Briefing paper:
The South African Energy Sector

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1. Environmental implications of energy production and use in the economy (including nuclear energy)

1.1 Environmental and social impacts of energy use by the industrial and commercial sectors

Among the dominant characteristics of the South African economy is the relative abundance of low cost energy. This is undoubtedly one of the economy’s key comparative advantages, and is likely to form the basis of growth in the minerals beneficiation and other energy-intensive industries. However, the abundance of cheap energy also has several unfavourable aspects:

- the low cost of energy is attributable, at least in part, to the absence of strict environmental controls on the production of energy and especially electricity, and to low labour costs in the earlier stages of the industry’s development;
- the relative cheapness and abundance of energy provides commercial users with little incentive to economise on its use, with the result that large inefficiencies exist among users;
- the heavy reliance on coal for over 80% of the country’s primary energy means that environmental impacts are generally more severe than they would have been if the economy was based on other energy sources - for instance, South Africa’s per capita emissions of carbon dioxide are well above global averages.

Moreover, the country’s energy mix is based primarily on non-renewable resources. Apart from coal-based electricity generation, South Africa also has a nuclear industry which was built up during the apartheid era ostensibly to increase the country’s self-sufficiency in the face of international sanctions against apartheid, but also to develop a nuclear capability for military purposes. The nuclear industry has benefited from enormous amounts of public finance over several decades; in spite of this, it is yet to achieve commercial viability. The low-level wastes produced by the industry are disposed of at the Vaalputs waste disposal site, operated by the Atomic Energy Corporation (AEC), in the northern Cape. High-level wastes, on the other hand, are returned to France for
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reprocessing, in accordance with an agreement with the French-led consortium which built Koeberg.

Environmental controls over electricity generation are aimed mainly at removing particulate matter from emissions, which is especially important in view of the high ash content of South African coal, and at using tall chimney stacks to emit flue gases into the upper atmosphere rather than close to ground level. At present, none of Eskom’s power stations are fitted with technologies to remove sulphur and nitrogen oxides from emissions. There is much popular concern over the effects of sulphur emissions on the acidity of precipitation, although no serious environmental damage has yet been attributed to these emissions. This is likely to be an area of ongoing investigation.

Another major sector of the energy-economy is the petroleum sector, which includes a large synthetic fuel industry (Sasol and Mossgas). As in the case of the nuclear industry, massive state support was directed to the establishment of an indigenous petroleum industry to reduce dependence on oil imports, based on an oil-from-coal process (Sasol) and an oil-from-gas process (Mossgas). Both of these form part of a highly regulated petroleum industry in which several local and multinational petroleum companies operate oil refineries.

1.2 Institutions, policies, legislation and standards

A large number of institutions are involved in the governance of the energy sector, with the Department of Mineral and Energy Affairs (DMEA) has primary responsibility for administering the relevant statutes:

- Liquid Fuels 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,

These acts collectively form the bulk of the legal framework within which the energy sector is governed. Several of these acts have environmental provisions, for example, those in the Nuclear
Energy Act which relate to the disposal of waste and inspection of nuclear facilities. Another relevant statute is the Atmospheric Pollution Prevention Act (No 45 of 1965) which governs the emission of pollutants from industries and other sources, although this act is administered by the Department of National Health and Population Development, rather than institutions in the energy sector.

Within the petroleum sector, institutions in the public sector include the Central Energy Fund, which is financed by levies on petroleum products and which financed much of the initial costs of Sasol and Mossgas; the Equalisation Fund which finances short-term deficits when the domestic fuel price is lower than international oil prices; the Strategic Fuel Fund which was responsible for purchasing and stockpiling fuel; and Soekor which is an oil exploration corporation and which discovered the limited gas reserves on which Mossgas was based.

The electricity sector is characterised by a highly fragmented institutional structure with over 400 distributors including racially-based local authorities. Governance of the industry is generally accepted to be ineffective, and incapable of ensuring that an accelerated electrification programme is implemented.

1.3 Global trends in the sector
The South African energy sector is likely to come under increasing international scrutiny, particularly as the country re-engages with foreign trading partners after the years of trade and financial sanctions. The stricter environmental controls of its main trading partners, particularly those in the European Community, are likely to place South African exporters under pressure to conform to international standards and conventions. The energy sector, as one of the main upstream inputs into minerals and related exporters, is therefore likely to be subject to these pressures. In particular, international concerns over global warming are likely to play a growing role in South Africa, especially in view of the large role of coal in the economy. While coal is likely to remain the dominant source of energy in South Africa for many years, it is also likely that international trends away from coal to gas and other cleaner sources of energy will influence future investment decisions in the local economy.
Another global trend which has an influence locally, is the *downturn* in the international *nuclear* industry. The experience of many countries has been that operating costs as well as decommissioning costs for nuclear plants nearing the end of their useful lives, are much higher than initially anticipated. Consequently, investment in new nuclear capacity has declined globally, except for countries like Japan and Korea which have ambitious nuclear programmes, and this will also influence South African investment decisions in years to come when the limits of current generation capacity are approached.

**1.4 Education**

Not applicable.

**1.5 Traditional knowledge**

Not applicable.

**1.6 Funding and priority setting**

Five areas of key policy significance stand out in the energy-economy for further investigation. Firstly, a better understanding is necessary of the relationship between South Africa's *low energy prices*, and the *environmental costs* of producing and using that energy. In other words, research must establish the extent to which local energy may be under-priced because it fails to account for environmental externalities, and also what the effects on the economy would be if energy prices were to rise to reflect environmental costs or in response to more direct regulation.

Secondly, the potential for *energy efficiency gains* to be made by industrial, mining and commercial consumers of energy need to be explored, and appropriate incentive/regulatory systems put into place to increase the efficiency of energy consumption.

Thirdly, investigation is required into *future electricity generation options*: whether the next source of energy after efficiency gains have been fully exploited, will be another coal-fired power station, or whether options such as natural gas or hydroelectricity imports from the region will be exploited. In addition, the question of whether flue gas desulphurisation is justified for existing power stations
remains.

Fourthly, further research is required into the *future of the nuclear industry* in South Africa taking into account international trends (both climatological and technical) and local demands on the fiscus to support development policies.

Finally, current investigations into the *future of the petroleum sector* including the synthetic fuel industry, and its system of governance and regulation, need to be continued until satisfactory solutions are derived.

1.7 *Reference to negotiations/struggles in the area*

The petroleum sector has witnessed a high degree of conflict and tension recently, in particular over a *petrol price rise* which countered agreements reached in negotiations between the state and participants in the National Economic Forum. Currently, a task force has been established, involving the oil companies, labour, government, consumers and other stakeholders, with the purpose of addressing changes to the industry and regulatory system.

The petroleum sector is also involved in tension over the pollution emitted by refineries, with several *neighbouring communities* involved in long-standing struggles to improve their atmospheric environments. Oil companies on the whole, however, claim that environmental concerns feature prominently in their operational and investment decisions.

1.8 *Work in progress in the area*

The future of the nuclear industry is the subject of research by the ANC's Science and Technology Desk in the Department of Economics and Planning, with a *conference* being planned for February 1994 at which a number of position papers will be presented, with a view to developing a policy position on the industry.
2. Energy use by poor urban households

2.1 Environmental and social impacts of energy use by the urban poor

The highly unequal access to services in South Africa is particularly evident in the household energy sector, where only one-third of the population has access to electricity in their homes. The effect of this is that the majority of poor urban households rely on less convenient and more hazardous energy sources, such as coal, paraffin, candles, wood and gas to meet their basic energy needs. The use of some of these energy carriers results in severe environmental problems, many of which impact directly upon peoples’ health.

Apart from environmental hazards such as paraffin poisoning in infants (especially in the Western Cape and other areas where paraffin is used extensively), and burns and fires caused by domestic energy sources such as candles and paraffin, a major environmental problem occurs in the form of air pollution from coal use. At least a million households rely mainly on coal for the primary energy services: cooking, space and water heating. These households are generally located relatively close to the coalfields on the Highveld, (where transport costs are low) and experience cold winters.

Several recent studies have indicated that inhabitants of these households are exposed to very high levels of airborne pollutants as a result of widespread coal use, with particulate concentrations being the most serious. In a CSIR/MRC study of 45 children, aged 8 to 12, from Sebokeng and Lekoa in the PWV, personal 12 hour exposures to total suspended particulates (TSPs) were found to be above health guidelines in 99% of the 72 monitoring sessions, with exposures ranging from 662 μgm\(^3\) in summer to 1333 μgm\(^3\) in winter. By comparison, the USA 24 hour standard for TSP is 260 μgm\(^3\), while the World Health Organisation’s level above which adverse health effects have been observed, is 180 μgm\(^3\). The sample included children from homes using either coal, or a mixture of coal and electricity, and found little difference between the two groups during winter. Average TSP levels for coal users were 1363 μgm\(^3\) and slightly less, 1168 μgm\(^3\) for the multiple fuel users. The small difference is probably attributable to the high background pollution levels experienced during winter. During summer, however, there was a significant difference between the two groups, with average concentrations of 387 μgm\(^3\) and 620 μgm\(^3\) for electricity-and-coal users and coal users respectively.
Related to the above exposure measurements, health surveys were conducted among 430 children in Evaton/Sebokeng during winter and found that the risk of developing lower respiratory illness (LRI, defined as bronchitis, continuous coughing, chest illness, asthma or pneumonia) was 190% higher in those living in unelectrified areas than electrified areas. Likewise, in the summer health survey, coal-use was found to be the most significant predictor of respiratory illness, even more so than parental smoking and crowding in households. In other words, these findings confirm that household dependence on coal plays an important part in the development of serious respiratory ailments.

The distribution of these ailments within households is also not even, with children and women, who spend the most time indoors and in the kitchen, generally being exposed to the highest levels of pollution. The severity of the problem is highlighted by the fact that respiratory illnesses (largely pneumonia) are the second highest cause of infant mortality in South Africa (after diarrhoea-related illnesses), with mortality rates in black children up to 270 times higher than those of children from Western Europe. The fact that pollution from coal (and wood - refer to later section) contribute to increased rates of these illnesses, emphasises the importance of the issue from a public policy perspective. The current and future costs, both social and economic, of these poor environmental conditions are likely to be very significant on a national scale.

2.2 Institutions, policies, legislation and standards

The area of urban air pollution resulting from energy use has historically been neglected and under-researched by institutions in South Africa, at least as far as unelectrified households are concerned. Whereas legislation exists to enforce smokeless zones in residential areas (effectively outlawing the use of smoky coal stoves), these regulations have been applied only in white residential areas. Whilst it would be inappropriate to enforce smokeless zones in townships until people have access to alternatives better than coal, it may be possible to use existing legislation (the Atmospheric Pollution Prevention Act 45 of 1965) if and when people gain access to cleaner fuels such as electricity and low-smoke coal.

Several institutions are active in monitoring and investigating energy-related air pollution. The CSIR Environmental Sciences division, in conjunction with the Medical Research Council (MRC) have
recently undertaken a number of important studies of peoples’ personal exposures to pollution from coal (and wood) fires. This appears to be an ongoing and growing area of study for the CSIR/MRC (funded mainly by the state). In addition, Eskom’s Environmental division has operated fixed outdoor monitoring stations in Soweto and other townships over the past decade and more. This research, however, has less of a public policy focus than that of the CSIR/MRC. Many other institutions are also involved in monitoring air pollution from whatever source, such as local authority health departments, although generally resources have not been directed at the problem being discussed here: pollution from energy use by the urban poor.

2.3 Global trends in the sector
Two points are worth noting. Firstly, the levels of pollution exposure recorded in the South African studies referred to above, are consistent with those from other international studies in Africa and Asia. Moreover, the foreign studies have found severe health effects, both short-term (eg. pneumonia) and long-term (eg. cancer), which suggests that the exposed portion of the South African population may also be at risk from these long-term illnesses (in addition to the short-term effects which have already been observed).

Secondly, international experience in the monitoring and control of air pollutants in some countries has suggested that a shift in focus is appropriate from the traditional approach of using fixed outdoor monitoring stations, to measuring the exposures actually encountered by people in their immediate and changing micro-environments. This trend suggests that personal exposure monitors will provide a better indication of the risks to public health than traditional outdoor fixed monitors. This is especially relevant to the air pollution which results from energy use patterns in poor urban and rural households.

2.4 Education
Few efforts are currently being made to educate energy users about the air pollutants produced by fuels such as coal and wood. In fact, recent studies have reported interesting attitudes to smoke caused by coal and wood. In many cases, people dislike the smoke, but in others, people express a preference for smoky environments because they perceive them to be warmer, to deter insects and
to have some spiritual and cultural dimensions. Education must play an important role in informing people of the risks posed to their health by these dirty environments.

2.5 Traditional knowledge
Not applicable.

2.6 Funding and priority setting
The combination of the severity of air pollution exposures suffered by coal and wood users, and the number of people affected, demands that air pollution from fuel usage be accorded a high priority from a public policy perspective. Moreover, funding and research resources should be directed at the areas of highest risk, which includes households in coal-using urban areas, as well as wood-using rural areas (addressed later in this report).

2.7 Reference to negotiations/struggles in the area
Although the issue is of concern in a small number of communities and forms part of a development agenda for some, it is not really a politicised issue at a national scale. At a local level, environmental groups have been established and operate in several townships and appear to growing in size and number. The issue falls within the scope of (inter alia) the National Electrification Forum, and specifically its End-use and Environment Working Group, which has been investigating the issue recently.

2.8 Work in progress in the area
The monitoring and research efforts of the CSIR/MRC and Eskom have been noted in section 2.2 above. Related to the issue of air pollution, is research currently being undertaken into the viability of low-smoke coals to replace conventional polluting coal. This is being coordinated by the Department of Mineral and Energy Affairs, with a number of other institutions and organisations involved in evaluating the social, technical and economic feasibility of various prototype fuels.
3. Energy use by poor rural households

3.1 Environmental and social impacts of energy use by the rural poor

Wood is the dominant fuel for the vast majority of rural households in South Africa, and two important environmental problems result. Firstly, the combustion of wood produces very high levels of indoor air pollution, and secondly, increased pressure is brought to bear on wood supplies.

(i) Indoor air pollution from wood combustion

Recent monitoring work supports the anecdotal view that air pollution in rural homes is very serious. A study by the CSIR/MRC (related to the study of urban air pollution problems referred to earlier) of pollution exposures of children in wood-using rural households has found even higher pollution exposures than in urban areas. For instance, personal exposures to particulate matter were over 9 times the USA 24 hour health standard, while sulphur dioxide and carbon monoxide levels were also frequently in excess of US health standards.

As expected these pollution exposures are reflected in even higher rates of respiratory illness. In one recent study, the risks of developing pneumonia were five times higher for rural wood-users than for urban electricity-users.

(ii) Effects of dependence on wood supplies

The dependence on fuelwood in rural areas has both a social and natural environmental dimension. In respect of the social impacts, generally the responsibilities for collection of fuelwood, the preparation of meals, and a myriad other tasks rest with women, who then suffer additional burdens when wood supplies become scarce. Although the time spent by women collecting wood does not carry any direct cash cost, it does carry an opportunity cost which can be imputed. Using conservative estimates of an average of 5 hours per week spent collecting fuelwood, at an imputed labour cost of R2 per hour (equivalent to a cash wage of about R350 per month), and one woman collecting wood for each of about 2.9 million unelectrified rural households, then the total annual opportunity cost of fuelwood collection is in the region of R1.5 billion. This is highly significant. Similar exercises, which have been done in a more rigorous fashion in East African countries, have
found that such non-monetised activities are very significant in relation to the country’s GDP.

The effects of increasing scarcity of fuelwood is felt in many ways:

- **More time** is spent in the collection process. Numerous studies of fuelwood use in rural areas have reported that supplies of wood are becoming increasingly scarce and that the amount of time spent collecting wood has increased. Using the above calculation as a benchmark, it is apparent that any increase in the time spent collecting wood (say an average of 30 minutes extra per trip) carries large social costs - in this case equivalent to R150 million.

- As the length of wood-collecting journeys increases, so women attempt to economise on time, by collecting *larger headloads* of fuelwood in order that fewer trips can be made. This additional physical burden imposes extra stresses on women’s physical well-being; in extreme cases, it is not impossible that spinal damage may occur.

- When faced with scarce wood supplies, households frequently adopt *coping strategies* which may, for example, involve economising in domestic activities, such as improving the efficiency of fireplaces or cooking with more than one pot at a time. Sometimes, however, the responses are likely to decrease the overall welfare of the household: fewer meals may be cooked, food may be cooked for shorter times, or it may be cooked in bulk and stored until a later meal, possibly presenting health and hygiene risks.

- Where households are unable to compensate for increasing scarcity in the ways described above, they may be forced to spend more of their incomes on *commercialised fuels*, including wood being sold by vendors. In these cases, wood scarcity imposes heavy financial burdens on already impoverished households which have to pay for what was previously a (cash) free service.

The second major effect of wood scarcity is additional pressure on the *natural environment*. It is clear that, for a variety of reasons, wood resources are under increasing pressure in many areas in South Africa, and as a consequence wood *scarcity* is an increasing phenomenon. In some cases, the scale of the problem is so severe, that woodlands have become completely denuded. This is most frequently found where large-scale *resettlements* of people were engineered in terms of apartheid legislation, resulting in very high population densities without the provision of basic services (such
as water or electricity), and without local economies which could support these populations.

Whilst the popular view is that large scale deforestation of rural areas is caused by the cutting of trees for fuelwood, local and international experience suggests that this may not be the case. It is not clear from the South African data what the major driving forces behind fuelwood scarcity are. As noted, fuelwood scarcity does occur in many areas, and is increasing in many places. As to the underlying causes of these scarcities, the experience in Africa and elsewhere suggests that the clearing of agricultural land carries primary responsibility. However, it is not certain that this is the case in South Africa. Nearly all potentially arable land has already been utilised for agricultural purposes in the homeland areas to which the rural poor have historically been confined, and therefore relatively little land clearing is still occurring for agricultural purposes. This suggests that other processes such as fuelwood collection, overgrazing, the clearing of land for human settlements, and the multiplicity of other uses of wood for rural dwellers (construction material, medicinal uses and so on) may be more important contributors to deforestation in South Africa.

It must also be noted that generalisations regarding deforestation are dangerous, since in many areas, there is no fuelwood scarcity, and in some, a more serious problem is one of bush encroachment.

3.2 Institutions, policies, legislation and standards
With respect to the air pollution problem resulting from wood combustion, there is almost a complete vacuum of legislation and institutions dealing with the problem. The CSIR/MRC study referred to earlier is the first to address this issue in any detail in South Africa. As far as the woodland denudation problem is concerned, the institutional and legislative arrangements are highly complex, with severe duplication of responsibilities both between governments in South Africa and the (former) homelands, and within those governing authorities. This duplication and diffusion of responsibilities has the net result of ineffective governance.

3.3 Global trends in the sector
International experience with the 'fuelwood trap' has recently begun to inform South African conceptualisations of woodland denudation. Essentially, recent thinking rejects the simplistic view
that deforestation is caused by fuelwood collection, and instead places the wood scarcity problem in the wider context of multiple uses for wood. This has the implication that energy-oriented policies to simply increase the supply of fuelwood, are inappropriate and unlikely to succeed.

3.4 Education
Not applicable.

3.5 Traditional knowledge
One of the responses currently advocated by development agencies concerned with rural woodland denudation, is to strengthen and build upon local best practices. Such practices include traditions of restricting or prohibiting access to woodlands for periods during which they can regenerate, and preventing livestock from destroying wood resources. Many such practices are closely tied to traditional authority systems, which have become progressively eroded over time.

3.6 Funding and priority setting
The issue of air pollution from wood usage is drastically under-researched in South Africa. Given that the pollution exposures found thus far are very serious, and that such a large number of people are potentially at risk, it is essential that a better understanding be obtained of the actual risks to public health. A systematic national programme is required, which will identify the scale of this risk and prioritise areas for policy intervention.

3.7 Reference to negotiations/struggles in the area
Not applicable.

3.8 Work in progress in the area
In addition to the activities noted above, the state-funded Biomass Initiative is also investigating the fuelwood issue in order to inform policy decisions about sustainable utilisation of supplies.