NEW ZEALAND

Asia-Pacific Energy Series Country Report

by

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Heather D. Keevill

Resources Programs
East-West Center
Honolulu, Hawaii

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Prepared for the
U.S. Department of Energy
Assistant Secretary for
International Affairs and Energy Emergencies

EXECUTIVE SUMMARY

GEOGRAPHY AND HISTORY

- New Zealand is composed of two main islands, the North Island and the South Island, which stretch from around 35°S to 47°S in the South Pacific Ocean. The land was once part of ancient Gondwanaland, but as the ocean plates shifted, land broke away from the eastern coast of Australia and drifted southeast to become what is now New Zealand. The physical landscape was shaped by glaciation and volcanic activity. The area remains volcanically active and prone to earthquakes.

- Around 1000 BC, the Maoris, a Polynesian people, arrived from the northeast by canoe and established a hunter-gatherer lifestyle in New Zealand. The first European to sight New Zealand was the Dutch explorer Abel Tasman in 1642. In 1770, British explorer Captain James Cook successfully circumnavigated and charted the two main islands. European settlers soon followed, bringing diseases that took a heavy toll on the native Maori population. In 1840, Captain Hobson brought over the Treaty of Waitangi, which put New Zealand under British rule. The terms of this treaty are in dispute because of the circumstances under which consent was gained from the Maori leaders. Other than this, British control has never been seriously challenged.

- New Zealand's population is approximately 3.4 million, around three-quarters of which is concentrated on the North Island. Around 85 percent of the population is of European extraction. The native Maoris now account for just 9 percent of the population. With a land area of 103,736 square miles, New Zealand is roughly the same size as the Philippines, but New Zealand is sparsely populated by comparison; the population of the Philippines is around 20 times as large as the population of New Zealand.

INDIGENOUS ENERGY RESOURCES

- New Zealand is endowed with a variety of energy resources, including oil, natural gas, coal, hydropower and geothermal energy. Uses of alternative energy sources, such as wind power, ocean thermal energy conversion, tidal power, solar energy, and biomass, are generally considered to be in the experimental phase. The government wishes to promote energy self-sufficien-

cy, but in the era of energy market deregulation, it is no longer willing to promote projects that are not economically competitive.

- Oil and gas reserves are concentrated in the Taranaki region on the west coast of the North Island. Oil and condensate reserves are a modest 160 million barrels, but the value of the reserves is raised by their light, low-sulfur quality. Natural gas reserves amount to around 3.6 trillion cubic feet (tcf), which equates to around 640 million barrels of oil equivalent. The country has proved more gas-prone than oil-prone.

- Coal reserves greatly exceed oil and gas reserves, amounting to around 8.5 billion tons, or about 18,900 million barrels of oil equivalent. The majority of the resource, however, is lignite, most of which is not commercially attractive at the present time. The subbituminous and steam coals are of high quality, as they are low in sulfur and ash. Coal deposits are widely scattered. Most of the mining activity takes place in the Waikato and Taranaki regions on the North Island and the West Coast and Southland regions on the South Island. The lignite resource is located chiefly in the southern part of the South Island.

- Hydropower resources abound on the South Island, where mountainous topography and frequent rainfall result in swift-flowing rivers. Hydropower is also well developed on the North Island. Geothermal resources are significant, though commercial development is currently limited to two facilities on the North Island.

ENERGY IN THE ECONOMY

- New Zealand's cultural landscape is dominated by agricultural pursuits, and in many ways the people tend to view themselves as rural and agrarian. Yet this perception is not entirely justified since agricultural output accounts for a mere 10 percent of GDP in an average year. Industry accounts for around 30 percent of output, and the service and government sectors provide about 60 percent of national production.

- Despite its small size, pastoral setting, and relatively remote location, in terms of energy use, New Zealand is fundamentally similar to other OECD "frontier" states: the United States, Canada, and Australia. Transportation energy use per capita is high, as are residential energy uses such as home heating and electrical appliance use.

- New Zealand's economic performance during the past two decades was disappointing. Real GDP fell during the 1970s and grew in the 1980s, leaving

the country with a real GDP per capita in 1990 that was only slightly above its 1970 figure. The ailing economy tops the list of concerns for most New Zealanders.

- Despite poor economic performance, energy demand increased at rates averaging 3.7 percent per year during the 1974-1990 period, bringing total energy demand from around 7 million tons of oil equivalent (toe) in 1974 to well over 12 million toe by the end of the period. The current energy mix is composed of around 36 percent natural gas, 32 percent oil, 17 percent hydropower and geothermal energy, and 15 percent coal and wood. Both energy use per capita and energy use per unit of GDP increased in the years following the first oil price shock.

- In response to the oil price shocks, the government aggressively promoted development of indigenous energy resources, most notably domestic oil and natural gas. Energy self-sufficiency ratios have improved over the 1974-1990 period; in 1990, self-sufficiency in oil was over 45 percent and total energy self-sufficiency was nearly 80 percent.

- The "Think Big" projects of the early 1980s had profound impacts on patterns of energy use. The petrochemicals industry, which manufactures methanol, ammonia/urea, and synthetic gasoline, is based on natural gas. The expanded steel plant uses coal. Overall, the economy has grown more energy-intensive, but oil intensity has remained roughly stable.

GOVERNMENT POLICIES AND INSTITUTIONAL ARRANGEMENTS

- New Zealand's government has been highly interventionist in the past, actively participating in virtually all segments of the energy market. Like many other governments, New Zealand reacted to the oil price shocks of the 1970s by instituting policies designed to increase energy security.

- The early 1980s gave birth to the "Think Big" projects, which were envisioned as the means to promote economic growth and increase energy self-sufficiency. The projects included a major expansion of the Marsden Point refinery, the expansion of the steel industry, and the construction of a methanol plant, an ammonia/urea facility, and the Motonui synthetic gasoline plant. These projects were extremely capital-intensive, and their commercial competitiveness has been limited since their economics were predicated on steadily increasing oil prices.

- When the price of oil dropped, many development schemes were rendered uneconomical, and New Zealand found itself taking heavy financial losses.

The government's response in the late 1980s was to rapidly deregulate the energy markets and remove itself from direct involvement. The intent was to promote efficiency and force domestic industry to become more competitive.

- One of the first steps was to transform three divisions within the Ministry of Energy into state-owned enterprises (SOEs), which were required to operate on a commercial basis. These divisions dealt with oil, coal and electricity and were known as Petrocorp, Coalcorp, and Electricorp, respectively. Petrocorp was sold to Fletcher Challenge Petroleum and is now fully privatized. The government also plans to privatize Coalcorp and Electricorp, though the sale of these two SOEs will be far more complicated than was the sale of Petrocorp.

- In 1990, the Ministry of Energy was merged into the Energy and Resources Division within the Ministry of Commerce, which now oversees the energy sector and issues permits for petroleum exploration and development. In late 1991, several key pieces of legislation were enacted: the Crown Minerals Act, the Resource Management Act, and the Petroleum Sector Reform Act. These bills set the stage for an ongoing process of reform in New Zealand's energy sector.

OIL INDUSTRY

- Five companies dominate New Zealand's oil market: BP, Mobil, Shell, Caltex, and Fletcher Challenge. All five own shares in the New Zealand Refining Company (NZRC), which operates the Marsden Point refinery. Fletcher Challenge, however, does not process crudes and feedstocks at the refinery, though it has filed suit to gain access to the facility. Fletcher Challenge's goal is to enter the domestic petroleum product market.

- New Zealand's crude and condensate production comes from five fields, all of which are in the Taranaki area: Maui, McKee, Waihapa, Kapuni, and Kaimiro. In 1990, production levels from these fields were approximately 15.4 mb/d, 10.1 mb/d, 8.3 mb/d, 5.6 mb/d, and 0.1 mb/d, respectively. Future prospects for commercial development include the Tariki, Ahuroa, Ngatoro 2, and Kupe fields. New developments, however, are not expected to completely offset production declines from existing fields. Production is forecast to decline from current levels of around 39 mb/d to 30 mb/d in 1995 and 25 mb/d in the year 2000.

- New Zealand will remain a net importer of petroleum. In 1990, imports amounted to 65 mb/d, while exports averaged 15 mb/d. Australia is the market for essentially all crude and condensate exports, while the Middle

East is the source of most crude imports. In 1990, the Middle East—chiefly Saudi Arabia—provided nearly 83 percent of New Zealand's feedstock imports, while the Asia-Pacific region—mainly Indonesia and Singapore—was the source of the remainder. While New Zealand will continue as an importer on a net basis, it is unlikely that its exports will cease, partly because of the premium commanded by New Zealand's high-quality crudes, and partly because Fletcher's lack of access to the refinery encourages it to seek overseas markets for its crude.

- The oil price shocks of the 1970s prompted a drop in New Zealand's demand for petroleum products—partly as a price effect, and partly from the phasing in of alternative resources. As in most countries, the bulk of the decline in demand was concentrated in the cut of the barrel most readily substitutable, the fuel oil cut. Fuel oil demand fell by 9 percent per year in the 1974-80 period, and dropped by more than 16 percent annually in the 1980-85 period. The only other fuel that showed a demand decline was gasoline, which, despite the major efforts undertaken to promote alternative fuel use in cars, fell by a mere 0.22 percent per year in 1980-85.

- As in most of the Asia-Pacific countries, oil demand in New Zealand staged a dramatic turnaround in the second half of the 1980s. Consumption increased at an average of about 5 percent per year, driven partly by a doubling of the demand for jet fuel.

- New Zealand's refinery upgrading project has enabled the country to do an outstanding job of balancing its output slate with a demand that is almost exclusively for transportation fuels. Current operations show a balance in most products, and even suggest a continuing surplus of very high-quality, low-pour diesel fuel.

- A further similarity to the "frontier states" within the OECD is that New Zealand has relatively low taxes on gasoline (the only countries with lower rates are the United States, Australia, and Canada) and other petroleum products. Although taxes had been increased in the mid-1980s, many were rolled back at the end of the decade; low tax rates, by international standards, were made even lower.

- The deregulation of the petroleum industry undertaken in the late 1980s was rapid and extensive. New Zealand has moved from a position as one of the most interventionist systems to one of the freest markets. Unlike many of the Asia-Pacific countries that have deregulated oil in recent years, New Zealand also opened the market to imports by traders; there are no base requirements in order to import products for domestic sale. The one question that remains unanswered from the earlier period of heavy regulation is that of Fletcher's

access to the refinery. When it was privatized, Petrocorp took over the government's share in the refinery; whether the shareholding entitles it to refinery access is a hotly debated issue now entering litigation.

NATURAL GAS AND GAS PROCESSING

- At 3.6 trillion cubic feet, New Zealand's gas reserves are four times the size of its proved oil reserves on an oil-equivalent basis. These are not large reserves by international standards, but they are large relative to potential domestic uses of the resource.

- Utilization of gas has been encouraged in every sector, with particular emphasis on industrial and residential uses. Indeed, many major projects, such as the move into petrochemicals, were undertaken as part of a strategy to achieve sufficient overall demand to justify development of the resource.

- Gas production has increased tremendously over the past two decades, growing from around 12 billion cubic feet (bcf) in 1974 to 147 bcf in 1990. The Maui field accounts for around 84 percent of total gas production as well as a large portion of condensate production.

- The gas processing industry centers around the Taranaki region, where there are six gas processing facilities and three petrochemical plants. The petrochemical industry consists of an ammonia/urea plant (165 mmt/y capacity), a methanol plant (530 mmt/y), and a synthetic gasoline facility (658 mmt/y).

- The petrochemical industry accounts for 40-45 percent of natural gas use in New Zealand. The other users are the electric power, residential, commercial and industrial sectors. A small amount of natural gas is used as a transportation fuel in the form of compressed natural gas (CNG). Use of CNG as a transportation fuel has diminished in importance during the latter half of the 1980s, however, as the price of oil dropped and as the government withdrew from direct involvement in the market. CNG sales reached over 13 MMcf/d in 1985, but declined to just 6 MMcf/d in 1990. Liquefied petroleum gas (LPG) has been more successful in gaining and keeping a share of the transportation fuels market. In 1990, over one-half of New Zealand's LPG was devoted to transport uses.

ELECTRICITY

- New Zealand is fortunate to be able to rely on indigenous hydropower and geothermal power for over 80 percent of its electric power needs. Hydropower supplies all electricity needs on the South Island, and excess South Island hydropower is exported to the North Island via a subsea transmission line.

- Oil initially played an important role in thermal power generation, but it was rapidly phased out after the 1974 oil price shock. In 1974, oil accounted for around 10 percent of the power sector fuel mix; by the second oil price shock, oil had been almost entirely phased out.

- As oil was phased out, natural gas rapidly became the premier fuel for thermal power generation. The share of natural gas in electricity generation jumped from just 1 percent in 1974 to 18 percent in 1977. The aggressive promotion of natural gas also displaced quantities of coal; in 1974, coal represented 6.5 percent of the fuel mix, but coal's share dropped to 1.6 percent by 1979. The electric power fuel mix in 1990 was composed of 73.9 percent hydropower, 18 percent gas, 6.7 percent geothermal, and 1.5 percent coal.

- The industrial sector is the largest user of electricity in New Zealand, accounting for around 40 percent of demand. Residential consumers are the second-largest group, with 37 percent of demand, followed by the commercial sector (20%), farming (2.5%) and other users (less than 1%). Demand for electricity has grown in all sectors, but has been most rapid in the commercial sector. Overall, electricity demand has grown at rates averaging 2.5 percent per year during the 1985-1991 period.

- The wave of deregulation sweeping New Zealand's energy markets is also transforming the electric power sector. Far-reaching reforms have been proposed, including the corporatization of local electricity supply authorities, removal of franchise areas, separation of line and energy functions, separation of the National Grid from Electricorp, and price reforms to promote conservation and thereby postpone or eliminate the need for new power plants. The original plan also called for the removal of the obligation to serve customers, but this proposal was so radical that it was recently withdrawn.

COAL

- Coalcorp is the principal coal producer in New Zealand, accounting for around two-thirds of national production. The company remains a state-owned enterprise, but has greatly increased its operating efficiency and operates on a fully commercial basis. The government's plans to sell Coalcorp are currently on hold, as questions of resource ownership remain to be settled.

- New Zealand's coal reserves are orders of magnitude larger than its oil and gas reserves, yet coal production was on a general downward trend during the 1970s and was stagnant during the 1980s. Production fell from 2.6 million tons (mmt) in 1974 to below 2.0 mmt in 1979 and remained in the range of 2.2 mmt to 2.7 mmt during the 1980-1990 period. Coal has largely been unable to compete with other energy sources. In addition, future expansion of coal use may be constrained by New Zealand's commitment to environmental protection and reduction of greenhouse gas emissions.

- The bulk of New Zealand's coal resource is composed of low-heat value lignites. Recoverable reserves are estimated to be 82 percent lignite, 14 percent subbituminous, and 4 percent bituminous coals. Despite their prominence in reserves, lignites account for less than 10 percent of production; mining activity focuses instead on higher-value steam and coking coals. These types of coal are, for the most part, very low in sulfur and ash, which adds to their attractiveness as export commodities.

- Export markets have grown increasingly important for New Zealand's coal producers faced with stagnant domestic markets. Exports were a modest 11 thousand tons (mt) in 1978, but grew to 486 mt in 1989—a record-high figure by New Zealand standards, but less than one-twentieth the size of a typical year's coal exports from Australia. Japan is the main destination of New Zealand's coal exports.

- On the domestic front, the industrial sector—chiefly the steel industry—is responsible for around three-quarters of coal consumption. Electricity generation absorbs around 15 percent, followed by the commercial/public sector and the residential sector which account for 6 and 4 percent, respectively. In the power sector, Electricorp is the only coal user, with two power plants on the North Island capable of burning coal.

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Preface

The New Zealand energy sector has undergone significant changes in the past few years. Reform and deregulation came to New Zealand in large doses and at a rapid pace. Unlike Japan where deregulation was designed for a five-year phase-in period or even Australia where the government was fully geared up to handle deregulation, deregulation occurred in New Zealand almost with no phase-in period and very little planning. Under fast-paced "Rogernomics," the energy sector was but one more element of the economy to be deregulated and/or privatized. While the New Zealand energy sector deregulation is generally believed to have been successful, there are still outstanding questions as to whether the original intent has been fully achieved. The fact that a competent energy bureaucracy was mostly lost in the process makes it even more difficult to find those with long enough institutional memories to untangle the agreements and understandings between the government and the private sector over the previous decade.

In the petroleum sector, privatization led to the creation of Petrocorp/Fletcher Challenge Petroleum as a resilient and dynamic domestic New Zealand oil company. The current legal problems between Petrocorp and the operators of the New Zealand Refining Company are an example of how the government, in its rush to get out of the oil business, left unanswered questions. It is unclear to which extent the taxpayers' contribution to the Marsden Point refinery in terms of investment subsidies and outright cash payments obligates the refinery operators to provide processing access to a domestic New Zealand oil company. For access to the refinery by four international oil companies, what did the government ask for in return, and how can the government enforce any understandings? Has the consumer benefitted from all this? The jury is still out on all these issues. One thing is certain, the New Zealand deregulation process is unique and provides an example of rapid changes in the energy sector over a relatively short period of time. The current report, authored by Dr. Nancy Yamaguchi and Heather Keevill, provides a useful survey of the key energy sector issues in New Zealand.

As part of our continuing assessment of Asia-Pacific energy markets, the Resources Programs has embarked on a series of country studies that discuss in detail the structure of the energy sector in each major country in the region. To date, our reports to the US Department of Energy, Assistant Secretary for International Affairs and Energy Emergencies, have covered Australia, China, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, the Philippines, Singapore, South Korea, Taiwan, and Thailand. The country studies also provide the reader with an overview of the economic and political situation in the various countries. We have particularly highlighted petroleum and gas issues in the country studies and have attempted to show the foreign trade implications of oil and gas trade. Finally, to the greatest extent possible, we have

provided the latest available statistics—often from unpublished and disparate sources that are unavailable to most readers. Staff members have traveled extensively in—and at times have lived in—the countries under review and have held discussions with senior policymakers in government and industry. Thus, these reports provide not only information but also the latest thinking on energy issues in the various countries.

It is our hope that over the next few years these country studies can be updated and will provide a continuous, long-term source of energy sector analysis for the Asia-Pacific region.

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Here at the East-West Center, a number of our colleagues were particularly helpful. Some of the early research on New Zealand was performed by David Hayes, a New Zealand national affiliated with the Resources Programs. Dr. David Isaak's good humor and perspicacity were invaluable throughout the writing of this report. Thanks also go to Dr. Charles Johnson, who reviewed our chapter on the coal sector. Finally, we would like to express appreciation for the efforts of Ms. Julia Culver-Hopper and Ms. Liza Balantac in editing and laying out the final report.

LIST OF MEASUREMENTS

b/d	barrels per day
bbl	barrel
bcf	billion cubic feet
°C	degrees Celsius
CNG	compressed natural gas
dwt	deadweight tonnage
GDP	gross domestic product
GCV	gross caloric value
GW	gigawatts (1000 megawatts)
GWh	gigawatt-hours
°F	degrees Fahrenheit
kcal/kg	kilocalorie per kilogram
km	kilometer
kV	kilovolt
kWh	kilowatt-hour
LNG	liquefied natural gas
LPG	liquefied petroleum gas
m	meter
m^3	cubic meter
MJ/kg	megajoules per kilogram
mm	millimeter
mb/d	thousand barrels per day
mmbbls	million barrels
mmboe	million barrels of oil equivalent
MMBTU	million British thermal units
mmcf	million cubic feet
MMcf/d	million cubic feet per day
mmt	million tons
mmt/y	million tons per year
mmtoe	million tons of oil equivalent
mt	thousand tons
MW	megawatts
NZ$	New Zealand dollar
NZ¢	New Zealand cent
tcf	trillion cubic feet
toe	ton of oil equivalent
ton	1000 kilograms or one metric ton
TWh	terawatt-hour
US$	US dollar

One

NATIONAL OVERVIEW

GEOGRAPHY

Located in the South Pacific Ocean, New Zealand is an island nation made up of two main islands with a total area of 103,736 square miles. New Zealand was once part of the ancient Gondwanaland where present-day Africa, South America, and Australia made up one large supercontinent. As the ocean plates shifted, land broke off from the eastern coast of Australia and drifted southeast. This land mass became what is now known as New Zealand, and is located between latitudes 34.5° and 47° south and longitudes 166° and 178° east (not including Bounty and Chatham Islands which are further east).

Plate tectonic processes continue to affect New Zealand as the Indo-Australian plate moves over the Pacific plate. Its location along a rift zone, where the ongoing process of subduction is taking place, creates a high incidence of earthquakes, comparable in frequency to those of California. The process of subduction caused the uplift which was the primary influence in the formation of the South Island mountains, in addition to some volcanic activity. Glaciers further altered the terrain, carving out valleys, wearing down mountains, and creating river systems. There are 360 glaciers in the Southern Alps of New Zealand, the largest of which—the Tasman Glacier—is 18 miles long.

On the North Island, the terrain has been structured primarily by volcanic processes and secondarily by glaciers, although no glaciers remain on the North Island today. Mt. Ruapehu is the only volcano still considered active. Mt. Ruapehu stands at 9,175 ft. and is the second highest point in the country after Mt. Cook (12,349 ft.) (see Figure 1.1).

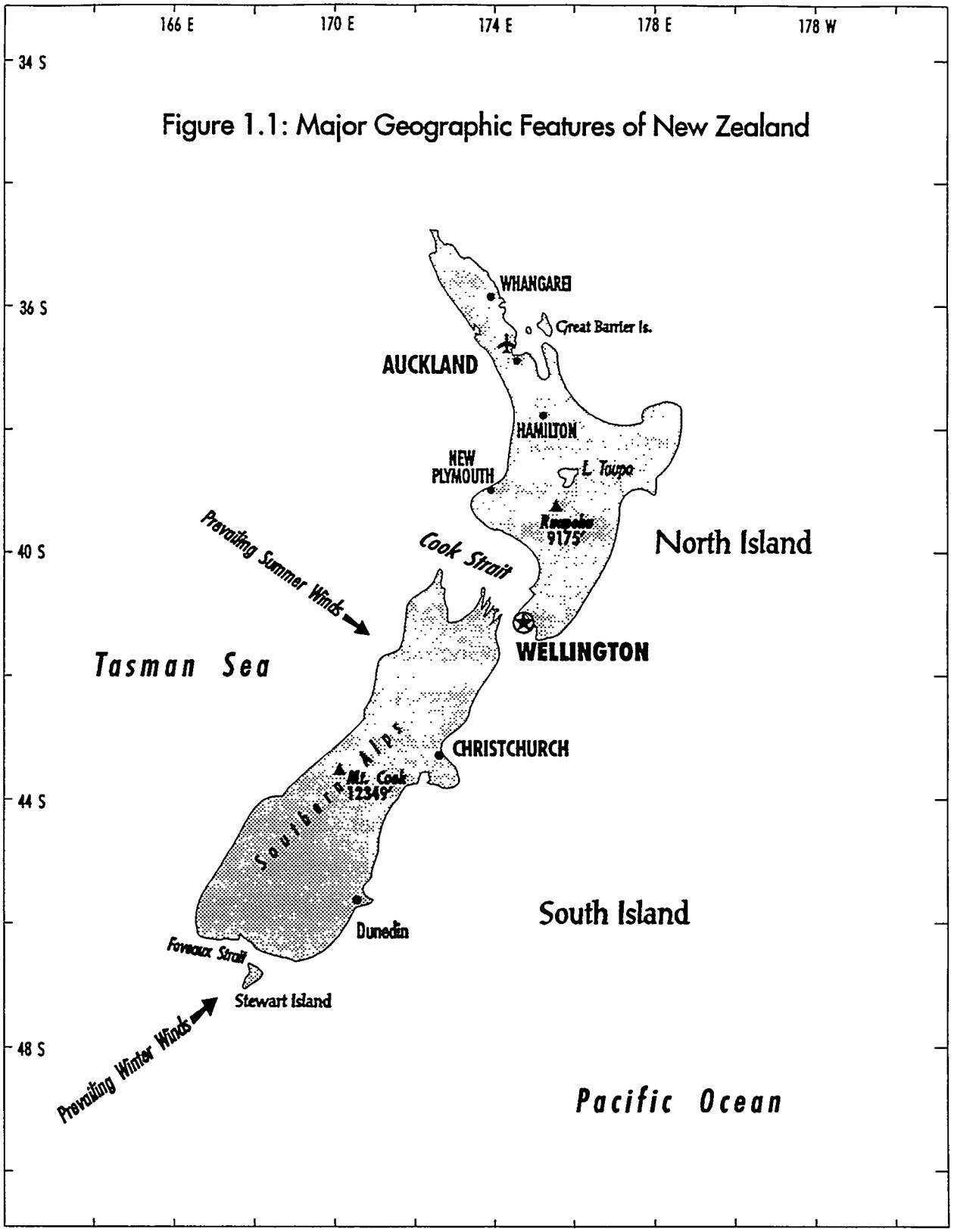

Figure 1.1: Major Geographic Features of New Zealand

While the economy can no longer be classified as agrarian, the landscape remains dominated by agricultural pursuits. The livestock population of 73 million cows, sheep and deer vastly outnumbers the human population of 3.4 million. The animals are bred for exports of meat and pelts and provide milk for a strong dairy industry. In addition to livestock, the fertile lands are used to grow fresh produce, particularly apples and the Kiwi fruit for which New Zealand is known. New Zealand also has extensive tropical forests, which are logged for timber and wood pulp.

New Zealand has a marine climate with prevailing westerly winds. The South Island experiences cooler temperatures and higher rainfall than does the North Island. Average temperatures for Auckland are around 74°F in the summer and 57°F in the winter, while in Christchurch, summer temperatures are about 70°F, with winter temperatures dropping down to around 50°F. The rainiest place in New Zealand is the west coast of the South Island, where rainfall ranges up to 300 inches a year. In contrast, the east coast of the South Island is sheltered by the Southern Alps and receives little rainfall. Most water supplies are therefore obtained from the many streams and rivers fed by the run-off from the Alps.

POPULATION

New Zealand has roughly the same land area as the Philippines; however, the Philippines has over 20 times the number of people. With a population of approximately 3.4 million people, New Zealand is sparsely populated for the most part. The three most-populated urban areas are Auckland (850,000), Wellington (325,000), and Christchurch (301,500). The population is concentrated on the North Island, with less than 900,000 people residing on the larger South Island. The country has undergone a steady process of urbanization; by 1986, 84 percent of the population was classified as urban.

Before the arrival of European settlers, the native Maori population was estimated to be between 100,000 and 125,000. This was reduced to around 60,000 after the onset of diseases and territorial warfare that accompanied the arrival of the Europeans. The present ethnic composition of the population is estimated to be 85 percent European, 8.8 percent Maori, 2.8 percent Pacific Islander, 0.6 percent Chinese, 0.4 percent Indian, with

0.4 percent others, and 1.2 percent unspecified. The European settlers multiplied rapidly from 1840 to 1880. After 1880, annual population growth rates stablized at 1-2 percent. In the 1980s, population growth declined further to below 1 percent per year. Government forecasts now predict that population growth rates will drop to around 0.5 percent per year through 2031, when the population is estimated to be 4.2 million (see Figure 1.2).[1]

Health care is financed by the government through general taxation, not one specific tax. New Zealand spends approximately 5.6 percent of its GDP on health care, a figure somewhat lower than other developed nations such as Australia (7.8 percent) and the United States (10.7 percent). Life expectancies for men and women have been slowly increasing over the past 40 years and now average 71 years for men and 77 years for women. Cancer and heart disease are the leading causes of death. Another factor affecting population growth is the infant mortality rate, which is 11.6 percent in New Zealand, a little higher than in other developed countries.

EDUCATION

Primary and secondary education are mandatory in New Zealand. Public funding is the main source of financial support, although private contributions are also made to individual schools. The Ministry of Education was established in October of 1989 to replace the former Department of Education and take over responsibility for policy, allocation of funds, and ensuring that schools are in compliance with all requirements. The 1988 educational review brought about several changes that have been made in the administrative structure. Schools that were previously controlled by the regional boards of education under the Department of Education are now the responsibility of a board of trustees for each individual school. This change in policy allows the community and administration to work together and jointly take responsibility for the charter objectives and allocation of funds.

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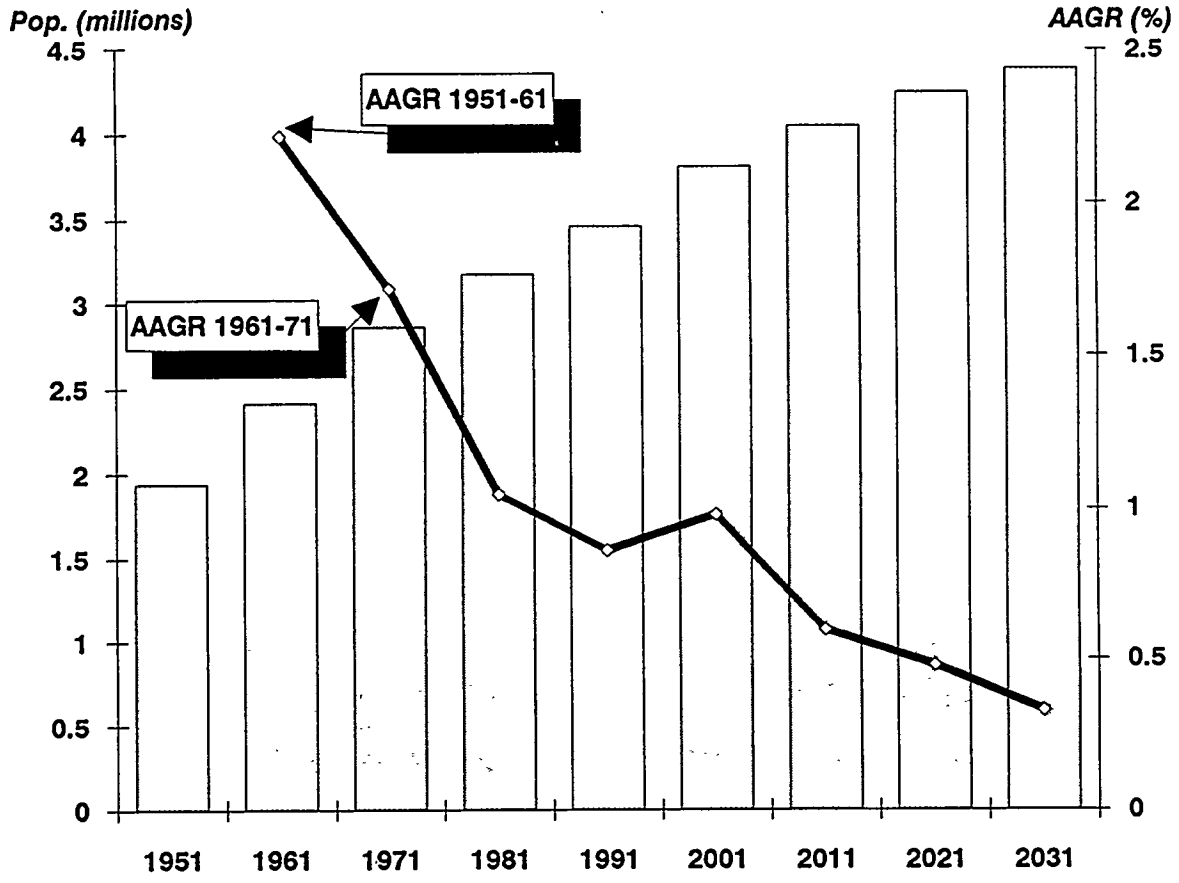
[1] Department of Statistics. *New Zealand Official Yearbook.* Wellington: New Zealand Government Press, 1990.

Figure 1.2: Population and Average Annual Growth Rates by Decade 1951-2031



At the university level, the government is encouraging increased reliance on private funding. The present system is based primarily on public funding. There are six universities which supported 56,930 students in 1988. Almost all students receive awards to help pay for their university education. Students applying to a university receive allowances based on their parents' income and whether or not they will be living at home. In 1988, 76,241 awards were granted. Different awards may include fees, housing, transportation, allowance, or any combination thereof, depending on the student's eligibility. Students may be eligible for more than one award, for example, a scholarship covering fees and a housing allowance.

HISTORICAL BACKGROUND

New Zealand was first settled around 1000 B.C by the Maoris who arrived by canoe from Polynesia. The Maori people lived simply as hunter-gatherers, gathering food from the natural vegetation and the sea, and hunting some of the large flightless birds found on the islands, primarily the moa. Their hunting for fowl had a great impact on the environment since they used fire to burn the moa (related to the Australian emu) out of hiding. This process not only led to the extinction of the moa and other birds, but also affected the indigenous vegetation. The Maoris were split into many tribes, some of which were very warlike and prone to fight with neighboring tribes over land and food. Fishing and travel were made possible by canoes built from the massive Kauri trees, which also produced a sticky gum used as a glue and sealant.

The first European to sight New Zealand was the Dutch explorer Abel Tasman in 1642. New Zealand was first circumnavigated and charted by British explorer Captain James Cook during his first voyage, which was undertaken between 1768 and 1771. During this voyage, Cook discovered that New Zealand actually consisted of two main islands, and the Cook Strait between North and South Islands still bears his name. Following Cook's voyage, European interest began to grow, and more and more settlers arrived in New Zealand, bringing with them diseases to which the Maoris had no natural immunities and taking a serious toll on the native population.

In 1840, Captain Hobson brought over the Treaty of Waitangi which put New Zealand under British rule. The terms of the Treaty of Waitangi are still disputed because of the circumstances under which consent was gained from the Maori leaders. Tribal chiefs were given a Maori translation of the English version which, as it turned out, was not equal in meaning. Additional encouragement took the form of blankets and other European goods that were given to each Maori chief only if he agreed to sign. The Maori people challenged the land rights provisions under the Treaty of Waitangi during the land wars of the 1860s, and recently, the issue has resurfaced in the courts. Other than this conflict over native land rights, British control has not been seriously challenged.

Great numbers of Europeans were drawn to New Zealand in the mid-1800s in pursuit of gold, as well as employment in the growing cities, and to harvest timber and

gum from the Kauri trees. Serious impacts on indigenous flora and fauna accompanied the settlers since they brought over new plant and animal species and seriously depleted the number of slow-growing Kauri trees. Among the animals introduced were cattle and sheep for food, hides and wool, as well as rabbits, opossum, and deer, in attempts to make the New Zealand countryside appear more like that of England, for which many of the new settlers were homesick. Since these animals had no natural predators in New Zealand, they multiplied beyond control. The government now allocates a portion of the annual budget to opossum control and is planning to reduce the number of rabbits. Earlier efforts focused on culling deer populations.

POLITICAL AND ECONOMIC STRUCTURE

New Zealand is a constitutional monarchy with a parliamentary form of government based on the English Westminster system. Queen Elizabeth II has the title of Queen of New Zealand. Under her is the Governor General, followed by the Prime Minister.

There are two political parties in New Zealand, the democratic Labour Party and the more conservative National Party. The parliament is made up of 97 seats, one for every electorate, including four Maori seats. General elections are held every three years. The most recent election was in October of 1990, when Jim Bolger of the National Party ousted Geoffrey Palmer of the Labour Party from the office of Prime Minister.

Perhaps the most important political issue, as seen by voters today, is the state of the economy. During the 1960s, the economy was booming, unemployment was unheard-of, and oil was plentiful and cheap. These were prosperous times for the country, with the farming sector providing the bulk of the nation's exports. Then in 1973-74, the first oil price shock hit New Zealand, forcing a dramatic rise in the rate of inflation, a steady rise in unemployment, and the end to an era of prosperity. The economy had to readjust to the realities of the international marketplace, to become efficient and adopt a marketing approach, which was not easy for an agricultural country accustomed to selling all it could produce.

The economy of post-oil-shock New Zealand has changed considerably, but agriculture continues to play a key role. New Zealand has one of the world's most efficient farming industries. Agricultural products still earn the bulk of New Zealand's export income, but their percentage contribution has declined in recent years. Emphasis has been placed on broadening the range of export commodities to reduce economic reliance on primary products and increase the development of the tourist and manufacturing industries.

One of the big changes brought about by the oil price shocks of the 1970s was the new approach to energy planning and policy. The new policy called for decreased reliance on oil imports, since spending on oil imports jumped from 5 percent to 21 percent of export earnings in the aftermath of the oil price shocks.[2] In 1978, the government established the Liquid Fuels Trust Board (LFTB) to research and implement methods of decreasing oil import reliance. During its nine years of existence, the LFTB introduced liquefied petroleum gas (LPG) and compressed natural gas (CNG) as alternative automotive fuels. Upon the LFTB's recommendation, a synthetic fuel plant was built in 1985 to produce gasoline from natural gas. The original goal of the LFTB was to attain 100 percent self-sufficiency in liquid fuels by the year 2000; however, when oil prices began to fall in 1985, instead of increasing as original forecasts had predicted, the focus was shifted to cost-efficiency. By the time the LFTB was decommissioned in 1987, it had outlined all the natural resources, investigated their potential for energy use, implemented feasible alternatives, and made recommendations for future development options based on cost-efficiency.

The other significant change that has affected energy policy was the process of deregulation, which has been proceeding rapidly since 1984. New Zealand's economy, up to that time, had been highly regulated through means such as import licensing, subsidies and tax incentives for export industries, and controls on the financial services industry.

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[2] Liquid Fuels Trust Board. *LFTB Final Report of Activities, October 1978 to December 1987.* 1990.

These policies were maintained in order to protect New Zealand manufacturers; however increased international competition made deregulation necessary. Deregulation has mainly affected the telecommunications, transportation and petroleum industries. Reducing government regulation of industry has meant selling some of the state-owned companies which, in turn, produced revenue for the ailing economy. Most importantly, deregulation has encouraged exporting industries to become more competitive, which is essential if New Zealand is going to pull itself out of the current economic recession.

As a small country, New Zealand is heavily reliant on trade, exporting its goods to gain income and importing everything it cannot produce economically. New Zealand's largest trading partners are Australia, Japan, the United States and the European Community (EC). While the EC is New Zealand's largest export market, Asian markets have gained in importance in recent years, attaining 29 percent of the export market in 1989.[3]

New Zealand holds trade agreements with several countries. The Trans-Tasman trade agreement between Australia and New Zealand is governed by the Australia-New Zealand Closer Economic Relations Trade Agreement (ANZCERTA) that was signed in March of 1983. The purpose of the agreement is to remove all trade barriers between the two countries by 1995, thus providing mutual economic benefits of enhanced trade. The South Pacific Regional Trade and Economic Cooperation Agreement (SPARTECA) provides unrestricted duty-free access to New Zealand and Australia on a nonreciprocal basis for exports from Fiji, Nauru, Papua New Guinea and Western Samoa. Close relations are also maintained with the Association of South-East Asian Nations (ASEAN), which works to initiate projects for development and trade cooperation, although it is not an official trade agreement.

New Zealand's principal import and export commodities are shown in Tables 1.1, 1.2 and Figures 1.3 and 1.4. One of the problems facing New Zealand is that raw materials make up 70 percent of its exports, many of which are then reimported in the

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[3] Department of Statistics. *New Zealand Official Yearbook.* Wellington: New Zealand Government Press, 1990.

Table 1.1
New Zealand Import Commodities, 1988-89*
('000 NZ$)

	Import Value v.f.d
1. Agricultural Products (Includes fruits, vegetables and animal products)	831,978
2. Manufactured Goods	8,080,740
3. Chemical Products	1,457,730
4. Fuels, lubricants, and related materials	596,302
5. Other Raw Materials	430,340
6. Unclassified	4,600
Total Merchandise Imports	**11,401,690**
Plus Transport	1,089,740
TOTAL COST	**12,491,430**

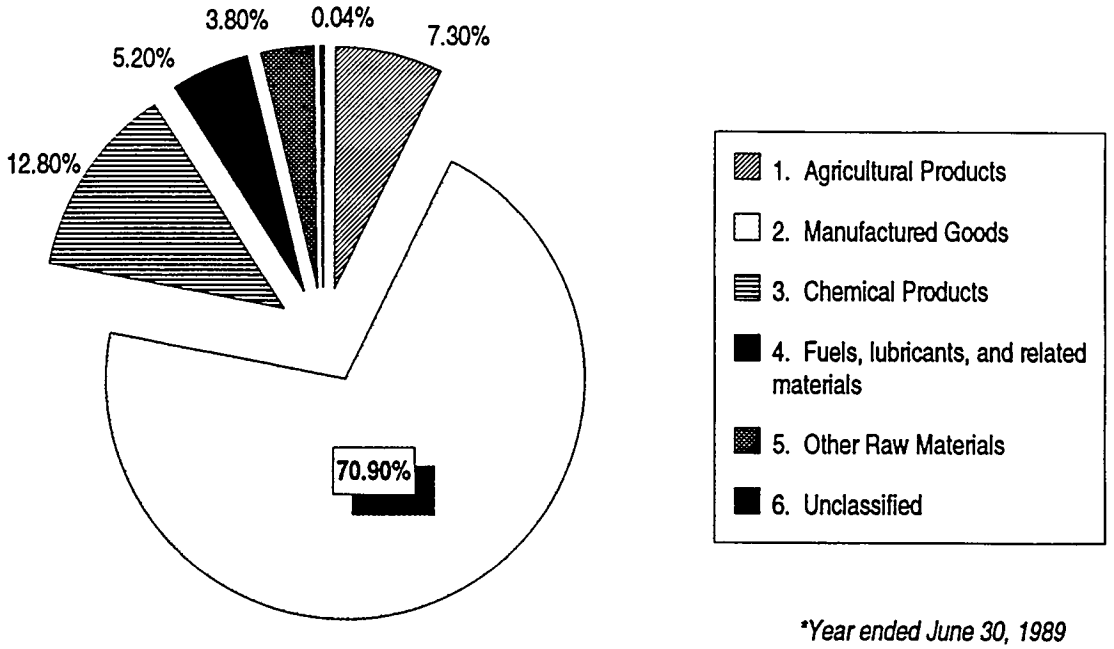
**Year ended June 30, 1989*
Note: v.f.d. stands for value for duty which does not include insurance and freight.

Table 1.2
New Zealand Export Commodities, 1988-89*
('000 NZ$)

	Export Value f.o.b
1. Agricultural Products	6,625,106
2. Manufactured Goods	3,283,906
3. Chemical Products	701,409
4. Fuels, lubricants, and related materials	184,598
5. Other Raw Materials	3,460,323
6. Unclassified	650,037
Total Merchandise Exports	**14,905,379**

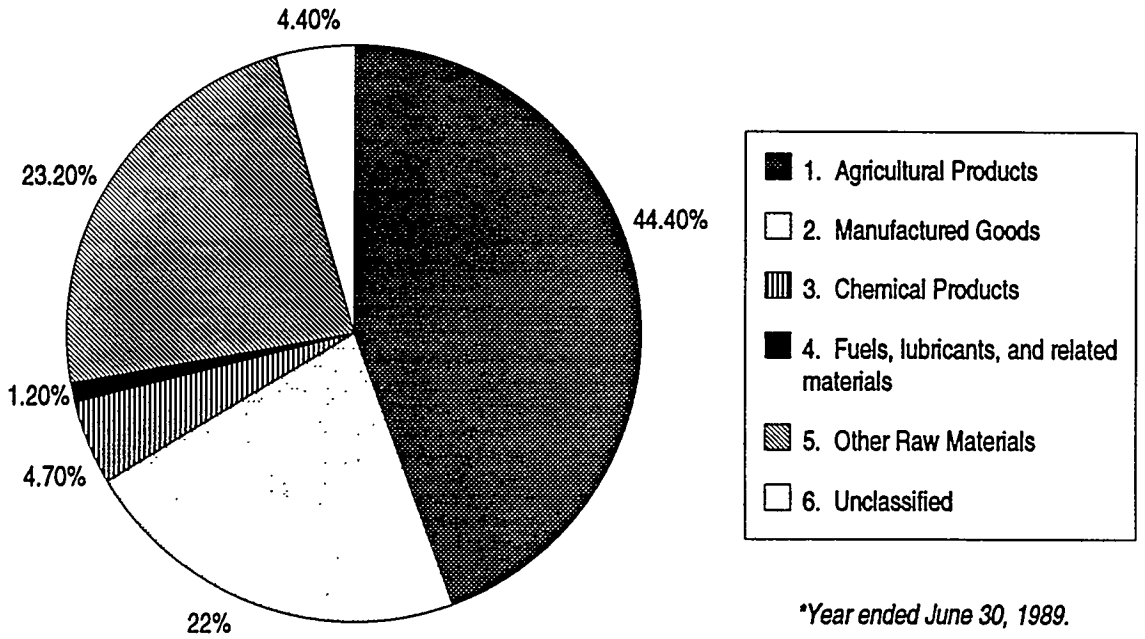
**Year ended June 30, 1989.*
Source: 1991 New Zealand Official Yearbook

Figure 1.3: Import Commodities by Percentage, 1988-89*



Year ended June 30, 1989

Figure 1.4: Export Commodities by Percentage, 1988-89*



Year ended June 30, 1989.

Table 1.3
Balance of Payments Summary
('000 NZ$)

	1985-86		1987-88		1988-89	
	credit	debit	credit	debit	credit	debit
Exports/Imports	11,598	11,369	12,441	12,061	14,063	11,673
Adjustments	-107	855	205	-908	-213	-939
Exports/Imports *(f.o.b. exporting country)*	11,491	10,514	12,646	11,153	13,850	10,734
Balance on Merchandise Trade	**977**		**1,493**		**3,116**	
Transportation	1,581	1,684	1,470	1,708	1,569	1,626
Travel	1,312	1,260	1,612	1,601	1,546	2,148
Insurance	-18	55	-4	24	10	115
Other Misc. Services	625	1,162	617	1,218	700	1,427
Government transactions	51	295	53	224	261	187
Balance on Services	**-905**		**-1,027**		**-1,417**	
International Investment Income	817	3,640	1,249	4,192	1,045	4,113
Transfers	843	608	863	559	895	533
Balance on Invisibles	**-3,493**		**-3,666**		**-4,123**	
Balance on Current Account	**-2,516**		**-2,173**		**-1,007**	

Source: 1991 New Zealand Official Yearbook

form of manufactured goods or finished products; an example is the export of wool to the UK and the reimport of yarn. Such a process forces the country to import the more costly manufactured goods and forego the income of the value-added goods it could be producing from the raw materials.

The balance of trade has shown a surplus for the three recent fiscal years of data (1986, 1988, and 1989) as a result of increased merchandise exports. However, even with trade surpluses, a deficit has prevailed, due to the invisible trade which includes import

and export services such as transportation, travel, and insurance costs (see Table 1.3). Reducing reliance on exports of raw materials and bolstering the manufacturing sector should have a positive effect on New Zealand's balance of trade.

INTERNATIONAL RELATIONS

New Zealand has been a member of the United Nations (UN) since its formation in 1945. The UN's purpose is to support peace, security, and encourage international co-operation. Over the years, New Zealand has concentrated its foreign policy efforts in areas such as nuclear arms control, peacekeeping operations, and humanitarian relief work such as resettling Indo-Chinese refugees and making contributions to the Red Cross. New Zealand has also worked in cooperation with UN special agencies and the World Bank to facilitate economic development in less-developed countries.[4]

In 1973, New Zealand joined the Organization for Economic Cooperation and Development (OECD). The OECD works to foster intergovernmental cooperation among the 24 member countries on matters relating to economic and social policy. One of the benefits of membership is the exchange of information. The OECD collects a variety of information and produces many reports, forecasts and reviews. New Zealand is also a member of the International Energy Agency (IEA) within the OECD. There are 19 countries in the IEA, the purpose of which is to promote cooperation between energy producing and consuming countries.

New Zealand is involved in three defense agreements with foreign powers: the Five-Power Defence Arrangement, the Manila Treaty, and ANZUS. In 1952, the ANZUS treaty was put in force between Australia, New Zealand and the United States. This trilateral defense agreement promises support from the other treaty countries if one or more is attacked. A bitter dispute arose between the United States and New Zealand in 1984 when the government set forth anti-nuclear policies barring all transit of nuclear weapons through New Zealand territory and waters. While the policy applies to all

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[4] Department of Statistics. *New Zealand Official Yearbook.* Wellington: New Zealand Government Press, 1989.

countries, the consequences primarily affected the United States. In response, the United States suspended cooperation under ANZUS.

The Five-Power Defence Arrangement includes the UK, Malaysia, Singapore, Australia, and New Zealand. No official arrangement pledging mutual support exists as under the ANZUS treaty, only the agreement that if any member is attacked, the governments would "immediately consult together for the purpose of deciding what measures should be taken jointly or separately in relation to such an attack or threat."[5] The Manila Treaty was signed in 1954 between Australia, the United Kingdom, France, New Zealand, Pakistan, the Philippines, Thailand and the United States.

New Zealand has a Royal Army, Navy, and Air Force, with over 12,000 people employed in the military. Military spending accounts for two percent of annual GDP, but even this relatively small amount is a topic of controversy within New Zealand. In late 1990, New Zealand purchased four frigates from Australia, a decision that was met with high levels of public displeasure. Recognizing that New Zealand is not a major world military power, the public viewed the purchase of the frigates as a politically motivated waste of money. Given the ailing state of the economy, many New Zealanders feel that military expenditures should be kept to a minimum. On the other side of the equation, however, New Zealand's allies have from time to time placed considerable pressure on the government to contribute to regional military forces.

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[5] Department of Statistics. *New Zealand Official Yearbook.* Wellington: New Zealand Government Press, 1990.

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INDIGENOUS ENERGY RESOURCES

BACKGROUND

New Zealand is endowed with a variety of natural resources, including the major nonrenewable fossil fuels—oil, natural gas and coal—as well as geophysical resources to generate hydroelectric power and geothermal energy. The locations where New Zealand's major energy resources are produced are indicated in Figure 2.1. Current oil and gas production centers on the Taranaki region along the western coast of the North Island. The Petralgas methanol plant and the Motonui Synfuels plant are also located in the Taranaki region. Coal deposits are widely scattered, with the bulk of current mining activity taking place in the Waikato and Taranaki regions on the North Island and the West Coast and Southland regions on the South Island. Hydropower resources abound on the South Island, where mountainous topography and frequent rainfall result in swift-flowing rivers. The North Island also has considerable hydropower resources. Geothermal resources are significant, although commercial development is limited to the Wairaki and Ohaaki facilities on the North Island. Moderate potential exists for the development of other renewable forms of energy, such as wind energy, biomass, tidal power, and solar energy, but none of these resources are commercially significant at the present time.

While energy security remains a government priority, the trend is toward reduced direct government involvement in the energy markets and less support for energy research and development. The viability of alternative and renewable forms of energy will be determined more via the marketplace and less by government sponsorship.

Historically, wood was the primary fuel for heating and cooking, with oil lamps and candles providing light. As such, most early colonial settlements were located near forests. By the latter half of the 1800s, coal ranges became commonplace, and coal mining became an important industry. Coal also became the main fuel for lighting. In

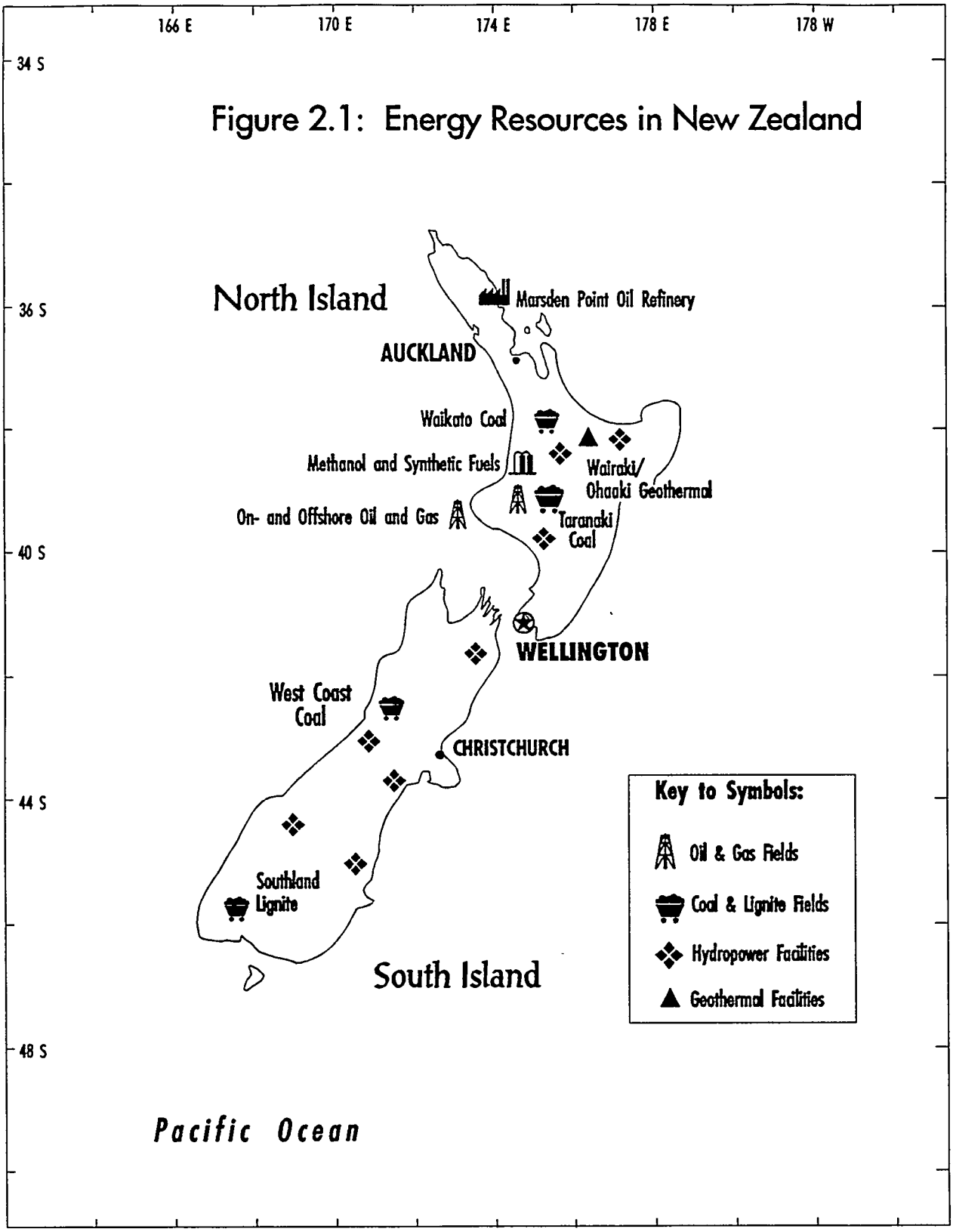

Figure 2.1: Energy Resources in New Zealand

1862, Auckland became the site of New Zealand's first coal gasworks, and by the end of the decade all major population centers had coal gasworks of their own. By 1916, coal gasworks were operating in 56 major centers, and the majority of urban households had access to coal gas for lighting and, to a lesser extent, for cooking.[1]

Electricity was first supplied to the public in 1888 in Reefton, on the South Island. By the following year, public electricity was also established in Wellington. In subsequent years, numerous urban areas were added to the power grid by private companies, but electricity was not widely available and affordable until the 1920s, when the government completed several large-scale hydropower projects. The government's role in the provision of electric power began to expand rapidly.

Oil exploration began in 1865; however, initial domestic finds were disappointing. Imported oil rapidly became an important primary source of energy during the early 20th century. By 1934, oil accounted for nearly one-fourth of primary energy use, and by 1964, oil's share had increased to over 50 percent of primary energy. Natural gas, in contrast, did not make a significant contribution to the primary energy mix until the 1970s.

OIL AND CONDENSATE RESOURCES

Overview

By 1964, oil had surpassed coal and wood to become New Zealand's primary fuel source. New Zealand has always been a net importer of oil. When New Zealand's refinery at Marsden Point was commissioned in 1964, all feedstocks were imported. By the early 1970s, however, small quantities of locally produced crude oil began to be included in the refinery feedstock slate. Domestic production grew significantly during the 1970s, given impetus by the oil price shocks of 1973-74 and 1979-80. In 1990, domestic crudes and condensates accounted for 28 percent of the refinery's intake.

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[1] The chief source of information for this section was the Department of Statistics. *New Zealand Official Yearbook.* 94th ed. Wellington: New Zealand Government Press, 1990.

Exploration efforts during the past two decades have been fairly aggressive; by 1990, production had increased ten-fold from its early 1970s level, when production amounted to under 4 thousand barrels per day (mb/d). In 1990, New Zealand was 50 percent self-sufficient in liquid fuels. It is considered possible, although unlikely, for New Zealand to be completely self-sufficient in liquid fuels in the future, but this would require a rapid expansion of production capability and the development of many fields which are now only marginally economic at best, such as those in the Great South Basin. Additionally, the extent of the proved and estimated oil reserves is limited; even if New Zealand were to achieve liquid fuel self-sufficiency, it would be short-lived.

Major Oil Fields and Reserves

Table 2.1 lists New Zealand's oil and gas fields, dates of discovery, operators, and estimated reserves. The Maui field is by far New Zealand's largest oil (condensate) and gas field. The next-largest oil fields are the much smaller Kupe, Kapuni and McKee fields, with other minor fields as outlined.

Oil reserves in New Zealand are relatively modest, amounting to around 160 million barrels (mmbbl) of crude and condensate, plus around 3.6 trillion cubic feet (tcf) of natural gas. Originally, it was thought that oil reserves would be exhausted well before 1999, so that any long-term indigenous energy production would have to come from other sources. However, the discoveries made in the 1980s, particularly the Kaimiro, Tariki, Ahuroa, Waihapa, Ngaere and Kupe fields, have pushed back the production horizon. Explorers are also optimistic about the Ngatoro 2 field, which is located southeast of the Kaimiro field. Since this field is close to the Omata tank farm at New Plymouth, transport costs are expected to be low.

New Zealand is not a major oil producer by international standards, but the production outlook is fairly good in relation to the size of the domestic market. It has even been suggested that New Zealand could briefly become a net oil exporter, albeit on a small scale and for a very limited time. Of course, this could be realized only under a regime of high world oil prices and aggressive domestic exploration and development. Offshore discoveries, in particular, would need to be quite large before development is

Table 2.1
Oil and Gas Fields and Reserves

Field	Year of Discovery	Operator	API Gravity	Oil/Condensate *(mmbbls)*	Natural Gas *(bcf)*
Kapuni	1959	Shell-BP-Todd	53.9	5.9	409.0
Maui	1969	Shell-BP-Todd	58.9	69.0	2,491.0
McKee	1982	Petrocorp NZ	38.5	23.2	85.0
Kaimiro	1982	Petrocorp NZ	42.0	1.2	38.7
Tariki	1986	Petrocorp NZ	52.7	1.7	59.9
Ahuroa	1986	Petrocorp NZ	46.1	0.6	28.0
Waihapa	1988	Petrocorp NZ	36.6	12.0	14.0
Stratford	1982	Petrocorp NZ	na	0.6	22.7
Kupe	1986	TCPL Resources	na	35.0	215.0
Toru	1990	TCPL Resources	na	7.5	71.0
Moki	1983	Petrocorp NZ	na	2.0	0.0
Manaia	1970	Petrocorp NZ	na	1.0	0.0
Ohai	1984	RC Macdonald	na	0.0	14.6
Ohanga	1990	NZ Petroleum	na	na	na
Ngatoro-2	1991	NZ Oil and Gas	35	na	na
Total				159.6	3,448.9*

*Total New Zealand natural gas reserves are around 3.6 trillion cubic feet.

na=not available

Source: Ministry of Commerce, "Petroleum Industry Statistical Summary" and industry sources.

economical. And, from a long-term energy security standpoint, it is not clear that this course would be in the best interests of New Zealand or its domestic oil industry.

Oil Pipelines and Transportation

About 40 percent of the total oil supply is distributed through the refinery-owned pipeline linking Marsden Point with Wiri in South Auckland. The balance is distributed to ports around the country by coastal tankers chartered by the four large refiner/-wholesalers, Shell, Mobil, Caltex, and British Petroleum (BP). Imported crude oil and semi-refined feedstocks from the Middle East and, to a lesser extent, the Asia-Pacific region, are shipped to the refinery at Marsden Point in large oil tankers, usually of around 100,000-150,000 tons capacity. Domestic crudes, condensates, and synthetic

gasoline are typically sent via truck or pipeline to New Plymouth, from where they are shipped to the refinery or exported.

Exploration Prospects

New Zealand's major sedimentary basins are outlined in Figure 5.3, in Chapter Five of this report. Many of these basins were surveyed decades ago and were immediately recognized as having the potential to contain reserves of oil and gas, but early exploration efforts met with little success. Following the Kapuni find in 1959, the government issued exploration licenses for tracts in a number of areas, including the Taranaki Basin, the Great South Basin, Hawkes Bay, Tasman Bay, Canterbury, Solander Basin, and around Bounty and Chatham Islands. Prospects for making commercially viable onshore discoveries of crude oil appeared slim until the 1980s, when a number of important discoveries were made. In general, the crude reserves are limited; the chances of finding condensates associated with gas in a natural gas field are much better than the likelihood of finding a large oil field with a low gas-to-oil ratio.

Potential petroleum-bearing structures are known or suspected in many areas of both the North and South Islands. The Taranaki area is the site of the greatest exploration success; however, most of its structures are complicated and deep and, therefore, relatively expensive to drill. Over the past decade, the development of several fields in the Taranaki area has led to the establishment of an oil and gas handling infrastructure, so that newer fields may face lower initial development costs.

A considerable amount of interest has also focused on the offshore Taranaki area. All of the commercially viable discoveries made over the past three decades (Kapuni, Maui, McKee, Kupe, Waihapa, and Kaimiro) have been in the Taranaki region. The area has proved to be gas prone; thus, further discoveries of gas/condensate are likely.

Besides the Taranaki region, the other likely prospect for a major discovery is the Great South Basin. Numerous large structures of the necessary geologic age and stratigraphic content that have been revealed by seismic prospecting in the Great South Basin may be large enough to hold oil in commercial quantities. Drilling results until 1978 were encouraging, but inconclusive. Even if major quantities of oil were found in

this area, there would be many obstacles to development. The basin lies in the Roaring Forties, subject to some of the roughest wind and sea conditions in the world. The water depth over the basin exceeds 500 meters, and most of the prospective structures are more than 150 km from land.[2] These conditions cast considerable doubt on the discovery of an economically viable oil source in the Great South Basin.

Crude Quality

New Zealand's crude/condensate resources are of exceptionally high quality, as they are very light and extremely low in sulfur. The API gravities of the major crudes and condensates are presented in Table 2.1. Even the heaviest crude now produced, Waihapa at 36.6° API, is a light crude by world standards. Sample assays for crude/condensate from the two largest producing fields, McKee and Maui, are provided in Table 2.2, which also presents crude distillation yields for four other crudes. Sulfur content of the crudes ranges from 0.08 percent in Maui condensate to an extremely sour 5.5 percent sulfur content in Venezuela's Boscan crude. Saudi Arabia's Arab Light, which is a major constituent of New Zealand's refinery input slate, has a sulfur content of around 1.8 percent. Alaska North Slope crude, the main refinery feed in the US West Coast region, has a sulfur content of 1.6 percent.

New Zealand's crudes compare very favorably in terms of quality with the Asia-Pacific region's crudes. Primary distillation yields are also favorable for the production of transportation fuels, as Figure 2.2 indicates. Primary distillation of Maui condensate yields around 74 percent straight-run naphtha and gasoline, 11 percent each kerosene and diesel, and just 2 percent residual fuel oil. Primary yields from McKee crude comprise around 25 percent naphtha/gasoline, 7 percent kerosene, 32 percent diesel, and 33 percent fuel oil. In comparison, the heaviest crude depicted, Venezuelan Boscan, has a naphtha/gasoline yield of less than 3 percent, kerosene and diesel yields of 5 percent and 9 percent, respectively, and a very high fuel oil yield, amounting to 83 percent of the barrel.

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[2]Ministry of Energy. *Goals and Guidelines.* Also see Figure 3.2.

Table 2.2

Comparison of Crude Distillation Yields from Various Crudes

(Percent yields)

Country	Crude	Sulfur Content (%)	Naphtha/ Gasoline	Jet/ Kerosene	Diesel	Residual Fuel Oil
Venezuela	Boscan	5.50	2.7	5.2	9.1	82.9
USA	Alaska North Slope	1.06	15.6	17.1	11.9	54.4
Saudi Arabia	Arab Light	1.79	21.0	20.4	10.3	45.9
Indonesia	Attaka	0.09	36.1	40.6	11.9	10.9
New Zealand	McKee Crude	0.15	25.2	7.2	32.2	32.9
	Maui Condensate	0.08	73.9	10.7	11.5	1.9

Note: Totals do not include fuelgas yields, and therefore may not sum to 100.

Sources: New Zealand data from Petrocorp NZ (personal communication)

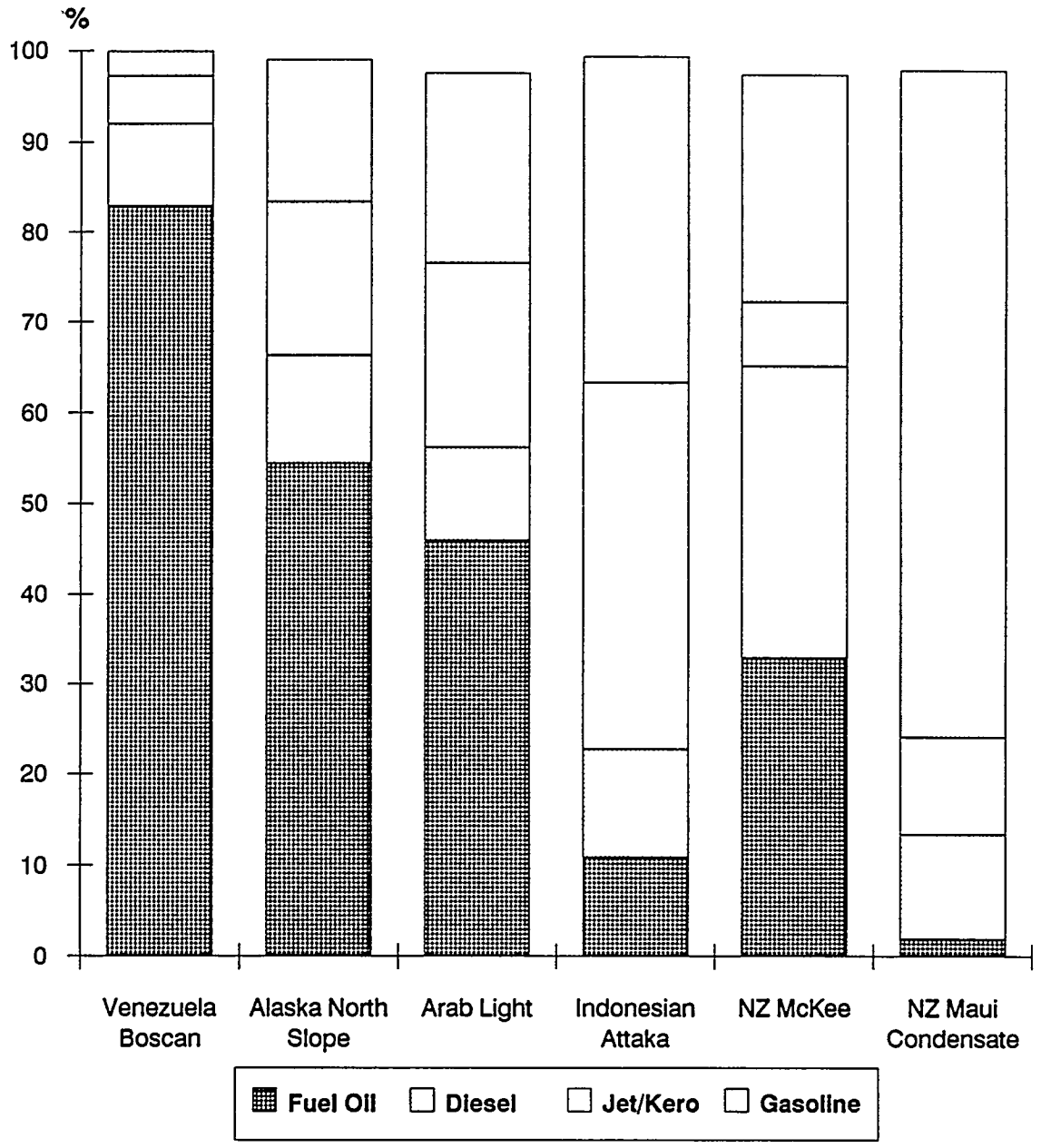
Other crudes from Oil and Gas Journal, "Guide to Export Crudes for the 80s," (various issues.)

NATURAL GAS RESOURCES

Background and Reserves

Natural gas is a highly valued energy resource, but it is difficult to transport and its use, therefore, is confined largely to the North Island. As with oil, any offshore discoveries have to be large to justify development. There are four gas fields currently in production; the largest is Maui, where reserves are estimated at 2,491 bcf, followed by Kapuni, McKee, and Kaimiro (409 bcf, 85 bcf, and 38.7 bcf, respectively). Other fields and their estimated reserves are listed in Table 2.1. Together, Maui and Kapuni supply most of New Zealand's gas, and constitute over three-fifths of gas reserves.

Figure 2.2: Comparison of Primary Distillation Yields



In 1959, the first significant natural gas find was made at Kapuni, near Hawera. The geology of the Kapuni field is complex, so that determining the extent of the reserves was a process of gaining successively better estimates. The estimation process was improved as further information became available, especially from experience in production and drilling. In 1977, a redetermination was carried out, and remaining reserves were estimated to be 96 million barrels of oil equivalent (mmboe), nearly three times the original estimate on which the sale of Kapuni gas was negotiated. The Maui field, discovered in 1969, is around six times larger than Kapuni, and also has a much simpler geologic structure. The Maui field is New Zealand's largest single energy resource, accounting not only for the bulk of natural gas production, but also for around 40 percent of total crude and condensate production.

Despite the recent gas finds, New Zealand's proved gas reserves are on a general downward trend, as shown in Figure 2.3, which tracks the course of gas reserves from 1970 and 1973 through the 1980s. In 1970, gas reserves were estimated at around 6.5 trillion cubic feet (tcf); in 1990, reserves were estimated at just above 4 tcf.[3]

Liquefied petroleum gas (LPG) is produced at the Kapuni treatment station and at the Maui production station at Oaonui. The Kapuni treatment station is fully utilized in treating gas from the Kapuni and Maui fields. Maui gas is the primary feedstock for the manufacture of ammonia/urea at the nearby petrochemical facility, and is also used at the Motonui Synfuels plant. Untreated carbon dioxide-rich Kapuni gas is used for methanol production. Consumers on the gas grid are supplied with either treated gas, untreated Maui gas, or a mixture of the two. The electric power industry uses mainly untreated Maui gas, with some Kapuni gas and, since 1990, some Waihapa gas which is used at the Stratford power station. Kapuni gas must be treated for the removal of carbon dioxide before use in the residential sector.

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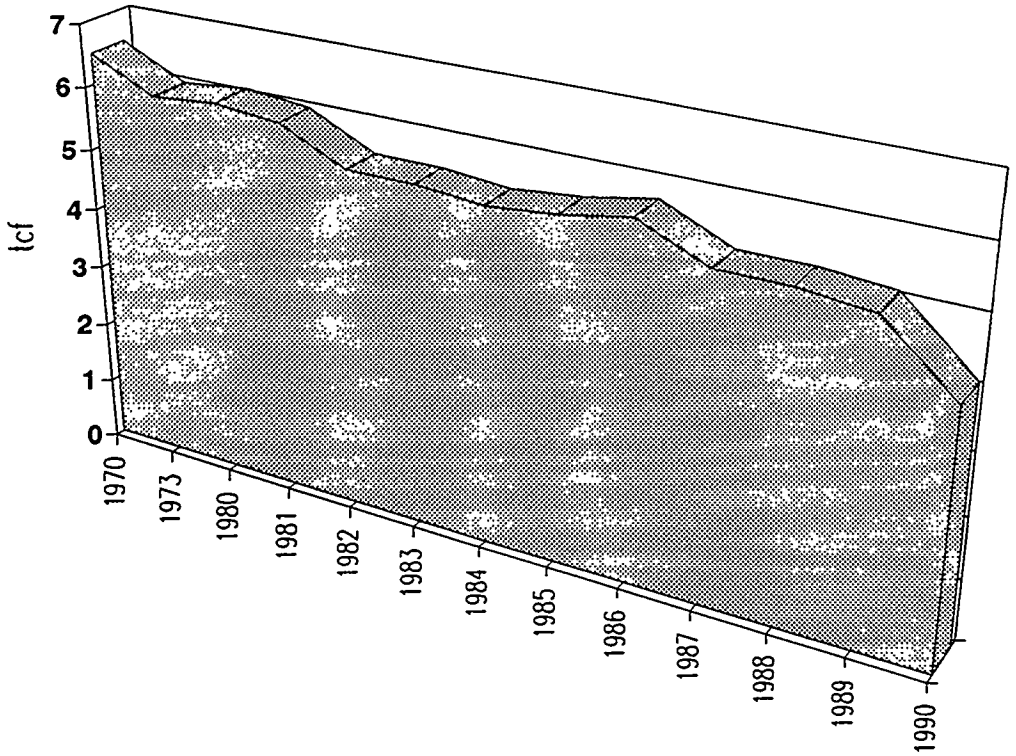
[3]"Annual Statistical Review." *Oil and Energy Trends*, May 1991.

Figure 2.3: Natural Gas Reserves, 1970-1990



Gas Composition

The compositions of the Maui C and D fields and the Kapuni field are provided in Table 2.3. In general, around 70-80 percent of the gas is methane, with 4 to 6 percent made up of propane, butanes, pentanes and heavier hydrocarbons.

Natural Gas Transport Network

The North Island is served by a network of pipelines which extends from Taranaki to Wellington in the south, to Whangarei in the north, and to Hastings and Gisborne on the east coast. There is also a pipeline to Taupo in the central North Island area.

Table 2.3
Composition of Key Gas/Condensate Fields in New Zealand

Component	Maui C (%)	Maui D (%)	Kapuni (%)
Carbon dioxide	4.96	13.32	6.4
Nitrogen	2.75	2.82	0.5
Methane	81.53	70.49	79.9
Ethane	6.21	7.14	7.8
Propane	2.48	3.21	3.4
I-butane	0.51	0.62	0.6
N-butane	0.66	0.89	0.7
I-pentane	0.23	0.3	0.2
N-pentane	0.18	0.26	0.1
Hexanes	0.14	0.23	0.4
Heptane +	0.35	0.72	-
Total	100	100	100
Gas SG	0.71	0.82	-
Cond API	45.6	45.5	46.6

Source: Petrocorp

Nearly all of the pipeline network is owned by the Natural Gas Corporation (NGC), a subsidiary of Petrocorp (New Zealand's domestic oil company), with the exception of the Maui Development, Ltd., pipeline from Oaonui to Huntly. There are other short pipelines owned by various companies, but these tend to be operated by NGC.

Exploration Prospects

Prospective gas-bearing structures occur in many parts of New Zealand. As with oil, the best onshore prospects are in Taranaki; however, the high cost of providing gas supplies to the South Island also encourages a limited exploration effort there, as well as along the east coast of the North Island.

Offshore, the best prospects seem to be near Taranaki. Most other areas have proved disappointing, although small discoveries are expected in some areas. The Great South Basin has been proved to contain natural gas, but the development of even a giant gas field would be very difficult and costly, if not prohibitive. Reviews by the NZ Geological Survey indicate that additional gas resources are more likely to be in smaller fields than the Maui field.[4]

COAL RESOURCES

History and Reserves

Until the 1950s, coal was New Zealand's major source of energy. By the 1880s, most coal fields had been discovered and mine development was well under way. Coal was the chief fuel for industry, transportation and households, and it was also a feedstock for the manufactured gas industry. Following a peak in 1960, when about 4 million tons were produced, coal production dropped to under 2 million tons in 1979, recovering to around 2.6 million tons in 1990.

Coal is mined by the Coal Corporation of New Zealand (Coalcorp), a state-owned enterprise awaiting privatization, and by smaller privately owned mining companies. Coalcorp is the major producer, with 15 mines producing around two-thirds of New Zealand's coal. The remainder is produced by 53 smaller private mines.

Coal is New Zealand's most extensive fossil fuel resource. The bulk of the resource is found in the south of the South Island. Recoverable reserves of all types of coal in New Zealand have been estimated at over 8,500 million tons, or about 18,900 mmboe. Recoverable coal reserves by region are given in Table 2.4.[5]

Coal fields and Coal Quality

New Zealand's coals are young by geological standards. The quality of coal varies depending on its environment and composition, but around 85 percent is lignite, the poorest quality coal in terms of heat content. On a thermal basis, the estimated lignite

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[4] Ministry of Energy. *Goals and Guidelines.*

[5] Figure 8.2 of this report also details major coal resources.

Table 2.4
Recoverable Coal by Region

Region	Quantity (mt)	Coal type
North Waikato	563	subbituminous
South Waikato	121	subbituminous
Taranaki	178	subbituminous
Nelson/West Coast	365	subbituminous, bituminous
Canterbury	1	subbituminous
Otago	1,239	subbituminous, lignite
Southland	6,079	subbituminous, lignite

Source: Energy 88, Ministry of Energy.

reserves are equivalent to about 20 Maui gas fields. Subbituminous coal accounts for 11 percent and bituminous coal for 4 percent of the reserves. Coalcorp's proved reserves to date amount to 130 million tons of bituminous and subbituminous coal. New Zealand coal is low in sulfur, and its low ash content makes it valuable as coking coal; virtually all of the coal exported from New Zealand is coking coal.

Transport Network and Export Terminals

Coal is mainly transported by the railways in New Zealand. There are no coal slurry pipelines to date. In the North Island, Huntly is the main coal-marshalling yard, and in the South Island, Wairio is the distribution center from Ohai. The mines at Reefton, Westport, and Greymouth dispatch the coal from their own fields. A regular shipping service carries coal from the West Coast to the North Island, and for shorter journeys, large specialized trucks are used. Road quality generally does not limit freight transport by truck. The state highways are well-maintained by the National Roads Board, and are almost always in good condition. Coal is freighted by rail between the West Coast on the South Island and the city of Christchurch on the east coast, where it is

used for industrial and domestic purposes. It is also exported to overseas markets (principally Japan) from Lyttelton Harbor, Christchurch, where coal export facilities have been expanded and upgraded. Prior to the port's expansion and upgrade, coal was moved by rail from the West Coast in standard 15 ton wagons, unloaded and carried by earthmoving machinery to a stockpile on the extremity of the port area. The coal was then loaded on 55,000 deadweight ton[6] (dwt) bulk carriers by a conveyor and conventional shiploader.

Exploration/Exploitation Outlook

In contrast to the estimated coal reserves of which lignite is by far the largest share, in current production lignite only accounts for 10 percent, while 70 percent of the coal produced is subbituminous and 20 percent is bituminous. There is more than enough coal to satisfy New Zealand's requirements in the short and medium terms. Upon analysis of the market sectors, it appears that the continued exploitation of coal is assured. The domestic industry has also been stimulated by a number of recently signed coal export contracts. Coal exports in 1990 totalled 394 thousand tons.

Summary

Given the size of New Zealand's coal reserves and the relatively low rate of extraction, coal as an energy resource can be expected to easily outlast all other current fossil fuel sources. Huge reserves remain untapped, but the increased use of coal is limited by its physical characteristics and environmental costs. Exports of coal appear certain to continue well into the future. It is possible, though unlikely at present, that the domestic market could also expand if private enterprises move forward with the construction of a new thermal power plant. The domestic power industry forecasts continued growth in electricity demand and considers coal and fuel oil to be likely fuel sources; the govern-

[6] A ship's deadweight tonnage refers to the ship's weight plus cargo and stores. For a large ship such as a bulk carrier or a tanker, most of the deadweight tonnage is cargo weight.

ment and a variety of environmental organizations feel that progress in conservation and efficiency should obviate the need for construction of a new thermal power plant.

HYDROPOWER RESOURCES

Installed Capacity

New Zealand's geography generally provides short river runs from the mountains to the coast, steep terrain, and relatively high rainfall, hence there exists substantial hydropower potential. The Electricity Corporation of New Zealand (Electricorp) had an installed hydropower generation capacity of 4,329 megawatts (MW) as of March 31, 1991, representing over 65 percent of the country's total installed capacity. In the year from March 1990 to March 1991, the electricity generated from hydro resources was 21,872 gigawatt-hours (GWh), representing 74 percent of total electricity generated. Around 69 percent of New Zealand's hydroelectricity is generated on the South Island.

Estimates of Potential

Surveys of potential hydropower capacity indicate that another 50,000 GWh per year (equal to 180 petajoules) could be available. This is equivalent to over 29 mmboe, or 84 mmboe assuming a plant efficiency of 35 percent. However, it is unlikely that this additional potential will be fully realized due to lack of demand and competing (recreational, agricultural, and horticultural) uses of the water resource. New Zealand's hydro resources are already extensively developed, and few new facilities are required.

New Zealand's total water resources are estimated to flow at a rate of 300,000 million cubic meters per year, although the resource is not evenly distributed. The wettest areas may have rainfall of nearly 400 inches (over 10,000 mm) annually, while rainfall in dryer areas may total only around 10-15 inches per year. The mountainous topography of the South Island, for example, creates many rain shadow areas where annual precipitation is very low—similar to the rain shadow areas on the leeward sides of the Hawaiian Islands. Of the 300,000 million m^3 annual water resource flow, use of water for hydroelectricity exceeds 100,000 million m^3. While this water obviously is not "used up," it represents a substantial commitment of water resources to hydropower. For

the sake of comparison, traditional uses of water amount to around 2,000 million m^3: around 1,100 million m^3 are used for irrigation, 350 million m^3 for livestock, 260 million m^3 for industry, and 210 million m^3 for households.[7]

Location of Major Projects

A complete listing of hydropower stations and their capacities is provided in Chapter Seven of this report. Around 70 percent of hydropower capacity is on the South Island, scattered up and down the spine formed by the Southern Alps, while the remaining 30 percent is concentrated mainly around the mountainous central area of the North Island. The Manapouri hydropower complex on the South Island at 600 MW is the second-largest power station in the country, second only to Huntly, a thermal (coal and gas) power station on the North Island with an installed capacity of 980 MW. The third-largest plant is the New Plymouth thermal power station on the North Island, but the country's fourth- through ninth-largest power plants are all hydropower stations.

The only major hydropower project recently undertaken is the Clyde Dam on the South Island, with a maximum capacity of 432 MW. The dam was originally expected to be commissioned in 1989, but now is expected to be operational by 1992 or 1993. Further projects may be undertaken by other organizations interested in entering the electricity generation market, but in the near term this is unlikely. Demand may not materialize, and hydropower stations have high capital costs. Developing the hydropower resource was largely the domain of the government; the private sector appears to be more interested in building thermal power stations, even though thermal power stations have higher operating costs.

Hydropower Transmission

A high-voltage direct current (HVDC) link across the Cook Strait connects the power grids of the South and North Islands, so that excess power from South Island

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[7] Department of Statistics. *New Zealand Official Yearbook.* Wellington: New Zealand Government Press, 1990.

hydropower stations may be sent to major areas of demand on the North Island. This is a 500 kV DC link with a transmission capability of around 600 MW. The construction of the cable and process of laying it across stretches of rough water was an undertaking of major proportions. The possibility of a line expansion to 1,240 MW has been discussed, but is now shelved, perhaps permanently.

Economic Geography of Hydropower Development

As noted, there are estimates of another 84 mmboe per year of potential hydropower, which is well over double the existing capacity. There is no immediate shortage of capacity, however, so expansion plans are limited. Environmental objections to power projects of all sorts are increasing, and it is often difficult and expensive to reach compromises that satisfy all parties. There also appears to be considerable potential for conservation and efficiency gains in the existing power generation system which should reduce or postpone the need for additional capacity. Competing recreational uses for the hydro resources are becoming more important, and there are also continuing agricultural and horticultural uses of the water. Despite the fact that hydropower is an indigenous resource and is considered environmentally benign in terms of emissions, damming swift-flowing rivers can wreak havoc on the environment. Most environmental organizations would prefer to see at least some rivers left in their wild state. In 1981, an amendment to the Water and Soil Conservation Act of 1967 was made to mandate water conservation when needed to protect water resources with outstanding wildlife and scenic, scientific, recreational, or fisheries value.

Summary

Hydropower has been the backbone of New Zealand's electricity generation, and in all likelihood will continue to be so. The capital costs of hydropower stations are high in comparison with thermal power stations, but they have much lower operating costs. Apart from the Clyde Dam in the South Island, there are no government hydropower projects under planning or construction, and it is unlikely that private enterprise would consider building a hydropower station in New Zealand at present. The South Island

provides around 70 percent of the country's hydropower, and about three-quarters of the country's electricity requirements are met by hydropower stations.

GEOTHERMAL RESOURCES

The North Island of New Zealand, lying on the Pacific "Rim of Fire", has large resources of geothermal energy, with nearly 200 geothermal fields and hot springs. It is estimated that there is a potential resource of over 12,225 mmboe of heat stored above 80° C (176° F).[8] It is also possible to use hot water below these temperatures, which would further increase the geothermal resource. Recoverable resources are much smaller, however, since only a fraction of the heat from geothermal sources can be converted economically into useful forms of energy. Electricity generation requires high temperatures, typically above 200° C (392° F), as well as good permeabilities and other field characteristics. The efficiency of conversion to electricity is less than 15 percent. There are also strongly competing uses for the resources, particularly tourism and home heating.

New Zealand's North Island has two geothermal generating stations: one located at Wairakei (about 12 miles northeast of Lake Taupo), with a capacity of 153 MW, and the new Ohaaki station located at Broadlands, with a capacity of 106 MW. The Wairakei power station was commissioned in 1958 and has nine generating units, with a very high load factor. In the year that ended March 31, 1991, the load factor was almost 91 percent—the second-highest in the nation after the Arnold hydropower station—indicating almost continuous use. The thermal bores at Wairakei yield a mixture of steam and hot water. The steam is separated at the wellhead and transmitted through large pipes to the station where it is used to drive the turbines. Additional steam is obtained by "flashing" at lower temperatures the hot water from the primary separators in the field. The waste bore water then runs into the Waikato river.

The Ohaaki geothermal power station was connected with the New Zealand national grid in early 1989, and was formally accepted for commercial operation on 31

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[8] "New regime will result in a more mature industry." *Petromin* (August 1989): p. 56.

October 1989. It has a generating capacity of 106 MW, and like the much older Wairakei station, it is expected to provide base-load power and run almost continuously. Ohaaki's load factor for the year that ended March 1991 was 90 percent.

A number of other geothermal fields continue to be under assessment for possible future development, including Rotorua, Rotokawa, Mokai, Ngawha, and Ngatamariki, but none are being commercially developed at the present time.

OTHER INDIGENOUS ENERGY RESOURCES

Alternative energy sources, such as wind, ocean, solar and biological sources, are not as yet making significant contributions to New Zealand's energy consumption, but are generally considered to be in experimental stages. Small amounts of wind power are used in remote areas to pump water, but there are no significant developments under way in wind, solar, or ocean energy.

In the 1970s and 1980s, until its dissolution at the end of 1987, the Liquid Fuels Trust Board (LFTB) had the lead in research into alternatives to imported oil. Research on non-fossil fuel sources included transforming biomass into alcohol fuel (ethanol) and biogas, and the production of fuels from natural oils and fats, such as rapeseed oil and animal tallow. Tallow methyl esters (TME), in particular, were considered a promising resource, since the country exported large quantities of low-value animal tallow and imported diesel oil. The attractiveness of TME was enhanced by the fact that its cetane values (a measure of fuel quality analogous to the octane rating given to gasoline) were higher than those of typical diesels produced from crude oil. The LFTB recommended the use of TME in a 10 percent blend with conventional diesel, noting that no additional distribution network would be required and that "per capita, New Zealand probably has the highest ratio of sheep to diesel usage of any developed country."[9] The LFTB calculated that this strategy would be cost-competitive at world oil prices of US$27/barrel.

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[9] Liquid Fuels Trust Board. *Final Report of Activities, October 1978 to December 1987*: p. 62.

As noted in Chapter Four of this report, the government is in the process of deregulating New Zealand's energy markets and reducing its direct involvement in the energy industry. Current activity in energy research and development is also limited. Future market penetration rates for alternatives and renewables will be determined chiefly on economic bases, not by government directives or sponsorship.

Three

ENERGY IN THE ECONOMY

OVERVIEW

New Zealand is thought of in many quarters as a primarily agricultural country. Although farming and grazing may dominate much of the landscape and, indeed, much of the country's perception of itself, the structure of New Zealand's economy is in many ways similar to that of other OECD countries. Agricultural output accounts for a mere 10 percent of GDP in an average year, while industry accounts for about 30 percent and the service and government sectors provide about 60 percent of national production. Despite its small size, pastoral setting, and relatively remote location, New Zealand is fundamentally similar to other OECD "frontier" states: the United States, Canada, and Australia. As in these OECD countries, transport energy use per capita is high by world standards, as is the consumption of energy in residential uses such as home heating and electrical appliance use.

Table 3.1 shows a few key indicators for New Zealand's economy and energy structure in the period 1974-1990. Overall, the results seem quite mixed: real GDP fell in the 1970s and grew in the 1980s, leaving the country with a real GDP per capita in 1990 that was only slightly above its 1974 level. Despite this rather disappointing economic performance, energy demand increased almost 80 percent over the period, with an average annual increase of about 3.7 percent. Thus, both energy use per capita and energy use per GDP increased rapidly in the years after the first oil shock.

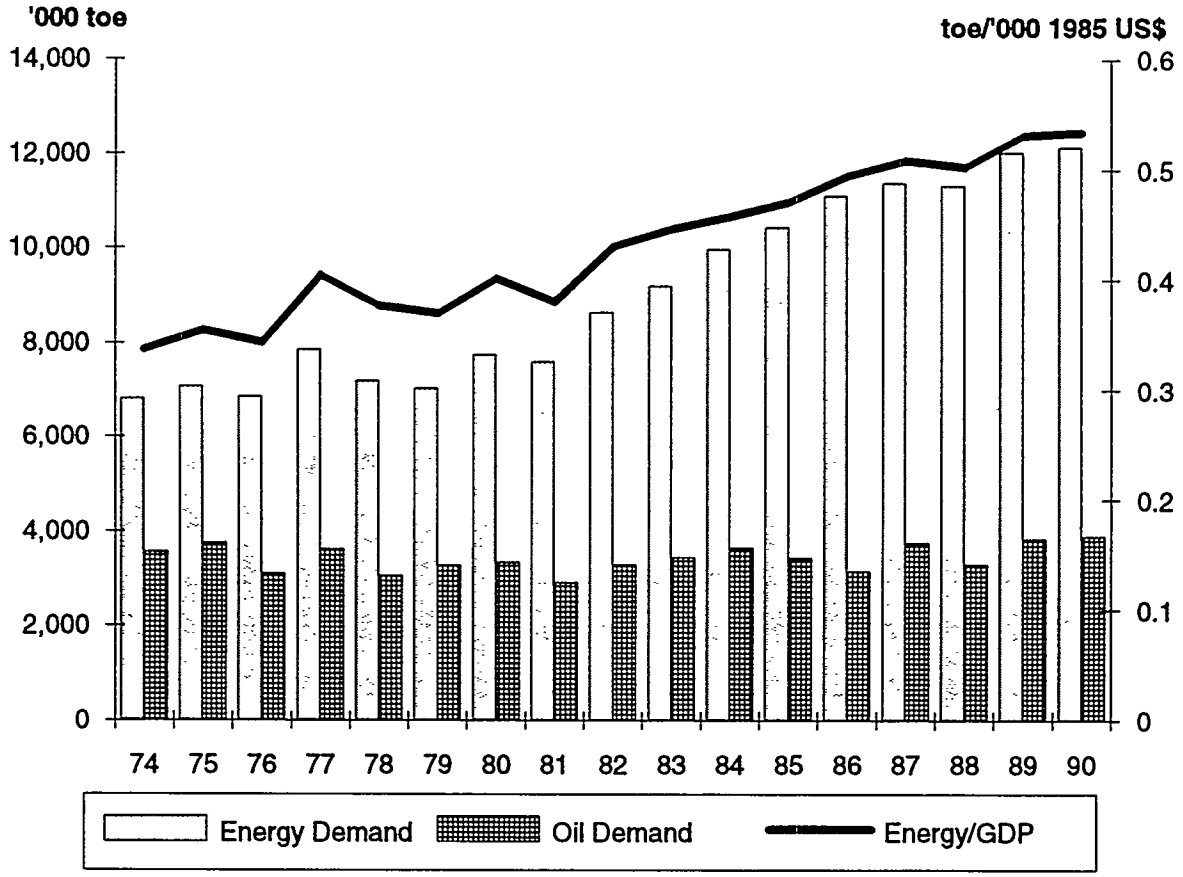
Figure 3.1 shows annual energy demand, oil demand, and energy/GDP ratios for the 1974-1990 period. Total energy demand has risen from about 7 million tons of oil equivalent (toe) to well over 12 million toe, equivalent to about 240,000 b/d of oil consumption. With a relatively stagnant real GDP, the energy/GDP ratio has climbed in lockstep.

Table 3.1
New Zealand Energy and Economic Indicators*

Total Change In:	1974-80	1980-90	1974-90
Population	3.6%	6.9%	10.8%
Real GDP	-4.2%	17.5%	12.6%
Real GDP/Capita	-7.6%	9.9%	1.6%
Energy Demand	13.8%	56.6%	78.3%
Oil Demand	-6.1%	16.5%	9.4%
Energy/GDP Ratio	18.8%	33.3%	58.4%
Oil/GDP Ratio	-2.0%	-0.9%	-2.8%
Energy/Capita	9.9%	46.6%	61.0%
Oil/Capita	-9.4%	9.0%	-1.2%

**economic and population figures for 1989/90 preliminary estimates*
Sources: IEA "Energy Balances of Member Countries;" IEA "Oil and Gas Statistics;" World Bank "World Tables 1991;" IBRD "International Financial Statistics."

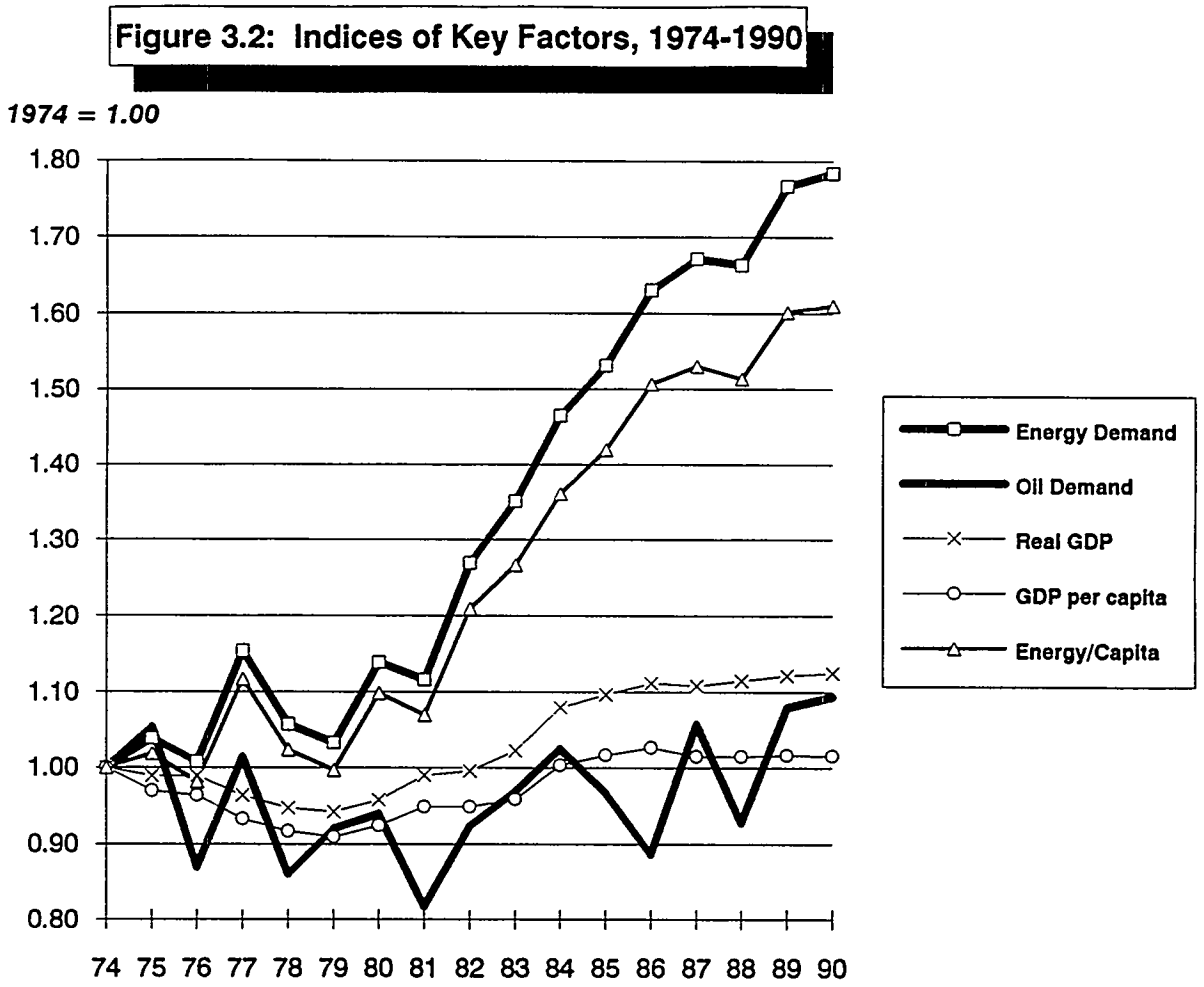
Figure 3.1: Energy Demand and Energy/GDP Ratio



What is notable, however, is that oil demand itself has been reined in over most of the period. This is even more evident in Figure 3.2, where the indices of the key factors are compared. Total energy demand and energy demand per capita skyrocketed in recent years, but oil demand slumped. Demand for oil only resumed growth with the weakening of international oil prices in the mid-1980s.

On the other hand, as Figure 3.1 suggests, the linkage between energy and GDP has "worsened," while the linkage between oil use and GDP has remained practically unchanged. The increase in the energy/GDP relationship is not necessarily significant, despite the fact that some schools of thought treat decreases in this ratio as a moral good in and of itself; this change can indicate fundamental structural alterations in the economy which are not necessarily good or bad. The lack of major change in the oil/GDP ratio, however, can be viewed as a disturbing commentary on the overall outcome of New Zealand's liquid fuels self-sufficiency strategy: regardless of oil's share in energy demand, can it be said that an economy is truly less oil-dependent when it takes the same amount of oil to produce the same amount of economic output?

It has become fashionable to criticize New Zealand's former economic strategies, perhaps most especially within New Zealand itself. In terms of real per capita income growth, New Zealand's performance has been rather dismal. In a traditionally "green" country, this might seem like an acceptable move toward a steady-state economy, if it were not for the fact that total energy consumption has increased so dramatically. Not only has New Zealand's economy stagnated, but it is consuming more resources than ever before. On the face of it, this certainly appears to be a failure of policy, and the modest economic revival of the late 1980s appears to be a strong argument in favor of privatization and limited government intervention. The situation is by no means as simple as a comparison of free-market versus government control, however. Without attempting to draw conclusions on such broad issues, it is still important from the perspective of energy analysis to look more carefully at what happened in New Zealand's energy consumption in the last 15 years.

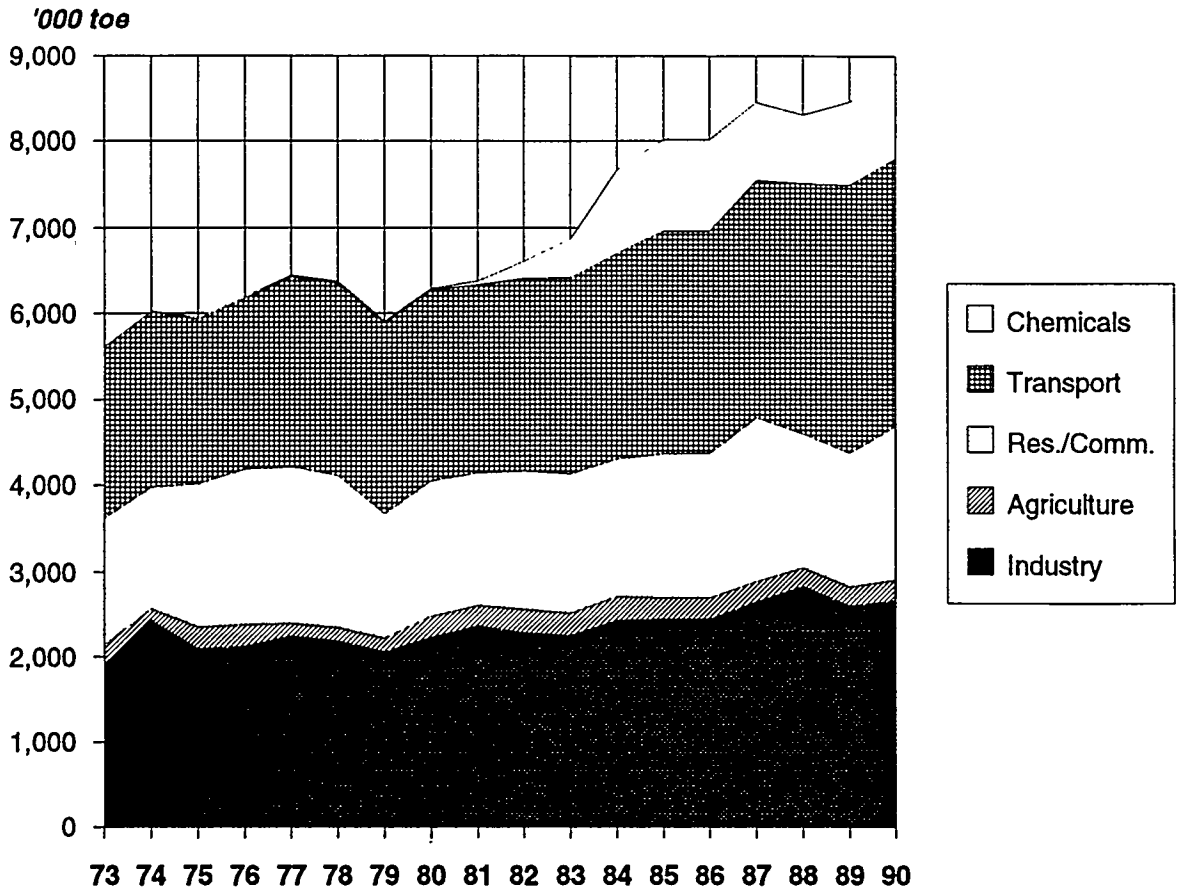


FINAL ENERGY DEMAND AND END USE SECTORS

Figure 3.3 shows end use energy demand by economic sector in New Zealand for the period 1973-1990. The pattern is quite revealing. Industrial energy demand (excluding the chemicals sector) increased only slightly over the period, at a rate of less than 2 percent annually. Agricultural energy demand has been essentially flat and the residential/commercial/public sector has seen energy demand growth of only a little over 1 percent annually.

Energy demand in the transport sector, on the other hand, grew at about 2.7 percent per year, increasing at the rapid (for an OECD country) rate of 3.7 percent

Figure 3.3: Energy Demand By Sector, 1973-1990



Sources: IEA "Energy Statistics of Member Countries;" Ministry of Commerce "Energy Data File."

annually in the latter half of the 1980s. The growth in the chemicals sector rose from such a limited base that discussion of growth rates is meaningless; suffice it to say that a sector with previously negligible demand now accounts for about 10 percent of New Zealand's final energy use. Without the increases in the transport and chemicals sectors, New Zealand's final energy demand would have increased only 20 percent between 1973 and 1990; with the growth in these two sectors, final energy demand increased by 60 percent.

One factor that makes broad conclusions about New Zealand's energy/GDP relationships somewhat suspect is the reliance of the New Zealand economy on com-

modities markets. Beyond New Zealand's well-known role as an agricultural exporter is the fact that much of the country's industry is also structured around relatively volatile commodities markets—processed food, fish, fibers, timber, and, with the advent of the chemicals industry, methanol as well. Higher energy prices, increased demands for oxygenates (methanol and derivatives), or price increases for agricultural products could all make New Zealand's current volumes of output seem far more valuable in terms of GDP, and all three are likely trends in the 1990s. Furthermore, although exchange rates are supposed to reflect the true value of a currency and the inflation prospects of a country, the poor commodity markets of the 1980s may have undervalued the New Zealand currency to some extent, making economic performance appear worse than actually may have been the case. This is not to suggest that New Zealand's economy has been healthy; past inflation and current unemployment rates demonstrate the contrary. But the past relationships between energy demand and GDP may not hold true in future years, because they relate to specific, exceptional increases in demand (the expansion of the chemicals sector) and also because they may well underpredict the future value of the same volume of economic output.

Table 3.2 shows the energy/GDP relationships in New Zealand's three main sectors (using the World Bank's categorizations) for the period 1977-1990. Agricultural energy use per unit of output has risen slightly. In the "other" sector, which includes the value of transport services and the service sector in general, the ratios have remained roughly constant. The industrial sector has shown sharp increases in the ratio, but there is reason to believe that this was a "one-time" effect, rather than a trend. In future years, it is likely that the ratio for the industrial sector will actually decrease, as the chemicals sector holds steady in energy use (and perhaps increases in value of output), while other, less energy-intensive, industrial activities continue to expand.

As Figure 3.4 shows, the changes in fuel composition by sector have been quite varied. Despite major incentives for alternative fuels, the transport sector remains overwhelmingly reliant on oil. Oil dependence in agriculture has actually increased slightly, from about 75 percent of agricultural energy to about 80 percent. In industry (excluding chemicals), on the other hand, oil dependence has fallen sharply as a conse-

Table 3.2
Energy/GDP Relationships in Three Main Sectors
(toe/1000$US)

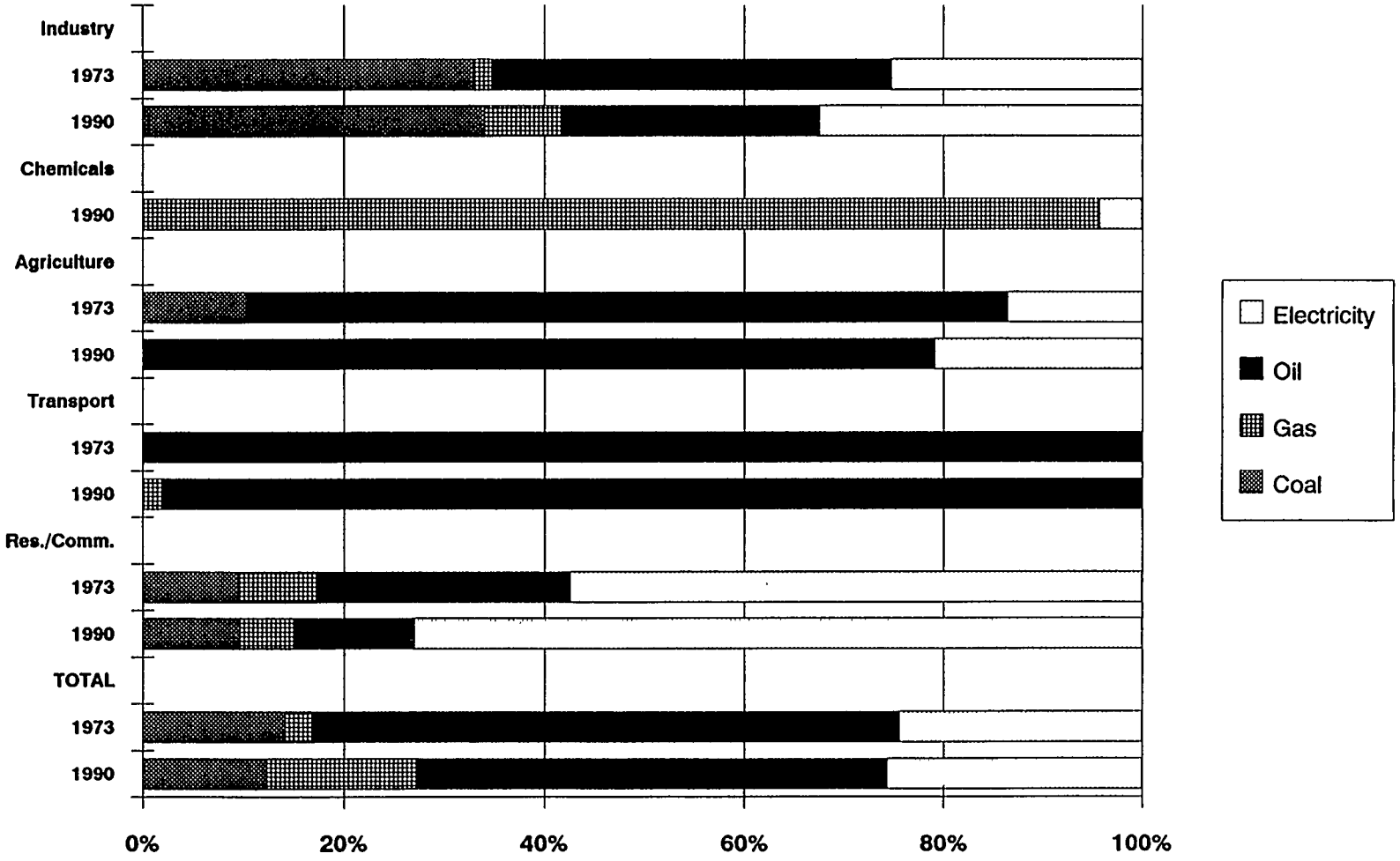
Year	Agriculture	Industry	Other
1977	0.07	0.37	0.36
1978	0.08	0.37	0.36
1979	0.08	0.35	0.33
1980	0.10	0.36	0.36
1981	0.11	0.39	0.32
1982	0.14	0.39	0.33
1983	0.16	0.40	0.32
1984	0.14	0.49	0.30
1985	0.10	0.48	0.34
1986	0.10	0.47	0.34
1987	0.13	0.51	0.34
1988	0.10	0.49	0.35
1989	0.12	0.56	0.32
1990	0.12	0.56	0.35
Period	**Average annual growth rate (%)**		
1980-1990	1.77	4.37	-0.27

Sources: IEA "Energy Balances of Member Countries;" IEA "Oil and Gas Statistics;" World Bank "World Tables 1991;" IBRD "International Financial Statistics."

quence of increased gas use, from 40 percent to only 25 percent of energy requirements. In the residential/commercial sector, oil use has been cut in half in terms of its share of demand, falling from 25 percent of consumption to 12 percent; in this case, however, gas substitution has not been as important as the growing role of electricity.

The behavior of the transport sector is of some consequence for New Zealand's future energy situation. As in Canada, Australia and the United States, a large amount of transportation energy per capita is required to hold together a geographically dispersed population. Although there are obvious limits on how much internal transport can be required in a nation composed of two large islands, there is still room for growth. Automobile ownership was not near universal in the 1970s when New Zealand's comprehensive energy strategy was laid out, and the government's recognition that an adequate

Figure 3.4: Final Energy Demand by Fuel and Sector



Sources: IEA "Energy Statistics of Member Countries," Ministry of Commerce "Energy Data File."

supply of liquid fuels (notably transportation fuels) was the critical issue for future years was essentially correct. One reason that the basic linkage between GDP growth and oil demand has not been broken is because increases in income in New Zealand tend to translate into increases in transportation demand, particularly demand for personal transportation.

The increases in energy intensity in New Zealand cannot be readily explained without reference to consumer behavior; as an excellent paper by I.G. Bertram recently stressed, the changes cannot be wholly explained by the "Think Big" projects such as the Motonui Synfuels plant, the Tiwai Aluminum smelter, or the expansion into chemicals. Although the fundamental structure of New Zealand's energy demand is familiar to those who have studied the United States, Canada, or Australia, the trend toward greater energy intensiveness differs from general trends in the OECD. In addition to the new energy demands of the megaprojects, a trend toward greater energy consumption throughout the New Zealand economy is evident, despite prices similar to those seen elsewhere in the OECD. This is a topic that deserves closer examination at the microeconomic level, since many factors—changes in consumer preferences, substitution of energy for labor, or the use of energy in lieu of new capital—might all contribute to greater energy intensity. A better understanding of the driving factors is required to improve existing forecasts.

PRIMARY ENERGY AND SELF-SUFFICIENCY

Table 3.3 shows New Zealand's primary energy requirements over the period 1974-1990. The results of the government's drive to reduce reliance on oil are clear; oil's share of primary energy fell from 52 percent in 1974 to 32 percent in 1990. As in the review of energy end uses above, however, the interpretation of these results is somewhat ambiguous. Oil demand has remained roughly constant, and its decreasing share is the result of great expansions in the consumption of other forms of energy. Holding oil demand constant in a period of greatly increased energy demand would be a substantial achievement in most situations, but it is less impressive against a backdrop of stagnant GDP.

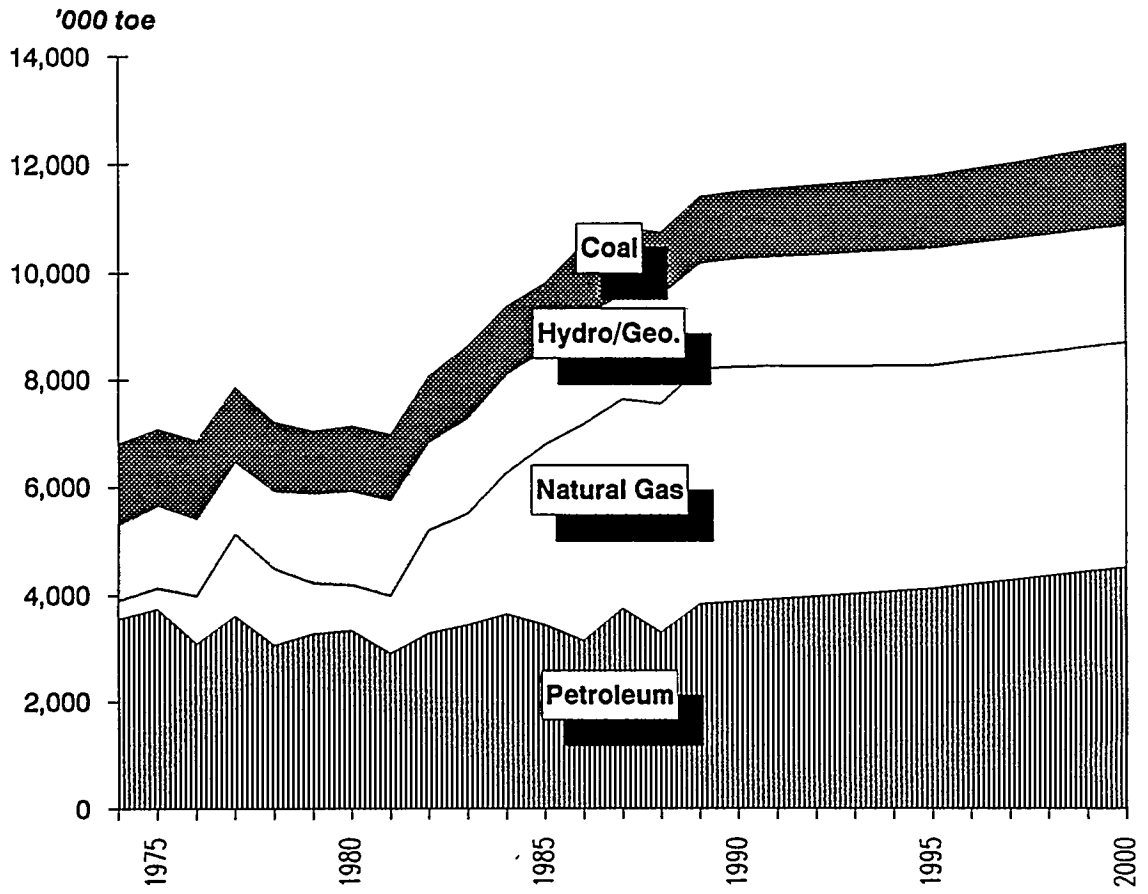
Table 3.3
Primary Energy Supply, New Zealand
('000 toe)

Year	Imported Oil/ Product	Indigenous Oil (net)	Natural Gas	Hydro/ Geothermal	Coal	Wood	Total
1974	3,369	191	346	1,404	1,500	0	6,811
1975	3,553	198	382	1,528	1,411	0	7,073
1976	2,569	525	896	1,426	1,445	0	6,861
1977	2,858	752	1,519	1,352	1,378	0	7,859
1978	2,424	640	1,426	1,435	1,275	0	7,200
1979	2,849	427	950	1,662	1,144	0	7,033
1980	2,937	406	848	1,734	1,213	616	7,754
1981	2,407	501	1,077	1,770	1,227	616	7,599
1982	2,517	771	1,908	1,652	1,215	580	8,645
1983	2,698	752	2,063	1,777	1,337	571	9,199
1984	2,677	974	2,615	1,841	1,258	607	9,972
1985	2,694	750	3,346	1,772	1,244	623	10,428
1986	1,755	1,399	4,019	1,982	1,378	573	11,107
1987	2,345	1,421	3,876	1,965	1,227	549	11,384
1988	1,827	1,476	4,246	2,025	1,180	576	11,329
1989	2,288	1,557	4,358	1,980	1,225	628	12,036
1990	2,536	1,359	4,346	2,035	1,227	642	12,145
Period		**Average annual growth rate (%)**					
1974-80	-2.26	13.39	16.09	3.58	-3.47	na	2.19
1975-80	-3.74	15.42	17.28	2.55	-2.98	na	1.85
1980-85	-1.72	13.06	31.60	0.44	0.51	0.23	6.11
1985-90	-1.20	12.63	5.37	2.80	-0.27	0.61	3.10
1974-90	-1.76	13.05	17.13	2.34	-1.24	na	3.68

Source: Ministry of Commerce, "Energy Data File," July 1991.
Original units in PJ. Conversion: 1PJ=23.88 MTOE

Figure 3.5 shows New Zealand's primary energy supply since 1974 and forecasts by fuel from Petrocorp. Despite a slow and steady projected growth in the supply of fuels other than natural gas, the overall picture presented is one that essentially freezes the current breakdown in place. This may not be an unreasonable assumption; the rapid phase-in of natural gas, beginning in the late 1970s, restructured a primary energy supply system that was previously relatively stable. To some extent, the take-or-pay gas contracts that were signed for the gas developments meant that the energy system was rapidly altered to accommodate soaring gas production; since the capacity of any

Figure 3.5: Primary Energy Supply, Major Fuels, 1974-2000



economic system to cross-substitute energy sources (particularly one with the massive infrastructural requirements for natural gas) is limited, the forced introduction of gas may in itself go a long ways towards explaining the increases in energy intensity.

If the energy demand forecasts are correct, and if New Zealand manages to sustain real economic growth in the 1990s, the result should be a substantial reversal in the trends in energy efficiency and productivity. It may be that economies have a limited "absorptive capacity" for new energy supplies, similar to the concept of absorptive capacities for capital so widely discussed in the 1970s in the context of the OPEC

countries. It may take time for an economy to adapt in such a way as to make efficient use of large supplies of new energy. Free-market economists would, of course, argue that the problem should never occur, and that the provision of new energy supplies should be driven by the microeconomic demands of individual consumers, rather than by government fiat. Such a contention is supported by the bulk of economic theory, as well as by the wide experience with government intervention in the energy sectors of many countries over the past two decades.

Nonetheless, in fairness to earlier policymakers in New Zealand, there are important factors in the energy sector that most economists prefer to ignore for the sake of simplicity. Although the principles of economies of scale are well understood in economic theory, in actual policy analysis they are often neglected. This is unfortunate, since scale is a critical factor in most energy supply projects. Oil and gas production and processing are particularly sensitive to scale, since they rely on pipes, vessels, rights-of-way, and complex control systems, all of which have very high minimum costs but relatively low costs for incremental expansions in capacity. In large markets, such as the United States, or even in typical European economies, a medium-sized gas field can be brought onstream with some confidence that the market will adjust to absorb the new production if it is competitively priced. Smaller economies, without large existing infrastructure for distribution and consumption, have often found the development of natural gas to be problematic. In both India and Pakistan, to cite just two examples, there were no ready markets for gas, despite heavy reliance on imported energy; in both cases, the governments had to make heavy financial commitments, identify or create large centralized consumers (so that smaller users could be "piggybacked" onto the major infrastructural investments), and provide incentives for fuel-switching. Ironically, the commitments and incentives have created such large additional demands that both countries are now short of gas.

In summary, when a country such as New Zealand is faced with a large new gas resource with high development costs and a very limited domestic market, the choice may be to either launch major consumption projects or not develop the gas at all. (The obvious alternative, to export the gas as LNG, was not economically attractive at the time

the decisions were made in New Zealand. The current LNG boom in the region is the result of government policies in East Asia that are themselves questionable from an economic standpoint.) In hindsight, many would argue that non-development would have been the wisest and cheapest choice, and this may well be the case. An analyst in the year 2000, however, could look back and arrive at a different conclusion.

Despite the emphasis on alternatives to oil, coal consumption in New Zealand declined somewhat in the aftermath of the first oil shock, and has remained essentially static since then. To some extent, this is attributable to the deliberate expansion of natural gas supplies and hydropower and geothermal electricity generation. The main areas where coal would be competitive—heavy industry and the power sector—are those areas that were targeted by the development of gas and primary electricity. Although coal is an energy source with potential for expansion in the future, New Zealand's "green" political temperament may now argue against further development in light of coal's high emissions of greenhouse gases.

In the early 1990s, it is difficult to recall the assumptions about energy policy that dominated policymaking in the early 1980s. Ensuring the security of supply and striving for energy self-sufficiency were viewed as government's primary roles in energy policy. Relatively conservative forecasts of oil prices saw crude prices reaching US$65/b by 1985 or 1990 (a price, incidentally, that would have made the Motonui Synfuels plant hugely profitable). Since these criteria were the driving forces behind policymaking at the time, we are justified in asking how far the government succeeded in meeting these goals, as opposed to examining only the purely economic criteria on which these policies are now judged.

Self-sufficiency is a seemingly simple yet slippery concept. For sources of energy that are not traded, or where trade is wholly one-way, the matter is fairly straightforward; if 25 percent of coal requirements are imported, for example, then self-sufficiency in coal is 75 percent. In areas where there is two-way trade, with different grades of a commodity being imported and exported, matters become more complex. For oil, where both crude and products may be imported, crude may also be exported along with some of the products from domestic refining. Thus, matters become quite muddled regarding details

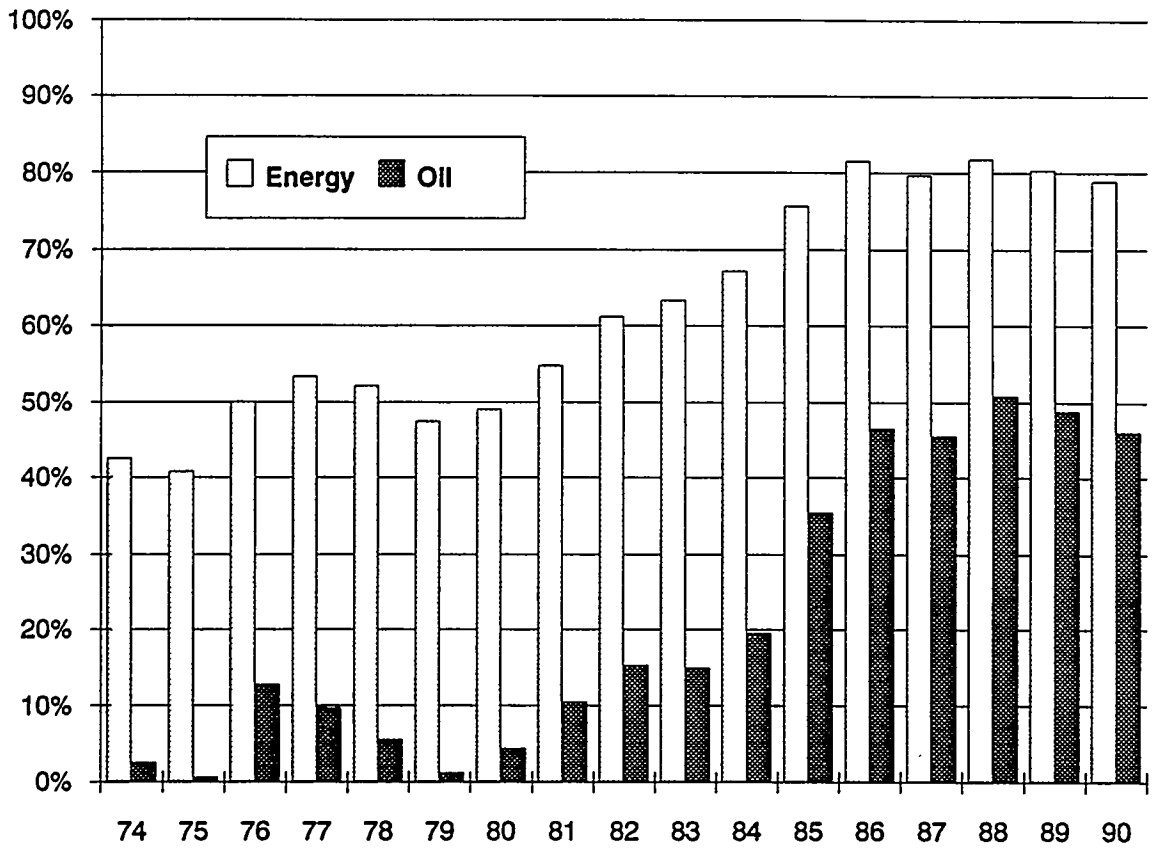
such as the treatment of refinery energy use, processing gains (which with hydrocracking can occur even on a tonnage basis), stock builds and draws, and other minor points.

Calculations of precise numbers may differ from one source to another, but the overall trend is apparent: in terms of the amount of energy requirements met from domestic sources, New Zealand's self-sufficiency has increased dramatically since the 1970s. The trend is shown for total primary energy and for oil alone in Figure 3.6. In 1974, New Zealand provided virtually none of its supply of liquid fuels; by 1990, it produced about half of its requirements. In terms of total energy, New Zealand in 1974 was dependent on imports for about half of its energy needs; by 1990, it was providing about 80 percent of its own energy.

Once again, however, the interpretation of these numbers is open to debate. The decreased reliance on oil imports is primarily a consequence of expanded domestic production of crude and condensate, and there are those who will argue that just as much oil would have been discovered and produced without any policy on the part of the government (though this can hardly be argued for the production of the fractions of condensate associated with the larger gas fields). In any case, the most widely discussed issues relating to oil-substitution measures, such as the synfuels plant and the use of CNG and LPG in vehicles, have had little impact on the overall energy situation; CNG and LPG still only provide very marginal amounts of total transportation energy, and the output from the synfuels plant, although it is an excellent and environmentally sound blendstock, accounts for only a fraction of the increase in New Zealand's oil output. The major change in New Zealand's oil situation has been its emergence as a substantial oil producer.

In terms of overall energy self-sufficiency, the key issue is once again the increase in energy demand without a concomitant increase in income. Other than oil, New Zealand has never been a major importer of energy. The major change in the country's energy situation since the mid-1970s is that consumption of indigenous resources has boomed, some might say unwisely. Although a fraction of this change is accounted for by increases in production of primary electricity, it is the widespread increase in gas utilization that dominates the statistics.

Figure 3.6: Energy Self-Sufficiency Ratios



Source: Calculated from IEA "Energy Statistics of Member Countries" and Ministry of Commerce "Energy Data File."

It is not clear that events other than the development of domestic oil reserves have made New Zealand's economy substantially more secure. Industrial use of natural gas has expanded, but only a limited amount of gas has been substituted for imported fuel. Imported energy has been pushed out of electricity generation, but it never accounted for more than 10 percent of the electricity supply in any case. As elsewhere in the world, the transport sector is still dominated by oil, although New Zealand has probably gone farther than any other country in phasing in alternative fuels. The agricultural sector remains strongly dependent on oil; four-fifths of its energy is still petroleum-

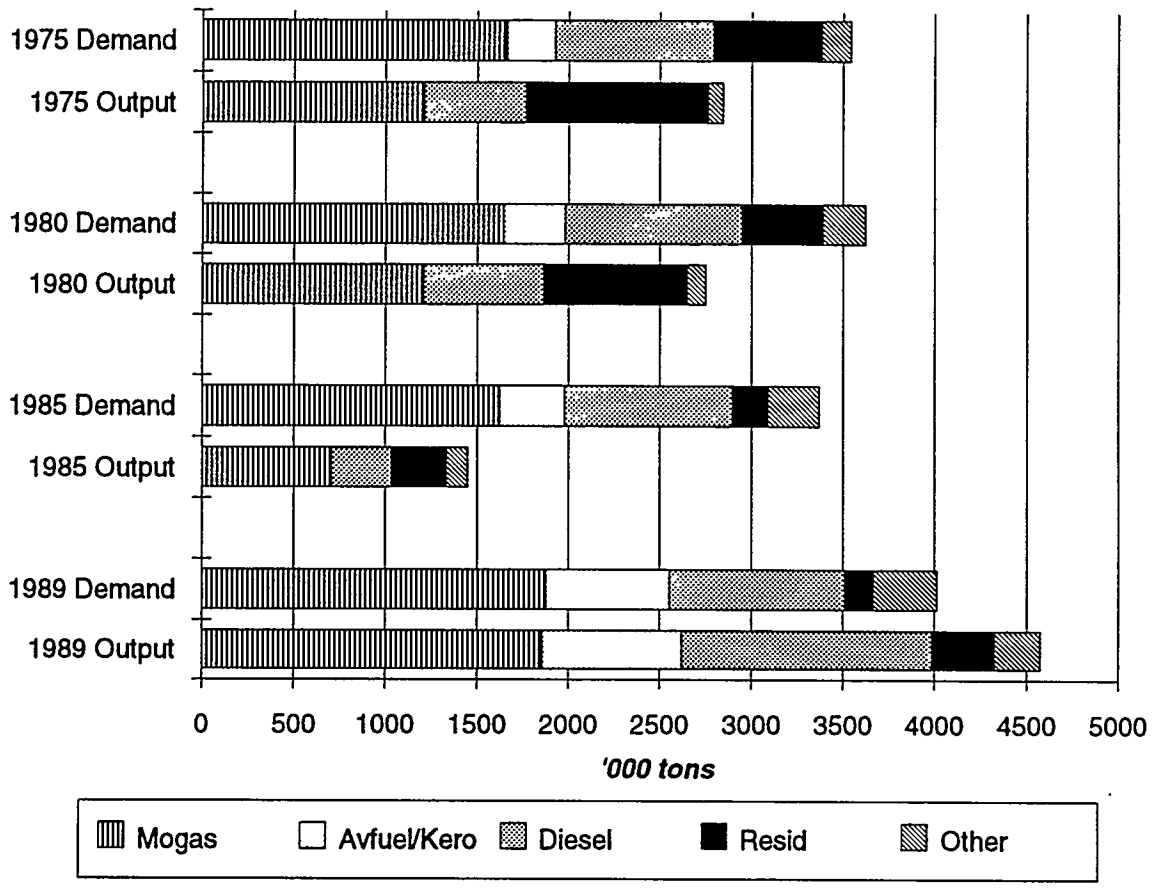
based. Only in the industrial and the residential/commercial sectors has there been a major decline in oil dependency, in the former case because of gas-substitution, in the latter because of much greater use of electricity. Despite the major changes in the structure of New Zealand's energy system since 1973, New Zealand's economy can hardly be described as well-insulated from oil-price shocks.

Indeed, it seems likely that most of what has been achieved in terms of fuel substitution and development of indigenous oil could have been achieved at lower cost by the use of domestic pricing mechanisms. Making oil much more expensive could easily have resulted in major changes in patterns of consumption since 1973, and could have led to greatly increased exploration and development without the concomitant investments in megaprojects. Price incentives, over such a prolonged period, might even have led to the development of the major gas fields without further government involvement or expenditures. The danger at the time seemed to be that high prices would damage the economy; many would now argue that the massive capital expenditures undertaken had the same result.

There is one area, however, where New Zealand's policies have been a clear success in terms of energy security. It is very doubtful whether the extensive upgrading of New Zealand's refinery would have been initiated by private interests alone. Although the upgrading was expensive, and its economics questionable, there is no doubt that it has left New Zealand with a refining system that is highly sophisticated and flexible.

Figure 3.7 shows the output patterns of the New Zealand refinery compared to the country's demand patterns for selected years. The shift toward a much lighter demand barrel, and an expansion in the share of transportation fuels, is not a consequence of New Zealand policy, but rather reflects a worldwide trend over the period. Now, at the beginning of the 1990s, New Zealand has a refining system that provides an excellent match to its oil product needs, minimizes surpluses of low-value outputs such as fuel oil, and, for the moment at least, leaves it with a comfortable export surplus of high-grade diesel fuel—the fuel most likely to be in short supply in the region in coming years.

Figure 3.7: Oil Product Output vs. Demand



Furthermore, the refinery has considerable flexibility in the types of crudes it can handle while still maintaining a good output slate. In this area at least, New Zealand's energy policies have left the country clearly better able to cope with disruptions in the oil market in future years, and have thereby substantially enhanced energy security.

Four

GOVERNMENT AGENCIES AND INSTITUTIONAL ARRANGEMENTS

OVERVIEW

Prior to the initiation of energy market deregulation in 1988, New Zealand's energy sector was governed by the Ministry of Energy, which regulated all aspects of the industry. The oil price shocks of the 1970s caused intense preoccupation with energy self-sufficiency. Energy policy priorities shifted towards reducing dependence on imported oil through development of indigenous energy resources. The government aggressively pursued programs to decrease import reliance, even when such programs were costly when compared to the cost of imported oil, since virtually all of the oil price forecasts at the time pointed to continued instability and high prices.

To increase liquid fuel self-sufficiency and find new uses for natural gas, New Zealand launched the "Think Big" projects, including a synthetic fuel plant to make gasoline from natural gas, two petrochemical plants, and upgrades to the country's single refinery. The government also promoted the use of liquefied petroleum gas (LPG) and compressed natural gas (CNG) as automotive fuels.

When the price of oil declined in the mid-1980s, the government found that many of the projects to which it had committed itself were no longer economically competitive. Many of the projects were recommended by the Liquid Fuels Trust Board (LFTB), which operated from 1978 to 1987. The LFTB was a government-established research group dedicated to decreasing import reliance through efficient development of New Zealand's natural resources. During its nine years of operation, the LFTB performed ground-breaking research, much of which served as a model for other governments and research groups. When the Think Big projects began operating in the red, there were those who found it convenient to fault the LFTB, though given the oil price forecasts of the day many other research groups were recommending the same types of development

strategies. Some of the LFTB's recommendations may have been ahead of their time—in fact, the New Zealand Department of Scientific and Industrial Research (DSIR) recently noted that it may soon be time to revisit the LFTB's work on coal conversion technologies for transportation fuel production.

By 1984, government policy began to focus more on promoting economic efficiency than on decreasing import dependence. In order to increase efficiency, the government began deregulating some areas of industry in hopes of increasing competition, productivity, and overall economic performance. Most of the deregulation is now complete, though the government is still in the process of restructuring itself and making adjustments to new legislation.

The major policy changes included deregulation of the energy sector. Prior to deregulation, the management of the Crown energy resources involved controlling coal, electricity, and petroleum as businesses within the Ministry of Energy (MoE). Petrocorp was first made a state-owned enterprise (SOE), and was later fully privatized via sale to Fletcher Challenge Petroleum, the largest company in the country. Coalcorp and Electricorp were also made SOEs, but have not yet been privatized, although this is the government's ultimate goal. The government also sold its interest in the money-losing Synfuels plant to Fletcher Challenge in mid-1990.

With the energy companies no longer controlled by the state, many of the functions of the MoE became obsolete. The Ministry of Energy was dissolved in 1990 and the remaining functions were absorbed by the Ministry of Commerce (MoC). Now the MoC's Energy and Resources Division controls Crown energy resources and addresses policy and regulatory matters, consulting as needed with the Ministries of Environment, Transport, and Conservation and the Department of Treasury. The MoE's Gas and Geothermal Trading Group (GGT) was not included in the functions transferred to the Ministry of Commerce; this group was phased out in 1990 and any residual functions dealing with geothermal interests were transferred to the Treasury.

As mentioned above, in 1990 the Ministry of Energy was merged into the Energy and Resources Division within the Ministry of Commerce, which now oversees the energy sector with input from other relevant Ministries and Departments when jurisdictions

overlap. On October 1, 1991, several key pieces of legislation were enacted, including the Crown Minerals Act, the Resource Management Act, and the Petroleum Sector Reform Act. In addition to the government agencies, the private sector also influences the energy market. The New Zealand-based corporation, Fletcher Challenge, purchased the government's 75 percent interest in the Synfuels plant as well as Petrocorp, the former national oil company.

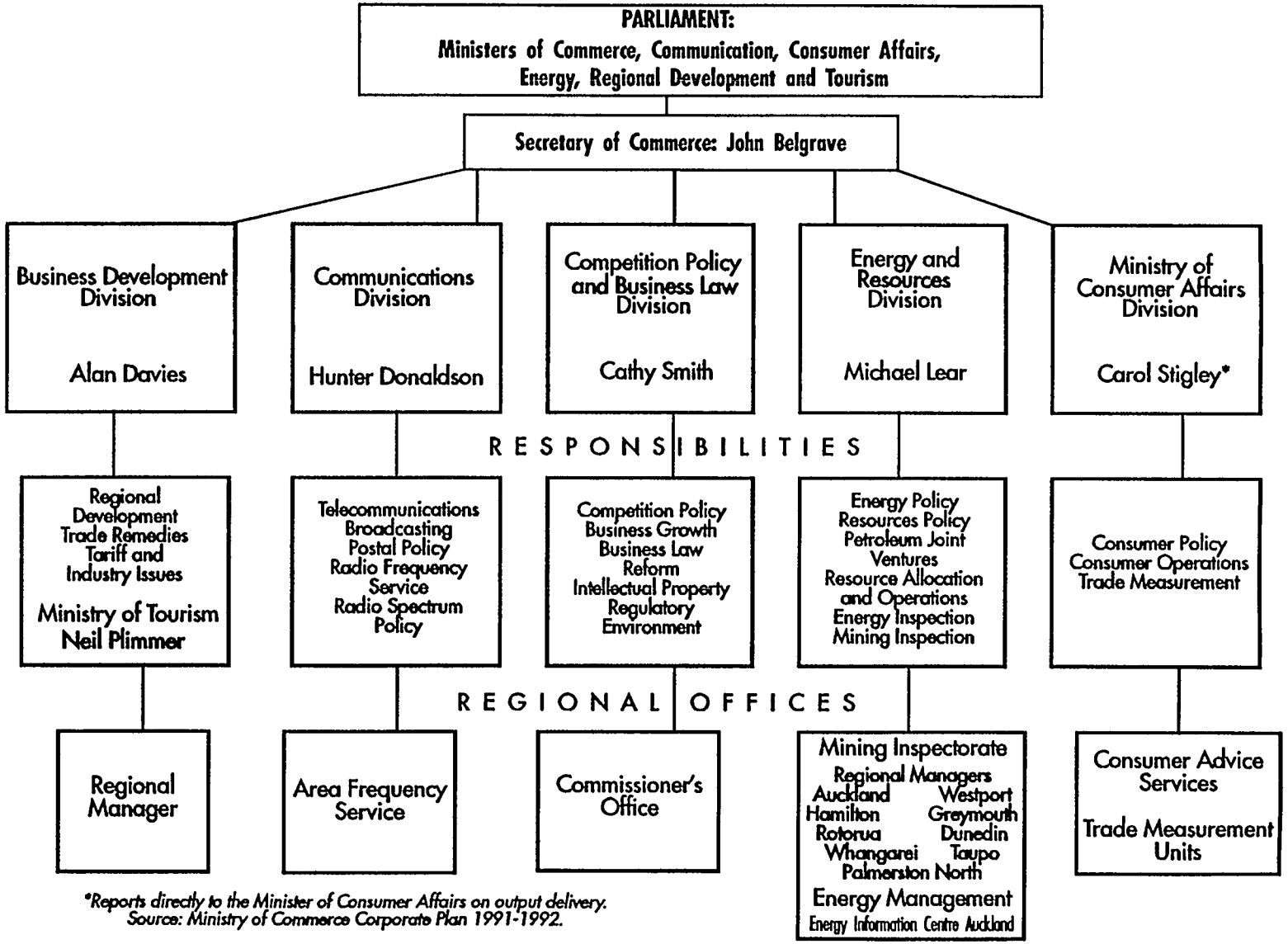
The government's primary goal is to keep moving towards economic efficiency, rather than providing supply security at any cost. The financial losses of some of the Think Big projects contributed to some of the largest government outlays in recent years, and the government is now understandably skittish about repeating such an adventure. While security of supply remains an important concern, the government is no longer willing to pay high prices to achieve an elusive security.

KEY AGENCIES AND ADMINISTRATIVE RESPONSIBILITIES

Ministry of Commerce

The Ministry of Commerce in Wellington coordinates five divisions: Business Development, Communications, Competition Policy and Business Law, Energy and Resources, and the Ministry of Consumer Affairs. Each division is headed by a general manager who reports to the Secretary of Commerce, with the exception of the head of Consumer Affairs who reports directly to the Minister of Consumer Affairs (See Figure 4.1). The Energy and Resources Division is in charge of energy and mineral resource allocation, which encompasses exploration and prospecting for—as well as extraction of—coal, petroleum, and other minerals. The office is also in charge of general energy policy, certain resource development and pricing matters, information services, and minerals-related financial issues. In terms of current personnel, Michael Lear, the head of the Energy and Resources Division, reports to John Belgrave, the Secretary of Commerce, and they, in turn, advise the Ministers in Parliament. Even though the Ministry of Energy was dissolved, there is still a Minister of Energy in Parliament, currently John Luxton.

Figure 4.1: Organizational Structure of the Ministry of Commerce



Reports directly to the Minister of Consumer Affairs on output delivery.
Source: Ministry of Commerce Corporate Plan 1991-1992.

Deregulating national control of industries has been an ongoing process since 1984 and is now nearing completion. Previous government responsibility involved running the entire energy industry and setting prices according to political goals. In contrast, the current tasks focus on policy and basic, "light-handed" regulation of the energy market. Energy policy goals include developing reliable, economically efficient energy sources, while tightening regulations on greenhouse emissions and on the level of lead in gasoline. Other regulations relating to health, safety, and the environment apply to prospecting and mining permits for coal, oil, natural gas, and geothermal energy. Petroleum products are tested to ensure quality, and electricity generation and storage facilities are inspected to confirm that all codes, standards and instructions are followed.

Ministry for the Environment

The Ministry for the Environment is responsible for the Resource Management Act, which came into effect on October 1, 1991. This act replaces several key pieces of legislation, including the Mining Act (1971), the Coal Mining Act (1979), and the Petroleum Act (1937). Contracts existing prior to October 1, 1991 will be governed by the earlier legislation until contracts expire. Originally, this integrated resource management bill would have included oversight of Crown-owned minerals, but this particular area was instead spun off into a separate Crown Minerals Act in order to keep regulatory and ownership functions separate. The Minister of Energy has responsibility for the Crown Minerals Act, which is a broad and powerful act in its own right.

The purpose of separating the Crown Minerals Act from the Resource Management Act was to avoid conflicting interests. In this way, the Resource Management Act functions as an environmental check on the Crown Minerals Act. Certain activities requiring permits may specify the need to obtain "resource consents." The Ministry for the Environment will award resource consents based on specifications set forth in the Resource Management Act. Part III, Section Nine of the Act states that activity involving "any excavation, drilling, tunnelling, or other disturbance of the land; or any destruction of, damage to, or disturbance of, the habitats of plants or animals in, on or

under the land" will require a resource consent.[1] Only in situations considered of national interest or security does the Minister of Energy have complete authority. Clearly, the authority over resource consents will give the Ministry for the Environment greater involvement in the energy sector and more opportunities for interaction with the MoC's Energy and Resources Division.

Other Key Agencies

The original unit established for scientific research in 1926 was the Department of Scientific and Industrial Research (DSIR), which was given the mandate to initiate and implement research for the benefit of New Zealand. Four major groups make up the DSIR: the Biological Industries Group, the Industrial Group, the Corporate Operations Group, and the Resources Group. During the years since its inception, the DSIR has carried out the bulk of government research, although research groups also exist in other government agencies such as the Ministry for Agriculture and Fisheries (MAF), the Ministries of Transport, Environment and Forestry, and the Department of Health.

As of July 1, 1992, all of the research groups associated with individual government agencies will be disbanded and the scientists transferred to the newly formed Crown Research Institute.[2] The Crown Research Institute will be made up of ten SOEs throughout the country. Locations have not yet been announced, but it is likely that existing DSIR structures and university laboratories will be used. It is the intention of the government to increase contracts for specific research by bringing all the scientists together to make stronger teams. Two shareholding ministers, one of which will be the Minister for Crown-Owned Research, will represent the ten SOEs in Parliament. The Crown Research Institute will have no pre-established research plan. Each year the

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[1] Resource Management Act. Wellington: New Zealand Government Press, October 1, 1991.

[2] Stantum, Adrien. Personal Communication. DSIR. Wellington, NZ, February 10, 1992.

allocated research budget will be made available and bids will be accepted from the Crown Research SOEs as well as any private interests that may wish to apply. The Ministry of Research, Science and Technology will handle policy issues and will be responsible for setting research priorities and determining allocations of funding, taking into consideration the current priority research areas and the bids submitted.

The new system is intended to encourage research according to need. Energy research was previously carried out by a number of agencies including the LFTB, the Resources Group within the DSIR, and the MAF, but it is thought that the consolidation and coordination of the research groups will result in more efficient operations and may also be more responsive to timely research requirements. As discussed in Chapter Three of this report, the New Zealand economy has performed poorly over the past decade. This contrasts sharply with the success of many Asia-Pacific countries, which rapidly became outward-looking, export-led economies. Many of New Zealand's industries are not competitive in world markets. The general feeling within the government is that much work remains to be done in the industrial sector, and that the restructuring of government research and development programs may also encourage greater private sector participation.

State-Owned Enterprises

The state-owned enterprises, or SOEs, are run like private corporations but are still owned by the state. The SOEs have limited liabilities under the Companies Act of 1955, but are subject to special accountability and control provisions under the State-Owned Enterprises Act of 1986. The head of each company reports to the Minister for State-Owned Enterprises, currently Doug Kidd. Initially, Petrocorp, Coalcorp, and Electricorp were transformed into SOEs as part of the deregulation strategy. The government soon thereafter completed the sale of Petrocorp to Fletcher Challenge Petroleum (FCP) and plans to sell Coalcorp and Electricorp as well. Sale of these two SOEs, however, is proving more complicated than the sale of Petrocorp.

Petrocorp is now owned by FCP and is no longer a state-owned enterprise, but a few comments on its role are included here for the sake of completeness. FCP controls

extensive energy resources and dominates the upstream sectors in both oil and gas, but the firm is not active in the wholesale and retail fuel markets because it cannot gain access to the country's only refinery. FCP has filed a lawsuit for rights to use the refinery, which is presently managed by the New Zealand Refining Company and used by Mobil, BP, Shell and Caltex. FCP argues that since the government built the refinery with public funds and also spent NZ$80 million for the upgrades, none of the oil companies actually "own" the refinery, and that use of the refinery should be subject to competition to keep prices down in return for the tax dollars that provided financing. Of the four oil companies, BP offered to sublet spare capacity to FCP, as long as the company agreed not to sell the products in the domestic market. The other three companies informed FCP that they had no spare capacity (see Chapter Five of this report for further details on the refinery access issue).

Coalcorp now operates as a private corporation without any government subsidies. Since the transition to SOE in April of 1987, productivity has increased substantially. Employment was cut from 1,728 workers down to 730 without any decrease in production.[3] Coalcorp was scheduled for privatization in 1988, but plans were delayed by Maori claims to the Waikato coal reserves. Until these claims are settled, Coalcorp cannot be sold.

Electricorp became a SOE at the same time as Coalcorp and is the largest SOE in terms of assets, because of the capital-intensive nature of electric power industries. The government plans to privatize Electricorp, but clearly this will prove much more difficult than privatizing a company like Petrocorp. The question arose as to whether fully privatizing the electricity company—to the extent of removing not only franchise areas, but also the obligation to serve—might be going too far, since electricity is one of the few energy activities usually run by public agencies or regulated utilities. The decision was made to separate the main transmission system from the generating facilities and then divide up the facilities in order to sell them off. This process has not yet taken place.

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[3] International Energy Agency. *Energy Policies of IEA Countries: Annual Review*. 1989.

The government also decided to remove franchise areas and the obligation to supply. In January 1992, franchise areas for residential consumers were eliminated, to be followed one year hence by the full removal of franchise areas for all consumers. The decision to remove the obligation to supply, however, was strongly opposed; thus, the obligation to supply will remain in place. The Energy Sector Reform Act, as it now stands, contains a transitional provision for the continuance of supply.

The planned reforms raise a host of questions: how can existing assets and the Electricity Supply Authorities (ESA) be packaged for sale; who will the new owners/-operators be; what will be their commitment to serving the public; what constraints, if any, will govern their business practices; will the reforms create a true wholesale market for electricity, and if so, how will consumers benefit; how will the new system affect remote customers or new establishments wishing to be hooked up to the supply system—in short, the New Zealand system, as envisaged, will be a large experiment. The lack of truly satisfactory, fully private electric companies in the rest of the world should, however, give some indication of how radical New Zealand's planned reforms are in this sector.

PETROLEUM EXPLORATION PERMITS

Petroleum exploration is regulated under the Crown Minerals Act through the Energy and Resources Division of the Ministry of Commerce. In order to begin exploring, a petroleum exploration permit must first be obtained, which may require resource consent as explained above. In order to gain resource consent, the Ministry for the Environment may require an environmental impact assessment. The burden of providing such an assessment falls on the permit applicant. Once the impact assessment is submitted, the DSIR reviews the document to ensure legitimacy and advises the Ministry for the Environment. It has not yet been decided what agency will take over the DSIR's role in this process after it is closed in June of 1992.

There are three types of permits for which a company may apply. Prospecting permits authorize regional reconnaissance exploration for up to two years. Such permits are not exclusive, and more than one may be issued for the same area. The second type

of permit is a petroleum exploration permit, which is granted for periods of up to five years. The third type is a mining permit, with a 40 year maximum term. Both the exploration and mining permits grant exclusive access rights and may be extended if necessary. Twice a year or more, the *Petroleum Exploration in New Zealand News* advertises licensing blocks or bidding rounds, with maps identifying specific coordinates and available geologic information. In addition, a potential explorer may make a "Notification of Interest" to express interest in a particular area not offered in the biannual rounds. This alternative was created by the government to facilitate petroleum exploration by making additional blocks accessible.

Applications for permits must include maps clearly defining the area, a proposed work program, cost estimates, proof of ability to carry out the proposed work both financially and technically, specifications of the type of permit requested and the length of time desired, and of course, an application fee. When deciding as to whether to grant permit approval, the government considers the work program in reference to the known geology and environmental restrictions. If an exploration or mining permit is granted, a deposit of NZ$250,000 is required to assure compliance with all terms and conditions of that permit. In the case of mining permits, the following rent conditions apply: 12.5 percent royalties must be paid on the sale of all petroleum produced, and copies of all data reports are to be given to the government. For exploration permits, the government may choose to either participate by investing 11 percent of development costs in return for 11 percent of production revenue or not invest and, therefore, not be entitled to later returns.[4]

SUMMARY

Over the past decade New Zealand has been working towards increasing energy independence and cutting costs. Changes in the government structure and regulatory powers have been initiated to phase the government out of direct involvement in energy

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[4] "The New Zealand Petroleum Exploration and Mining Regime." *Petroleum Exploration in New Zealand News* (September, 1991).

markets. An ongoing period of adjustment is to be expected after so many changes in ministry portfolios and legislation, such as the Resource Management and Crown Minerals Acts. The Ministry of Commerce, in particular, has taken on numerous additional responsibilities. Critics contend that since the dissolution of the Ministry of Energy the country lacks a true energy policy, and that this may lead to future conflicts between economic and environmental goals. For example, the government has a commitment to reduce CO_2 emissions, yet desires the economic benefits associated with a vital fossil fuel industry. The Ministry of Commerce believes that its energy policy is quite straightforward: to promote competition and economic efficiency in energy markets; to correct for market failures; to protect energy security; and to expand public knowledge about energy markets in order to assist both producers and consumers in making better decisions about investments and energy use.

Clearly, there is a range of opinions on how the energy sector should operate and on the role the government should play in energy markets. The energy market reforms are far-reaching; obviously their effects will continue to be felt for many years as the markets adjust. Many feel that the reforms were phased in too rapidly, while others may feel the reforms did not go far enough. The situation is evolving still, and the only clear conclusion is that changes will continue, since New Zealanders seem to indicate their displeasure with government policies every three years at the polls. The government is unlikely to reverse most of its deregulation policies, but further changes in government structure and policy implementation are virtually inevitable.

Five

THE OIL INDUSTRY

OVERVIEW

The oil sector in New Zealand has undergone major changes over the past decade: a number of new oil fields have been discovered; a major refinery expansion program was completed; the synthetic gasoline plant was commissioned; the national oil company was privatized; the market was deregulated; and the Ministry of Energy was merged into the Energy and Resources Division within the Ministry of Commerce. In addition, the new Crown Minerals Act sets out terms for prospecting and mining. Recently, several companies have attempted to enter the gasoline market, and Petrocorp, the newly privatized state oil company, is battling to gain access to the refinery so that it too may enter the wholesale market. To date, none of these efforts have been successful. Market deregulation began only in 1988, however, so the new order is still evolving.

MAJOR PLAYERS

Five companies dominate New Zealand's oil market: British Petroleum (BP), Mobil, Shell, Caltex, and more recently, the New Zealand-based Petrocorp Exploration, Ltd., which is wholly owned by Fletcher Challenge Petroleum, Ltd. (FCP). Shell and BP are engaged in both upstream and downstream activities, while Caltex and Mobil are engaged in downstream activities only. These four major oil companies process crude and other feedstocks at the Marsden Point refinery, which is operated by the New Zealand Refining Company (NZRC). All five oil companies own shares in NZRC. Petrocorp is active in upstream activities and has been trying—unsuccessfully to date—to gain access to the refinery and to participate in downstream marketing as well.

Currently, the wholesale market is divided approximately as follows: BP, 30 percent; Mobil, 28 percent; Shell, 27 percent; and Caltex, 15 percent.

Petrocorp originally was formed as New Zealand's national oil company, and initially all shares were held by the Ministers of Energy and Finance on behalf of the government. In 1987, 30 percent of Petrocorp's shares were offered to the public, and in that same year, the government decided to sell its remaining 70 percent interest. Fletcher Challenge, the largest company in New Zealand, purchased the government's shares and subsequently acquired the remaining shares. Petrocorp is now a fully owned subsidiary of Fletcher Challenge Petroleum (FCP). It is also a multinational company, with offices and interests in New Zealand, Thailand, the Philippines, Indonesia, and Canada; an office in Singapore; and interests in China, where it is currently the only foreign company prospecting onshore. The company is currently negotiating for exploration permits for acreage offshore Vietnam. Petrocorp has also participated in exploration activities in the United States, Australia, Papua New Guinea, and Colombia. FCP is also a major player in the international methanol market, and recently acquired a world-scale methanol facility in Chile.

The other major player in New Zealand's oil market is the government, although its role has changed significantly since the market was deregulated. The 1970s and 1980s were a time of great volatility in the international oil market. The oil price shocks of 1973-74 and 1979-80 heightened concerns over supply security in oil-importing countries around the world. Yet even by world standards, New Zealand's concern over self-sufficiency and security of supply bordered on the obsessive. Post-oil shock New Zealand entered the era of the "Think Big" projects, which included the Petralgas methanol plant, the Petrochem ammonia/urea plant, the Motonui Synfuels project, the Marsden Point refinery expansion and upgrade project, and the expansion of the steel industry. These projects were largely a product of the Muldoon administration (National Party) in the 1978-84 period; although the synfuels plant was not commissioned until 1985 and the refinery expansion was not completed until 1986, these projects were all approved under the National Party government.

In July 1984, the Labour Party, under the leadership of David Lange, won the general election. The new Labour government's energy policy emphasis shifted away from its preoccupation with energy self-sufficiency and began to take steps toward rationalization and the promotion of cost-efficiency. The state withdrew from direct involvement in the coal and electric power sectors by establishing State-Owned Enterprises (SOEs), known as Electricorp and Coalcorp, to operate these businesses on a purely commercial basis. As mentioned above, the national oil company, Petrocorp, was acquired by Fletcher Challenge Petroleum. Prior to deregulation, these three energy entities were administered by the Ministry of Energy (MoE), which was subsequently transformed into the Energy and Resources Division and merged into the Ministry of Commerce (MoC).

EXPLORATION AND DEVELOPMENT ACTIVITIES

Oil exploration activities in New Zealand commenced in 1865, and by the turn of the century, 19 exploration wells had been drilled. Table 5.1 provides details on drilling activities from 1865 to 1990. The early years of exploration were generally disappointing; outside of a small oil and gas find at Motorua, New Plymouth, no commercial accumulations were discovered until the Kapuni find in 1959. As indicated in Figure 5.1, virtually all the wells drilled up to that point were exploration wells. The Kapuni discovery was an event of considerable importance. The discovery heralded a revival of interest in exploration. During the 1950s, 16 exploration wells were drilled; in contrast, 47 exploration wells were drilled during the decade following the Kapuni discovery. No appraisal or development wells were drilled during the 1950s; appraisal and development drilling was almost entirely a phenomenon of the post-1960 period. With the advent of deep drilling and modern exploration techniques, exploration activities began to be more successful. Since the 1980s were characterized by fairly aggressive exploration, Table 5.1 and Figure 5.2 provide a closer look at the types of onshore and offshore wells drilled each year in the 1980-90 period.

Petroleum exploration and development was regulated by the Ministry of Energy, which issued the prospecting licenses that were required for exploration, and mining

Table 5.1
Petroleum Wells Drilled in New Zealand, 1865-1990

	Exploration		Appraisal		Development			Total	
Period	Wells	Meters	Wells	Meters	Wells	Meters		Wells	Meters
1865-1900	19	4,427						19	4,427
1900-1909	30	7,710						30	7,710
1910-1919	29	11,293			2	1,762		31	13,055
1920-1929	20	12,564						20	12,564
1930-1939	22	11,960						22	11,960
1940-1949	18	20,394						18	20,394
1950-1959	16	9,206						16	9,206
1960-1969	47	63,882	1	3,568	4	1,596	s	52	69,046
1970-1979	56	101,641	2	4,991	7	27,402	s	65	134,034
1980-1990	96	276,087	8	21,753	25	68,289		129	366,129
Annually Onshore									
1980	3	9,223						3	9,223
1981	1	3,050	1	2,250				2	5,300
1982	2	8,974	1	4,935				3	13,909
1983	6	16,126	1	5,037	2	9,314		9	30,477
1984	5	15,098						5	15,098
1985	10	17,649			3	6,326		13	23,975
1986	14	38,067			1	2,290		15	40,357
1987	5	133,354			7	18,427		12	151,781
1988	6	15,765			3	7,696		9	23,461
1989	3	9,317	2	6,331	2	5,149		7	20,797
1990	2	4,205			4	9,493		6	13,698
Annually Offshore									
1980									
1981	4	13,719						4	13,719
1982									
1983	2	5,007						2	5,007
1984	8	28,626						8	28,626
1985	5	13,707						5	13,707
1986	1	3,503			3	9,594		4	13,097
1987	6	16,169						6	16,169
1988	6	24,261						6	24,261
1989	2	8,050						2	8,050
1990	5	12,217	1	3,200				6	15,417

Notes: Excludes Maui-A Platform wells MA1-MA12.

s=service wells included: Kapuni-1, Kapuni-5, McKee Disposal-1.

Source: NZ Ministry of Commerce, "Petroleum Industry Statistical Summary," (not dated)

Figure 5.1: Wells Drilled by Type and Period

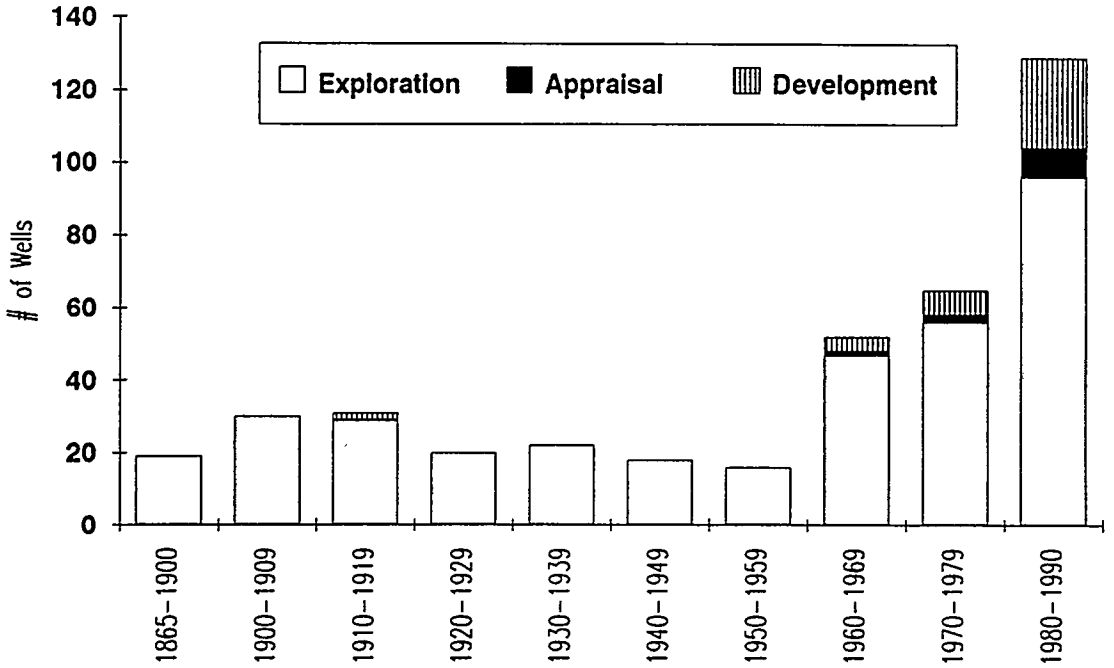
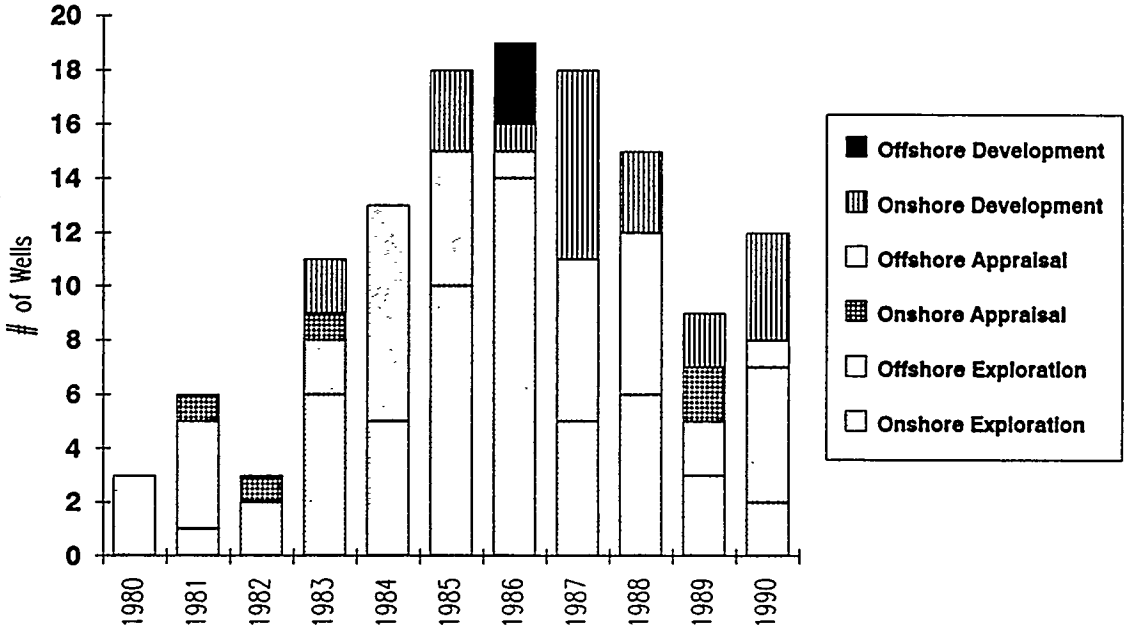


Figure 5.2: Onshore and Offshore Wells Drilled By Type



licenses for exploitation. The contracts that were finalized prior to the disestablishment of the MoE remain in force under the original terms, but all new exploration and development falls under the purview of the MoC, which is now in charge of issuing prospecting, exploration and mining permits.

After the Kapuni find, the government issued exploration licenses for areas offshore Taranaki, Hawkes Bay, Canterbury, and Tasman Bay in 1965, and for the Great South Basin, Solander Basin, and around Chatham and Bounty Islands in 1968 and 1969. Figure 5.3 notes the locations of the major sedimentary basins and oil/gas fields. Each of the licenses had an initial term of five years, with an option for a five-year extension. Licensees were obliged to carry out seismic work and drill at least one well in each area, according to an agreed-upon work program.

Exploration activities paid off in 1969, when sizeable quantities of condensate and associated natural gas, along with some crude oil, were found in two separate areas by the Maui 1 well offshore Taranaki. Further drilling at Maui 2 and Maui 3 also had shows of gas and condensate in the same zones as Maui 1. This early success greatly bolstered hopes for subsequent major discoveries; expectations were boosted even further when the Maui 4 well found oil further south, even though the quantity was too small to be commercially exploitable with the technology and crude prices of the day.

In 1974 and 1975, arrangements were made for government participation in the offshore license areas. The arrangements specified that the government would cover 40 percent of the cost of exploration in return for a 51 percent share in any subsequent developments and extension of the terms of some of the licenses. However, there followed a long dry spell during which, with the exception of some promising shows in the Great South Basin, all the wells drilled were either dry or showed only traces of hydrocarbons. At the end of the 1977-78 financial year, the only offshore licenses remaining current were in the Great South Basin, the Bounty and Chatham Islands area, and a portion of the Taranaki Basin area. The sharp drop-off in the area covered by petroleum prospecting licenses (PPLs) is shown in Table 5.2 and Figure 5.4. In 1978, nearly half a million square kilometers were licensed under PPLs, but by the following year, most of the offshore licenses had expired and were not renewed.

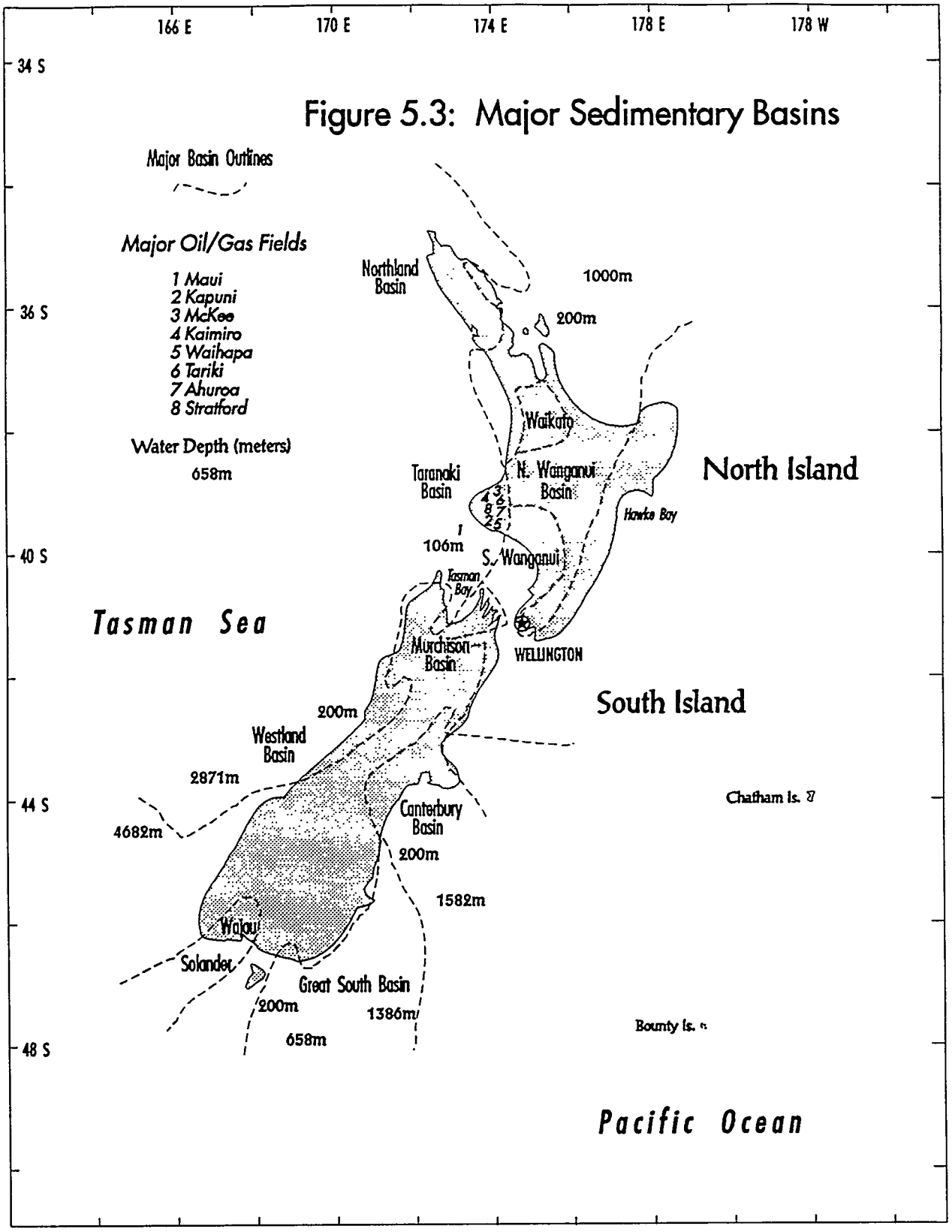


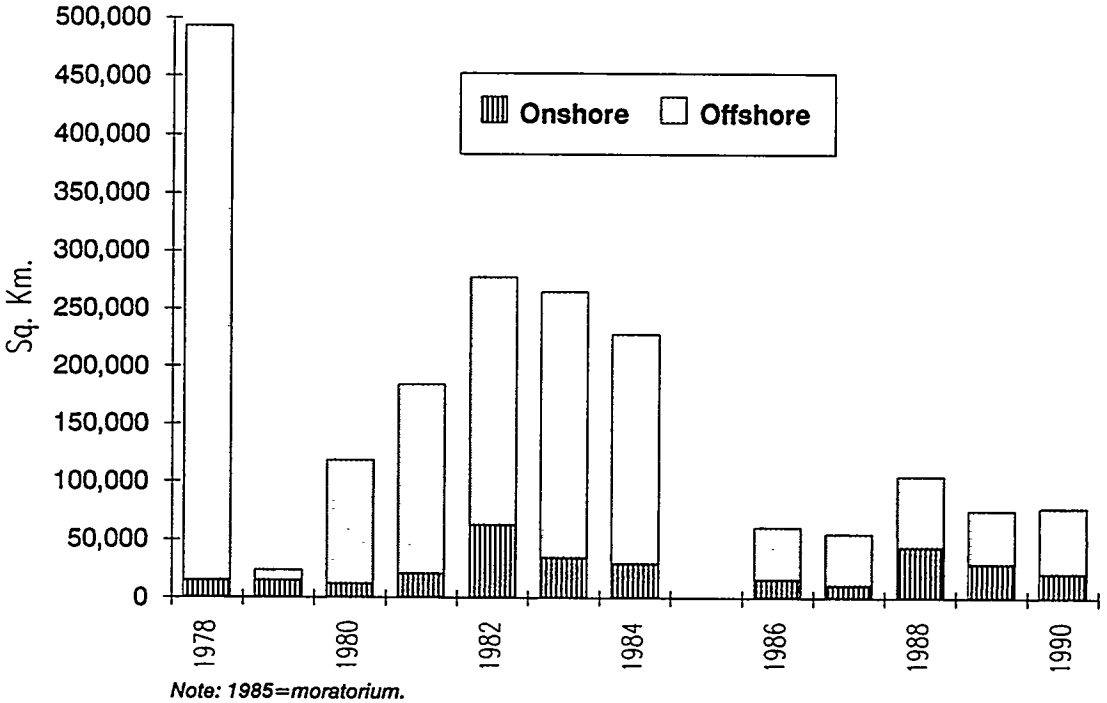
Figure 5.3: Major Sedimentary Basins

Table 5.2
Petroleum Prospecting Licenses
(area in sq. km. under license at year-end)

Year	Onshore	Offshore	Total	# of Licenses
1978	14,543	478,652	493,195	26
1979	14,771	9,088	23,859	5
1980	11,591	107,044	118,635	na
1981	20,467	164,015	184,482	na
1982	62,429	215,439	277,868	39
1983	34,353	230,665	265,018	38
1984	29,223	199,127	228,350	33
1985	0	0	0	0
1986	15,903	44,985	60,888	23
1987	10,889	44,410	55,299	31
1988	43,957	61,290	105,247	54
1989	29,273	46,639	75,912	43
1990	21,098	57,157	78,255	43

Notes: 1985=moratorium. No. of licenses held in 1978-79 is estimate only. na=data not available.
Source: Ministry of Commerce, "Petroleum Industry Statistical Summary," (no date).

Figure 5.4: Area Under Petroleum Prospecting Licenses, 1978-1990



Note: 1985=moratorium.

After the second oil price shock in 1979-1980, exploration activity picked up around the world. In the mid-1980s, vast acreages were advertised for exploration under block offers, attracting many companies to apply for new PPLs. Advertised blocks were located in several sedimentary basins, including onshore and offshore Taranaki, onshore and offshore on the east coast of the North and South Islands, onshore North Wanganui Basin, and onshore Northland. The area under PPLs increased, as did seismic surveying activity, indicated in Table 5.3 and Figure 5.5. Fortune changed in the 1980s, when numerous fields were discovered: the McKee field was discovered in 1980, followed by the Kaimiro and Stratford fields in 1982; the Moki field in 1983; the Waihapa gas and condensate field in 1985; the Tariki, Kupe and Ahuroa fields in 1986; the Waihapa/-Ngaere oil fields in 1988; and the Toru and Ohanga fields in 1990. The 1987-88 financial year saw four new mining licenses and 14 new prospecting licenses granted to New Zealand and international companies; the number of PPLs hit a peak of 54 in 1988.

Currently, there are 43 petroleum prospecting and 11 petroleum mining licenses held. The only commercial fields, however, are the Maui, Kapuni, McKee/Kaimiro, and Waihapa fields. Other fields remain under appraisal. Although development plans are not yet finalized, the Tariki and Ahuroa fields are tentatively expected to come onstream in 1996, and the Kupe field is expected to come onstream in 2001. The Kupe field was operated under a petroleum prospecting license (PPL 38116) by TCPL Resources, Ltd., in a joint venture, but this license expired in 1991. Many parts of New Zealand's potentially hydrocarbon-bearing basins have yet to be fully evaluated.

The Ngatoro 2 field may also become a commercial success. This field was discovered in 1991 in a block prospected by New Zealand Oil and Gas under PPL 38706. Since the block is located directly southwest of the Kaimiro field, operators feel that development and transport costs will be relatively low.

The chief petroleum mining licenses (PMLs) issued by the MoE/MoC are detailed in Table 5.4. For PMLs 38137-38141, the licenses issued were initial term licenses which allowed the licensee to produce for testing purposes only. Of those fields, Waihapa is the only one that has gone into commercial production. The Waihapa joint venture

Table 5.3
Seismic Surveys, 1977-1990
(Line-Kilometers)

Year	Onshore	Offshore	Total
1977			0
1978	839		839
1979	554		554
1980		1,412	1,412
1981	484	6,561	7,045
1982	1,075	15,321	16,396
1983	477	1,128	1,605
1984	1,100	4,300	5,400
1985	780	960	1,740
1986	717	3,693	4,410
1987	524	3,225	3,749
1988	536	3,048	3,584
1989	895	4,469	5,364
1990	148	4,617	4,765

Source: Ministry of Commerce, "Petroleum Industry Statistical Summary," (no date).

Figure 5.5: Extent of Seismic Surveys, 1977-1990

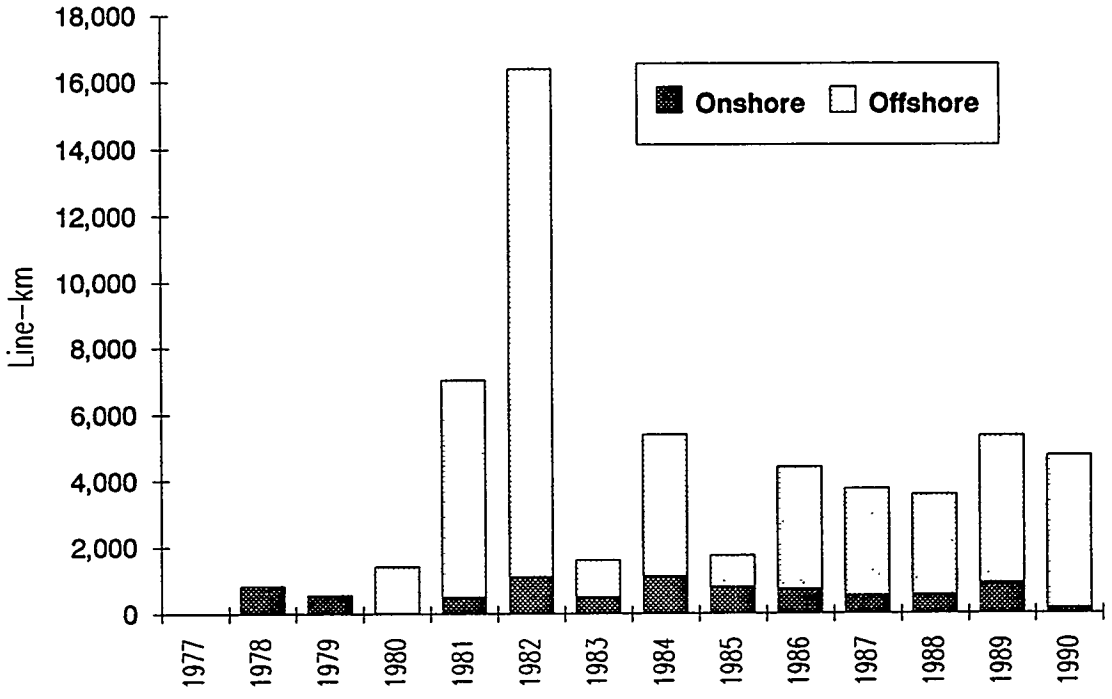


Table 5.4
Petroleum Mining Licenses

Field Name/		Term	Ownership (%)			
PML No.	Date	(years)	SBPT*	Petrocorp	Other**	Crown
Kapuni/38839	7/1/70	42	62.5	37.5		
Maui/381012	6/28/73	42	31.25	68.75		
McKee/38086	11/11/83	20		100		
Kaimiro/38091	4/6/84	30		100		
Stratford/38137	7/21/87	3		49		51
Tariki/38138	7/21/87	3		30.04	31.6	38.36
Ahuroa/38139	7/21/87	3		30.04	31.6	38.36
Waihapa/38140	7/21/87	3		30.04	31.6	38.36
Waihapa (fixed term)	7/90	26		30.04	31.6	38.36
Ngaere/38141	5/4/88	1.5				100

*SBPT includes Shell, BP and Todd.

**Other Waihapa partners per *Oil and Gas Journal*, Nov. 19, 1990: Southern Petroleum 22.6%, Nomeco 5%, Bligh Oil & Minerals 2%, Carpinteria Exploration 2%

Sources: Ministry of Commerce; *Petroleum Intelligence Weekly; Oil and Gas Journal.*

project received a specified-term mining license in July 1990 after its three-year initial term license expired. During the test period, Waihapa was flaring around 200,000 m^3 of gas daily. The wasteful flaring practices continued for two and one-half years until the new PML was finalized, after which flaring was reduced to minimal levels. The Waihapa joint venture had negotiated a gas supply contract with Electricorp in 1989 but had been forced to await the issuance of the PML in 1990 before commercial sales could take

place. The first delivery of Waihapa gas to the Stratford power plant took place in September of 1990.[1]

The Ngaere field, which is located in Block 7 immediately north of the Waihapa field, has been a topic of controversy. When the Waihapa consortium partners were appraising the Waihapa field in February 1988, they quickly found that the field extended beyond the boundary of their license area into the as-yet unlicensed Ngaere area. The consortium applied for an extension of its mining license to include the Ngaere area, but by the end of April 1988, five other companies had applied for prospecting licenses in Block 7.

Rather than extend the license area of the Waihapa consortium or grant a license to one of the new applicants, the Minister of Energy at the time, David Butcher, granted the license to the government under the provisions of the Petroleum Act, which grants broad powers to the Minister to manage petroleum resources in the public interest. The Minister's actions were upheld by the New Zealand High Court in October 1988, but the Waihapa consortium won a reversal from the Court of Appeals in August 1990. The Court of Appeals ruled that the government, as a member of the Waihapa consortium, had contractual obligations to act in the best interests of the partners.

Mr. Butcher then appealed the Court of Appeals decision to the Privy Council in London, which is New Zealand's final court of appeal. The Privy Council ruled in favor of the government, holding that although the Minister did have a responsibility to act in the interests of the consortium, this did not bar the Minister from using his regulatory powers to act on behalf of the nation as a whole. The Crown therefore retains 100 percent ownership of the Ngaere license area.[2]

The government has since announced its intention to sell the Ngaere field as well as its 38.36 percent interest in the Tariki, Ahuroa, and Waihapa fields. The Waihapa

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[1] "New Zealand's Waihapa project proceeding." *Oil and Gas Journal* (Nov. 19, 1990): p. 33.

[2] "New Zealand government wins dispute over Ngaere development rights." *Asian Oil & Gas* (June 1991): p. 9.

holdings will be offered to the other joint venture partners: Southern Petroleum (22.6%), Nomeco (5%), Bligh Oil and Minerals (2%), and Carpinteria Exploration (2%).

OIL PRODUCTION AND THE CRUDE OIL BALANCE

Domestic petroleum production consists of the condensates associated with gas offtake from the Kapuni and Maui fields, plus crude oils produced by the onshore Taranaki fields: McKee, Kaimiro and Waihapa. Figure 5.6 depicts the locations of key oil/gas fields and related infrastructure. Table 5.5 lists New Zealand's producing oil and gas fields, dates of discovery, field operators, and number of wells, as well as production by field. The Kapuni and Maui fields are operated by Shell-BP-Todd (SBPT), an oil and gas exploration and production consortium. In late 1990, Petrocorp expanded its natural gas holdings by purchasing BP's 18.75 percent share in the Maui field, plus BP's 37.5 percent interest in the Kapuni field. This brought Petrocorp's stake in the Maui field to 68.75 percent. The offshore Maui field is New Zealand's major producer, with the owners forming a consortium called Maui Development, Ltd. Production of Maui condensate amounted to around 15,000 b/d in 1990. Maui gas is also processed to yield liquefied petroleum gas (LPG). The other producing fields, McKee, Kaimiro and Waihapa, are operated by Petrocorp. Petrocorp's Natural Gas Corporation (NGC) also produces LPG, condensate and carbon dioxide from Kapuni gas.

Table 5.6 and Figure 5.7 detail the overall crude balance for the period from 1974 through the first quarter of 1991, while Table 5.7 provides a forecast of production by field for the 1991-2000 period. Production is expected to peak at around 40 thousand barrels per day (mb/d) in 1993, dropping to under 25 mb/d by the end of the decade. This assumes that production from Tariki/Ahuroa commences in 1996.

The Motonui Synfuels plant in Taranaki is another important source of non-crude liquid fuels. This plant uses Maui natural gas to make a synthetic gasoline, which is either sold directly into the unleaded gasoline market in the south part of the North Island or blended—and sometimes leaded—at the refinery to boost the octane rating. The Synfuels plant provides gasoline for about 28 percent of New Zealand's demand; 1990 synfuels production amounted to around 12.8 mb/d, as compared to gasoline

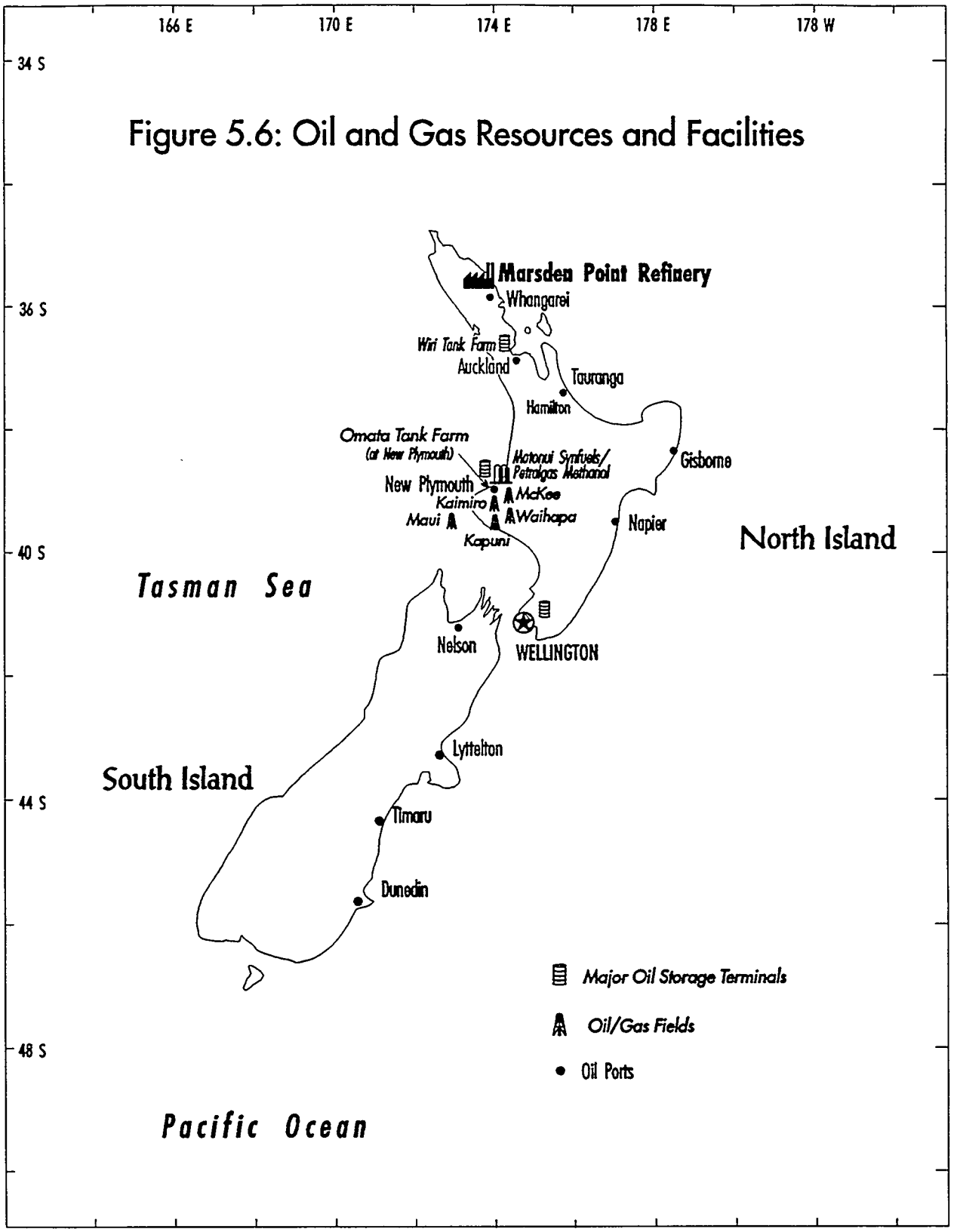


Figure 5.6: Oil and Gas Resources and Facilities

Table 5.5
Oil Producing Fields in New Zealand
(b/d)

Field	Year of Discovery	Operator	API	# of Wells, 1990 Producing	Total	Production 1986	1988	1989	1990
Kapuni	1959	Shell-BP-Todd	53.9	11	14	6,469	5,935	6,100	5,550
Maui	1969	Shell-BP-Todd	58.9	14	14	14,286	6,795	15,000	15,400
McKee	1982	Petrocorp NZ	38.5	19	22	8,659	9,984	11,000	10,100
Kaimiro	1982	Petrocorp NZ	42.0	2	2	74	74*	74	100
Tariki	1986	Petrocorp NZ	52.7	0	1	0	1,474*	0	0
Ahuroa	1987	Petrocorp NZ	46.1	0	1	0	852*	0	0
Waihapa	1988	Petrocorp NZ	36.6	5	6	0	2,943*	6,100	8,250
Totals				51	60	29,488	28,057	38,274	39,400

**Estimated production rates only. No permanent production facilities in place.*

Sources: 1986-1989 data per Oil and Gas Journal, "Worldwide Report,"
1990 estimated data based on NZ Ministry of Commerce "Energy Data File," July 1991 and industry sources.

demand of around 45.6 mb/d. Quantities of synfuels are also exported; in 1989, around 45 percent of output was exported (4.7 mb/d of 10.3 mb/d total production).

In 1990, production totalled around 12.8 mb/d and exports amounted to around 1.9 mb/d—a small quantity, but in the future, New Zealand's synthetic gasoline may become an extremely attractive gasoline blendstock for refiners in areas where gasoline specifications restrict aromatics content. In California, for example, the reformulated gasolines are to have a cap of 25 percent on total aromatics. To a California refiner faced with a stringent aromatics specification, the value of a blendstock like New Zealand's syngas could be well above the value of conventional gasolines. If price differentials are favorable, it may be optimal for New Zealand to export syngas and import regular gasoline, though the magnitude of this type of trade may be limited by the continued growth in gasoline demand and the dynamics between Mobil, which is entitled to up to 60 percent of synfuels production; Fletcher Challenge, which takes the remainder of production as either syngas or methanol, depending on market conditions;

Table 5.6
New Zealand Crude Oil Balance
('000 b/d)

Year	Production	Imports	Exports	Demand
1974	3.8	52.5	0.0	56.3
1975	3.9	40.3	0.0	44.2
1976	10.4	41.0	0.0	51.4
1977	14.9	40.4	0.0	55.3
1978	12.6	32.5	0.0	45.1
1979	8.1	42.0	0.0	50.0
1980	7.2	41.0	0.0	48.2
1981	9.5	34.6	0.0	44.1
1982	14.8	31.0	0.0	45.8
1983	14.4	31.4	0.0	45.8
1984	18.4	32.4	0.0	50.8
1985	26.9	18.2	14.0	31.1
1986	29.7	22.0	4.0	47.6
1987	28.3	46.5	2.2	72.6
1988	34.1	51.0	7.0	78.1
1989	38.2	62.4	9.5	91.1
1990	39.4	64.9	14.9	89.4

Conversion assumptions: 8 bbl/ton NZ crude+condensate, 7.5 bbl/ton foreign crudes.
Source: NZ Ministry of Commerce, "Energy Data File," July 1991.

Figure 5.7: Crude Balance, 1974-1990

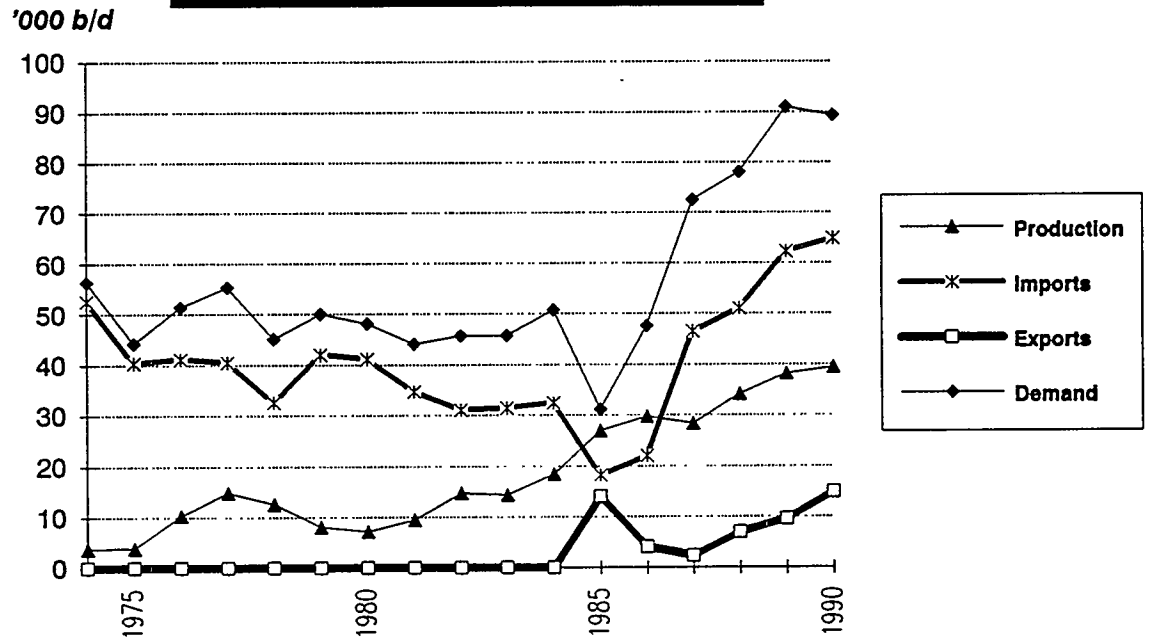


Table 5.7
Oil Production Forecast by Field
(b/d)

Field	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Kapuni	5,147	5,147	5,147	5,147	5,147	5,147	5,147	5,147	5,147	5,147
Maui	14,853	14,523	20,579	18,294	17,955	18,087	18,043	17,398	16,483	16,526
McKee	9,331	8,602	6,627	5,164	4,150	3,363	2,688	2,181	1,762	1,429
Kaimiro	131	27	23	18	14	9	9	5	5	5
Tariki/Ahuroa	0	0	0	0	0	496	635	580	607	802
Waihapa	9,661	7,722	7,468	6,209	2,762	1,800	1,232	984	848	711
Total	39,124	36,021	39,843	34,833	30,027	28,903	27,754	26,294	24,852	24,618

Sources: NZ Ministry of Commerce, "Energy Data File," July 1991, and industry sources.

and the government, which is paid a clawback by Fletcher Challenge on sales up to 580,000 tons per year. Additional details on the synfuels plant are included in Chapter Six of this report.

CRUDE IMPORTS AND EXPORTS

New Zealand is not a major crude oil exporter, though exports have increased considerably in recent years as domestic crude production has risen. Crude exports did not commence until 1985, and the amount exported in that year (14 mb/d) was an aberration at the time; this high level of exports was occasioned by the closure of the refinery from July to November of that year. By the following year, crude exports fell to 4 mb/d, and 1987 export levels amounted to only around 2.2 mb/d. By 1988, however, crude production began to rise and exports climbed to 7 mb/d in 1988, 9.5 mb/d in 1989, and nearly 15 mb/d in 1990. Australia is the destination of essentially all of New Zealand's crude exports.

As Table 5.6 indicates, New Zealand is a net importer of crude oil. Imports were at a very low level of around 18.2 mb/d in 1985 when the refinery was closed for part of the year, but imports since then have risen steadily, reaching a record-high 65 mb/d in 1990. This may seem odd in light of the fact that, as mentioned in the paragraphs above,

crude exports also reached an all-time high in 1990, but the pattern makes more sense if viewed as a function of crude quality and price coupled with the political and economic priorities of the oil companies involved. As noted in Chapter Two of this report, New Zealand's indigenous crude and condensate resource is light and extremely low in sulfur content. Insofar as exporting high-quality domestic crudes and importing lower-quality foreign crudes provides profit, this behavior would be expected to persist. In addition, a certain level of Middle Eastern crude imports are required for the production of asphalt. However, it is argued that, at least in part, this trade pattern exists because Petrocorp has not been allowed access to the refinery to process its domestic crude. The export market is all that remains for Petrocorp production that is not purchased by one of the four refiners.

Crude oil imports originate from a variety of sources, chief among which are Saudi Arabia, the United Arab Emirates, Australia, and Indonesia. Crude imports and exports by source/destination are detailed in Table 5.8. Figure 5.8 emphasizes the importance of Middle Eastern crudes in New Zealand's import slate. In 1990, nearly 83 percent of crude imports came from the Middle East, with the total OPEC share amounting to around 76 percent. Import crudes are purchased by the four major companies currently refining at the Marsden Point Refinery. New Zealand has no government-to-government deals for the supply of crude oil.

Oil Pipelines and Transportation.

Imported crude oil and semi-refined feedstocks from the Middle East and the Asia-Pacific region are shipped to the refinery at Marsden Point in large-range tankers, usually of around 100,000-140,000 deadweight tons capacity (dwt).[3] Ships of this size class are typically referred to as Large Range tankers (in the terminology of AFRA), Suezmax ships (the largest size capable of passing through the Suez Canal fully laden), or the "million-barrel" ships (referring to the approximate cargo size). The jetties servicing the refinery are situated at the entrance to Whangarei harbor and have the deepest

[3] Deadweight tonnage=the weight of ship, cargo and stores.

Table 5.8
Crude Oil/Feedstock Imports and Exports by Source and Destination
('000 tons)

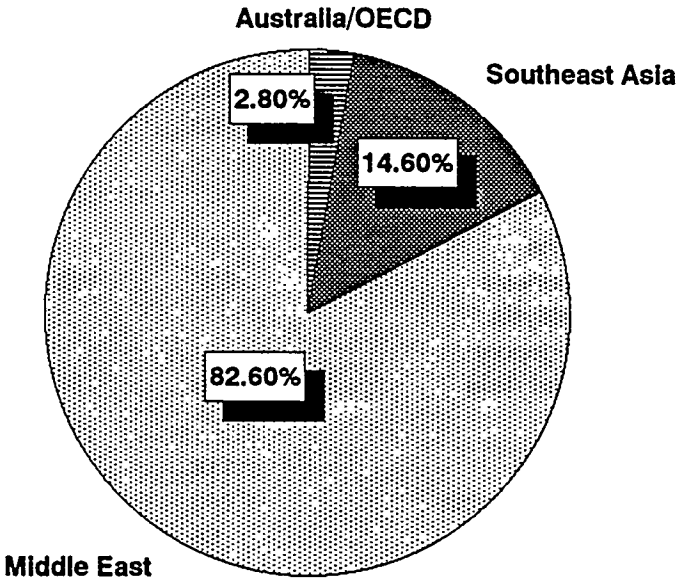
	Imports			
Source	**1987**	**1988**	**1989**	**1990**
Australia	488	632	235	74
USA				15
Total OECD	488	632	235	89
China	107			
Indonesia	252	166	320	301
Malaysia				60
Singapore				102
Total Asia	359	166	320	463
Iran		190		
Kuwait	118	76		
Saudi Arabia	1,240	1,045	1,541	1,716
UAE	85	312	698	407
Other Near/Middle East			232	498
Total Middle East	1,443	1,623	2,471	2,621
TOTAL	2,290	2,421	3,026	3,173
Total OPEC	1,695	1,789	2,559	2,424
Destination		**Exports**		
Australia	100	316	435	695

Sources: IEA, "Oil and Gas Information, 1987-1989," and "Quarterly Oil Statistics."

berths in New Zealand, approximately 15.5 meters. These berths handle more cargo than any other port in the country. The jetties were upgraded at the time of the refinery expansion, and can now accommodate tankers of up to 145,000 tons displacement with no limitation on overall length. Two of the cargo berths at Port Whangarei, with 9.45 meter depth and around 183 meters maximum length, are equipped for refined product discharge.[4]

[4] Lloyd's of London. *Ports of the World.* 1988.

Figure 5.8: Crude & Feedstock Imports by Source, 1990



Total imports=3,173 mt; OPEC share=76.4%

The domestic McKee and Waihapa crudes and Maui and Kapuni condensates are sent via pipeline or truck to New Plymouth, site of the Omata tank farm, before being shipped to the refinery at Marsden Point. Four coastal tankers have been hired on long-term leases by the oil companies involved with the refinery and are used to transport condensate, crude, and synthetic gasoline from New Plymouth to the refinery. These tankers bring domestic feedstocks to the refinery three to four times a week and also pick up refined products for local distribution.

A 170-km pipeline links the refinery with the bulk-storage depot at Wiri in South Auckland. The pipeline was commissioned in June 1985 at a cost of US$49 million. This pipeline delivers one-third of the refinery output; the other two-thirds are shipped by tanker. The coastal tankers for product distribution are chartered by the four large wholesalers, Shell, Mobil, Caltex, and BP, for service to ports around the country. The major oil ports are shown in Figure 5.6. For a variety of safety and economic reasons, the pipeline is the preferred mode of transport for products, and the line has also helped

reduce traffic congestion at the refinery jetties. The flow of products through the pipeline is controlled from Marsden Point. Around one million tons per year of five refined "white," or "clean," products (gasolines and middle distillates, as opposed to "black oils" or "dirty" products, which are the heavier products like fuel oil and bitumen) are pumped through the pipeline. There is a single pumping station at Marsden Point. The pipeline is used 24 hours a day to pump gasoline, automotive diesel, and kerosene for further distribution by road tanker, or in the case of aviation fuel, the product is pumped directly to the International Airport at Mangere, Auckland.

PETROLEUM PRODUCT DEMAND AND PRODUCT BALANCES

Like many developed countries, New Zealand's oil demand fell in the period following the oil price shocks of the 1970s. Also as in many other countries, however, the drop in demand was almost entirely accounted for by fuel oil. Table 5.9 presents actual oil demand by product for 1974-1990, plus a forecast of demand during 1991-2000. Figure 5.9 depicts the overall trend. In the 1974-80 period, fuel oil demand dropped by around 9 percent per year, accelerating its rate of decrease to around 16.5 percent per year in the 1980-85 period. The only other fuel to show an actual decline in the 1980-85 period was gasoline, which declined by a fairly modest 0.22 percent per year. In part, this was a result of a government program to promote the use of LPG and compressed natural gas (CNG) as automotive fuels. Demand for LPG and natural gas liquids (NGL) increased more than six-fold during the 1980s.

During the latter half of the 1980s, oil demand was surprisingly strong, posting average growth rates of around 5 percent per year. Gasoline demand rebounded at rates approaching 4 percent per year during the 1985-90 period. The most rapid growth was seen in the jet fuel market, where demand doubled between 1985 and 1990. To provide a more detailed look at the major petroleum products, Tables 5.10 through 5.15 present historical product balances from 1974 through the first quarter of 1991.

Table 5.10 provides the LPG/NGL balance. As natural gas production grew, so also did gas processing and LPG extraction. Production expanded from less than 0.1

Table 5.9
Actual and Forecasted Oil Product Demand, 1974-2000
('000 b/d)

Year	Other	Fuel Oil	Diesel	Kero/Jet	Gasoline	LPG/NGL	Total
1974	2.70	23.19	18.69	5.57	37.19	0.17	87.52
1975	1.61	17.31	20.70	6.22	47.43	0.09	93.36
1976	0.33	18.51	23.49	6.49	46.53	0.25	95.59
1977	1.44	16.33	22.33	6.77	38.83	0.35	86.04
1978	1.09	13.05	20.77	7.53	38.58	0.43	81.45
1979	2.03	13.98	20.01	8.17	35.87	0.50	80.57
1980	2.80	13.10	20.82	7.74	38.06	0.60	83.11
1981	2.90	10.57	20.81	6.98	38.63	0.84	80.73
1982	2.99	8.04	21.12	6.68	39.57	0.99	79.39
1983	3.02	8.58	20.88	6.69	38.99	1.10	79.25
1984	3.40	5.89	21.68	7.49	39.72	1.66	79.84
1985	3.48	5.32	21.96	7.89	37.63	2.98	79.27
1986	3.10	4.92	20.68	9.13	39.78	3.47	81.09
1987	3.08	5.41	21.24	11.96	42.32	3.53	87.55
1988	3.23	5.28	23.51	13.81	41.67	3.72	91.21
1989	3.94	5.58	26.09	15.37	44.23	3.74	98.94
1990	3.21	7.22	25.31	15.85	45.56	3.91	101.06
1991	3.26	7.22	25.64	16.09	46.04	3.91	102.16
1992	3.32	7.21	25.98	16.34	46.52	3.90	103.27
1993	3.38	7.21	26.31	16.59	47.01	3.90	104.40
1994	3.44	7.20	26.65	16.84	47.50	3.90	105.54
1995	3.50	7.20	27.00	17.10	48.00	3.90	106.70
1996	3.52	7.20	27.11	17.14	48.39	3.90	107.26
1997	3.54	7.20	27.22	17.18	48.79	3.90	107.83
1998	3.56	7.20	27.33	17.22	49.19	3.90	108.40
1999	3.58	7.20	27.45	17.26	49.59	3.90	108.98
2000	3.60	7.20	27.56	17.30	50.00	3.90	109.56
Period		**Average annual growth rate (%)**					
1974-80	0.60	-9.08	1.81	5.64	0.38	23.62	-0.86
1980-85	4.44	-16.49	1.08	0.39	-0.22	37.73	-0.94
1985-90	-1.61	6.29	2.88	14.96	3.90	5.58	4.98
1990-95	1.76	-0.06	1.30	1.53	1.05	-0.04	1.09
1990-00	1.16	-0.03	0.85	0.88	0.93	-0.02	0.81
1995-00	0.57	0.00	0.41	0.23	0.82	0.00	0.53

Source: 1974-1991 data from Ministry of Commerce, "Energy Data File," July 1991; forecast by authors.

Figure 5.9: Petroleum Product Demand, 1974-2000

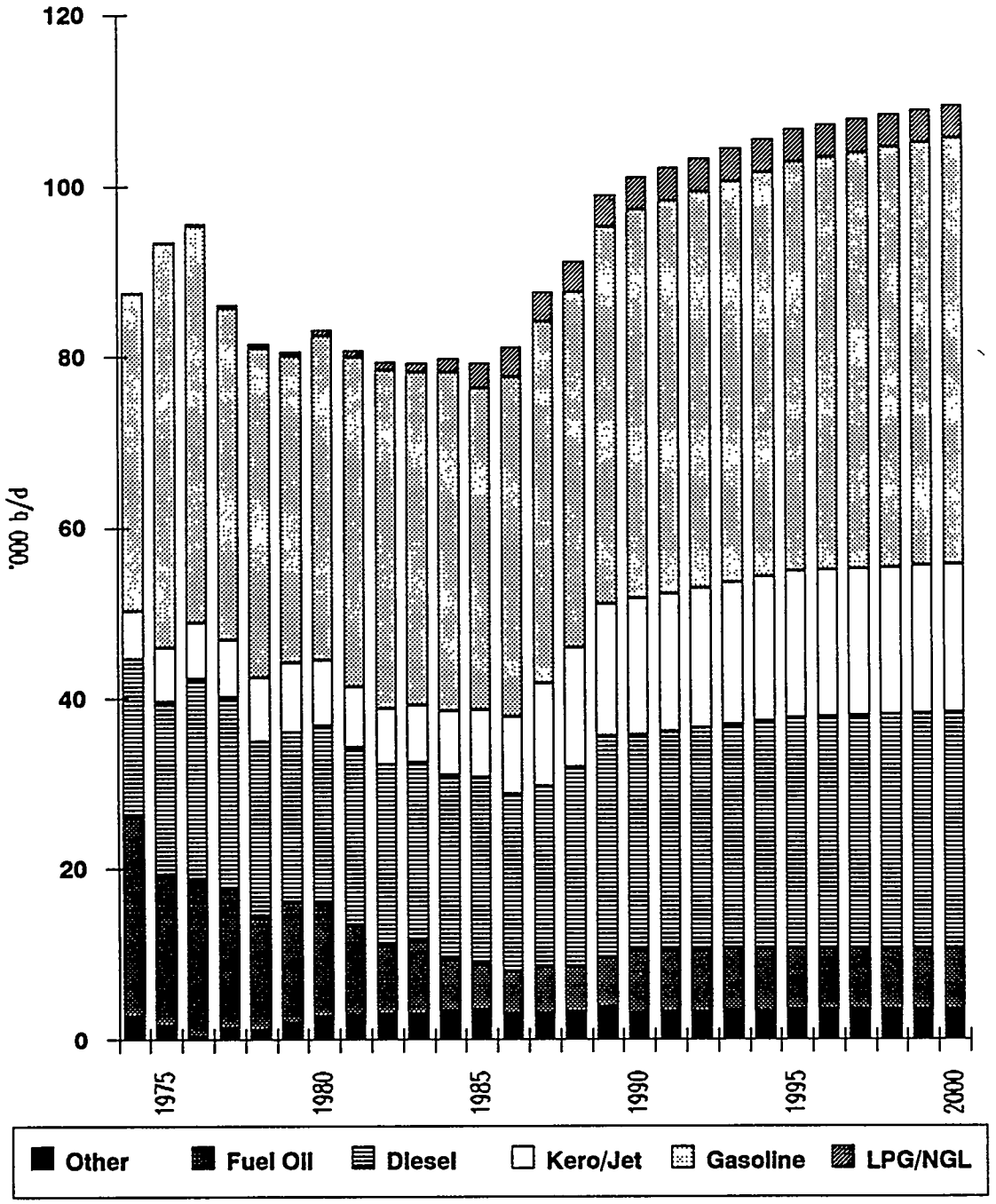


Table 5.10
LPG/NGL Balance, 1974-1991*
('000 b/d)

Year	Production	Imports	Exports	Consumption	Stock Change
1974	0.07	0.00	0.00	0.17	-0.10
1975	0.09	0.00	0.00	0.09	0.00
1976	0.25	0.00	0.00	0.25	0.01
1977	0.35	0.00	0.00	0.35	0.01
1978	0.44	0.00	0.00	0.43	0.01
1979	0.75	0.00	0.00	0.50	0.25
1980	1.36	0.00	0.00	0.60	0.76
1981	0.83	0.00	0.00	0.84	-0.01
1982	1.00	0.00	0.00	0.99	0.01
1983	1.09	0.00	0.00	1.10	-0.01
1984	1.67	0.00	0.00	1.66	0.01
1985	2.99	0.00	0.00	2.98	0.01
1986	3.49	0.00	0.00	3.47	0.02
1987	3.49	0.00	0.00	3.53	-0.03
1988	3.61	0.00	0.00	3.72	-0.10
1989	3.69	0.00	0.00	3.74	-0.04
1990	3.95	0.00	0.00	3.91	0.04
1991*	3.91	0.00	0.00	3.92	-0.01
Period		**Average annual growth rate (%)**			
1974-80	64.19	na	na	64.19	na
1980-85	17.09	na	na	17.09	na
1985-90	5.71	na	na	5.71	na
1987-90	4.14	na	na	4.14	na

"Stock Change" includes balancing item.
"1991 data are for the 1st quarter only.
Source: Ministry of Commerce, "Energy Data File," July 1991.

mb/d in 1975 to around 3 mb/d in 1985 and nearly 4 mb/d in 1990. During the 1970s and early 1980s, the government was also actively involved in promoting the use of LPG and CNG as transportation fuels. Many consumers and service station owners were encouraged by the government's support, and they converted automobiles and pumping stations to accommodate natural gas-based transportation fuels. With the collapse in oil prices, the commissioning of the synthetic gasoline plant, and the withdrawal of government support, many consumers switched from CNG back to gasoline during the

latter half of the 1980s. Use of LPG as an automotive fuel has also been declining somewhat, but the local industry continues to promote LPG consumption and fewer consumers have been motivated to switch away.

Table 5.11 presents the supply/demand balance for gasoline, while the data are plotted in Figure 5.10. The transportation fuels balances strikingly illustrate the impacts of the refinery expansion project: in 1985, the year of the refinery shutdown, refined product output dropped precipitously and imports rose to fill the supply gap. By the following year, the refinery expansion was largely complete, and transportation fuel production capabilities had been improved to the point that the gasoline market was roughly in balance (including the output from the synfuels plant). There were even exportable surpluses of aviation fuels and diesel. Prior to 1985, gasoline production capability was around 30 mb/d; in 1990, output was over 42 mb/d. Demand growth during the 1985-1990 period, however, was a surprisingly strong 3.9 percent per year, so that New Zealand remained a slight net importer.

Tables 5.12 through 5.15 provide balances for aviation fuels, diesel, fuel oil, and other petroleum products (chiefly asphalt and lube oils). Demand for aviation fuels had been growing strongly during the 1970s, and all aviation fuels were imported until 1986. With the completion of the hydrocracker, jet fuel production commenced in 1986, reaching around 11 mb/d by the following year and increasing to 17.2 mb/d in 1990. As supplies became more readily available and air travel increased, aviation fuels demand growth averaged 15 percent per year in the latter half of the 1980s.

The completion of the hydrocracker also increased diesel production capability, which rose from historical levels of around 13 mb/d to around 20.5 mb/d in 1987 and 27.6 mb/d in 1990. Diesel demand growth rates also accelerated as additional supplies became available. As a major fuel in the agricultural sector, diesel remains a key fuel in New Zealand. If New Zealand manages to remain a net exporter of diesel throughout the 1990s, this could offer New Zealand a valuable export-earning opportunity, since Asia-Pacific diesel supplies are forecasted to become increasingly tight. Given the extremely high capital costs associated with the refinery upgrade, there could be strong

Table 5.11
Motor Gasoline Balance, 1974-1991*
('000 b/d)

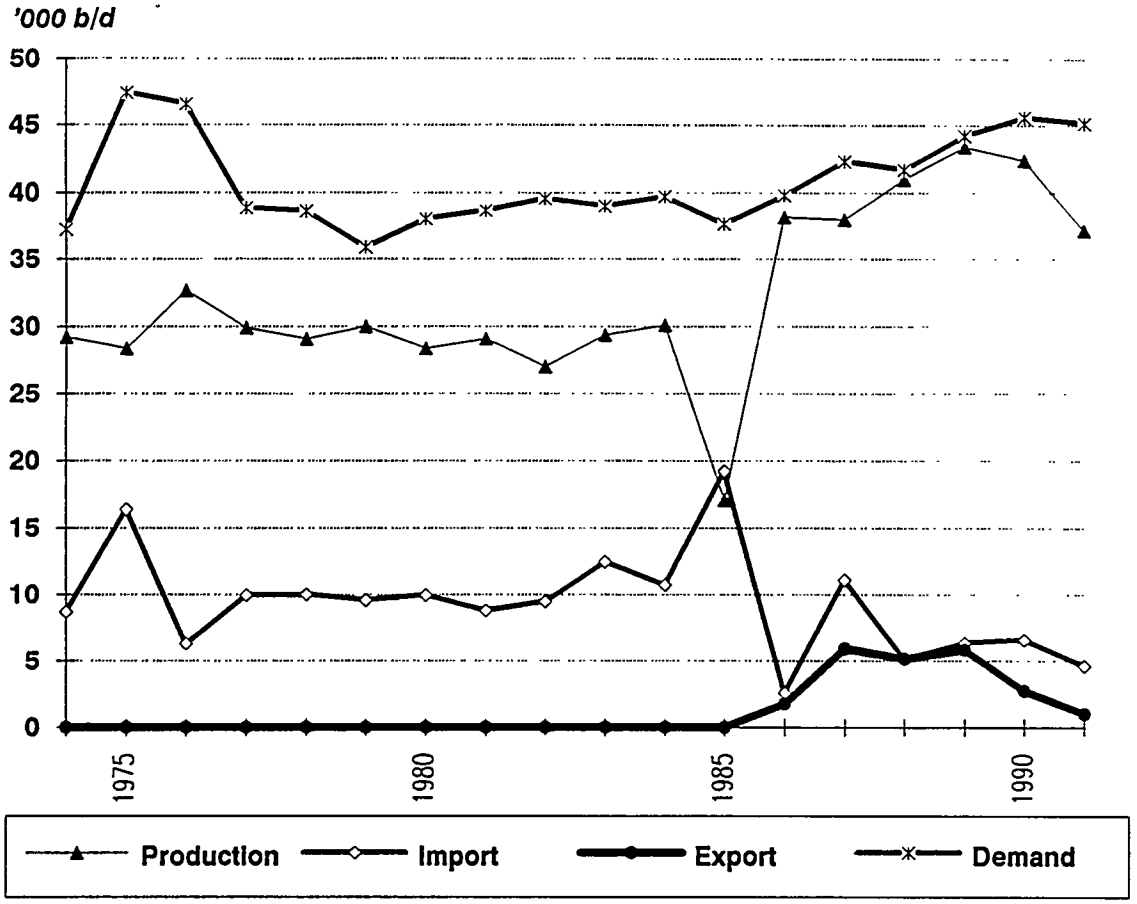
Year	Production	Import	Export	Consumption	Stock Change
1974	29.22	8.71	0.00	37.19	0.74
1975	28.35	16.41	0.00	47.43	-2.67
1976	32.66	6.31	0.00	46.53	-7.56
1977	29.88	9.94	0.00	38.83	0.99
1978	29.07	10.00	0.00	38.58	0.49
1979	30.00	9.58	0.00	35.87	3.71
1980	28.38	9.92	0.00	38.06	0.24
1981	29.09	8.77	0.00	38.63	-0.77
1982	27.02	9.44	0.00	39.57	-3.10
1983	29.40	12.46	0.00	38.99	2.87
1984	30.11	10.72	0.00	39.72	1.12
1985	17.10	19.22	0.00	37.63	-1.31
1986	38.17	2.59	1.77	39.78	-0.79
1987	37.98	11.11	5.88	42.32	0.89
1988	40.98	5.13	5.12	41.67	-0.68
1989	43.40	6.35	5.80	44.23	-0.29
1990	42.41	6.57	2.74	45.56	0.68
1991*	37.17	4.59	0.98	45.17	-4.39
Period		**Average annual growth rate (%)**			
1974-80	-0.49	2.20	na	0.38	na
1980-85	-9.64	14.14	na	-0.22	na
1985-90	19.92	-19.32	na	3.90	na
1987-90	3.74	-16.06	-22.46	2.49	na

"Stock Change" includes balancing item.
"1991 data are for the 1st quarter only.
Source: Ministry of Commerce, "Energy Data File," July 1991.

economic motivation to keep utilization rates high so that exports of high-value products can continue.

Fuel oil demand declined sharply during the 1974-1985 period, as electric utilities switched away from oil. The Marsden A power plant is now the only facility that regularly relies on fuel oil. Other facilities capable of using oil generally are expected to do so only as a backup if hydropower output drops below demand levels. Ship bunkering and industrial activity account for most of the fuel oil use in New Zealand. Total

Figure 5.10: Gasoline Balance, 1974-1991*



*1991 data is for the 1st Quarter only.

demand for fuel oil in 1990 was only around 7 mb/d. Demand during the coming decade is unlikely to fall far below this level.

Demand for other refined products, such as asphalt, petroleum coke, and lubricating oils, is minimal in New Zealand. The Marsden Point refinery has a small (0.8 mb/d) asphalt plant, but is not equipped with a lube oil plant, so lube oils account for most of the imports listed in the balance.

Table 5.12
Aviation Fuels Balance, 1974-1991*
('000 b/d)

Year	Production	Imports	Exports	Consumption	Stock Change
1974	0.00	5.64	0.00	5.57	0.07
1975	0.00	9.66	0.00	6.22	3.44
1976	0.00	6.13	0.00	6.49	-0.36
1977	0.00	6.90	0.00	6.77	0.13
1978	0.00	7.60	0.00	7.53	0.07
1979	0.00	8.38	0.00	8.17	0.21
1980	0.00	8.29	0.00	7.74	0.55
1981	0.00	6.68	0.00	6.98	-0.30
1982	0.00	6.46	0.00	6.68	-0.22
1983	0.00	6.21	0.00	6.69	-0.47
1984	0.00	7.30	0.00	7.49	-0.19
1985	0.00	8.12	0.00	7.89	0.23
1986	0.47	8.30	0.00	9.13	-0.37
1987	10.60	1.98	0.26	11.96	0.36
1988	14.29	0.47	2.32	13.81	-1.37
1989	16.65	0.86	2.48	15.37	-0.34
1990	17.20	0.86	2.27	15.85	-0.06
1991*	16.22	0.44	1.12	14.83	0.70
Period		**Average annual growth rate (%)**			
1974-80	na	6.61	na	5.64	na
1980-85	na	-0.41	na	0.39	na
1985-90	na	-36.17	na	14.96	na
1987-90	17.50	-24.28	105.03	9.84	na

**1991 data are for the 1st quarter only.*
Note: Stock Change includes balancing item.
Source: Ministry of Commerce, "Energy Data File," July 1991.

Table 5.13
Diesel Balance, 1974-1991*
('000 b/d)

Year	Production	Imports	Exports	Consumption	Stock Change
1974	12.28	5.87	0.00	18.69	-0.54
1975	11.33	9.12	0.00	20.70	-0.25
1976	13.75	6.66	0.00	23.49	-3.09
1977	13.40	8.82	0.00	22.33	-0.11
1978	12.85	7.81	0.00	20.77	-0.11
1979	13.32	8.16	0.00	20.01	1.48
1980	13.33	7.45	0.00	20.82	-0.04
1981	13.71	5.36	0.00	20.81	-1.74
1982	11.31	8.84	0.00	21.12	-0.97
1983	12.49	8.60	0.00	20.88	0.20
1984	12.55	9.02	0.00	21.68	-0.11
1985	6.70	14.03	0.00	21.96	-1.23
1986	12.54	8.24	0.00	20.68	0.10
1987	20.47	1.00	0.37	21.24	-0.14
1988	24.30	0.10	4.55	23.51	-3.66
1989	27.87	0.00	6.37	26.09	-4.58
1990	27.61	0.19	4.55	25.31	-2.06
1991*	31.92	0.26	8.44	24.83	-1.08
Period		**Average annual growth rate (%)**			
1974-80	1.37	4.06	na	1.81	na
1980-85	-12.84	13.50	na	1.08	na
1985-90	32.72	-57.63	na	2.88	na
1987-90	10.48	-42.28	130.60	6.02	na

**1991 data are for the 1st quarter only.*
Note: Stock Change includes balancing item.
Source: Ministry of Commerce, "Energy Data File," July 1991.

Table 5.14
Fuel Oil Balance, 1974-1991*
('000 b/d)

Year	Production	Imports	Exports	Consumption	Stock Change
1974	26.08	0.08	0.00	23.19	2.97
1975	18.10	2.23	0.00	17.31	3.02
1976	21.14	0.00	0.00	18.51	2.63
1977	19.49	0.00	0.61	16.33	2.54
1978	15.56	0.00	0.75	13.05	1.76
1979	16.02	0.00	0.18	13.98	1.86
1980	15.91	0.01	0.72	13.10	2.10
1981	10.17	0.01	0.36	10.57	-0.75
1982	7.23	0.63	0.00	8.04	-0.18
1983	6.41	0.65	0.25	8.58	-1.77
1984	6.28	0.89	1.41	5.89	-0.13
1985	5.50	1.49	1.46	5.32	0.21
1986	3.81	1.46	0.32	4.92	0.03
1987	5.83	0.00	0.24	5.41	0.18
1988	5.11	0.21	0.00	5.28	0.04
1989	6.19	0.10	0.65	5.58	0.07
1990	7.11	0.00	0.06	7.22	-0.17
1991*	8.16	0.00	0.00	7.86	0.30
Period		**Average annual growth rate (%)**			
1974-80	-7.91	-25.96	na	-9.08	na
1980-85	-19.14	154.74	15.02	-16.49	na
1985-90	5.27	-100.00	-47.05	6.29	na
1987-90	6.80	na	-37.18	10.07	na

**1991 data are for the 1st quarter only.*
Note: Stock Change includes balancing item.
Source: Ministry of Commerce, "Energy Data File," July 1991.

Table 5.15
Other Petroleum Products Balance, 1974-1991*
('000 b/d)

Year	Production	Imports	Exports	Consumption	Stock Change
1974	2.22	0.33	0.00	2.70	-0.15
1975	1.48	0.59	0.00	1.61	0.47
1976	1.98	0.00	0.00	0.33	1.65
1977	1.97	0.00	0.00	1.44	0.54
1978	1.84	0.04	0.00	1.09	0.79
1979	1.78	0.74	0.36	2.03	0.13
1980	1.86	1.37	0.00	2.80	0.43
1981	1.45	1.26	0.00	2.90	-0.19
1982	1.25	1.22	0.00	2.99	-0.52
1983	2.04	1.25	0.00	3.02	0.27
1984	2.39	0.92	0.00	3.40	-0.09
1985	1.62	1.67	0.00	3.48	-0.19
1986	1.93	0.76	0.00	3.10	-0.41
1987	2.35	0.77	0.00	3.08	0.04
1988	2.44	0.95	0.00	3.23	0.17
1989	2.39	1.14	0.00	3.94	-0.41
1990	2.50	1.02	0.00	3.21	0.31
1991*	2.40	0.73	0.00	3.70	-0.57
Period		**Average annual growth rate (%)**			
1974-80	-2.91	26.88	na	0.60	na
1980-85	-2.78	4.11	na	4.44	na
1985-90	9.06	-9.33	na	-1.61	na
1987-90	1.96	9.88	na	1.33	na

'Stock Change' includes balancing item.

**1991 data are for the 1st quarter only.*

Source: Ministry of Commerce, 'Energy Data File,' July 1991.

Product Imports and Exports

Table 5.16 provides a listing of product imports by source between 1987 and 1990. By virtue of proximity, industry capabilities, generally compatible product specifications, and amiable trade relations, Australia remains New Zealand's major trading partner for petroleum and petroleum products. Australia was the source of most middle distillate imports prior to the Marsden Point refinery expansion and remains a steady supplier of gasoline. Other sources of gasoline include the USA, OECD Europe, Saudi Arabia, and Singapore. Product exports by destination are detailed in Table 5.17. As with product imports, Australia is the leading trade partner, with two-way trade in gasoline and middle distillates. The refinery expansion project has also enabled New Zealand to export quantities of middle distillates to Japan.

STRUCTURE OF DEMAND BY END USE

Table 5.18 provides a breakdown of oil consumption by product and end use sector. New Zealand has been very successful in its drive to reduce dependence on oil in the power sector and has also made considerable progress towards diversifying the sources of automotive transportation fuels. As mentioned earlier, output from the Motonui Synfuels plant is capable of satisfying around 30 percent of domestic gasoline demand, while LPG and CNG also make significant contributions as automotive fuels. On a net calorific basis, CNG sales amounted to around 2.6 percent of the automotive fuels market in 1990, while LPG accounted for around 2.9 percent. Still, the transport sector remains heavily oil-dependent, as Figure 5.11 illustrates. The transport sector accounts for fully 78 percent of New Zealand's oil use. The industrial sector accounts for around 15 percent of the country's oil demand, while the agricultural and residential/commercial sectors account for around 4 percent and 3 percent of demand, respectively.

The disposition of petroleum products used in the four key sectors is depicted in Figure 5.12. Predictably, the bulk of the gasoline and jet fuel are committed to transport use, as well as 58 percent of the LPG/NGL and around 53 percent of the fuel oil. Around 36 percent of the fuel oil supply is used by industry. The industrial sector also

Table 5.16
Oil Imports by Source, New Zealand, 1987-1990
('000 tons)

	Naphtha				Gasoline				Kerosene				Diesel			
	1987	**1988**	**1989**	**1990**	**1987**	**1988**	**1989**	**1990**	**1987**	**1988**	**1989**	**1990**	**1987**	**1988**	**1989**	**1990**
Australia	18			27	119	15	112	86	18	7	9		21	1		
USA					85		1	67								
OECD Europe					53	28	29	30								
Total OECD	18	0	0	27	257	43	142	183	18	7	9	0	21	1	0	0
Singapore					37	14	1	30	56		10		3			10
Total Asia	0	0	0	0	37	14	1	30	56	0	10	0	3	0	0	10
Bahrain					27											
Saudi Arabia					109	177	119	88								
Total Middle East	0	0	0	0	136	177	119	88	0	0	0	0	0	0	0	0
Venezuela													26			
Other S. America					19											
Total S. America	0	0	0	0	19	0	0	0	0	0	0	0	26	0	0	0
Romania			17	17												
Unspecified		48			43		30	30	1					4		
TOTAL	18	48	17	44	492	234	292	331	75	7	19	0	50	5	0	10
Total OPEC	0	0	0	0	109	177	119	88	0	0	0	0	26	0	0	0

Sources: International Energy Agency, "Oil and Gas Information, 1987-1989," and "Quarterly Oil Statistics."

Table 5.16
Product Imports by Source, New Zealand, 1987-1990
('000 tons)

	Fuel Oil				Coke				Other			
	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
Australia			5						37	40		
USA										1		
OECD Europe									2			
Total OECD	0	0	5	0	0	0	0	0	39	41	0	0
Singapore		10							15	3		
Total Asia	0	10	0	0	0	0	0	0	15	3	0	0
Bahrain												
Saudi Arabia												
Total Middle East	0	0	0	0	0	0	0	0	0	0	0	0
Venezuela									1	1		
Other S. America												
Total S. America	0	0	0	0	0	0	0	0	1	1		0
Romania												
Unspecified		1			87	118			23	18	210	0
TOTAL	0	11	5	0	87	118	0	0	78	63	210	0
Total OPEC	0	0	0	0	0	0	0	0	1	1	0	0

Sources: International Energy Agency, "Oil and Gas Information, 1987-1989," and "Quarterly Oil Statistics."

Table 5.17
Oil Exports from New Zealand by Destination, 1987-1990
('000 tons)

	Gasoline				Kerosene				Diesel				Fuel Oil			
	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
Australia			20			11	28			28	121				34	
Japan					6	33	18			101	55					
Total OECD			20	30	6	44	46			129	176				34	
Other W. Hemis.		15	26			54	49			36	64				1	
Asia-Pacific							10				24	102				
Unspecified	251	204	203	102	6	9	8	104*	18	59	25	121	13			1
TOTAL	251	219	249	132	12	107	113	104*	18	224	289	223	13		35	1

** Australia is the destination of the bulk of NZ "Unspecified" petrol exports.*

Sources: International Energy Agency, "Oil and Gas Information, 1987-1989," "Quarterly Oil Statistics," and EWC Energy Program files.

Table 5.18
Oil Demand by End Use Sector, 1990
(Thousand tons oil equivalent delivered)

	LPG/NGL	Gasoline	Kero/Jet	Diesel	Fuel Oil	Other	Total
Industry	17	0	5	180	56	349	607
Transport	64	1810	672	603	82	0	3231
Agriculture	0	68	0	102	2	0	172
Res./Comm.	30	0	1	69	16	0	116
Total	111	1878	678	954	156	349	4126

% of total by fuel

	LPG/NGL	Gasoline	Kero/Jet	Diesel	Fuel Oil	Other	Total
Industry	3	0	1	30	9	57	100
Transport	2	56	21	19	3	0	100
Agriculture	0	40	0	59	1	0	100
Res./Comm.	26	0	1	59	14	0	100
Total	3	46	16	23	4	8	100

% of total by sector

	LPG/NGL	Gasoline	Kero/Jet	Diesel	Fuel Oil	Other	Total
Industry	15	0	1	19	36	100	15
Transport	58	96	99	63	53	0	78
Agriculture	0	4	0	11	1	0	4
Res./Comm.	27	0	0	7	10	0	3
Total	100	100	100	100	100	100	100

Note: Gasoline includes synthetic fuels.

Sources: Ministry of Commerce, "Energy Data File," July 1991, and OECD "Energy Statistics of Member Countries."

Figure 5.11: Sectoral Demand for Oil Products, 1990

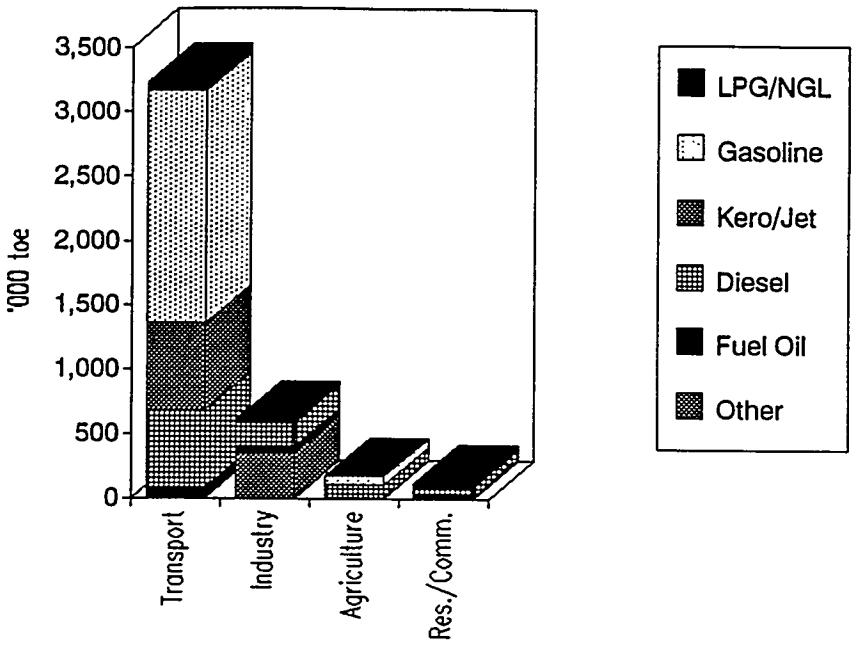
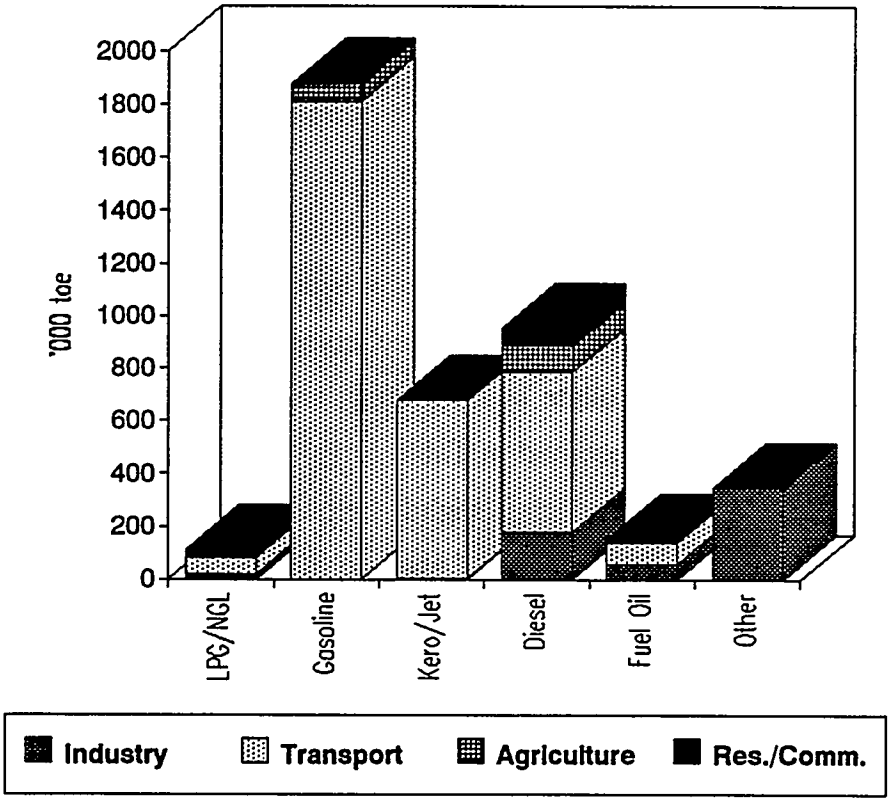


Figure 5.12: Oil Product Demand by End Use Sector, 1990



consumes around 19 percent of total diesel and 15 percent of LPG/NGL supplies. Diesel is the key fuel of the agricultural sector. Around 11 percent of the diesel used in 1990 was devoted to agriculture.

THE REFINING INDUSTRY

The refinery at Marsden Point in the north of the North Island is owned and operated by the New Zealand Refining Company, Ltd. (NZRC). Shares in NZRC are divided as follows:

BP	23.66%
Mobil	19.20%
Shell	17.14%
Caltex	8.57%
Petrocorp	15.53%
Other	15.90%

Commissioned in 1964, the Marsden Point refinery ushered in a new energy era in New Zealand, ending total reliance on imported petroleum products. By the 1980s, the refinery's relatively simple hydroskimming configuration was outmoded, and the refinery was expanded and upgraded as part of the Think Big strategy. During the expansion, crude capacity fell from its prior level of 74 mb/d to an average of around 54 mb/d, but the subsequent expansions increased crude capacity to around 95 mb/d and added substantial conversion capability via the construction of a hydrocracking unit and an associated hydrogen plant, which supplies the hydrocracker with sufficient hydrogen of up to 97.5 percent purity. Other processing technologies at the refinery include catalytic reforming, naphtha and distillate hydrotreating, and asphalt manufacture. The current refinery configuration is presented in Table 5.19. The refinery cracking-to-distillation ratio[5] is around 26 percent, which is slightly below the ratios seen in Australia and Singapore, and is also below the world average of around 33 percent. It is less than half

[5] Defined as (coking+thermal cracking+catalytic cracking+hydrocracking)/crude distillation capacity.

Table 5.19
Marsden Point Refinery Configuration 1990
('000 b/d)

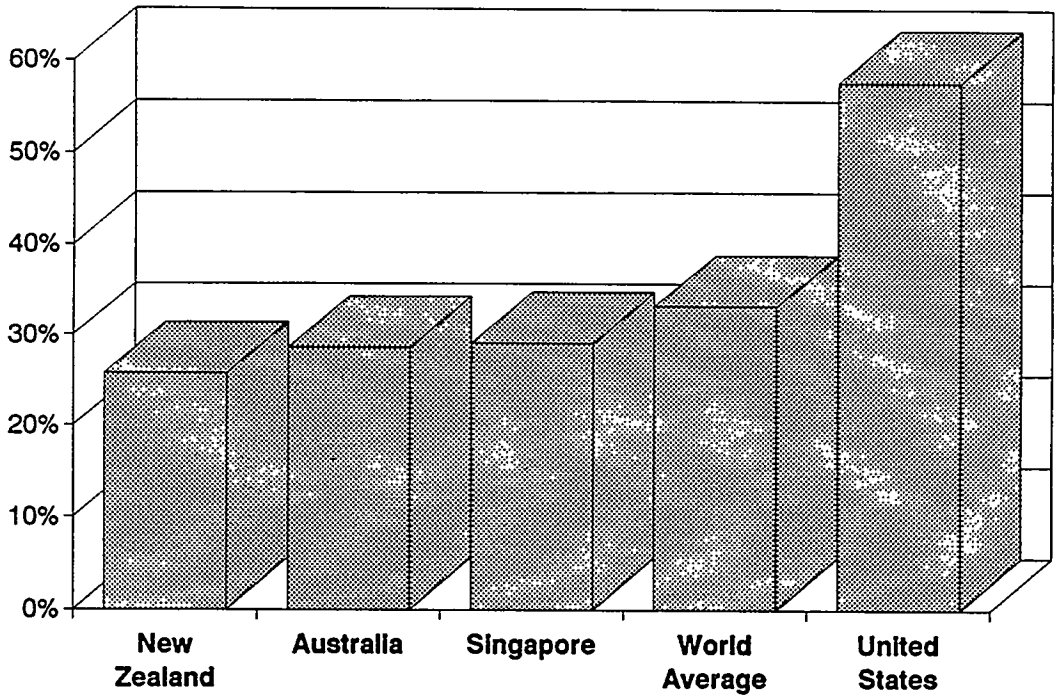
Unit	Capacity
Crude Distillation	95.1
Vacuum Distillation	41.9
Hydrocracking	24.5
Catalytic Reforming	26.6
Naphtha Hydrotreating	40.2
Middle Distillate Hydrotreating	20.5
Asphalt Manufacture	0.8
Hydrogen (MMcf/d)	44.0
Cracking to Distillation Ratios*	
New Zealand	0.26
Australia	0.29
Singapore	0.29
World Average	0.33
United States	0.58

**Defined as (coking+thermal cracking+cat cracking+hydrocracking)/CDU capacity*
Source: Oil and Gas Journal, "Worldwide Report," Dec. 23, 1991.

of the United States' ratio of 58 percent. Figure 5.13 displays comparative cracking-to-distillation ratios. Since hydrocracking is the "Rolls Royce" of cracking technologies, however, this simple ratio greatly understates the flexibility and sophistication of New Zealand's refinery. In 1990, fully 90 percent of the refinery's output was transportation fuels.

The refinery is capable of processing a wide range of feedstocks into an extensive product slate, the most important products being the middle distillates: aviation turbine fuel or avtur, kerosene, and diesel oils. The hydrocracking configuration has enabled New Zealand to become an exporter of jet fuel; prior to the expansion, all jet fuel supplies had been imported. Diesel production has also been enhanced, which is of particular importance since diesel is the basic fuel of farming, fishing and commercial transport. Diesel is the product in greatest demand in the Asia-Pacific region, and

Figure 5.13: Comparison of Cracking-to-Distillation Ratios*



*Defined as (coking+thermal cracking+cat cracking+hydrocracking)/crude distillation capacity

demand for diesel is expected to show continued strong growth throughout the coming decade. As such, having to meet marginal demand for diesel through imports is likely to become an increasingly expensive proposition. In this respect, the addition of the hydrocracker should prove a valuable investment, despite the high capital costs.

The oil companies provide feedstocks to the refinery in the form of crude oil, condensate, residual fuel oils, and naphthas, which are then processed into two grades of gasoline, automotive and marine diesel, jet fuel and kerosene, various fuel oils and bitumen. A by-product of the refinery process is sulfur, used to supply the local fertilizer industry. The feedstocks are delivered by tanker from around New Zealand and overseas. The refinery is capable of processing all kinds of crude, from light crudes to very waxy or heavy crudes. Condensate from Maui and Kapuni and crude oils from

McKee and Waihapa account for around 30 percent of the refinery input slate. The refinery produces an array of products including:

Regular unleaded gasoline, 91 RON clear;
Premium leaded gasoline, 96 RON, 0.35 g/l lead maximum;
Aviation turbine fuel;
Premium kerosene;
Automotive diesel, 45 cetane, 0.3% sulfur maximum;
Marine diesel;
Light fuel oil;
Heavy fuel oil and bunker fuel;
Power station fuel oil (for Marsden A power station);
Bitumen; and
Sulfur.

The modernized refinery accommodates all of New Zealand's immediate and anticipated refining requirements. In the first year of operations with the new plant fully commissioned, capacity exceeded local demand, enabling the export of middle distillates.

TAXES, PRICING AND MARGINS

Oil pricing and taxation has, of course, changed significantly since deregulation in 1988. Prior to deregulation, gasoline prices were assigned maximum and minimum levels to ensure price stability for both buyers and sellers. Margins were also predetermined. For example, the 1987 maximum retail price margins for premium grade gasoline (US$0.54 per liter) contained the following margins:

Retailer margin	4.68¢
Inland distribution	6.55¢
Coastal distribution	1.00¢
Refinery margin	2.24¢
GST on margins	4.93¢
Excise duty	21.45¢
Pool account credit	1.91¢
Production cost	11.50¢

The excise duty was by far the largest individual price component; it included a 0.39 cent local authority levy, a 5.84 cent contribution to the National Roads Board and 16.82 cents for the Consolidated Fund, of which 9.44 cents were intended to cover repayments on the Marsden Point refinery expansion.

In 1990, the tax (in the local currency) on premium gasoline included the following elements:

Local fuels levy	6.6¢
Excise tax (Consolidated Fund)	25.9¢
National Road Board	10.9¢
GST	6.0¢
Total tax, 1990	43.5¢ (around 27.2¢ US)

To provide a look at the prices faced by consumers in New Zealand, Table 5.20 and Figure 5.14 present retail prices of regular unleaded gasoline, premium leaded gasoline, diesel, light fuel oil, and heavy fuel oil, while Table 5.21 and Figure 5.15 present the data adjusted to the CPI for the first quarter of 1991. The overall price trend in nominal dollars is fairly consistent with international price trends in terms of response to the oil price shocks in 1973-74 and 1979-80 and the price collapse in 1986. It also appears that deregulation in 1988 resulted in a slight drop in prices; in nominal dollars, premium gasoline sold for an average NZ$0.92 in 1987 versus NZ$0.89 in 1988. The price drop in nominal dollars soon reversed, with 1990 prices averaging NZ$0.93; however, when prices in the local currency are adjusted to the first quarter 1991 consumer price index, it appears that gasoline continued to become cheaper in 1990.

On July 1, 1989, the government reduced taxes on gasoline and diesel as an anti-inflationary strategy and also to make the local industry more competitive in the international market. Table 5.22 details prices (including tax) and the tax components for gasoline and diesel, converted into US dollars for purposes of comparison with other OECD countries. In 1988, prior to the tax reduction, the tax on gasoline was close to 30¢ per liter, and the tax on diesel was almost 20¢ per liter. By 1989, the taxes had been reduced to around 25¢ and 14¢ per liter for gasoline and diesel, respectively. Gasoline

Table 5.20
New Zealand Retail Prices of Petroleum Products
(NZ cents per liter)

Year	Premium	Regular	Diesel	LFO	HFO
1971	10.6	9.9	4.3	2.4	2.3
1972	10.8	10.1	4.6	2.6	2.5
1973	10.6	9.9	4.6	2.6	2.5
1974	15.2	14.5	9.5	5.7	2.6
1975	27.0	26.1	14.9	10.7	10.3
1976	27.0	26.1	17.9	10.7	10.3
1977	26.9	28.7	17.2	12.3	11.9
1978	31.6	30.7	17.2	12.3	11.9
1979	43.0	41.5	27.0	19.3	18.7
1980	54.0	52.0	38.8	27.4	25.9
1981	64.0	61.0	48.0	35.9	34.4
1982	71.0	68.0	58.5	39.4	37.9
1983	71.0	68.0	58.5	39.4	37.9
1984	90.0	87.0	68.5	39.4	38.0
1985	94.0	91.0	73.3	39.4	38.0
1986	82.0	79.0	61.3	39.9	31.4
1987	92.0	89.0	69.0	39.9	38.2
1988	89.0	86.8	70.3	na	na
1989	93.1	90.8	62.7	na	na
1990 avg.	96.4	94.7	na	na	na
1990 March	92.1	90.1	na	na	na
1990 June	92.6	90.4	na	na	na
1990 Sept.	94.0	92.5	na	na	na
1990 Dec.	107.0	105.6	na	na	na
1991 March	103.0	97.9	na	na	na

Source: Ministry of Commerce, "Energy Data File," July 1991

Figure 5.14: Retail Prices of Petroleum Products

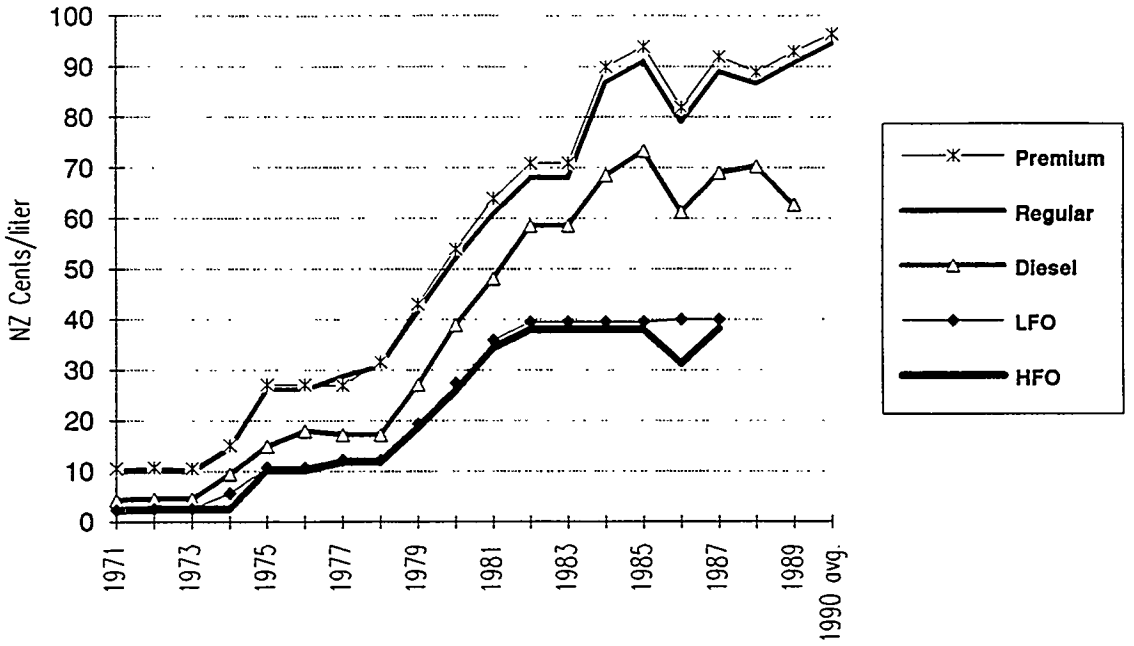
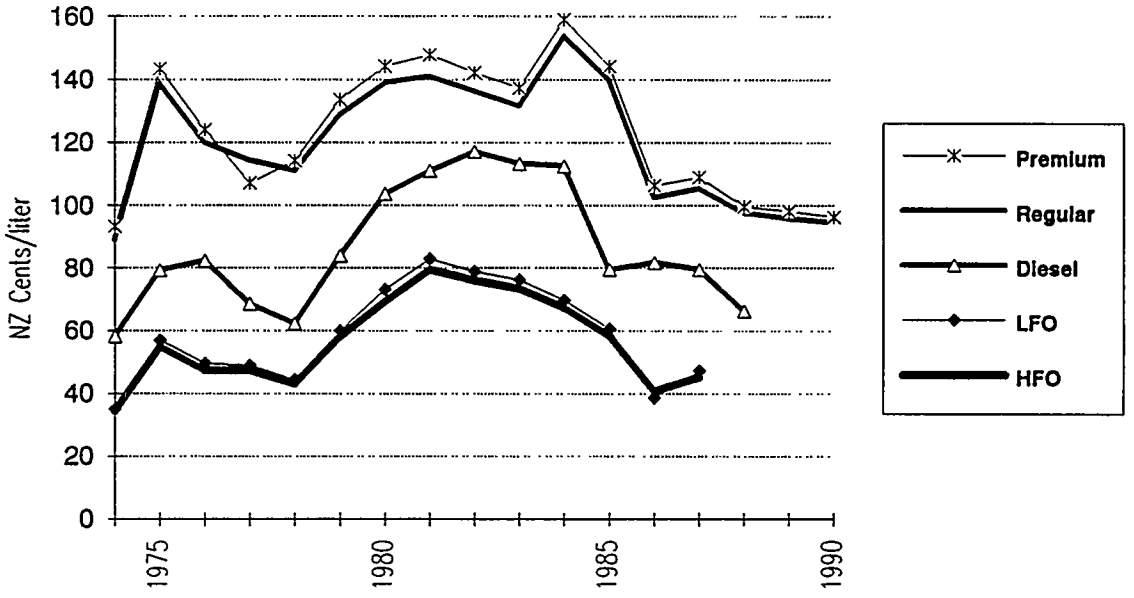


Figure 5.15: Adjusted Retail Prices of Petroleum Products*



**prices adjusted to 1st Qu. 1991 CPI. NZ$1.00 1983=NZ$1.935 March 1991*

Table 5.21
Retail Prices Adjusted to 1st Quarter 1991 CPI
(NZ cents per liter)

Year	Premium	Regular	Diesel	LFO	HFO
1974	93.4	89.1	58.1	35.1	34.5
1975	143.5	138.8	79.2	56.9	54.7
1976	124.1	120.0	82.3	49.5	47.3
1977	107.1	114.3	68.5	49.0	47.4
1978	114.3	111.0	62.2	44.5	43.0
1979	133.6	128.9	83.9	59.9	58.1
1980	144.3	139.0	103.7	73.2	69.2
1981	148.0	141.0	111.0	83.0	79.5
1982	142.2	136.2	117.2	78.9	75.9
1983	137.4	131.6	113.2	76.2	73.3
1984	159.2	153.9	112.5	69.7	67.2
1985	144.2	139.6	79.6	60.5	58.3
1986	106.4	102.5	81.7	38.8	40.8
1987	109.0	105.4	79.5	47.3	45.2
1988	99.6	97.6	66.2	na	na
1989	98.2	95.8	na	na	na
1990	96.43	94.65	na	na	na
1990 March	92.10	90.10	na	na	na
1990 June	92.60	90.40	na	na	na
1990 Sept.	94.00	92.50	na	na	na
1990 Dec.	107.00	105.60	na	na	na
1991 March	103.00	97.90	na	na	na

Notes: 1988 prices are post-deregulation. na=not available
$1.00 1983=$1.935 March 1991
Source: Ministry of Commerce, "Energy Data File," July 1991

Table 5.22
Transportation Fuel Prices and Taxes, New Zealand
(US$/liter)

Year	Gasoline	Diesel	% Tax, Gasoline	% Tax, Diesel
1978	0.318	0.172	44.4	2.4
1979	0.353	0.204	27.6	3.0
1980	0.478	0.342	27.6	2.6
1981	0.516	0.363	22.9	2.2
1982	0.515	0.404	21.9	7.8
1983	0.475	0.391	23.2	13.0
1984	0.451	0.359	21.5	12.0
1985	0.460	0.357	20.9	10.5
1986	0.432	0.326	30.9	20.8
1987	0.530	0.407	49.5	43.1
1988	0.587	0.463	50.3	42.3
1989	0.538	0.393	47.0	36.0
1990	0.545	0.361	47.5	30.2

Note: 1989 diesel price is 3rd Quarter avg. only
Source: International Energy Agency, "Energy Prices and Taxes," various issues.

and diesel prices and taxes are depicted in Figures 5.16 and 5.17, which also show the tax component as a percentage of total price. After the second oil price shock in 1979-80, the prices of gasoline and diesel rose markedly, but the tax component remained fairly constant; taxes accordingly represented a smaller percentage share of total price. In 1986, the government raised taxes on both fuels, and increased them again in 1987 and 1988. Taxes as a percentage of total price rose sharply. In 1985, taxes accounted for 21 percent of the price of gasoline and 10.5 percent of the price of diesel. By 1988, the percentages had more than doubled for gasoline (over 50 percent of the price was taxes) and quadrupled for diesel (over 42 percent of the price was taxes). After the tax reduction in 1989, the percentage shares declined somewhat.

In July 1990, the government announced that it would lift the excise tax on automotive diesel as of January 1, 1991. This reduced the total tax by NZ¢11.2 per liter,

Figure 5.16: Gasoline Prices and Taxes, 1978-1990

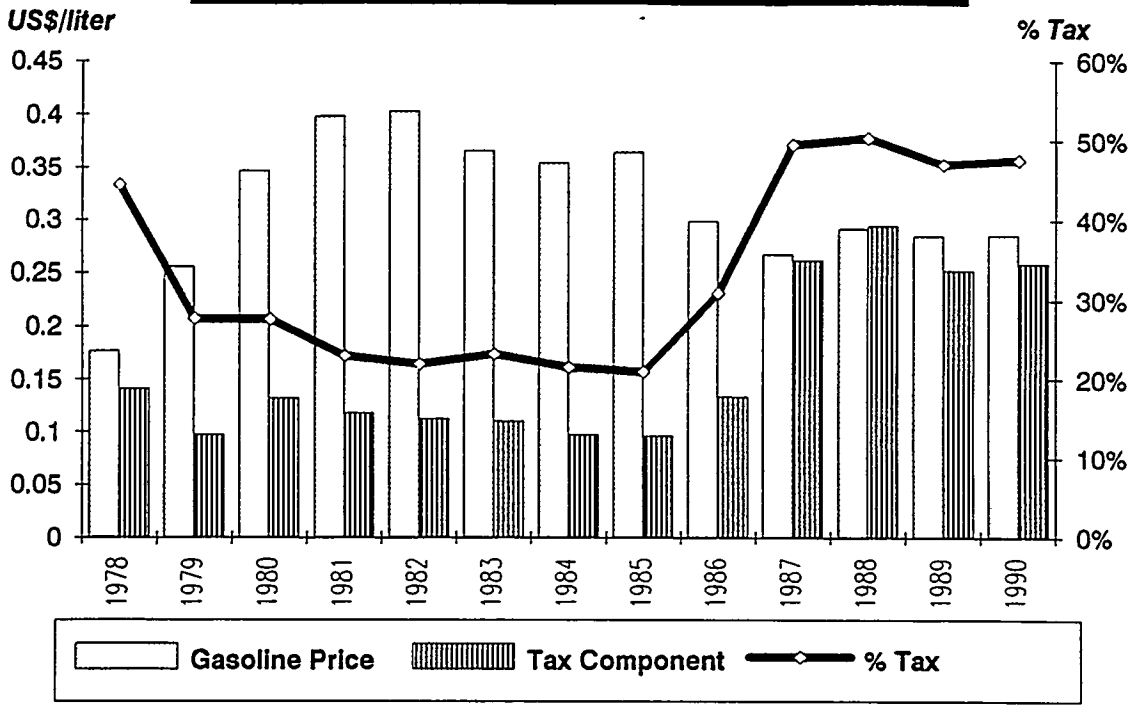
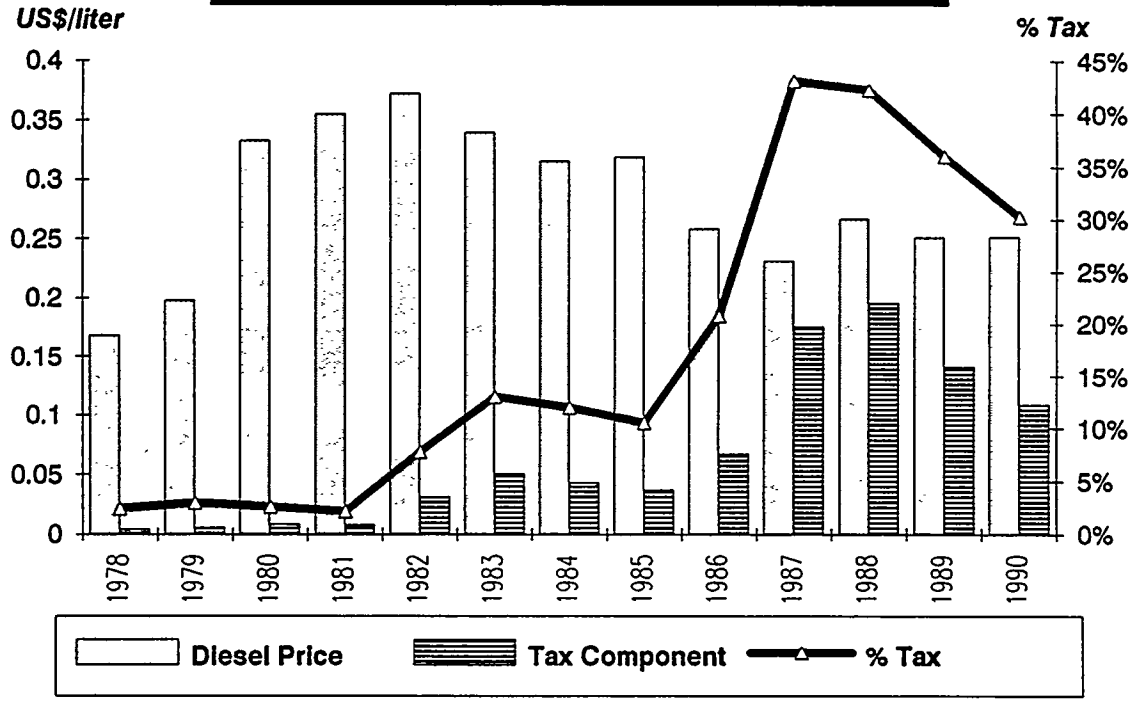


Figure 5.17: Diesel Prices and Taxes, 1978-1990



amounting to an overall price cut of around 20 percent. At the same time, the government moved to discourage addition of lead in gasoline by placing a tax of NZ¢6.6 per gram of lead. In response, refiners cut the maximum lead level in leaded 96 octane gasoline from 0.45 grams/liter to 0.35 grams/liter. Around the Asia-Pacific region, the move toward unleaded and low-lead gasoline grades has been unexpectedly rapid. New Zealand stands out as one of the countries slowest to phase out lead in gasoline. The new tax regime may have had an impact, however; in 1990, the share of leaded fuel was around 80 percent, but following the tax hike, leaded gasoline's share fell to 72 percent in the first quarter of 1991. As recently as 1987, leaded fuel accounted for around 96 percent of the market. The government planned to eliminate lead in fuel by 1996, but after vehement opposition, this goal was moderated into a requirement for 70 percent unleaded fuel by 1995.

Table 5.23 displays prices, including taxes and the tax component, for light fuel oil used by industrial and residential consumers and heavy fuel oil used by industry. Taxes assessed on fuel oil are considerably lower than those assessed on gasoline. The percentage tax share for fuel oil (Figure 5.18) hovered within a band of 5 percent to 15 percent prior to the tax increases instituted in the latter half of the 1980s. The most significant divergence from this tax pattern was the tax rate increase on LFO to residential consumers between 1985 and 1987. In general, when oil is seen as a "consumer good" rather than a "productive good"—as industrial and agricultural fuels are usually considered—governments often tax it at a higher rate.

It is worth noting, however, that New Zealand's gasoline prices and taxes are quite low in the greater context of the OECD. Table 5.24 compares gasoline prices and tax components for the OECD countries in the first quarter of 1991. New Zealand's gasoline tax rate of around 45.4 percent is the fifth-lowest in the OECD. The lowest tax rates are in the United States, where the first quarter average was 33 percent. At the high end of the scale, tax rates on gasoline in Italy were nearly 77 percent of the retail price. As Figure 5.19 displays, New Zealand's gasoline prices, including taxes, were the fourth lowest in the OECD.

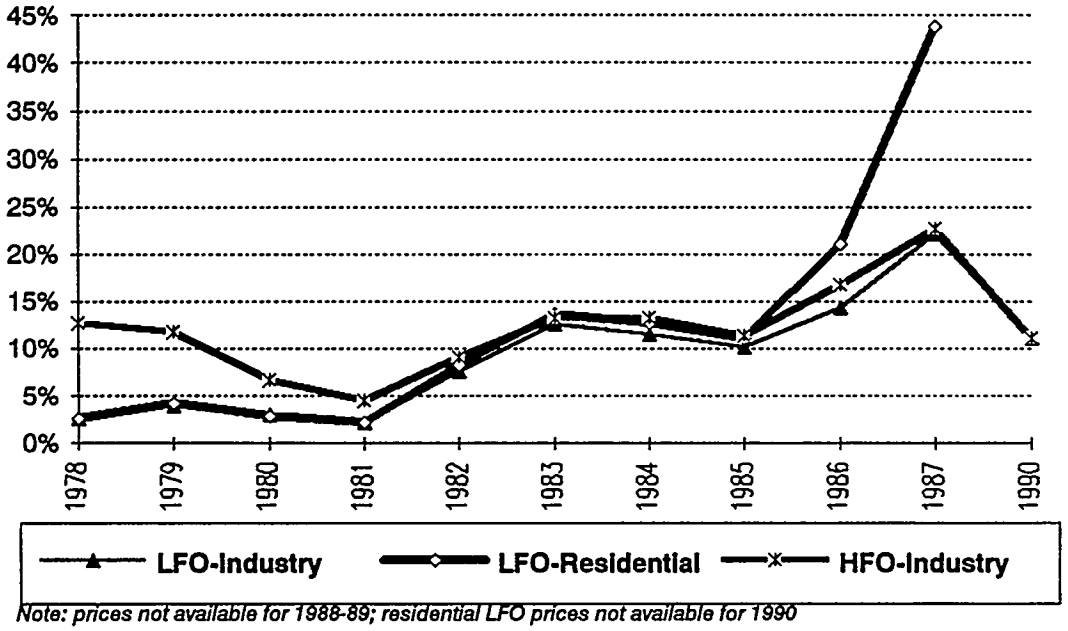
Table 5.23
Fuel Oil Prices and Taxes, New Zealand
(prices in US$/liter)

	Prices			*Tax Percentage (%)*		
Year	Lt. Fuel Oil, Industry	Lt. Fuel Oil, Residential	Hvy. Fuel Oil Industry	Lt. Fuel Oil, Industry	Lt. Fuel Oil, Residential	Hvy. Fuel Oil Industry
1978	0.17	0.18	0.14	2.6	2.5	12.6
1979	0.18	0.20	0.15	3.9	4.2	11.7
1980	0.31	0.33	0.25	2.9	2.8	6.6
1981	0.41	0.42	0.34	2.2	2.1	4.4
1982	0.40	0.41	0.31	7.6	8.2	9.0
1983	0.39	0.39	0.29	12.5	13.6	13.2
1984	0.36	0.36	0.24	11.5	12.6	13.2
1985	0.35	0.36	0.25	10.1	11.1	11.3
1986	0.25	0.33	0.20	14.3	21.1	16.7
1987	0.23	0.40	0.24	22.1	43.9	22.7
1988	na	na	na	na	na	na
1989	na	na	na	na	na	na
1990	0.25	na	0.26	11.1	na	11.1

na=data not available

Source: International Energy Agency, "Energy Prices and Taxes," 2nd Quarter 1991.

Figure 5.18: Percentage Tax in Fuel Oil Prices by Sector



Note: prices not available for 1988-89; residential LFO prices not available for 1990

Table 5.24
Gasoline Prices and Tax Components, OECD, 1st Quarter 1991
(US$/liter)

	Base Price	Tax	Total	% Tax
Australia	0.28	0.23	0.51	45.2
Austria	0.37	0.54	0.91	59.3
Belgium	0.33	0.65	0.98	66.6
Canada	0.35	0.21	0.56	37.8
Denmark	0.34	0.71	1.05	67.8
Finland	0.49	0.62	1.12	55.7
France	0.25	0.79	1.04	76.4
Germany	0.30	0.56	0.86	65.2
Greece	0.31	0.56	0.87	64.1
Ireland	0.36	0.76	1.12	67.6
Italy	0.32	1.06	1.38	76.9
Japan	0.54	0.45	0.99	45.0
Luxembourg	0.32	0.41	0.73	55.5
Netherlands	0.31	0.68	0.99	68.7
New Zealand	0.32	0.26	0.58	45.4
Norway	0.48	0.73	1.21	60.1
Portugal	0.32	0.83	1.15	72.1
Spain	0.33	0.63	0.96	65.2
Sweden	0.39	0.82	1.21	68.0
Switzerland	0.34	0.51	0.85	60.3
Turkey	0.36	0.40	0.76	52.2
United Kingdom	0.30	0.55	0.86	64.7
United States	0.20	0.10	0.30	33.0

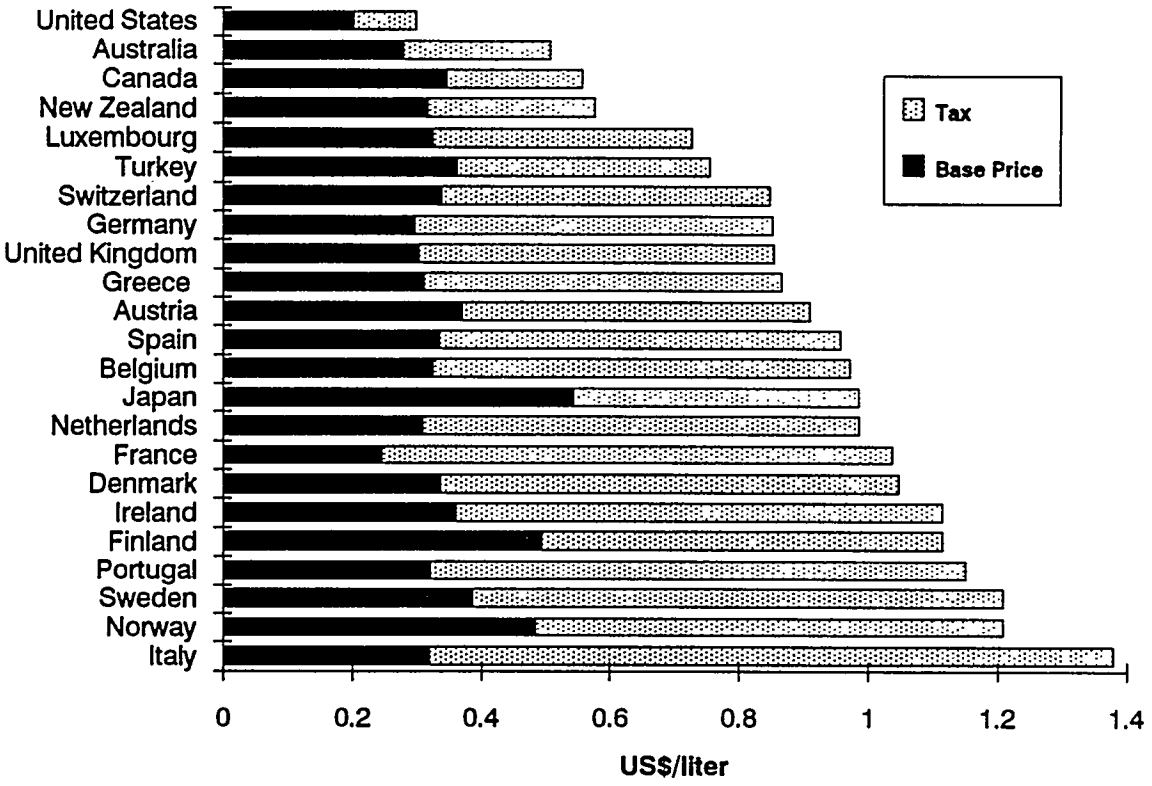
Average Price:	
OECD Europe	0.98
OECD	0.52

Source: International Energy Agency, "Energy Prices and Taxes," 2nd Quarter 1991

DEREGULATION

By far the most striking feature of the New Zealand oil market in recent years has been the process of market deregulation, which commenced officially on May 9, 1988. The aim of deregulation was to introduce greater competition into the sector at both wholesale and retail levels, and to bring New Zealand's market more in line with international markets. The chief target of deregulation was gasoline, though all oil

Figure 5.19: Gasoline Prices and Taxes, OECD



Note: Data are for the first quarter of 1991.

products naturally were affected; since petroleum products are jointly produced, regulating one fuel invariably affects the entire refinery output slate.

Prior to deregulation, the gasoline market was tightly controlled. Supply was controlled through licensing of retailers and wholesalers and mutual agreements amongst wholesalers to support the Marsden Point refinery. Minimum and maximum prices were set to ensure both a "fair" price to consumers and a "fair" level of income for those in the industry. In addition, wholesaler "interests or estates" in retail outlets were restricted to divorce the wholesale sector from the retail sector. The system of wholesale licensing and price controls restricted wholesaling to the main oil companies operating in New

Zealand—BP, Caltex, Mobil and Shell—and the setting of both maximum and minimum prices at the retail level prevented price competition. "Price wars," such as those seen in the United States, were unheard-of in New Zealand, so the consumer never saw extremely low gasoline prices, but the maximum price level also ruled out the possibility of "price gouging" by the companies.

Before deregulation, petroleum products could be imported only by the companies operating the refinery. Now, any importer can bypass the refinery and import refined petroleum products directly. The economics of product imports depend upon the prevailing price differentials between crudes and products, the costs of transport, and the costs of product storage and distribution.

In the Asia-Pacific region, virtually all countries exercise some sort of regulatory control over their energy markets. Controls range from loosely worded "guidelines"—which at least in the case of Japan have had far greater impact than their language would suggest—to complete control over a wide range of supply, price, and end use issues. Regulation is common in markets that tend toward natural monopolies, such as the power sector, where government participation is seen as essential for the protection of the public good. However, many authorities have acknowledged that there is truly an international market for petroleum, and during the late-1980s there was a spate of oil market liberalization activity in the Asia-Pacific region. Singapore and Hong Kong alone had truly free markets, but in recent years many market controls have been lifted, not only in New Zealand, but also in Australia, Japan, South Korea, Taiwan, and Thailand.

It is not coincidental that so many oil market deregulation plans were born in the latter half of the 1980s. The 1986 collapse in oil prices made numerous energy development schemes uneconomical, and it drove home the fact that achieving energy self-sufficiency was a public policy that was not necessarily in the public's best economic interest. In New Zealand, cost overruns of the Marsden Point refinery expansion project gave the Labour government an additional incentive to deregulate. Because the previous government had financed the project on a cost-plus basis, the contractors had no incentive to minimize costs. Industrial relations were extremely poor, and the unions took full advantage of the cost-plus arrangement, deliberately causing cost overruns. The

cost of the project ended up being twice what was originally expected. When the expansion was completed in mid-1986, the final cost was NZ$1,850 million, or around US$964 million. In addition, operating costs have been high ever since completion, and at several points in time the government even considered mothballing the facility.

Objections to deregulation were based on the contention that New Zealand is too small a market to fully capture the benefits of unregulated competition. Objectors argued that the removal of price controls would lead to price instability, higher risks for operators and a greater rate of business failure in the industry. The government agreed to phase in the process of deregulation in order to minimize shocks to the existing companies. Agreement was reached in May of 1988 to pay NZRC, the operator of the Marsden Point refinery, a subsidy of NZ$85 million (US$52.8 million) over three years—NZ$30 million for the first two years and NZ$25 million in the final year—to ease the transition. Moreover, the government agreed to assume NZRC's loan obligations to finance the expansion; the remaining debt at the time amounted to around NZ$1,600 million, which at the prevailing exchange rate in 1988 was equivalent to over US$1 billion.

The four major multinational companies, Shell, BP, Caltex, and Mobil, all had a long-established presence in the market and appeared to have worked out a coexistence of sorts where their market shares remained fairly stable. In a free market, this aspect of New Zealand's market would have occasioned complaints of collusion, but the country's market was regulated, and there were no incentives for "cutthroat competition" among the majors. There were indeed a variety of factors—chiefly relating to the small size and isolated nature of the market—that pointed to greater economic efficiency being gained through cooperation rather than competition. All four of the majors participating in New Zealand's market shared, and continue to share, a single refinery at Marsden Point, and they also effectively controlled distribution pipelines and major storage terminals. The market is not large enough to support two large, complex refineries, and it is generally accepted that the construction of an entirely separate refining and distribution network, including such capital-intensive facilities as refineries, tanker terminals, storage tank farms, and pipelines, would not be cost-effective. Accordingly, the four majors share

facilities. Insofar as this lowers costs, it is perceived as beneficial. The current conflict involves access to facilities by new entrants into the market.

Refinery Access

Fletcher Challenge Petroleum/Petrocorp currently accounts for around 60 percent of New Zealand's crude and condensate production, yet almost two-thirds of its production is exported and only one-third is sold to the four refiners. At current production levels, this amounts to around 9 mb/d. Petrocorp is understandably interested in gaining access to the refinery and to the storage and distribution facilities that would enable it to enter the wholesale market. If this does occur in the near future, it is likely that Petrocorp would seek to process a volume at least equivalent to the 9 mb/d of production now being sold to the other refiners. It is also possible that additional volumes of domestic crude would be processed domestically if the refinery has spare capacity.

During the process of deregulation, there was a general understanding that, in order to implement the policy goal of greater competition in the market, access to the market would have to be granted to potential new entrants. Prior to deregulation, the government made several statements to the effect that it considered access to the refinery and/or to product storage and terminal facilities a prerequisite to meaningful involvement in the market. Now, after almost four years of deregulation, the dispute still continues over what constitutes reasonable access to facilities, and neither Petrocorp nor any other new entrant has been allowed access to the refinery. Petrocorp applied directly to NZRC for refinery access shortly after the market was formally deregulated in May 1988, but was turned down. NZRC stated that there was no spare capacity available, and suggested that Petrocorp contact the four refiners directly to arrange for subcontracting of space. But of the four refiners, only BP stated that it had spare capacity to subcontract, and then only under the condition that Petrocorp export all resultant product. Since Petrocorp is ultimately seeking the opportunity to participate in New Zealand's wholesale market, these terms were dissatisfactory, and the company appealed to the government for intervention. The government has been reluctant to

intervene directly in the now-deregulated market; its position was that Petrocorp should exhaust all other means in order to gain access, including seeking relief through the courts. In October 1991, Petrocorp filed suit. As of the time of this report in early-1992, the situation remains unresolved.

Petrocorp's position is that, first, if deregulation is to introduce greater competition in the marketplace, new entrants must be allowed. The construction of a new refinery with associated infrastructure is an economic hurdle that no company could reasonably be expected to clear. Moreover, such extensive construction would be inefficient if it duplicated existing facilities that were not fully utilized. Second, Petrocorp is a major domestic producer and finds itself in the position of exporting its crude while the refiners import foreign crudes, some of which are comparable in quality to Petrocorp's export crudes. For example, in 1990, quantities of light, sweet Indonesian, Malaysian, and Australian crudes and condensates were imported, while light, sweet domestic crudes and condensates were exported. Third, Petrocorp points out that the refinery was built and expanded with public funds, so Petrocorp feels it is the government's responsibility to ensure access. BP made its offer to Petrocorp, but Petrocorp found the terms dissatisfactory. The other parties maintain that no spare capacity exists.

The concept of "spare" capacity—in reference to refineries and storage tanks alike—is a hazy one. In some countries, refiners are required to maintain a certain amount of spare capacity as a matter of strategic policy. Taiwan, for example, has idle crude capacity built into its system. Several South Korean refineries are capable of running far more crude than their officially rated capacities. With reference to storage facilities, tank farms may define their capacity as "full" at different levels at different times of the year, and may feel it reasonable to keep a buffer of empty tankage available at all times. As to the issue of spare capacity at the Marsden Point refinery, in 1990 feedstock intake at the refinery averaged 86.9 mb/d. With a rated crude capacity of 95.1 mb/d, this implies a utilization rate of 91.4 percent. Typical utilization rates, allowing for downtime, may be around 93 percent for other refineries of this type, so in this sense, spare capacity did appear quite limited. If non-crude and non-condensate feedstocks are

separated out from the slate, however, input amounted to only 83.3 mb/d, implying a utilization rate of 87.7 percent. If the refinery had operated at 93 percent capacity, the slack amount in 1990 would have been a little over 5 mb/d. Since Petrocorp is seeking access for 10 mb/d, spare capacity of this type alone will be insufficient, and other refiners will have to sacrifice space for a new competitor. Greater competition is the government's goal, but it cannot be said that this is a goal shared by the oil companies. The existing refiners act rationally in refusing to sacrifice refinery space to a potentially strong competitor; Petrocorp acts rationally in pursuing access to the refinery and the downstream market; and the government does not wish to intervene since it wishes to minimize direct involvement in the energy market. The end result is that Petrocorp has been pursuing access to the refinery since mid-1990, but appears no closer to success.

SUMMARY

Although not oil-rich by international standards, New Zealand's oil resource plays a major role in the country's energy mix and contributes to a liquid fuels self-sufficiency ratio of around 50 percent. The domestic crudes and condensates are of high quality and are also attractive export commodities. The potential for large new discoveries is limited and production is expected to enter a period of decline by the middle of the decade. Still, domestic crudes will continue to be important feedstocks to the country's refinery well into the twenty-first century. The domestic oil industry is well-established and capable, and the general downward trend in Asia-Pacific crude availability should provide an incentive to maintain at least some level of domestic production.

Oil demand has been surprisingly strong and resilient despite the generally poor economic situation in New Zealand. After the oil price shocks of the 1970s, oil demand dropped noticeably, but the decline in demand was accounted for mainly by a decrease in demand for fuel oil—as was the case in many other countries at the time. Fuel oil is the easiest fuel for which to find suitable alternatives, and it therefore lends itself most readily to fuel conservation and fuel-switching schemes. New Zealand's electric power industry, for example, now uses essentially no fuel oil. Yet demand for transportation fuels continues to grow and shows no immediate sign of slowing or reversing. The

government took aggressive action to promote the use of alternative transportation fuels such as LPG and CNG, but following the oil price crash of 1986 and the subsequent deregulation of the market, oil is shouldering aside the alternatives.

The national oil company, Petrocorp, has been fully privatized and is a subsidiary of Fletcher Challenge Petroleum. Fletcher dominates upstream activities but has yet to gain access to the Marsden Point refinery and break into the wholesale and retail market for petroleum products. The process of deregulation is still underway, however, so many changes are still possible.

Six

NATURAL GAS AND GAS PROCESSING

OVERVIEW

Exploration efforts in New Zealand's sedimentary basins have revealed that the country is, in general, more gas-prone than oil-prone. Proved gas reserves of around 3.6 trillion cubic feet (tcf) equate to nearly 640 million barrels of oil equivalent (mmboe), an amount roughly four times the size of the proved oil reserve. This proved reserve figure may be somewhat conservative, since estimates for several recently discovered fields have yet to be published. Still, gas reserves are not extensive when viewed from an international perspective; gas reserves in Indonesia are over 25 times as large as New Zealand's, enabling Indonesia to be the world's foremost exporter of liquefied natural gas (LNG). In New Zealand, gas is not a traded commodity, and this situation is unlikely to change.

During the 1970s and 1980s, the natural gas pipeline network was expanded to reach virtually all major centers on the North Island. Large users such as the power sector and the petrochemical industries in Taranaki account for around three-quarters of national gas consumption. In contrast to the oil market, New Zealand's natural gas market remains regulated both at the wholesale and retail level, chiefly because of Petrocorp's premier position in the market as a major producer, processor, and pipeline distributor.

The government strongly encouraged gas utilization in the residential sector as part of its overall goal to reduce dependence on imported oil. In part, this was the impetus behind the Maui gas take-or-pay agreement and the Motonui synfuels project. The subsequent collapse of oil prices in 1986 made many alternative fuel development projects uneconomical, including New Zealand's gas-to-gasoline synfuels plant. The government found itself subsidizing the synfuels plant and, in December 1988, sought to sell its 75 percent interest to Petrocorp. The Commerce Commission at the time

disallowed the sale, however, citing Petrocorp's already-dominant position in the gas market. A sale was eventually concluded in 1990, which relieved the government of commercial involvement but in essence was equivalent to paying a lump-sum subsidy, rather than annual subsidies. The government also promoted development of the petrochemical industry, though in this case the government was not displacing oil, but rather launching an entirely new energy-intensive industry.

Fletcher Challenge is now the majority owner of the synfuels plant, but the conditions of sale included a number of constraints. Mobil retains offtake rights for up to 60 percent of the output and receives a discount of US$1.45 per barrel below the international price. Fletcher Challenge is also required to pay a clawback to the Crown on gasoline or methanol-equivalent production up to 580,000 tons per year.

MAJOR PLAYERS

On the upstream side, the five fields currently producing oil are also producing natural gas; the Shell-BP-Todd (SBPT) consortium operates the Maui and Kapuni fields, while Petrocorp operates the McKee, Kaimiro and Waihapa fields. The major players in New Zealand's natural gas industry are Petrocorp, both as a producer and as a marketer operating through its subsidiary the Natural Gas Corporation (NGC), SBPT, and Maui Development, Ltd. Each of these organizations is intricately linked to the others through consortia or agreements. Prior to deregulation, the government was also a major player in the market through the Gas and Geothermal Trading Group (GGT), a division of the former Ministry of Energy. GGT has been disbanded, and any residual functions have been transferred to the Department of the Treasury.

The Maui field is owned by Maui Development, Ltd., which in turn is owned by Petrocorp (68.75%) and Shell-Todd (31.25%). In late 1990, Petrocorp purchased BP's 18.75 percent share in the Maui field, as well as BP's 37.5 percent stake in the Kapuni field, which had been fully owned by SBPT. Under the original terms of the agreement on Maui development, GGT, on behalf of the government, contracted to purchase all gas produced from the Maui field from Maui Development, Ltd., under a take-or-pay agreement. GGT then sold the gas to the bulk consumers: the Petralgas methanol

plant, which is 100 percent owned by Petrocorp; the Motonui Synfuels plant, which is owned by Mobil and Petrocorp; and Electricorp. Kapuni gas is used as feed for the Petrochem ammonia/urea plant and is also sold to NGC. NGC supplies non-bulk customers via an extensive pipeline network which extends to most urban areas on the North Island. The pipeline network is proprietary, giving Petrocorp a virtual monopoly on distribution via the grid, with the only major exception being the Maui Development, Ltd., pipeline from the Oanui facility to Huntly, the site of the country's largest thermal power plant.

GAS PRODUCTION AND DISTRIBUTION

Table 6.1 details gross natural gas production, liquefied petroleum gas (LPG) extraction, flaring/loss/conversion, manufactured gas production, and total production from 1974 through the first quarter of 1991. Total production has increased tremendously over the past two decades, growing at average annual rates of 15 percent during the 1974-1980 period and nearly 32 percent during the 1980-1985 period. During the latter half of the 1980s, production hit a peak of over 148 billion cubic feet (bcf) in 1989 before levelling off at 147 bcf in 1990.

The Maui field accounts for around 84 percent of domestic gas production, as well as a large portion of domestic condensate production. In all, it is the single largest energy resource in the country. Maintaining high levels of gas output is largely a function of maintaining output from the Maui field. Towards that end, the second stage of Maui development is now underway. As of late-1991, the summer season "window" for offshore development activity, over 60 percent of the work had been completed on the new Maui B platform, a 15-km pipeline between the existing and new platforms, and modifications to the Maui A platform and the onshore Oanui production station. The project is expected to be completed by April of 1993.[1] Initially, the Maui B project had been envisioned as a stand-alone system, with an estimated cost of US$1.6 billion; scaling

[1] "Second stage of Maui project on plan." *Oil and Gas Australia* (August 1991): pp. 6-8.

Table 6.1
Natural Gas Production, 1974-1991
(mmcf)

Year	Gross Production	LPG Extracted	Flare,Loss, Conversion	Net Production	Manufactured Gas Production	Total Production	Total *(MMcf/d)*
1974	10,493	35	2,970	8,169	3,713	11,882	33
1975	11,463	47	3,037	9,128	4,515	13,642	37
1976	30,015	123	4,440	27,760	0	27,760	76
1977	48,022	173	4,784	47,023	4,515	51,538	141
1978	44,396	214	2,851	45,057	4,056	49,113	135
1979	35,179	368	8,993	27,785	3,896	31,681	87
1980	31,731	667	3,978	24,302	3,346	27,648	76
1981	42,224	409	3,612	32,242	3,346	35,588	98
1982	72,955	484	4,157	60,232	3,002	63,234	173
1983	79,201	547	4,246	65,435	2,544	67,978	186
1984	98,940	814	4,896	84,739	2,177	86,916	237
1985	125,425	1,465	5,821	108,435	1,604	110,039	301
1986	145,172	1,711	3,194	135,286	1,123	136,409	374
1987	140,746	1,711	2,567	131,172	344	131,516	360
1988	156,082	1,283	3,866	142,873	252	143,125	391
1989	162,925	1,286	2,963	147,961	229	148,190	406
1990	161,381	1,343	3,291	147,216	160	147,376	404
1991	36,582	302	836	33,258	0	33,258	370
Period			**Average annual growth rate (%)**				
1974-80	20.3	63.7	5.0	19.9	-1.7	15.1	15.1
1980-85	31.6	17.1	7.9	34.9	-13.7	31.8	31.9
1985-90	5.2	-1.7	-10.8	6.3	-36.9	6.0	6.0

Note: "flared, lost, & converted" gas includes gas used in manufactured gas production.
Source: Ministry of Commerce, "Energy Data File." Original units in PJ. 1991 data=1st Qu. only.

the project down to a satellite of the existing platform, which is located 33 km offshore, cut the expected cost in half. The Maui B platform is expected to be capable of producing 400 million cubic feet per day (MMcf/d) initially from six wells, and for a period of around five years it will also produce up to one thousand barrels per day of crude and condensate from two wells. The partners are Fletcher Challenge Petroleum (68.75%), Shell Petroleum Mining (18.75%), and Todd Petroleum Mining (12.5%).[2]

[2] "Maui B project modified from original plan." *Oil and Gas Australia* (August 1991): p. 9.

After the Maui field, the second-largest gas producer is the Kapuni field, which accounts for around 10-11 percent of total production. The McKee and Kaimiro fields account for 3-4 percent, while the remaining 2-3 percent comes from the Waihapa field. The only new production expected onstream during the 1990s will come from the Tariki/Ahuroa fields which, as mentioned in the previous chapter on the oil industry, are expected to come onstream in 1996. This new production, however, will serve mainly to offset production declines in the McKee, Kaimiro, and Waihapa fields, so overall gas production will expand very little during the remainder of the decade. The Kupe field is not expected to enter commercial production until after the turn of the century.

Natural Gas Distribution Network

The country's first natural gas pipeline network connected the Kapuni field with Huntly and Papakura to the north and Wellington to the south. After the development of the Maui field and the negotiation of the Maui take-or-pay agreement, the pipeline network was expanded significantly. The Maui platform was linked to shore at Oanui, and from there pipelines carried gas to bulk consumers in the New Plymouth area, to other consumers as far north as Whangarei, throughout the northeast coast region connecting inland to Taupo and extending as far east as Gisborne, with a second major line moving south and east to Hastings.

Petrocorp has near-monopoly control over gas transmission through its subsidiary, NGC, which operates the entire pipeline network, with the notable exception of the Maui-to-Huntly pipeline which is owned by the Maui Development, Ltd. NGC is the key supplier of natural gas to domestic and commercial users on the North Island; supplies are delivered through NGC's high-pressure pipeline system which, in the years since 1978, has tripled in size and now reaches virtually all major population centers on the island. A number of compressor stations along the pipeline keep line pressure high, including stations near Wanganui, Mokau, Te Awamatu, Kawerau, Huntly, and Auckland.

GAS PROCESSING

The gas processing industry is centered in the Taranaki area near the producing fields. There are six gas processing facilities; Table 6.2 lists processing capacities and recent production by plant. Maui gas comes ashore at Oanui, the site of New Zealand's largest gas processing facility, with a capacity of 640 MMcf/d. The facility is operated by SBPT, and it uses a refrigerated absorption process to strip the gas of propane, butane, LPG, and condensate. Condensate is the main product, with output averaging 12.5 mb/d during the June 1990-June 1991 period.[3] Treated Maui gas then enters the pipeline network serving a variety of North Island users. The other five gas processing facilities are located at Kapuni. SBPT's facility at Kapuni produces around 5 mb/d of condensate, and the remaining natural gas is generally sold to NGC. The other facilities are operated by NGC and the Petrochemical Corporation of New Zealand (Petrochem), both of which are fully owned subsidiaries of Petrocorp. NGC's facilities use a combination of refrigeration, absorption, and refrigerated absorption processes to strip out liquid fractions, such as propane and debutanized natural gasoline, before delivering the gas into the pipeline.

Petrochem's facilities at Kapuni are used to prepare gas feedstock for the ammonia/urea plant. These facilities use a combination of refrigeration, absorption, refrigerated absorption, and compression to remove LPG, butane, and debutanized natural gasoline before sending the remaining natural gas fraction and carbon dioxide to the ammonia/urea plant.

The joint venture partners in the Waihapa project are also planning to build a pipeline and gas processing facility, which will handle Waihapa gas, as well as gas from the Tariki and Ahuroa fields when they come onstream in 1996. The cost of the project is estimated at NZ$35.2 million (US$19.7 million).

GAS CONSUMPTION

Table 6.3 and Figure 6.1 display natural gas consumption by end use. In 1990, around 64 percent of total production was consumed by electricity generation and the

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[3] "Worldwide Gas Processing." *Oil and Gas Journal* (July 22, 1991).

Table 6.2
Gas Processing Facilities in New Zealand

Company	Plant/Location	Gas Capacity (MMcf/d)	Throughput (MMcf/d)	Process/ Method*	Production (mb/d) based on 1990-91 Propane	Butane	LPG	Debutanized Nat. Gasoline	Condensate
Natural Gas Corp.	Kapuni	100	57	1,2,3	39.0			9.0	
	Kapuni	152	37	3					
Petrochem NZ	Kapuni, Waimate West	100	50	1,2,3,4		0.7	37.7	9.6	
	Kapuni, Waimate West	152	43	1,2,3,4					
Shell-BP-Todd	Kapuni	300	121	4					209.7
	Maui, Oanui	640	318	2	0.1	1.1	97.0		524.0
Totals		1,444	626		39.1	1.8	134.7	18.6	733.7

*Key to gas processing/conditioning methods:
1=absorption, 2=refrigerated absorption, 3=refrigeration, 4=compression.

Source: Oil and Gas Journal, "Worldwide Gas Processing Survey," July 22, 1991

Table 6.3
Natural Gas Consumption, 1974-1991
(mmcf)

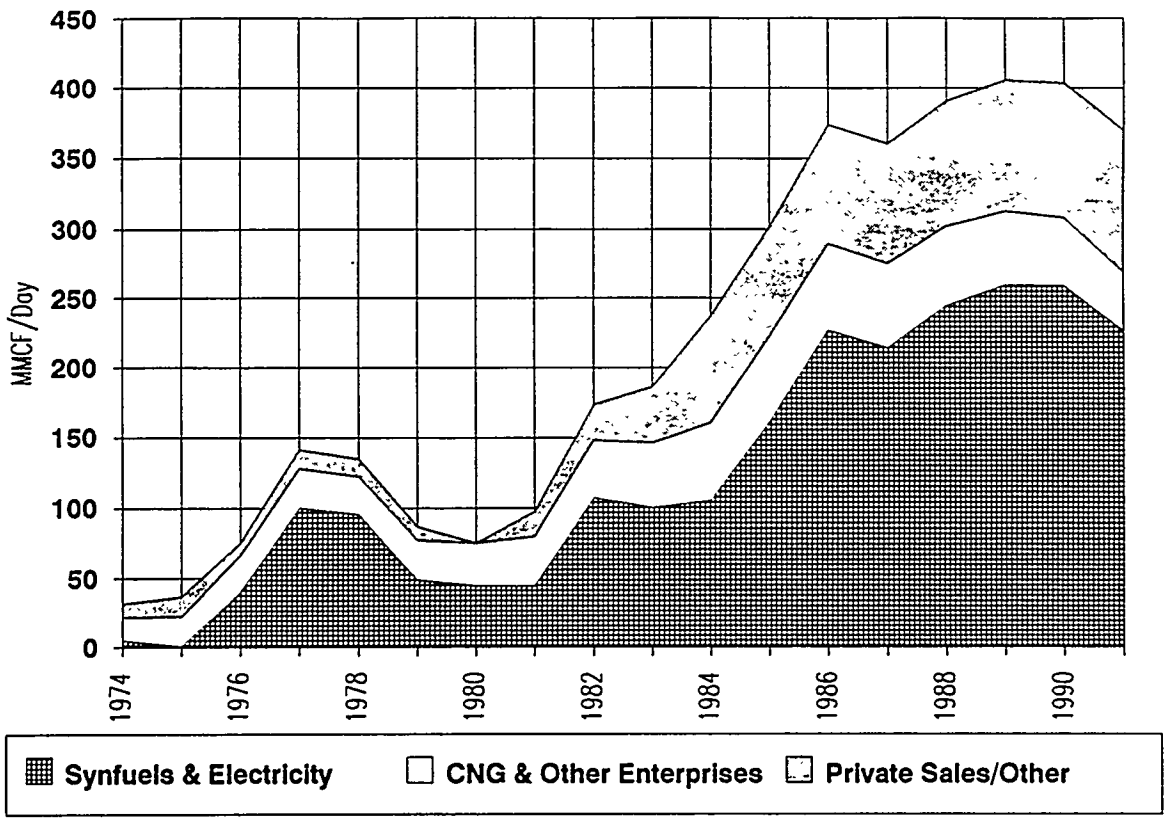
Year	Total Production	Synfuels & Electricity Gen.	CNG & Other Enterprises	Private Sales
1974	11,882	1,712	6,358	1,491
1975	13,642	197	8,136	2,401
1976	27,760	14,773	9,726	3,253
1977	51,538	36,454	10,045	2,139
1978	49,113	34,725	9,873	1,901
1979	31,681	17,854	10,447	762
1980	27,648	16,314	11,397	-2,352
1981	35,588	16,314	13,012	4,138
1982	63,234	39,067	15,003	7,268
1983	67,978	36,544	16,797	13,003
1984	86,916	38,584	20,124	26,703
1985	110,039	58,732	22,377	27,899
1986	136,409	82,682	22,959	29,817
1987	131,516	78,135	22,197	30,702
1988	143,125	89,606	21,033	32,062
1989	148,190	94,694	19,501	33,242
1990	147,376	94,416	18,026	34,610
1991	33,258	20,378	3,851	8,931
Period	**Average annual growth rate (%)**			
1974-80	15.1	45.6	10.2	0.0
1980-85	31.8	29.2	14.4	0.0
1985-90	6.0	10.0	-4.2	4.4

Notes: Original units in PJ. 1991 data=1st Qu. only.
"Private Sales" a calculated amount being the remainder of production
Source: Ministry of Commerce, "Energy Data File."

synfuels plant (with roughly equal shares), around 12 percent was used by enterprises including the manufacture of compressed natural gas (CNG), and the remaining 24 percent was accounted for by private sales. Major industrial and commercial users include the building industry, dairy factories, pulp and paper mills and freezing works.

The commissioning of the methanol plant in 1983 resulted in a visible increase in gas use, as did the commissioning of the synfuels plant in 1985. Throughout the 1980s, natural gas use in the power sector also rose considerably, so that natural gas grew to

Figure 6.1: Natural Gas Consumption by End Use, 1974-1991



**1991 data are for the 1st quarter only.*

dominate thermal electricity generation. Natural gas accounts for around 89 percent of thermal public electricity generation, with the remainder accounted for by coal and a very small amount of oil. Further details on the electricity sector are provided in Chapter Seven of this report.

The drop seen in gas use for CNG and by other enterprises during the latter half of the 1980s largely can be explained by the drop in CNG use as an automotive fuel. Table 6.4 and Figure 6.2 show the rapid increase in CNG sales during the early 1980s, when the government was actively promoting CNG as an automotive fuel, followed by a

Table 6

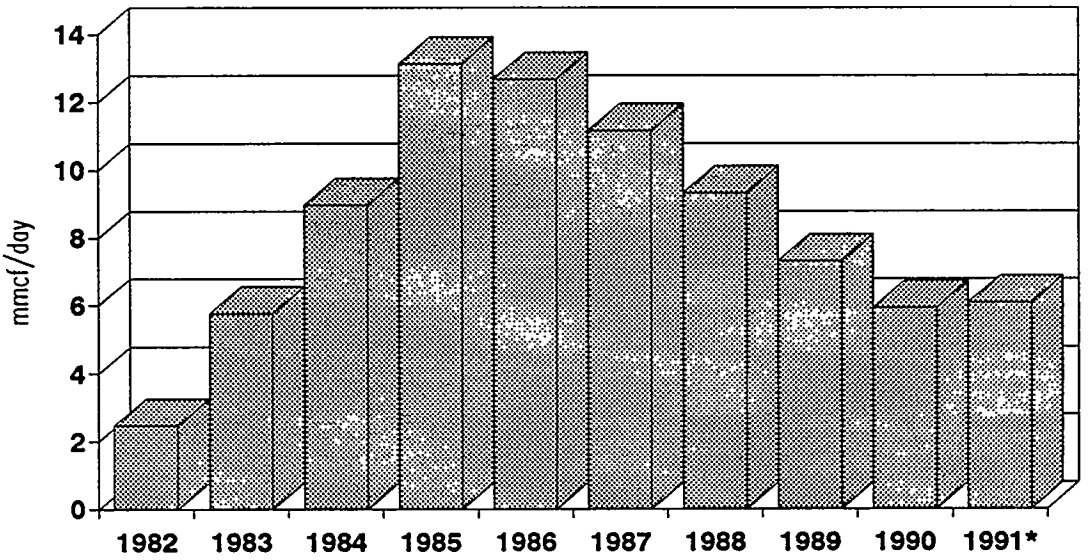
Table 6.4
CNG Sales, 1982-1991*

Year	Annual (mmcf)	Daily (MMcf/d)
1982	904	2.5
1983	2,104	5.8
1984	3,286	9.0
1985	4,793	13.1
1986	4,629	12.7
1987	4,075	11.2
1988	3,414	9.3
1989	2,669	7.3
1990	2,168	5.9
1991*	548	6.1

Period	Average annual growth rate (%)
1982-86	50.4
1986-90	-17.3

Source: Ministry of Commerce, "Energy Data File," original units in PJ.
Conversion: 1PJ=1.22045 BCF

Figure 6.2: CNG Sales, 1982-1991*



**1991 data are for the 1st quarter only*

steady decline from 1985 to 1990. There were several reasons for the decline. First, the price of oil dropped in 1986, so that in relative terms CNG became more expensive. The Liquid Fuels Trust Board (LFTB) had based analyses of CNG's cost-competitiveness on the assumption that the retail price of CNG would be held at 50 percent of the price of premium gasoline on an energy-equivalent basis,[4] but after 1986, the CNG:gasoline price ratio rose to 60 percent. Used car dealers began to remove CNG kits before reselling the cars. Second, the rate of conversion slowed considerably after the government discontinued conversion loans in December 1987. Conversion kits cost in the range of NZ$1,500-2,000 (US$950-1,250).[5] Third, there was some natural aging and attrition in the existing CNG fleet, and fourth, there was very little by way of a concerted marketing scheme by the CNG industry.

Both CNG and LPG had been promoted by the government as a means of diversifying sources of automotive fuel, but as the government began to withdraw from direct involvement in the energy market, the vehicle conversion loan scheme was handed over to the private sector, and financial and administrative assistance for marketing and promotional activities was withdrawn. While the CNG industry was slow to promote the use of CNG, the LPG industry was quite active in advertising and marketing, and as a result, the LPG industry suffered far less after the fall in oil prices.

LPG typically consists of propane and butane in roughly a 60:40 ratio. Since propane (C_3) and butane (C_4) have higher boiling points than methane (C_1) and ethane (C_2), LPG is easier to transport and also has a higher heat content. LPG can substitute for gasoline, particularly in large fleet operations, and can also substitute for diesel and kerosene in certain industrial and commercial applications, especially those where a clean-burning fuel is required and sources of reticulated natural gas are not readily available. As discussed in Chapter Five, LPG and natural gas liquids (NGL) consumption increased substantially during the 1970s and 1980s, growing from less than

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[4] Liquid Fuels Trust Board. *Final Report of Activities, October 1978 to December 1987*: p. 33.

[5] LFTB. *op. cit.*: p. 122.

0.2 mb/d in 1974 to nearly 3 mb/d in 1985 and 3.9 mb/d in 1990. In total transportation fuel use, the volumes of LPG are small, representing in 1990 only 2.3 percent of transportation fuel use. Still, in the context of the LPG/NGL used in 1990, around 52 percent was devoted to transportation use, indicating the relative importance of the transport sector to LPG marketers. Other LPG end users are the industrial sector (36% of LPG use in 1990) and the residential sector (12% of LPG use).

PETROCHEMICAL FACILITIES

The major bulk users of natural gas are the three petrochemical facilities: the Petrochem ammonia/urea plant at Kapuni, the Petralgas methanol plant at Waitara, and the New Zealand Synthetic Fuels Corporation synthetic gasoline facility (owned 75% by Petrocorp and 25% by Mobil) located at Motonui, slightly east of Waitara. These three facilities are detailed in Table 6.5, with their approximate output and calculated feedstock requirements. Based on standard industry references,[6] we calculate the feedstock requirements for the ammonia/urea plant at 6.5-7 MMcf/d of gas, the methanol plant requirements at 39-41 MMcf/d, and the synfuels plant requirement at 121-134 MMcf/d. Total gas feedstocks needed by these three establishments can range from around 167 MMcf/d to 182 MMcf/d—equal to 41 to 45 percent of total gas production in 1990. Actual feed inputs depend on utilization rates at the facilities. The Synfuels plant, for example, has a rated capacity of 570,000 tons/year, but actual output is capable of exceeding 650,000 tons/year. In the 1987-88 financial year, an explosion at the plant's methanol reformer resulted in an annual production total of only 476,455 tons (around 11.1 mb/d), but by the following year production reached 657,900 tons (15.3 mb/d).[7]

Since the intermediate product in the synfuels process is methanol, Petrocorp is able to take its share of the output as either methanol or syngas, depending on the market value of the commodities. Petrocorp either sells the syngas to the refiners for

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[6] "Petrochemical Handbook '91." *Hydrocarbon Processing* (March 1991).

[7] International Energy Agency. *Annual Energy Policies of Member Countries.* 1989.

Table 6.5
Petrochemical Plants in New Zealand
(output in tons/year)

Company	Location	Feedstocks	Approx. Feedstock Requirement *(MMcf/d)*	Urea	Methanol	Synthetic Gasoline
Petrochemical Corp. of NZ Ltd.	Kapuni	Natural gas	6.5-7.0	165,000		
Petralgas Chemicals NZ Ltd.	Waitara	Natural gas	39.4-41.5		529,250	
NZ Synthetic Fuels Corp.	Waitara	Natural gas	121-134			657,900

Note: Feedstock requirements are calculated; assumptions: 6.5-7.0 Gcal/ton ammonia, 7-8 Gcal/ton methanol, 17.3-19.1 Gcal/t syngas.
Sources: Oil and Gas Journal, "1990 Worldwide Petrochemical Survey" for urea and methanol facilities,
synthetic gasoline production is 1988/89 output per OECD "Energy Policies and Programmes of IEA Countries," 1989

blending or exports the product since, as mentioned in the previous chapter, Petrocorp is not involved at the wholesale level. Mobil takes the majority of its output as syngas, which it sells directly into the unleaded regular gasoline market or ships to the refinery for blending into leaded premium gasoline.

The ammonia/urea plant is also producing at levels greater than its original rated capacity of 87,000 tons/year of ammonia, which in turn produces 150,000 tons/year of urea. Recent production levels are estimated at 95,700 tons/year of ammonia, producing 165,000 tons/year of urea. The urea produced is a premium-grade granulated form, which makes storage, transport and application more convenient. Around one-third of the urea produced is used by domestic agriculture (as a fertilizer) and by industry (in resin manufacturing), with the remainder exported via the Port of Taranaki. Australia, Japan, East Asia, and the United States are the main export markets. Any ammonia not required for urea production typically is sold in New Zealand for refrigeration purposes.

The Petralgas methanol plant, which was commissioned in 1983 with a design capacity of around 400,000 tons/year, has been producing at levels at least 20 percent higher than nameplate capacity, and one industry reference reports production capability to be as high as 529,250 tons/year.[8] The facility is noted as one of the most efficient methanol plants in the world.

PRICING, TAXES AND REGULATION

Table 6.6 displays natural gas prices including taxes and the tax component for sales to industrial and residential users between 1978 and 1990. Prices and taxes for gas sold to the electric power sector are not reported. Figure 6.3 charts the price trend. In the early part of the period, industrial users on average were receiving natural gas supplies at roughly 50 to 60 percent of the prices faced by residential users; the absolute tax burden was the same for both end user groups, therefore industrial users paid a larger percentage tax than residential users. During the latter half of the 1980s, gas prices for industry came more in line with gas prices for residential users, rising to

[8]"1990 Worldwide Petrochemical Survey." *Oil and Gas Journal.*

Table 6.6
Natural Gas Prices (Including Taxes) and Taxes
(Average price in US$ per MMBTU, GCV)

Year	Industry Price	Industry Tax	Residential Price	Residential Tax	% Tax, Industry	% Tax, Residential
1978	2.62	0.50	4.83	0.50	19.0	10.3
1979	2.57	0.49	5.28	0.49	19.0	9.2
1980	3.36	0.46	5.85	0.46	13.8	7.9
1981	3.31	0.42	5.78	0.42	12.6	7.2
1982	2.92	0.36	5.23	0.36	12.3	6.9
1983	2.59	0.32	4.64	0.24	12.3	5.3
1984	2.40	0.27	3.32	0.27	11.3	8.2
1985	2.40	0.24	2.91	0.24	9.8	8.1
1986	2.93	0.33	3.60	0.35	11.2	9.6
1987	4.16	0.66	4.96	0.73	15.8	14.7
1988	5.42	na	5.69	na	na	na
1989	4.75	0.78	5.60	0.86	16.4	15.3
1990	4.84	0.84	5.82	0.94	17.2	16.1

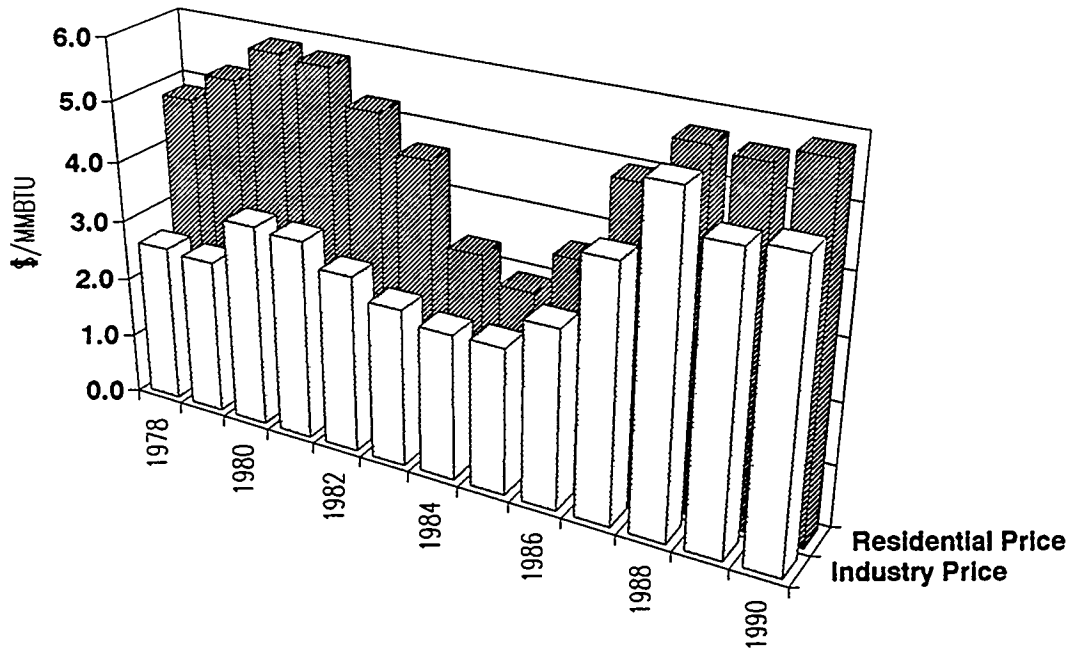
Source: International Energy Agency, "Energy Prices and Taxes."

around 83 percent of the residential price in 1990. The absolute tax burden on gross caloric value rose for the residential sector, but in percentage terms the tax component remained somewhat lower than that seen in the industrial sector.

Gas prices are regulated in all sales contracts apart from Maui gas sold to the consumers, Electricorp, NGC and Petralgas; the Maui contracts are not regulated, and are negotiated between the two parties. The price of gas is based on systems pricing, which considers the raw gas cost, plus the operating cost, plus the return on capital. The operating cost and capital cost differ between regions in New Zealand depending on the infrastructure used. The price of natural gas thus varies somewhat across the country.

The gas industry remains regulated at both wholesale and retail levels to prevent any possible abuse of market power by the parties in control. Deregulation is a topic of discussion within the government, but deregulating reticulated gas is considered more difficult than deregulating oil, largely because of NGC's near-monopoly on transmission. The government is examining the possibility of opening natural gas distribution franchises

Figure 6.3: Natural Gas Prices to Industrial and Residential Users



at the retail level to increase the number of players involved. Production is dominated by just two firms, SBPT and Petrocorp, and Petrocorp has recently expanded its gas holdings even further by purchasing BP's interests in the Maui and Kapuni fields. The Crown is the buyer of Maui gas, but it has agreed in advance to sell certain quantities to Petrocorp for use at the synfuels plant. NGC has a monopoly in gas wholesaling which is guaranteed by the present contract. Deregulating this sector appears unlikely to lead to any improvements in prices for the average consumer, unless this contract can be renegotiated, or the appropriate clause declared void because of possible conflict with the Commerce Act.

Petrocorp's near-monopoly in the transmission sector may continue to make regulation necessary. The regulation may continue to take the form of current price

controls, or other explicit regulations such as enhanced "common carrier" provisions may be adopted. Another possibility is the separation of the transmission system from Petrocorp to prevent the cross subsidization that can occur with vertical integration.

SUMMARY

New Zealand's sedimentary basins have proved more gas-prone than oil-prone, with proved gas reserves amounting to roughly four times the proved oil reserve. As a domestic, non-oil energy source, natural gas is highly valued. The gas industry was given an early boost by the government's involvement, and the government continues to be a major player in the market. Gas production expanded rapidly during the 1970s and early 1980s, but slowed considerably toward the late 1980s. In general, new developments in the Taranaki area are viewed more as a means of slowing production declines than expanding the industry. Already, a considerable commitment has been made to gas-intensive industries, and the North Island has been extensively reticulated. The gas resource is not large by international standards and most likely will continue to be absorbed domestically. Additional gas finds are possible, but since some of the more promising structures are located in remote areas, such as the Great South Basin, the fields would have to be very large to justify development. This should hold true even if gas prices in the region rise, as they are likely to do because of booming demand for liquefied natural gas in countries like Japan, Taiwan, and South Korea.

Seven

ELECTRICITY

HISTORY AND OVERVIEW

The evolution of New Zealand's electric power industry followed a course similar to that seen in developed countries around the world: as the industry began to grow around the turn of the century, the government took a more active role in the provision of public electricity and established public agencies to meet growing demand. In the early years, the abundance of the hydropower resource spared New Zealand many of the more difficult choices faced by resource-poor countries in promoting electrification. Since hydroelectric projects are extremely capital-intensive, government involvement was essentially a prerequisite for development. The first public electricity supply was provided to the South Island town of Reefton in 1888. The government's commitment to electricity generation grew, and in 1911 the Hydroelectric Branch of the Public Works Department was established. The State Hydroelectric Department was established in 1946 to cope with increasing demand. As the electric power industry grew, however, it began to rely on fuels other than hydropower. In 1958, the New Zealand Electricity Department was established, and with the formation of the Ministry of Energy, this department became the MoE's Electricity Division.

The wave of deregulation that began to transform New Zealand's energy sector in the late 1980s has fomented significant changes in the electricity sector as well. In 1987, the government took steps to promote economic efficiency by spinning off the Electricity Division and forming instead the Electricity Corporation of New Zealand, Ltd. (usually referred to as Electricorp), under the terms of the State-Owned Enterprises Act of 1986. Technically, the electricity market is deregulated; competitors can enter the market, apply for permits, and build new generating and transmission facilities. In practice, such an approach is largely uneconomical, and Electricorp remains the leading supplier, generating over 95 percent of the total supply.

MAJOR PLAYERS

Electric utilities are as a general rule considered "natural monopolies;" the capital costs for constructing an electricity supply network are so high that duplicating the system is uneconomical, and therefore a single company tends to dominate the market. Electricorp dominates the electric power industry in New Zealand, accounting for 95 percent of the power generated and also operating the National Grid through its wholly owned subsidiary, Trans Power New Zealand, Ltd. The National Grid consists of around 11,000 km of high-voltage transmission lines. The main transmission voltages are 110 kV and 220 kV, with a 500 kV high-voltage direct current (HVDC) transmission line stretching from the Benmore power station on the South Island to Haywards Substation on the North Island. Part of this transmission line is a subsea cable through the Cook Strait, which makes possible the export of hydropower from the South Island to the North Island.

Electricorp's other wholly owned subsidiary, PowerDesignBuild Group, Ltd., incorporates DesignPower, which specializes in design and consulting work, and PowerBuild, a construction and contracting firm. In terms of assets, Electricorp is the largest state-owned enterprise, operating 39 power stations as well as most of the distribution system. For the year that ended in March 1991, Electricorp assets were valued at NZ$10.7 billion (around US$6.7 billion), and the company employed 12,572 people, down from 13,142 people two years previously. When Electricorp was formed, the company began a concerted process of reorganization and decentralization, which included cutting staff by 20 percent, revaluing assets, renegotiating fuel supply contracts, introducing more flexible pricing regimes, and aggressively promoting sales. The company is expected to operate on a fully commercial, competitive basis.

Electricorp sells bulk electricity to local Electric Power Boards (EPBs) and Municipal Electricity Departments (MEDs), generically referred to as Electricity Supply Authorities (ESAs). Electricorp also sells bulk power to a number of large industrial users such as Comalco.

The remaining 5 percent of New Zealand's electricity is generated by twenty-two ESAs, which operate small generating systems of their own ranging in size from 0.2 MW

to 53 MW. Some ESAs are able to export power to Electricorp or other ESAs via the grid, but for the most part, the ESAs purchase power from Electricorp. Currently, there are 51 ESAs licensed under the terms of the Electricity Supply Act of 1968 to sell power to end users. The ESAs purchase power in bulk from Electricorp and resell it to customers in their licensed service areas. The new power sector reforms, however, include the removal of the licensing requirement and the franchise areas. The government feels that this paves the way for corporatization of the ESAs and inter-ESA competition for customers.

ELECTRICITY GENERATION AND THE FUEL MIX

New Zealand is fortunate to be able to rely on indigenous hydropower and geothermal power for over 80 percent of its electric power needs. In the early years of electrification, hydropower was the basis of virtually all public electricity, but as demand for electricity began to outstrip readily available supplies on the North Island, a number of thermal power plants were built. Initially, oil played a significant role in thermal power generation, but the oil price shocks of the 1970s firmed government resolve to reduce reliance on petroleum. In 1974, oil accounted for around 10 percent of the power sector's fuel mix, coal's share was nearly 7 percent, and natural gas represented just 1 percent of the fuel mix. By the time of the second oil price shock, oil-fired power generation had been almost entirely phased out, although facilities exist which utilize fuel oil or diesel oil as conditions warrant.

Natural gas rapidly became the premier fuel for thermal electricity generation. As Tables 7.1 and 7.2 indicate, the share of natural gas in electricity generation jumped from just 1 percent in 1974 to over 18 percent in 1977. Percentage shares are charted in Figure 7.1. The share of gas declined during the 1979-1981 period, but recovered to around 18 percent in 1982 and has remained roughly at this level until the present time. The power generation fuel mix in 1990 was composed of approximately 73.9 percent hydropower, 18 percent gas, 6.7 percent geothermal, and 1.5 percent coal. Around two-thirds of the hydropower generated is on the South Island. Excess hydropower is exported to the North Island by a high-voltage direct current (HVDC) transmission line

Table 7.1
Electricity Generation by Fuel Type
(TWh)

	Primary			Secondary			
Year	**Hydro**	**Geo.**	**Coal**	**Oil**	**Gas**	**Others**	**Total**
1974	15.04	1.31	1.28	1.95	0.18	0.02	19.77
1975	16.50	1.30	1.03	0.79	0.03	0.01	19.65
1976	15.34	1.23	1.08	1.28	1.78	0.02	20.73
1977	14.57	1.16	0.90	0.73	3.93	0.02	21.31
1978	15.50	1.18	0.71	0.20	3.74	0.02	21.35
1979	18.26	1.06	0.35	0.05	1.92	0.02	21.66
1980	19.01	1.15	0.38	-0.01	1.47	0.01	22.01
1981	19.48	1.09	0.34	-0.01	1.79	0.01	22.71
1982	18.12	1.11	0.37	0.00	4.34	0.01	23.96
1983	19.56	1.12	0.60	0.14	4.09	0.01	25.53
1984	20.17	1.24	0.68	0.00	4.51	0.01	26.61
1985	19.51	1.11	0.65	0.05	5.70	0.01	27.03
1986	21.86	1.18	0.35	0.00	4.43	0.00	27.82
1987	21.68	1.18	0.77	0.01	4.68	0.00	28.30
1988	22.37	1.18	0.58	0.01	5.07	0.00	29.21
1989	21.37	1.65	0.31	0.00	5.51	0.00	28.83
1990	21.72	1.96	0.44	0.00	5.28	0.00	29.39
Period			**Average annual growth rate (%)**				
1974-80	4.41	-3.00	-19.74	0.00	46.24	-9.61	2.33
1980-90	1.34	5.45	1.43	0.00	13.63	na	2.93
1974-90	2.33	2.56	-6.49	0.00	23.38	na	2.51

Source: Ministry of Commerce, "Energy Data File," July 1991

stretching from the Benmore power station on the South Island to Haywards Substation on the North Island.

One of the surprising changes in the fuel mix was the reduction in coal use. In 1974, coal accounted for 6.5 percent of the fuel mix, but by 1979 this share had dropped to 1.6 percent. The aggressive promotion of natural gas displaced not only oil, but coal as well. Despite the abundance of coal in New Zealand, only two power plants currently use coal. One of these, the dual-fired Huntly plant, is capable of using both coal and natural gas, but despite the plant's proximity to the Huntly area coal fields, natural gas

Table 7.2
Percentage Shares of Electricity Generation by Fuel Type
(%)

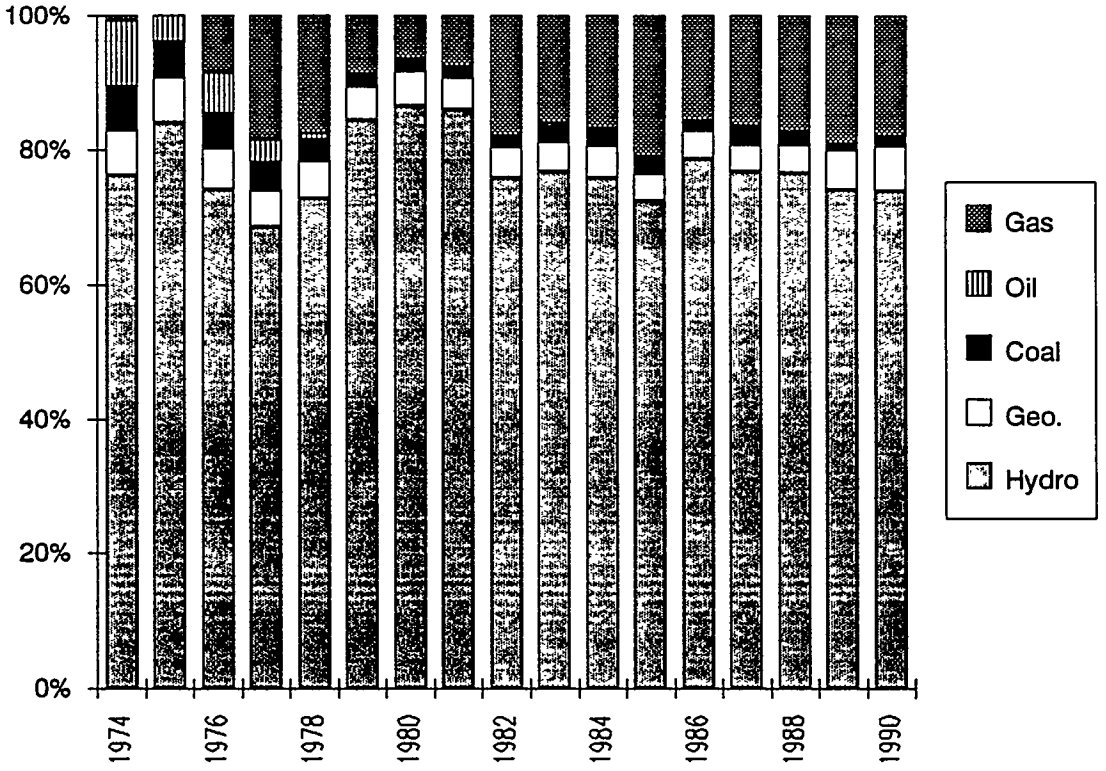
	Primary		Secondary				
	Hydro	Geo.	Coal	Oil	Gas	Others	Total
1974	76.1	6.6	6.5	9.8	0.9	0.1	100
1975	83.9	6.6	5.3	4.0	0.1	0.1	100
1976	74.0	6.0	5.2	6.2	8.6	0.1	100
1977	68.4	5.5	4.2	3.4	18.5	0.1	100
1978	72.6	5.5	3.3	0.9	17.5	0.1	100
1979	84.3	4.9	1.6	0.2	8.9	0.1	100
1980	86.3	5.2	1.7	0.0	6.7	0.1	100
1981	85.8	4.8	1.5	0.0	7.9	0.1	100
1982	75.6	4.6	1.6	0.0	18.1	0.1	100
1983	76.6	4.4	2.4	0.6	16.0	0.0	100
1984	75.8	4.7	2.6	0.0	16.9	0.0	100
1985	72.2	4.1	2.4	0.2	21.1	0.0	100
1986	78.6	4.2	1.2	0.0	15.9	0.0	100
1987	76.6	4.2	2.7	0.0	16.5	0.0	100
1988	76.6	4.0	2.0	0.0	17.4	0.0	100
1989	74.1	5.7	1.1	0.0	19.1	0.0	100
1990	73.9	6.7	1.5	0.0	18.0	0.0	100

Source: Ministry of Commerce, "Energy Data File," July 1991

has been the main fuel used. The other plant, Meremere, is a dedicated coal-fired plant, but utilization rates have been very low; Electricorp reported that for the year that ended in March 1991, the load factor at the Meremere plant was just 2.1 percent. The load factor is defined as the ratio of average to maximum power.

Figure 7.2 depicts the trends in electricity generation by fuel type between 1974 and 1990. Overall, electricity generation increased at rates averaging around 2.3 percent per year during the 1974-1980 period, picking up to over 2.9 percent annually in the 1980-1990 period. When compared to those in other developed OECD countries, these rates of growth are quite rapid. Electricorp recently proposed raising electricity prices in anticipation of the need to build a new thermal power plant by the turn of the century. The government, however, sees considerable room for improvements in system efficiency

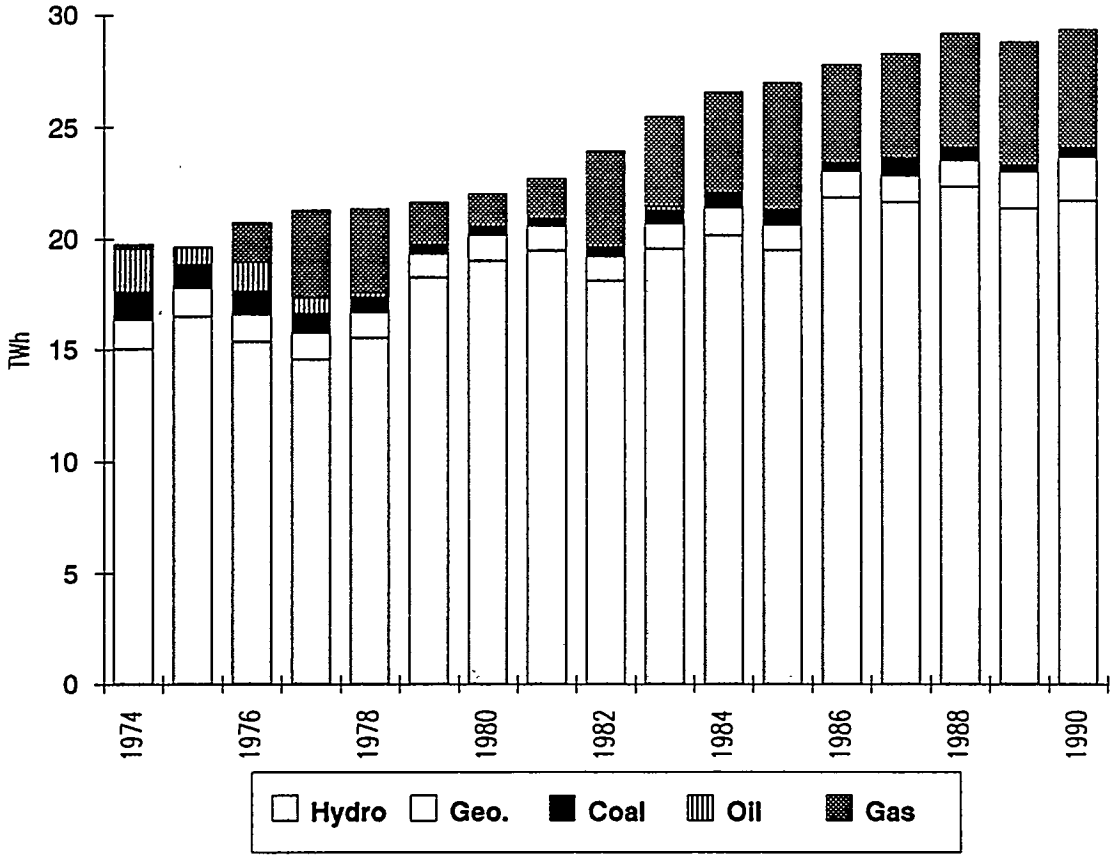
Figure 7.1: Percentage Shares of Electricity Generation by Fuel



and conservation, which could obviate the need for new construction. Currently, there is only one new plant under construction, the Clyde Dam hydropower project.

New Zealand is known as being staunchly anti-nuclear, so nuclear power plays no role in the electricity sector and is not expected to in the future. From the historical sense, however, it is interesting to note that in the period following World War II, the Wairakei geothermal development project was designed as a combined plant to produce not only power, but also heavy water for atomic energy applications. This plan drew the attention of the United Kingdom Atomic Energy Authority (UKAEA), which entered into a joint venture with the New Zealand government in order to acquire the new

Figure 7.2: Electricity Generation by Fuel Type



supplies of heavy water. By the mid-1950s, however, the capital cost estimates had escalated, and UKAEA withdrew. The plans for Wairakei had to be redrawn. The first power from Wairakei entered the national grid in late 1958, and construction was completed six years later.[1]

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[1] Ralph N. Love and Michael Bolton. "Wairakei Geothermal Power Project: New Zealand." In *Geothermal Energy Projects*, edited by L. J. Goodman and R. N. Love. New York: Pergamon Press, 1980.

INSTALLED CAPACITY

Table 7.3 provides a detailed listing of Electricorp's 39 power plants, broken out into three main supply regions: North Island Thermal, North Island Hydro, and South Island Hydro. For the year that ended in March 1991, these three regions generated, respectively, 26 percent, 23 percent, and 51 percent of the total electricity supply. The table includes data on fuel type, installed capacity, electricity generated, load factor, and availability factor by station. The availability factor is defined as the percentage of total time the unit is available for service, excluding planned and forced outages. In general, the geothermal and hydropower units have had very high availability factors and are relied upon for the majority of baseload power. The only North Island thermal station to rival the geothermal and hydropower installations in availability was the Huntly dual-fired gas/coal plant. At 980 MW, the Huntly plant is the largest in the country.

Two of the thermal plants listed, Marsden and Otahuhu, show negative figures under the MWh generated column. Both of these facilities were kept on line to maintain system viability and to serve as voltage stabilizers for the system as a whole. There were net imports of electricity into both plants. In all, Electricorp's installed capacity totalled 7,305 MW, and power generated amounted to around 29.6 TWh.

ELECTRICITY CONSUMPTION AND PRICING

Table 7.4 displays electricity consumption by end use sector between 1985 and 1991. The largest end use sector is industry, which accounts for around 40 percent of total demand. Residential consumers are the second largest user group, with 37 percent of demand, followed by the commercial sector (20%), farming (2.5%), and other users (less than 1%). The trends in electricity consumption by sector are presented in Figure 7.3. While demand has grown in all sectors, the fastest growth in demand has been in the commercial sector. In 1985, the commercial sector consumed 17.6 percent of total electricity; by 1991, the share had increased to 19.8 percent, implying an average annual growth rate of around 4.5 percent. Demand growth rates in the residential sector averaged 2.2 percent annually across the period, while annual growth rates averaged 1.9 percent in the industrial and farming sectors.

Table 7.3
Installed Capacity by Type and Region
(Year Ended March 1991)

Station	Capacity (MW)	MWh Generated	Load Factor (%)	Availability Factor (%)	Fuel Type
North Island Thermal	**2,544**	**7,710,782**			
Huntly	980	5,152,043	61.26	89.4	Steam Turbine (Gas or Coal)
Marsden*	114	-8,191	0.00	60.7	Steam Turbine (Residual Oil)
Meremere	112	20,611	2.10	46.4	Steam Turbine (Coal)
New Plymouth	575	304,170	6.04	91.0	Steam Turbine (Gas or Residual Oil)
Ohaaki	106	851,360	89.99	91.1	Geothermal
Otahuhu*	90	-14,931	0.00	79.2	Gas Turbine (Gas or Diesel)
Stratford	198	187,503	10.81	94.8	Gas Turbine (Gas)
Wairakei	153	1,217,014	90.80	88.2	Geothermal
Whirinaki	216	1,203	0.06	98.8	Gas Turbine (Diesel)
North Island Hydro	**1,592**	**6,810,156**			
Arapuni	160	844,269	60.24	76.2	
Aratiatia	84	393,280	53.45	92.3	
Atiamuri	79	339,824	46.18	98.2	
Kaitawa**	34	0			
Karapiro	96	619,692	73.69	98.7	
Mangahao	19	101,492	60.98	88.8	
Maraetai	360	980,442	31.09	92.8	
Matahina	72	314,772	49.91	95.7	
Ohakuri	112	467,790	47.68	92.1	
Piripaua**	37	0			
Rangipu	120	543,420	51.70	54.4	
Tokaanu	210	820,330	44.59	96.8	
Tuai	58	524,981	46.46	92.3	
Waipapa	51	283,743	63.51	99.2	
Whakamaru	100	576,121	65.77	99.2	
South Island Hydro	**3,169**	**15,061,501**			
Arnold	3	24,849	94.55	89.5	
Aviemore	220	964,375	50.04	94.9	
Benmore	540	2,506,683	52.99	95.9	
Clyde***	432	0			
Cobb	32	174,619	62.29	96.0	
Coleridge	35	227,057	74.06	94.8	
Highbank	25	80,449	36.73	64.0	
Manapouri	600	4,439,457	84.46	97.4	
Ohau A	248	1,328,540	61.15	91.5	
Ohau B	212	1,079,244	58.11	96.6	
Ohau C	212	1,081,135	58.22	95.9	
Roxburgh	320	1,497,283	53.41	97.7	
Tekapo A	25	153,844	70.25	77.7	
Tekapo B	160	947,815	67.62	80.7	
Waitaki	105	556,152	60.46	90.4	
Electricorp Totals	**7,305**	**29,582,439**			

Notes:
** Net import of electricity into station to maintain station viability and system voltage stability*
*** No figures available for Piripaua and Kaitawa.*
**** Under construction.*
Source: Ministry of Commerce, "Electric Power Industry in New Zealand," 1991.

Table 7.4
Electricity Consumption By Sector
(GWh, year ending March 31)

	1985	1986	1987	1988	1989	1990	1991	AAGR* '85-91
Industrial	9,995	10,038	10,764	10,764	11,065	11,187	11,200	1.92%
Residential	8,998	9,080	9,424	9,423	9,510	9,824	10,264	2.22%
Commercial	4,224	4,417	4,772	4,833	5,250	5,461	5,497	4.49%
Farming	613	578	567	566	686	655	687	1.92%
Others*	164	162	164	169	187	183	171	0.70%
Total	23,994	24,275	25,691	25,755	26,698	27,310	27,819	2.50%

(% Shares)

	1985	1986	1987	1988	1989	1990	1991
Industrial	41.7%	41.4%	41.9%	41.8%	41.4%	41.0%	40.3%
Residential	37.5%	37.4%	36.7%	36.6%	35.6%	36.0%	36.9%
Commercial	17.6%	18.2%	18.6%	18.8%	19.7%	20.0%	19.8%
Farming	2.6%	2.4%	2.2%	2.2%	2.6%	2.4%	2.5%
Others**	0.7%	0.7%	0.6%	0.7%	0.7%	0.7%	0.6%
Total	100%	100%	100%	100%	100%	100%	100%

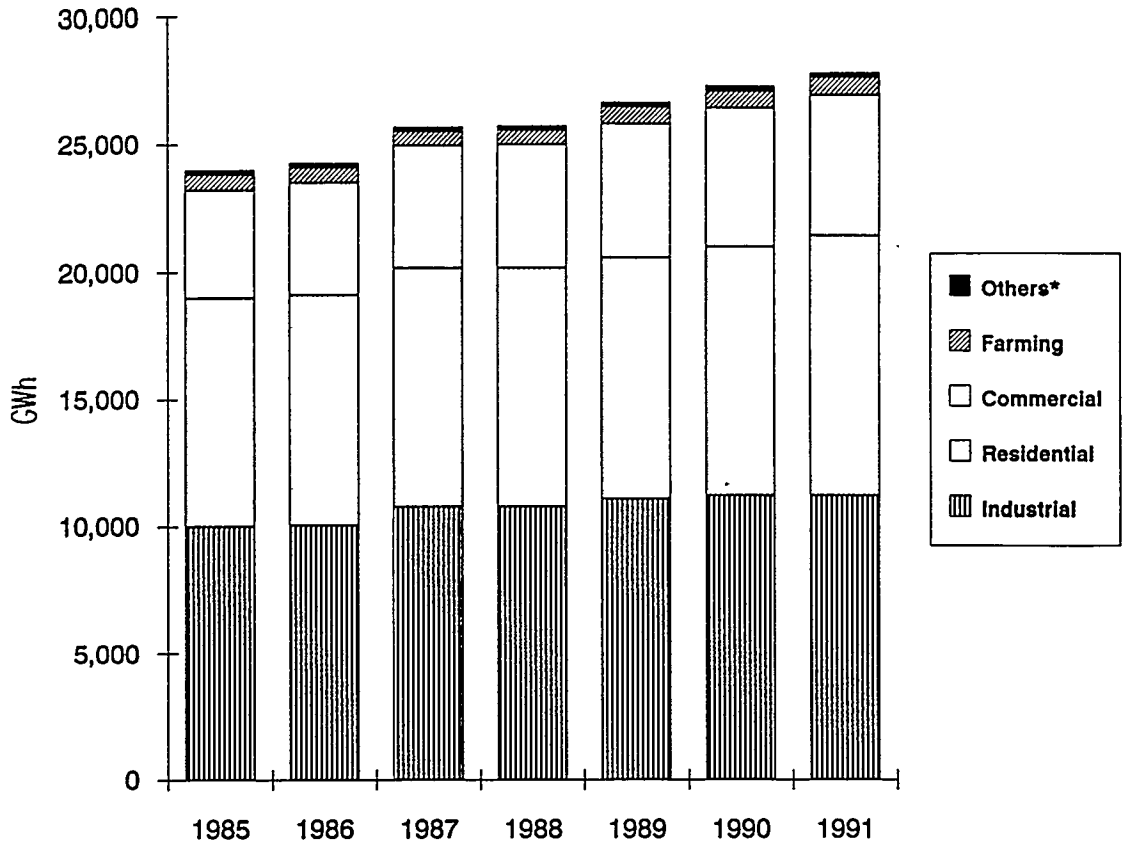
**Average annual growth rate*

***Includes public lighting, railway and urban traction.*

Source: Ministry of Commerce, "Electric Power Industry in New Zealand," 1989-1991 editions.

Table 7.5 provides greater detail on electricity use by end use categories for the year that ended in March 1991. Out of nearly 1.6 million customers, 1.3 million were residential users. Commercial users totalled around 171 thousand, farm customers 95 thousand, industrial users less than 10 thousand, and other users (including public lighting, electric railways and urban transportation) totalled around 2 thousand. Within the industrial sector, three large end users—the iron and steel industry, the wood, paper and pulp products industry, and the food, beverage and tobacco industry—account for over three-quarters of the electricity consumed. Other significant end uses include the manufacture of chemicals and chemical products; mechanical and electrical equipment; glass, pottery, earthenware, china and building materials; and textiles, wearing apparel, and leather and rubber products.

Figure 7.3: Electricity Consumption By Sector



**Includes public lighting, railway and urban traction*

Naturally, the average amount of power consumed per customer ranges widely from an average of nearly 1.2 million kWh per industrial consumer to around 7-8 thousand kWh per farm or residential user. As the table indicates, the average rate paid per kWh also varies widely, so that even though the industrial sector is the largest electricity user, it accounts for less than 28 percent of Electricorp's sales receipts. In contrast, receipts from the residential and commercial sectors account for around 39 percent and 29 percent, respectively, of total sales receipts. In the local currency, the average industrial user paid just 5.4 cents/kWh, while typical residential consumers paid 8.2 cents/kWh, farming concerns paid 11.1 cents/kWh, commercial users paid 11.7 cents/kWh, and other users paid 13.4 cents/kWh.

Table 7.5
Electricity End Users by Category, Year Ended March 1991

Classification of End Users	MWh Consumed	Income ('000 $)	Avg Income per kWh (cents)	Number of Consumers	Avg. MWh/ Consumer
Residential	**10,263,873**	**845,712**	**8.240**	**1,303,863**	**8**
Commercial	**5,496,423**	**640,888**	**11.660**	**171,355**	**32**
Farming	**687,171**	**76,545**	**11.139**	**94,908**	**7**
Other:	**171,233**	**23,009**	**13.437**	**2,308**	**74**
Public Lighting	110,377	12,920	11.705	2,292	48
Railway Traction	56,991	9,665	16.959	12	4,749
Urban Traction	3,865	424	10.980	4	966
Industrial:	**11,200,030**	**602,309**	**5.378**	**9,445**	**1,186**
Coal Mining	27,591	2,903	10.522	80	345
Other Mining	165,985	15,266	9.197	447	371
Iron & steel basic; non-ferrous metals	5,321,939	171,002	3.213	130	40,938
Manuf. of mech. & electrical equipmt.	306,971	30,372	9.894	1,614	190
Manuf. of chemicals & chem. products	507,490	36,747	7.241	333	1,524
Manuf. of glass, pottery, earthenware, china & building materials	199,246	14,866	7.461	505	395
Manuf. of textiles, leather & rubber products, wearing apparel	241,467	19,991	8.279	786	307
Food, beverages & tobacco	1,514,921	131,758	8.697	2,076	730
Wood, paper & pulp products	2,775,943	164,732	5.934	1,263	2,198
Other manuf. industries	115,257	12,326	10.694	889	130
Construction works	23,219	2,347	10.109	1,322	18
Total Retail Sales	**27,818,731**	**2,188,463,312**	**7866.870**	**1,581,879**	**18**

Source: Ministry of Commerce, "Electric Power Industry in New Zealand," 1991

Table 7.6 compares industrial and residential sector electricity prices in US cents per kWh for the period 1978-1991. Residential users have paid consistently more than industrial users, and the gap between the two prices has widened. In 1979, residential users paid around 1.3 times as much per unit as industrial users; in the first half of 1991, the residential rate averaged 1.7 times as much as the average industrial rate. Unlike industrial consumers, residential users also pay an electricity tax.

In 1991, Electricorp proposed an electricity price increase in anticipation of the need to build another thermal power plant within the coming decade, but this request was rejected in early 1992. The Ministry for the Environment (MfE) opposed the price

Table 7.6
Electricity Prices (Including Taxes) and Taxes
(Average price per kWh, US cents)

Year	Industry Price	Residential Price+Tax	Residential Tax
1978	2.40	na	0.00
1979	2.51	3.24	0.00
1980	2.77	3.58	0.00
1981	2.72	3.52	0.00
1982	2.65	3.42	0.00
1983	2.38	3.13	0.00
1984	2.05	2.71	0.00
1985	2.10	2.77	0.00
1986	2.51	3.70	0.34
1987	3.03	4.69	0.43
1988	3.50	5.69	0.52
1989	3.22	5.43	0.60
1990	3.29	5.64	0.63
1991*	3.32	5.79	0.64

**1991 data are for the 1st half year only*
Note: Industrial users are not assessed tax on electricity
Source: International Energy Agency, "Energy Prices and Taxes," 2nd Quarter 1991.

increase, maintaining that there is considerable room for improvement in the efficiency of the current system, and that achieving greater efficiency will forestall the need for additional thermal power plants. In part, the MfE believes that some inefficiencies exist because the current pricing system gives no incentives for conservation. According to the MfE, around one-half of Electricorp's wholesale electricity tariff to ESAs is fixed charges. The ESAs pass these costs on to the retail consumers, along with some small fixed charges of their own. The end result is that conservation behavior may have very little impact on the total electricity bill, and the consumer may be discouraged by the lack of visible savings.

Additionally, the MfE feels that the lack of a progressive pricing system sends the wrong market signals because it places many consumers in a position where per-unit costs decrease as consumption increases. This clouds the fact that electricity costs in

New Zealand actually increase per unit consumed, since the marginal cost is set by the more expensive thermal power stations, not the lower-cost hydropower and geothermal stations. If demand continues to grow and the existing system is pushed to the limits of its capacity, the marginal cost of electricity will be the cost of constructing new facilities. The MfE summarized its position in a submission to the House of Representatives, Commerce and Marketing Committee:

> MfE considers that current proposals to raise the price of **all** electricity to the cost of new power stations - the long run marginal price - are not justified, but raising the cost of **additional** electricity consumption would be. (However, energy efficiency is a cheaper alternative to selling more electricity and price increases...)[2]

The MfE cites numerous examples of energy-saving measures which are simple, cost-effective, and collectively capable of eliminating the need for new power plants. While there is only one new project currently under construction, the Clyde Dam, other projects have also been discussed, including the lower Clutha hydro project, the Waikato thermal project, the Queensbury hydro project, and the Mokai geothermal project. As noted, electricity demand growth has been moving apace in New Zealand, with consumption growing at rates averaging around 2.5 percent per year during the 1985-1991 period. Stemming such demand growth will take a concerted effort and may require more direct government involvement than is compatible with the spirit of deregulation. The Secretary for the Environment has noted the need for a number of reforms, including more detailed information for consumers, restructuring of the industry to promote efficiency, corporatization of new Electric Power Companies (under the conditions of the proposed Energy Sector Reform Bill), and establishment of proper incentives to encourage the new companies to market energy services at the least cost to

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[2] Ministry for the Environment. Submission to the House of Representatives, Commerce and Marketing Committee. *Inquiry into Proposed Increases of Wholesale & Retail Electricity Prices.* August 11, 1991.

consumers.[3] As mentioned, the MfE also favors price reform. The question arises as to how many of these changes will be possible if the government follows through with its goal of full privatization of Electricorp. If new, private electricity companies proliferate, the most successful ones most likely will be those generating the largest profits, and this goal is often at odds with public policy goals.

POLICY ISSUES

With the disestablishment of the Ministry of Energy in 1990 and the formation of Electricorp, the government's direct role in the electricity sector has been greatly reduced. Instead of retaining direct control of the electric power industry, the government has set the stage for a number of changes designed to increase competition and promote efficiency. An Electricity Task Force was set up to investigate the impacts of deregulation and recommend strategies to increase efficiency. Some of the major reforms proposed include:

- Corporatization of local electricity supply authorities (ESAs) and removal of their franchise areas;
- Removal of the obligation to supply;
- Separation of line and energy functions within the ESAs so that line and energy charges can be separated;
- Separation of the National Grid from Electricorp;
- Phasing out the Rural Electrical Reticulation Council, which had been subsidizing rural electrification via a levy on electricity sales;
- Promotion of greater self-monitoring by industry concerning safety standards;
- "Light-handed" regulation, relying on comprehensive information disclosure;
- Price reform to eliminate disincentives for conservation and thereby postpone or eliminate the need for new generating facilities.

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[3] Blakely, Roger. Secretary for the Environment. "Urgent need to consider alternatives to building more power stations." *Environment Update* (August 1991).

The separation of the main transmission system from Electricorp will be arranged by the newly formed Transpower Establishment Board, which will oversee the development of electricity wholesale marketing in New Zealand. The government's ultimate goal is full privatization of Electricorp, but many issues must be resolved before the sale is feasible. Debate continues on how, if at all, Electricorp's generating assets should be broken up for sale. The privatization of the ESAs is also complicated. Since full deregulation of electricity generation will be a complex and long-term process, the first step taken has been deregulation of power distribution. As of January 1, 1992, franchise areas for supply to residential users were removed, to be followed in one year's time by full removal of franchise areas for commercial customers as well. Efforts are underway to transform the EPBs and MEDs into private companies, but this too will be a lengthy process, requiring additional legislation and continued government involvement.

The extent to which the electric power industry should be privatized is a topic of considerable debate. It is not at all clear, for example, that removing franchise areas and the obligation to supply benefits consumers. The cost of supplying electricity to a new customer in a remote area may be orders of magnitude higher than the cost of supplying an established, nearby customer. What is the new customer to do if none of the ESAs vie for his business? Without some form of regulation or government oversight, power companies have no obligation to serve the public good. For this reason, electricity is far more commonly run by public agencies or regulated utilities. New Zealand's planned reforms in the power sector are radical; of all the energy sector reforms proposed, those affecting the electric power industry appear the most difficult and most prone to derailment.

Eight

COAL

OVERVIEW

Primary energy use in New Zealand was dominated by coal in the late 19th century and throughout the first half of the 20th century. In 1924, coal accounted for 87 percent of primary energy consumption, and coal continued to meet over half of the country's primary energy needs until the 1950s. Coal use has been relatively stagnant over the past decade, with increases in industrial coal use offset by decreases in commercial and residential uses. In the near-term, patterns of coal use are unlikely to change significantly; export markets offer the greatest opportunity for domestic coal developers. If electricity demand continues to grow at high rates, however, coal use in the power sector could increase by orders of magnitude as the twenty-first century draws near.

Coal is the largest fossil fuel resource in New Zealand and is expected to outlast both oil and gas—as noted in previous chapters, both oil and gas reserves are quite limited in international terms. Domestic coals are not so extensive that they play a major role in the international market, but they are typically low in sulfur and ash, which adds to their value as export commodities despite the small volumes involved. On the domestic front, the industrial sector is by far the largest user of coal, followed distantly by the electric power sector. Yet despite the abundance of the resource, the potential for greatly increased coal use is constrained by coal's inability to compete economically with other energy sources. Additionally, recent years have witnessed greatly heightened concern over environmental protection and reduction of greenhouse gas emissions. Coal mining can be not only devastating to the geophysical environment, but the mining process also releases methane gas, an important greenhouse gas. And, of course, coal

combustion emits more carbon dioxide per unit of energy than any other fuel, and also is a source of particulate matter and sulfurous gases.

MAJOR PLAYERS

Like the oil and electricity sectors, the coal sector in New Zealand is also being transformed by deregulation. On April 1, 1987, the State Coal Mines agency within the Ministry of Energy became a state-owned enterprise (SOE) known as the Coal Corporation of New Zealand, Ltd., or Coalcorp. The SOEs have limited liabilities under the Companies Act of 1955, but are subject to special accountability and control provisions under the State-Owned Enterprises Act of 1986. The government planned to fully privatize Coalcorp in 1988, but this plan was set back by the Tainui Maori Trust Board's claim to the Waikato coal reserves. The issue must be submitted to the Waitangi Tribunal and formally resolved by the government. Until ownership of reserves is sorted out, the sale cannot proceed. Although the Crown continues to own Coalcorp, no subsidies are paid to the coal sector, and it operates on a fully commercial basis.

Coalcorp is New Zealand's major coal producer, controlling 15 mines which account for nearly two-thirds of national production. There are also a number of smaller, private coal companies which collectively operate 53 mines. After the government began to rationalize the coal industry, a number of domestic and international companies, including Coalcorp, began to expand their activities. Coalcorp took immediate steps to streamline its operations and operate solely as a commercial enterprise. It closed an uneconomical underground mine and instead began to place emphasis on open pit mines. Coalcorp staff was also cut in half, with little or no impact on productivity. After becoming a SOE, Coalcorp's organizational structure is now analogous to most private companies: a board of directors sets overall policy, a chief executive officer implements the policy directions, one general manager is based in Wellington to head the corporate office, and two general managers oversee semi-autonomous business units handling mining activities in the northern and southern regions. Each business unit has a team of support staff, including production managers, marketing managers, and export managers.

When increased priority was given to the development of export markets—in part because of favorable prices for high-grade coking and steaming coals in the regional market, and in part because the domestic market had been fairly stagnant—several private companies and the Railways Corporation entered into joint venture export deals with Coalcorp. The strongest interest is generally in the development of the highest-grade bituminous coals, such as those in the West Coast region. A consortium of domestic and Japanese companies formed the Greymouth Coal Company to investigate Greymouth field's Rapahoe block. The NZ Oil and Gas Company has also been actively prospecting in the West Coast region, conducting seismic surveys in the Pike River coal field.

COAL PRODUCTION AND TRANSPORT

Table 8.1 presents coal production data for the period from 1974 through the first quarter of 1991. Coal production was on a general decline during the 1970s. In 1974, production totalled nearly 2.6 million tons (mmt); production dropped below 2.0 mmt in 1979 and remained in the 2.2 to 2.6 mmt range until 1989, when production exceeded 2.7 mmt. In part, the recovery in production was a function of improved export opportunities. Figure 8.1 displays the role of coal exports in the overall sales between 1974 and 1990; export markets have been one of the strongest areas of growth for the coal industry.

New Zealand's major coal regions and facilities are mapped in Figure 8.2, which also lists estimated reserves by type and region. Lignites and subbituminous coals in the Otago and Southland regions constitute the bulk of the reserves. Most of the coals produced are subbituminous coals in the Taranaki and Waikato regions on the North Island and subbituminous and bituminous coals in the West Coast region of the South Island. Recoverable reserves are estimated to be 82 percent lignite, 14 percent subbituminous, and 4 percent bituminous coals.[1] The chief producers of bituminous

[1] Department of Statistics. *New Zealand Official Yearbook*: p. 496. Wellington: New Zealand Government Press, 1990.

Table 8.1
Coal Production and Total Sales
('000 tons)

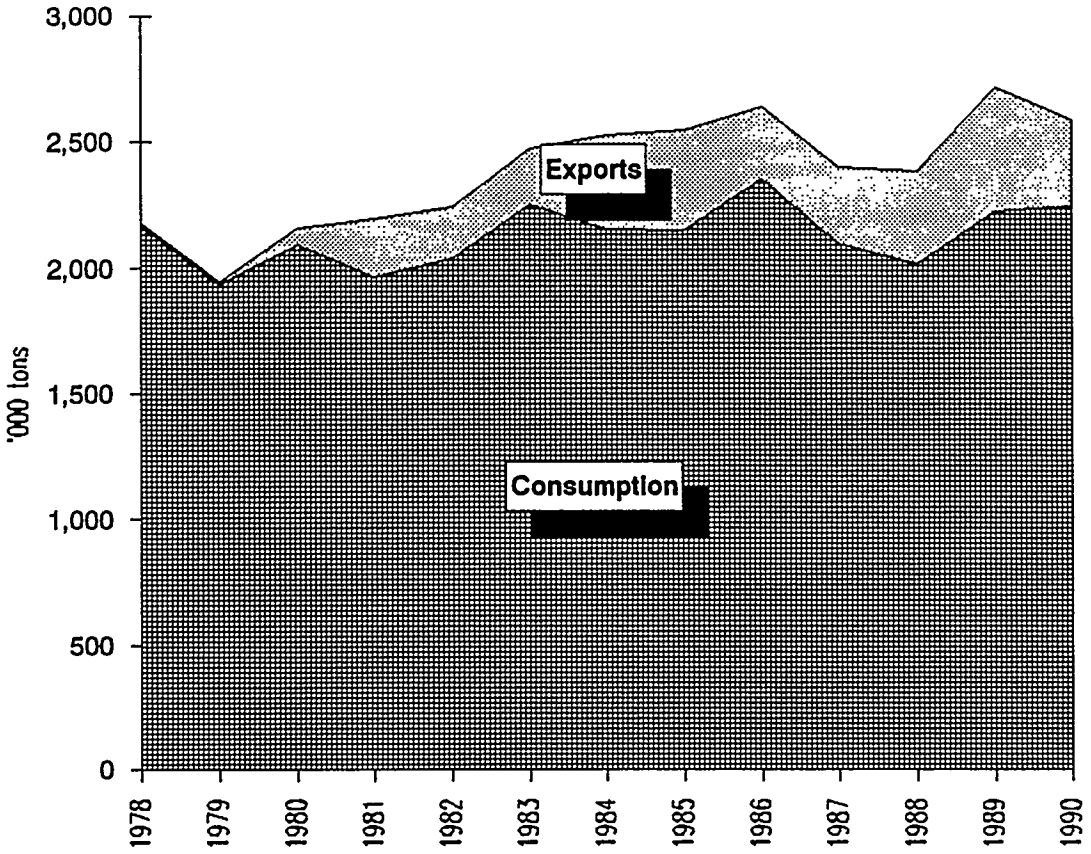
Year	Production	Total Sales	Exports
1974	2,564	2,582	na
1975	2,412	2,369	na
1976	2,487	2,493	na
1977	2,369	2,338	na
1978	2,183	2,215	11
1979	1,948	2,128	10
1980	2,163	2,085	70
1981	2,197	2,121	232
1982	2,244	2,249	204
1983	2,474	2,290	222
1984	2,527	2,354	371
1985	2,546	2,386	395
1986	2,641	2,078	282
1987	2,402	1,980	300
1988	2,385	2,153	365
1989	2,713	2,688	486
1990	2,586	2,529	339
1991*	603	592	na

** 1991 data are for the 1st quarter only*
Note: "Total sales" includes exports and electricity generation; na = data not available
Sources: Production & Sales per Ministry of Commerce, "Energy Data File," July 1991
Exports through 1990 per IEA/OECD "Coal Information."

coals are the Greymouth, Garvey Creek, and Buller coal fields. The main producers of subbituminous coals are the Huntly, Rotowaro and Maramarua fields in the Waikato coal region and the Ohai coal field in the Southland coal region. The East Southland field is the main lignite producer.

Coal production by type is detailed in Tables 8.2a, 8.2b and Figure 8.3. Despite their prominence in the composition of reserves, lignites have averaged less than 10 percent of total production throughout the 1980s. The majority of coals produced in New Zealand are subbituminous/steam coals. In the early part of the decade, these types of coals accounted for 80 to 85 percent of total production, but the expansion of coking coal production has changed the overall picture. The share of coking coals in total production was around 8 percent in the early 1980s, but climbed to a range of 15 to 25

Figure 8.1: Coal Consumption and Exports, 1978-1990



percent during the latter half of the decade. The growth in this sector is primarily the result of improved export marketing opportunities, since coking coals are the chief—and usually the only—export coal. Yet the external market for these coals is limited, as is the ability of New Zealand to compete with other exporters. Australia is the largest coal exporter in the region, for example, and Indonesia is also expanding its coal export capability. Both of these countries are far better situated to export to the major markets of Asia.

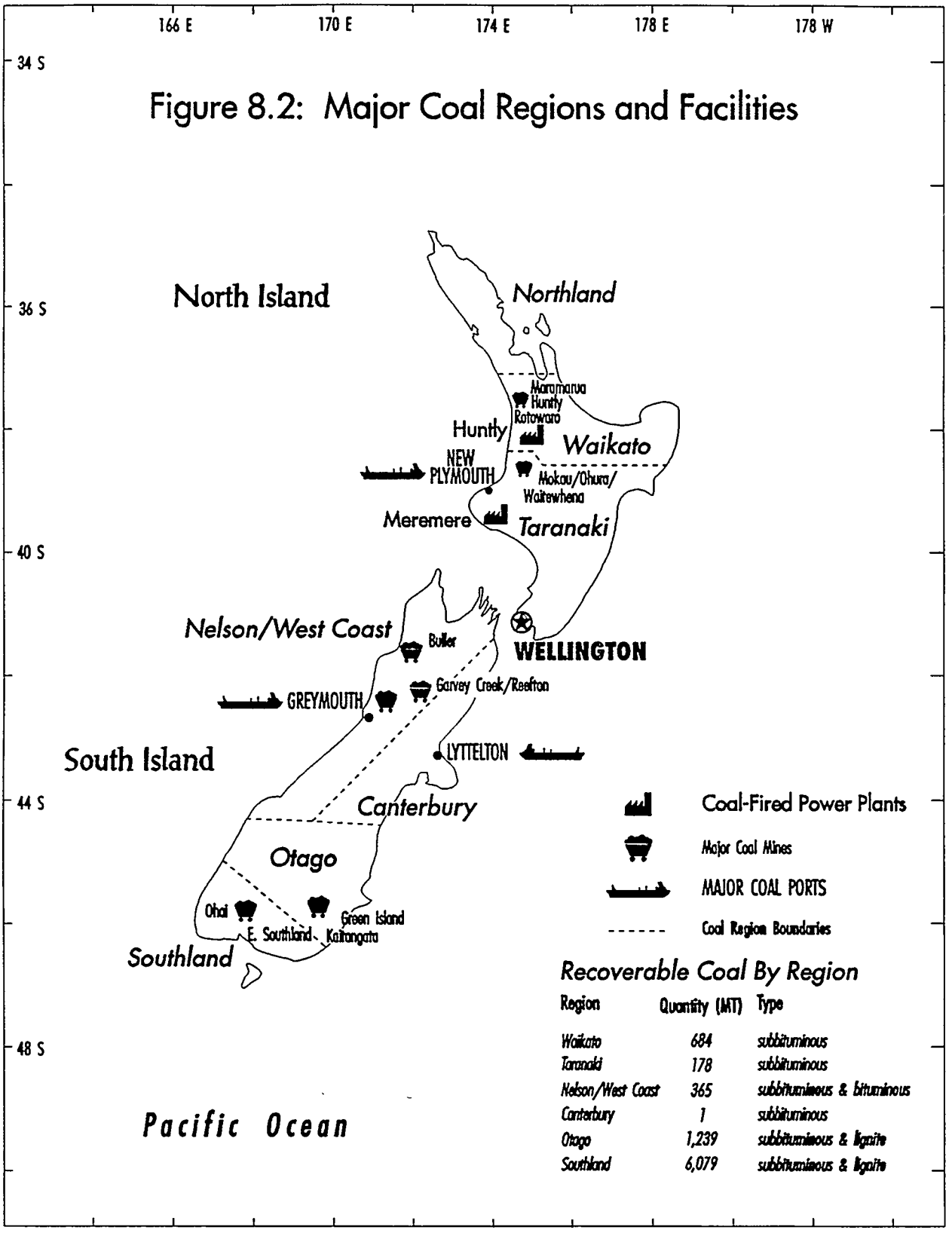


Figure 8.2: Major Coal Regions and Facilities

Recoverable Coal By Region

Region	Quantity (MT)	Type
Waikato	*684*	*subbituminous*
Taranaki	*178*	*subbituminous*
Nelson/West Coast	*365*	*subbituminous & bituminous*
Canterbury	*1*	*subbituminous*
Otago	*1,239*	*subbituminous & lignite*
Southland	*6,079*	*subbituminous & lignite*

Table 8.2a
Coal Production by Type
('000 tons)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990*
Coking Coal	173	159	184	213	308	319	462	372	467	681	370
Steam Coal	284	319	259	283	276	322	235	172	121	92	0
Subbituminous Coal	1,473	1,514	1,664	1,759	1,723	1,638	1,479	1,738	1,639	1,781	2,060
Brown Coal	208	212	152	229	226	247	195	86	174	159	160
Oven & Gas Coke	49	33	15	17	17	10	5	1	0	0	
Pat. Fuel & BKB	9	7	6	4	3	2	0	0	0	0	
Total	2,196	2,244	2,280	2,505	2,553	2,538	2,376	2,369	2,401	2,713	2,590
Total Main Coals	2,138	2,204	2,259	2,484	2,533	2,526	2,371	2,368	2,401	2,713	2,590

Table 8.2b
Percentage Shares of Production by Coal Type

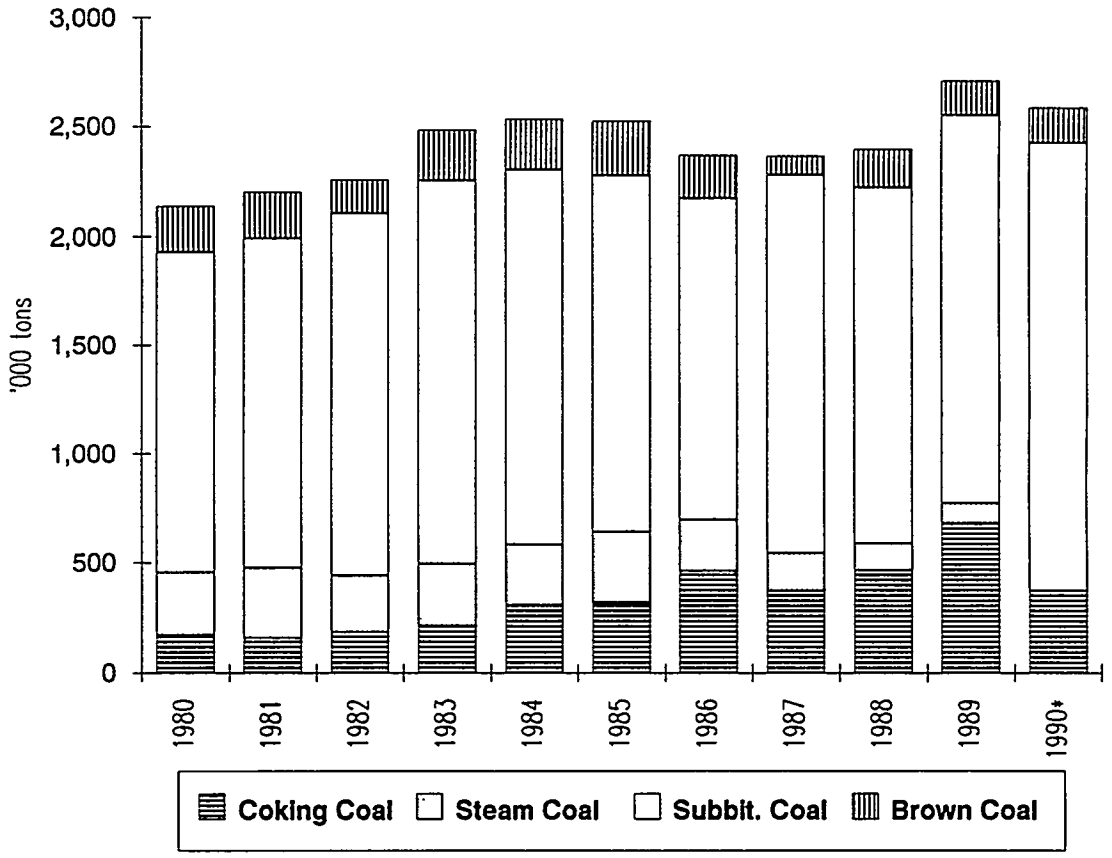
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990*
Coking Coal	8.1	7.2	8.1	8.6	12.2	12.6	19.5	15.7	19.5	25.1	14.3
Steam Coal	13.3	14.5	11.5	11.4	10.9	12.7	9.9	7.3	5.0	3.4	0.0
Subbituminous Coal	68.9	68.7	73.7	70.8	68.0	64.8	62.4	73.4	68.3	65.6	79.5
Brown Coal	9.7	9.6	6.7	9.2	8.9	9.8	8.2	3.6	7.2	5.9	6.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

** 1990 data are preliminary. No disaggregation is available for steam coal and subbituminous coal.*
Source: IEA/OECD "Energy Balances of Member Countries."

COAL PROCESSING AND TRADE

New Zealand's coals are geologically young, but the coking coals are of very high quality and thus are attractive as an export commodity. Coal is generally washed at the mine site before being transported to remove ash and pyritic sulfur, which also serves the purpose of cutting transport costs since total tonnage is reduced. Some major coal consumers have their own coal processing facilities. Little or no washing is required, since most New Zealand coals are either low or exceptionally low in ash content. As a general rule, coals of less than 8 percent ash content do not require washing. Around two-thirds of the coals produced in New Zealand contain less than 5 percent ash on a dry·

Figure 8.3: Coal Production by Type



**No disaggregation available for steam and subbituminous coals in 1990.*

basis, while only around 1 percent of production is classified as high-ash (10% ash or higher on a dry basis). The specialty coals produced for the Japanese export market are usually less than 2 percent ash and sometimes less than 1 percent ash. The low ash content makes these coals suitable for tailoring into petroleum coke and charcoal substitutes. New Zealand's coals are also very low in sulfur, typically less than 0.3 percent on a dry basis.

The major ports handling bulk coal cargoes are New Plymouth, Greymouth, and Lyttelton. The Greymouth port handles exports of most West Coast coals, but coals from the mines located further inland, such as Reefton and Garvey Creek, are sent via a

396 km rail link to coal-handling facilities at Lyttelton Harbour. The Lyttelton coal handling facilities were recently expanded and upgraded. Lyttelton's Cashin Quay can accommodate ships of up to 275 m length and 11.3 m draft. A bulk shiploader is located at this quay. Most of the wharves are connected to the NZR railway system, and stockpiling facilities are available for coal and coke exports.

The port at Greymouth is not a true harbor, but rather a pair of breakwaters sheltering a river mouth. This places strict limits on the size of ship which can safely enter the port. The maximum dimensions of such a ship are 400 dwt, 109 m length, and 5.5 m draft—which is a very small ship in relation to most coal carriers. Since shipping costs are strongly influenced by economies of scale, it is clear that exports from this port are automatically handicapped by facing higher transport costs. Storage area for bulk cargoes of up to 1,000 tons is available. All wharves are served by rail.

New Plymouth's Port Taranaki is a major harbor facility that handles a number of dry bulk cargoes, chiefly fertilizer and urea from the Petrochem plant, but also cargoes of coal. The depth of the harbor is 11 m generally, 12 m at the entrance. There are nine main berths, with lengths ranging from 60 m to 211 m and depths ranging from 6.5 m to 11m.[2]

New Zealand has in the past imported small quantities of coking coals, chiefly from Australia, though cargoes of anthracitic coals have been imported from sources as distant as the United States, the United Kingdom and Germany. Although no coals are currently imported, the prospect of imported coal nonetheless adds an element of competition to the market. An Australian company, CRA, Ltd., even proposed building a new 500 MW coal-fired power plant at Marsden Point, to be fueled by imported coal.

Coal export markets have grown increasingly important for domestic producers. Coal exports were a modest 11 thousand tons (mt) in 1978, but by 1981 exports had expanded to 232 mt. After Coalcorp became a SOE in 1987, exports expanded to around 365 mt in 1988 and hit a record-high of 486 mt in 1989 before dropping to 339 mt in 1990. To provide a sense of scale, however, it is worth noting that Australia

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[2] Lloyd's of London. *Ports of the World.* 1988 ed.

exported around 100 million tons of coal in 1990, a figure over 20 times higher than any level ever achieved by New Zealand. Table 8.3 and Figure 8.4 provide a look at coal exports by destination. Japan is the major export market, accounting for anywhere from 60 to 100 percent of exports in any given year. Coalcorp recently signed a three-year supply contract with Mitsubishi Kasei, which entails 200,000 tons/year of high-quality coal, the quality of which is specified as 7,100 kcal/kg, 0.5 percent sulfur, 6 percent ash, and 3.9 percent moisture. The contract price will be US$58 per ton, FOB. A second 200,000 tons/year supply contract was signed with the Steel Authority of India, with a price of between US$54 and US$60 per ton of coking coal. Coal exports have also been shipped to Australia, other Asia-Pacific destinations, and OECD Europe.

COAL CONSUMPTION AND PRICING

Tables 8.4a and 8.4b provide a breakdown of coal consumption by end use sector, while Figure 8.5 depicts the consumption trends by sector along with the growth in exports. In 1989, industry absorbed around 75 percent of New Zealand's final coal consumption. Electricity generation accounted for around 15 percent of coal use, and the commercial/public and residential sectors accounted for around 6 percent and 4 percent, respectively.

Coal is usually priced lower than other fuels to compensate for higher capital and handling costs borne by the user. The use of domestic coal also fulfills a government goal of using indigenous energy resources whenever possible. In the industrial and commercial sectors, coal is used mainly for heating purposes or raising steam. In the residential sector, coal is used for home heating, but is becoming increasingly less competitive with other fuels. In 1980, residential uses represented nearly 14 percent of total coal use, but by 1989, this percentage had dwindled to 4.4 percent. Residential demand varies seasonally and by location, as the temperature in the northern region of the North Island rarely drops below 18°C (around 65°F), while the temperature in the South Island is often near freezing in winter.

The steel industry is currently the dominant industrial user of coal, though in the earlier part of the decade the main coal-using industry was food processing. Other major

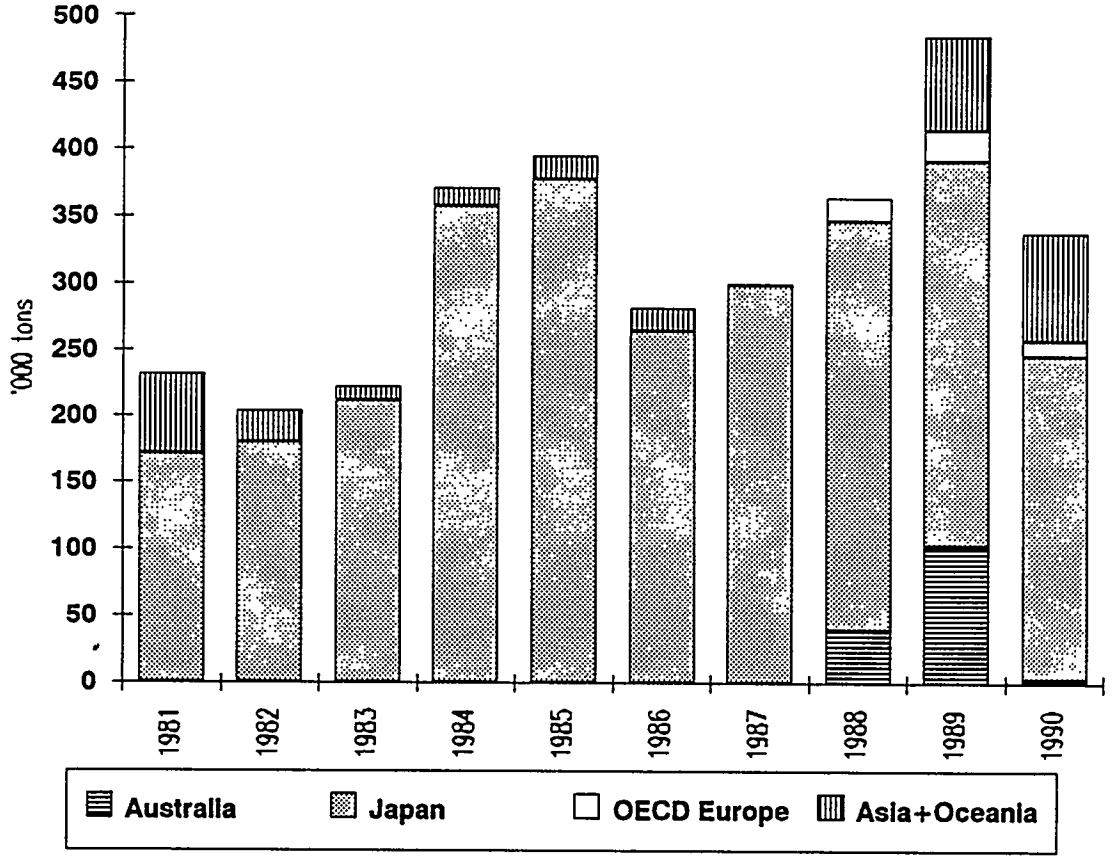
Table 8.3
Coal Exports by Destination
('000 tons)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Australia											39	103	3
Belgium											18		
Japan	11	10	70	171	180	212	358	378	265	299	308	290	243
Netherlands												23	12
United Kingdom										1			
Total OECD	11	10	70	171	180	212	358	378	265	300	365	416	258
Asia/Oceania	0	0	0	61	24	10	13	17	17	0	0	70	81
Total Exports	11	10	70	232	204	222	371	395	282	300	365	486	339
% Japan	100	100	100	73.7	88.2	95.5	96.5	95.7	94.0	99.7	84.4	59.7	71.7

Notes: 1990 data are preliminary.
Source: IEA/OECD "Coal Information," various dates up to 1991.

industrial users include the paper, pulp and printing industry, and the non-metallic minerals industry. Coal use in the iron and steel industry has expanded significantly, growing from around 137 mt in 1981 to 600 mt in 1989. New Zealand Steel, Ltd., was incorporated on July 26, 1965, following government investigation into the viability of a local steel industry based on indigenous ironsands. Facilities for major operations (galvanizing, pipe making, hot rolling, and color coating) began to be commissioned in 1967. The plant is located at Glenbrook, near Auckland and also near ironsand deposits and coal supplies. Yet the ironsand deposits were only marginally economic and the coal was of relatively high cost. This integrated iron and steel plant is an example of another "Think Big" project which ended up being quite burdensome and costly for the government; expansions were announced in 1981 and were subject to massive cost overruns during the 1980s, culminating with the government assuming responsibility for NZ$1.9 billion in debt during two stages of restructuring in 1986 and 1987. At the outset, the cost of the expansion was estimated at NZ$783 million. Delays and industrial

Figure 8.4: Coal Exports by Destination, 1981-90



disputes raised costs to NZ$1.1 billion, and financing and exchange rate losses brought the total bill to NZ$2.7 billion.[3]

In the power sector, Electricorp is the only coal user, and only two of its thermal power plants currently burn coal: the 112 MW Meremere plant in the Taranaki area, which is a dedicated coal plant, and the Huntly power station in the Waikato region, which is dual-fired using gas and coal. With a capacity of 980 MW, Huntly is New Zealand's largest power plant. The Huntly plant was designed to burn coal of around 21.5 MJ/kg caloric value, 5 percent to 10 percent ash, and 0.5 percent sulfur, though some variations are possible.

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[3] "BHP Steel acquires 31% investment interest." *Petromin* (August 1989): p. 60.

Table 8.4a
Coal Consumption by End Use Sector
('000 tons)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Electricity	302	330	368	582	540	455	247	390	305	320
Other Transformation	111	87	49	54	36	39	30	5	0	0
Coal Mine Use	4	3	2	2	2	3	16	8	8	8
Industry	1,045	1,026	1,093	1,057	1,153	1,168	1,173	1,277	1,763	1,627
Transport	3	2	2	4	4	4	4	0	0	0
Commerce	230	251	241	234	202	193	155	137	108	128
Residential	269	270	278	238	196	179	146	160	100	96
Total	1,964	1,969	2,033	2,171	2,133	2,041	1,771	1,977	2,284	2,179

Table 8.4b
Percentage Shares of Coal Use by Sector
(%)

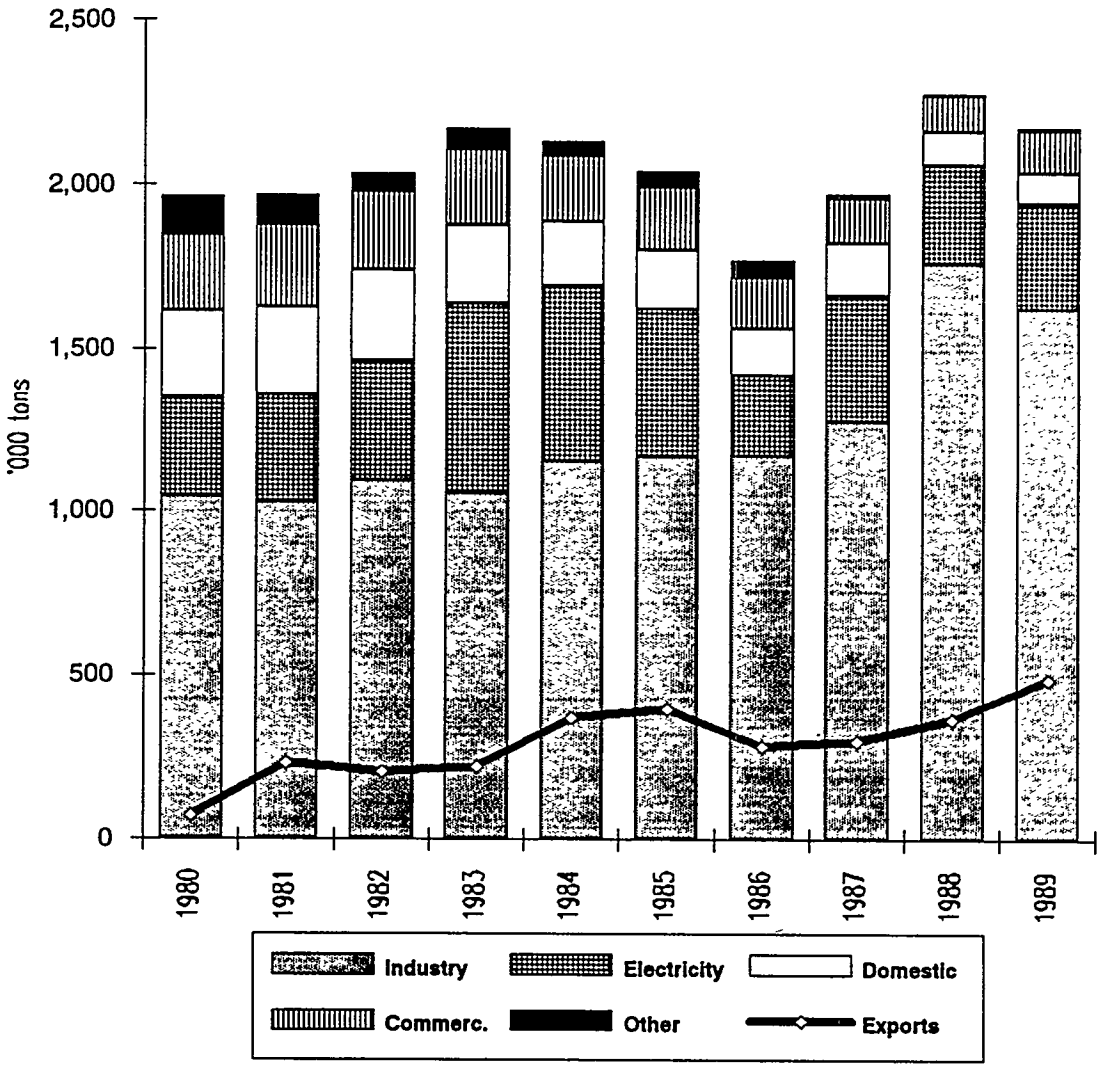
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Electricity	15.4	16.8	18.1	26.8	25.3	22.3	13.9	19.7	13.4	14.7
Industry	53.2	52.1	53.8	48.7	54.1	57.2	66.2	64.6	77.2	74.7
Commerce	11.7	12.7	11.9	10.8	9.5	9.5	8.8	6.9	4.7	5.9
Residential	13.7	13.7	13.7	11.0	9.2	8.8	8.2	8.1	4.4	4.4
Other	6.0	4.7	2.6	2.8	2.0	2.3	2.8	0.7	0.4	0.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: IEA/OECD "Energy Balances of Member Countries."

A large portion of coal supplies to the power sector have come from the Huntly West, Rotowaro and Maramarua coal mines, though sources are now becoming more diverse. While Coalcorp remains the largest coal producer and marketer, increased competition has resulted in Coalcorp losing part of its market share. After Coalcorp and Electricorp became SOEs in 1987, their existing supply contracts were nullified. New arrangements were made, and although price data is scarce, it appears that coal prices to the power sector (and other users) have decreased considerably. Under the old arrangements, Electricorp was paying around NZ$112 per ton, while prices after 1987 averaged just over NZ$60 per ton.[4] With new players in the market and the prospect of

[4] "NZ commitment to RD&D intensifies." *Petromin* (August 1989): p. 36.

Figure 8.5: End Use Sectors and Exports of Coal



coal imports, prices fell for all classes of consumer. The average price per ton in the 1986-87 fiscal year was NZ$73.84, falling to NZ$69.51 per ton in 1987-88 and NZ$62.60 in 1988-89.[5]

In 1988, Electricorp signed a supply contract for 100,000 tons per year with a private company in Waikato. Electricorp has constructed an independent coal reception

[5] International Energy Agency. *Annual Energy Policies of Member Countries*, 1989.

area for coals from mines other than the Coalcorp mines in the Huntly area. Coal imports also remain a possibility if the price is right, but only a fairly large user would be motivated to build the necessary receiving and distribution infrastructure.

Coal supply contracts are negotiated privately between the parties involved, with prices and terms that may vary considerably. Coalcorp received the supply contract for the steel industry, but the terms of the contract were not disclosed, nor were the terms of Coalcorp's early export contracts with Japan. It is thus difficult to track coal prices and taxes by end user. One of the key sources of data on pricing and taxes, the OECD, stopped publishing complete data on steam coal prices in 1984. At that time, the industry price was NZ$64.38 per ton, including NZ$1.00 tax, while the residential price was NZ$141.09, also including NZ$1.00 in tax.[6] During the 1981-1984 period, when complete data were available, however, the industry price was consistently less than one half of the residential price.

Table 8.5 and Figure 8.6 provide indices of retail prices for major energy sources: oil products, gas, electricity, and coal. It is significant that the prices of coal, gas and electricity all have risen much more rapidly since the 1985 base year than the price of oil products. The sharp drop in the oil price index in 1986 may be largely attributed to the worldwide crash in oil prices. Oil product prices thereafter remained fairly low, and New Zealand consumers responded. As noted in Chapter Five of this report, oil product demand grew at rates averaging nearly 5 percent per year during the 1985-1990 period. Coal sales, in contrast, increased at rates of less than 1.2 percent per year during the same period. In the 1988-1991 period, however, the retail price of coal grew very modestly, indicating, perhaps, that increased market competition since deregulation and the expanded use of gas in the power sector have resulted in relatively lower coal prices to the consumer. Coal is having a difficult time competing in the domestic market.

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[6] International Energy Agency. *Energy Prices and Taxes.* various issues.

Table 8.5
Index of Retail Prices for Major Energy Sources
(1985=100)

Year	Oil Products	Gas	Coal	Electricity
1979	39.0	73.8	44.0	55.4
1980	54.9	88.3	52.2	65.5
1981	63.0	101.1	61.5	71.3
1982	72.1	98.1	76.5	80.9
1983	76.4	92.1	80.5	83.2
1984	84.2	92.0	81.9	84.5
1985	100.0	100.0	100.0	100.0
1986	90.3	121.2	122.4	117.7
1987	98.0	135.1	137.6	140.9
1988	96.9	153.9	142.8	151.7
1989	97.7	171.9	145.5	159.4
1990	104.7	179.1	146.1	164.9
1991*	110.2	192.8	147.1	173.2

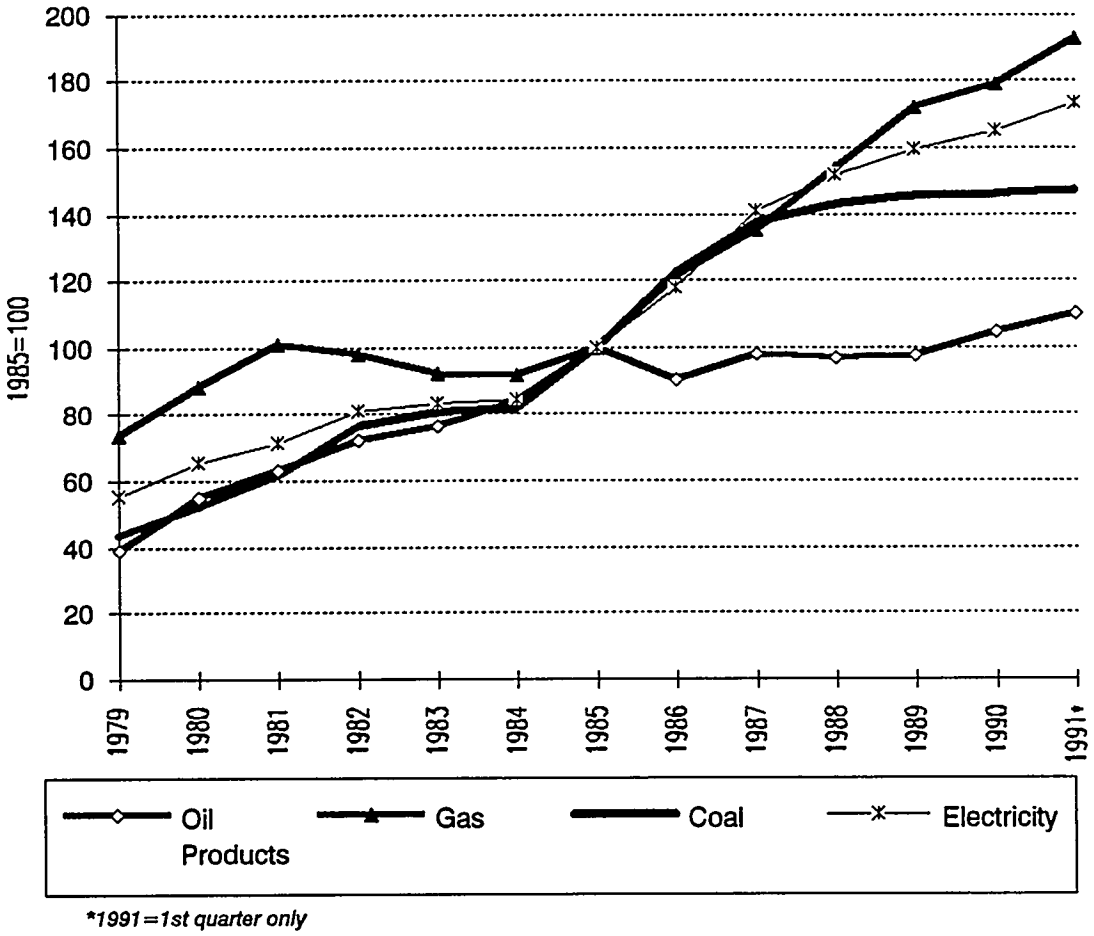
**Data are for the 1st quarter only*
Source: IEA, "Energy Prices and Taxes," 2nd Quarter 1991

GOVERNMENT POLICIES AFFECTING COAL USE

Despite the fact that Coalcorp remains a state-owned enterprise, New Zealand's coal market is deregulated. There are no artificial limits on prices charged for coal, nor are there production constraints which could influence prices. There are also no barriers to trade. The markets are influenced by the local availability of coal, the economics of inter-fuel competition, and general forces of supply and demand. A number of new competitors have diluted the influence of Coalcorp, which must compete on an entirely commercial basis but continues to dominate the market. No direct subsidies have been paid to Coalcorp.

Outside the realm of pricing and taxation, the government may have influence over patterns of coal use via its overall policies on energy security, economic development, and environmental protection. Worldwide, a considerable amount of pressure has come to bear on major coal—and other fossil fuel—users in relation to carbon dioxide emissions and the greenhouse effect. It is not clear whether New Zealand

Figure 8.6: Indices of Retail Energy Prices, 1985=100



*1991=1st quarter only

would, or should, constrain coal use, since most analyses seem to indicate that New Zealand's contribution to global warming is insignificant, and it appears that the vegetation in New Zealand absorbs several times more CO_2 than the country actually produces. Still, the country is committed to achieving a 20 percent reduction in greenhouse gas emissions by the turn of the century. Coal combustion releases more carbon dioxide per unit of energy gained than any other fuel and also releases sulfurous gases and particulate matter. New Zealand does not suffer from a severe air quality

problem, but air pollution is of particular concern in certain population centers located in air basins which trap emissions.

In addition, coal mining, processing and transport can create numerous environmental hazards, damaging not only to the physical surroundings, but also releasing significant quantities of methane gas—an important greenhouse gas—into the atmosphere. The quantities of methane in certain coal mines are so high that they may become commercially exploitable in their own right. In 1991, the government for the first time gave approval to a coal-bed methane extraction project in Southland province's Ohai coal field. Feasibility studies for projects such as this had been underway for a number of years on the South Island, which has no commercial gas fields and no gas distribution system. If the project is found to be economically feasible, a pipeline network would be required to serve customers. The developers and the Minister of Energy consider the market potential for gas to be fairly high in the Southland and Otago regions.

Established uses of coal appear likely to continue, but there is widespread opposition to the construction of additional coal-fired power plants. Aggressive pursuit of export markets may be the most effective way for coal producers to expand their operations, but these markets too may be limited. Additionally, markets for low-grade lignites, which constitute the bulk of New Zealand's reserves, are almost non-existent. In order to commercially develop these resources, it is likely that advanced coal conversion technologies would be required so that the low-value lignites could be liquefied or otherwise transformed into higher value commodities. This course could be pursued only under a regime of greatly strengthened oil prices. There may be some room for clean coal technologies in New Zealand, but the economics would have to improve significantly. The expansion of conventional coal uses is also limited, both by economic factors and by the country's commitment to environmental protection and reduction of greenhouse gas emissions.

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