New imperatives for energy policy in South Africa

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Abstract

This paper provides a comprehensive analysis of the South African energy sector, in the context of a shift in energy policy away from the energy security concerns of the apartheid government, to more universal goals of economic efficiency, social equity and environmental sustainability.

The paper begins by describing the existing energy filiere and the institutions which operate within the sector. Some of the major macro-economic impacts of energy sub-sectors are mapped out. The petroleum sector is the most significant in terms of past state involvement and recurrent macro-economic impacts, particularly the foreign exchange savings attributable to synthetic fuel production by Sasol, and to local refining of crude oil. The electricity supply industry has demanded large investment resources and has contributed significantly to foreign debt. The coal sector is an important contributor to export revenue. The energy sector also has major environmental impacts, and some of these are described briefly, particularly the pollution exposures of people who rely on wood and coal for their energy needs.

A new system of governance is proposed for the energy sector which will result in better co-ordination, stake-holder representation, integrated energy planning and professional regulation. The paper then discusses important policy options in each of the energy sub-sectors. Of the three goals, efficiency, equity and sustainability, the primary objective of a post-apartheid government must be to improve equity. In the immediate term, policy should therefore include interventions in the household energy sector around electrification, low-smoke coal development, afforestation and other strategies. In order to achieve the targets of a national electrification programme, it is important that the electricity distribution industry be restructured along more effective and equitable lines. An independent regulatory agency in the electricity industry is also proposed, to ensure compliance with energy policy.

Policy options for the petroleum industry are presented, which have the aim of reducing unnecessary subsidies for synfuel production, and to attempt to level the playing fields for all oil companies, while maintaining the industry's employment levels and the viability of small businesses. Analysis of the nuclear fuel industry leaves little conclusion other than that state support must be phased out in the next few years, and that the Atomic Energy Corporation will have to achieve its vision of commercial viability if it is to survive. No major changes in the coal industry are proposed, although some kind of regulation may be required to facilitate the development and substitution of low-smoke coal for conventional, polluting coal in households. With regard to the efficiency or otherwise of energy production and consumption, the tension between economic competitiveness (low energy prices) and environmental sustainability was noted, with a suggestion for increased policy research into appropriate strategies to improve the efficiency of the economy's energy use. Finally, the paper makes explicit some of the implications of the goal of 'environmental sustainability' for energy policy and planning.

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1 The apartheid inheritance

Energy policy under apartheid was governed primarily by the desire for greater energy security. A white minority government, facing the opprobrium of the world and a United Nations led oil embargo, spent many billions of rand on the Sasol and Mossgas synthetic petroleum fuel plants and building up a local nuclear capability through the Atomic Energy Corporation. Although these investments resulted in foreign exchange savings, South Africa still pays a premium for locally produced petroleum and nuclear fuels. The cost to the economy has been enormous and the opportunity for investment in more productive social infrastructure has been squandered.

South Africa has never become fully self-sufficient in either petroleum or nuclear fuels and in spite of international sanctions continued to import these fuels. Energy policy under apartheid government was a costly failure, if evaluated against the objective of energy self-sufficiency.

The energy sector during this period was also governed by excessive secrecy which made rational and public debate on energy policy impossible. The Petroleum Products Act (no 120 of 1977) prohibited the "publication, releasing, announcement, disclosure or conveyance to any person of information or the making of comment regarding the source, manufacture, transportation, destination, storage, consumption, quantity or stock-level of any petroleum product acquired or manufactured or being acquired or manufactured for or in the Republic." The penalties were severe, and secrecy was effectively maintained. The corollary of these secrecy provisions was an absence of state commitment to collect and publish data on the energy sector which would allow the development of rational and balanced energy policies. These restrictions have finally been repealed with the installation of a multi-party transitional government council in December 1993 and the lifting of the United Nations oil embargo.

The state is deeply involved in particular energy sub-sectors. In some respects, this is un-surprising. Energy projects typically involve huge investments. Traditionally the state has paid a crucial role in developing the infrastructure which is essential to the successful functioning of a developed economy. The scale of these investments and the period over which a reasonable return could be expected were such that private capital was generally unable or unwilling to participate. However the state has effectively controlled all aspects of the commercial energy system. The electricity industry is an effective state monopoly, as is the nuclear industry and along with the petroleum industry they are tightly regulated. It is only recently that coal prices and distribution were finally deregulated. Woodfuel is possibly the only un-regulated energy sector, although even here, a modicum of regulation exists in certain traditional tribal authorities. The effectiveness of the energy regulatory system is a legitimate area for policy investigation. The overall orientation of regulation is biased towards the survival of apartheid's energy creatures: Sasol, Mossgas and the Atomic Energy Corporation. In other areas, such as the electricity industry, apartheid resulted in a disastrously fractured distribution sector linked to racially segregated local government and unable to provide electricity to the majority of South Africans.

South African energy prices (for industry and mining) are low by international comparison (and could have been lower if more economically efficient investments had been made). South Africa has an above average energy intensity; i.e. more energy is used per unit of economic output than in many other countries. Only 10 countries have higher commercial primary energy intensities (World Bank, 1990). This high energy intensity is largely a result of the structure of the economy and its reliance on coal for production of electricity and liquid fuels. Both of these energy transformation processes are relatively inefficient in their conversion of energy. The country also does not employ latest developments in energy efficient technology, and government energy policy has favoured supply-side actions rather than encouraging more efficient use of energy.

Energy production and utilisation has resulted in significant environmental costs, which have also arisen because of inequitable access to fuels of choice for the majority of South Africans. Air pollution as a result of the combustion of wood and coal is of increasing concern. Recent studies have indicated serious health risks associated with poor indoor and outdoor air quality resulting primarily from coal and fuelwood combustion. Peoples' exposures to certain air pollutants have been found to be many times higher than local and international health guidelines, and epidemiological studies have observed higher incidences of respiratory and other illnesses in inhabitants of unelectrified houses (Terblanche et al 1992). Respiratory diseases are the second highest cause of South Africa's unacceptably high infant mortality rate. Yet two thirds of South Africans remain without access to electricity in spite of large excess electricity generation capacity.

Similarly, the social costs of current energy usage patterns are enormous. The additional time spent collecting and purchasing fuels where electricity is not available or affordable, is significant, and represents the loss of time for potentially more productive activities such as farming, child-minding, education and entertainment. Women generally have the responsibility in rural areas to collect fuelwood and often spend upwards of 2 to 3 hours per trip with 2 to 4 trips per week. This represents a huge social burden. Further, the lack of high-quality lighting in the home, which is delivered most effectively by electricity, severely impedes the education process and at street-level does nothing to increase security and combat crime. Moreover, the lack of access to electricity means that millions of people are denied the convenience and improved quality of life which comes with electric appliances.

The pattern of energy investment in the apartheid era has mirrored the disparities in provision of social infrastructure with the consequence that South Africa has a highly unequal distribution of income and access to basic services. The imminent and unprecedented representation in government of the majority of South Africans will inevitably lead to greater redistributive investment and government expenditure directed more at the basic needs of the poor. Indeed this has already begun. Growing international environmental concerns and the likelihood of environmental conditionality related to foreign investment and exports, and growing local health costs associated with pollution, will mean that energy policy will also have to promote environmental sustainability. And to grow a successful economy, South Africa has to become more competitive in manufactured exports. Low energy prices will assist that objective.

Before considering new energy policies which would more effectively serve the economic and social goals of a post-apartheid and post-sanctions era, it is useful to obtain an understanding of the existing energy systems and their impacts on the economy.

2.1 The energy filiere

South Africa has a great abundance of energy. It has the 5th largest reserves of coal in the world (DMEA 1992:26). Coal mostly occurs in thick, shallow seams in the eastern Transvaal, Northern Orange Free State and Northern Natal and mining costs are relatively low. It forms the basis of South Africa's energy intensive economy, contributing more than 80% of primary energy consumption, mostly for electricity generation and also liquid fuels production in the Sasol plants. The balance of energy consumption derives from biomass (currently exploited for firewood on a non-sustainable basis), nuclear energy (from Africa's only nuclear power plant), hydro-electricity (from two small installations on the Orange River) and imported petroleum. Natural gas, off the southern coast, will make a further small contribution through the Mossgas process which converts it to petroleum products. South Africa is the 3rd largest exporter of coal and 7th largest producer of uranium in the world (ibid:26,31). Within the region there are large gas and hydro-electricity resources which await exploitation.

The major components of and institutions in the energy sector of the economy are coal mining and marketing (chiefly Amcoal, Rand Coal, Trans Natal, Shell, JCI, Total and Sasol), uranium oxidation and enrichment (Chamber of Mines and Atomic Energy Corporation), electricity generation and high voltage transmission (primarily Eskom), electricity distribution (Eskom and over 430 local authorities), synthetic fuel production (Sasol and Mossgas), petroleum refining (Caltex, Engen, BP, Shell, Total and Sasol) and petroleum product marketing (the latter companies plus Zenex, Sonap and Trek). Fuelwood provision is largely an informal sector activity.

The South African energy *filiere* is illustrated in Figure 1.

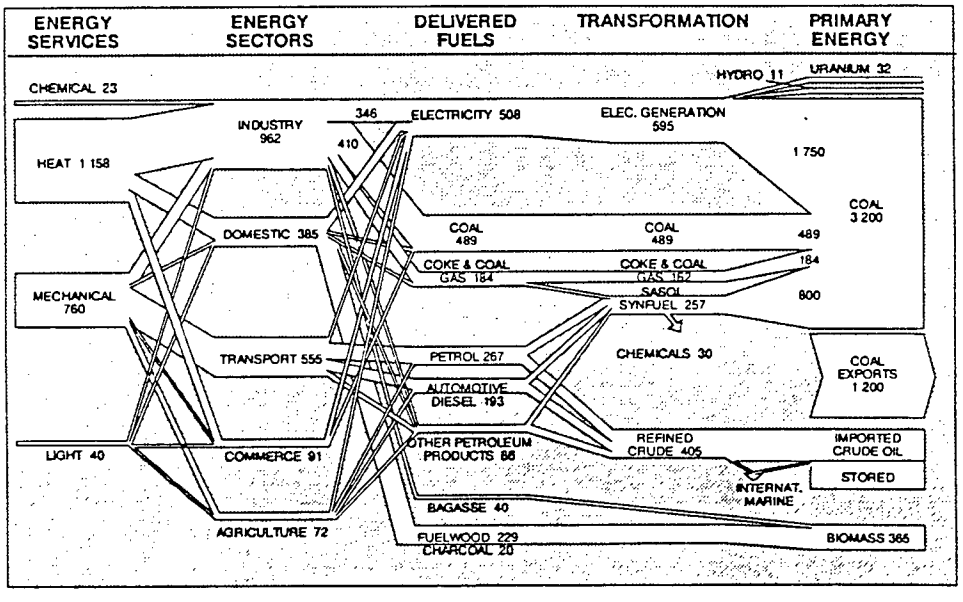

Figure 1 The South African Energy Filiere

Much of the South African energy system is comprised of a closely interlinked set of energy and minerals industries including such large energy transformation industries as the coal-to-petroleum plants, coal-fired power stations and the energy-intensive mining and minerals beneficiation sector. The minerals-energy complex is a significant contributor to GDP. Rustomjee (1992) estimates that if mineral-energy complex activities are removed from the standard "manufacturing" classification in GDP statistics, then manufacturing has not grown very much and has remained within a fairly narrow band of 15-17% of GDP since 1960, while the mineral energy complex has grown to 25-27% of GDP.

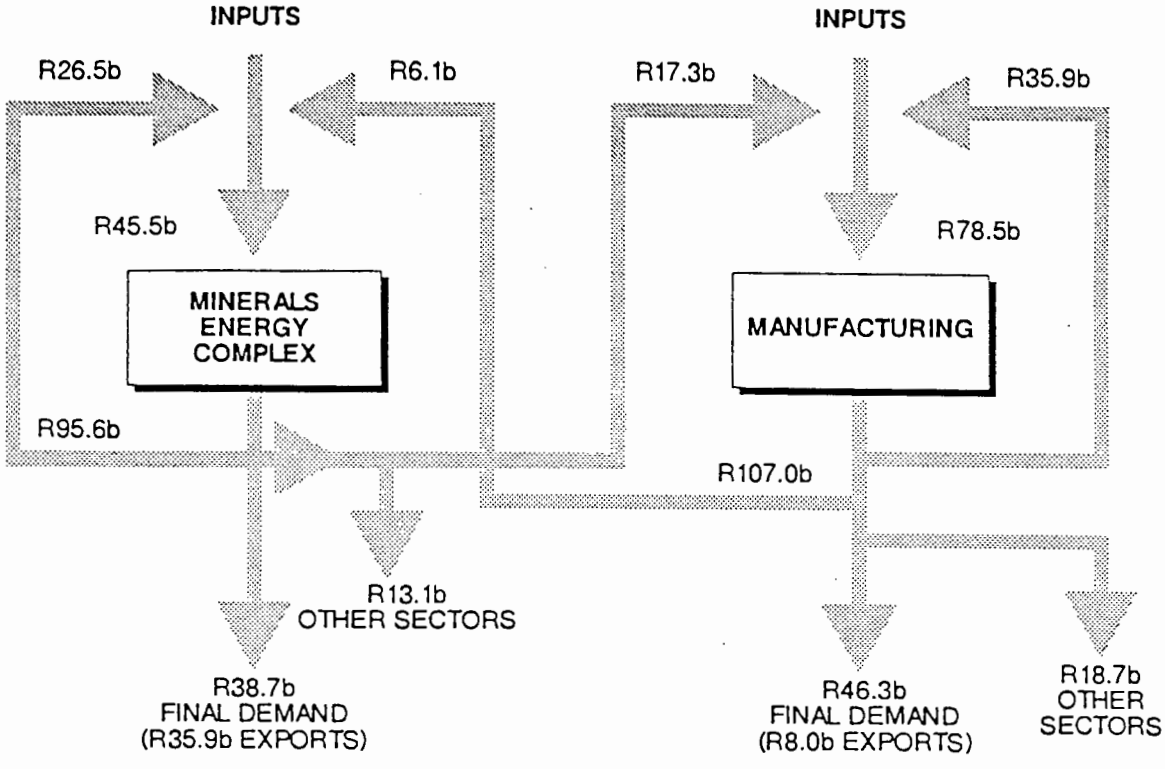

Figure 2 Material flows betwen the minerals-energy complex and manufacturing (Rustomjee 1992).

According to Rustomjee (1992), the mineral energy complex contributed R 35,9 billion (63%) to exports in 1989. Gold accounted for roughly half of this and coal about 10%. Direct commercial energy production, which is nearly all coal based (petroleum products and electricity), is largely for the domestic market and it contributes negligibly to exports. South Africa is thus largely a resource-based economy, with coal mining and exports, and fuel and electricity production being significant. Rustomjee (1992) and Jourdan (1992) argue that the minerals-energy complex is an important basis for industrial and economic growth in South Africa.

2.2 Government and the energy sector

While the mining of coal and uranium has been within the preserve of the private sector, the state has had extensive involvement in the regulation of

energy pricing, production, procurement and marketing. This section of the paper describes the main institutions in the sector through which governance occurs.

Department of Mineral and Energy Affairs (DMEA)

State involvement in the energy sector was consolidated for the first time in 1980 with the creation of the Department of Mineral and Energy Affairs (DMEA). Energy functions were transferred from the former Department of Environmental Planning and Energy and the former Energy Policy Committee. The Electricity Control Board reported to the DMEA and responsibility for Escom and Sasol was transfered from the former Department of Industries, and several other institutions and functions concerned with liquid fuels from the former Department of Commerce and Consumer Affairs. Then in 1988, many DMEA functions were transferred to a National Energy Council, a statutory body with an appointed council and a professional staff able to function more efficiently than within the constraints of the civil service. But four years later, largely as a result of Ministerial in-fighting, it was dissolved and downgraded to an Energy Chief Directorate back within the DMEA.

South Africa's remaining energy statutes are as follows:

- Liquid Fuel and Oil Act, No 49 of 1947,
- Central Energy Fund Act, No 38 of 1977,
- Petroleum Products Act, No 120 of 1977,
- Electricity Act, No 41 of 1987,
- Eskom Act, No 40 of 1987,
- Nuclear Energy Act, No 131 of 1993.

The first three acts determine the responsibility of the State in respect of the acquisition, manufacture, price determination and distribution of liquid fuels. The Electricity Act defines the structure, functions and responsibilities of the Electricity Control Board and assigns the sole right of electricity supply within municipal boundaries to local government, although these authorities may cede this right to other agencies subject to the approval of the Control Board. The Eskom Act defines the responsibilities of Eskom to supply electricity at neither a profit or a loss, but does not give it a public mandate to supply electricity to all. The act also defines the structure and responsibilities of the Electricity Council and Eskom's Management Board. The Nuclear Energy Act brought all nuclear activities funded by the State under the control of the Atomic Energy Corporation with the exception of the independent Council for Nuclear Safety.

Regulation of the Petroleum industry

There are several state institutions in this sector.

The *Central Energy Fund (Pty) Ltd* was established by an act of parliament and is responsible for the administration of the Central Energy Fund, the Equalisation Fund and the Strategic Fuel Fund. CEF (Pty) Ltd is controlled by a board of directors representative of the State and the private sector's energy

and financial sectors. The CEF also controls the state-financed oil exploration corporation (Soekor).

The *Central Energy Fund* is financed by levies on petroleum products and has the purpose of promoting the production of liquid fuels from local resources. It was used to finance a large portion of the initial costs of Sasol and Mossgas.

The *Equalisation Fund* is also financed from levies on the sales of petroleum products and has been used to finance premiums on the procurement of oil, subsidies for Sasol and Mossgas and the equalisation of domestic fuel prices in the face of short-term fluctuations in international oil prices.

The *Strategic Fuel Fund Association* is a wholly owned non-profit subsidiary of CEF (Pty) Ltd involved in the purchase and stockpiling of fuel. The SFF Board of Directors is constituted from directors of the CEF Board. National fuel storage facilities exist at Saldanha Bay, north of Cape Town and at Ogies in the Transvaal which together have a storage capacity of 180 million barrels. In December 1993, 77 million barrels were being stored - equivalent to about 8.5 months of imported crude oil requirements.

Soekor is a largely state-funded corporation and was established 26 years ago to search for indigenous oil and gas reserves. It stopped exploration on land in 1978 and has drilled some 200 off-shore wells, finding limited natural gas reserves off the south coast, which formed the basis of the Mossgas project.

In addition to the public sector institutions mentioned above, the petroleum sector has a complex set of regulatory arrangements, which revolve mainly around the protection of the strategic investments in Sasol and Mossgas.

Control over crude oil procurement
In response to the oil embargo, the procurement of crude oil was done centrally by the government's Strategic Fuel Fund (SFF), although in recent years oil companies have also imported oil themselves. The state previously obliged the oil companies to buy through the SFF.

In-bond-landed-cost (IBLC) pricing
The IBLC is the price paid to local refiners for their refined product and is determined on a monthly basis by the DMEA from the following:

- the cost of refined product from two refineries in Singapore and one in Bahrain,
- the notional cost of transporting the product to South Africa,
- based on average rand:dollar exchange rates for the month.

Effectively, therefore, local refiners derive their profitability from the difference between the IBLC they receive, and the total of crude oil purchases and refining costs. The IBLC constitutes approximately 30% of the pump price of petrol and is the second largest component after government taxes (EDRC 1993:61).

Although a theoretical price, an important effect of the IBLC mechanism is that it provides the industry with sufficient security to commit large amounts for investment in refinery expansions. This issue will be revisited in section 4 of the paper.

Inland transport allowance
The two inland oil refineries, Natref and Sasol, receive an additional allowance on top of the IBLC, as do coastal refineries which transport their product inland through Transnet's pipeline (EHR 1993:13). In December 1992, this allowance amounted to 10.2 cents per litre. It has been suggested that the transport allowances are inflated because they are based on Transnet's pipeline tariffs, which are in excess of actual operating costs, and therefore increase the margins of recipients (ibid:22).

Synfuel tariff protection
Sasol is currently guaranteed a floor price of $23 per barrel for its products, with any shortfall being recovered through the Equalisation Fund. An average of 10.8 cents per litre in 1992 was paid to the synfuel industry (EDRC 1993:61), estimated to be a total of R450 million for the year (EHR 1993:24). This protection has attracted obvious criticism from many sources, and needs to be weighed up against other factors. On the one hand, Sasol's synfuel production saves foreign exchange of about R3 billion per annum, while on the other hand, this tariff protection has provided Sasol with an advantage over its competitors in respect of its ability to expand its activities into other areas such as petrochemicals. This is clearly a key area for future policy.

Marketing of synfuel production
The oil companies are obliged to market the total synthetic fuel production of Sasol (and shortly Mossgas) through their own distribution outlets, and Sasol is allowed to operate one pump on each service station for their own account ('blue pumps'). In turn, Sasol's total market share from these pumps is limited to just over 9%, a level which it has not yet achieved (EHR 1993:14). The oil refiners are compensated for the underutilisation of their refining capacity arising out of the obligatory purchase and marketing of synfuels, through the 'synlevy', which is funded from the Equalisation Fund. The total paid to the refiners in 1992 was approximately R100 million (EDRC 1993:61), and the total paid to-date is about R1.3 billion (Bartlett 1993).

Wholesale margins: Marketing Petroleum Activities Return (MPAR)
In terms of this agreement, the wholesale margin earned by the oil companies is based on a target return on marketing assets of 15% (EDRC 1993:62). The pump price is adjusted only if this return drops below 10% or rises above 20% - current levels are reported to be less than 15% (EHR 1993:26). The margin was 13.6 cents per litre in April 1993, or 8.3% of the pump price (EDRC 1993:70).

Retail margins
Retail margins are set in the same way as wholesale margins, and amounted to 15.1 cents in April 1993, or 9.2% of the pump price. Political pressure exists for this control to be removed, to allow discounting of pump prices by cutting retail margins. This is another important policy issue.

Retail rationalisation plan (Ratplan)
The Ratplan emerged in response to a proliferation of service stations in the 1950s, with low volumes and limited viability per site. An agreement was reached in 1960 between government, the oil industry and the representative body of service stations (the Motor Industries Federation), in terms of which the number of service stations around the country was rationalised and further expansion was controlled. The effect has been that the number of service

stations grew by only 17% from 4200 in 1960 to 4913 in 1991, while petrol sales volumes increased by 320% over the same period (EDRC 1993:62). Nonetheless, it has been suggested that the ratio of service stations to vehicles remains high (EHR 1993:28). The Ratplan prohibits the oil majors from operating service stations (although they do own and lease out many sites), and also stipulates that full service must be provided.

Government taxes
The fuel tax is currently the largest portion of the pump price, amounting to 54.9 cents per litre on petrol and 47.4 cents on diesel (EDRC 1993:63). In addition, Customs duties raise another 4 cents per litre on both fuels. These taxes raised about R8 billion or 10% of government revenue for 1992/93.

Sasol

The history of the Sasol group of companies goes back to 1950 with state support for the establishment of the oil-from-coal plant at Sasolburg and the incorporation of the South African Coal, Oil and Gas Corporation Limited. During the 1960s Sasol diversified into the manufacture of petrochemicals and fertilizers, gas supply (from coal) and crude-oil refining. In 1974 it was decided to build a second much larger coal conversion plant at Secunda (Sasol II, completed in 1980), followed by the decision in 1979 to construct Sasol III.

The state effectively held all shares in Sasol, but Sasol entered the private sector in 1979 with the incorporation of Sasol Limited as the holding company and its listing on the Johannesburg Stock Exchange. A major rights issue during 1983 enabled it to acquire the state's interests in Sasol II and the balance of the state's holdings in Sasol III were acquired in 1991, although soft state loans will only be redeemed by 1996.

The Sasol group of companies has diversified involvement in coal mining, coal conversion, oil refining, fuels marketing, chemicals, polymers, mining explosives and fertilizers. In 1991, the group employed 32 000 people, had fixed assets with a book value of R7.9 billion, turnover of R7.5 billion, and an attributable profit of R1.04 billion.

Mossgas

Mossgas was established by the Central Energy Fund in 1987 to undertake the production of petroleum products from natural gas extracted off the south-west coast near Mossel Bay. In terms of the initial financing arrangements, Gencor had the option of taking up 30% of a capitalisation issue (Scott et al 1992:11), which option it recently decided not to exercise. Consequently, the CEF now has full responsibility for the ownership, management and financing of Mossgas. The marketing of its output is guaranteed by the same regulatory system which applies to the synfuel produced by Sasol.

Regulation of the coal industry

Until the mid-1980s, the State controlled the pit-head, wholesale and retail prices of *coal* and also its distribution and export. In 1987 price control was finally abolished when the pithead price of coal was deregulated. In 1990, the DMEA abolished one of the last controls on the domestic coal industry with the lifting of the embargo on the sale of cheaper Transvaal coal in Natal. Coal export permits were abandoned soon after and coal deregulation was completed with the Coal Resources Repeal Act (no 6 of 1992).

The Electricity Control Board

The Electricity Control Board was instituted in 1958 to exercise control over the supply of electricity by Eskom, by private undertakings and by local authorities beyond the areas of their jurisdiction. Its functions were further defined by the Electricity Act of 1987. The Board comprises between 7 and 9 members appointed by the Minister. It controls the electricity supply industry through the issue of licences for the supply of electricity and the approval of tariff increases.

Eskom

Eskom, the national electricity utility, is the largest and most significant energy institutions in South Africa, with fixed assets (in 1992) of R36.9 billion, turnover of R12.6 billion, a net profit of R1.5 billion and 42 000 employees (Eskom 1993).

Eskom (originally the Electricity Supply Commission) was established in terms of the Electricity Act of 1922 and was controlled by a commission appointed by the State President. It is currently regulated by the 1987 Eskom Act and also by the 1987 Electricity Act. It is now controlled by an Electricity Council which is appointed by the state according to specific categories defined in the Act. The composition of the Council recently changed to become more representative, following negotiations between the government and the democratic movement. A Management Board, headed by a Chief Executive, is responsible for its day-to-day running. The Board is appointed by the Council. Eskom has committed itself to becoming a professionally managed and customer-focused business with four strategic priorities:

"• Improving business efficiency within Eskom
- Marketing electricity
- Bringing electricity to 3 million homes by 1996
- Harmonising with the new socio-economic climate, including more emphasis on affirmative action" (Eskom Annual Report 1991).

While Eskom does not have an exclusive right to generate electricity (some industries and municipalities have their own generation plant), it has a practical monopoly in bulk electricity sales. In 1991 it supplied 98% of electricity in South Africa. Eskom operates the integrated national high voltage transmission system and supplies directly to large consumers such as mines and mineral beneficiators. It supplies directly to commercial farmers and to a limited number of residential consumers. It also sells electricity in bulk to local

municipal authorities who in turn distribute to industry, commerce and residences within their municipal boundaries.

Although Eskom is a public corporation, it is largely self-financing, through internal reserves and external borrowings. An exception regarding this financial autonomy, occurred in the form of ad-hoc subsidies made available by the DMEA over the years for the electrification of remote commercial farms.

Local government electricity distributors

Figure 3 indicates the fragmented nature of the electricity distribution sector in South Africa.

Transkei, Venda and Bophuthatswana have their own electricity supply corporations. Other homelands, such as Kangwane (through Kescor - a joint undertaking with Eskom) also have particular distribution arrangements. Regional Service Councils and Management Boards have responsibility in some rural areas, while more than 430 local authorities or municipalities have legal responsibility for residential electricity supply.

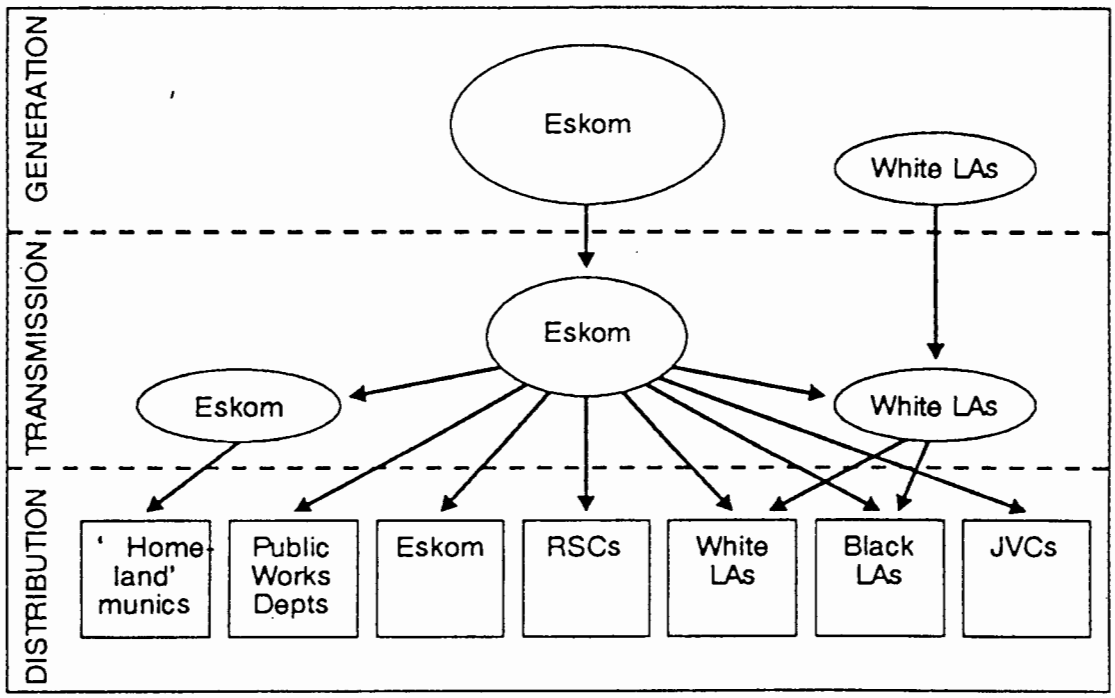

Figure 3 Structure of the electricity supply industry in South Africa (Theron et al 1991).

The structure of the EDI and its relationship to a national electrification programme is discussed in detail in section 4.3.

Atomic Energy Corporation

South Africa's nuclear involvement was formalised in 1948 when the Atomic Energy Board (AEB) was established by an Act of Parliament to exercise control over and trade in uranium. The Uranium Enrichment Corporation of South Africa (UCOR) was established in 1970 and in 1985 it was amalgamated with the Nuclear Development Corporation (NUCOR, previously the AEB) to form the Atomic Energy Corporation (AEC), which reports through a Chief Executive and Chairperson to the Department of Mineral and Energy Affairs.

The AEC operates a nuclear research centre at Pelindaba, a uranium conversion and enrichment plant at Valindaba (both near Pretoria) and a radioactive waste disposal site at Vaalputs in the northern Cape. Eskom owns and operates Africa's only nuclear power station, at Koeberg, outside Cape Town. Uranium oxide is produced by the Nuclear Fuels Corporation (NUFCOR) which is part of the Chamber of Mines of South Africa. Uranium oxide derives from ammonium diurnate slurries which are a by-product of the gold mining industry.

The nuclear production facilities at the AEC are not commercially viable, even with the favourable electricity rates provided by Eskom and the inflated prices it pays for its nuclear fuel. Disaggregated figures for the different nuclear production facilities are shown in Table 1.

Table 1 AEC average production costs and sales prices compared to spot prices in 1993 - ignoring capital expenditure

	Conversion R/kgU	Enrichment R/SWU	Fuel fabrication R/kgU
AEC production cost	47	879	2259
AEC sales price	24	619	1394
Spot price (June 93)	15	224	1100

Source: Auf der Heyde 1993

The AEC production costs are between 2 and 4 times current spot prices, without even taking into account capital expenditure and depreciation. It is clear that the AEC has charged well above market rates to local customers - notably Eskom, nevertheless its production costs remain more than double these inflated prices.

South Africa does not have the technology to *reprocess* spent nuclear fuel. According to an agreement with the French-led consortium which built Koeberg, all reprocessing of Koeberg's irradiated fuel rods must be done in France. In the interim, spent fuel rods are left to cool in water tanks at Koeberg.

The AEC has operated the Vaalputs *waste disposal* site since 1986 and claims that it recovers costs by passing these on in full to clients, mainly Eskom. Koeberg's fuel pools will be full between 1996 and 1998 and interim fuel storage in above ground flasks is envisaged. The Vaalputs facility is the one operation of the

AEC which is guaranteed future inputs. Research work is continuing on better disposal techniques.

Nuclear weapons programme
The development of an indigenous nuclear fuel cycle was only partially motivated by a concern to support a national nuclear electricity generation programme. The other motive was to develop nuclear weapons. The existence of an apparently peaceful nuclear electricity generating programme was the cover for developing scientific and technological capacity in uranium enrichment for weapons production. This decision was taken in 1974. President De Klerk acknowledged in 1993 that six nuclear fission devices had been manufactured by 1989 when the decision was taken to dismantle them and that South Africa would accede to the Nuclear Non-proliferation Treaty which it did on 10 July 1993. A multi-year decontamination programme is currently underway.

Council for Nuclear Safety

The licensing branch of the AEC was moved into an independent Council for Nuclear Safety in 1988 and now falls under the Minister of Mineral and Energy Affairs. It is entrusted with the licensing of all nuclear installations and operations in South Africa to ensure that international safety standards are adhered to.

2.3 Macro-economic impacts of energy sub-sectors

The energy sub-sectors have varying impacts on the national economy. This section briefly maps out the impacts of the major energy sub-sectors on the key macro-economic variables: balance of payments, investment levels, government revenue and expenditure, and employment. This can assist in assessing the relative significance of each sub-sector in the national economy, which is especially useful when evaluating areas requiring further policy attention.

Impacts of the petroleum industry on the macro-economy

South Africa's requirements for petroleum products are met through three main streams. Firstly, crude oil is imported, historically by the Strategic Fuel Fund with exception of Shell and Total who defied the United Nations oil embargo. Engen and BP are now also involved in oil importation. Crude oil is refined by the major oil companies in four refineries around the country. These refineries have a combined capacity at present of about 450 000 barrels of oil per day (EDRC 1993:58). The second source of oil is from Sasol's synthetic fuel (oil-from-coal) plants, which have a total current capacity of about 150 000 barrels per day, and which supply about a third of total petroleum consumption. A third source of petroleum is from the Mossgas oil-from-gas plant, which has recently come on line, and which has a capacity of about 45 000 barrels per day. These three options effectively eliminate the need to import refined oil products. However, the product composition of the refined barrel is such that more diesel and less petrol is produced than is demanded in the domestic

economy, with the result that surplus diesel is exported and a small amount of petrol is imported. Refinery expansions are being undertaken by the multinational companies to meet this demand for petrol.

The direct impact on the balance of payments of the import substitution policy which gave rise to Sasol and Mossgas, was a *foreign exchange* saving of approximately R3 billion in 1992 (ibid:63), equivalent to nearly 5% of total imports for the year (SARB 1993:92). This was about half of actual expenditure on crude oil imports for the year. The fact that the major oil companies refine crude oil in South Africa, rather than importing the refined product, avoided *further* foreign exchange outflows equivalent to about R1.7 billion in 1992. In addition, exports of refined product to Sub-Saharan Africa amounted to about R1 billion in 1992 (EDRC 1993:63).

While the synthetic fuel investments have reduced what would otherwise have been an even greater outflow of foreign earnings for oil imports, they have done so at considerable cost to the economy. The total expenditure on Sasol and Mossgas is not easily accounted for, as it includes both the construction costs, which collectively run into tens of billions of Rands, and ongoing operating subsidies which are also substantial. According to the government itself, the total establishment costs of Mossgas are estimated to be R11.1 billion, while total state investment in Sasol has been R4.9 billion: a total direct investment by the state of R16 billion in nominal terms (Bartlett 1993).

Levels of investment in the petroleum industry are significant in aggregate: actual capital expenditure in 1992 for refinery expansion was around R700 million, while planned investment for the next three years is even larger (EDRC 1993:59). Sasol has commitments of about R3.5 billion with a further R2 billion under consideration, while it is estimated that the other oil companies will invest over R6 billion, split between refinery expansions and marketing assets such as service stations. This is significant in relation to total Gross Domestic Fixed Investment (GDFI) in 1992 of R52 billion (SARB 1992:92), although a portion of this new investment will be financed by the overseas holding companies of the multinational companies.

Taxes on petroleum prices are a major source of *government revenue*. Fuel taxes of 54.9 c/l on petrol and 47.4 c/l on diesel in December 1992, and a further Customs and Excise duty of 4 cents on both fuels, raised about R8 billion or 10% of 1992/93 fiscal revenue (EDRC 1993). Moreover, it has been suggested that South Africa is relatively lightly taxed on fuel compared to most developed countries, leaving some scope for raising further revenue for the state from this source, although this has clear inflationary effects.

The oil industry as a whole is a fairly significant *employer*, with a total of about 110 000 people working in service stations, the synfuels industry, refineries, and marketing (EDRC 1993:64). Of these, approximately 30 000 are employed by Sasol, with Mossgas expected to employ only about 1250 people on a permanent basis (Scott et al 1992:1).

Impacts of the nuclear fuels industry on the macro-economy

The most significant economic impact associated with the Atomic Energy Corporation is the level of direct *government expenditure* on the Corporation. This grant amounted to about R713 million in 1990/1, R685 million in 1991/2 and R451 million in 1992/3. Between a quarter and a third of this grant is for interest redemption payments on a state guaranteed loan. In spite of this subsidy, the AEC has not been able to achieve commercial levels of fuel production. Conversion, enrichment and fabrication costs are two to four times higher than international spot market prices. Eskom is able to import enriched uranium more cheaply from abroad, but peculiarly continues to contract the AEC for fuel for its Koeberg nuclear power plant. The premium paid by Eskom to the AEC for its fuel (about R40 million per annum) represents another cost of the apartheid state's energy self-sufficiency policy (Auf der Heyde 1993).

Impacts of electricity generation on the macro-economy

At the end of 1992, Eskom had a total nominal installed electricity generating capacity of 39060 MW compared with a total national peak demand of 22640 MW. Since it became apparent that it had over-estimated the demand for electricity in the late 1980s and early 1990s, Eskom's investment in additional generation capacity has been cut down to the base levels in respect of which it already had commitments. Because of the long lead times, however, its current capital expenditure still includes investment in two additional coal-fired power stations, Kendal and Majuba. Levels of capital expenditure have declined considerably from the 1985 peak of R5.3 billion, to 1992 investment of R3.6 billion (current Rands) (Eskom 1993:15). At its peak in 1985, Eskom's investment was very significant in the national economy, amounting to 15% of GDFI, whereas at 1992 levels, capex is only about 6% of GDFI (SARB 1992:92, EDRC 1993:43).

For purposes of comparison, estimates of the current costs of a new coal-fired power station similar to the large 3 600 MW stations most recently built by Eskom, are in the region of R10 billion (EDRC 1993:32). Given the current excess capacity, and notwithstanding the electrification programme, capex budgets for this decade are expected to be in the region of about R3 billion per annum, thus continuing the decreasing trend in real terms.

Related to the issue of Eskom's investment in generation plant, is the level of foreign debt which was taken on to finance expansion. While additional foreign loans are not being actively pursued at this stage, significant amounts flow out of South Africa to foreign creditors through repayment of capital and finance charges. In 1992, about R1 billion was paid to foreign sources as finance charges. Total outstanding foreign debt amounted to about R9.2 billion (Eskom 1993).

Eskom is a significant employer, although its number of employees has dropped significantly, from 66 000 in 1985 to 42 000 in 1992 (EDRC 1993:48). Notwithstanding its status as a public corporation, it does not receive any direct financial support from the state; the other side of the coin, however, is that it is exempt from paying income tax, and so it is able to retain its full surplus,

which amounted to R1.5 billion (or 10.7% of total assets) in 1992. Its contribution to the fiscus is therefore limited.

Impacts of household electrification on the macro-economy

Total capital expenditure by Eskom in 1992 on household electrification was less than R500 million, with a further R100-150 million by all local authorities combined. Compared to capital expenditure in other energy sub-sectors described above, and even to government subsidisation of the AEC, it is clear that the investment requirements of the current national electrification programme are relatively modest. Even with a programme with a connection rate double the present rate, peak levels of capital expenditure will be about R1.7 billion. Likewise, leakages through the Balance of Payments in respect of direct materials imports (mainly for transformers) and second-round appliance imports, are not likely to be significant (EDRC 1993:12).

On the other hand, household electrification will have positive impacts on economic activity in general, over and above the improvement in quality of life it brings about for new consumers. While the electrification programme is still in its early stages, and major economic effects can therefore not yet be demonstrated, it is clear that major spin-offs will arise in coming years for employment, small-scale enterprises, productivity, appliance and material suppliers, and so on. In addition, electrification should result in environmental benefits for households which replace coal and wood with electricity. These effects may be very significant in the long-term.

Impacts of the coal sector on the macro-economy

Coal plays a central role in the South African economy. Total coal production in 1991 was 228 Mt, of which nearly 180 Mt was of saleable quality (DMEA 1992:26). Local consumption (mostly in Eskom's power stations and Sasol's liquid fuel plants) accounted for 74% of sales, with the remaining 49 Mt being exported. These exports realised R4.3 billion in 1991, at an average price of R87 per ton, compared to local prices of R34 per ton (ibid:27). Export revenue from coal constituted 14% of total mineral export revenue in 1991, second only to gold, and represented 6% of total South African exports (ibid, SARB 1993:92).

The coal mining industry is capital intensive and employs about 45 000 people, which is only about 10% of total mining employment (Von Glehn 1993). Similarly, its direct contribution to the fiscus is relatively small, due to generally low profit margins in recent years, and tax allowances which permit companies to write off capital expenditure in the year in which it is incurred.

2.4 Environmental impacts in the energy sector

The energy sector has numerous interfaces with the environment, and has many of these have suffered severe environmental degradation. Environmental quality has generally been accorded a low priority in the South African energy sector, with the result that some of the impacts have been particularly severe. Apart

from the direct environmental impacts of coal mining and processing, possibly the most serious environmental impact stemming from energy use patterns in South Africa, occurs in the household sector, where unelectrified households rely mainly on coal, wood and/or paraffin. Recent studies in urban townships in the PWV area have found that people are exposed to levels of particulate pollution (from the combustion of coal, which has a high ash content), which are far in excess of acceptable health standards. For instance, in a recent study which monitored the exposures of a group of children in Sebokeng and Lekoa, average exposures to particulates on a summer day were 387 μgm^{-3} in electrified areas and 620 μgm^{-3} in unelectrified areas (Terblanche et al 1992:41-43). As expected, increased coal combustion in winter was reflected in higher exposure levels. Average concentrations on a winter day were 1168 μgm^{-3} in electrified areas and 1363 μgm^{-3} in unelectrified areas. By comparison, the World Health Organisation's lowest-observed-effect level is 180 μgm^{-3}. The relatively small difference between electrified and unelectrified areas is significant, and is attributable to the high levels of background air pollution resulting from the close proximity of electrified and unelectrified areas, and to the continued use of coal in most areas. The same study found that coal use was the most significant predictor of respiratory illness, when compared to crowding, socio-economic status and parental smoking.

Major indoor air pollution problems are also experienced by people who burn *wood*, often in open fireplaces, without proper chimneys or ventilation. The first epidemiological study of its kind in rural South Africa, measured a group of children's exposures to various pollutants, and found even *higher* exposure levels than in urban areas. Average levels (also over 12 hours) were 2367 μgm^{-3}, with a maximum individual exposure of 8330 μgm^{-3} (CSIR 1992:1). The average measurements in the urban and rural studies referred to, are presented graphically in figure 4 below.

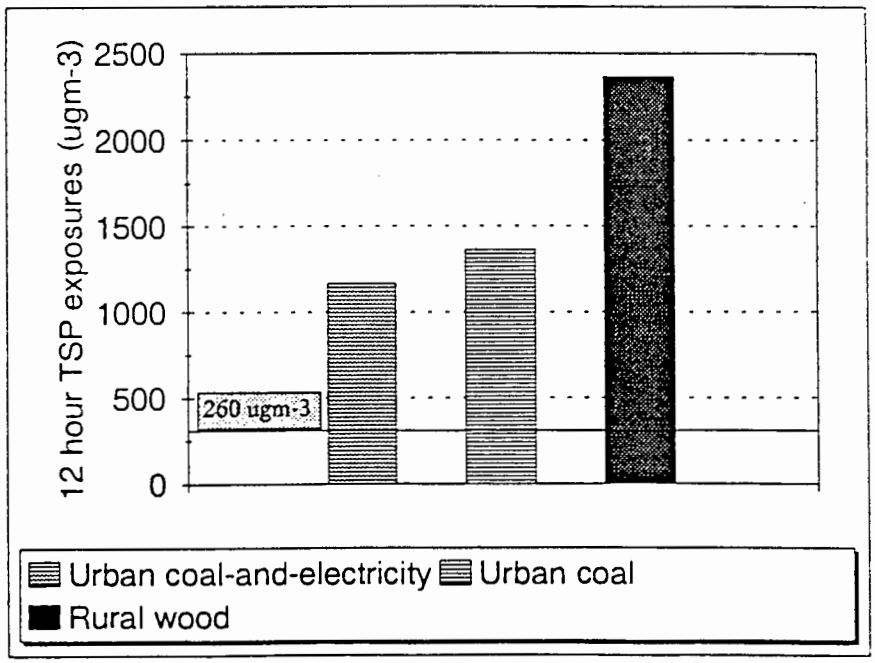

Figure 4 Exposures to total suspended particulates in various studies (Terblanche et al 1992a, CSIR 1992)

It is clear from this data that major environmental and health problems stem from peoples' reliance on wood and coal for their energy needs, and that policy interventions are urgently required. Other environmental problems experienced by the household sector include incidents of trauma and even death from paraffin poisoning (especially in infants of 12 to 36 months), burns and fires from accidents with candles and other fuels. Similarly, the outdoor environments of many urban townships are further degraded by pollution from the combustion of non-electric fuels.

These environmental problems have received far less attention from public authorities than those arising from electricity generation, in spite of the fact that the pollution levels encountered are far higher, and are experienced on a daily basis by far more people.

At a different level, environmental problems result from the generation of electricity in Eskom's coal-fired power stations, most of which are located on the coalfields in the Eastern Transvaal Highveld (ETH). All power stations are fitted with control technologies to remove particulate matter from emissions, although gaseous pollutants such as sulphur and nitrogen oxides are not removed at all. Instead, they are emitted through tall chimneys into the upper atmosphere, in order to penetrate the inversion layer which prevails on the ETH. The emission of these gases into the atmosphere increases the ambient pollution levels, which are already high because of the concentration of industry in the area, and increase the acidity of rainfall further (Tyson et al 1988). Energy policy will have to grapple with the question of whether the costs of retrofitting control technologies (such as desulphurisation equipment) to existing power stations are outweighed by the environmental benefits which will result, and if so, when these costs are best incurred.

Taking a longer-term and more global view on the energy sector, it becomes clear that certain fundamental problems will have to be addressed. The most profound of these is the reliance of the whole energy sector, and indeed the South African economy, on non-renewable resources, particularly coal. Renewable sources of energy currently contribute insignificant amounts to the total energy needs of the country, particularly when biomass is excluded. In the long-term, a shift will therefore have to be encouraged towards clean and sustainable sources of energy. One of the driving factors in such a transition, may emerge in the form of international efforts to reduce the emission of greenhouse gases (especially carbon dioxide). South Africa, although currently responsible for only about 2% of global emissions (President's Council 1991:52), emits far more carbon dioxide on a *per capita* basis than the global average, mainly because of the predominance of coal in the economy. Consequently, local efforts to reduce these emissions can be expected to receive increasing attention from the international community. This pressure is already evident through emerging trade relationships between large exporters (such as Alusaf) and European customers who are subject to strict environmental regulations. These questions also require policy attention now, because of the long time required to effect such major structural changes with minimal disruptive impacts in the remainder of the economy.

3 New paradigms governing energy policy

The context for energy policy and planning in South Africa is shifting radically. Gone are the exclusive concerns of fuel security and self sufficiency held by an apartheid government beleaguered with international sanctions. As the country moves towards widened democracy and is accepted back into the international community, energy policy will align itself with new social and economic policies aimed at reconstruction and development. Energy policy specifically will seek to:

- improve *social equity* by specifically addressing the energy requirements of the poor;
- enhance the *efficiency and competitiveness* of the South African economy by providing low-cost and high quality energy inputs to industrial, mining and other sectors; and
- work towards *environmental sustainability* by addressing both short-term environmental problems, and planning for a long-term transition towards renewable sources of energy with minimum negative environmental impact.

In the South African context, these three principles encapsulate the desirable features of post-apartheid energy policy. The primary goal of democratic government will be to address the high levels of inequality which characterise both the energy sector, and the economy as a whole. At the same time, inefficiencies in the energy sector will have to be eliminated, particularly those which were shielded by the state's energy security policies, so as to maintain and enhance the comparative advantage inherent in the country's relatively cheap supplies of energy. On the other hand, the low cost of South African coal and electricity is attributable, at least in part, to the lenience of environmental controls over the various stages of the electricity generation cycle, and energy policy will therefore have to include adequate management of environmental impacts arising from energy production and use. It is likely that some of South Africa's major trading partners will increasingly impose environmental conditionality on its exports and, as a disproportionate contributor to global warming, the energy sector will come under pressure to lower emissions. In the longer-term, policy will have to address the essentially finite resource base on which the energy sector, and indeed, the whole economy, is based.

The concept of 'sustainable development' has received widespread international support, particularly since the publication of the Brundtland Report (WCED 1987), and during the process leading up to the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in July 1992. Whilst the goal of sustainable development enjoys almost universal support, sharp conflicts exist over the interpretation of the term and its implications for policy making - as evidenced in the UNCED process, with strong differences emerging between countries from the North and South over the allocation of responsibilities for environmental problems and their control.

In South Africa, the concept of sustainable development has recently received some attention from the research and academic community (DEA 1992, EMG 1992, Cock and Koch 1991), but has so far not informed national policy-making in any substantial way. There can be little doubt that many of the concerns embodied in the sustainable development paradigm will have to be addressed explicitly by policy-makers in the coming decade - the question is whether these

concerns will be addressed in systematic, well-planned ways or in an ad-hoc manner as the need arises. It is suggested here, that the sustainable development paradigm offers an important theoretical framework for the development and implementation of energy policy in South Africa.

Clearly, equity, efficiency and sustainability are three goals which may necessitate direct trade-offs, but in many cases, as this will become evident later in this paper, these goals tend to converge around specific policy options.

4 Policies for the future

4.1 A new system of governance for the energy sector

The governance of South Africa's energy sector remains highly fragmented and uncoordinated, and important stakeholders have no structured input into policy making. The most economically significant and regulated sector - petroleum - has no formal professional regulator, and the extensive set of regulations are mediated by ad-hoc meeting between the industry and the Department of Mineral Affairs. The state and the private sector compete in the procurement of fuel with the state still operating the Strategic Fuel Fund Association. Its Central Energy Fund continues to subsidise Sasol and Mossgas. Levies are imposed on petroleum and not on other fuels, and constitute a significant source of government revenue. The other major energy sector - electricity - reports to a different minister - Public Enterprises - who appoints the governing Electricity Council. Local authorities mostly govern the supply of electricity in municipal areas while the Electricity Control Board, appointed by the Minister of Mineral and Energy Affairs, exercises nominal control over the supply of electricity by Eskom, private undertakings and local authorities beyond their areas of jurisdiction. The coal sector is now unregulated and is in the hands of major private conglomerates. The nuclear fuels industry reports directly to the Minister of Mineral and Energy Affairs through the Chief Executive of the Atomic Energy Corporation and has enjoyed extraordinarily favoured access to state resources. The fuelwood sector is highly fragmented and neither the state nor non-governmental organisations have made any impact on securing a supply of fuel which is relied on by the majority of the population in rural areas. Confusion exists at government level whether the Department of Agriculture, Forestry, Community Development or Mineral and Energy Affairs should take responsibility for this area.

The fragmented, uncoordinated, unprofessional and unrepresentative nature of governance in the energy system has led either to inactivity in key policy areas or to irrational, sub-optimal and wasteful investment decisions in individual energy subsectors. For example, Eskom ended up with massive over-investment in generating capacity. The state squandered billions on Sasol and Mossgas when these fuels continued to be imported at cheaper prices, despite an international oil embargo. The state continues to spend half a billion rand a year, or 70% of its Department of Mineral and Energy Affairs budget, on an uneconomic nuclear fuels industry which produces less than 6% of South Africa's electricity and 1% of total primary energy. South Africa uses energy inefficiently, with high environmental impacts, and the majority of the population still do not have access to affordable convenient energy services. In short, there has been no coherent, rational energy policy and the current system (or lack) of governance has failed.

A new proposal

South Africa needs a co-ordinated, integrated energy policy which takes adequate account of national social and economic development goals and trends, desired energy end-uses, demand-side management strategies and the potential of all energy sectors to meet demand. This will only be possible with

a new system of energy governance where all energy sub-sectors are governed by the Department of Mineral and Energy Affairs; where participation and representation by key stakeholders in the formulation of energy policy is statutorily entrenched along with professional regulation to ensure the efficient implementation of policy.

It is proposed that:

1a the *Minister* of Mineral and Energy Affairs will assume primary responsibility for *policy-making* and *governance* over the entire energy system and all energy sub-sectors.

1b the Minister will be *supported* by the Department of Mineral and Energy Affairs (*DMEA*) which will *implement* energy policy and *administer* energy legislation.

2a a National Energy Policy Council (*NEPC*), representing key *stakeholders*, will be established to *assist* the Minister in energy *policy formulation*.

2b the *NEPC* will be *supported* by *professional staff* who will commission *research* to support policy formulation and manage *information systems* for integrated energy planning.

3a *regulators* will be appointed by parliament for particular energy sub-sectors to audit, monitor, mediate and referee the relationship between government and energy institutions and ensure the efficient achievement of public policy goals.

3b the regulators will be *supported* by professional staff which provide independent *technical expertise*.

Figure 5 indicates how the system might work. Clear organisational distinction has been made between different functions: the Minister of Mineral and Energy Affairs is responsible for making and implementing energy policy; a new National Energy Policy Council enables key-stakeholders to advise the Minister; and regulators referee the relationship between government and energy sector institutions. Each of these functions has a second tier of professional support staff: the Minister has the Department of Mineral and Energy Affairs which implements energy policy; the National Energy Policy Council is supported by full-time professional staff who develop policy options, commission research and maintain energy information and planning systems; and the Regulators' professional staff provide detailed audits of energy sector performance

These three functions of governance are discussed below:

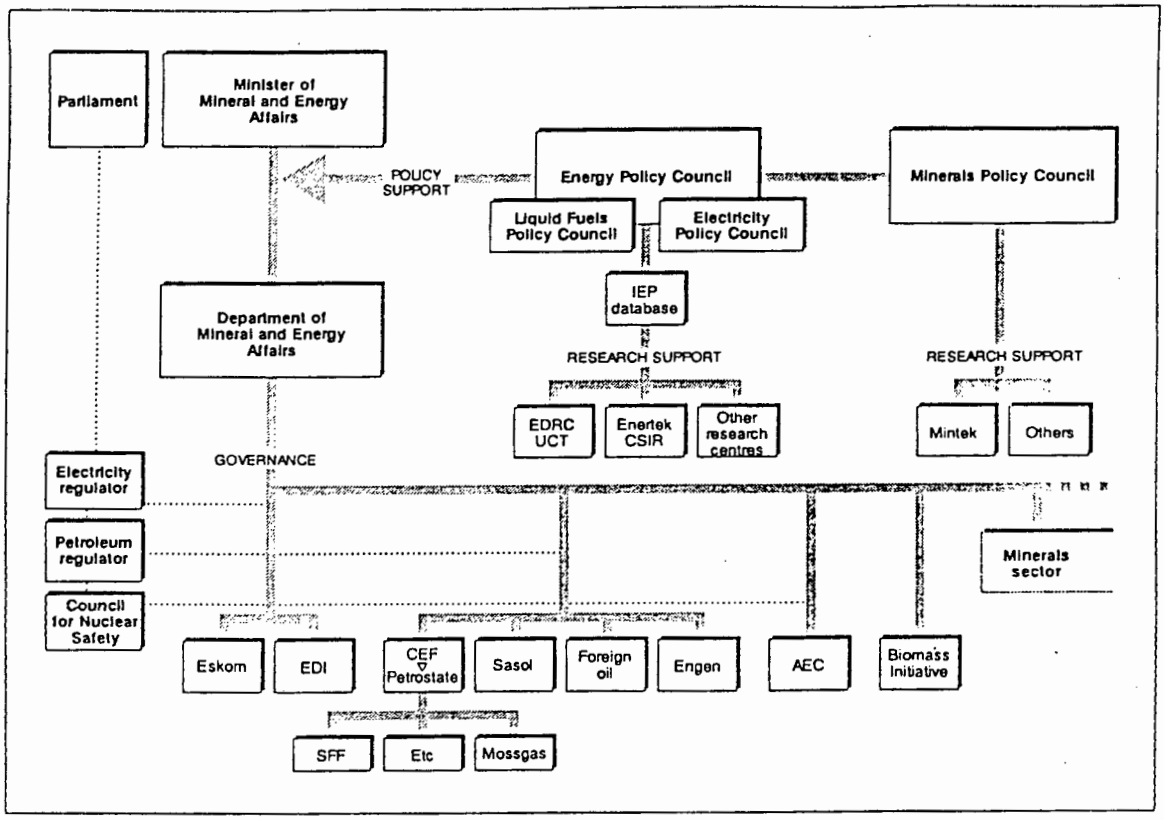

Figure 5 Proposed governance structure for the energy sector

Co-ordination of policy-making and governance in the DMEA

It is proposed that policy formulation and governance of all energy sectors fall under the Department of Mineral and Energy Affairs and that the coal, petroleum, electricity, nuclear fuel and woodfuel sectors be governed within an integrated energy planning framework.

The three broad policy imperatives of social equity, economic efficiency and competitiveness and environmental sustainability cannot be tackled in a piecemeal, sectoral and supply-sided manner but need an integrated approach to energy policy analysis, planning and management. The linkages between the energy system and the economy need to be understood. Energy end-uses need to be analysed and all energy sub-sectors evaluated to select optimal energy service options.

The state needs to understand where markets fail and result in sub-optimal choices. Externalities and non-monetised considerations such as environment or security of supply, for example, often require state corrective action. Given the importance of the energy sector in the economy and for the welfare of households, the state has to play a key policy and governance role. In the future this should be undertaken within a framework of integrated energy policy analysis.

Institutionalise the role of stake-holders : create a National Energy Policy Council

One of the remarkable features of the transition to democracy in South Africa is the participation in a plethora of forums by a wide range of not only political parties but also organs of civil society. Within the energy sector, it is clearly advantageous to incorporate energy end-users in the process of formulating policy which affects them. The recent political debacle where fuel prices were increased without adequate consultation illustrates the wisdom of institutionalising appropriate stake-holder representation.

Significant sectors of the energy economy remain in the public sector (Eskom, AEC, Mossgas, Soekor, CEF, etc) and the state exercises extensive regulatory control over the liquid fuels industry. Public corporations such as Eskom already have stake-holder representation on their Electricity Council and provisional arrangements have been made to make the council more representative. However, there is currently no body which involves stake-holder participation in overall energy policy formulation.

It is proposed that in future DMEA's responsibilities be limited to implementation and administration of energy related acts, and that an National Energy Policy Council (NEPC) be created to advise the Minister on energy policy. It would comprise a representative council of stake-holders supported by a professional secretariat and staff.

Sub-councils might be formed in the key energy sectors of electricity and liquid fuels. The National Electrification Forum could be transformed into an electricity policy sub-council and the Liquid Fuels Task Group into a liquid fuels policy sub-council.

The rationale for an NEPC is therefore:

(i) legitimation and enhancement of energy policy formulation through the involvement of energy end-users and stake-holders; and

(ii) application of integrated energy policy analysis by the council supported by a professional secretariat and staff.

Stakeholders will include consumers, government, management of supply institutions, labour, and perhaps lending agencies. Organisations are represented, rather than individuals being appointed. Sub-councils enable more extensive representation of stake-holders in particular energy sub-sectors. Consumers are the most important group of stakeholders. Government could be considered to represent them as they elect the government which balances and mediates sectoral interests. However, there are some advantages in direct consumer representation which might better protect their interests. Particular consumers also have particular concerns which need to be represented.

The composition of the NEPC would be defined in legislation as well as the procedure for constituencies to nominate representatives. While the NEPC reports to the Minister, council members are accountable not to the Minister, but to their own constituencies. Council members would not be full-time and the NEPC would meet monthly.

While the Minister should retain the prerogative to make policy, the status of the NEPC should be assured and legislation should require the Minister to consult the NEPC before formulating policy.

The NEPC could be funded either through a levy on fuels or through the fiscus. The former arrangement has the advantage of providing a secure funding base to establish a strong, professional policy formulation base protected from political expediency. The latter arrangement enables regular review of budgetary needs in relation to competing fiscal demands.

Commission research and build planning systems

Good policy requires good data and a good understanding of the energy system and energy end-uses. Key policy questions are identified and then linked to information requirements. The implication is that if energy policy formulation is to be effective, it requires a strong national institutional base to co-ordinate research, information gathering and analysis.

The institutional capacity of the Department of Mineral and Energy Affairs to undertake integrated energy policy analysis and planning is extremely weak. Its staff have been greatly reduced and inadequate energy information systems and planning tools exist. The proposed NEPC will provide a more attractive working environment than the civil service for professional staff.

The proposed NEPC will be charged with setting up the necessary systems to undertake integrated energy policy analysis such as databases and planning tools. Professional staff will provide full-time policy support for the Council. They will be empowered to commission supportive policy research and will be charged with the responsibility of developing national capacity to undertake this work.

There will be a need for both short-term policy analysis to answer immediate questions and longer term policy research which deepens knowledge and understanding. The latter is best achieved in multi-year, multi-person research programmes under experienced research leadership. The NEPC will have to invest in building this capacity in a limited number of centres of excellence.

Appoint independent regulators

The state is extensively involved in three energy sub-sectors: petroleum, electricity and nuclear fuels. The reasons for this involvement differ between sectors[1]. There is a need to professionalise the state's regulation of these sectors and to create a structure which ensures arms-length governance: i.e. the state formulates general policy and performance targets but desists from

1. Separate papers outline new state policies for these sectors, including new forms of regulation. Steyn, G 1994. Restructuring the South African electricity supply industry. Energy Policy Research and Training Project, Energy for Development Research Centre, University of Cape Town; Eberhard, A A 1994, Options for energy policy and planning in South Africa: where does the nuclear industry fit in? Conference on Nuclear Policy for a Democratic South Afdrica, 11-13 February, Cape Town.

interfering in the day-to-day management of public utilities or private corporations which, in order to remain viable and efficient, require a level of managerial autonomy. The best way to achieve these goals is for parliament to appoint independent regulators for each of these sub-sectors. These regulators are backed by professional staff who provide independent technical expertise to audit industry performance.

In a changing political environment, statutory regulators offer a transparent mechanism for monitoring the implementation of public policy according to defined rules. Regulators do not make policy - they provide independent technical expertise to monitor its implementation and where necessary to mediate the relationship between the state and energy organisations according to established "rules of the game".

In the petroleum sector, the regulator will oversee, monitor and refine the complex set of regulations governing the price of petroleum products and their marketing and distribution. The regulator will also monitor on a regular basis the necessity (or otherwise) of continued public support for Sasol and Mossgas.

In the electricity sector, the regulator will assist in the development of a rolling five year contract plan for the electricity supply and distribution industry and will monitor performance targets.

In the nuclear sector, the regulator will assume the responsibilities of the Council for Nuclear Safety as well as the current regulatory functions of the Chief Executive Officer of the Atomic Energy Council.

Conclusion

The above proposal provides a coherent, consistent and integrated system of governance for the energy sector which is a logical improvement over the current fragmented, unco-ordinated, unprofessional and unrepresentative system.

4.2 The immediate priority: greater equity

Current patterns of energy consumption by South African households mirror the inequality which characterises the country's social, political and economic order, and this differentiation is defined largely according to racial grounds. The vast majority of the black population do not have electricity in their homes, whilst almost all whites, even those on remote rural farms, are connected to the national grid. Unelectrified households rely instead on wood, coal, paraffin, gas, candles and batteries for cooking, heating and lighting, and are denied the convenience and flexibility of electrical appliances such as kettles, irons, fridges and the multitude of time savings devices found in high-consumption homes. Many of the non-electric forms of energy also degrade the local environments of users, which in turn, cause adverse impacts on the health of people exposed to these effects. For many of the urban poor who do have access to electricity, the quality of the service they receive is far inferior to that enjoyed by white

consumers, with interruptions in supply and poor maintenance. Moreover, poor consumers in townships which have been electrified, often pay higher electricity tariffs than consumers from historically white areas in which the grid and reticulation costs have long-since been paid off.

The immediate priority for energy policy is therefore to ensure that poor urban and rural households gain wider access to adequate and affordable supplies of energy. This is the focus of a two-year *Energy Policy Research and Training Project* (EPRET) being conducted at the Energy for Development Research Centre at the University of Cape Town, and which has involved some 20 person-years of research. An Integrated Household Energy Policy which is aimed at improving the welfare of poor households will necessarily have many components, ranging from demand to supply options, and including considerations which cut across both demand and supply sectors, such as environmental issues, pricing and financing policy. This section sets out some of the main policy options aimed at improving equity in the household energy sector. The discussion which follows cannot hope to be comprehensive, and ignores numerous policy issues such as the links between household energy and energy for small-scale enterprises and farms. Details of the EPRET policy proposals can be found in the set of research papers produced on the project.

A national electrification programme

Electrification will form the backbone of household energy policy throughout this decade and into the next. According to Eskom, approximately 3.1 million households had access to electricity by the end of 1992 which is equivalent to approximately 36% of the total number of households in South Africa.

Eskom has already launched an electrification programme, and made about 160 000 new connections itself in 1992, while local authority distributors brought the national total to around 200 000. Eskom's plans envisage a total of about 3 million new connections in the seven years to 1998, with about a third of these being undertaken by itself and the remainder by local authorities. The achievement of these targets, however, is constrained by the current structure of the electricity distribution industry (EDI). This will be discussed more fully in the next section.

Two main scenarios can be presented to illustrate the possible impact on the level of household electrification. In the first instance, assuming that no major changes in the structure of the EDI occur in the medium-term, the rate of new connections might be in the region of 200 000 to 250 000 per annum. If this is maintained for 15 years, then by 2008, roughly two-thirds of all households will have access to electricity: a modest gain over a long period. If, under a second scenario, the distribution sector is able to deliver more quickly, and finance is available and utilised, a more ambitious electrification programme can be achieved. This is the option which should be pursued by government and key players in the sector, if real gains for the poor are to be achieved over a reasonable time period. Assuming that the rate of connection increases to about 500 000 per annum, two-thirds of all households would be electrified by the end of the decade, and by 2010, about 86% of all dwellings would be connected to the grid.

A fairly distinctive situation applies to *farmworkers* on mainly white-owned farms. Several million people find themselves in this category, and whilst the farmers themselves have generally been connected to the electricity grid (often subsidised directly by the state), only about 15% of farmworkers have electricity (Hofmeyr 1993). Given that these workers' houses are therefore fairly close to the grid, their electrification will be feasible at reasonable cost. An important issue is to ensure that control over the electricity supply rests with the workers rather than, as at present, with the farmer, who generally exercises an inordinate amount of control over employees.

In addition to the structure of the electricity distribution industry, two key issues in the electrification process are the *financing* arrangements and *pricing* policy. The current arrangement is that loan finance for the capital cost of new connections is provided by the distributor, sourced either from internal reserves, external funders or from capital markets. These costs are then recovered from consumers, through the tariff, over a period of about 15 years. At present, no government or Eskom subsidies are applied to the capital costs of electrification. In the case of the operating costs, however, some tariffs do carry implicit cross-subsidies from industrial and commercial consumer classes to residential classes. This occurs only in those local authorities which have a mix of domestic and commercial consumers in their areas of supply - generally the well-established, historically-white areas. The fact that poorer electricity consumers generally do not receive any such benefit, represents a regressive situation from a welfare point of view. Moreover, there is no national set of electricity tariffs applied to end-users, so that different circumstances apply to different distributors. As a result, there are over 1 000 domestic tariffs in the country.

Pricing policy is therefore an area requiring substantial revision, and is a key focus of the National Electrification Forum, in which all key players in the electricity supply industry (ESI) are participating. It is suggested that several principles should inform pricing and financing of electricity during the current transition. Firstly, a *uniform set* of tariffs should be consistently applied to consumer categories across geographical regions. In particular, it is proposed that *all domestic consumers* face the same system comprising two tariffs: a *single energy rate tariff* (possibly in the region of 18 to 20 c/kWh), which will be paid by the vast majority of households, and a *time of use tariff* which will apply to higher level consumers who are able to shift their loads from peak to off-peak periods when tariffs (and costs) are lower. The advantages of having a system in which the single energy rate is the dominant tariff are as follows:

- by having *all* domestic consumers paying the same rate, in a context where electricity tariffs are highly politicised, a high degree of fairness will apply;
- a single energy rate is far simpler to implement in practice than other tariffs such as a two-part tariff, which cannot be implemented with existing prepayment meters (of which about 400 000 are in use);
- the single energy rate is progressive from a welfare perspective, as low level consumers are effectively cross-subsidised by high-level consumers; only an inclining block tariff is more progressive;
- significant sources of revenue will become available to the ESI if a single energy rate tariff is implemented across the board - more so than for a two-part tariff; it is suggested that to minimise price shocks for

consumers currently paying lower than average tariffs, the increase should be phased in over a few years.

These proposals relate specifically to the short- and medium-terms, that is, for a period of five to ten years during which a large portion of the electrification programme will have to be financed. Thereafter, it may be desirable to move to more cost-reflective tariff structures, such as a two-part tariff; however, for the present, the need for effective redistribution to the mass of unelectrified people should have preference over more theoretical efficiency concerns. In the longer term, it may also be desirable to set tariffs to be more reflective of real transmission costs, which are far higher than currently provided for in tariffs.

Secondly, any *external* subsidy funds which are available, should be applied to the *capital* costs of new electricity connections rather than ongoing *operating* expenses and energy costs. Investment in capital represents a more productive use of resources, and is finite in nature. An appropriate mechanism for the *raising* and *allocation* of bulk sources of loan and grant finance, it is proposed, is a national *Electrification Fund*. This Fund should utilise innovative financing mechanisms such as Eskom's Electrification Participation Note (EPN, or Electrification Bond) which raised R600 million from institutional investors in 1993 specifically for electrification. Such a bond would fall within the definition of 'prescribed assets' should such regulations be re-introduced for the large investors, as appears likely. With financing requirements of an accelerated electrification programme reaching R1.7 billion per annum and a cumulative R22.4 billion until 2010, it is clear that a mechanism such as a Fund is necessary to raise this finance. Figure 6 shows the annual and cumulative financing requirement of such a programme.

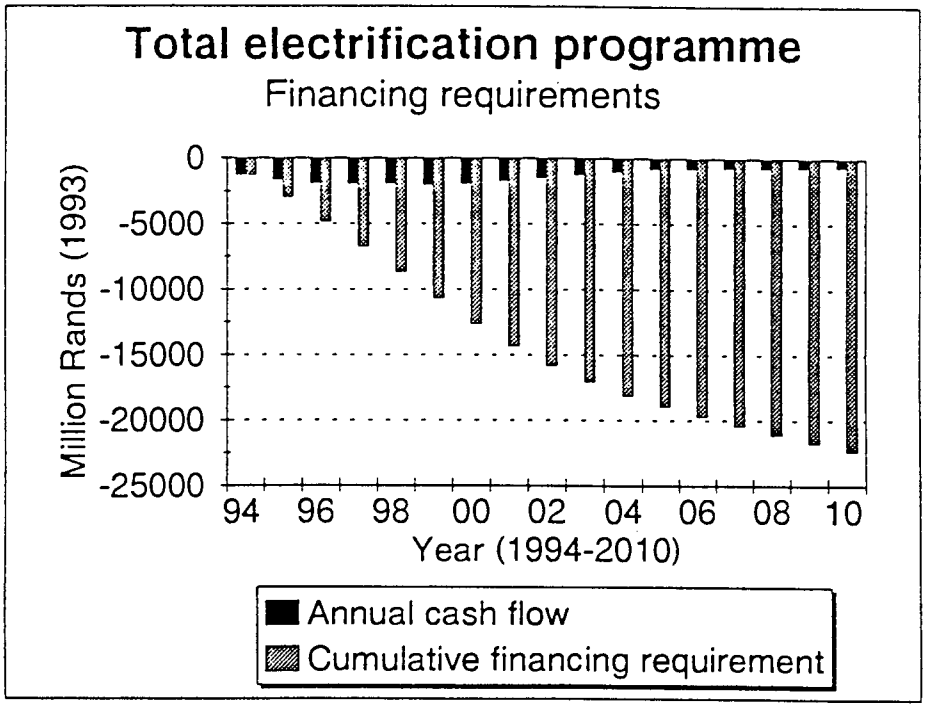

Figure 6 Financing requirements of an accelerated electrification programme making 500 000 connection per annum and electrifying 86% of households by 2010 (Van Horen 1993).

Thirdly, it will be necessary to *cross-subsidise* those domestic consumers who are unable to afford electricity costs, from *internal* sources, from wealthier domestic consumers, and/or from other consumer classes (industry, mining, commerce). Several considerations are relevant. In principle, cross-subsidisation can be financially sustainable provided the additional burden on the subsidisers can be borne without adverse effects. Secondly, the system as a whole should be fully transparent, so that it is clear who is subsidising whom, and by how much. Thirdly, the incremental cost to subsidisers should not cause any major distortions in their cost structures and competitiveness, particularly in relation to exports, inflation and competitiveness with non-electricity consuming industries. Given the relatively small amount of electricity likely to be consumed by newly electrified households from the poorest sector, the additional burden on other consumers should not be problematic. Figure 7 indicates how the total financing requirement can be reduced by incorporating internal cross-subsidisation based on a single flat-rate national domestic tariff of 20 c/kWh. The total financing requirement decreases to R9.9 billion, due to the contribution from high level consumers, whose current average tariff is around 15 c/kWh (Van Horen 1993).

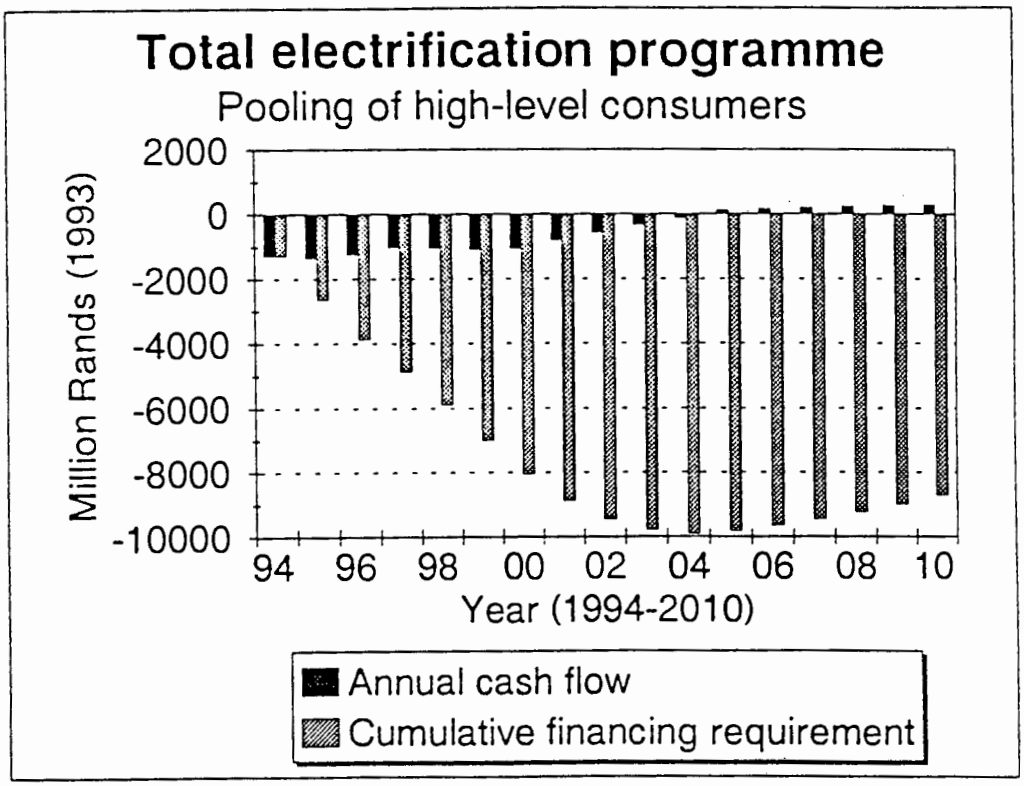

Figure 7 Financing requirements of electrification, with pooling of existing high level consumers, at a national tariff of 20 c/kWh.

A final consideration related to the financing of electrification, is that all of the programme's financing requirements can potentially be met from within the industry itself and from other *local sources* of capital. Supplementary to the internal reserves generated by Eskom and local authorities from their trade in electricity, large amounts of finance can potentially be obtained from private savings. The massive cash flows of institutional investors (such as life assurance

companies and pension funds) could, with relatively little state involvement, be applied to areas of social investment such as electrification and housing. This has already been demonstrated with the recently released Electrification Participation Note, mentioned above. Such a financing mechanism, with a guarantee from the government, and backed by security in the Electrification Fund endowed by the state, private investors and foreign sources, can unlock large amounts of funds for investment in electrification and other areas of social demand such as housing, education and health. If these mechanisms can be put in place, then availability of finance should not act as a constraint on rapid and sustained electrification.

On the positive side, it is clear that electrification will bring about major economic benefits. While the nature and extent of the multiplier effect is subject to much debate (which remains necessarily academic until the effects can measured), international experience with large-scale electrification suggests that massive benefits accrue. This should also be the case in South Africa, although the number of new jobs, and additional demand for goods and services which will result *directly* from electrification will be fairly modest due to the over-capacity currently prevailing in many supply sectors. However, major benefits will probably accrue *indirectly*, such as increased opportunities for small-scale and informal sector activities. These effects can have favourable distributional implications.

A low-smoke coal programme

Evidence from low-income areas which have been electrified in the last 15 years or so, and in which coal was previously used and remains available at low cost, suggests that access to electricity will not necessarily result in a complete substitution of other energy sources. For instance, actual consumption by households which were connected by Eskom in 1992, was under 100 kWh (Ligoff 1993). Many reasons have been postulated for low electricity consumption levels and continued coal usage, such as the higher efficiency of coal stoves for heating purposes, the low cost of coal on the PWV and nearby coalfields, the high costs of electrical appliances such as stoves and geysers, the unreliability of electricity supply in many areas, and the multiple utility derived from coal stoves. Consequently, policy must acknowledge that coal use by households may continue into the longer-term.

Environmental factors are also important. Several recent studies have identified very high levels of air pollution associated with coal usage, and have also observed negative impacts on the health of exposed people, especially in the incidence of respiratory illness (Terblanche et al 1992). It has been suggested that air pollution from coal usage has major costs in terms of additional health care expenditure and lost productivity. Thus, from the perspective of the negative health and environmental impacts of domestic coal usage, and working on the assumption that coal will not be replaced by electricity immediately, perhaps even for some time after electrification, it is imperative that conventional bituminous coal be replaced by cleaner energy sources, such as low-smoke coal.

Two prototypes of low-smoke coal have been produced under a DMEA-funded project, and appear to have the potential for substituting conventional coal in

the household sector, while eliminating or reducing the worst cause of air pollution. Both utilise waste coal, and one type has the advantage of being suitable for labour-intensive production methods. Social acceptability surveys conducted to date suggest that the products may be favourably received, but that they may require a price advantage over conventional coal, at least initially. Rough estimates of production costs indicate that some subsidy may be required. This might come from two sources: firstly, direct state subsidisation might be justified on the grounds of the environmental and health benefits which will accrue, possibly resulting in avoided health care costs in the medium-term. Secondly, it is possible that a levy be imposed on conventional coal prices and applied to subsidise low-smoke coal, sufficient to shift the price advantage towards the latter. This alternative is theoretically superior, in that it entails the internalisation of externalities. In any event, the amounts involved are not very significant on a macro-scale. Based on estimated domestic consumption of 3 million tons per annum (LHA 1987:8), and assuming that production costs of low-smoke coals are as much as R25-60 per ton higher (Tait 1993), the total operating subsidy would be a maximum of R75-180 million per annum. These figures are conservative and could be far lower - in any case, they are small in relation to the health and social benefits which will arise from substitution of conventional coal in households.

Woodland management and afforestation programmes

Energy policy seeking to benefit poor households will also have to deal explicitly with rural households, and must do this in the context of a broader rural development policy. The majority of poor rural households rely predominantly on fuelwood, the bulk of which is obtained at no cash cost, from natural woodland. Numerous studies over the past decade have observed that wood supplies have become increasingly scarce during the past generation (Best 1979, Gandar 1984, Eberhard 1986). While fuelwood collection clearly plays a significant role in the denudation of woodlands, it is essential that other causes are not ignored: clearing of land for agriculture and for settlement, wood collection for construction and fencing purposes, and so on. The way in which the fuelwood scarcity issue is analysed has important implications for energy policy. If woodland denudation is narrowly viewed as an *energy problem*, which must therefore have an *energy solution*, it is likely that the kinds of interventions suggested (such as mass plantations) will fail. The experience internationally and especially in Sub-Saharan Africa is that fuelwood issues must be addressed as part of multi-faceted development interventions rather than simply attempts to increase the supply of wood (Munslow et al 1988, Leach and Mearns 1988).

Rural energy policy in South Africa is relatively underdeveloped. Nonetheless, a number of interventions are likely to form part of future policy, and can potentially impact upon the welfare of the rural poor. Policy measures must aim to ensure the sustainable utilisation of wood resources, which can potentially provide a cheap and renewable source of energy. Several policies are proposed:

- Improved management of natural woodland, which is by far the biggest source of firewood at present, through, for example, building on traditional land and resource management practices.

- The supply of fuelwood can be increased through social forestry programmes, which are multi-faceted in that their output includes not only fuelwood, but also timber, fruit, food products and fodder.
- The products of social forestry programmes can be supplemented by woodlots and plantations, which will produce fuelwood and other wood products on a commercial basis.
- Expansion of small-grower schemes operated by large forestry companies can further enhance the supply of wood.
- Finally, support should be provided to small traders to transport wood from areas of surplus (such as commercial forests) to areas of deficit.

Policy interventions aimed at rural households must also be linked to support for *productive activities*, particularly small-scale agriculture. In many areas, the lack of adequate energy supplies (such as for draft power) acts as a major constraint on farming activities. Rural electrification and improved diesel supply networks, for example, could facilitate both small-scale agriculture and rural development in general.

The high levels of pollution encountered in rural homes, which were described earlier, make it imperative that open wood fires be replaced by less damaging energy-appliance combinations. Wood stoves with proper ventilation may therefore have an important role to play, along with attempts to substitute fuelwood with electricity, gas and paraffin.

Paraffin and gas: improved access, affordability and safety

Although paraffin is widely available throughout the country, there remains scope for reductions in the prices paid by small consumers. This can be achieved partly through better enforcement of price regulation, especially in cases where intermediate paraffin traders add mark-ups resulting in end prices in excess of the regulated 33% above wholesale prices. Lower prices can be achieved, for both paraffin and gas, by bringing bulk supplies closer to domestic purchasers, through the establishment of oil company depots and bulk-buying cooperatives in townships and rural areas. Tighter enforcement of regulated prices can reduce excessive mark-ups. This can result in real savings for consumers of 30 to 40% of their paraffin budgets.

Regarding the problem of paraffin poisoning, it is proposed that government support be provided to current research efforts (managed by the Medical Research Council) to develop child-resistant paraffin lids for commonly-used containers. In addition to reducing the risks of poisoning, such a programme can have direct employment benefits.

Energy efficiency and demand-side management programmes

In spite of the cost-effectiveness of investments in demand-side management and energy efficiency, South Africa has until recently, neglected this area almost entirely. Concerns have, however, recently been raised about the increasing influence of household demand on Eskom's electricity generation system, since households typically have demand profiles with high morning and evening peaks relative to their base loads. This kind of demand profile necessitates more

expensive generation capacity, and its increasing effect on the national system may bring forward the time when new investment in generation capacity is required.

Relatively simple energy efficiency strategies, however, can have major economic and environmental benefits at many levels. Some of these strategies, in which mutually-beneficial partnerships can be forged between households, suppliers and the state, include:

- adoption of a 'least-cost' approach to energy planning and investment alternatives;
- improved thermal performance, both through upgrading of existing dwelling structures, and particularly through appropriate design of new housing developments which are likely to take place in coming years;
- promotion of energy-efficient appliances such as compact fluorescent light bulbs and solar water heaters;
- labelling of appliances with information about their energy consumption characteristics and life-cycle costs;
- implementation of time-of-use tariffs to encourage more efficient use of electricity systems.

Most strategies in the area of demand-side management are more cost-effective than conventional alternatives such as investment in additional generation capacity, but frequently face a constraint of having high initial capital costs which are then recovered through lower operating expenses. This means that, particularly for the poor, financing arrangements are required to ensure that they share in the benefits of such programmes.

Conclusion

Real progress can be achieved in the near future in widening access to adequate energy services for the urban and rural poor. Moreover, many of the policy proposals will have positive employment effects and favourable economic spin-offs. The household energy sector is thus one in which a democratic government will be able to deliver visibly and rapidly, with all the favourable implications this has for social equity, economic growth and political stability.

4.3 Restructuring the electricity sector

The electricity supply industry (ESI) can be differentiated according to its three main operational functions: generation, transmission and distribution. All of these functions are, in turn, subject to some kind of regulatory system. This section sets out some of the major policy issues related to each of these areas.

Electricity generation and transmission

Apart from a few power stations owned by local authorities, electricity generation in South Africa is the preserve of Eskom, which is the fourth largest utility in the world, based on sales in GWh and on total generation capacity (Eskom 1993:6). Over-optimistic estimates of economic growth during the 1980s, has led to massive over-capacity on the system, with over 6 000 MW of plant

having been mothballed. With Eskom committed to the construction of another 4 000 MW during the next 7 years, and with possibilities for increasing supply from Mozambique's Cahora Bassa hydro-electric scheme in the near future and the Southern African region in the longer-term, it is clear that no new power stations will have to be built until at least the turn of the century, and depending on economic growth rates, possibly well beyond 2000.

Nonetheless, the long planning horizon required for electricity generation investments, means that major decisions will have to be made in the next few years. There are at least five major bulk generation options available in the longer-term:

- Firstly, additional *coal-fired power stations* could be built, as South Africa has large coal reserves, and a successful track record in the design, construction and operation of large coal power stations. However, this option is costly, and carries large environmental costs.
- The *nuclear option* has not yet been officially abandoned by Eskom, which is still active in the selection and purchase of possible sites for additional nuclear power stations. However, this option is unlikely to materialise in the foreseeable future, as current cost structures make nuclear electricity far more expensive than alternatives. In addition, numerous environmental concerns have not yet been resolved.
- The sub-continent has massive *hydro-electric* potential, some of which has already been partially developed (such as Cahora Bassa and the Lesotho Highlands scheme). The Inga site on the Zaire River is reported to have the potential to generate over 40 000 MW (more than Eskom's current total capacity), *without* requiring any major dam construction. This is an option which has been opened up by the political transition in South Africa, but which also brings the energy security question back into sharp focus.
- A recent possibility is the utilisation of *natural gas* from Mozambique's Pande field and Namibia's Kudu field in relatively new combined cycle technologies. These technologies operate at higher efficiencies than coal plants and have far smaller environmental impacts including carbon dioxide emissions. The technological capacity for this option would, however, have to be built up or acquired from scratch in the South African industry.
- Although not strictly a *generation* option, *demand-side management* (DSM) can achieve enormous gains which will reduce the need for new investment in generation capacity. At present, the system's over-capacity acts as a disincentive for DSM, but numerous factors point towards this as an essential investment route. Efficiency measures are the most cost-effective method of reducing total environmental impact (from local air pollution to global climate change). Further, DSM can delay the need to build additional power stations by several years, and perhaps most significantly, DSM can improve the peaky load profile associated with domestic electricity consumption, with major implications for cost saving.

With the above options available, it is possible that future bulk electricity demands might be met in ways which will not require the construction of any new power stations in South Africa. In the short-term, it is suggested that electricity generation and transmission functions remain vertically integrated within Eskom. In the longer term, or when new generation plant is required, consideration could be given to separating generation and transmission and

facilitating entry by independent generators. The distribution sector, however, requires immediate and fundamental restructuring.

The electricity distribution industry

The current structure of the South African electricity distribution industry (EDI) acts as a major constraint on rapid and widespread electrification of urban and rural households. The historical and currently prevailing system of local government allocates the legal responsibility for electricity distribution to local authorities, which, given the highly fragmented nature of local government in South Africa, means that there are over 600 local authorities with legal supply rights. Of these, about 430 have exercised their rights (DMEA 1992:14). The racial differentiation of local government means that black local authorities (BLAs), in addition to their political illegitimacy, generally lack the technical, financial and institutional capacity to electrify new areas or service existing customers in their jurisdictions. White local authorities (WLAs) on the other hand, usually have well-staffed electricity departments, large capital development funds, access to additional external finance, and profitable returns from well-diversified residential and commercial customers bases (Steyn 1992:5).

The electrification which is currently taking place in South Africa is centred largely in urban centres, and is being undertaken by only a handful of the larger distributors. Of the local authorities, Durban appears to be making most progress, with about 2000 new connections per month (Whitehead 1993). Until 1992, Durban's electricity department was the largest distributor in the country (DMEA 1992:16), but in 1992 Eskom became the largest direct retailer, as a result of its own electrification programme, and the take-over of a number of areas from local authorities (Eskom 1993:24). Given the lack of capacity among the bulk of electricity distributors, most of whom have a small number of households in their areas of supply, it is unlikely that electrification by local authorities will increase significantly under the present institutional arrangement.

It is widely agreed that the EDI must be restructured if it is to deliver electricity to the majority of the country's people. Several important processes are already under way in this regard. On the one hand, a trend appears to be that Eskom is negotiating the take-over of the supply rights of larger local authorities, such as Khayelitsha and Soweto, and that it will make new connections itself, or manage existing customers, as the case may be. Another trend is that adjacent black and white local authorities are merging as local government is restructured along non-racial lines. Whilst these arrangements are likely to change as clarity emerges over the future structure of local government and the EDI in a democratic dispensation, in the meantime, electrification is at least proceeding on this basis.

The future structure of the EDI will be determined by fundamental debates taking place at a number of levels and in several forums. National constitutional negotiations, and particularly the issue of regional powers, as well as the writing of the new constitution in the next five years, will establish the powers and functions of national, regional and local tiers of government. Also of direct relevance to the EDI's future, are debates being conducted in the

relevant working groups of the National Electrification Forum and the Local Government Negotiating Forum.

Certain principles are informing the future structure of the EDI. In the first instance, it will be necessary to ensure that all distributors have a reasonable mix of residential and commercial electricity consumers in their supply areas. With a predominantly residential customer base, operating costs will be higher because of the undiversified nature of electricity demand which results in a worse load factor on the system. Consequently, it is essential that distributors be structured so that predominantly residential areas (such as townships and rural areas) are included in the same supply areas as nearby commercial bases. Alternatively, if electricity distribution responsibility remains at a more localised level, such as at local government level, mechanisms need to be established to allow the transfer of resources from better-off areas to poorer areas where costs of supply would otherwise have been unaffordable. This paper will not describe the possible models for the future structure of the EDI, although it is worth noting that whichever model is ultimately implemented, it is necessary to have an arrangement which allows for redistributive transfers between areas.

A range of other principles will guide the restructuring of the EDI in the long-term, such as the need to ensure the financial viability of the EDI as a whole, to rationalise electricity tariffs into a simpler and more equitable system, and to ensure that electricity and other services are appropriately prioritised from end-user and national perspectives to avoid duplication of infrastructures or unproductive competition for resources.

Restructuring will also be influenced by another crucial aspect of the future ESI: the nature and form of governance and regulation.

Governance and regulation of the ESI

The current system of governance over the EDI involves a maze of local authorities, the Provincial Administrators, the Electricity Control Board, Eskom's Electricity Council and the Minister for Public Enterprises (Steyn 1993:10). It is widely recognised within the local electricity industry, as well as from international experience, that there is a need for a governance system which puts at arms-length the day-to-day operational management of the industry from policy formulation.

A first step will be to separate the roles of electricity policy formulation from the day-to-day management of the undertakings. Electricity policy formulation should be situated within government and involve national and regional government, and stakeholders. The policy formulation process should include, inter alia, national electrification planning.

Secondly, electricity undertakings should be removed from local government and located within public corporations. The management boards of these utilities should be appointed and rewarded on the basis of negotiated performance contracts that embody electricity policy as determined by government. These contract plans should detail utility performance over four to five years and should specify effective performance indicators to enable performance evaluation on an annual basis.

Thirdly, a national regulator is required to mediate the contract plan relationship between government and stakeholders on the one side, and the utility on the other. The regulator should translate government policy into a contract plan framework, to facilitate the negotiation process, and it should scrutinise utility submissions during performance reviews. The regulator should also act as an impartial ombudsperson to resolve disagreements between consumers and the utility.

4.4 Regulation in the petroleum industry

As in most other countries, the petroleum sector has major impacts on the national economy, and because of its significance to the economy, the sector is also subject to a large degree of state involvement. In South Africa, however, this involvement is fairly unique, insofar as a complex regulatory framework has evolved primarily in order to protect the large energy-security investments, Sasol and Mossgas. The issue of the regulatory framework in the petroleum sector is thus a key area for policy, and will continue to be so for some years, given the complexity and significance of the industry.

Political attention has recently been focused on industry regulation, especially because of pressure from large retailers and motorists who have objected to the regulatory system which has prevented the discounting of pump prices. The government undertook to investigate the regulatory system, and decided in May 1993 to retain most aspects of the system intact with the exception of secrecy provisions which were relaxed (Bartlett 1993). A national Liquid Fuels Task Force has been established within the National Economic Forum. Some possible policy directions are set out below as a contribution to this process.

Adjustments to the regulatory framework cannot easily be made in a piecemeal manner, because of the interconnectedness of the whole system. Any regulatory changes must be motivated by clear evidence that they will result in a more efficient industry with lower prices to consumers and that there will not be disruptions in supply or significant losses in jobs or foreign exchange savings.

Disclosure of relevant information and data

The lifting of secrecy provisions must be accompanied by full disclosure of the information which has been classified until now. This is essential if, for example, informed debate is to occur around the question of synfuel tariff protection. The foreign oil companies may also be wise to publish financial statements to counter current local perceptions that their profit margins are excessive.

IBLC, wholesale and retail price control

At the heart of the current regulatory system is retail price maintenance on petrol sales. The state determines retail and wholesale (MPAR) margins and the in-bond-landed cost (IBLC) which is the price paid to refiners.

Any proposals for de-regulation need to guarantee that prices would fall, levels of service would not drop, that employment would not be threatened and that oil companies would continue to invest locally. The current refinery and wholesale margins have been adequate to provide the industry with sufficiently low risk to undertake large investments in refining and distribution. These margins should continue to be monitored so as to maintain this stability without becoming excessive. Oil company profit remittances and possible transfer pricing should be monitored.

It may be feasible to allow discounting of retail prices, as this could result in a decrease in the fuel costs of consumers. However, *complete deregulation* may have negative effects which outweigh the positive ones. Firstly, complete deregulation of retail prices may result in loss-leading by large supermarkets or chains, with the result that smaller service stations would be unable to compete and would be squeezed out. This would lead to concentration of the retail sector into fewer, larger concerns, who could afford to cut margins in exchange for higher volumes. Such a trend would result in the closure of many urban dealers. In rural areas, on the other hand, lower volumes would mean that markups would be higher, with the effect that rural consumers would be subsidising urban consumers: generally a regressive situation. Finally, if pressure is on retailers to reduce their prices, they will seek to cut labour and other costs, with self-service possibly replacing full service (unless otherwise prevented).

Consequently, it is possible that retailers may be permitted to price their fuel within a reasonable range, which would prevent loss leading by high volume dealers, and excessively high prices in, for example, rural areas. This could result in savings for motorists, while maintaining sufficient margins for small businesses to survive. Furthermore, the aspect of the Ratplan which stipulates that retailers maintain full service should be maintained, otherwise it is probable that a large portion of the 65 000 people currently employed in service stations would become redundant.

Consideration needs to given to making IBLC more reflective of lowest possible product prices. One option is the use of an International Parity Price (IPP) which is an average refinery gate price at agreed international refineries.

Alternatively, consideration might be given to substituting the current regulation of petroleum prices through the IBLC, wholesale and retail margins, with a simple import tariff (if this is necessary for the financial viability of synfuels produced by Sasol - although it probably is not). The social costs of de-regulation, such as unemployment and concentration of ownership and numbers of service stations, could be countered by legislation requiring full service and prohibition of loss-leading on petrol sales by supermarkets. Lower petrol prices would not be certain, particularly given the history of collaboration between oil companies in South Africa.

Phased reduction of tariff protection payable to synfuel industry

Uncertainty exists over the extent to which Sasol's synfuel production currently depends on tariff protection. In the first place, secrecy provisions have prevented disclosure of such information, and secondly, the way Sasol is

structured, means that it is difficult to separate the results of its synfuel production from those of its petrochemical and other operations. The absence of financial and reporting autonomy means that the possibility of cross-subsidisation and transfer pricing cannot be refuted.

Estimates by industry analysts suggest that Sasol's synfuel process is commercially viable at prevailing oil prices and that it achieves an operating profit of 3 cents per litre, based on received IBLC prices (EHR 1993:24-25). In 1992, tariff protection amounted to about 10.8 cents per litre of Sasol's output (Bartlett 1993), or 3.4 cents per litre of all petrol sold. If this analysis of Sasol's operations is correct, then tariff protection is no longer necessary to maintain the viability of Sasol's synfuel production, and represents a public contribution to Sasol's private profits. This should be investigated as a matter of urgency, and if confirmed, then the tariff protection could be reduced or phased out. This might take the form of a reduction in tariffs based on a lowering of the guaranteed floor price to Sasol from its current $23 per barrel to prevailing international oil prices. The maintenance of a guaranteed minimum would be important to maintain the stability of the synfuel industry and to reduce risk to acceptable levels. One complicating factor is that any adjustment to the current regulatory framework would mean an adjustment of the terms of repayment of CEF's loan to Sasol (due to be redeemed in 1996). Reduction of tariffs would have significant effects throughout the industry, and would require other changes to the regulatory framework. The proposals set out below would thus require consideration.

Restructuring of Sasol

The current structure of Sasol, which does not maintain autonomy between its synfuel operations and its petrochemical and other commercial operations, lends itself to the possibility for transfer pricing which will provide it with an unfair advantage in relation to its non-petroleum competitors. It has been claimed that the protection and allowances granted to its synfuel activities, lowers its risk and exposure in this sector, thereby giving it the opportunity to invest in higher-risk ventures than its competitors are able to, thus achieving a higher market share than would have occurred had the 'playing fields been level'. Consequently, it is proposed that Sasol's synfuel operations be conducted separately from the remainder of its operations and that Natref (the inland refinery in which Sasol and Total have a share) also be ring-fenced.

Marketing of Sasol products

If tariff protection is to phased out, then Sasol will have to compete for a share of the market, along with the other oil companies. This will necessitate the phasing out of the 'blue pump' (Sasol's guaranteed pump on each forecourt), the marketing of Sasol's products itself, and the removal of the obligatory requirement for oil majors to market all of Sasol's production. In terms of current agreements, there is a five year notice period from both sides, for any change to the obligatory marketing by oil majors of synfuels, unless this agreement is breached by either side. Changes to the regulatory framework as suggested here, would effectively terminate this agreement. This proposal need not imply that Sasol could not enter into arrangements with the oil majors to

market each others' products in geographically convenient areas, as presently happens. It is vital, however, for foreign exchange reasons, that Sasol produce at full capacity and that all its fuel is marketed. The state would need to retain the prerogative to force the oil companies to market Sasol's products if necessary.

Policy on Mossgas

A recent report by the Auditor-General shows that Mossgas is hopelessly uneconomic. It is accepted that Mossgas will be unable to pay back the R11 billion capital injection from the Central Energy Fund, and will probably not be able to contribute to the roughly R2 billion in foreign loans for which the CEF is still responsible. The analysis shows that even relieved of these ordinary (but huge) obligations, Mossgas will struggle to be cash-positive. A further R0.5 billion is required for gas-well completions and operating costs in respect of 'FA field' compressions and satellite fields. The economic viability of the project is highly sensitive to a number of variables, not least among them the oil price. The life-time of the gas field is much shorter than anticipated and the cost of developing the further 'EM field' probably too high in relation to expected earnings.

An investigation should therefore be undertaken of alternative, and potentially more viable production streams from Mossgas.

An independent financial analysis should be undertaken every 6 months and if the project is projected to be cash-negative over its remaining life (to 2004), then a decision should be taken to close it down. CEF (Petrostate) should remain responsible for managing Mossgas.

Removal of synlevy

The corollary of the removal of tariff protection and the entry of Sasol into the market on an equal footing, is that the synlevy, which is currently paid to the petroleum companies to compensate them for the underutilisation of their refineries due to the obligatory purchase and marketing of synfuel production, would have to be removed. There is a strong argument that this should be removed now as all the refineries have embarked upon capacity expansions.

Review of inland transport allowance

The payment of this allowance to inland refiners appears to provide them with an additional subsidy to the extent that the allowance exceeds actual transport costs. The allowance is currently based on Petronet's pipeline tariffs, which are reported to be excessive. The basis of the allowance should therefore be reviewed and revised, so as to eliminate what currently amounts to an additional 'hidden subsidy'.

Government fuel taxes

South African fuel taxes are relatively low in comparison to developed countries (EDRC 1993:64), and scope exists for changes in this tax. One possibility which may merit attention, is to shift the balance between the pump prices for petrol and diesel in favour of the latter, by means of the fuel levy. Generally, diesel is an input into productive activity (trucks, machines, public transport), whereas petrol is consumed mainly by private motor vehicles (that is, mainly for private transport and leisure travel). If diesel were to enjoy a greater price advantage, it may facilitate structural changes which are desirable from an efficiency and equity point of view. Information about their price elasticities will provide insights into the likely responses to price changes, although clearly, structural shifts of the kind referred to here require far more pervasive changes than can be effected by adjusting the fuel levy. From the refineries' perspective, such a shift would be desirable, because of the excess supply of diesel and shortage of petrol, based on the barrel composition from local refineries.

4.5 Removal of state expenditure on nuclear fuels

As shown in Figure 5, the AEC production costs for conversion, enrichment and fuel fabrication are between 2 and 4 times current spot prices, without even taking into account capital expenditure and depreciation. It is clear that the AEC has charged well above market rates to local customers - notably Eskom, nevertheless its production costs remain more than double these inflated prices (Auf der Heyde 1993).

If the main motivation for the AEC's existence has been to support nuclear electricity generation, then its output has been singularly disappointing - fuel for 4 of the 9 years of Koeberg's operation to date, and then mainly for only one of its two reactors, and this at a cost of many billions of rand of state expenditure. It would have been a great deal cheaper for both Eskom and the country if all of Koeberg's fuel was supplied from abroad.

It has been argued that South Africa faced an international nuclear fuel embargo and that it was essential to develop an indigenous fuel cycle - but Eskom has always managed to obtain nuclear fuel from abroad (just as South Africa continued to obtain oil despite an UN oil embargo). In any case, Eskom has had significant excess generating capacity and the closure of Koeberg would not have prejudiced South Africa's energy security.

Of course, the AEC has produced more than simply 4 years of fuel for one of Koeberg's reactors. The development of scientific and technological skills is not easily valued. Some converted and enriched uranium has been exported. It also produced material for at least 6 atomic bombs, although what practical, politically-sane use these could have had is beyond comprehension. Some of the AEC's non-nuclear fuel technologies are now beginning to generate income - but, as a whole, they are still making a loss, even ignoring the large amounts that are being spent on technology and business development.

The AEC's best budget for the next 5 years, envisages continued large state grants - totalling over R1 billion and a further three-quarter billion rand in interest and loan redemption. The AEC's enrichment plant will close during this period and Eskom will cease buying enriched uranium from the AEC

Policy scenarios

The AEC assumes that the next nuclear power plant will have to be commissioned by Eskom sometime in the first decade of the next century and that many more will be built in ensuing years. They argue that it is essential for South Africa to maintain a nuclear technological capability in order to support an indigenous nuclear fuel chain including conversion, enrichment, fuel fabrication and disposal. They argue, further, that their technological competencies are potentially wealth generating. Closure of the AEC, they argue, would result in the loss of these skills and will make it virtually impossible for South Africa to re-start a local nuclear fuels industry in the future.

Eskom will have to commission new generating capacity (or effect dramatic power savings through demand side management) sometime in the first decade of the next century. At this stage, Eskom's first preference is not nuclear power, as generating costs are still very much higher than alternatives. The most likely options are a further coal-fired plant (with adequate pollution control), hydro-electricity imports from the region, or a natural gas fired power station. The latter two options imply much lower greenhouse gas emissions. There is no certainty as to when Eskom would next commission a nuclear plant.

It would thus be a minimum of two decades, and probably more, before Eskom *might* want to purchase nuclear fuel for further reactors. Even in this scenario, it is also far from clear that Eskom would want to purchase fuel from the AEC. Indeed, Eskom has now made it clear that it will not continue to purchase fuel from the AEC's Z-Plant which will be forced to shut down by 1996 and possibly sooner. The AEC's hope for remaining in the enriched uranium business rests with the experimental MLIS enrichment process whose commercial viability remains unproven. The question arises as to whether this is a propitious time to be investing in new enrichment technology.

The AEC predicts that international markets for enriched uranium will pick up after 1995 when new nuclear power plants will be commissioned. An international review indicates that relatively few new nuclear power stations are being built or ordered and, given the long design and construction lead-in times for new plants, it is thus unlikely that demand for enriched uranium will increase dramatically in the next two decades. It also remains the case that there are substantial stockpiles and spare production capacity for uranium enrichment following the dramatic fall in nuclear weapons production and the dismantling of existing weapons. The USA has a contract with Russia for the deconcentration of Highly Enriched Uranium. The entry of Russia and the other CIS states into international markets will increase supply and depress spot markets further. Most analysts agree that uranium conversion, enrichment and fuel fabrication for the next fifteen to twenty years will outstrip demand by as much as 70 or 80% (Auf der Heyde 1993).

Twenty years is a long time to maintain a nuclear fuels production capacity in the hope that new nuclear power plants might be built and demand for fuel will increase.

The AEC may be correct in suggesting that closure of the AEC will severely prejudice the possibility of re-creating an indigenous nuclear fuel production industry. However, the track record of the past must be considered. The AEC has been unable to produce a competitive, commercially viable nuclear industry despite massive, almost unrestricted, investments. Considering also the uncertainties of future demand, a prudent decision would be to cut losses now. No further state subsidies should be provided for nuclear fuel production and supporting services and the conversion, enrichment and fabrication plants will have to be closed down if they cannot show a trading profit or if commercial partners are not found.

A decision to unravel the substantial technological capacity that exists within the AEC cannot be taken lightly - an indigenous nuclear fuels industry cannot easily be recreated and many highly skilled personnel will lose their employment. However, a sober assessment of international markets, indicates that the AEC is unlikely to secure sufficient income to cover its operating costs. Viable technological processes and products should be privatised and remaining technological competencies should be transferred to the CSIR and other research institutions. Applications for state support for technology development should be treated on merit within the general science and technology budget.

The activities of the Chamber of Mines NUFCOR calcining plant will be relatively unaffected by these policy interventions and they should be encouraged to concentrate on developing their export market for uranium oxides.

Overall, the inescapable conclusion must be that the costs of the AEC have hugely outweighed the benefits and future state support for the AEC has to be reconsidered.

4.6 Fine-tuning the coal sector

The coal sector currently operates relatively efficiently, and competes effectively in international markets. Two key factors affect the local demand for coal: consumption by Eskom and by Sasol. Both of these factors are dependent, in the first place, on levels of economic activity throughout the economy. Sasol's demand for coal may also be influenced by energy policy decisions, although its demand is not likely to decrease as a result of the policies proposed in this paper. At the same time, however, it is unlikely that further growth will stem from Sasol's synfuel demand, as it is not likely to invest further in synthetic fuel production. Similarly, Eskom's demand for coal may grow in the medium-term and then stabilise once current capacity is fully utilised, especially if future generation expansion utilises options other than domestic coal.

The coal sector was recently de-regulated, and it is not proposed that the sector should be re-regulated. However, some intervention may be required around

household consumption, particularly to facilitate the replacement of bituminous coal by cleaner options such as low-smoke coal. This might be achieved by levying a tax on the price of coal, upstream of retailers and merchants, and applying this revenue to cross-subsidise the price of low-smoke coal. As noted in section 4.2, the amount of the subsidy required for domestic consumption, which is around 3 million tons per annum, would be relatively small.

The coal distribution system in townships (mainly on the PWV) is fairly diverse and informal, and thus not particularly conducive to price regulation of this kind. It may be more effective therefore, to intervene at the wholesale or pithead points in the supply chain. A system might be designed which, while taxing conventional coal sales destined for households, offers credits or rebates to suppliers for their sales of low-smoke coal, thus providing them with incentives to market and distribute more of the latter. This form of price regulation could be relatively self-regulating, with administrative responsibility resting with the DMEA.

4.7 Improving energy efficiency

It was noted in the introduction to this paper that South Africa has a very high energy intensity, as measured by the amount of energy consumed per unit of GDP. This is a result primarily of the high dependence on coal in the local economy, both for electricity generation by Eskom and synthetic fuel production by Sasol and Mossgas. The latter processes are regarded as being inherently energy inefficient, so that the economy is structurally locked into the status of 'energy inefficient' for as long as those processes continue to dominate the energy sector. This notwithstanding, it is possible that major *energy efficiency gains* can be achieved in the South African economy, and at investment costs which make this option highly cost-effective.

A principal mechanism to improve the efficiency of energy consumption patterns, is in the *price* of energy. Current pricing practices, especially in the electricity sector do not present consumers with any significant incentive to be more efficient in utilising this input. In fact, South Africa's electricity prices are among the lowest in the world, which on the one hand, represents a major comparative advantage for South African industries, but on the other hand, also reduces incentives to economise on energy use. These low prices, while partly attributable to abundant supplies of coal, also fail to fully reflect all environmental costs associated with the production and use of electricity. In other words, the failure of electricity prices to account for negative environmental externalities represents an inefficiency in the system which may ultimately result in larger environmental costs. This is an area in which difficult trade-offs may have to be made: between shorter term goals of international competitiveness and economic growth, and longer term goals of environmental sustainability. This nexus needs to be informed by thorough policy analysis and research.

Two policy philosophies offer themselves with respect to improving efficiency of energy use: firstly, direct regulation and prescription, and secondly, using market-related mechanisms. The former approach involves more direct control over technological processes used by certain industries, in which, for example, operating licences are granted only if processes conform to environmental standards. The latter approach utilises such mechanisms as tradeable emission

permits, the price mechanism, taxes and subsidies related to energy use patterns. Considerable debate surrounds the relative merits and demerits of both approaches. It is suggested that in a developing country context, such as South Africa's, a minimum level of regulation is required to enforce basic standards, and that market-related approaches to enhancing efficiency may be appropriate either at a later stage, or in very specific cases where markets are sufficiently mature for such mechanisms to operate as they should in theory. In other words, a mixture of the two approaches may be most appropriate, with greater use being made of established regulatory mechanisms than sophisticated market mechanisms.

The importance of energy efficiency measures can be emphasised by noting that they are generally the first route taken by industrial concerns in response to pressures from government and environmental groups to mitigate their environmental impacts. Likewise, efficiency investments are seen by electricity utilities in many countries as the most cost-effective means to reduce or minimise their emissions of greenhouse gases. These gains in efficiency generally yield favourable returns for utilities and commercial concerns which make the necessary initial investments. In South Africa, a concerted *policy push* from government is required to give efficiency options the boost they require to make an impact on domestic consumers. In the household sector, as has already been noted, the likely impact of an ever-increasing number of consumers on the national generation system, is likely to present a growing incentive for Eskom to invest in demand-side management strategies. This incentive will be enhanced as soon as general economic activity (and therefore demand for energy) begins an upturn. In the interim, policy research into options for improving both household and commercial use of energy is essential.

4.8 Towards sustainability in the energy sector

This paper has proposed that the concept of sustainable development be employed as a framework for integrated energy planning, when this is understood to imply the pursuit of three objectives: economic efficiency, social equity and environmental sustainability. Most of the discussion in this paper has revolved around efficiency and equity goals. It is therefore worth making explicit some of the environmental issues.

The goal of 'environmental sustainability' must be properly contextualised if it is to have any relevance to a developing country such as South Africa. Whilst environmental issues such as enhanced global warming are pertinent to South Africa, it would be an artificial imposition of developed country concerns, if these issues came to *dominate* local energy and environment planning. More pressing environmental problems face South Africans, such as the degradation of millions of peoples' living environments through the lack of access to basic energy and other services. These environmental problems can be addressed only through developmental interventions, many of which entail a natural convergence of equity, efficiency and environmental objectives. It should not be assumed, therefore, that these goals are always in opposition to each other.

The apparent conflict between legitimate long-term concerns around the sustainability of the energy-economy, and the more pressing environmental problems experienced by people, can be accommodated in the goal of 'environmental sustainability', by identifying two time frames. In the first place, the most immediate problems are usually a result of inequality, poverty and underdevelopment. Examples include the high levels of indoor and outdoor air pollution to which coal- and wood-burning households are exposed, accidental paraffin poisoning, and denudation of natural woodland in rural areas. Most of these impact directly (and adversely) on the quality of life of the poor. In many respects, these environmental problems are also development problems. This category of environmental problems must be addressed as a first step on the path to sustainability. The second category of environmental concerns, which can be addressed in parallel to the first, entail long-term planning for a transition to true sustainability. For instance, policy must include support for research on ways of facilitating a gradual substitution of renewable technologies for the current dependence on coal; also policy must identify least-cost options for the mitigation, reduction and prevention of the impacts of global warming.

Consequently, it is proposed that energy policy should embrace the concept of a sustainable energy economy, and that planning should begin for a transition to sustainability. As a matter of urgency, however, policy must address the more immediate environmental problems which impact directly upon the lives of millions of South Africans. This necessitates support for systematic research which can identify areas of most significant health and environmental risks.

5 Conclusion

This paper provides a comprehensive analysis of the South African energy sector, in the context of a shift in energy policy away from the energy security concerns of the apartheid government, to more universal goals of economic efficiency, social equity and environmental sustainability.

The paper begins by describing the existing energy filiere and the institutions which operate within the sector. Some of the major macro-economic impacts of energy sub-sectors are mapped out. The petroleum sector is the most significant in terms of past state involvement and recurrent macro-economic impacts, particularly the foreign exchange savings attributable to synthetic fuel production by Sasol, and to local refining of crude oil. The electricity supply industry has demanded large investment resources and has contributed significantly to foreign debt. The coal sector is an important contributor to export revenue. The energy sector also has major environmental impacts, and some of these are described briefly, particularly the pollution exposures of people who rely on wood and coal for their energy needs.

A new system of governance is proposed for the energy sector which will result in better co-ordination, stake-holder representation, integrated energy planning and professional regulation. The paper then discusses important policy options in each of the energy sub-sectors. Of the three goals, efficiency, equity and sustainability, the primary objective of a post-apartheid government must be to improve equity. In the immediate term, policy should therefore include interventions in the household energy sector around electrification, low-smoke coal development, afforestation and other strategies. In order to achieve the targets of a national electrification programme, it is important that the electricity distribution industry be restructured along more effective and equitable lines. An independent regulatory agency in the electricity industry is also proposed, to ensure compliance with energy policy.

Policy options for the petroleum industry are presented, which have the aim of reducing unnecessary subsidies for synfuel production, and to attempt to level the playing fields for all oil companies, while maintaining the industry's employment levels and the viability of small businesses. Analysis of the nuclear fuel industry leaves little conclusion other than that state support must be phased out in the next few years, and that the Atomic Energy Corporation will have to achieve its vision of commercial viability if it is to survive. No major changes in the coal industry are proposed, although some kind of regulation may be required to facilitate the development and substitution of low-smoke coal for conventional, polluting coal in households. With regard to the efficiency or otherwise of energy production and consumption, the tension between economic competitiveness (low energy prices) and environmental sustainability was noted, with a suggestion for increased policy research into appropriate strategies to improve the efficiency of the economy's energy use. Finally, the paper makes explicit some of the implications of the goal of 'environmental sustainability' for energy policy and planning.

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