course, is that it assumes the risk for the improvements working as well as they are supposed to. This would, in the first instance, be overcome by the requirement for a technical audit of the planned improvements to accompany the bid the supply authority would receive. This would give an independent assessment of the expected level of electricity savings. But the results may not be able to be predicted completely and may also depend on the quality of installation. Thus the authority may insist on a performance bond in the form of, say, 20% of the due payment being withheld for a period until the level of savings is confirmed.

A major question, as already outlined, is the setting of the bounds and frequency of the tenders. The first obvious point at which a tender is practical is at the time each year when supply authorities negotiate with Electricorp or other potential generators for power supply. Here, a tender could be called with quite wide bounds and a least cost mix chosen. The potential problem is that Electricorp could quite reasonably adopt a position of 'buy all you need at this low price from us, or pay a higher total bill if you accept bids for saved power'.

A first step to overcome this possibility would be an explicit instruction from the shareholding ministers that the corporation was to accommodate energy savings through the tender process. More important would be devising a set of rules for the tender process which guarded against this and other such problems. These would be overseen by the same agency vetting the selection of bids, as would also be responsible for determining the timing of tenders.

More frequent tenders, say every two months, would also be desirable. With greater frequency, the bounds would have to be narrowed to maintain competition. In this case, the auction could be limited to a certain percentage of the supply authority's total load. Other matters relating to the implementation of this scheme are discussed on p. 50.

The tender system does not rely entirely on independent entrepreneurs, as supply authorities would also produce their own proposals. But independents are needed to set the pace of competition. Most of the major barriers to their emergence are removed under the avoided cost tender system. In summary, supply authorities can be bound in to the contract with the consumer so that it too has an incentive to make the investment work. Further, once the bid is accepted, the risk is largely shifted to the supply authority. And the capital base of the entrepreneur need no longer act as a constraint, as the entrepreneur can act largely as a broker.

While all these arrangements are far from simple, they are not much more complicated than the entrepreneur alone signing up the consumer — probably the simplest system. The additional complications are hidden from the consumer so it need not pose a marketing problem. Intervention is needed for only two purposes. One is to require that such tenders be held, and another to require that the process be vetted in terms of the form of the bids made and the selection of bids. Both are simply to ensure that the least cost mix of options is used to supply electrical services.

An Energy Savings Corporation

A traditional New Zealand response to the need for a service not provided by the private sector has been the establishment of state trading companies. This involves no intervention as such: the Government instead becomes a player in the market.

Many state trading enterprises had appalling financial records before corporatisation, but some played very valuable roles in their earlier years, providing services the market was not. For example, The Post Office Savings Bank was established in the 1860s to meet the need for a safe deposit facility. This reduced the barriers to development of rural New Zealand, but the need had long since expired when PostBank was sold in 1988.

As an energy efficiency entrepreneur, the state would have two very valuable advantages over other third party operators. The first, is simply that it would be seen as being government-backed by customers, and therefore less risky. But the main advantage would be that the ministers it would report to would be those with an eye on Electricorp and the electricity industry reform process. This would greatly aid acceptance of its work within the electricity industry.

An energy savings corporation (Savercorp) would operate very much as described for third party financiers (see p. 31). It would act chiefly as an energy efficiency broker, arranging contracts for energy efficient services, mainly retrofits. Much of this business could be expected to be by way of loans. It would assess the potential, recommend a solution, arrange contracts for the installation work and possibly arrange the finance.

Savercorp would be constituted as a profit-making state-owned enterprise. A sizeable base of working capital would be needed to secure customer loans. Its limited purpose should be well recognised; once there was some depth to the energy efficiency market, it would be sold or disbanded.

A first difficulty would be simply finding sufficient capital for the new enterprise when the Government's budget is so tight. It could offer a government guarantee to reduce its equity contribution, but this is far from normal SOE policy.

There are also risks inherent in developing a new market, proving efficiency devices across a range of installations and pricing services correctly. Possibly a greater risk for the Government would be accountability. The major criticism of the SOE framework is that it does not provide accountability equivalent to that in the private sector. It would be especially hard to monitor the performance of a new SOE in a comparatively undeveloped market. It would be difficult to assess whether poor performance was the result of certain poorly conceived business opportunities or poor management. Overall, the level of risk would be too high.

Substantial Intervention

Discussion of further minimal reform options, which tends to involve consideration of quite different institutional arrangements, is beyond the scope of this study.

The following set of mechanisms for achieving energy efficiency would generally involve substantial intervention on the part of the Government. In briefly reviewing these, the assumption is made that, were one of these mechanisms to be adopted for a

primary role in a major initiative, it would have as its ultimate target not energy efficiency but the reduction of greenhouse gas emissions. While some of these mechanisms could be supplementary to an energy efficiency programme, their use as a primary mechanism would not seem to be justified to simply achieve the economic gains from energy efficiency.

Transferable Permits

Transferable permits for emission of greenhouse gases is one of the mechanisms most frequently discussed as a global solution to greenhouse warming. Its effect would be to make energy efficiency even more attractive by raising the cost of consuming fossil fuel, and as an international instrument, it has many attractions. However, it is particularly inappropriate for isolated application to electricity generation in New Zealand as it now stands.

This is because the success of the permit system relies on a well-contested market, and New Zealand would be a very thin market for emission permits. In other words a few major buyers could effectively dominate it, and insider trading would be very difficult to detect.

In addition to this, Electricorp would be especially well placed to reduce the effects, through its near-monopoly position. About 75% of Electricorp's generation is from hydro sources, so only 25% would require emission permits.* As Electricorp has already secured the cheapest hydro sites, competing generators building new stations would, as a general rule, require emission permits. But the new generator could not spread the extra cost over generation from renewable sources and, combined with Electricorp's dominant position, tradeable permits would act as a barrier to competition.

A breakup of Electricorp may change this position but will not alter the thin market. The market could be artificially thickened, but only by raising transaction costs of permit trading to too high a level. Thus tradeable permits are best considered only in the context of an international market.

Minimum Efficiency Standards

Efficiency standards can be put in place reasonably simply for new equipment and buildings, but would not cover those already in existence. Applying efficiency standards would not be an effective short- or medium-term solution, unless applied retrospectively. This would be highly interventionist and would require extensive work to catalogue all improvements of equal efficiency value, and to follow up on their implementation.

Standards are also not a good general solution, as there are many areas they cannot cover — such as light bulbs, leaks in buildings and hot water temperature settings. Also, the lack of depth in direct experience would hamper setting initial standards in many applications. Constantly changing performances and methods mean standards for efficiency would lag behind developments.

However, standards remain an effective supplementary mechanism where others fail to penetrate particular market segments.

Grants and Subsidies

Grants and subsidies are not likely to be very effective as a principal mechanism, largely because of the high costs involved. Offering Electricorp money for achieving energy savings would be an expensive method, and while the corporation is still in state

* Geothermal energy, which makes up the other 5% of renewable generation, releases carbon dioxide and would require emission permits.

ownership, the Government has more straightforward options. The results of working through electricity retailers are more difficult to anticipate, for as noted earlier, there will be conflicting incentives for the promotion of efficiency.

Subsidising an energy-savings corporation would be the most effective route if subsidies were to be used but this would most likely be only as a complement to other policies. Sections of the market which were particularly difficult to reach — such as low income earners and tenants — may be more efficiently targeted in this way (see p. 32). But the sheer financial burden of subsidies as a principal tool would be too great. A tax policy would be preferred over subsidies.

Demand Ceilings

A very crude mechanism would be to set a production ceiling for Electricorp to directly regulate the amount of power produced. However, restraining demand of one source of energy alone would produce an imbalance in the energy market. Demand ceilings would also have to be set for other fuels (and possibly other greenhouse gas sources). Such a process would be fraught with difficulty. The ceilings would also generate windfall profits for suppliers which, in fairness, should be returned at least to government, if not to consumers.

Price control on energy production as a means of keeping prices down presents the major problem of who would then allocate the product. This suggests a tax on energy at its source would be much cleaner than production restraint. A tax would be preferred so that an efficient allocation mechanism was in place.

Taxation and a Carbon Tax

A generic tax on power would, in the case of electricity, amount to the same as a carbon tax so long as fossil fuels were still being used for generation. However, a specific carbon tax would be preferred as it would have to apply to other energy sources and should not disadvantage renewable sources. Such a carbon tax could be expected to reduce energy use, both through conservation (consumers going without) and energy efficiency. A wider gap between energy prices and efficiency measures would help overcome barriers to achieving savings.

Carbon taxes rely on an acceptable level of emissions being decided upon. The tax is then set so as to raise the cost of emission-generating activities so they are reduced to the desired level. A firm looking to minimise costs, for example, could cut back emissions until the marginal cost of further reductions was equal to the tax.[36]

Taxes are simple to apply at source; they are not subject to market dominance and are easily changed as responses are evaluated and targets altered. However, the low responsiveness of consumption to higher energy prices means taxes would have to be high to achieve a significant impact. These revenues could be returned to consumers through reductions in other taxes. But the adoption of carbon tax policy unconnected to a global agreement will reduce the international competitive advantage of industries relying on energy inputs. Thus carbon taxes will increase energy efficiency and reduce greenhouse gas emissions, but will compromise international competitiveness unless parallel moves are adopted globally.

7. Assessment and Implementation

Preferred Mechanism

From the discussion thus far it is not clear that, of itself, the market will deliver substantial electricity efficiency savings in the expected commercial environment — at least not for quite some time. Although the economic potential is there, many factors could combine to inhibit the development of an effective market in saved energy. Additional reform is expected to be needed to activate an electricity efficiency market to facilitate serious savings.

There are three stages or rationale for intervention. These are described below in what is presumed to be ascending order of the level of intervention required.

- First, where the economic gains from greater energy efficiency are judged to be worth the intervention (competitive advantage, better allocation of resources, deferred capital commitments, etc.)

- Second, where energy efficiency assists in achieving the Government's emissions target for the year 2000

- Third, where an international agreement binds New Zealand to an emissions reduction policy.

Naturally, these stages will overlap and the order may change: for example, the Government's emissions target could exceed what an international agreement would require. But assuming the above order, policy-makers will be targeting one of the above goals when considering what level of intervention may be justified. Again, in seeking the greatest energy efficiency for the least cost and distortion, it would first be assessed what could be justified on purely economic grounds. The previous section looked at minimal reform mechanisms which could be expected to meet this test. Those dependent on substantial intervention are unlikely to be used as the primary mechanism to advance economic goals alone.

The minimal reform mechanism preferred is a policy requiring electricity retailers to tender for power supply, in a way that allows electricity efficiency savings to be accepted, where the savings are less than the avoided cost of power supply, as described on pp. 41–4. This reform appears to offer the best single step, justified on economic grounds alone, without fundamentally altering existing and expected institutional and contractual arrangements.

It is inexpensive and the institutional framework would be relatively simple to establish. Supply authorities are already the leading advocates of energy efficiency so the reform would work with their interest.

It would utilise market mechanisms to a high degree, relying on intervention for only two purposes. The first would require that tenders be called, and the second that the tender process be vetted to ensure its objectives are adhered to. Although many contractual arrangements would need to be made, they would all be ones the market is accustomed to providing.

An immediate consideration is, would other mechanisms designed to achieve greater reductions in greenhouse gases through energy efficiency, be complementary to the tender system or give rise to serious problems? The tender policy would be possible to implement without compromising later measures and the reverse question is more relevant. A number of mechanisms suggested for reducing global warming, only change the price of energy and would rely heavily on an energy efficiency market for their results, unless conservation is to be largely relied on along with some fuel switching. The 'substantial intervention' mechanisms described on pp. 44–5 are either more effective with an active energy savings market, or would not need to be pursued to such a degree.

Thus an immediate benefit of the tendering process suggested here, is that it can be implemented without further consideration of other mechanisms which may be used to achieve an emissions target.

Implementation would also not pose difficulties if there was a sudden rise in the level of electricity savings, which was independent of this reform. The reform would require comparatively few resources to implement, and would be likely to still produce additional energy savings whatever the natural level of savings.

The sections below assess the wider implications of an avoided cost tender mechanism, and its implementation. Mechanisms requiring substantial intervention are not considered further. Steps which the Government may take, over and above those which can be justified on economic grounds, need to be carefully considered in terms of potential international treaty requirements on greenhouse gas reduction and other sources of emissions, along with carbon sink options. Such consideration is beyond the scope of this paper.

Wider Implications of Avoided Cost Tender Policy

Supply Authorities

A requirement that supply authorities tender for energy savings, and accept those less than the avoided cost, would have little financial impact under present arrangements where authorities are essentially non-profit. However, it would affect the value of shares in the new retailing companies.

The effect on the share price need not all be negative though. Sales will be lost, but an authority's best strategy would be to develop its energy efficiency services so it takes a good slice of the market, and these services could be quite profitable. What the financial balance between the two would be is unclear. In terms of the effect on share values, much could depend on the ability to predict the level of energy savings likely to be adopted over time, to reduce the risk weighting.

Electricorp

For Electricorp, the immediate effect would be reduced demand for generation. As explained earlier, 95% of generation at the margin comes from thermal power stations. This means that less gas would be burnt, gas already partly paid for. How much less naturally depends on the degree of savings.

If the result was that Electricorp had contracted for gas surplus to its requirements, the corporation could onsell the gas, providing it returned any profits arising from this to the Crown. While this would be an obvious first strategy to keep costs down, markets for a substantial amount of gas may not be easy to secure. The gas supply contract appears to allow competition at the wholesale level with the current supplier, Petrocorp. Thus Electricorp could simply pass on the gas at the low price it pays the Crown and possibly capture some of Petrocorp's customers. The wider impact in this case would be reduced gas sales by Petrocorp.

The other major option would be to defer burning the gas — in effect, spreading out its value as a backup to the largely hydro system. This would have advantages for both Electricorp and consumers, but it would have to be technically possible as well as financially sound.

In technical terms, the major constraint is the life of the offshore Maui platforms. They will only be kept operative so long as there is a sufficient volume of gas to warrant this, so there will be a cut-off point. Financially, the impact would depend on the conditions of the contract Electricorp has with the Crown. As long as the Government owns Electricorp, a renegotiation could also be carried out much more simply.

If Electricorp was unable to onsell sufficient gas, use it more slowly or renegotiate for less gas, the corporation would produce lower profits and a reduced dividend to the Government. Wholesale electricity prices may rise slightly, depending on how far demand falls. Alternatively, the Government could adjust the valuation it set for the corporation to take account of changed conditions, and prices could be largely unaffected.

The tender process also presents an opportunity for Electricorp to provide efficiency services. The corporation's 1991 Annual Report states that because of its restriction from the retail market, its opportunities to promote energy efficiency are reduced.

Vertical Integration Pressures

Under the tender policy Electricorp would lose sales because supply authorities were able to 'buy' saved energy for less than Electricorp could supply it. In this case there would be a natural incentive for Electricorp and other generators to take over supply authorities, to manage the avoided cost bids at one end and the impacts on their generation system at the other. If there was no overcapacity of generation plant, this would not be a problem, because a generator would otherwise also have an incentive to tender for power savings on an avoided cost basis. But as long as there is an overcapacity, ownership of supply authorities by generators would serve to undermine energy efficiency measures.

The situation could change somewhat if Electricorp's generation assets are broken up into a number of competing companies. But until it could be adequately demonstrated that such vertical integration would not undermine the avoided cost tender policy, or a new policy mechanism was put in its place, it may be necessary to require a certain degree of separation of the generation and retail businesses, by means described below.

Implementation

It is already intended that once ultimate ownership of the new electricity retailing system has been settled, a set of rules for the organisations will be formed to cover specific issues. It is at this point that the policy of tenders for avoided-cost savings could be introduced. Some supply authorities are already concerned that there be rules to counter the incentive to maximise sales volumes.

In legal terms, the requirement to hold tenders could be written into the articles of association of the new electricity retailing companies. These would need to be entrenched, possibly through legislation or a form of kiwi share arrangement. Provision would also have to be made for the continued independence of the retailing company from control by generators, for the time being at least. It may be sufficient simply to require that the businesses be kept as completely separate accounting units, with no transfer pricing permitted and companies subject to special auditing on this question. However, this would have to be more closely considered.

To make Electricorp's position clear, the shareholding ministers would need to issue a directive that it was to facilitate and not frustrate the objectives of the tender process. Specifically, the corporation would be obliged to continue to profit maximise subject to the constraints of the tender process.

As noted earlier, setting comprehensive, effective and efficient rules for tenders would be crucial to the success of the mechanism. The rules would cover matters including: the form in which bids were to be cast; bidding and negotiating timetables; and who would vet the bids and how.

To reduce transaction costs and encourage a diverse source of bids, standard contracts for the sale of energy savings would be written as part of establishing the tender process.

Operation of the Tender Mechanism

The essential concepts embodied in the avoided cost tender process are detailed on pp. 41–4. The process provides for a comparison of the cost of efficiency options versus the cost of power from generators. A least cost mix is selected. That basic idea can be developed in a number of forms: it is the concept rather than the specific form which is promoted here. The following is an example of how the tender process could operate.

Once a supply authority has advertised the date and form of a tender, both the authority's staff and entrepreneurs supplying efficiency services (including Electricorp) would begin preparing bids. The entrepreneur would be looking for opportunities to save electricity for an organisation and sell the savings to the supply authority.

Say this firm believes it would cost only 2.5 cents a unit (kWh) to save a sizeable proportion of the power in a building. It would approach the building owners with a proposal that they let the entrepreneur retrofit the building according to an agreed plan at no up-front cost to the owners. The owners, however, will continue to pay the current level of power charges — 9 cents a unit — less an incentive to sign up of 1 cent a unit. The owners would continue to pay this 8 cents a unit for, say, three years, after which the benefits of the savings would all go to the owners.

The entrepreneur takes the 2.5 cents a unit basic cost for the retrofit work, and adds a finance cost and a profit margin to arrive at a figure of, say, 4 cents a unit which is then offered to the supply authority. At 4 cents a unit, this is less than the cost at which the supply authority could otherwise buy an average unit of power from Electricorp.

If the entrepreneur's bid is accepted, the supply authority guarantees to pay that firm 4 cents a unit for the saved power (subject to performance audit on, say, 20% of the amount). The entrepreneur can now arrange the finance for the work (say, 0.5 cents a unit) and a subcontractor to undertake the installation (the 2.5 cents a unit figure). The entrepreneurial firm makes 1 cent a unit at the end of the process.

The chain of payments in this example is shown in Figure 7.1, where the amounts on the link lines are payments (left to right) and those inside the circles represent money retained.

What Will the Avoided Cost Be?

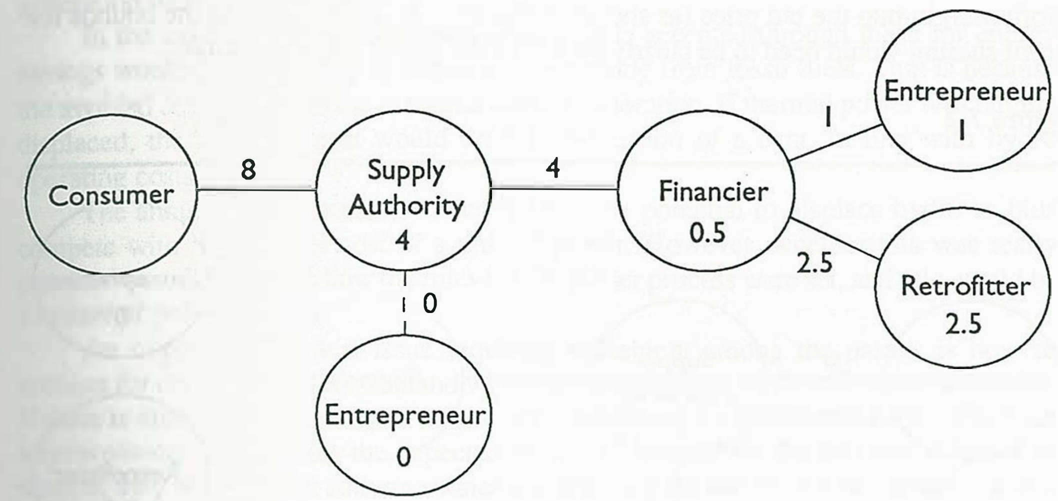
The avoided cost will vary between supply authorities as a result of their size and geographic location. But putting these differences aside, what is the avoided cost likely to be on average?

The cost of power to each authority is made up of two charges: one for the electricity and another for bulk transmission. The basic case is where a tender is held in conjunction with the supply authority's negotiations with Electricorp for power supply.

The charge for electricity from Electricorp is agreed to annually by each authority. Across the nation, the average charge for power is about 4.2 cents a unit.[37]

The average charge for transmission is currently 1.9 cents a unit.[38] However, the pricing of transmission services is currently being completely revised as part of the

Figure 7.1



industry restructuring. The new prices will depend primarily on the valuation placed on Trans Power's assets, and the proportion of the transmission charges which is fixed and that which varies with the amount of power used.

This last factor is particularly important in terms of determining the avoided cost. As much as 80% of the costs of operating the transmission service are fixed. While no decision has been made as to what proportion of the transmission charges will be fixed, the percentage could be quite large, perhaps as high as 80%. This fixed charge would be paid as an annual access fee by the supply authority and would be related to its previous levels of power consumption. The balance would be charged out at so many cents a unit.

Thus the proportion of the supply authority's transmission costs which could be avoided may be quite low — anywhere from 50% to 20% — making the avoidable transmission charge somewhere between 1 and 0.4 cents a unit. On this basis, the overall charge the supply authority could avoid would be between 4.6 and 5.2 cents a unit.

This avoided cost of 4.6 cents a unit or more is possible because, at the time of the annual negotiations with Electricorp, the supply authority can completely redetermine its expected supply needs. Thus it can save power at the average cost of supply. However, the avoided cost would be quite different for more frequent tenders.

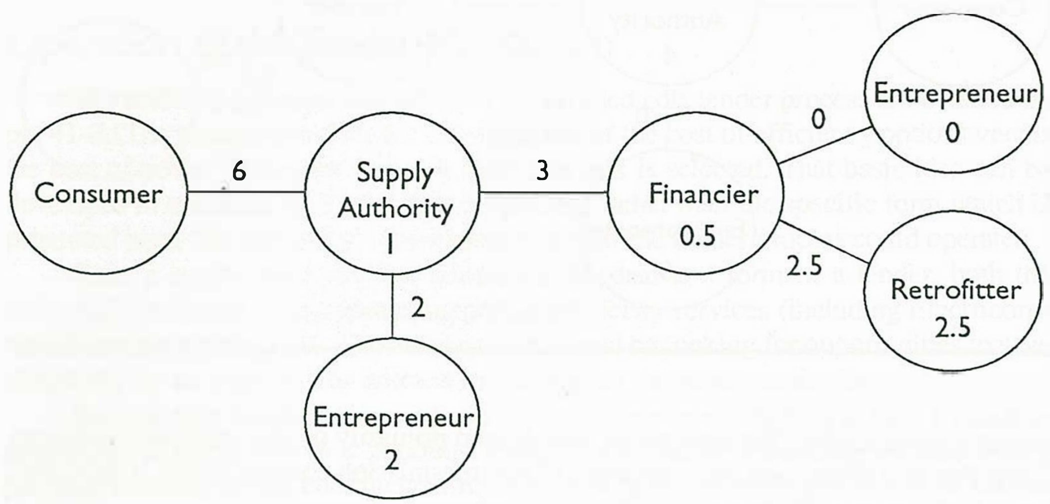
Tenders called, say, every two months may, in the first instance, simply displace power bought from Electricorp at the weekly spot rate. Taking a current rough value for this spot price of 2.5 cents a unit and adding transmission charges of 1 to 0.4 cents a unit, the avoided cost could be as low as 3.5 to 2.9 cents a unit.

Once any spot price power had been displaced, tenders for energy savings which were accepted would displace power contracted for purchase from Electricorp. The avoided cost in this case would depend on the level of penalty payments due under the contract.

Thus two different tender markets would develop. The one held annually could accept more costly bids, as the avoided cost would be higher. It could also allow for substitution of a significant proportion of a supply authority's load. So this tender would capture bids for large-scale savings and more expensive energy efficiency retrofits.

The more frequent tenders would have a lower cut-off point, as the avoided cost is lower. They would also have to be restricted so that, for example, bids could only be accepted up to a very small percentage of the authority's load. This limit would be set with regard to what was practicable to accommodate, and that which would keep bidding competitive. The chain of payments would probably also differ to give the entrepreneur a better return. The entrepreneur could profit share with the authority rather than building a profit margin into the bid price (as shown in Figure 7.2). Rules defining the bounds for profit sharing would need to be clearly set out in the tender documentation.

Figure 7.2



Where profit margins are taken in the chain, as well as the level of profits, is completely open to negotiation. The tender process should be self-balancing as, if the entrepreneur is getting too great a margin, the supply authority can enter the market to a greater extent itself. And if the entrepreneur receives too low a margin, there is a point where it is worth that company taking all the risks and capital constraints and dealing direct with the consumer. So long as the entrepreneurial firm has a reasonable proportion of its work tied in with the supply authority, it can afford to work directly with the customer.

Other Issues

Another aspect of transmission pricing which will affect the economics of energy efficiency is the level of fixed charges supply authorities will make to consumers. As already noted, competition between supply authorities will force more accurate costing of local transmission services. This will tend to raise the fixed charge for connection which the consumer pays, and reduce the cost of each unit of power.

This will not affect the competitiveness of tender bids. But it will reduce the profit margin due to the supply authority, and possibly the entrepreneur, depending on how contracts are arranged. Alternatively, it would extend the time the consumer needed to be making contract payments.

Should tenders prove very effective at reducing electricity demand, the incentive would be for Electricorp to sell power direct to a greater number of large consumers. Such sales would not be subject to the tender process. However, these contracts would tend to weaken those supply authorities which lost the major customers. The arrangements proposed for competition between Electricorp and supply authorities at this level would need to be examined in light of this.

Another question which arises if the tender mechanism proves very effective is what happens once the power generated by fossil fuels becomes displaced? Would hydro generation then be displaced?

In the case of the more frequent tenders, bids accepted through these for energy savings would only be likely to displace power made from fossil fuels. That is because the avoided cost is close to the marginal cost of generation. If thermal power was largely displaced, the marginal cost would drop to a fraction of a cent, in line with hydro operating costs.

The annual tender would technically have the potential to displace hydro as bids compete with the average cost of a unit of power. However, whether this was really possible would depend on how the rules for the tender process were set, and this would be a matter of policy.

An important technical issue requiring agreement among the parties is how to account for changes in power demand which are independent of the efficiency measures. If there is much the same demand for the services electricity is delivering, the efficiency improvements will produce the expected return. If demand for the services is less than normal, they will pay that amount sooner and the contract can be wound up early. But if demand is higher than normal, this will erode profit margins.

Provision could be made for a clause in the contract with the consumer that takes account of major variations in the natural demand for electricity services. For example, a base payment would be set as the historical average. A calculation of the theoretical savings potential of the improvements would determine the length of the contract with the consumer and the expected level of electricity demand. If actual demand varied by more than a certain percentage, the base payment would also rise or fall accordingly.

In cases where tracking variations in natural demand could prove too difficult, some risk could be borne by the consumer. This would involve the consumer taking some of the risk that the efficiency improvements actually work as well as they are expected to. Instead of consumers paying a fixed electricity bill, they would pay their bill on the basis of actual usage (now lower because of efficiency improvements) plus an amount which is an estimate of the value of the electricity saved through the improvements. Special provisions for tests and adjustments to the additional payments would give reassurance to consumers that the improvements were indeed performing up to scratch.

Naturally there are many other possible forms of contract which could be expected to evolve to cater for differing situations. It may take time for these to be finetuned, and teething problems may arise. But the contracts would have many parallels in other industries to draw on, as well as the direct experience of United States utilities which engage in similar tenders (including Southern California Edison, Pacific Gas and Electric, and New England Electricity Supply).

There is no doubt that these complexities will add to the transaction costs of implementing energy efficiency. But if the indicative costs for saved electricity (described under Potential Electricity Savings) are a reasonable guide, there is room for these. Naturally these transaction costs fall in proportion as the size of the retrofit increases, so the barriers will not be as great in these cases.

Other Measures

Information

The Ministry of Commerce's Energy Management Group already acts as a substantial resource of information on energy efficiency in New Zealand. It is engaged in promoting energy efficiency through various means, including: information distribution, technique demonstration, research, policy advice and provision of specific installation advice.

But there is a major gap at another level — that of energy statistical data and analysis. As already noted, estimating the potential for energy efficiency in New Zealand is hampered by the lack of primary information as to where energy is currently used and what for. An active and efficient market in energy efficiency requires reliable data on these questions.

With the curtailment of many of the former Energy Ministry's information gathering services, a private sector group of energy producers has partly filled this gap. The Energy Foundation aims both to collect basic energy statistics and produce forecasts for future demand to improve forward planning. While this should considerably improve the data base, it would also benefit from complementary information gathering. But it is not just the data collection which is important. Interpretation and analysis of the information is also needed — a role implicit in the Government's pledge to establish an Energy Resources Conservation and Monitoring Authority.

Labelling is another important extension of the provision of information. A comprehensive scheme requiring that the energy consumption of appliances in particular be specified on the good, seems a relatively minor requirement of producers as a means of informing consumers about alternatives.

Building Code

The Labour Government's 1990 Budget specified that there would be a national building code with energy efficiency provisions: "The government has agreed that the [Building Industry] Commission will develop performance-based energy efficiency standards for inclusion in the building code ... The use of performance standards will allow the builder to choose the most cost-effective method of meeting the standard for each building."

To date, only performance standards which were instituted in 1977 as a result of the first oil crisis have been put in place. Currently they are justified by the Commission only on health grounds because there is no national purpose statement to establish a comprehensive standard.

However, if the Government was to require electricity retailers to conduct avoided cost tenders, would energy efficiency provisions still be needed in the building code? Differential connection fees for new buildings could be an alternative to mandatory standards. Under this scheme, supply authorities vary the charge for the connection depending on the degree of efficiency design employed in the building. While this allows greater flexibility for the building owner in deciding to what degree efficiency will be incorporated, and how it will be brought about, it relies on supply authorities having an interest in saving electricity.

Where the supply authorities are required to tender, they would produce greater incentives for energy efficiency. But it is very hard to predict to what degree. The authorities could be required to run such a scheme but it would be very difficult to monitor the real effectiveness, given the many different ways requirements could be met. Thus performance standards included in the building code are likely to increase the overall level of energy efficiency attained in buildings. As long as the standards are set conservatively, this should be a minimal intervention.

Conclusion

The goal in restructuring the electricity industry is greater economic efficiency in the delivery of electricity to the consumer. The key reform suggested here of avoided cost tenders extends that concept. It is extended to seeking economic efficiency in the delivery, not of electricity, but of electrical services.

Consumers are ultimately concerned with the cost of electrical services such as light and heat, rather than the cost of electricity. Electricity is only a means to those services and energy efficiency can lower the overall cost.

The current proposals for reform of the electricity industry should considerably enhance the economic efficiency of the delivery of electricity. But it is far from clear that they will produce appropriate and sufficient incentives for energy efficiency, and thus for the least cost delivery of electrical services.

In particular, it is not clear which party will actually lead the provision of efficiency services. This is especially so in the short to medium term where there is surplus capacity (and possibly just one overwhelmingly dominant wholesaler).

Overseas, significant reductions in consumption through energy efficiency have generally been led by the electricity industry rather than by consumers. In the case of Electricorp, while there is surplus generating capacity, the incentives for promoting substantial reductions in consumption through energy efficiency are clearly negative overall.

In the case of the supply authorities, the incentives are much more mixed. Competition for consumers across former franchise boundaries means energy efficiency will be used to win new customers. But the less electricity sold as a result of efficiency savings, the lower the return on the authorities' investment in Trans Power and the lower the profit on sales of electricity put through their local lines.

The extent of the influence of the last factor will depend on how pure a separation of charges is made for use of the lines on the one hand, and the charge for electricity running through them on the other. There is concern from a number of quarters that supply authorities should not be free to set the balance themselves (which would likely result in low charges for each unit of electricity and a low profit margin on each unit sold). It is possible that a significant proportion of the cost of operating the local lines will be required to still be built into the charge for each unit of electricity, though not to the present extent. Thus supply authorities would have a greater interest in maintaining or increasing the volume of electricity sold. Without such a change, the separation of charges will reduce the economic potential for energy efficiency.

For third party entrepreneurs, in the short to medium term, the business risks are very high. The interests of both electricity wholesalers and retailers are in conflict with the work entrepreneurs would undertake during this period. Electricorp's size and monopoly power would be cause for concern to an entrepreneur, even under the most rigorous competition law. A breakup of Electricorp may diminish such worries, but as long as there is a generation surplus, those concerns will remain.

However, it is the supply authorities which pose the greater threat to entrepreneurs. For them, competing suppliers of efficiency services will almost invariably be antagonistic to their commercial interests. Energy efficiency supplied by an entrepreneur is either taking away power sales on which they could have made a margin, or it is taking away business they would rather have undertaken themselves — that is, the supply authority could make the money installing efficiency services and possibly win a new customer. An entrepreneur must also compete against a supply authority which holds existing customer relationships and billing services.

Electricity Industry Reform

In the face of this analysis which questions whether the proposed set of reforms will provide adequate incentives for energy efficiency, it is appropriate to look at ways of extending the reform to give better incentives for the least cost delivery of electrical services.

The avoided cost tender mechanism suggested here is a means of ensuring the comparison between energy supply and energy savings is made explicitly. The outcome should be the best mix available to provide the services.

The tender process creates a market for efficiency services, in the sense of creating an 'exchange' for prices for electricity services in the way a stock exchange functions for shares. This reduces the risks considerably for entrepreneurs as they can act simply as efficiency brokers. They would onsell contracts for efficiency retrofits to supply authorities so they would not be constrained by a lack of capital in developing new business. And the requirement for the supply authority to tender gives security that a competitive bid will be accepted, while vetting ensures no favouritism on the part of the authority for its own operators.

It may be argued that if Electricorp is broken up into two or more separate generation companies, tender processes will naturally develop to allow supply authorities to get the lowest-cost electricity from the competing generators. Establishment of a tender for this purpose would certainly make it easier for energy efficiency entrepreneurs to make a case that their competitive bids for savings should be taken. But it gives no assurance that supply authorities will set the bounds of the tender to provide for energy savings, or even accept a lower price bid from a third party. Neither does it require the authority to take over the contract for supply of efficiency services in the way it would otherwise be required to.

It is difficult to estimate the costs of requiring supply authorities to tender in terms of the effect on economic efficiency. Simply holding tenders can be costly, although, as discussed above, they may evolve for competing generators in any case. Other costs to economic efficiency would be likely to arise from an independent agency setting the bounds of the tender. They would also arise from the nature of the rules determining what form of bids are acceptable.

The important point, though, is that none of these costs appear to have strong structural characteristics — that is, none seem likely to alter the expected industry framework. The tender scheme does not restrict supply authorities, or any other party, from pursuing other mechanisms to advance energy efficiency. Neither does it require them to produce a minimum number of bids to demonstrate competition. It simply requires that they call for tenders and accept the least cost combination of bids. If no competitive energy savings bids come forth, supply authorities need go no further.

The direct benefits which could be expected are also very difficult to predict. The indicated potential for economic efficiency conversions is certainly high. But there are also many barriers to overcome. There are also residual feedbacks to be allowed for. Energy efficiency may reduce a consumer's demand, but the consumer may spend some of the money saved on more energy consumption, and certain electricity uses (a very small proportion of demand) can actually be more efficient than direct use of fossil fuels (eg. heat pumps and electric vehicles). Even carbon dioxide levels may be increased through energy efficiency in very special circumstances where fuel sources are changed. However, none of these factors seems likely to seriously influence the dominant direct reductions in carbon dioxide and energy use.

Estimation of a particular level of savings which could result from the tender would depend on a host of factors. But it appears that the tender mechanism directly addresses the key barriers identified to achieving greater energy efficiency. And the wider potential benefits are on a grand scale.

Benefits of Energy Efficiency

A major benefit would be an improvement in New Zealand's international competitiveness. An energy intensity 50% above the OECD average suggests quite strongly that the nation is not using energy efficiently. While some of this high level may be attributed to structural change in the economy and particular industries, this only partially accounts for the wide disparity with other countries. Energy is a basic input to production, and a reduction in its cost through energy efficiency is a source of sorely-needed competitive advantage.

Turning the issue around the other way, it is clear that unless the rate of growth in electricity demand is slowed, electricity prices will rise considerably in real terms. Energy efficiency could delay or even circumvent electricity price rises, but not overnight. It takes time for the effectiveness of an energy-savings industry to build up.

Resource allocation would also be improved. Power stations are very capital intensive and if energy efficiency can provide the same service at less cost, this would release funds for further productive investment otherwise crowded out.

The nation's leading company and second-biggest energy producer, Fletcher Challenge, has already concluded that the current rate of growth in energy demand is "unsustainable and unaffordable". As a result, the company's Energy and Resources Group has stated that "New Zealand urgently needs strong, committed Government leadership of a national energy management programme".[39]

The minimal reform proposed to help capture these benefits pales beside that likely to be required to enforce internationally set greenhouse emission limits. While this study has focused on mechanisms for achieving energy efficiency which could be justified on economic grounds alone, this does not exclude taking account of the potential impact of future measures to restrict carbon dioxide emissions. Although a little distant, a meaningful response to global warming is a near certainty.

A carbon tax, for example, which seems a likely element for enforcing emission limits, represents a major intervention. It relies on pricing energy high enough so that demand drops to the approved level. To get a substantial reduction in demand, it has been suggested that energy prices may need to more than double.[40]

Introducing avoided cost tenders is very mild by comparison. If implemented, it could be expected to reduce the level of carbon dioxide otherwise emitted. Thus any subsequent measure seeking to reduce emissions further would not need to achieve as much. In the case of a carbon tax, the tax could be set lower. Also important would be the fact that an energy efficiency industry would have been established. As a carbon tax relies on higher prices, forcing consumers to either use less energy or use it more efficiently, an active efficiency industry will increase the responsiveness of demand to the price rise so that the level of the tax can be minimised.

Further investigation of the balance of costs and benefits is obviously required along with practical details of the scheme's operation. But it is important that this be done now, rather than after this stage of the restructuring.

Wait and See?

It could be argued that if it is still possible that the reforms already proposed will deliver appropriate and sufficient incentives for energy efficiency, why not wait and see if further reform is in fact needed? The problem is that the circumstances will not be the same after this round of reform. Once supply authorities are established under the Companies Act, with shares issued, the shareholders are likely to have a stake in obstructing the introduction of a requirement for their company to conduct avoided cost tenders. Unlike the present position, the government would have to account to and perhaps compensate supply authority shareholders for a reform which may reduce the value of their shares. While Electricorp is still in state ownership, no barriers exist from undertakings which could be given to a private purchaser at a later date.

It may be that a breakup of Electricorp leads to a so-called 'pool' system being established where generators feed prices for electricity into a central pool on a daily basis, as operates in England. This would supercede longer-term contracts for electricity to supply authorities and make operation of the avoided cost tender mechanism difficult. But such a development is a considerable way off and, again, it is easier to undo the mechanism than to try to establish it should a pool system not eventuate.

It may be that even if the current reforms were to result in the establishment of something similar to avoided cost tenders, the requirement would speed the process along. This has been part of the philosophy behind United States regulatory intervention promoting energy efficiency. It is a matter of hurrying along something that may otherwise take longer to come about, and it is also an insurance policy against the best not coming to pass. There will certainly be many worthwhile energy savings made over the next few years whatever the industry structure. But there are important benefits to be gained by bringing forward those savings to achieve a much higher level of energy efficiency earlier.

The need to require supply authorities to hold tenders is possibly only a short-term one as a result of surplus generating capacity. The process may also be self-sustaining once initiated. After the entrepreneurs have established themselves and the process has been finetuned, it would seem difficult for a supply authority to justify its withdrawal unless replaced by an equivalent mechanism. Thus the reform could have a sunset clause of 10 years or a review at this stage.

It is the concept of an avoided cost tender rather than the detail of its operation which is stressed here. The tender seems a valuable extension of the current reforms to refocus the goal from economic efficiency in the delivery of electricity to that for electrical services. It is not a complete solution to obtaining electricity efficiency, but it seems an important element and the next best step forward.

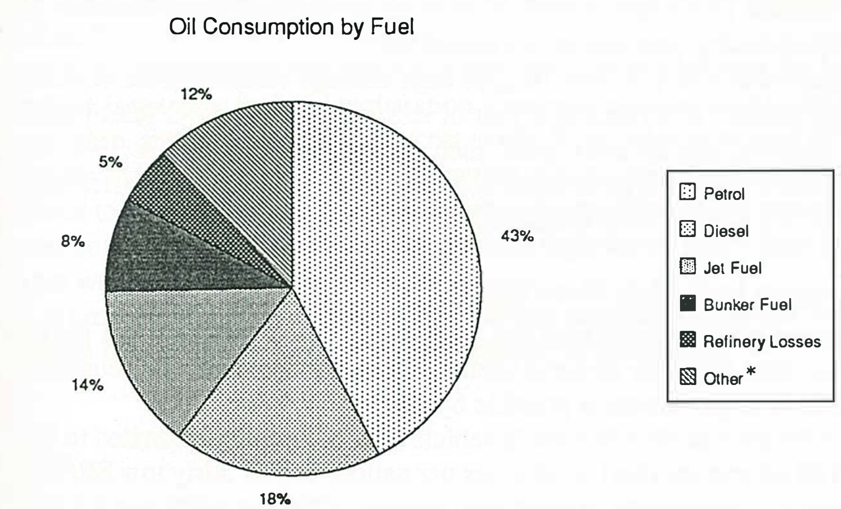
8. Oil and Gas Potential Savings

This section of the report examines the potential for energy efficiency in the two other large energy sources, oil and gas. The review is necessarily brief, partly because of the low level of basic data. Both also tend to involve mechanisms which extend beyond the scope of this paper.

Oil Savings

In New Zealand, over 80% of oil is used for transport. Looking for oil savings is therefore a matter of looking for savings in transport fuels which in turn is dominated by land transport.

Figure 8.1



* These products include lubes, LPG and asphalt. None are greater than 3% and are largely byproducts of the refining process.

Source: Mobil Oil, 1990 data

Unlike electricity, the information base for transport options is not well developed. Data on composition of the vehicle fleet are quite dated, so even estimating the current average level of fuel efficiency is difficult.

There are also few 'technical fix' options: retrofitting vehicles is a very limited answer. Sources of substantial savings tend to involve wider policy questions. It is for these reasons that this section provides only a background to the potential savings.

Retrofits

Retrofitting vehicle engines to achieve higher efficiency, in general, achieves only small savings — often with detrimental side effects. Changes can be made to improve engine control, the fuel air mixture, and through using fuel additives.

Tests of individual commercial retrofits in New Zealand have shown efficiency improvements of only around 5% or less. In general terms, retrofitting options combined with fuel efficiency options are likely to achieve less than a 10% improvement.[41] The relatively low gains made from changes, combined with the disadvantages which commonly accompany them (reduced acceleration, excess engine wear), limit the utility of such options. The overall level of savings likely to be achievable through retrofits is small.

Improved Driving and Maintenance

Regular maintenance can improve fuel efficiency by around 4%; slightly greater savings are possible through better driving habits. But aside from actually getting people to make such changes, the experience has been that continual reinforcement is needed to maintain different driving patterns.[42] Thus these measures are both small and difficult to sustain.

Fuel Conversion

Switching from petrol to CNG is not really an energy efficiency measure as much the same amount of energy is used. It is more an economy measure and gives some assistance to reducing greenhouse gas emissions.

It is estimated that a further 140,000 high mileage vehicles could currently convert to CNG and achieve a payback in a year or less.[43] However, CNG sales peaked in 1987 and have declined significantly since then. CNG use does yield a 19% reduction in carbon dioxide output, and greenhouse concerns may lead to a wider differential in petrol and CNG prices which would assist greater use of the fuel.

Improvements in Vehicle Fleet Efficiency

Improved efficiency through the purchase of newer vehicles is a major potential source of savings. The New Zealand Climate Change Programme's discussion document assumes a 33% improvement is possible by 2005.[44]

The efficiency of New Zealand's vehicle fleet is currently estimated to be around 10 litres per 100 kilometres (km) or 28 miles per gallon. This is fairly low by comparison to new car ratings. The average of those sold between 1985 and 1989 was 8.5 litres per 100 km while a number currently on the market achieve 7 litres per 100 km. Models in commercial use overseas are lower still at around 4.7 litres per 100 km, and test models for commercial development have yielded 3.5 litres per 100km or 80 miles per gallon.[45] Thus the potential for savings is great but depends on complete renewal of the vehicle.

Other Measures

Substantial savings are also possible over a longer period through much greater reliance on public transport. This would involve major reorienting of town planning and urban transportation policies. Reduced speed limits offer some savings, but unless speeds are cut drastically the savings are not great.

Savings Mechanisms

The problem of achieving major efficiency savings in the use of oil is quite unlike that for electricity. Modifying existing vehicles does not achieve great savings: vehicle replacement is required. Changing a vehicle for one of the same size but more efficient (newer) is generally considerably more expensive than the fuel savings. Changing to a smaller vehicle means sacrificing space and/or performance.

So there is no natural efficiency market to be tapped, as with electricity. It is not a question of removing barriers so the market can exploit opportunities for substantial savings in oil. There is only a natural increase in the average fuel efficiency of the fleet through its continual renewal, and if significant savings are desired over and above this natural level, intervention is required.

The pathways to significant savings are essentially these: to get purchasers to change vehicles to one more efficient and/or to one smaller than before, and to get drivers to use vehicles less.

Greater reliance on public transport probably offers the greatest potential savings when looking over an extended period. The Swedes have achieved impressive results: "In Stockholm, Gothenburg and Malmo, where more than 25% of Sweden's population resides, mass transit, motor bikes and pedal bikes account for 75% of all commuting. The figure for the entire country is 46%."[46]

However, the mechanisms needed to bring about such a major realignment of transport patterns involve policy considerations wider than the economic benefits of energy efficiency, and are beyond the scope of this study.

A mechanism used in the United States is the Corporate Average Fuel Economy (CAFE) standard. This requires auto manufacturers to sell a mix of vehicles which, on a weighted average basis, does not exceed a set fuel efficiency level — currently 27 miles per US gallon.[47]

Another mechanism targeting fuel efficiency, and offering perhaps the least degree of intervention, is taxes on fuel and registration. One reduces consumption by raising the cost of ownership, and the other raises the cost of use. Both taxes were used in Sweden in the early 1970s and were reported to have "strongly affected the use of the automobile".[48] The tax added to petrol resulted in a 250% increase in the price of the raw product, and this was combined with sales taxes on new cars and registration fees which increased in cost with the weight of the vehicle.

This is probably the option which offers the best potential for further investigation when adequate data on the makeup of the vehicle fleet is available.

Gas Savings

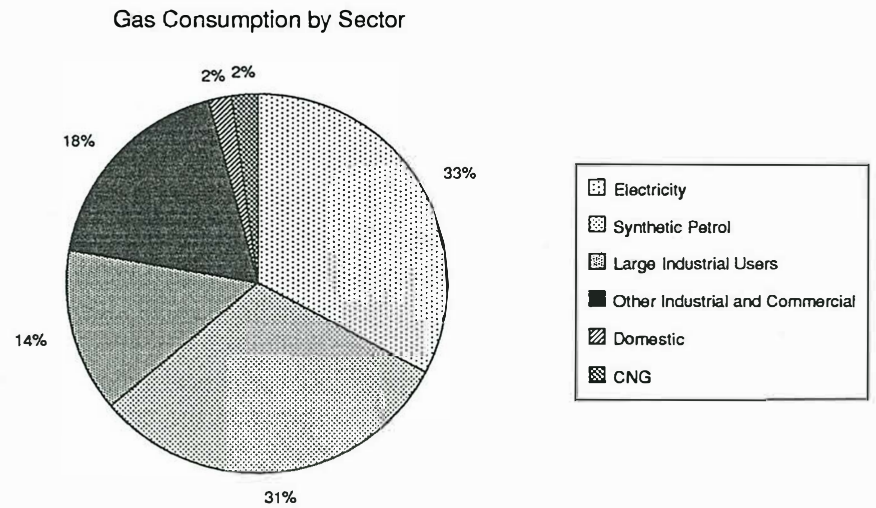
Natural gas is the third-largest source of energy after electricity and oil. While the options for saving gas through efficiency measures are more numerous than for oil, the information base is again not nearly as good as that for electricity.

No study is available which matches gas use with efficiency potentials and costs to give an approximation of the savings available across the economy. Neither does the data base held by the Ministry of Commerce yield figures showing what gas is used for. The Gas Association statistics break down consumption of reticulated gas into three sectors of use, but again not by type of use. While gas retailers have rough estimates of more detailed sector breakdowns prepared for internal use, the figures are generally not publicly available and, where provided, are not attributable.

The best available breakdown of demand simply shows sectors of use (see Figure 8.2). This lack of more detailed data, and the relatively sparse cost estimates for gas efficiency retrofits, prevents a useful estimation of total gas savings available.

An energy savings market for gas may service as little as 20% of demand. This is because about a third of gas is used for electricity generation. Roughly another third is consumed by the Motunui synthetic petrol plant, and any significant changes would involve considerable contract renegotiation. A further block is dedicated to large industries which already have substantial incentives to implement efficiency savings, but can be expected to participate to some degree.

Figure 8.2



Source: Ministry of Commerce, Gas Association of NZ, 1989 data

An indication of the potential for gas efficiency can be gleaned from studies of savings in particular applications and industries considered economic to implement. The following very briefly describes some sources of gas efficiency. These include not just retrofits but also fuel substitution efficiency gains.

- Savings of 15 to 20% can be achieved in fuel for boilers through retrofits in the dairy and food industries. Heat recovery equipment on boiler flues alone saves 10%, and new plant making use of the best technology yields a 30% saving.[49]

- In Swedish forestry mills, wood wastes now serve as the energy source for an average of 80% of former fossil fuel demands. The New Zealand Forestry Council estimated in 1979 that 70% of fossil fuel use could be economically substituted with wood waste.[50]

- The use of gas engines for direct drive of refrigeration plant was found to produce "significant" savings.[51]

- As with electricity, low-temperature heat demands naturally present an area for economic savings. While gas is generally cheaper per unit of energy delivered than electricity, and thus opportunities for savings in heating are reduced, the very low cost of achieving these heat savings means this area is still important. Both space- and water-heating measures which are used to save electricity translate directly to gas-saving applications.

- Another source of savings is where heat and electricity are needed at the same time. Here, gas can be burnt to produce the two together (co-generation), so the energy in the gas is used considerably more efficiently doing two jobs at once. Plant is now available for co-generation equipment, ranging in size from 45 kW to substantial generation facilities.

Mechanisms

The gas industry resembles the electricity industry to a considerable degree. Both have main trunk transmission networks which are natural monopolies. And both are dominated by one producer, which in the case of gas is Petrocorp. The majority of gas retailers are also separate from the producer, with 60% of sales through companies independent of Petrocorp.

More importantly, the commercial incentives for marginal production are similar at present. So long as there is an ability to deliver gas over and above demands contracted for, it is in Petrocorp's interest to increase sales. This will be true to an even greater extent when the second Maui platform, Maui B, is in place from the mid-1990s. As the Maui field production declines, the ability to deliver beyond contractual demands will diminish. Whether Petrocorp then has a commercial incentive to increase gas sales depends on the level of production and arrangements made for other remaining and new gas fields.

So again, like electricity, it is not barriers at the customer level that will be crucial to achieving substantial savings. As long as marginal cost remains lower than average cost, Petrocorp (and in turn the retailers) have little commercial incentive to devise programmes for major savings. It would appear some form of intervention would be needed to achieve substantial efficiency savings.

A state-owned energy savings corporation could be just as effective in the gas industry as for electricity, similarly performing a broking role. However, concerns of a lack of capital to set up the corporation, and accountability problems already noted, again suggest this is not the best method.

But the intervention mechanism preferred for electricity — avoided cost tenders at the retail level — would seem workable. Just as with electricity, retailers could call for tenders for efficiency proposals which would then compete with supplies from gas producers on a price basis. If retailers were compelled to hold such tenders, this would create a market for gas efficiency and could be expected to yield worthwhile savings.

However, before drawing the analogy any further, there are important differences in the case of the gas industry. The first is that although central and local government own virtually all the electricity production and distribution industry, local government owns only a small fraction of the gas industry. What has facilitated the Government's close involvement with restructuring of the electricity industry is its ownership of key assets. While the Government could still impose changes on the gas industry from without, it would be appropriate that changes be negotiated.

As the changes would be likely to reduce the profitability of the retail and wholesale companies, it can be expected that negotiations would involve claims for compensation. Compensation may be sought not just for potential over-investment in supply capacity, but also for contractual liabilities. Gas retailers currently make arrangements for supply of gas from Petrocorp on a take or pay contracts (similar to the Maui contract) which extend up to 15 years ahead.

So unlike electricity, it could be costly to set up a tender system to cover the gas retail market. To further assess the merits of this scheme, study of the costs and the expected level of benefits would be needed. It would also be necessary to compare these costs with estimates of the cost of increasing the production efficiency of the very large gas consumers. This in turn would need to be compared to the costs of renegotiating sections of important gas industry contracts. Such analysis is beyond the scope of this study.

Other mechanisms for promoting efficient gas use requiring substantial intervention have much the same limitations outlined for the electricity industry. Carbon taxes and tradeable permits are dependent on parallel international systems. But as with electricity, some use of minimum efficiency standards is likely to produce useful savings for comparatively little intervention. If market-based mechanisms prove too costly, because of the expense of changing contracts for example, greater use could be made of minimum efficiency standards — but only up to the limit where the gains in efficiency clearly justify the intervention.

Overall, the contractual arrangements through the gas industry are major barriers to market-based mechanisms. Further assessment of options for substantial savings requires study with producers and distributors to better understand these barriers.

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Appendix I
Measures of the Economic Potential for Energy Savings

There are different ways of assessing levels of economic potential. The following is an explanation of the main distinctions.

New Investment vs Retrofit

When assessing the economic potential of energy efficiency, it is first important to distinguish between what is economic to retrofit and what is economic only when new investment takes place. New investment will usually offer higher savings, as constructing a new building or buying a new appliance allows the best efficiency to be bought for the difference between what the best will cost and what is otherwise being spent.

Everything is eventually renewed, so to an extent it is a time-related distinction. But for the purpose of planning five to 10 years ahead, only a limited proportion of major items will be renewed and most of the potential for savings will lie in retrofitting. Those larger and more complex capital investments provide many grey areas which enhance the retrofit potential. One example is where major renovations to an existing building made additional retrofitting economic.

Supplier Perspective vs Consumer Perspective

The potential for economic savings can vary when viewed from the supplier's perspective rather than the consumer's. This is because consumers compare the cost of energy savings to the cost of the standard charge for that energy. Producers compare the cost of producing another unit of energy with the price it is sold for, and if that marginal cost is above the sale price, the producer has an incentive to assist consumers to save even further. Thus, energy efficiency potential can be seen as greater when viewed from the producer's perspective, or greater from the consumer's perspective.

Average Cost vs Marginal Cost

Potentials for savings will also differ depending on whether they are calculated on the basis of average cost or marginal cost. If energy-savings systems are examined individually, comparing their cost per unit of energy saved with the ruling price for that energy, only the measures which are less than the ruling price will be implemented. But where maximum savings are sought (possibly by an electricity supplier wanting to reduce demand as much as possible at a certain time) a company selling energy efficiency can offer the consumer extra economies by saving more power at an average cost still less than the ruling energy price.

Calculation Assumptions

Details of the assumptions used to make the cost estimates also need to be examined when comparing savings potential. Factors such as the assumed life of the asset, the discount rate, and frequency of use are important assumptions.

Appendix 2

Oil Product/Energy Demand Outlook

	1987	1988	1989	1990	1991	1992	1995	2000	2010
Country: New Zealand									
Oil products demand (TBD)									
Auto Gasoline	41.1	42.1	44.0	45.6	46.9	47.6	50.0	54.8	63.5
Super Unleaded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Premium Unleaded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.9	38.1
Regular Unleaded	1.9	3.1	4.8	9.1	15.0	17.2	20.3	21.9	25.4
Premium Unleaded	39.2	39.0	39.2	36.5	31.9	30.7	30.5	0.0	0.0
Regular Leaded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphtha/Avgas	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Jet Fuel	10.7	11.6	13.7	15.1	15.3	16.1	18.6	21.5	26.2
Heating Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Auto Diesel Fuel	18.4	18.4	18.6	19.5	20.0	20.4	21.6	23.9	29.2
Other Distillates	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Residuels	3.3	3.4	2.9	3.1	3.1	3.1	3.1	13.1	38.2
Sulphur Wt % up to 0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	35.1
above 0.3 up to 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
above 1.0 up to 2.9	1.5	1.5	1.3	1.4	1.4	1.4	1.4	1.4	1.4
above 2.9	1.8	1.9	1.6	1.7	1.7	1.7	1.7	1.7	1.7
Lubes	1.20	1.10	1.13	1.09	1.09	1.10	1.10	1.10	1.20
Memo: Auto Lubes	0.70	0.70	0.71	0.66	0.66	0.70	0.70	0.70	0.80
Asphalt	2.1	2.3	2.3	2.1	2.1	2.1	2.1	2.2	2.3
LPG	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Other Products	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.5
Total Inland	**81.8**	**83.9**	**87.5**	**91.6**	**93.6**	**95.5**	**101.6**	**121.8**	**165.9**
Distillate Bunkers	2.8	2.4	2.8	3.7	4.0	3.7	3.5	3.0	2.0
Residual Bunkers	2.2	2.1	3.2	4.4	4.5	4.4	4.0	3.5	2.0
Total Market	**86.8**	**88.4**	**93.5**	**99.7**	**102.1**	**103.6**	**109.1**	**128.3**	**169.9**
Refinery Fuel	6.9	7.1	7.5	7.3	7.3	7.3	7.3	7.3	7.5
Total Products	**93.7**	**95.5**	**101.0**	**107.0**	**109.4**	**110.9**	**116.4**	**135.6**	**177.4**
Refinery Gain	1.1	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7
Total Oil	**92.6**	**93.9**	**99.4**	**105.3**	**107.7**	**109.2**	**114.7**	**133.9**	**175.7**
Synthetic Oil	14.3	14.3	15.4	15.5	11.7	11.0	11.1	11.0	0.0
Total Oil Excl Synoil	**78.3**	**79.6**	**84.0**	**89.8**	**96.0**	**98.2**	**103.6**	**122.9**	**175.7**
G+D Incl Jet	73.2	74.7	79.3	84.1	86.4	88.0	93.9	103.4	121.1
Total Residuals	5.5	5.5	6.1	7.5	7.6	7.5	7.1	16.6	40.2
Energy Demand (TBDOE)									
Oil	78.3	79.6	84.0	89.8	96.0	98.2	103.6	122.9	172.5
Natural Gas	75.9	79.6	81.9	78.6	76.1	77.5	83.4	74.0	48.5
Solid Fuels	24.1	24.3	23.5	23.8	25.1	25.3	27.6	34.6	50.6
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	114.9	118.4	115.7	120.4	122.8	125.0	129.1	135.7	135.7
Total Energy	**293.2**	**301.9**	**305.1**	**312.6**	**320.0**	**326.0**	**343.7**	**367.2**	**407.3**
Real GNP ($ Bill. 1985)	25.5	25.5	25.6	25.6	25.6	25.9	26.6	29.4	37.6
Population (Mill.)	3.3	3.3	3.4	3.4	3.4	3.4	3.5	3.6	3.8