THE NEW ZEALAND ENERGY SCENE NOW AND POST-MAUI

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Abstract

Supply and demand forecasts to 2020 published by the Ministry of Commerce highlight the significance of the depletion of the Maui gas and condensate field for the New Zealand energy scene. Maui currently produces around 34% of our primary energy and 45% of our transport fuels, including fuel from the synthetic fuels plant.

The depletion of Maui around 2010 is expected to reduce our liquid fuel self-sufficiency and reduce the availability of gas for electricity generation and petrochemicals. The Ministry's forecasts conclude this will result in price rises for gas and electricity, and increased use of coal, geothermal, hydro, wind and other renewables for generation. The depletion of the Maui field highlights the importance of developing an attractive petroleum royalty regime to encourage further exploration of New Zealand's petroleum resources.

Introduction

The Maui gas and condensate field is New Zealand's largest single energy source currently in use and dominates our local energy scene. It currently produces around 34% of our primary energy and 45% of our transport fuels, including synthetic petrol.

Figure 1 shows Maui's importance to our oil and condensate reserves. At 431 PJ it accounts for 48% of our estimated recoverable reserves of oil and condensate. Kupe is the next largest with 180 PJ or 20% of our total reserves. Figure 2 shows Maui's dominance of our natural gas reserves accounting for 72% of total reserves, at 2418 PJ at December 1993.

The timing of Maui depletion and the rate of its depletion is clearly going to have a major impact on New Zealand's energy markets, particularly given the expected continued growth in future energy demand.

Initial Development Period

Maui has dominated energy decision-making in the last 20–25 years. To provide the incentive to develop this large resource the government of the day guaranteed the Maui partners a market for their gas. This was achieved through a "take or pay" agreement.

Early work showed reticulated demand was likely to be relatively small and it had been proposed that this be met by Kapuni. Consequently the synthetic petrol, methanol, ammonia/urea and thermal electricity plants were developed to take advantage of the cheap, abundant Maui resource. These investments were specifically designed to draw on Maui and most will be rendered uneconomic by the depletion of the field. Even if significant new gas finds are made which hold down the price of gas, the economic lives of the original plants will be running out early next century.

Historical and Current Usage of Gas

Figure 3 shows the significant growth in the use of natural gas since Maui came on stream. Since the late 1970s gas use has risen from around 11 PJ in 1975 to around 179 PJ in 1993. The New Plymouth and Stratford power stations were commissioned in 1974 and 1976 respectively using natural gas; Huntly came online in 1982. Electricity generation underpinned an initial peak in gas use in 1978; annual consumption was greatest (193 PJ) in 1992 due to the hydro shortage.

Since 1983 the petrochemicals industry has also developed into a major consumer of natural gas, with the synthetic petrol plant accounting for the majority of consumption. Gas usage for petrochemicals has now peaked as the plants are operating at or around full capacity. Reticulation has grown steadily since 1972 from 3 PJ pa to around 39 PJ pa in 1993.

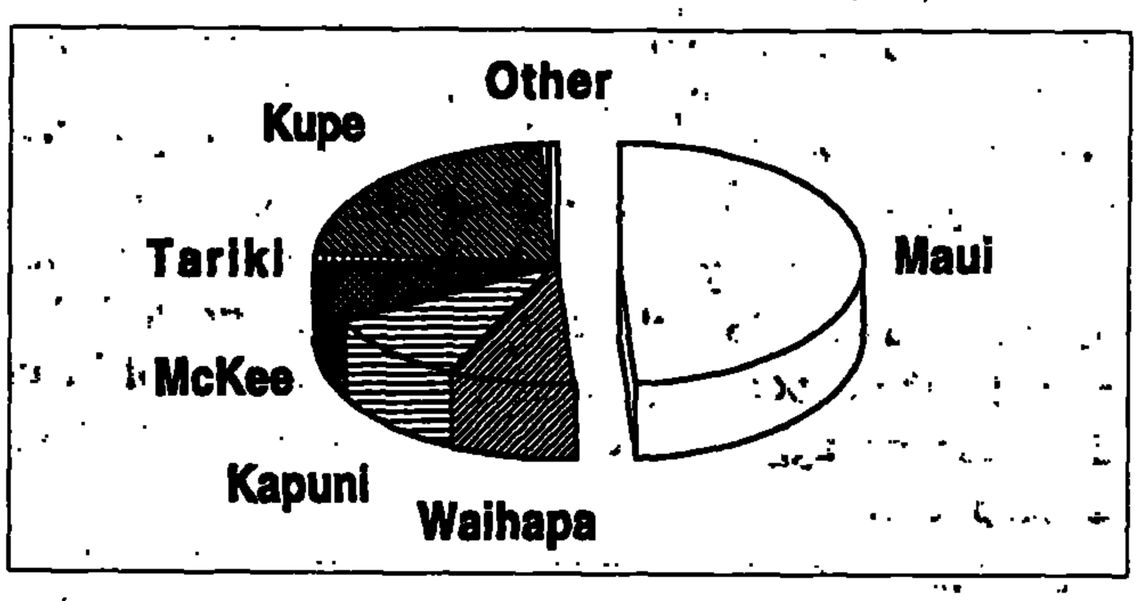

Fig. 1. Estimated oil and condensate reserves (at December 1993).

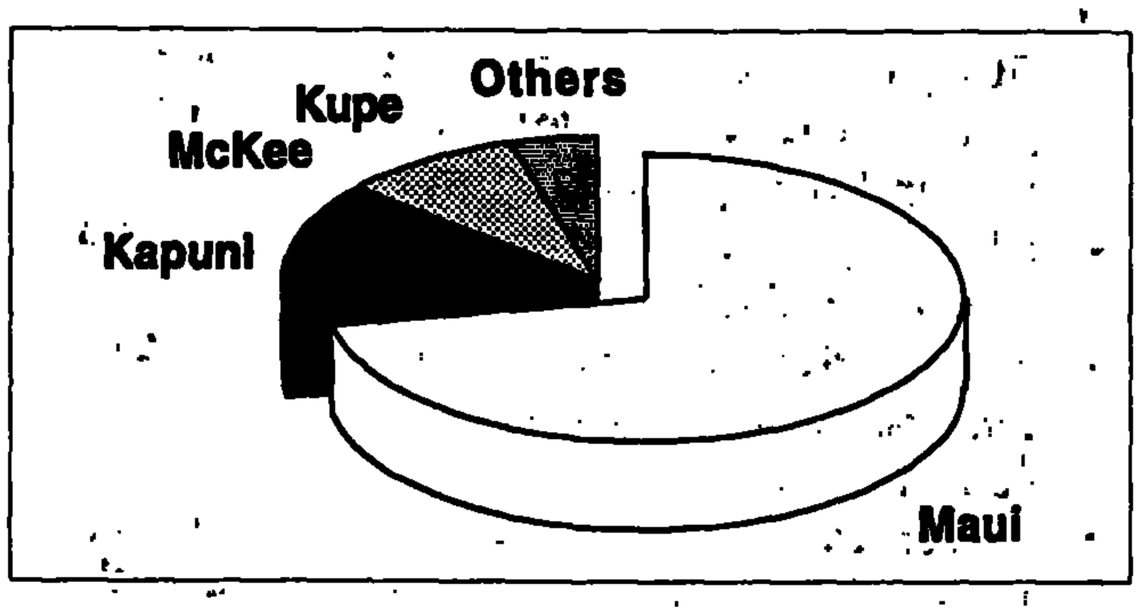

Fig. 2. Estimated natural gas reserves (at December 1993).

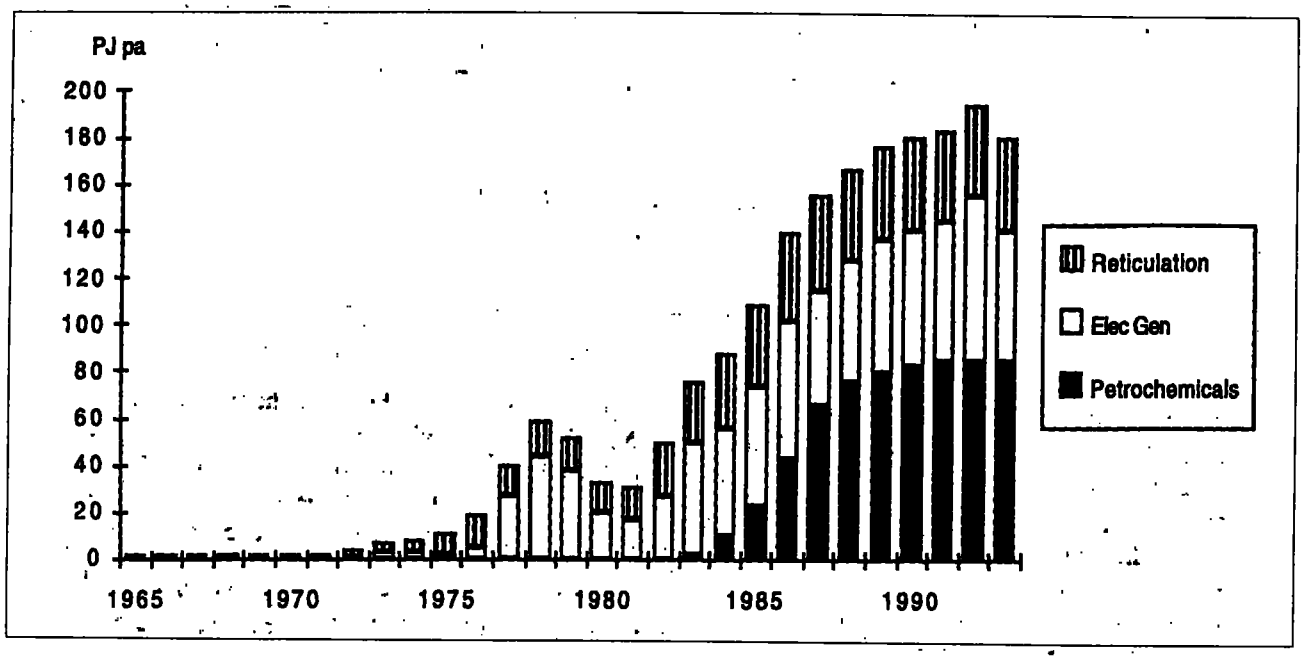

Fig. 3. Historical gas use.

In 1992/93 total gas production was distributed as follows: 32% to the synthetic gasoline plant, 10% to the Petralgas chemical methanol plant, 3% to the Petrochem ammonia/urea plant, 36% to ECNZ and 19% to NGC. Maui currently produces 72% of total natural gas needs.

Impact of Maui's Depletion on New Zealand's Energy Markets: Ministry of Commerce Forecasts

The questions that arise are:

- what effect is Maui's depletion likely to have on our energy markets?
- what are the likely scenarios post-Maui?

The "take or pay" contract between the Crown and the Maui partners sets out the agreed phased depletion of the Maui field. The energy supply and demand forecasting programme of the Ministry of Commerce provides a vehicle to examine in a more formal way the supply and demand interactions in New Zealand's energy markets. The Ministry's recent as yet unpublished work "Supply and Demand Scenarios to 2020" provides the opportunity to examine the effects of Maui depletion on aggregate energy markets under varying assumptions.

A combination of quantitative and qualitative methods were used by the Ministry to derive the baseline forecast. The key assumptions under which the baseline forecast was made are:

- GDP growth around 3% for most of the period
- gas discoveries sufficient to meet average annual demand of around 70 PJ pa post-Maui
- oil prices grow in line with IEA forecasts: 3.5% (in real terms) pa to US$30 by 2005 and stable thereafter
- new oil and condensate finds sufficient to maintain long run production at around 90 PJ pa or about 20% above current levels
- accelerated uptake of energy efficiency technology (0.5% pa), i.e. above the historical intrinsic rate of uptake
- no new policy adjustments (such as a carbon tax)

Future Aggregate Consumer Energy

Figure 4 shows a growing divergence between the assumed GDP path and the growth in demand for consumer energy. The dip in consumer energy demand around 2010 is due to the anticipated closure of the petrochemicals plants. GDP is assumed to grow at 3% pa and consumer energy is estimated to grow at only 1.4% pa. The contributing factors to this divergence are:

- the increased uptake of energy efficiency measures (0.5% pa)
- higher energy prices for electricity and gas helping to constrain energy demand
- removal of the drivers of high growth in the past which included new energy intensive projects using Maui gas and surplus electricity, reduction in motor vehicle prices (with import deregulation), transport deregulation, and real price decreases in the last 10 years for oil and electricity

A result of the divergence between growth in GDP and consumer energy is a fall in our energy intensity over the next 30 years. This can be seen in Figure 5 where energy intensity declines from around 1990, with a marked drop around 2009 when the petrochemicals plants are anticipated to close.

Figure 6 gives estimates for total consumer energy for the outlook period growing from 378 PJ in 1990 to 556 PJ by 2020, an increase of 47%, the transport and industrial and commercial sectors lead demand growth with an average increase of 1.4% pa. Residential demand is expected to grow by only 0.6% pa.

The estimated consumer energy demand growth profile suggests significant changes will occur in primary energy supply as Maui gas is depleted.

Fuel Shares Profiles

Figure 7 shows the historical and estimated use of fuels for consumer energy. For the period 1961–2020 coal grows fastest increasing at 2.2% pa. from 44 PJ in 1990 to 86 PJ in 2020. Electricity increases at 1.8% pa and oil demand grows at 1.5% pa. In contrast, gas consumption falls by 1.6% pa.

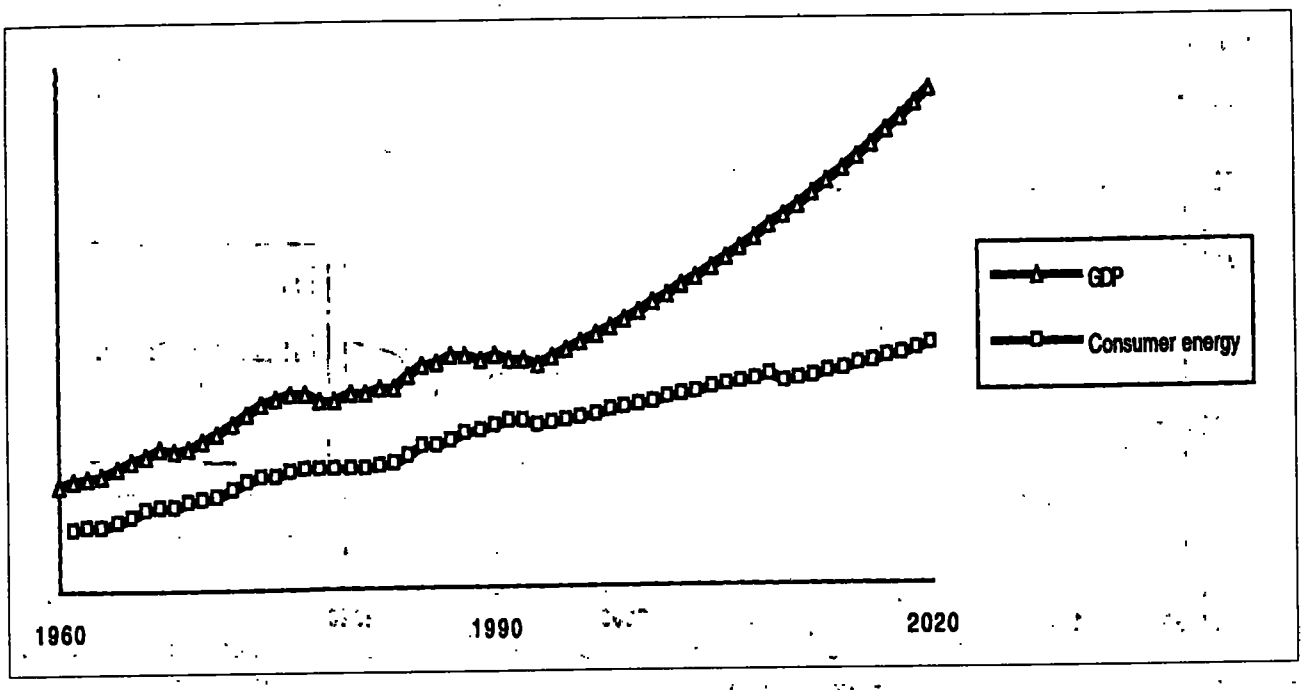

Fig. 4. GDP growth and energy demand.

There is a noticeable dip around 2009 due to the anticipated closure of the petrochemicals plants and demand then continues to decline as a result of reduced use for electricity generation.

Maui gas has remained relatively cheap in New Zealand by world standards at around $3/GJ for the NGC real wholesale price including taxation and levies (but excluding transmission costs). This compares with gas (pipeline) imports into the EEC during 1992 of around $NZ 4.90/GJ on average. This is due to the large quantities of gas available under the "take or pay" agreement relative to demand. However, price control was taken off gas from 1 April 1993. In the longer run, as resource availability becomes a constraint, the market is expected to trade gas from low value uses to high value uses. Wholesale and retail prices should rise over time reflecting the growing scarcity of the resource.

The reduction in gas supply and the increasing relative price competitiveness of other energy sources, as Maui depletes, is expected to result in other fuels increasing their shares of consumer energy needs. Gas's highest share was in 1986 when it reached 19% of consumer energy, mainly as a result of displacing oil. The Ministry's estimates, shown in Figure 8, are for gas's share to fall from around 17% in 1990 to around 7% in 2020. The dip around 2009 reflects the anticipated closure of the petrochemicals plants. Electricity and coal increase their shares by 4% each to 30% and 15% respectively and petroleum consumption increases 2.4% to 47% of total consumer energy. These changes are due partly to the result of Maui depletion and to the increase in the price of gas.

Liquid Fuels

In Figure 9 the estimated growth in demand and supply of liquid fuels is shown by sector. Demand grows from around 172 PJ in 1990 to around 263 PJ in 2020, 1.4% pa. The industrial and commercial sector is estimated to increase its

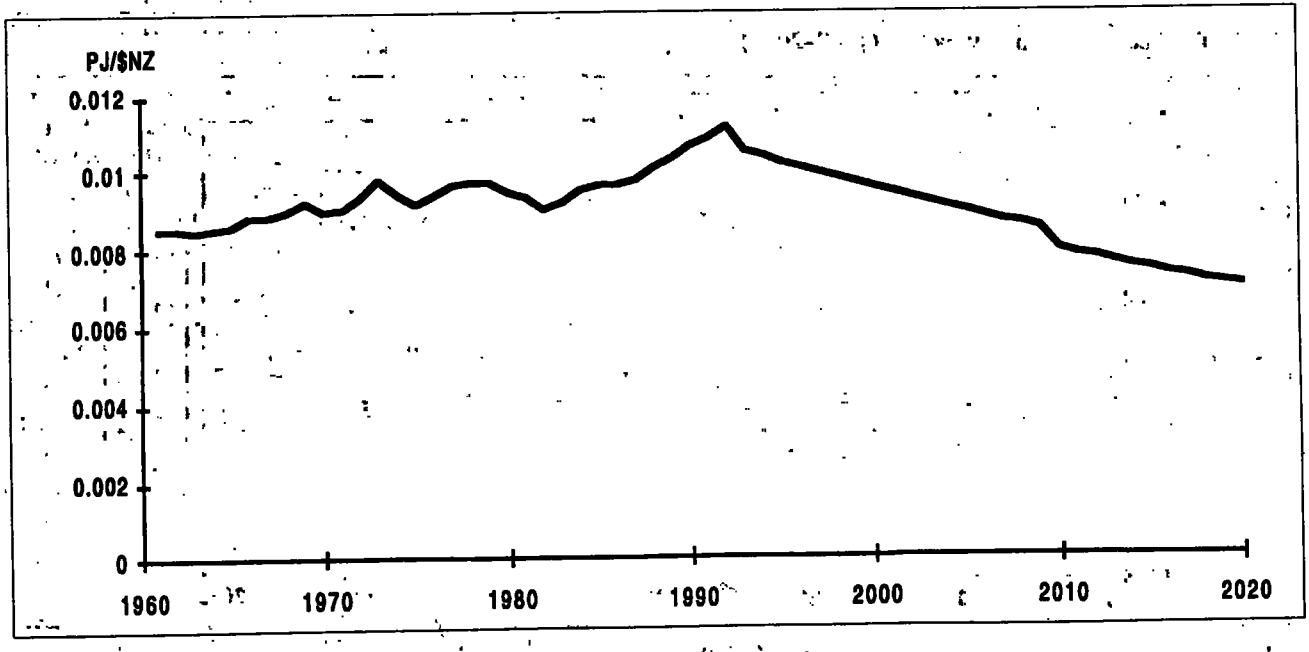

Fig. 5. Energy intensity (PJ/$NZ).

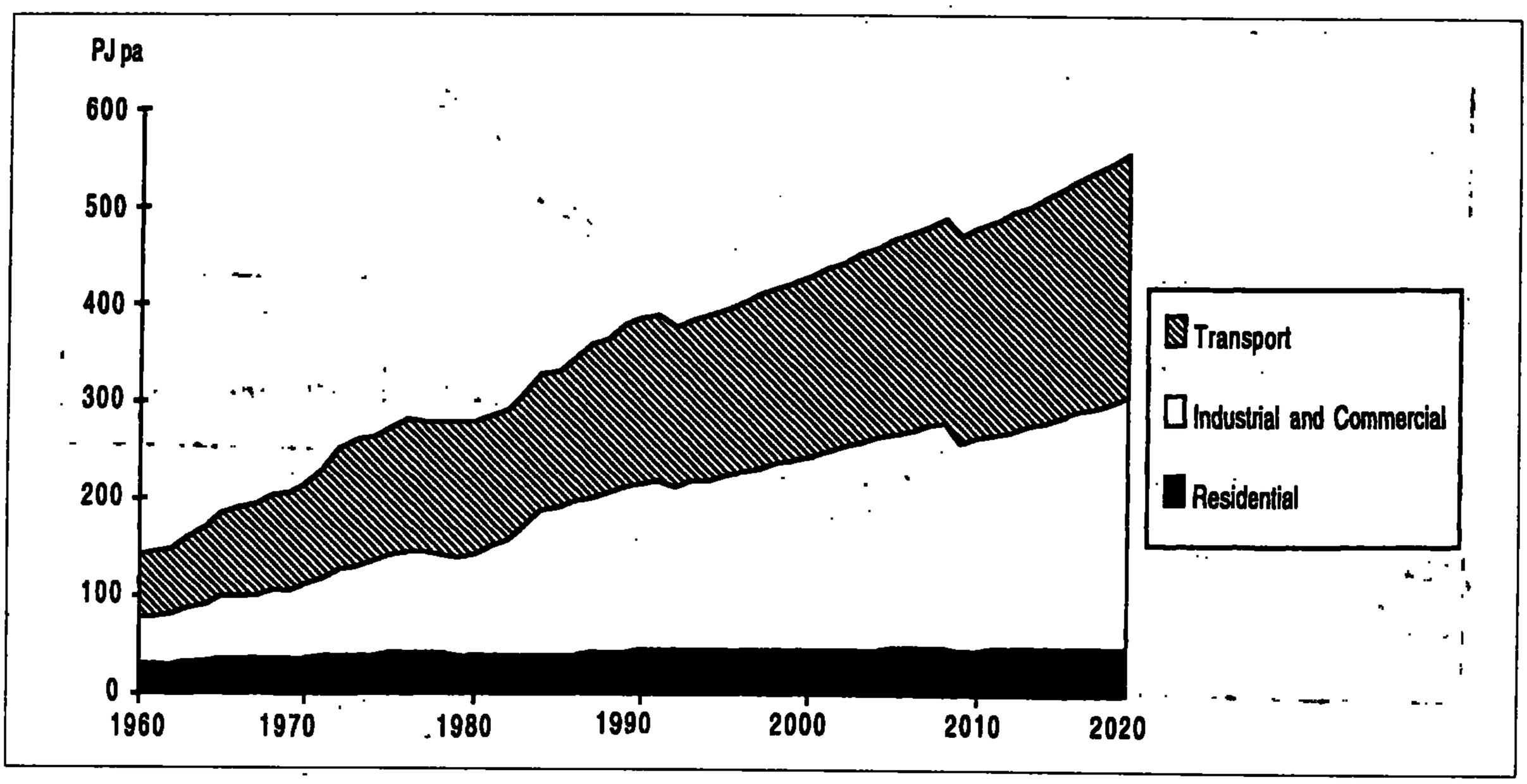

Fig. 6. Total consumer energy by sector (1960–2020).

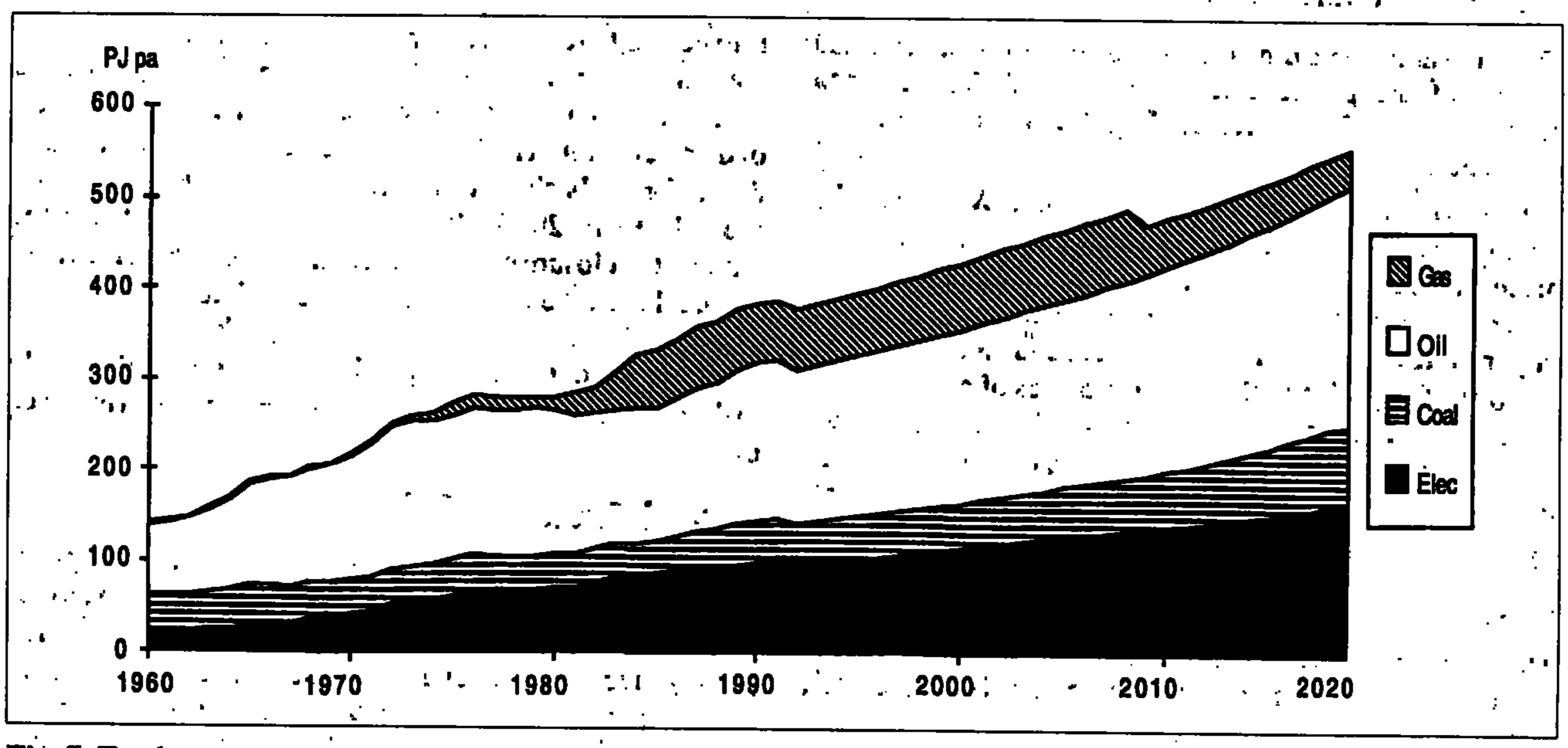

Fig. 7. Total consumer energy by fuel (1960–2020).

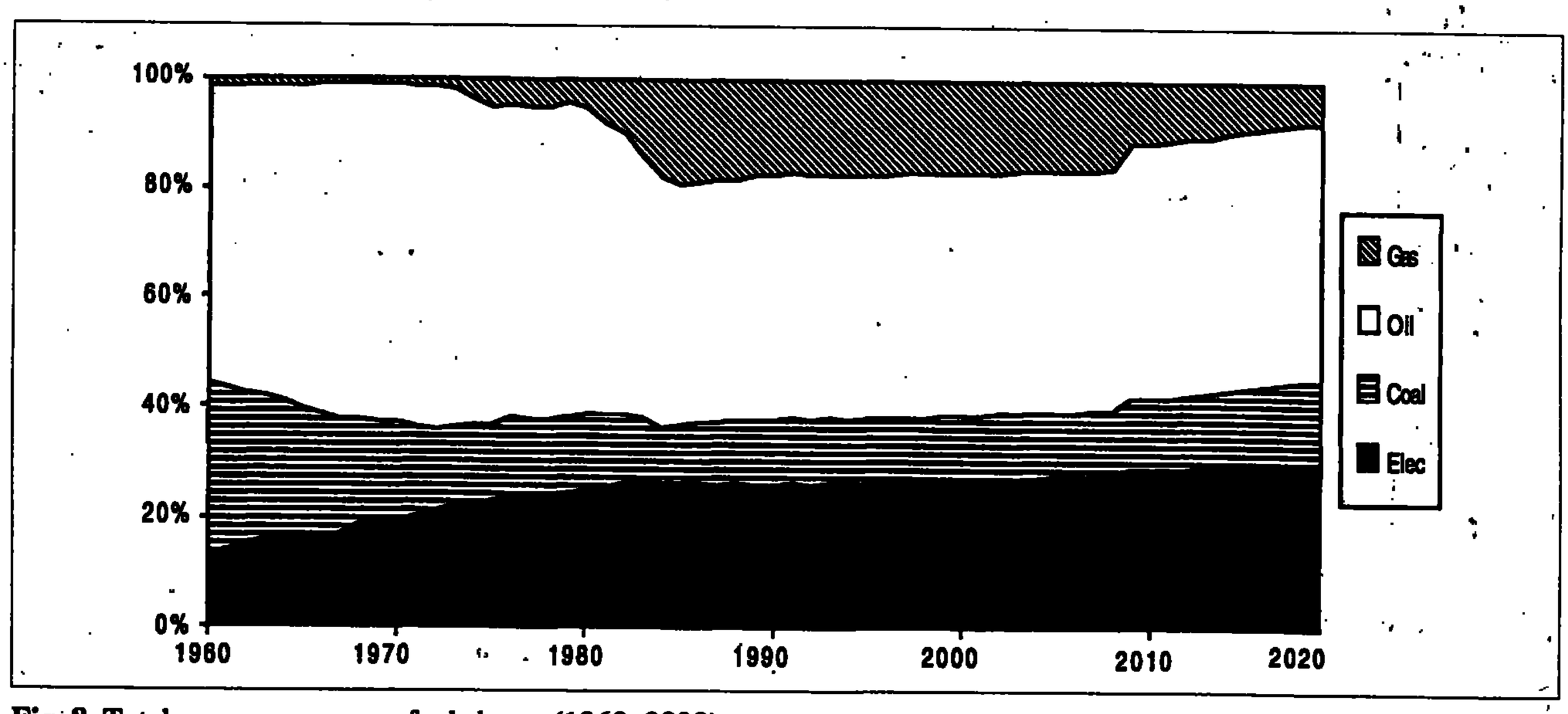

Fig. 8. Total consumer energy fuel shares (1960–2020).

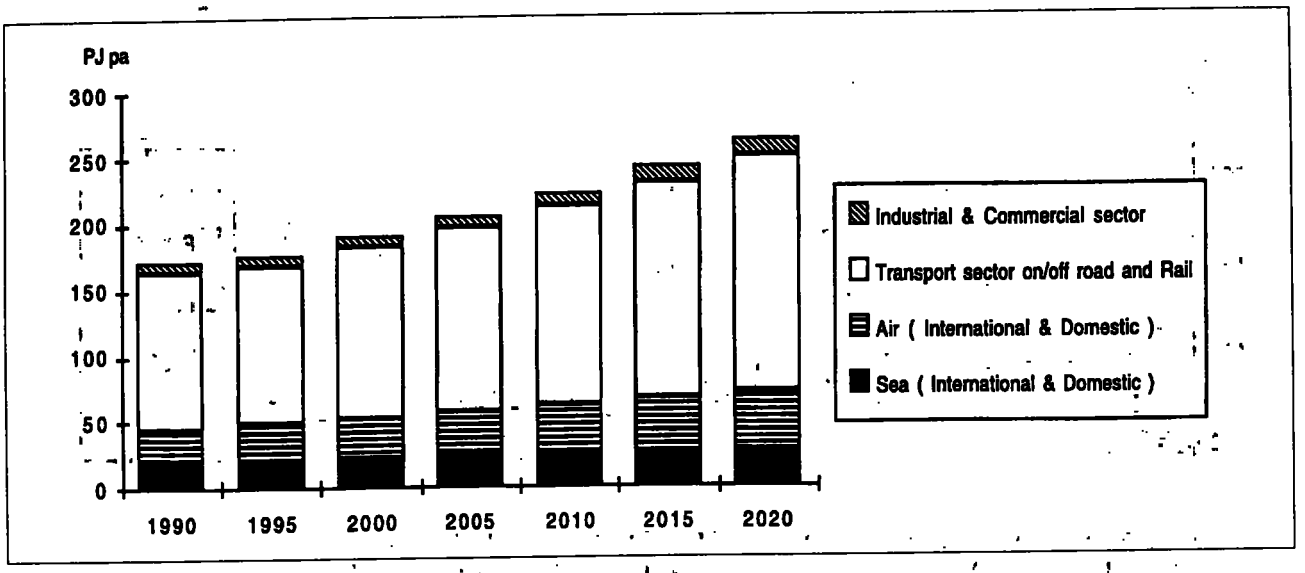

Fig. 9. Demand and supply for liquid fuels by sector.

demand from around 7 PJ in 1990 to around 13 PJ in 2020, 2.1% pa. Sea transport increases from around 19 PJ to around 27 PJ from 1990 to 2020, 1.2% pa. Air transport also rises from around 25 PJ in 1990 to around 44 PJ in 2020, 1.9% pa. However, the most significant increase comes from the transport sector (on/off road) where demand grows from 118 PJ in 1990 to 177 PJ in 2020, 1.4% pa. The significant change in fuel shares is for petrol which declines 4% to around 45%; on/off road diesel increases 5% to 22%, reflecting in particular, the relatively faster growth in the forest sector.

Future Gas Availability and Usage

The negotiated back-to-back "take or pay" agreements for Maui gas will all expire between 2003 and 2009. The Motunui synthetic petrol plant's contract expires in 2003 and the ammonia/urea and methanol plants' contracts expire in 2005. Only the ECNZ and the NGC contracts extend to 2009. However, it is expected to be economic for the petrochemicals plants to negotiate to extend their contracts. Nonetheless, with the conservative assumption of ongoing modest natural gas finds the Ministry's modelling shows that gas price rises are likely to make the synthetic petrol and methanol plants uneconomic around 2009.

Figure 10 gives the Ministry's estimate, under the assumptions outlined earlier, of future gas consumption by end-use to 2020. Overall natural gas use is estimated to peak in 2000 at 204 PJ and then reduce to around 68 PJ in 2020. As electricity demand increases and the current excess capacity disappears ECNZ's thermal stations will be used for base loads for increasingly longer periods. Additionally, an estimated 200 MW gas combined cycle plant will be needed by 2000. Gas use for electricity generation will decline from then on as gas prices rise with Huntly likely to switch to coal after 2000.

Following the estimated closure of the synfuels plant around 2009, a substantial drop off in gas use is estimated in line with diminishing reserves. Reticulation is estimated to peak in the following year at about 51 PJ. From there it declines to about 38 PJ in 2020; as its price continues to rise. Most of the gradual decline in aggregate gas use from 2009 comes from the reticulated market as some of the marginal lower value industrial users in the reticulated market change to alternative energy sources, with consumption for electricity generation reducing only slightly.[1]

Energy Self-sufficiency

The depletion of the Maui gas field will affect energy self-sufficiency. However, the assumptions of ongoing modest oil, condensate and natural gas discoveries will reduce the negative effect. Figure 11 shows our past self-sufficiency levels since 1975 and the future estimated trends. Since 1975 our total self sufficiency rose from 43% to 81% in 1990 and liquid fuels self-sufficiency rose from just 4% to 51% over the same period. Self-sufficiency is estimated to peak in 1995 when total self-sufficiency reaches 83% and liquid fuels self-sufficiency reaches 56%. However, subsequently there is a continuous decline in both through to 2020 when total self-sufficiency reaches 67% and liquid fuels self-sufficiency reaches 27%.

The depletion of the Maui field and our other reserves of natural gas, oil and condensate mean that the increased demand for energy over the next 30 years is likely to be increasingly met by imports. The reduction in oil, condensate and gas production as reserves decline means reduced indigenous supply of refinery feedstocks and synthetic petrol. Our liquid fuels self-sufficiency is most dramatically affected as a result of this, especially after 2009 as the petrochemicals plants close. Aggregate energy self-sufficiency remains high as New Zealand is well endowed with energy resources.

Additionally the decline in self-sufficiency may not be as large as currently estimated because the large supply of natural gas and low prices of the past 15 years provided low exploration incentives. However, rising prices as reserves deplete, combined with improvements to the petroleum mining taxation and royalty regimes, are likely to encourage exploration.

[1] Although the reticulated market is considered a high value end use compared to electricity generation, it also includes a number of industrial users with relatively low value use and as the gas price rises it is these marginal users which will switch to other energy forms.

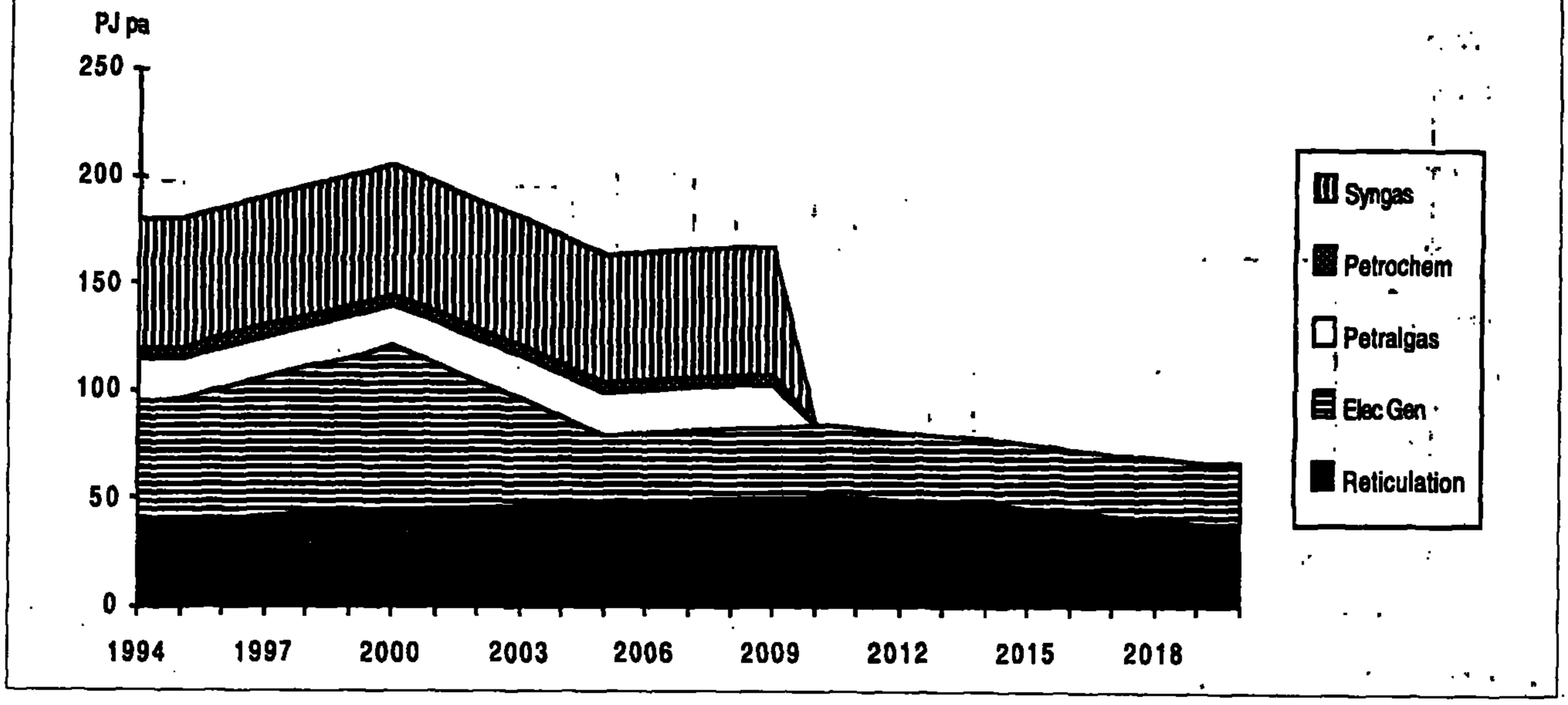

Fig. 10. Estimated gas consumption by end use.

Electricity Generation: New Power Station Requirements

Since the mid to late 1970s natural gas, specifically Maui gas, has played an important part in New Zealand's electricity generation as a supplement to hydro. The hydro electricity system does not have sufficient storage to cover peak winter demand, when thermal stations are required. New Zealand has around 1840 MW of installed capacity which can operate on natural gas, at the Huntly, New Plymouth, Otahuhu and Stratford power stations. There are also distillate, residual oil and coal stations, some of which are currently unused.

The Ministry's forecasts show that, under the assumptions specified earlier, electricity demand will grow from around 98 PJ in 1990 to around 167 PJ in 2020. Natural gas will be affected in two ways, first the increase in demand will lead to gas being used in the next five to seven years more often for baseloads and for longer periods, resulting in increased gas use. Second, as gas is currently used on the margin 80% of the time in electricity generation, the gas price increases will raise the marginal cost of supply and therefore electricity prices. The need will then arise for alternative baseload stations to replace gas. The result will be a significant change in the composition of electricity supply in the next 30 years.

Figure 12 shows the options for new supply which are expected to be feasible around a decade from now. This shows the relatively small quantity of renewables generation capacity that is likely to be economic without price increases. A number of small geothermal sites are the most competitive, while hydro will continue to contribute to renewable generation; small quantities of wind are economic at around 8 c/kWh. As prices increase to this level coal becomes economic and will remain below other renewables options until technology improves their economics.

Figure 13 shows the quantity and composition of the new generation capacity requirements. Initially the extra demand, under the Ministry's assumptions, is anticipated to be met by co-generation, gas combined cycle plants, hydro efficiencies and a little geothermal energy to around 2005. The gas

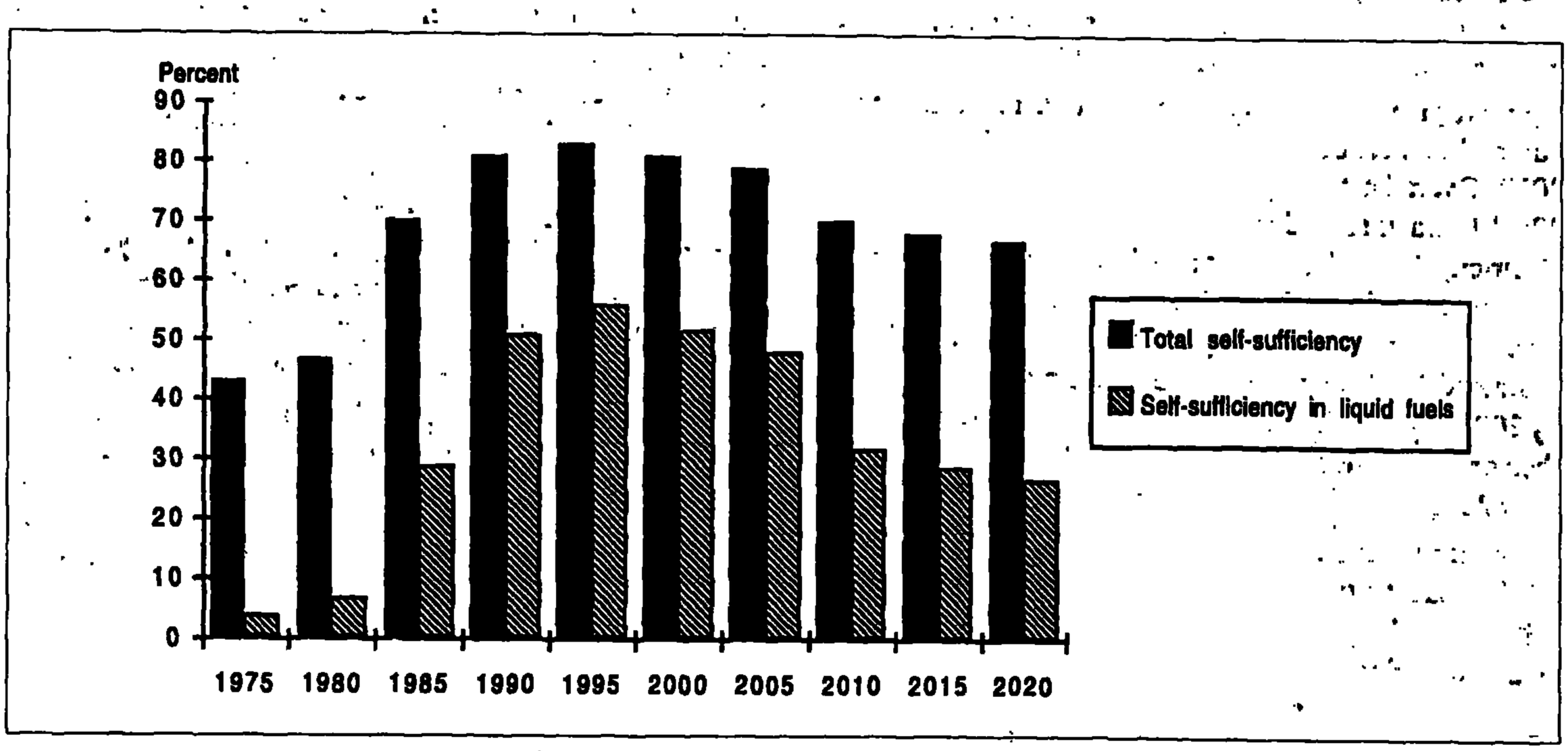

Fig 11. Energy self-sufficiency.

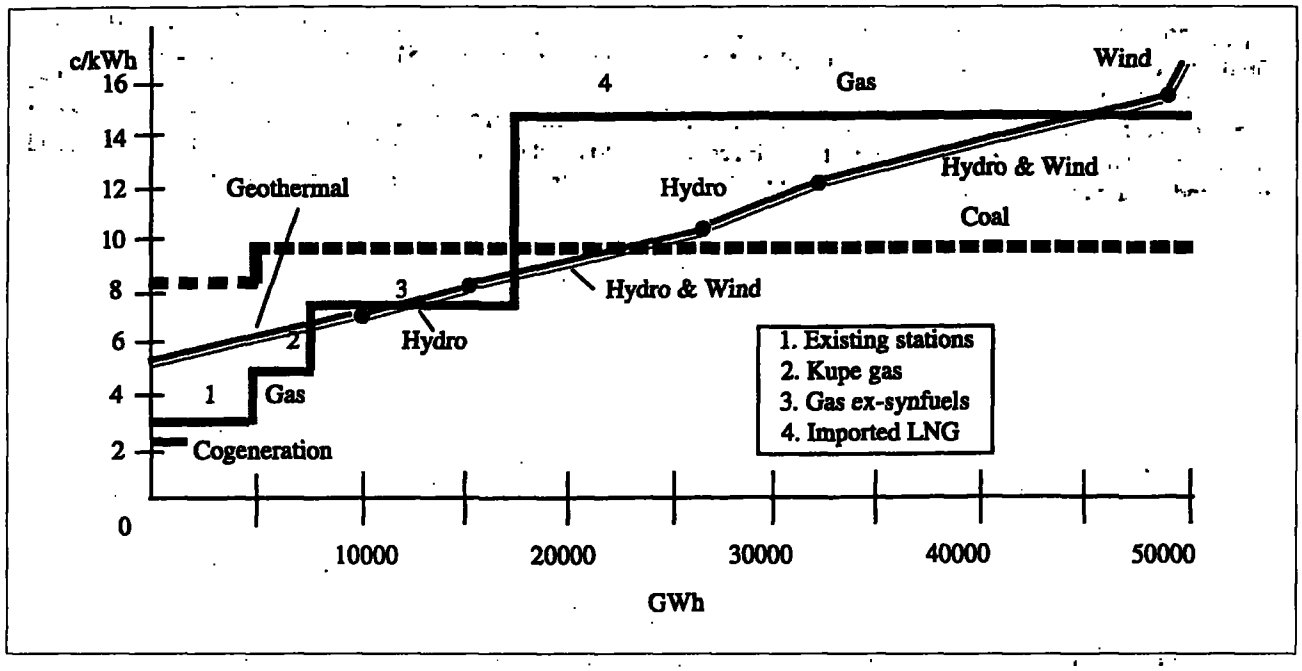

Fig. 12. Cost of new generation and resource potential (2002).

combined cycle plants will be approximately 26% more efficient than Huntly based on the current Stratford proposal and will displace the other thermal power stations in the merit order. After 2005 significant baseload capacity will be required. Gas will no longer be attractive at this stage unless significant new discoveries are made. More hydro developments are likely.

These hydro developments will be on sites which are more expensive to develop with correspondingly higher unit costs around 8 c/kWh. Substantial use of coal could also occur with Huntly switching to coal permanently after 2000. Assuming coal is not precluded on environmental grounds, a large 500 MW coal plant could be needed around 2015. Hydro's share is likely to fall from around 75% in 1990 to 57% in 2020 despite the construction of two major new hydro projects; coal's share under these assumptions goes from nil in 2000 to 16% in 2010 and 20% by 2020, and geothermal's share continues rising from 6% in 2000 to 12% in 2020.

Summary

Maui is New Zealand's largest single energy source and has dominated our energy markets. With its depletion and the forecast growth in energy demand New Zealand's energy markets will undergo significant change in the next 30 years.

- Under a set of plausible assumptions consumer energy is estimated to grow from 378 PJ in 1990 to 556 PJ by 2020.
- Maui currently produces around 34% of our primary energy and 45% of our transport fuels.
- It accounts for 72% of estimated recoverable natural gas reserves and 48% of oil and condensate reserves.
- It currently provides 72% of total natural gas needs.
- Maui is expected to be depleted early next century.
- The main effects of depletion under the assumptions used in the Ministry's forecasting will be: gas prices will rise over time reflecting scarcity of the resource; gas demand is estimated to peak in 2000 at around 204 PJ and then decline to around 68 PJ in 2020; the petrochemicals plants will close before 2010; Huntly will convert to coal

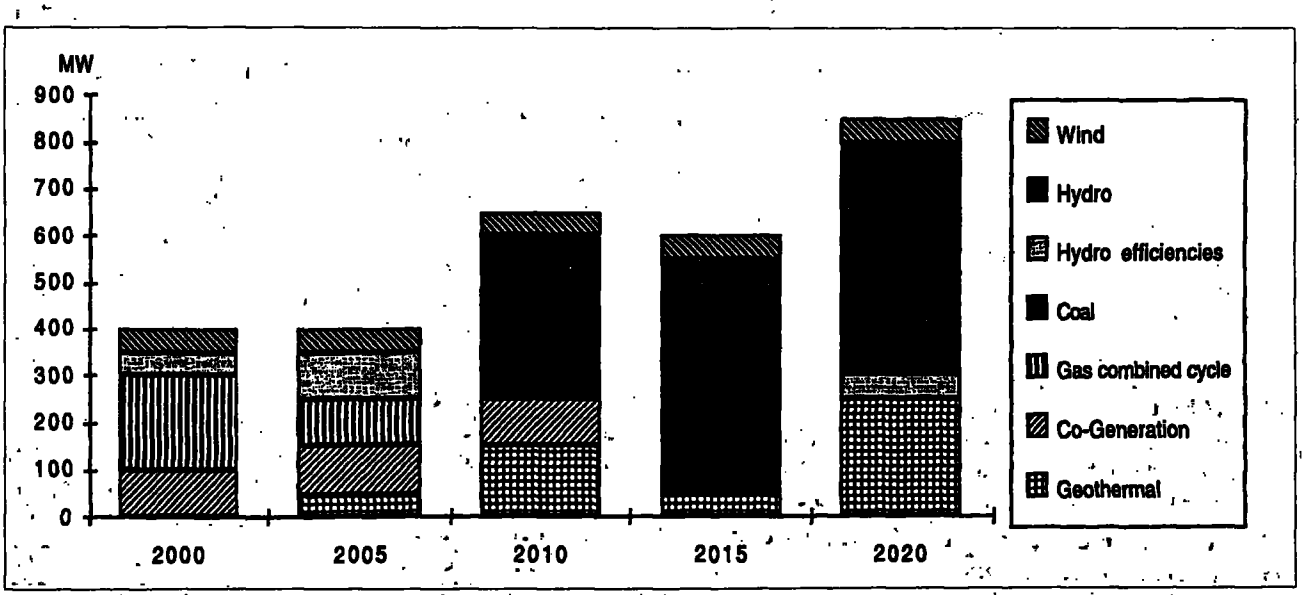

Fig. 13. Estimated power station requirements.

after 2000 and there will be increasing interest in coal-fired stations, provided they are not ruled out on environmental grounds; CO_2 emissions will rise as coal substitutes for gas in industry and electricity generation (assuming environmental constraints don't prohibit coal use); and total energy self-sufficiency and liquid fuels self-sufficiency could decline from 81% in 1990 to 67% in 2020 and from 51% to 27% respectively.

- Continued exploration should result in minimum modest new finds of oil and condensate and natural gas sufficient to meet future demand in the reticulated gas market and electricity generation peaking demand.

Author

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Mike joined the predecessor of the Ministry of Commerce, the Department of Trade and Industry, in 1972, and has worked mainly on industrial development and trade issues. He has also undertaken trade commissioner assignments in Rome (1976–1980) and Tokyo (1982–1985), and he was Consul General in Osaka from 1985–1987. Prior to his current position he headed the policy section in the Communications Division, covering the telecommunications, broadcasting and postal sectors.