Report to the
Department of Mineral and Energy Affairs

MARKET INTERVENTIONS TO PROMOTE LOW-SMOKE FUELS

by

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September 1995

Abstract

Current low-smoke fuel prototypes were assessed in terms of their cost of production and their likely distribution costs. The analysis indicated that the retail price of low-smoke fuels will be consistently higher than that of bituminous coal. Health costs of household coal use have been found to be significant and the introduction of low-smoke fuels has the potential to substantially reduce these costs. Therefore there is a need for market intervention to assist low-smoke fuels achieve price parity with bituminous coal. This will facilitate the penetration of low-smoke fuels into the household coal market.

A set of workable market interventions, which facilitate the penetration of low-smoke fuels into the household bituminous coal market, were advanced. It is recommended that a multi-faceted policy package be adopted. The different policy options that are recommended do not have significant impacts on their own, but when implemented in combination, their cumulative effects can have an impact on the market penetration of the low-smoke fuels. Five different, mutually supportive policy options are identified. These are the introduction of a pollution tax on bituminous coal, price support for low-smoke fuels, the provision of indirect tax incentives, the provision of access to finance and the introduction of legislation to support low-smoke fuels. The simultaneous implementation of other interventions, such as a publicity and education campaign and transparent government communication of its plans is considered essential for the success of these market-based interventions.

Executive summary

Introduction

In South Africa a large number of primarily urban households utilise bituminous coal to meet a substantial proportion of their energy need. For these households there are a number of reasons for using coal. Firstly, it is easily obtainable, as in most areas it is sold door to door by a well developed network of coal merchants. Secondly, coal is a versatile fuel that is used for cooking, space heating, water heating and ironing. Thirdly, coal is cheaper than alternative fuels. One major drawback, however, to the use of bituminous coal is that during combustion it emits harmful air pollutants, which apart from contributing to the ambient pollution load, are often trapped or confined in the homes of coal users.

Indoor air pollution monitoring has shown that human exposure levels far exceed government and international health standards and this results in a number of illnesses with consequent costs for individuals, their families and South Africa as a whole. Apart from direct costs to the family for the purchase of medicines and health services and the possible loss of income, there are also costs borne by employers due to the loss of production, and by the state which must provide medical services.

Although over the long term, the supply of electricity to coal-burning townships is seen as the most effective answer to these air pollution related health problems, research during the recent past has shown that, of the households that are electrified, a high proportion continue to use coal in significant quantities, especially during winter.

Low-smoke fuels can be used in coal burning appliances to perform precisely the same functions for which coal is currently used, but have the advantage of emitting significantly lower quantities of pollutants. Thus, in the short to medium term, low-smoke are seen as having potential to considerably reduce household air pollution levels. The resultant reduction in human exposure to pollutants will have an important impact on the health of the urban poor and has the potential to lead to cost savings in the provision of health services.

Ideally, a switch from ordinary bituminous coal to low-smoke fuels would be facilitated by bringing low-smoke products into the market at a price equal to or lower than that of bituminous coal. It is, however, clear from previous research that the cost of production of low-smoke fuels will be significantly higher than the cost of mining bituminous coal. Hence, if low-smoke fuels are to penetrate the household coal market , it will be necessary for government to intervene to nullify or reduce the retail price differential. The question of which market interventions are likely to be most cost-efficient and the most effective is the subject of this report.

Market based policy options for low-smoke fuel promotion

The current scenario of household coal consumption embodies a classic instance of *market failure* as it is described in economics literature. This report utilises this economic theory of air pollution to identify the abatement options which are available to policy-makers.

Several methods have been developed for calculating or estimating the economic value of environmental and health externalities, but the method which is most appropriate for the household coal market in South Africa is the estimation of *damage costs* resulting from poor air quality. Three studies (although none are detailed) have addressed this subject , and all these suggest that the health costs of coal use, measured in fairly narrow terms, are significant. Thus, the allocation of public resources to support low-smoke fuels can be justified by the fact that it has the potential to deliver significant health benefits, which translate into sizable economic savings.

Accepting that low-smoke fuels deserve support there are many policy options which could be practically implemented in the South African context. These include a pollution tax on bituminous coal, price support for low-smoke fuels, marketable emissions permits, direct and indirect taxation incentives, and access to finance. All of these options, with the exception of marketable emissions permits, have a potential role in a low-smoke support package and will be analysed later.

The cost of producing and distributing low-smoke fuels

To consider the impact of the various market intervention options it is important to quantify the price differential between bituminous coal and low-smoke fuels. There are seven organisations involved in developing low-smoke fuels, and this report provides technical and cost information on prototype fuels. These fuels include the Wits/UCP low-smoke coal, Coal Tar Products' low-smoke coal, CSIR briquettes, Ecofuel, Duffco's Easi Coal, and Aro's Firebrick.

An appraisal of production costs shows that the ex-production cost of the cheapest low-smoke fuel is three and a half times more than the pithead price of bituminous coal (measured in energy terms). However, if it is assumed that the cost of distributing low-smoke fuel will be identical to that for bituminous coal, the retail price of the cheapest low-smoke fuel is 72% above the retail price of bituminous coal (see Table 1).

Table 1: Summary of the retail price of low-smoke fuels [1995 prices]

Fuel	*Price ex production (incl. VAT) [Rand/ton]*	*Distribution cost (inc.VAT) [R/ton]*[1]	*Retail price [R/ton]*	*CV [MJ/kg]*	*Energy price [c/MJ]*	*Energy Price Ratio [Low-smoke fuel/Bit. coal]*
Bituminous coal (C grade)	55	173	228	25	0.91	1
DEVOLATILISED COAL						
Wits/UCP	203	173	376	22	1.71	1.88
Coal Tar Products	171	173	344	22	1.56	1.72
BRIQUETTED FUELS						
CSIR	203	173	376	24	1.57	1.72
Ecofuel	[2]	[2]	500[3]	26	1.92	2.11
Duffco	860	[2]	2286[3]	25	9.14	10.03
ARO Firebrick	2000	173	2173	31	7.01	7.69

1 *The distribution cost includes transport from the mine or point of production as well as door to door delivery by township coal merchants. The distribution cost for the various low-smoke fuels is assumed to be the same as that of bituminous coal .*

2 *No data available*

3 *Ecofuel and Duffco have indicated that their fuels will not be marketed through coal merchants and the retail prices shown are those given by the producers.*

Legislative options to support the introduction of low-smoke fuels

Although on its own, legislation is not an effective mechanism to ensure the penetration of low-smoke fuels into the coal market, it does have the potential to be an effective support mechanism. In the Atmospheric Pollution Prevention Act (N° 45 of 1965), Part III is relevant to the elimination of domestic use of coal and makes provisions for the restriction of coal use and smoke emissions on the one hand, while making provisions for the promotion and support of energy alternatives on the other. The Act empowers the Minister of National Health and Population Development[1], with the concurrence of the local authority concerned, to declare the provisions applicable to part or all of a local area. The power to enforce Part III of the Act is placed in the hands of the local authorities who appoint qualified municipal inspection officers to police the Act by monitoring emissions and enforcing the regulations.

To-date, this Part of the Act has been implemented in historically white residential areas only. This can be attributed to the fact that the enforcement of *smoke control zones* is easier, both politically and economically, in those areas where the dependence on and use of coal is low and for those people who can afford cleaner alternatives. Therefore, while it has been easy to implement smoke control legislation in historically white local areas, it would have been futile to apply the Act to coal-using townships, owing to their dependence on coal-based appliances and poor access to alternative energy.

Even with the amalgamation of previously racially-defined local authorities, resource constraints persist in poorer areas, making the enforcement of the Act difficult. The Act in itself is incapable of ensuring that people switch from bituminous coal to low-smoke fuels, but it can provide necessary support if other conditions are met prior or simultaneous to its utilisation. Firstly, an affordable low-smoke alternative to bituminous coal must be widely available. Secondly public awareness on the benefits of low-smoke fuels is vital, and thirdly it is essential that local authorities have sufficient funds to enforce its application.

Analysis of policy options

There are five interventions, which it is suggested, could constitute a comprehensive and multi-faceted policy package which is mutually supporting and therefore more likely to be successful. Each of these is dealt with briefly.

Pollution tax

A pollution tax or levy on bituminous coal is potentially one of the most important interventions which government could make in the household coal market. If such a tax is introduced on household coal, it will have the effect of narrowing the price differential between low-smoke fuels and bituminous coal, thus encouraging a shift away from bituminous coal towards cleaner alternatives (which will include not only low-smoke fuels but also electricity).

There are a number of important issues surrounding the implementation of such a tax:

- A pollution tax should internalise the externalities associated with the production and consumption of coal in the household sector, rather than raise general revenues for the fiscus.
- A pollution tax should be levied at the *producer stage* as opposed to end-user or intermediary stages in the supply chain.
- The *amount* of the tax should be determined with reference to the external costs which are

[1] In future, the Minister of Environmental Affairs and Tourism will hold this power.

currently incurred in the use of conventional bituminous coal.

- The tax should be imposed on the sale of coal destined for the *household* market and not on export sales or coal used for industrial purposes.
- The tax should not be imposed until consumers have access to an *alternative* source of energy which is affordable and does not cause any loss in welfare.
- The *administration costs* for such a system of taxation need not be significant due to the relatively small number of coal producers involved and the fact that their accounting systems are relatively sound. The cost to government of employing one or two people to administer the tax would be minimal in relation to the revenue generated by the tax.

It was noted earlier that inadequate data exists on which to base sound estimates of the external costs of household coal use, but if an annual amount of R100 million is assumed for present purposes, and this is spread equally over the annual household consumption of 3.3 million tons, then the suggested pollution tax should be in the region of R30 per ton. The effect of introducing such a tax on relative prices of bituminous coal and low-smoke fuels would be as shown in Table 2.

Table 2: Comparison of various fuel price structures with and without a pollution tax of R30 per ton

Fuel	Retail price [R/ton]	CV [MJ/kg]	Energy price [c/MJ]	Energy price ratio with no tax	Energy price ratio with a tax
Bitum coal - no tax	228.01	25	0.91	1.00	-
Bitum coal - R30 tax	262.21	25	1.05	-	1.00
Wits/UCP	376.32	22	1.71	1.88	1.63
Coal Tar Products	344.29	22	1.56	1.72	1.49
CSIR	375.92	24	1.57	1.72	1.50
Ecofuel	500.00	26	1.92	2.11	1.83
Duffco	2286.00	25	9.14	10.03	8.70
ARO	2173.00	31	7.01	7.69	6.68

It is evident from Table 2 that the price premium of the various low-smoke fuel prototypes over bituminous coal is reduced when a pollution tax is imposed. Thus, for example, the price excess for the Wits/UCP product would reduce from R148.31 to R114.11 per ton, or on an energy cost basis, from a premium of 88% to 63%. This impact is clearly not large enough, by itself, to make a major difference to the competitiveness of low-smoke fuels, but when combined with other measures, this intervention could be important.

In considering whether a pollution tax might be introduced, it should also be noted that several *precedents* exist for the introduction of levies or taxes in the energy sector: from the fuel levy which comprises over a third of the petrol or diesel pump prices, to the levy on electricity sales which finances the National Electricity Regulator, to the tariff protection granted to synthetic fuels. The case for a tax or levy on coal as part of a national low-smoke fuel programme is, if anything, stronger than in the existing cases, both on economic and environmental grounds.

Price support

There are several guiding principles to follow when considering price support for low-smoke fuels.

- Price support should not favour any one product or producer. Given this principle, the level of price support should be determined so as to allow the lowest cost low-smoke fuel to be competitive with bituminous coal.
- The amount of price support should be sufficient to reduce the risk facing producers considering entering the low-smoke fuel market.
- The amount should be determined such that producers will have a strong incentive to innovate and improve their products and service.

The three possible points identified for the practical implementation of price support are:

- rebate coupons to end users,
- rebates to distributors and
- rebates to producers.

The first two of these options are rejected due to practical difficulties with implementation and associated high administration costs. Rebates to producers are considered to be a viable option, on the other hand, as they offer a relatively uncomplicated point at which financial support can be injected into the supply chain.

If all fuels received equivalent price support at the level which allows the lowest cost low-smoke fuel to be priced equivalent to bituminous coal the rebate required will be R 126/ton. (see Table 3). With this rebate, three fuels (Wits/UCP, Coal Tar Products and CSIR) would be competitive with bituminous coal. The rebate would in fact bring Coal Tar Products' fuel onto the market at a lower 'per ton' price than bituminous coal (although the energy cost would be equal). The other three low-smoke fuels will still not be competitive although the rebate will assist expansion of their markets.

Table 3: Retail price of low-smoke fuels assuming a standard rebate of R126/ton for all fuels

Fuel	Price ex-production (excl VAT) [R/ton]	Rebate [R/ton]	Nett Price [R/ton]	VAT [R/ton]	Price ex-production (incl VAT) [R/ton]	Distribution cost [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy Price [c/MJ]	Retail energy price ratio
Bit. Coal	48.25	0.00	48.25	6.76	55.01	173.00	228.01	25	0.91	1.00
Wits/UCP	178.00	126.39	51.61	7.23	58.84	173.00	231.84	22	1.05	1.16
CTP	150.25	126.39	23.86	3.34	27.20	173.00	200.20	22	0.91	1.00
CSIR	178.00	126.39	51.61	7.23	58.84	173.00	231.84	24	0.97	1.06
Ecofuel		126.39				*	356.00	26	1.37	1.50
Duffco	754.39	126.39	628.00	87.92	715.92	*	2142.00	25	8.57	9.42
ARO	1754.39	126.39	1628.00	227.92	1855.92	173.00	2028.92	31	6.54	7.18

* *Ecofuel and Duffco have provided a retail price for their fuels and thus the retail price is not based on the distribution cost of bituminous coal.*

Tax incentives

Tax incentives such as accelerated depreciation write-offs and direct taxation allowances or rebates are not recommended on the grounds that they carry large administrative and collection costs and that their effectiveness in terms of influencing the investment decisions of producers is questionable. The possibility of introducing *incentives in indirect taxation*, and specifically Value Added Tax (VAT) does, however, warrant consideration. Although, in theory, VAT is payable at each of the links in the coal distribution chain, in practice this is the case only at the more formal upstream ends of the supply chain. Consequently, changes to VAT legislation would be effective only if they were introduced at producer stage.

Several categories of zero-rated products exist already, most of which can be described as commodities which meet basic needs, and this category could easily be extended to include low-smoke fuels. If low-smoke fuels were zero-rated at the point of production, then this would introduce another structural price advantage in their favour. The effect of zero-rating is relatively small (see Table 4), but when combined with the other interventions it can contribute towards a more supportive environment for low-smoke fuels. The opportunity cost of such a tax, in terms of revenue which is foregone, would not be highly significant.

Table 4: Comparison of various fuel price structures with and without zero-rating of low-smoke fuels at producer stage

		VAT included			VAT zero-rated		
Fuel	Production price [R/ton]	Retail price: with VAT	Energy price [c/MJ]	Retail price ratio	Retail price: zero-rated	Energy price [c/M]	Retail price ratio
Bitum. coal	48.25	228.01	0.91	1.00	-	0.91	1.00
Wits/UCP	178.00	376.32	1.71	1.88	351.00	1.60	1.76
Coal Tar Products	150.00	344.29	1.56	1.72	327.00	1.49	1.64
CSIR	178.00	375.92	1.57	1.73	351.00	1.46	1.60
Ecofuel	na	500.00	1.92	2.11	na	na	na
Duffco	754.39	2286.00	9.14	10.04	2180.39	8.72	9.58
ARO	1754.39	2173.00	7.01	7.70	1927.39	6.22	6.84

na - information not available.

Access to finance

The various low-smoke fuel production techniques vary considerably with regard to capital requirement for the establishment of production facilities. While some potential producers are part of large industrial groups, and could therefore secure finance at prevailing market rates, the same will not be true of small producers who may wish to enter the market. These smaller producers may face constraints in securing any finance at all, or if they do, it may carry a premium due to their relative institutional weakness.

Notwithstanding these potential difficulties in accessing finance, the impact of having access to concessionary finance (through the Small Business Development Corporation or the Industrial Development Corporation) on the retail price of low-smoke fuels is small. However, similar to other interventions, it reduces the price differential between low-smoke fuels and bituminous coal and can, therefore, be a useful component of an intervention strategy.

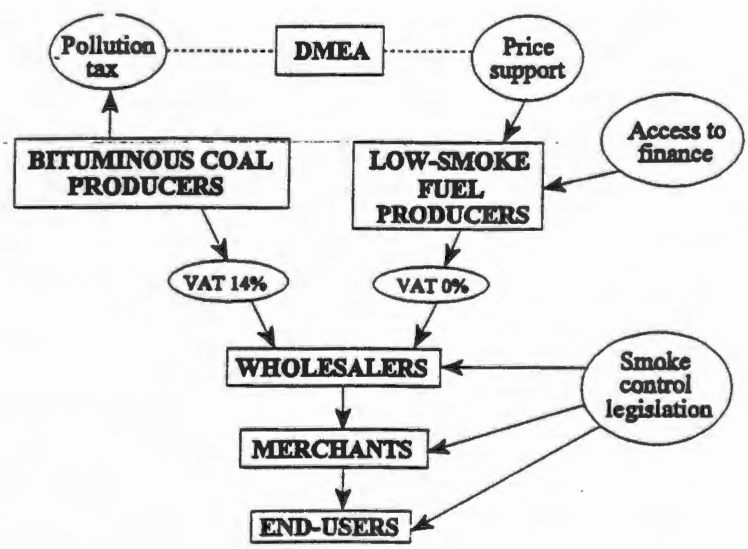
Legislative support

Legislation has the potential to be an effective instrument of support for the introduction of low-smoke fuels to the low-income market. Part III of the Atmospheric Pollution Prevention Act (No 45 of 1965) is an existing piece of legislation, which makes provision for both the restriction of coal use and smoke emissions (through the creation of smoke control zones) and the promotion and support of energy alternatives. The Act is enforced at local government level and is policed by municipal inspection officers. While compliance with the Act tends to be encouraged through education and compromise, the Act does make provisions for the prosecution of offenders.

Summary of intervention options

Figure 1 sets out the five intervention options and indicates how they could interact with the bituminous coal and anticipated low-smoke fuel supply chain.

Figure 1: Intervention options for the support of low-smoke fuels



Recommendations for an intervention policy

Having examined each option on its own, consideration can be given to how these could be combined into a comprehensive policy package. The aim of the intervention policy should be to bring low-smoke fuels on to the market at an energy price equivalent to bituminous coal. Assuming this as a basic objective, the recommended components of a policy package are set out below.

1. Of the four feasible market based options discussed in this chapter, concessionary finance has the

smallest impact on the price of low-smoke fuels. Nonetheless, this intervention is a practical and achievable option and hence it is recommended that government assists potential producers in obtaining access to concessionary finance through parastatal financing agencies such as the Small Business Development Corporation and the Industrial Development Corporation.

2. Zero-rating VAT on low-smoke fuels has a somewhat higher impact on the price of low-smoke fuels than concessionary finance and hence can reduce the price differential between the two types of fuel. Thus it is recommended that the DMEA motivates for zero-rating on low-smoke fuels. There may, however, be difficulties in persuading fiscal agencies to grant a concession, especially seeing that current reforms in the revenue collection system is moving towards fewer exceptions and special cases.

3. A third recommendation is that a pollution tax should be levied on the sale of bituminous coal . The value of the tax should ideally be set at a level which takes the external costs associated with the use of household bituminous coal into account. Present estimates show that this could be about R30 per ton.

4. It will be necessary to use the fourth feasible market based option, price support for low-smoke fuels, to make up the remaining price differential between bituminous coal and low-smoke fuels after the effect of the above three options has been quantified. This rebate should be valued so as to bring the price of the lowest cost low-smoke fuel down to a point where it equals the energy cost of bituminous coal.

5. With regard to the utilisation of legislation, timing is very important. It is generally accepted that the Air Pollution Prevention Act will be impossible to enforce unless the penetration of the bituminous coal market by low-smoke fuels is well advanced. This implies that the above market-based interventions will have to lead the way, with legislation playing a supportive role at a later stage.

In attempting to quantify the combined impact of these recommended four market-based interventions, there are many permutations that could be considered given the uncertainty in the figures presented in this report. However, using the figures that have been presented, Table 5 shows the retail prices of the low-smoke prototypes relative to bituminous coal. The figures are based on the following assumptions:

- concessionary finance will be available at about 5% below market rates ,
- VAT on low-smoke fuels is zero-rated, and
- a pollution tax of R30/ton is levied on bituminous coal sales.

It is evident that the resulting energy price of three of the low-smoke fuels (Wits/UCP, CSIR and Coal Tar Products) makes them competitive with bituminous coal. The 'per ton' price of Coal Tar Product's fuel will be more than 10% lower than that of bituminous coal while the Wits/UCP and CSIR fuels will have the same price per ton as bituminous coal.

Table 5: Recommended market intervention package for the support of low-smoke fuels

Fuel	Price ex-production excl VAT [R/ton]	Savings finance charges [R/ton]	Tax/ (Rebate) [R/ton]	Nett Price [R/ton]	Distribution cost [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy Price [c/MJ]	Delivered Retail price ratio
Bit. Coal	48.25	(0)	30.00	89.21	173	262.21	25	1.05	1.00
Wits/UCP	178.00	(1.19)	(88.11)	88.70	173	261.70	22	1.19	1.13
CTP	150.25	(4.41)	(88.11)	57.74	173	230.74	22	1.05	1.00
CSIR	178.00	(0.10)	(88.11)	89.89	173	262.89	24	1.10	1.04
Ecofuel			(88.11)			399.55	26	1.54	1.47
Duffco	754.39	(9.17)	(88.11)	657.11	1426	2083.11	25	8.33	7.94
ARO	1754.39		(88.11)	1616.23	173	1839.28	31	5.93	5.66

[1] *VAT is payable on bituminous coal (14% x R 58.75)*
[2] *No information available*
[3] *No information available on cost of production plant. Although savings on finance charges have not been included there will in fact be some savings which will make a small difference to the nett price*

Given that coal is a basic commodity for large numbers of poor households, a R30 tax imposed at an early stage in an intervention strategy would have undesirable equity consequences. Thus the above recommendation is seen as a target to be met in the medium term. In the immediate short term, it is suggested that a lower pollution tax of about R10/ton is levied, with this increasing to R30/ton over a period of years. This will obviously mean that initially, a higher rebate would be required. The cost to the government, however will be countered by the fact that initially, bituminous coal sales will be considerably higher than low-smoke fuel sales. In the longer term, once low-smoke fuels have established themselves and are being widely utilised, it would be desirable for government to reduce the level of price support over a period of time.

The establishment of a nett cost to government for any combination of the above intervention options will require more accurate base data and also a detailed consideration of the likely shift in market proportion between low-smoke fuels and bituminous coal.

Related issues

Whilst the policy interventions which have been described above represent a comprehensive package of strategies which need to be implemented in co-ordination with each other, there are several other interventions which should take place at the same time. These include:

- A *publicity and education campaign* to raise the awareness of end-users and other participants in the household coal market (such as merchants and wholesalers) with regard to the current health problems arising from bituminous coal use, and of the many issues surrounding the government's efforts to introduce low-smoke fuels.
- Government *communication* of its intentions and plans in a clear and open manner, so that end-users and participants in the supply chain are informed and can plan accordingly.
- Whatever intervention options are exercised by government it will be important to establish an ongoing monitoring process to gauge the impact of the overall intervention strategy and to institute amendments should they be required.

Further Research

Through this report, a number of areas for further research have been identified. These include:

- There is a need for more extensive and detailed quantification of the current external costs of coal use in the household sector to be undertaken to improve upon the rough estimates which currently exist. The importance of this lies in the fact that this estimate is the key factor which should determine the size of the pollution tax on bituminous coal.
- There is a need for further research into the coal distribution network, especially of the informal segment which comprises numerous small merchants and traders. A better understanding of the distribution network will facilitate decision-making with regard to policy options, specifically in terms of the amount of revenue raised or the amount of support required.
- If the market-based interventions outlined in this report, such as a pollution tax on bituminous coal and price support for low-smoke fuels, are to be implemented, then clearly more detailed work needs to be done leading to the actual implementation of those strategies.
- A possible problem with levying a pollution tax on household coal is that it can be difficult to distinguish between coal going to household market and small industry. Thus it may be necessary for coal distributors and merchants to have improved accounting systems as mentioned in Chapter Two. This is an area that requires further research and input from involved parties.

MARKET INTERVENTIONS TO PROMOTE LOW-SMOKE FUELS

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Chapter One

Introduction

In South Africa, and specifically in Gauteng, a large number of primarily urban households utilise bituminous coal to meet a substantial proportion of their energy need. For these households coal is easily obtainable, as in most areas it is sold door to door by a well developed network of coal merchants. Coal is generally used in stoves with four to six plates and an oven. These stoves are also extremely effective space heaters and are used for heating water and irons. In addition to this versatility, one of the main advantages to coal is that it cheaper than alternative fuels[1]. One major drawback, however, to the use of bituminous coal is that during combustion it emits harmful air pollutants. Apart from contributing to the ambient pollution load, these pollutants are often trapped or confined in the homes of coal users.

Indoor air pollution monitoring has shown that human exposure levels far exceed government and international health standards. High exposure over long periods results in a number of illnesses with consequent costs for individuals, their families and South Africa as a whole. Apart from direct costs to the family for the purchase of medicines and health services and the possible loss of income, there are also costs borne by employers due to the loss of production, and by the state which must provide medical services.

There are a number of possible approaches to reducing the quantity of pollutants produced due to household coal combustion. One approach is to reduce consumption by improving thermal performance of housing or taking better advantage of solar energy through improved house design. A second line of attack is to improve the combustion performance of the large number of coal stoves used in Gauteng townships, thereby reducing harmful emissions. During the 1980's improved coal stove standards were enacted in an attempt to have a widespread impact on household coal combustion efficiency, however, this has had little impact on the air pollution problem. A third approach is for bituminous coal users to switch to other non-polluting fuels. Currently the principal alternative is electricity and although in the long term it is likely to be effective in reducing coal consumption, research has shown that in the short to medium term electricity is not being used in place of coal for many household needs. Of the households that are using electricity, a high proportion continue to use coal on a significant scale, especially during winter.

Another alternative to bituminous coal which can considerably reduce household air pollution levels is low-smoke fuel. Low-smoke fuels can be used in coal burning appliances to perform precisely the same functions for which coal is currently used, but will have the advantage of emitting significantly lower quantities of pollutants. The resultant reduction in human exposure to pollutants will have an important impact on the health of the urban poor and has the potential to lead to cost savings in the provision of health services.

Ideally, a switch from ordinary bituminous coal to low-smoke fuels would be facilitated by bringing low-smoke products into the market at a price equal to or lower than that of bituminous coal. It is,

[1] The retail price of coal is about 0.91c/MJ (see Chapter Four) as against 3.5c/MJ for electricity, 4.3 c/MJ for gas and 4.1 c/MJ for paraffin. After taking account of the efficiency of appliances, coal is still competitively priced, especially if used for space heating.

however, clear from previous research that the cost of production of low-smoke fuels will be significantly higher than the cost of mining bituminous coal. Hence, if low-smoke fuels are to penetrate the household coal market to any significant degree, it will be necessary for government to intervene in the market to nullify or reduce the retail price differential between low-smoke fuels and bituminous coal. The question of which market interventions are likely to be most cost-efficient and the most effective is the subject of this report. The primary objective of the report is to present 'a set of workable market interventions that will enable low-smoke fuels to penetrate the existing household bituminous coal market and ultimately replace the household use of bituminous coal.'

The first methodological step in developing such a set of workable market interventions is to assess which theoretical policy options exist. A parallel activity is to appraise current low-smoke fuel developments, mainly with respect to their cost of production and distribution. It is also necessary to examine the price structure of household bituminous coal in order to determine the price differential that will need to be nullified or substantially reduced by an intervention strategy. A further question is whether legislation can play an effective role in combating air pollution and how it can acceptably be integrated into an intervention package. Thus existing legislation and the implications of it being applied are examined. The final step is to assess and quantify, in financial terms, each of the feasible options, using the production and distribution cost information. From analysis, recommendations can be made for an effective intervention strategy.

The report begins in Chapter Two by setting out the theoretical issues surrounding market-based policy options. These issues include the theory of externalities and a theoretical optimum level of pollution. Given current market failure to account for external costs, four categories of policy responses are discussed. These include free market bargaining options, environmental standards and regulations, pollution taxes and subsidies, and marketable emissions permits. After considering environmental valuation methods, the second part of Chapter Two estimates the value of external costs in the South African household coal market. Further, the chapter discusses issues around the levying of a pollution tax on bituminous coal, providing price support for low-smoke fuels, the effectiveness of marketable emissions permits, tax concessions and incentives for low-smoke producers, and access to finance for the establishment of low-smoke fuel production facilities.

Chapter Three describes the prototype low-smoke fuels which are in various stages of development in South Africa and provides estimates of their likely production costs. There are essentially two approaches to the production of low-smoke fuels. The first involves the devolatilisation of rewashed discard coal or ordinary lump coal while the second involves the briquetting of discard coal fines and duff as well as other wastes such as paper.

Chapter Four describes the current household bituminous coal market as well as the system for distributing coal from the mines to end users. A cost structure for the mining and distribution of bituminous coal is given and compared with similar cost structures for the low-smoke fuel prototypes.

Chapter Five describes existing legislation governing the emission of air pollution from household sources in residential area. Although this is not a `market-related' intervention *per* se, the legislative option is included in this report because it could usefully *complement* the other interventions described in the report. The legislation is described in terms of the authorities responsible for its administration and financing, provisions for the restriction of coal use, provision for the promotion and support of energy alternatives, and the enforcement of the legislation. The chapter goes on to describe how the Atmospheric Pollution Prevention Act (N° 45 of 1965) has been utilised in practice and some of the issues surrounding its administration. The final section of the chapter considers the implications of enforcing the Act in coal burning townships.

Chapter Six uses information on prices of bituminous coal and low-smoke fuels presented in Chapters Three and Four to quantify the impact of the various market based intervention options that were identified in Chapter Two. These quantified impacts are then used to recommend an integrated market intervention package. Finally, Chapter Six flags a number of issues that are closely related to market based interventions and also identifies certain areas in which further investigation is required.

Chapter Two

Market-based policy options for low-smoke fuel promotion

2.1 Theoretical issues: market failure and external costs

There is a large body of literature within the economics discipline which is directly relevant to the problem of air pollution in South Africa's household coal market. The current scenario of household coal consumption embodies a classic instance of *market failure* as it is described in the literature. Before outlining a range of practical options for market intervention in the household coal market, this section of the chapter will describe the economic theory of air pollution and of the abatement options which are available to policy-makers.

2.1.1 The theory of externalities

A central concept in the economic analysis of air pollution problems is that of an *externality*. An externality or `external effect' can be either positive or negative, although policy is most frequently concerned with the latter, and occurs when two conditions are met:

- an activity by one economic agent causes a change of welfare to another agent, and
- the welfare change is not compensated or appropriated (Pearce & Turner 1990:61).

Thus, in the case of the household coal market, the combustion of coal results in the emission of air pollution, which in turn reduces the welfare both of residents of that house and of neighbours; furthermore, those people are not compensated in any way for the loss of welfare they experience in the form of poor air quality and the consequent health effects. The air pollution from coal combustion therefore represents a negative externality, since its welfare effects are not captured in the market relationship between producers and consumers of the coal as reflected in the price of the product.

The concept of externalities can also be explained by reference to the divergence between private and social costs. *Private costs* are those costs which are actually borne by the producer of a product: in practice, these would comprise the costs of purchasing coal, processing and marketing it. A coal merchant's profitability will be determined by the extent to which revenues exceed (private) costs. In economic terms, *social costs* are the *full* costs associated with the production or consumption of any commodity or service, and may be borne not only by the producer or consumer, but also by other groups in society. The difference between social costs and private costs, then, represent the *external costs* which are incurred by society at large. Inevitably, these costs are not evenly distributed across society, but fall more heavily on some groups or classes than others.

In the case of the household coal market the social costs of coal production will include, *in addition to* the private costs, the costs associated with air pollution released during coal combustion: the expenditure on health care due to increased respiratory illness, expenditure on transportation to and from medical treatment facilities, and the opportunity costs (foregone productivity) resulting from illness, absenteeism from work and school, amongst other factors. A rough assessment of the external costs of coal combustion will be presented later in the chapter.

These principles are demonstrated graphically in Figure 2.1. The individual producer faces a horizontal marginal revenue curve (MR), equivalent to the price of the product, since under competitive market conditions, any one producer is unable to influence the price of the product. A producer which seeks to maximise profits under these conditions would increase its output until it reaches the point where its *marginal private cost* curve (MPC) is equal to the *marginal revenue* curve (MR), that is, at a level of output equivalent to Q_1. The logic for this is easily demonstrated: at levels of output below Q_1, the marginal revenue of producing an extra unit still exceeds the marginal cost of producing it, and so a firm will increase its level of output. Once it passes output level Q_1, however, the marginal cost of producing every additional unit of output exceeds the marginal revenue, and so the producer would cut back to the quantity Q_1. The economically efficient level of output, from the *private producer's perspective*, is therefore where MR equals MPC - at point B.

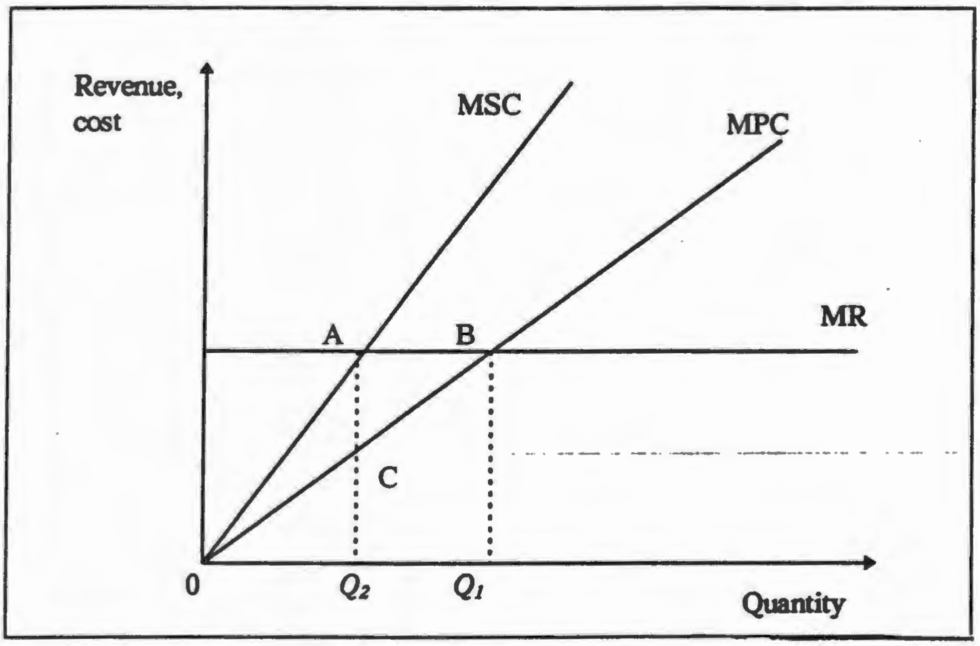


Figure 2.1: Illustrative Marginal revenue (MR), Marginal private cost (MPC) and Marginal social cost (MSC) curves in a competitive market

It is evident from the figure that the marginal social cost exceeds the marginal private cost incurred by the producer, as shown by the MSC curve lying above the MPC curve, and that at the output level Q_1, there is a significant external cost (the vertical difference between the MSC and MPC curves). In essence, the triangle OAB represents the external cost of an unregulated market in which the producer acts with no reference to its wider impacts on society; by definition, these costs are borne not by the producer, but by other groups within society at large. This represents an economically inefficient situation, *from the perspective of society as a whole*. The true economic optimum lies at the point where the marginal revenue equals the marginal *social* cost, that is, at output level Q_2. At this point, the benefits to society are exactly equal to the costs to society of producing Q_2, and so, if the objective is to maximise *social* welfare (rather than individuals' surpluses), then it does not make any sense to deviate to either side of Q_2.

It is interesting to note that, even at the point where MR equals MSC - the economic optimum - there will still be some pollution (the external costs of which are measured by the triangle OAC). This is an important point of departure in environmental economics, namely that there will be an optimal level of pollution, which is usually above zero, as determined by the relationship between marginal revenues and costs. The *environmentally* optimum level of pollution, on the other hand, will probably be at or close to zero, corresponding to zero economic activity. These different approaches may partly account for the divergent views often encountered between economists and environmentalists.

2.1.2 Achieving the 'optimum' level of pollution: in theory

The situation outlined thus far, in which a private producer is responsible for the generation of externalities, represents an important instance of *market failure*: left to itself, such a market will not produce an economically efficient result. Consequently, some interventions are required to achieve an optimum level of output. Following on from the discussion of externalities and market failure, the economics literature also contains extensive treatment of various policy interventions which may attempt to correct these failures. Four categories of responses exist and have been extensively analysed by environmental economists; each is described briefly below, and then discussion focuses in some detail on those approaches which are potentially useful in the case of low-smoke fuels.

2.1.2.1 Laissez-faire or free market bargaining options

The *first* approach to achieving the `optimum' level of pollution is perhaps the most theoretical and least practicable in the context described by this report. Essentially, it entails a *laissez-faire* approach in which the polluter and pollutee are left to bargain over the level of pollution and any associated compensation which may be required. In terms of what is known in the literature as the Coase Theorem, it is suggested that, if a market-like bargaining process can be established, a socially-optimum level of pollution and output will be achieved without any direct government involvement (Coase 1960). While this appears attractive at first sight, it is clear that the Theorem is based on a number of highly restrictive assumptions which are clearly not applicable in reality. Numerous criticisms have been directed at this theory, one of the most important being concerned with its assumption that the transaction costs of undertaking such bargaining processes are not significant, which is obviously not the case where large number of polluters and pollutees are involved (Pearce & Turner 1990:75). If the *laissez-faire* approach envisaged in the Coase Theorem were applicable in reality, then it should be possible to argue that the current situation in the household coal market approximates the socially optimum level of output and pollution. This is demonstrably not the case - current pollution levels are far in excess of socially desirable levels, and the `market' has thus far not succeeded in improving the situation, thus necessitating some form of policy intervention. The *laissez-faire* approach is therefore not workable in the household coal market and so this option will not be dealt with any further in this report.

2.1.2.2 Environmental standards and regulations

The *second* type of response to pollution problems, which is at the other end of the scale to the *laissez-faire* option, entails the use of ***regulations and standards***, which are usually set with reference to health-related criteria. These are the most commonly applied means of pollution control in practice, and may take the form, for example, of a maximum concentration of specified pollutants to be emitted during the combustion of a fuel, or of control over the use of certain polluting fuels under specific conditions. The Atmospheric Pollution Prevention Act (which is discussed in more detail in Chapter Five) is another example of such a tool.

Environmental standards have both advantages and disadvantages, with the former applying more in *practice*, and the latter in theory. Perhaps their biggest advantage, which accounts for their widespread use in reality, is their relative simplicity and ease of implementation. In many countries, standards and regulations have been the first instrument of pollution control to be adopted by governments. They are usually considered the most appropriate option under two scenarios: firstly, where the pollutants concerned are so hazardous as to require a total ban on their use, which can be achieved through direct regulation. Secondly, standards are often employed where ideal conditions - freely operating markets as envisaged by Coase (1960) - do not exist and where little institutional capacity exists in governments and regulatory agencies to devise, implement and operate more complex systems of pollution taxes and permits.

In spite of these practical advantages, strong theoretical arguments have been advanced against the use of direct forms of control, on the grounds that these standards seldom result in an economically efficient solution (Pearce & Turner 1990:102-106). This is mainly because regulators seldom have adequate information to enable them to set standards at the appropriate level which encourages polluters to produce at the economically optimum level (Q_2 in Figure 2.1). A second reason why environmental standards have been argued to be inefficient, is that they require considerable resources for ***enforcement***, and if these are absent, the effectiveness of the system is undermined. Polluters would generally assess the ***probability*** of being caught if they transgress the regulations, together with the severity of penalties likely to be imposed, and base their production decisions on that assessment; clearly, if enforcement of regulations is poor, the risks facing polluters are low and so they are less likely to avoid pollution. A third disadvantage of environmental standards is that they provide polluters with little or no incentive to innovate and reduce pollution levels if they are below the maximum acceptable limit, even though damage costs might not be insignificant.

2.1.2.3 Pollution taxes and subsidies

The *third* category of pollution responses, which falls between the *laissez-faire* option and the standard-setting option, centres around the use of *taxes and subsidies* to correct for external costs not ordinarily reflected in private decisions (Helm & Pearce 1990:5). The intellectual work analysing this option was done as far back as 1920 and usually entails the imposition of a tax or levy to bring a polluter's cost function into line with the full social costs of production, including any externalities, thereby encouraging the producer to reduce its pollution output to the socially desirable level (Pigou 1920). This logic underlies the contemporary terminology of the `polluter pays principle'. With reference again to Figure 2.1, the tax would be imposed on the polluter in an attempt to bring the private cost function (MPC) closer to the social cost function (MSC). Although the same logic applies to the use of subsidies to compensate victims of pollution for damages incurred by them, this option is much less frequently applied in practice and is not dealt with further here.

The advantages of pollution taxes over options such as environmental standards are, firstly, that taxes are more likely to lead to an economically efficient solution, since they provide producers with direct incentives to reduce their pollution levels to the socially optimum point. Secondly, taxes are held to be superior to standards since they should deliver positive social benefits, even in the context of uncertainty and inadequate information, provided the tax brings the polluter's cost function *closer* to the social cost function. Thus, even in the practical situation where regulatory agencies lack full information about MPC and MSC curves, pollution taxes can deliver immediate benefits and then be revised iteratively as more information becomes available.

At the same time, it must also be noted that pollution taxes also suffer from a number of disadvantages, ranging from the practical problems of having to estimate the MPC and MSC curves faced by polluters and by society at large (Helm & Pearce 1990:5), to highly technical issues around multiple equilibrium points arising from non-convexities in the cost functions which result for example, from step-changes in pollution occurring when polluters take remedial action at some level of pollution (Fisher 1981:176).

2.1.2.4 Marketable emissions permits

The *fourth* and last category of pollution responses which is covered extensively in the literature, is the use of *marketable emissions permits (MEPs)*. As in the case of environmental standards, the regulatory authority specifies a maximum permissible amount of emissions and issues permits for that amount. In this case, however, the permits can be traded in a market. This option has a number of advantages (Pearce & Turner 1990:111-115). Firstly, MEPs will encourage the achievement of a least-cost solution, since producers with low abatement costs will prefer to reduce their emissions and sell their permits, while producers with high abatement costs will prefer to buy permits which allow them to emit pollution, rather than incur high expenditure on abatement controls. Secondly, MEPs are not denominated in monetary terms and so do not need to be adjusted for inflation over time (unlike taxes). Thirdly, the system is flexible enough to allow the regulatory agency (or even other interested parties) to reduce the permissible level of pollution by buying up permits if this is desired. Fourthly, the MEP system can accommodate changing conditions through its price mechanism: demand for permits will be variable, depending on the goals of the regulator, the lumpiness of investments and uncertainty on the part of polluters - these conditions can be accounted for in permit prices, rather than having to adjust standards or regulations.

Marketable emissions permits have been employed in several countries especially in North America, where their impact on the whole appears to have been positive. However, MEP systems are also subject to numerous problems. Firstly, MEPs do not contain any in-built incentives for polluters to innovate and reduce their emissions, unlike taxes. Secondly, even through the system is self-regulating to an extent, it still has high administration costs due to the need to manage the MEP market and to ensure producers do not exceed their quotas. Finally, where there are market imperfections other than the presence of externalities, such as a monopolistic industry structure, the opportunity exists for hoarding of permits not on the basis of abatement costs, but as a means of maintaining or increasing control over the market. This could have inequitable consequences since large producers would benefit to the detriment of smaller firms.

This chapter has thus far outlined the theoretical analysis of pollution externalities, as well as four categories of policy responses which have been extensively analysed in the economics literature. Of the four broad options, only one can be discarded on the basis of the general arguments found in the theory, namely the *laissez-faire* bargaining option in which the situation is left to the market participants to resolve themselves. Of the other three, all have their strengths and weaknesses, and no clear order of preference emerges from the literature. Rather, each should be evaluated in the specific circumstances applicable to any given policy choice. This is done in the remainder of this chapter. Before doing so, however, the following section addresses the issue of the external costs associated with the household coal market, in order to provide a better understanding of how significant these externalities may be in practice.

2.2 External costs in the South African household coal market

The central task in evaluating externalities is to arrive at a valuation in monetary terms, of the unaccounted for external costs. While the theory is fairly straight forward, as outlined in the previous sections, the practicalities of deriving these valuations are more complex since, by definition, no market exists in which externalities are priced. Several methods have been developed for calculating or estimating economic valuations of environmental and health externalities; they are reviewed very briefly in the next section.

2.2.1 Environmental valuation methods

The first category of valuation approaches is known as the *contingent valuation method* (CVM), which usually involves the use of questionnaire techniques to gauge peoples' willingness to pay for an improved environment, or to accept compensation for the degraded environment. On the basis of their hypothetical valuations in such a theoretical market, an imputed value is derived for the environmental commodity in question. Thus, in the coal market, people would be surveyed and asked what Rand value they would place on clean air and the improved health status which might follow. On the basis of the sample's responses, a total valuation would be calculated. Whilst this method has been widely used, especially in North America, it has little application to the household coal market in South Africa, particularly since poor people are unlikely to say that they are willing to pay any significant amount for cleaner air, given their lack of disposable income. However, it would be patently incorrect to derive a zero (or very low) valuation for cleaner air on the basis of such responses. This methodological approach will therefore be discarded for present purposes.

A second method sometimes used, is *hedonic pricing*, in which valuations for environmental conditions are imputed from actual valuations in land and property markets, on the basis that those markets already embody valuations of their related environmental conditions (for example, clean air). This approach also has several problems in practice, and could not be applied to the valuation of air quality in the present context, since the markets in housing and property in low-income areas cannot be said to operate efficiently enough to reflect differences in air quality encountered in those areas.

A third category of valuation methods, the *travel cost method*, derives valuations for environmental commodities on the basis of the actual expenditure incurred by people travelling to and from such environmental resources. This method is most commonly used for valuing game reserves and recreation areas which are visited by people who have to travel from afar. Apart from numerous theoretical and generalisable problems with this approach, there is no easily apparent way in which it could be applied to the household coal market, since people from polluted residential areas do not travel to other areas with cleaner air simply to enjoy that atmosphere.

A fourth and final category of environmental valuation methods, which is the most appropriate for present purposes, entails the measurement or estimation of *damage costs* which result from poor air quality. These are the actual costs incurred in existing markets, costs which result from the environmental impact in question. One of the key challenges with this approach is to identify the 'dose-response' relationship: the causal link between the emission of pollution and damage to human health and other environmental components. This is usually attempted with the assistance of epidemiological and similar methods.

2.2.2 Estimates of external costs in the South African household coal market

No detailed studies have been undertaken to-date of the external costs of coal production and consumption in the household sector. A number of studies, however, have addressed this subject with a limited degree of rigour and from these, a wide range of estimates are available. In assessing the external costs, distinctions can be made between the kinds of impacts:

- the direct costs of poor health, especially increased respiratory illness (such as pneumonia, colds, tuberculosis), in the form of expenditure on treatment, medication, travel costs and hospitalisation;
- the indirect costs of poor health, in the form of the reduced productivity of working people and school students, absenteeism from work or school and reduced opportunities to secure employment.

In addition to these forms of damage costs which can be measured with reference to actually existing markets, damage costs should also include an indication of the costs (however these are measured) of early death, especially among infants. However, this is a highly controversial area in welfare economics, mainly because of the ethical objections to the placing of monetary prices on human life. Nonetheless, it is uncontroversial to state that any environmental effects which result in the loss of human life carry an extremely high cost.

At the highest end of the scale, Viljoen (1992) made a `back-of-the-envelope' estimate of the cost of air pollution from coal combustion in poor households on the Highveld, and arrived at an estimated annual cost of R260 million.[1] This was based on two categories of external costs: expenditure on treatment of children and adults who suffered respiratory illnesses (R175 million per annum) and the opportunity cost of absence from employment (R85 million per annum). Viljoen further speculated that if other effects such as the long-term impairment of productivity and the aesthetic penalty of living in degraded environments were taken into account, then the total external costs of coal use could be in the region of R500 million per annum. These amounts are highly significant in relation to the household energy market and to the regional economy. Unfortunately, the calculations are extremely rough and could not be used as the basis for making cost-benefit decisions in the policy arena.

At the other end of the scale, Van Horen (1994:50) estimated the direct costs of hospitalisation of patients with respiratory illness, using South African and Chinese data on the number of deaths from pneumonia and the ratio of deaths-to-hospitalised cases respectively. This calculation yielded a direct cost of R23 million per annum (1993 Rands). It was stressed that this probably represented an absolute minimum estimate of the social costs of air pollution, because it excluded the loss of production due to illness, travel costs for medical care, and because it was based on official statistics which usually significantly understate the true extent of such illness.

The third study which addressed the health effects of coal use attempted to quantify the benefits which might follow from electrification (Delport 1994). Again, this study had to make a number of simplifying assumptions in order to produce estimates of the effects of electrification. This exercise yielded an estimate that electrification, which would cause about half of coal-using households to switch to electricity, would ***avoid expenditure*** of about R350 million on the treatment of respiratory

[1] The original paper used a figure of R280 million, although checking of the figures yield an amount of R260 million.

illness.[2] Again, while several assumptions in the study could be questioned, it nevertheless underlined the point made earlier, namely that the health costs of air pollution are considerable.

The estimates produced by these three exercises therefore vary widely; nonetheless, all three suggest that the health costs of coal use, measured in fairly narrow terms, are not insignificant. The implication of this for policy-making is that any interventions, such as the promotion of low-smoke fuels, which make an impact on pollution levels, will have direct economic benefits as well as environmental ones. Consequently, it may be economically justifiable to utilise public resources to promote these low-smoke fuels. A cost-benefit analysis should be undertaken to determine the extent to which resources can justifiably be allocated to the support of low-smoke fuels. A preliminary cost-benefit analysis, using rough estimates of the costs of providing price support to low-smoke fuels, and of the expected health benefits, suggested that interventions could have a benefit:cost ratio of greater than one, meaning that such interventions should be undertaken (Van Horen & Eberhard 1994). This is an area which merits more rigorous investigation, but the implications for policy are clear: the allocation of public resources to support low-smoke fuels can potentially deliver significant health benefits, which will translate into sizeable economic savings.

2.3 A pollution tax on bituminous coal

One of the most important interventions which could be made by the government is to *impose a pollution tax on bituminous coal*. The theory behind this option was outlined earlier, but essentially, the motivation for such a tax is that it would *internalise* the external costs associated with the production and consumption of the coal. This is in line with the 'polluter pays' principle, which is currently also being espoused by the Department of Environmental Affairs and Tourism (DEAT 1995:4).

There are many aspects to the possible mechanisms for the implementation of such a tax. Firstly, the *point in the distribution system* at which the tax is imposed is important. Given the highly complex and informal nature of the distribution sector beyond the producer and especially the wholesaler stages, it would be impractical to attempt to levy the tax further down the distribution chain. Rather, it would be preferable to impose the tax at the point where coal leaves the mines and is sold to bulk wholesalers and merchants. Accounting systems are generally adequate in these entities to facilitate the processing of tax collections and their subsequent payment to relevant authorities. This is not the case among informal merchants. Moreover, there are only a few coal producers who supply coal to the household market, which means that the efficiency of administering such a system could be high.

A second important question relates to the *scope of the tax*: in other words, to which parts of the coal market should the tax apply? At its narrowest, the pollution tax could be imposed only on coal which is sold to the *household* market, which amounts to about 3.3 million tons (Palmer Development Group 1995). Alternatively, if the non-household coal market were included in the scope of the tax, this would affect coal prices paid by some or all of the following: industrial and commercial consumers (11 million tons in 1992), the synthetic fuel industry (Sasol - 39 million tons), the coal-based power generation industry (Eskom - 74 million tons) and export sales (50 million tons) (ibid:6). The obvious

[2] It was not explicitly stated in the report, but it is assumed that this refers to an *annual* saving of R350 million.

advantage of widening the scope of the tax is that more revenue stands to be generated by the pollution tax. However, there are several reasons why a pollution tax should *not* be introduced throughout the entire coal market:

- the external costs which the tax is supposed to be internalising are produced in the *household* market, not the other components, and so it would be theoretically difficult to justify imposing the levy on non-household sectors;
- a tax on normal coal could have significant (negative) knock-on effects on industry, electricity prices, synthetic fuels and perhaps most importantly, the competitiveness of coal exports;
- the political implications of imposing such a tax would be problematic and would be likely to elicit stringent opposition from the large mining houses.

Consequently, the tax should be targeted towards some or all of the household coal market - currently amounting to a total of about 3.3 million tons per annum.

Thirdly, the *timing* of introducing a pollution tax is critical. Given that mining houses are most likely to simply *pass on* the tax to their (wholesale) customers, who will do the same with theirs, the net effect is that the end-user will face a higher price for coal. This could have highly unfavourable effects, if consumers do not have any effective *alternative* means of meeting their energy needs. If a tax were to be introduced without any alternatives, it would simply increase the expenditure burden on low-income households - an inequitable situation which is undesirable given the government's commitment to improving the quality of life of the poor. Consequently, a pollution tax should be introduced *only* when *affordable alternatives* are available to households, such as a low-smoke fuel.

Fourthly, the *amount of the tax* is an important consideration. Ideally, the amount would be set equal to the marginal external cost associated with any given level of output (with reference to Figure 2.1, this would be the MEC, equal to the difference between MSC and MPC). In order to estimate this amount, it would be necessary to produce a better estimate of the health costs resulting from coal use (as outlined in section 2.2 above). If, for example, the external costs were estimated to be R100 million per annum, and a linear relationship was assumed to exist between coal consumption (3.3 million tons nationally) and health effects,[3] then this would translate to a pollution tax of just over R30 per ton of coal sold in the household market. This represents about 60% of the pit-head price, or 15% of average retail prices which are around R200 per ton. For present purposes, a figure of R30 will be used as an indication of the order of magnitude of such a tax; however, it is imperative that the level of certainty about health costs is increased before introducing such a tax in practice. It is also interesting to note that the tax would be much lower if its scope was widened: if the R100 million was spread across the entire local coal market (some 131 million tons), then the effective tax would be only R0.76 per ton, and if export sales were also taxed, then the levy would be further reduced to R0.55 per ton of coal. However, there are disadvantages of widening the scope of the pollution tax beyond the household market as described above.

An added advantage of imposing a pollution tax on bituminous coal use by households, once low-smoke fuels are in the market, is that the price differential between the two kinds of product will then be reduced by virtue of the higher price for normal coal. The required level of price support for low-

[3] It is not strictly correct to assume that health effects will vary directly with coal consumption, but for practical purposes, this is the simplest approach and does not compromise the essential logic of the argument.

smoke fuels (which is discussed in the following section) would be accordingly reduced.

It must also be noted that the intention of imposing a pollution tax on bituminous coal should *not* be to raise general revenue for government. Rather, the tax is intended to internalise the external costs associated with coal. Consequently, the tax should not be directed towards the general fiscal pool, but should be administered separately. Numerous options exist for administering such a tax, ranging from the use of companies under government control, such as the Central Energy Fund, to in-house administration in the Department of Mineral and Energy Affairs. It should also be noted that the additional administration costs could be financed out of the proceeds of the tax. This need not represent an excessive financial cost: for instance, if the pollution tax was, say, R30 per ton, and 80% of the tax was actually collected (that is, 20% bad debts), this would generate about R79 million per annum. Such a tax could perhaps be administered by two to three full-time staff, including professional inspectors, and even with generous allowance for overheads, operating costs would be less than R500 000 per annum - this represents only 0.6% of revenues going towards administrative costs.

This is sometimes referred to as 'earmarking' of funds - in other words the proceeds of the pollution tax are dedicated to some kind of environmental fund (intended, for example, for the cross-subsidisation of low-smoke fuels). Whilst earmarking is preferred on the basis of the argument in the previous paragraph, it should be noted that there are also disadvantages to this approach: firstly, it constrains the treasury in its overall allocation decision-making, since the earmarked revenues are not under its control and are therefore not evaluated according to the same criteria as other social needs. Second, there is a cost attached to maintaining a separate accounting and administrative system for this fund; if there was a multiplicity of dedicated funds, the administration costs could become excessive. Third, there can be complications in the reporting of government expenditure (a key macroeconomic variable) if this expenditure is distributed in a range of dispersed accounts.

These issues require weighing up against the advantages of having a relatively secure source of dedicated funding available for low-smoke fuels. If this option is followed, it would be important to ensure that the allocation decision is reviewed periodically by the fiscal authorities and by the political decision-making process, so that the allocation decision inherent in a dedicated fund, will not diverge from macroeconomic priorities over time.

The levying of a pollution tax on household coal may necessitate improved accounting systems at the point of sale on the mines, since a clear distinction will need to be made between coal sales destined for household consumption and coal destined for industrial or commercial users. In practice, this might be achieved by requiring merchants and wholesales to produce exemption certificates in respect of coal which they will be selling to industrial or commercial consumers. The validity of such certificates could be verified with reference to adequate sales records.

Finally, it should be noted that a number of precedents exist, even in South Africa, for the imposition of taxes and levies on energy sources. Firstly, the levy on petrol and diesel was originally intended to generate funds for investment in road transport, but has subsequently become a major source of general government revenue. As at December 1992, the fuel levy amounted to 54.9 cents per litre of petrol and 47.4 cents for diesel, and raised a total of R8 billion for government, or 10% of fiscal revenue for that year (Eberhard & van Horen 1994:14). Secondly, in the electricity industry, the budget of the recently-established National Electricity Regulator is being financed through a very small levy (a fraction of a cent) on every unit of electricity sold. Thirdly, the synthetic fuel industry has received tariff protection since its inception, with a view to allowing the locally-produced synfuels to compete with conventionally-refined petrol. This tariff protection, which was paid to Sasol, was estimated to amount to around R450 million in 1992 (EHR 1993:24).

Consequently, there is little ground for opposing a pollution tax on the basis that taxes on energy commodities have not been applied before in South Africa. If anything, there are much stronger theoretical arguments in favour of the imposition of a pollution tax on dirty household coal, than there are in favour of already existing taxes on petroleum and electricity sales. This is certainly the case when the development benefits of low-smoke coal are compared with the effects of other forms of fiscal intervention.

2.4 Price support for low-smoke fuels

It has been widely argued that low-smoke fuels need to be priced competitively with bituminous coal if they are to make any real inroads into the low-income household coal market. It is probably prudent to assume for the meantime that if households are able to pay a premium for low-smoke fuels, then it will probably be so small as to be negligible. Current estimates of production and distribution costs of the various low-smoke fuel prototypes suggests that none of them are able to compete directly with bituminous coal on price alone (refer Chapter Three and Four). Consequently, low-smoke fuels will require some measure of price support to bring their prices within the range of household affordability, at least until they have secured enough market share to have a measurable health impact.

One of the first issues to address, relates to the *amount of price support* which the government could offer to promote low-smoke fuels. Given that a wide range of low-smoke products may soon be on the market, with very different price structures and levels, it is not possible to specify exactly what amounts are appropriate to expend. Several principles can be established:

- Price support should not favour any one product or producer over another, implying that products with different retail prices will receive the same level of support in absolute terms (Rands per ton), rather than in relative terms to bring down their retail prices to a common level.
- The amount of price support should be sufficient to *reduce the risk* facing producers considering making an entry into the market.
- The amount should be determined such that producers will have a strong *incentive* to *innovate* and improve their products and service. This would not be the case, for example, if the amount of the subsidy was fixed, at a high level, which gave producers no incentive to bring down their production costs or to achieve economies of scale.

Another critical issue in the provision of price support relates to the *point of intervention* in the supply chain. This issue is especially important in view of the fact that there are still *several* low-smoke fuel products which are potential candidates for price support. Consequently, any price mechanism which is designed at this stage should be sufficiently robust and generalisable that it can be applied to any number of the prototype fuels which may be developed further. Moreover, it does not appear at this stage as if the policy approach is to `pick a winner' and then support that one product; rather, the approach should be to facilitate the production of any or all low-smoke fuels which meet the necessary technical specifications.

These considerations need to be consistent with the practicalities of intervening in the supply system.

Broad options for the point of intervention include:

- *End-users* could be given financial assistance to purchase low-smoke fuels rather than bituminous coal. This could possibly be done with the use of rebate coupons, which could be given to consumers who could then use them to pay coal suppliers who, in turn, would redeem these coupons with the official agency. This option, however, presents great practical difficulties insofar as the issuing and administration of coupons to end-users is concerned, since it would be extremely difficult and costly to establish a system whereby consumers could be given the coupons in the correct quantities and at appropriate times. Further, it would be difficult to ensure that the coupons were used for the purchase of low-smoke rather than conventional coal, especially if it was in merchants' interests to sell the latter.
- The second category of stakeholders in the coal market, is the *intermediary* group of wholesalers, distributors and merchants. This seems to be an impossible arena for intervention, because of the variability and informality of this market; in some cases, end-users by-pass these intermediaries altogether and purchase from mines instead.
- The final group of participants in the low-smoke fuel market, will be the *producers* themselves. This appears to be potentially the best point at which to provide price support, because there will be relatively few parties (at least compared to end-users), accounting systems could potentially be fairly reliable, and quality control checks can be done here.

Considering this option in more detail, it could be possible to provide rebates to producers of low-smoke fuels which meet all technical specifications, on the basis of a specified value per ton of output. This amount could be paid over to producers on a regular basis (so that their cash flow is not unduly stressed), on the submission of simple returns to the implementing agency. The rebate could be paid to producers when the product has been produced, before it is sold. This would not expose the system to abuse from unscrupulous producers, since there would be no incentive for them to produce any quantity of low-smoke fuel, simply to collect the rebate, unless the product is sold to consumers. They are unlikely to incur any expenditure, (and therefore receive any rebate), unless they are assured of selling their products in the market, which means that they will have every incentive to market and distribute their products in the target market.

With regard to the *enforcement* of this possible system of price support, it would be necessary to have a small number of (one or more) technical staff whose responsibility it would be to audit the returns of the manufacturers, to ensure that they have produced the quantity of low-smoke fuel for which they are claiming a rebate. This core of staff could possibly be linked with the quality control function, which would periodically ensure that low-smoke products do in fact meet the specified technical standards. Once again, the costs of enforcement, if the rebate is operated in this segment of the market could be reasonably low.

Two main *sources of finance* exist for this price support. The first is the *general budget* of the Department of Mineral and Energy Affairs. Motivations would have to be made by the Department for funds to be allocated to low-smoke fuels, and this would have to be evaluated along with all other competing demands on the government's budget. In the context of the direct benefits which are likely to accrue to a large number of people, it is suggested that such motivations could and should be looked upon favourably by the fiscal authorities, especially in relation to the other large budgetary grants which are made to the nuclear and other sectors.

The second main source of finance would be available if price support is implemented in conjunction with a pollution tax (as outlined in the previous section). The revenue generated by a pollution tax could be dedicated to finance low-smoke fuels and managed in a special-purpose fund. In essence, therefore, this option entails a *cross-subsidy* from bituminous coal to low-smoke fuels. At some point, the revenue collected from the pollution tax could exactly offset the amount expended on price support for low-smoke fuels, and the net effect on the fiscus would be zero. This point depends on the relative sizes of the pollution tax and the amount of the rebate (in Rands per ton). On either side of this break-even point (Q_1 in Figure 2.2), it is clear that the inflows and outflows from government would be unequal and budgeting would have to proceed accordingly.

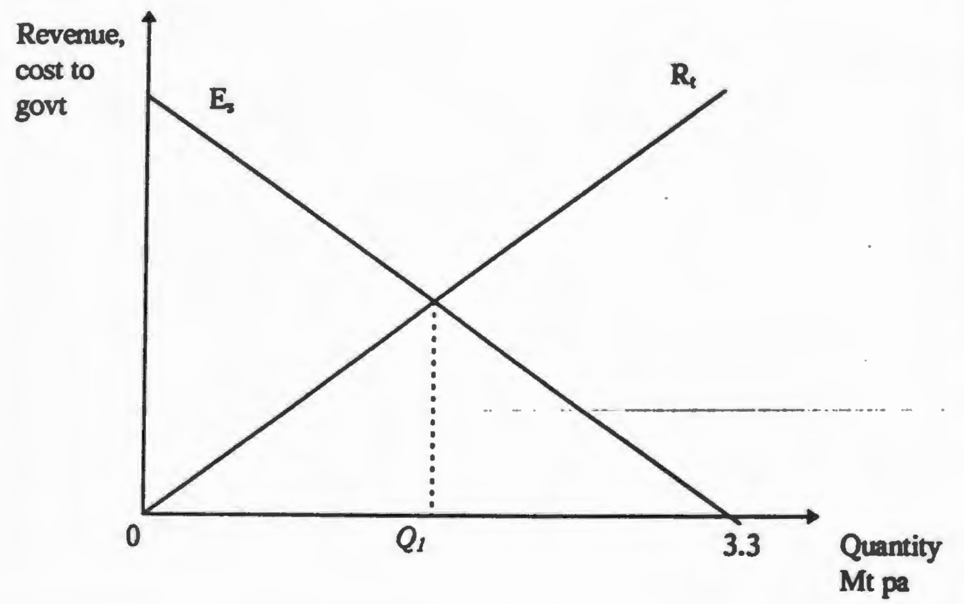


Figure 2.2: Illustration of relationship between revenues from a pollution tax on bituminous coal (R_t), and expenditure on price support for low-smoke fuels (E_s)

In the short- and medium-term, it would be necessary for the government to make a *clear commitment* to provide a specified level of support for low-smoke fuels. This commitment is necessary to provide the kind of enabling environment in which private producers would make investment decisions and enter the market - in essence, it is important for government to clearly lay out its intentions in this regard, and give a commitment to producers for as long as possible. This will have the effect of *lowering the risks* faced by private manufacturers of low-smoke fuels, which as stated earlier, should be a key objective for government.

In the longer-term, price support could be phased out if conditions in the household coal market change sufficiently to warrant this. A scenario can be envisaged in which general disposable incomes rise across the board (which is dependent on macro variables such as economic growth, improved income distribution), following which households might be more willing and able to pay a greater premium for low-smoke fuels or, indeed, for electricity. Similarly, if there is an effective substitution of fuels, it may be possible to phase out price support in the longer-term. Again, the conditions under which this might happen - basically once bituminous coal has been fully and permanently substituted by other energy sources - should be clearly specified so that producers entering the low-smoke market have minimum uncertainty about the long-term future of government support for their products. This would obviously also be tied to legislative options for enforcement of smoke control zones (refer to Chapter Five).

2.5 Marketable emissions permits (MEPs)

This was identified in the literature as a control option which could be applied in markets where pollution is commonly emitted. For this to be applied in the South African coal market, several requirements would have to be met:

- The government would have to set an overall limit on the amount of pollution which could be emitted by households, and based on this limit, issue a corresponding number of permits to producers of coal.
- Government would then have to establish a market or forum in which these permits could be traded and exchanged by interested parties.
- This market would have to be managed by government authorities, in particular, it would be necessary to have an enforcement or regulatory function, which would ensure that permit holders were responsible for emissions not in excess of their allowable quota.

The motivation for this system would be that producers of coal would have an incentive to produce and sell coal with lower emissions, because then they would not have to purchase permits. In the correct circumstances, producers would move towards less-polluting technologies or products with favourable environmental effects overall.

In the context of the South African household coal market, this policy option faces considerable impediments, which effectively preclude it from further consideration at this stage:

- MEPs are most usefully implemented where producers are able to make differential changes in technology or process; however, in the household coal market, there is significant uniformity in the coal market. There would be little incentive for producers of coal to change their products at all, since all producers would be faced with exactly the same additional cost (for the permits), the same consumer demand and the same ability to simply pass on the additional cost to their captive market. This lack of differentiation between producers means that there would be no incentive created by MEPs on their own, for producers to shift towards low-smoke fuels.
- The administration costs of the MEP option would be considerable. In the first place, the market would have to be established, which would require much publicity and education since this has not been introduced before in South Africa. Secondly, the market would have to be managed on an ongoing basis; in practice this would mean that an arena would have to be provided in which all stakeholders could make offers to buy or sell their permits. Thirdly and perhaps most importantly, there would be large costs associated with ensuring that permit holders consistently adhere to their allowable emissions quotas (effectively, that they sold only as much bituminous coal as they were entitled to).

In the face of these practical difficulties, it does not appear that a system of marketable emissions permits could feasibly be implemented in the household market, certainly, not with the desired effect on pollution levels.

2.6 Tax concessions and incentives

An option which is sometimes proposed by specific interest groups in various sectors, is the use of fiscal incentives or tax concessions to encourage behaviour which is consistent with the relevant goals. In the case of low-smoke fuels, these incentives could take two main forms.

2.6.1 Direct taxation incentives

Firstly, amendments could be introduced to the system of *direct taxation,* specifically income tax. Such incentives could take the form of more rapid depreciation write-offs of capital equipment used in the manufacture of low-smoke fuels, or special deductions for related expenditure which would otherwise be treated in the usual manner as specified in the Income Tax Act. Precedents exist for such special treatment in the South African taxation system; for example, exporters were granted generous deductions for their marketing expenses during the apartheid era when international sanctions restricted access to foreign markets (sections 11 *bis* and 17 of the Income Tax Act No 58 of 1962). Likewise, film-making has also benefited from special taxation treatment (section 24F). An argument could thus be offered that special treatment should be provided to encourage investment in products which meet national development goals, such as low-smoke fuels.

While the option of providing tax incentives to participants in the low-smoke fuels sector may appear attractive from the perspective of energy policy-makers, it presents some problems for fiscal agencies - specifically the revenue collection authorities. The introduction of certain provisions for specific sectors carries its own *cost,* in terms of the increased collection and administration burden on income tax authorities. South African income tax practice has historically been characterised by increasingly fragmented and disjointed legislation and administration, and current reforms of the system are moving towards *fewer* exceptions and `special cases'. Thus while this represents a disadvantage to the policy option outlined here, it is not to say that the DMEA which is responsible for promoting low-smoke fuels should not attempt to persuade the fiscal authorities to introduce legislative amendments which will support its other initiatives. On their own, however, it is unlikely that tax breaks will be very effective in promoting investment in the low-smoke fuels market.

2.6.2 Indirect taxation incentives

A second manner in which fiscal incentives could be applied to encourage the production and distribution of low-smoke fuels, would be reduce or waive *indirect taxation* on products which meet the necessary specifications. Bituminous coal is, at least in theory, subject to Value Added Tax (VAT) of 14%. Thus if low-smoke fuels were to be zero-rated (or exempted from VAT), as is the case with certain basic commodities, this would give these fuels an immediate advantage over normal coal. This would make low-smoke fuels more affordable to low-income consumers, which could therefore increase the return on investment to potential producers.

In practice, however, this scenario would probably not work as it has just been outlined, particularly at the end of the supply chain. As noted previously, the household coal market is extremely informal and VAT legislation is not adhered to on the whole among merchants and informal traders.

Consequently, amendments to the VAT system affecting the end of the supply chain would be largely ineffective under current market conditions. However, the potential for introducing a price advantage for low-smoke fuels is much greater ***higher up*** the supply chain, at the point where coal leaves the mines. VAT is currently levied and collected from sales of bituminous coal by mines, which adds 14% to the pithead price. If low-smoke fuels were zero-rated, they would have an immediate structural price advantage. Moreover, this price advantage would possibly have an increased effect on end prices, especially if subsequent mark-ups in the supply chain are based on percentage increases as opposed to absolute amounts, since these percentages would then be based on a lower starting price for low-smoke fuels.

The general principle underlying exemptions and zero-rating for VAT purposes is that this applies only to commodities which are classified as meeting the basic needs of the poorest social classes. A strong argument could be made by the government that low-smoke fuels are doing exactly that: meeting the basic energy needs of the urban poor, in a manner which simultaneously improves their health status.

There appear to be two immediate disadvantages with this option. The first is the same problem as occurs with income tax exceptions, namely the preference of fiscal authorities for a simpler taxation system with fewer exceptions and therefore lower administration costs. This policy option obviously conflicts with that objective.

The second problem with zero-rating low-smoke fuels is that there would be a loss of revenue to government if and when these fuels replace conventional coal which is taxed as normal. Assuming for illustrative purposes that VAT is collected only at the first link in the supply chain - from mine sales - then the total revenue which may be foregone can be estimated as follows: total quantity sold is 3.3 million tons, average pit-head price is R50 per ton,[4] and so the total VAT currently collected on this is R20.3 million per annum (R6.14 per ton times 3.3 million tons per annum). This amount is insignificant in relation to total government revenue, which is in the region of R130 billion for the current fiscal year. Moreover, it is unlikely that low-smoke fuels will saturate the entire household coal market for some time to come, so that this represents an upper limit of potential revenue loss, and in practice, the foregone revenues would probably be much lower.

2.7 Access to finance

A final area in which the government can provide an ***enabling*** policy environment for low-smoke fuels, is in the provision of ***finance*** for potential investors in low-smoke fuels. While some potential producers are part of large industrial groups, and could therefore secure finance at prevailing market rates, the same will not be true of small producers who may wish to enter the market. Many smaller producers may face constraints in securing any finance whatsoever, or if they do, it may carry a high risk premium due to their relative institutional weakness.

In line with the government's current efforts to encourage the development of small and medium enterprises (SMEs) especially those owned by people from historically marginalised communities, it will be important for the government to assist new producers of low-smoke fuels to secure the

[4] Few reports of coal prices specify whether this is the price ***including*** or ***excluding*** VAT. For present purposes, it is assumed that prices include VAT; either way, this assumption will not materially affect the calculation being done here.

necessary finance on the most favourable terms. It can do this by assisting potential investors with making loan applications to parastatal financing agencies, such as the Small Business Development Corporation (SBDC) and the Industrial Development Corporation (IDC). The Department of Mineral and Energy Affairs should use its leverage to encourage relevant public sector institutions to provide low-cost finance to investors which show potential for making progress in the low-smoke fuels market.

This is consistent with the approach suggested earlier, which should seek to provide producers with an enabling environment, and specifically one in which the risks of entering the low-smoke fuel market are reduced. One of the key risks faced by potential investors, is *financial risk*, and this can be considerably reduced by providing access to concessionary sources of finance.

Chapter Three

Current low-smoke-fuel prototypes and their cost of production

3.1 Introduction

The cost of low-smoke fuels, relative to presently used bituminous coal is an important determinant in the likelihood of low-smoke fuels replacing bituminous coal as the commonly used household fuel. Thus in order to consider possible market intervention options it is important to quantify this difference. As a first step in making this comparison it is necessary to determine the likely *production cost* of low-smoke fuels and hence this chapter will describe the various fuels, their method of production and provide available information on their ex-production cost. Chapter Four will address *post production* costs incurred mainly in the distribution of the fuels.

Although it is also important to consider the technical performance of fuels with regard to emissions and other features such as reactivity, hardness and cleanliness as these influence their acceptability to potential users, for the purposes of this report it will be assumed that all the fuels will meet a low-smoke fuel standard that is presently in the process of being established through the low-smoke fuel programme.

3.2 Description of low-smoke fuels

There are two broad approaches to producing low-smoke fuels:

- bituminous lump coal or processed discards are partially devolatilised to produce a lean coal, and
- discard coal fines and duff, and in some cases biomass wastes, are briquetted using a binder.

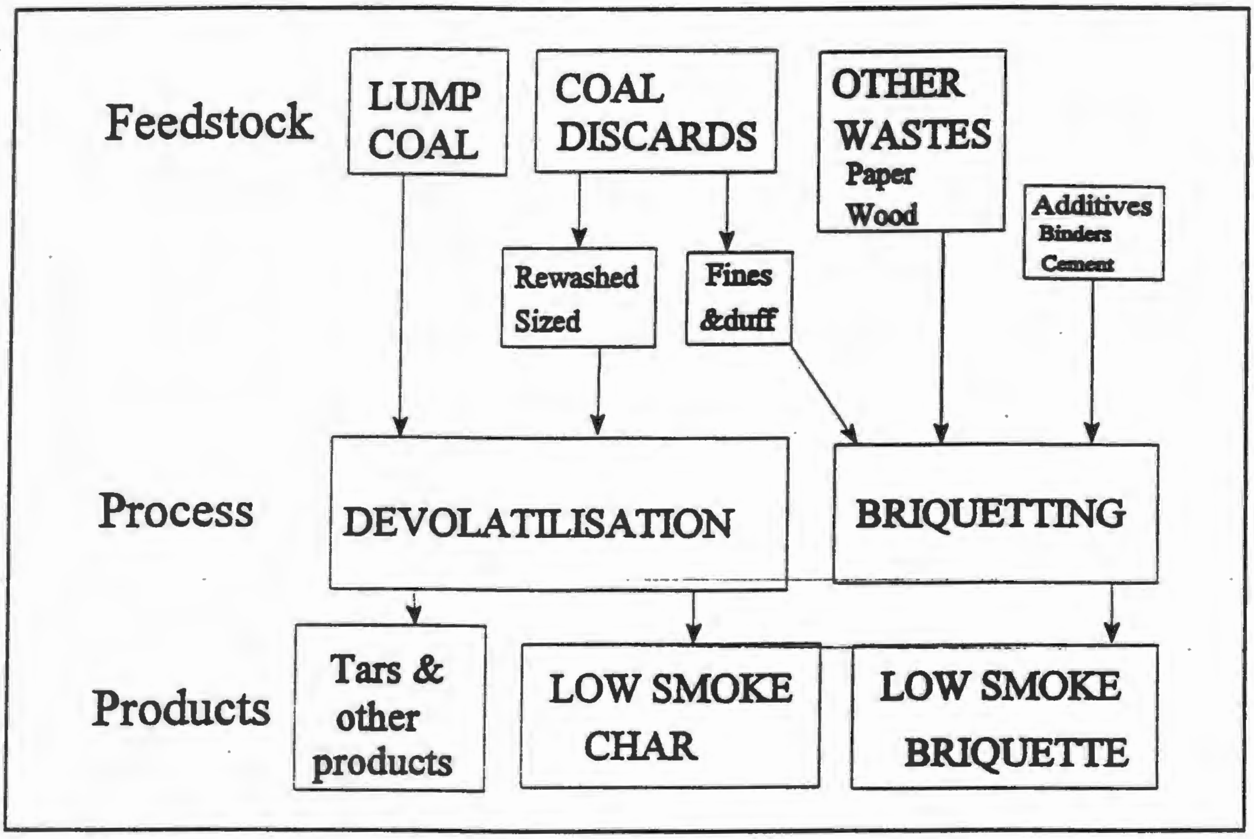
These two processes with their constituent feedstock are depicted in Figure 3.1.

Figure 3.1 shows that there are three categories of feedstock for the production of low-smoke fuels; lump coal, coal discards and biomass wastes. Lump coal is available in sufficient supplies although its cost is high relative to the other feedstocks. In the case of lump coal, tars can be captured during devolatilisation and their value can, to a minor extent, offset the cost of the bituminous coal feedstock.

With regard to coal discards, South Africa produces large quantities of plant discards, with a calorific value (CV) ranging from 5 - 20 MJ/kg (Horsfall 1994). The quantity produced is of the order of ten times the national annual household coal consumption. A number of mines in the Witbank area, notably those supplying the export market, reject large amounts of reasonable quality coal (ash 25-30%, CV≤ 20MJ/kg).

The quantity of biomass wastes such as saw dust, wood shavings, food processing by-products and paper, is at present not clear. Paper consumption in South Africa is 49 kg/capita/annum (Heron 1995). Given a population of 40 million, this translates into a total national paper and board consumption of 1.96 million tons/annum. Of this, the pulp and paper industry is recycling 38% (ibid) of the annual consumption leaving a total of 1.2 million tons/annum of unutilised waste paper and board. There is no information on the proportion of this that may be suitable for briquetting, although it is likely that a large proportion is unsuitable. In addition, this waste is generated across the entire country and hence there is a high associated collection cost.

Figure 3.1: LSF production approaches (Dickson et.al. 1995)



Seven organisations are currently involved in the development of low-smoke fuels. These are listed in Table 3.1 and each fuel is described in Section 3.2. It should be noted that there are presently no commercially available low-smoke fuels, although two fuels are being marketed on a pilot scale and are close to production on a scale large enough for commercial distribution (Ecofuel and Easi Coal). Only three of the seven fuels (Wits/UCP low-smoke coal, CSIR briquettes and Ecofuel) have been tested with respect to emissions (Rogers & Pieters 1994) and these three fuels have also been the subject of field tests which sought to test acceptability to consumers (Hoets 1992, Hoets 1994, Dickson et al 1995).

Table 3.1: Summary of low-smoke fuels described in this report.

Fuel	*Feedstock*	*Production Process*	*Organisation undertaking development*
DEVOLATILISED FUELS			
Wits/UCP low-smoke coal	Sized discard lump coal.	Devolatilisation on moving grate using waste heat.	Univ. of Wits and United Carbon Producers
Coal Tar Products low-smoke coal	Lump coal or sized discards.	Devolatilisation in a continuous retort process. Tars are also captured during the process.	Coal Tar Products (Pty) Limited
Sastech fuel	Lump coal	Devolatilised lump coal or briquetted precharred fine coal .	Sastech - a division of Sasol
BRIQUETTED FUELS			
CSIR briquettes	Discard fines, duff & Portland cement	Mixture cast in a slab and broken into blocks after curing.	Council for Scientific and Industrial Research
Ecofuel	Waste material (wood shavings, coal duff), wax and unspecified binder	Extruded cylindrical briquette with a hollow core	Ecofuel (Pty) Ltd
Easi Coal	Duff coal and/or high carbon content waste with calciumligno-sulphanate binder	Briquetted into cube shaped blocks with perforations	Duffco, in association with Anglovaal
Sastech fuel	Precharred fines and duff coal .	Briquetted	Sastech - a division of Sasol
Firebrick	Waste paper, wax and other unspecified chemicals.	Pressed, solid brick-shaped briquette.	Alan Rodkin Organisation

3.2.1 Devolatilised coal

3.2.1.1 Wits/UCP devolatilised discard coal

Research at the University of the Witwatersrand, in association with United Carbon Producers has resulted in the development of a prototype low-smoke fuel (Wits/UCP fuel). The production process entails the washing of discard coal which separates the combustible fraction from excess ash and stone. The washed coal is then heated, using waste heat, under controlled conditions to a point where it is divested of most of the smoke forming tars. Sufficient gaseous components in the coal particles are retained to allow easy ignition and combustion in natural draught appliances designed for ordinary discard coal (Horsfall 1994).

The concept of the fuel is based on the fact that South African coal deposits are characterised by seams containing variable materials with some portions having a low inorganic content, while others have a high inorganic content with the different components possessing varying calorific values. The major smoke forming component of coal is contained in the 'vitrinite' which tends to be concentrated in particles of lower density which is also the component extracted for export. As a result the discards have the potential for producing less smoke even if not heat treated. Standards demanded by the export market mean that coals with a relative density above about 1.6 (ash content greater than 25%) are rejected and hence seam components with a relative density greater than 1.6 (but less than 1.9, where the calorific value becomes too low) are available as a potential feedstock for low-smoke coal. Tests at one particular mine showed that at a washing density of 1.9, a product with 25% ash content, 20% volatile matter, 1.0-1.1% sulphur content and in the 10 to 15 mm size range could be produced with some consistency. Rewashed discards may be sized into any range required for processing because, as mentioned above, the quantity of coal discarded each year far exceeds the present household coal market. The washing of the discards presents no technical problem as well-established economically-viable technology is available. Discards from any one mine could be screened to give a narrower size range.

The characteristics of the prototype low-smoke coal produced by UCP at their Vaal facility at Viljoensdrif are given in Table 3.2 and compared with the rewashed feedstock used and D grade coal.

Table 3.2: Comparison of smokeless fuel with grade D coal and rewashed discards (Source : Horsfall 1994:16)

	D Grade coal	*Rewashed Discards*	*Low-smoke fuel*
Ash [%]	23	30	35
Volatiles [%]	24	20	13
Calorific Value [MJ/kg]	25	20	22

Early tests showed that there were a number of problems with the fuel (Horsfall 1994). Firstly it was slow to ignite and slow to heat the stove to a point where it was usable for cooking. Also there was too much undersized fuel in the batch. These problems were largely a result of using a chain grate facility that was not designed specifically for the production of low-smoke coal and indications are that the fuel would be far more acceptable if produced in a modified plant. Thus the system of heat treatment has been defined but cannot be achieved until the required capital is invested for the modification of a stoker. The fuel, however, showed smoke emissions considerably lower than those of normal bituminous coal, and because the fuel burned at a lower power, fires could burn for long periods and also result in more efficient use of the heat generated (ie. less heat is lost up the chimney with a slower burning fire).

3.2.1.2 Coal Tar products devolatilised lump coal

Coal Tar Products (Pty) Ltd is a company linked to General Energy Systems, a company undertaking energy management in industrial plant, and has expertise in coal technology, coal combustion and gasification of coal, as well as other energy-related issues. Relatively recently Coal Tar Products has undertaken development work on a low-smoke coal (Beningfield 1994).

Coal Tar Products undertook design work to improve on moving grate technology offered by United Carbon Producers for the devolatilisation of coal. The objectives of the design were:
- to reduce the thermal shock effect on the coal to retain the size grading of the "char" and eliminate the fine particles as much as possible (of specific concern is the production of a reactive carbon material which is sufficiently strong for handling and transportation), and
- to offset the cost of production by the recovery of the volatile matter in the form of tar and oil, which are commercially valuable.

Coal Tar Products has built a pilot plant which demonstrates the process and caters for the controlled production of reactive carbon with whatever volatile content is required. The plant has been successfully operated with a variety of coal types. Presently a full scale plant for the production of char for the chrome industry is being constructed and will be complete in August 1995. The plant design is based on a continuous retort concept which has steam injection to provide the carbon reactivity requirements. The same plant or an identical version could be used to produce low-smoke coal with the necessary volatile content. Based on the production of char with a volatile content of 2% for the chrome industry, the design output of the full scale plant is 120 000 tons/annum. However, if it is used for the production of low-smoke coal (with a higher volatile requirement) the throughput of the plant will be higher.

3.2.2 Reconstituted fuels

Although large quantities of discard coal are generated each year in South Africa not all of it is suitable for low-smoke briquette production. Total discard production was estimated at 49 million tons in 1991, 62 million tons in 1994 and it is estimated that this will grow to 82 million tons in the year 2000 (Grobbelaar & Horsfall 1994). Of these quantities only the fines and duff or about 12 % (5.9, 7.4 and 9.8 million tons in 1991, 1994 and 2000 respectively) has sufficiently high CV to be suitable for the production of low-smoke briquettes. The fines and duff will need to be separated from the overall discards produced and hence there is an associated cost. The cost of separating the required fines and duff will to some extent be offset by the present cost of discard disposal.

3.2.2.1 CSIR coal briquettes

As part of the DMEA funded low-smoke fuels programme, Mattek at the CSIR has developed a briquetted low-smoke fuel which is produced by binding coal discard fines and duff with cement. The process is labour intensive and extremely simple and hence has the potential to create numerous work opportunities. Production involves mixing the ingredients, in a ratio of 100 kg of coal to 15 kg of cement and 21 kg of water (Tait 1993) either in a concrete mixer or by hand, and casting a 100 x 3000 x 3000 mm slab on the ground. While the mixture is still green, it is scored in order to facilitate its breaking up into sizes suitable for use in standard coal stoves and braziers. After the slab has cured for seven days the slab is broken into small sizes and then bagged. One slab produces 2 tons of fuel. There is about a 20% wastage due to fines being generated during the breaking process. This is reused in subsequent mixes. Table 3.3 gives the specifications of the CSIR briquettes in comparison with a typical bituminous lump coal.

Table 3.3: Comparison of lump coal and CSIR briquettes. (Source: Tait 1993)

	CSIR briquettes	*Lump Coal*
Calorific Value [MJ/kg]	24.0	26.7
Ash Content [%]	24.9	17.1
Volatile Content [%]	18.0	28.4
Carbon content [%]	54.1	53.5
Smoke sulphur [%]	0.7	2.8

To date briquettes have only been produced in-house by the CSIR in Pretoria. Nevertheless Tait has suggested three approaches to the production of the briquettes (cited in Dickson et. al. 1995: 4-12). All of the approaches are labour intensive and have employment creation as one of their fundamental objectives.

- *Coal merchants utilise fines generated by bituminous coal handling in their yards to manufacture briquettes.* For the merchant, the advantages of this approach is that no-value fines are converted into a saleable product. Because the feedstock has already been transported and is hence available close to the market, the cost of briquette production is low. However production on this basis can never replace the bituminous coal market as it is based on sales of bituminous coal being far greater than that of the reconstituted fuel. For this reason this approach will not be considered further as a possible viable approach to low-smoke fuel production.
- *Coal merchants purchase suitable duff coal from mines and produce briquettes in their yards.* In this scenario the manufacturer and the distributor is the same party and hence the overall cost to the end user could be lower.
- *Integration of briquette production with the rehabilitation of duff coal dumps.* In this scenario it is unlikely that the coal merchant will be the briquette producer and hence there will be an extra party involved in the production/distribution process.

A notable characteristic of the CSIR production technique is that very basic equipment is required for production and hence the capital requirement for establishment of plant is low. However, because the fuel output per work-station is low, a large number of workstations will be required to satisfy overall demand. A potential problem with having a large number of small producers at many different locations is that *quality control* of the fuel will be difficult to achieve.

3.2.2.2 Ecofuel briquettes

The company Ecofuel has developed a fuel which is an extruded, cylindrical briquette with a hollow core. The briquettes are manufactured under high pressure from recycled material (anthracite or coal duff - 3 mm and smaller), with a binder and are then covered with a wax coating to form a hard briquette capable of withstanding rough handling during packaging and distribution.

The fuel was originally intended to compete with wood in areas experiencing fuelwood scarcities, but because of the products high relative cost, the marketing focus has shifted to urban areas and aims to compete with gas and paraffin as a convenient and quick fuel. The fuel is clean to handle and has a high reactivity, allowing swift ignition and rapid development of a hot fire which allows for quick cooking operations. The shape of the briquettes, with the cylindrical centre hole give it a high surface area to mass ratio allowing good air flow through the fire and hence a high burn rate. Another advantage of the fuel is that it can burn on the ground (like wood) and therefore does not necessarily require an appliance. The DMEA incorporated this product into its research support programme during 1993 and hence has been tested for emissions in the laboratory and also field tested for user acceptability. These tests showed that the fuel performed very well with regard to emissions (Rogers & Pieters 1994) and was also found to be very acceptable by users (Hoets 1994).

3.2.2.3 Duffco's Easi Coal low-smoke briquettes

Duffco has been involved in the development of low-smoke fuel briquettes for about five years. About two years ago Anglovaal became a major shareholder in the company and this has allowed the accelerated development of a low-smoke briquetted fuel product. It is intended that the product will be in production and available on the market by June 1995. The product is aimed at the poorest sector of the household fuel market and in-house market research has shown the product to be acceptable.

The briquettes are 105x105x50 mm in size with perforations to facilitate air supply during combustion. They are manufactured from D grade duff coal with calciumlignosulphanate, a waste product from the production of paper, as a binder. According to Jabremski (1995) about 70% of the mass of the fuel is duff coal with the remainder being made up of a waste product with a high carbon content and the binder. The calorific value of the fuel has not yet been measured however it is estimated by Duffco to be about 25 MJ/kg.

According to Duffco one briquette is sufficient to cook one meal. This is based on the assumption that the briquette will be used in a specially made "5 litre can stove" and hence will burn very close to the base of the pot. These five litre can stoves can be extremely easily and cheaply made from virtually any circular 5 litre tin and a few pieces of wire, however if the briquettes are used in standard coal stoves more than one briquette will be required and hence the fuel will be expensive to use.

Advantages of the fuel are as follows:

- The briquettes ignite very easily and quickly and are, therefore, suitable for quick cooking operations. This rapid ignition makes the fuel more efficient than less reactive fuels when used for cooking, as there is no waiting period before the fire is hot enough to start cooking (this argument obviously does not hold if the fire is also being used as a space heater).

- The shape of the briquettes allows compact packaging and hence the energy density of the packaged fuel is high. This facilitates cost effective transport and handling.
- The technology developed by Duffco is not limited to the use of duff coal as a feedstock, and can be used for the production of briquettes using biomass based waste products such as 'filter cake' from fruit juice production in the Western Cape. Duffco is in the process of investigating these other options.

3.2.2.4 ARO Firebrick

The Alan Rodkin Organisation's "firebrick" is a fuel that has reached prototype stage and consists basically of compressed wastepaper which is impregnated with an unspecified flammable chemical and then coated with wax. The developer has not disclosed the relative proportions of components of the firebrick. Both the wax and the chemical are products of Sasol.

To date prototype bricks, which are 230x100x100 mm in size with a weight of between 1.1 and 1.2 kg have been manufactured in a hand operated press. A determination of the energy content of the fuel was carried out by Sasol Waxes using the American standard test method (ASTM No D2015/77). For the test a small sample of the brick was cut off and the results could vary depending on which portion of the brick was used due to the coating having a different CV to the core. Tests were undertaken on two versions of the firebrick, one uncoated and a second with a coating of wax. The calorific values are 30.2 and 31.8 MJ/kg respectively.

3.2.2.5 Sastech low-smoke fuels

Sastech has performed "laboratory" work on the development of technology to briquette most South African coals without a binder (Slaghuis, 1994). Sastech points out that the concept and production of low-smoke coal is not new and that the technology is well known. The basic concept and characteristics of Sastech's fuels have been set out by Ooms et. al. (1994) and are as follows:

- South African coal is low in vitrinite and therefore requires different processing conditions to those developed for the northern hemisphere, to produce a binderless briquette. Sastech has developed a suitable technology to briquette most South African coals without a binder.
- These briquettes have shown exceptional strength and resistance to temperature shock during devolatilisation. The briquettes have been shown to be water durable.
- Capital requirements are relatively high and calculations have shown the production of the briquettes to be marginally economical.
- As a possibly more economic alternative, Sastech has developed a technique by which precharred fine coal is moulded into briquettes using a readily available inexpensive binder. These briquettes have a porous structure giving them high reactivity as well as good burning properties.

At present Sastech does not have a low-smoke coal that can be marketed or tested in the field, but says that it will assess its position with regard to further development as the government's low-smoke fuels programme progresses. Thus for the purposes of this report Sastech fuels will not be considered further.

3.3 Cost of producing low-smoke fuels

3.3.1 Cost of producing devolatilised coal

3.3.1.1 Cost of production of the Wits/UCP fuel

Indicative costs of the commercial production of the Wits/UCP fuel from discards have been calculated by Ritchie and Rodgers (1994). Before calculating the cost, certain assumptions were made. These are as follows:

1. Tavistock Collieries Ltd (JCI) would make available sufficient material with the following specification:

i.	Product size	-90mm +20mm
ii.	Calorific value	21.5 - 24 MJ/kg
iii.	Ash	< 30%
iv.	Yield	40 - 50%
v.	Possible production ex ATCOM	27 000 tons/month
vi.	Operating costs	R4/ton clean coal
vii.	Capital costs	Approx. R10 million
viii.	Cost per ton of discards f.o.t. mine	R12.50/ton

Note: Tavistock Collieries would have to develop a middlings plant extension at their ATCOM facility which would entail a new middlings washing system and road truck load out facilities.

2. UCP's plant throughput is anticipated at 102 tons/day/furnace
3. UCP would realise a yield of 55%
4. The method used hitherto for the production of smokeless fuel would be that used in future, i.e. UCP would utilise their current technology.

Based upon the above assumptions and current operating costs (June 1994), the following is indicative of what the price of smokeless fuel would be in an unbagged form, available at the UCP Vaal facility.

Cost Item	*Cost [Rand/ton]*
Cost of coal f.o.t. mine	12.00
Transport to UCP Vaal plant	38.00
Landed cost of coal	50.00
Assumed yield 55%	90.92
Operating and depreciation	42.00
Sub-Total	**132.91**
Gross margin before tax (22%)	29.24
TOTAL (1994 prices)	**162.15**
Add 10% for inflation	16.20
Total	**178.35**
VAT @ 14%	25.00
TOTAL ex-production price	**203.35**

Ritchie and Rodgers (1994) state however, that as certain key information is not as yet available to UCP, cognisance must be taken of elements that would materially affect the indicative costings. These are:

- *Seasonal demand* - this factor could seriously impact upon the profitability of the scheme, making it marginal. Although the fuel can be stockpiled, the seasonal demand will create a cash flow problem for the producer.
- *Total demand* - the acceptability and consequent total demand for the product would be governed by the availability of feedstock from Tavistock Collieries and subsequently other collieries, and also UCP's ability to produce the required tonnage. Were UCP to develop their Vaal facility to its full potential, they would be in a position to gear up over a period of time to produce 27 000 tons/month or 324 000 tons/annum).

Table 3.4: Summary for Wits/UCP devolatilised lump discards

Capital cost of plant [R]	*Anticipated plant production [tons/annum]*	*Cost ex-production [R/ton]*	*Calorific value [MJ/kg]*	*Energy cost [c/MJ]*
11 million	324 000	203	22	0.92

3.3.1.2 Cost of production of Coal Tar Products' low-smoke coal

The estimates for the cost of production by the Coal Tar Products' plant is based on a capital cost of R15 million and a production capacity 120 000 tons of low-smoke coal per annum. The cost of the establishment of the plant is realistic given the fact that an actual plant is presently in the process of being erected and hence real costs are at hand. There is the possibility that the output of 120 000 tons/annum could be higher as the estimate is based on the production of char with 2% volatiles which requires longer heating periods than char with 12 % volatiles remaining as required for low-smoke coal.

The estimated cost is based on the following assumptions:

- the plant is installed at the source of coal and hence no pre-production road or rail transport is required,
- the volatile content of the feedstock is about 26% and the process will reduce these to 12%,
- the weight of char yielded will be 70% of the lump coal input,
- R15 million loan capital for the construction of the plant will be available at 15% interest over 10 years,
- low-smoke char output will be 120 000 tons/annum.

Cost Item	Cost [Rand/ton]
Equivalent cost of feedstock given 70 % yield on	
D grade coal @ R50.00/ton	71.00
Cost of loan capital (15% over 10 years)	24.20
Operating and overheads	25.00
SUB-TOTAL	**120.20**
Gross margin before tax (25%)	30.05
Total	**150.25**
VAT @ 14%	21.05
TOTAL ex-production price	**171.30**

Table 3.5: Summary for Coal Tar Products devolatilised lump coal

Capital cost of plant [R]	*Anticipated plant production [tons/annum]*	*Cost ex-production [R/ton]*	*Calorific value [MJ/kg]*	*Energy cost [c/MJ]*
15 million	120 000	171	22	0.78

3.3.2 Cost of producing briquetted fuels

3.3.2.1 The cost of producing CSIR briquettes

The components in the cost of producing the CSIR's briquettes are coal discards, cement, labour and depreciation on equipment. If it is assumed that the briquettes are produced at the source of the discards, that is at coal mines, the estimated cost of production will reflect those in Table 3.6. Pilot production by Mattek showed that on average a team of six workers could produce 4 tons of the fuel per day giving a labour cost of one and a half person-days per ton. The equipment required to achieve this includes a concrete mixer as well as tools such as spades and wheel barrows at a capital cost of about R3000. If it is assumed that there are 240 production days per annum, the annual output from one workstation will be 960 ton/annum.

Table 3.6: Estimates of cost of production of CSIR low-smoke briquettes (Mattek1994a)

Item	*Cost [R/ton]*
Cost of fines and duff *	15
Binder (15% cement @ R340/ton)	51
Labour (1.5 mandays/ton) @ R50/day	75
Equipment depreciation (3 years)	1
Sub-total	142
Gross margin (25%)*	36
Total	**178**
VAT @ 14%	25
Total ex-production price	**203**

* *Assumed figures.*

Table 3.7: Summary for CSIR briquetted low-smoke fuel

Capital cost of plant [R]	*Anticipated station production [tons/annum]*	*Cost ex-production [R/ton]*	*Calorific value [MJ/kg]*	*Energy cost [c/MJ]*
3000	960	203	24	0.85

3.3.2.2 Cost of producing Ecofuel briquettes

Ecofuel has provided no details of the cost of production of their fuel. Thus for the purposes of the remainder of this chapter Ecofuel is not considered further. Ecofuel does however provide an estimate of the likely retail price of their product (see Chapter Four for details).

The calorific value of the fuel varies between 25 and 28 MJ/kg and will be on the market at between 45 and 50 c/kg. Thus, for a fuel with a CV of 25 MJ/kg and a cost of 50c/kg, the energy cost is 2.0 c/MJ. If the CV is 28 MJ/kg and the cost reduced to 45c/kg the energy cost will come down to 1.6 c/MJ.

3.3.2.3 Cost of producing Duffco's Easi Coal briquettes

The ex-production cost of Duffco's Easi Coal briquettes will be 26.3c (30c including VAT) per briquette (Jabremski 1995). Each briquette weighs 350 grams and hence the cost is 75c/kg. Given a CV of 25 MJ/kg, the energy cost is 3.00 c/kg. These figures are based on a pilot plant that is close to going into production in Alrode. The capital cost of the plant is about R 2.5 million and has a production capacity of 2.3 million briquettes/month; ie. 805 tons/month or 9550 tons/annum.

Table 3.8: Summary for Easi Coal briquettes

Capital cost of plant [R]	*Anticipated production [tons/annum]*	*Cost ex-production [R/ton]*	*Calorific value [MJ/kg]*	*Energy cost [c/MJ]*
2.5 million	9550	860	25	3.44

3.3.2.4 Cost of producing ARO's Firebrick

The expected ex-factory price for the firebrick is R2.00 per brick, although there is a possibility that this cost could be lower, depending on economies of scale (Rodkin 1994). Nevertheless, assuming a cost of R2.00 per firebrick, the cost per kilogram will vary between 167 and 182 c/kg (depending on the density). At a CV of 31 MJ/kg the ex-production energy cost is thus between 5.4c and 5.9 c/MJ.

Table 3.9: Summary for ARO's briquetted waste paper

Capital cost of plant [R]	*Anticipated station production [tons/annum]*	*Cost ex-production [R/ton]*	*Calorific value [MJ/kg]*	*Energy cost [c/MJ]*
*	*	2000	31	6.45

** No data available*

3.3.2.5 Summary of the cost of production of low-smoke fuels

Data presented in Chapter Three is summarised in the table below for purposes of comparison.

Table 3.10: Summary of the cost of production of low-smoke fuels [1995 prices]

Fuel	*Capital cost of plant [R]*	*Anticipated production [Tons/annum]*	*Price ex-production incl. VAT. [Rand/ton]*	*CV [MJ/kg]*	*Energy price [c/MJ]*	*Energy Price Ratio [Low-smoke fuel/Bit. coal]*
Bituminous coal (C grade)	-	-	55	25	0.22	1
DEVOLATILISED COAL						
Wits/UCP	11 000 000	324 000	203	22	0.92	4.2
Coal Tar Products	15 000 000	120 000	171	22	0.78	3.5
BRIQUETTED FUELS						
CSIR	3000	960	203	24	0.85	3.8
Ecofuel	No information available					
Duffco	2 500 000	9550	860	25	3.44	15.6
ARO Firebrick	*	*	2000	31	6.45	29.3

***** *No information available***

Table 3.10 indicates that at best, the ex-production price of low-smoke fuels will be three and a half times more than the cost of purchasing bituminous coal at the pithead when compared on the basis of energy content. This, however does not mean that the retail price of low-smoke fuels will also be three and a half times the price of bituminous coal as the cost of distribution still needs to be taken into account. The cost of distribution is the subject of Chapter Four.

Chapter Four

Current household coal distribution

4.1 *Introduction*

The retail price of low-smoke fuels will largely be determined by the combination of the two major cost elements; the cost of production and the cost of distribution. Chapter Three has provided a description of the low-smoke fuels that are under development in South Africa and presented a summary of their likely costs of production. In considering the second major determinant of the retail price, the cost of distribution, an obvious first option to investigate is the existing household bituminous coal distribution network that operates effectively throughout the urban coal using areas. The existing coal distribution system is, of course, not the only option for the distribution of low-smoke fuels, but by examining the present cost of distributing coal, and assuming low-smoke fuels will be marketed through the same channels, it will be possible to estimate the retail price of low-smoke fuels. In order to evaluate the impact of lower distribution costs on the retail price of low-smoke fuels, proportional reductions in the present costs will be assumed. Thus this chapter will describe the current bituminous coal distribution system and report on costs involved. These distribution costs will then be used, in conjunction with the production costs given in Chapter Three, to estimate the retail price of the various low-smoke fuels.

4.2 *The household coal market*

4.2.1 Quantification of the household coal market

Before describing the household coal distribution system, it is worth putting the size of the household coal market in perspective relative to overall South African coal sales. Table 4.1 shows total South African coal sales in 1992 to be 181 million tons. It is notable that, according to this source, a very small percentage of the total coal sales, only 4 million tons, went to the household market, as opposed to 74 million tons (or 18 times as much) being used for the generation of electricity, with other large proportions going to exports and the synfuel industry.

Table 4.1: Total South African steam coal sales in 1992 (Source: von Glehn, 1993)

	Quantity of coal [mill tons/annum]	*Proportion of total [%]*
Exports	50	28
Electricity	74	40
Synfuel	39	20
Industry	7	4
Metallurgical	4	3
Household	4	3
Other	3	2
TOTAL	181	100

There is, however, considerable uncertainty on the quantity of coal that is actually consumed by the household sector. This is evident from Table 4.2 which gives figures presented by various authors for the quantity of coal utilised directly by the household sector.

Table 4.2: Annual South African household coal consumption

Quantity [million tons/annum]	*Reference*
1.7 (consumption in Gauteng only)	LHA, 1987
2.0 (1.1% of total S A production.)	Borchers & Eberhard, 1991
4.0	Von Glehn, 1993
1.5 (estimate for Gauteng only)	Horsfall,1994, p12
1 to 5	DMEA, 1994
3.0	Horsfall, 1994b
1.5 to 7.4	McGregor, 1994.
6.5	Chadwick, 1994
3.3	Palmer Development Group, 1995

The last figure of 3.3 million tons/annum in Table 4.2 is an estimate provided by the Palmer Development Group (1995) and would appear to be more thoroughly considered than the other estimates given in the table. It is however, still only an estimate, as it is based on interviews with coal producers as well as an estimate of the number of coal using households in combination with estimates of the average consumption per household.

Several grades of bituminous coal are marketed and these range from grade A (highest energy content) to grade D (lowest energy content). The coal that is generally burned as a household fuel is "grade C nuts", where "grade C" refers to coal with an energy content of over 26 MJ/kg and "nuts" refer to the size range of 22 to 40 mm (Palmer Development Group, 1993).

National annual coal consumption is not consistent as the severity of the winter has a significant impact on the quantity that households use. In addition, there are a number of other factors that impact on overall household consumption. These include the current electrification drive which negatively affects the household coal market, although in the short term this could be countered by enforcement of payment for electricity (Palmer Development Group 1995). Although there are a number of compelling reasons for the continued use of coal (van Horen 1994) in the face of electrification, it is generally accepted that more and more homes will be electrified and that household electricity consumption will gradually increase and consequently, over the long term, lead to an overall reduction in household coal consumption.

There are also indications that an increase in coal exports and higher demand on the domestic market, mainly by Eskom (Star 1995) will put upward pressure on local coal prices. Given that exports and industry consume predominantly A and B grades, it would seem at face value that the household market which uses C and D grades will not be directly effected. However, in the event of shortages, industry is apparently prepared to take lower grades (Palmer Development Group 1995: 39). Thus there is the likelihood that an increase in the price of coal going to the household market will have the effect of reducing consumption, or at least of making other energy sources more competitively priced.

Overall, however, no figures are available on the annual fluctuations caused by variations in weather, nor has there been any research investigating other impacts on the household coal market. Hence, for the purposes of analysis in this report, an annual national household coal consumption of 3.3 million tons, as estimated by Palmer Development Group (1995), will be used.

In addition to annual variations, seasonal variation in consumption of coal is also an aspect requiring consideration as this will affect the cash flow, and hence viability, of organisations or individuals that may be involved in low-smoke fuel production and distribution. Again there are only broad estimates on seasonal variations in demand. Palmer Development Group (1995) estimate that consumption during winter is 2.4 times higher than during summer[1]. Another estimate on seasonal variation by Pondo (1995) of Africoal is that up to 85% of coal sales occur during the four coldest winter months[2].

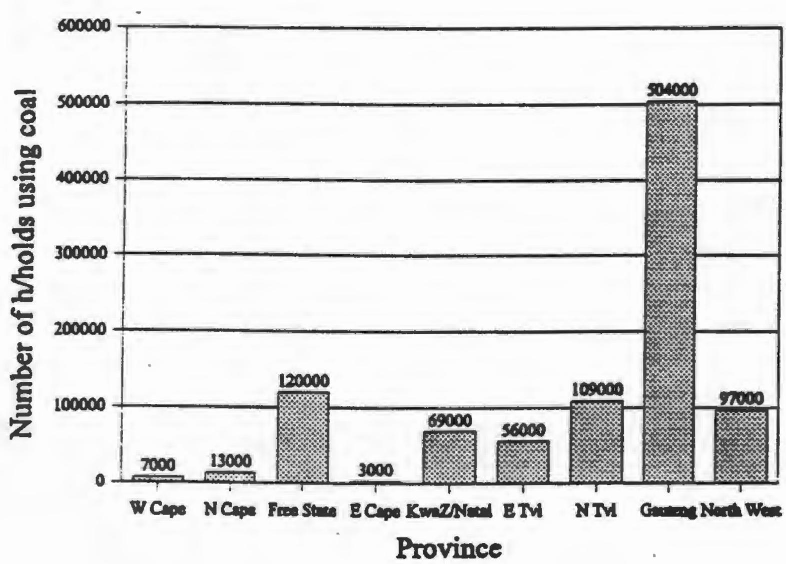
4.2.2 Location of the household coal market

Household coal users are generally restricted to areas that experience cold winters and are relatively close to coalfields. Also, it is mainly urban and peri-urban areas that use coal. Nearly five times more household coal is consumed in Gauteng than in any of the other provinces (EDRC 1992, cited in Palmer Development Group 1995) and this accounts for over half of total national consumption. The number of households using coal is given in Figure 4.1.

[1] With an annual consumption of 3.3 million tons and taking this estimate literally and assuming winter months are from May to August, winter consumption will be 450 000 tons/month with summer consumption being 188 000 tons/month. At the household level, a typical summer monthly consumption is 175 kg per household, while typical winter consumption is 413 kg/month/household (Palmer Development Group 1995).

[2] Again, taking this estimate literally, the national winter consumption would be 700 000 tons/month while summer consumption would be 62 000 tons/month.

Figure 4.1: Location of household bituminous coal market (EDRC 1992)



4.2.3 Source of household coal

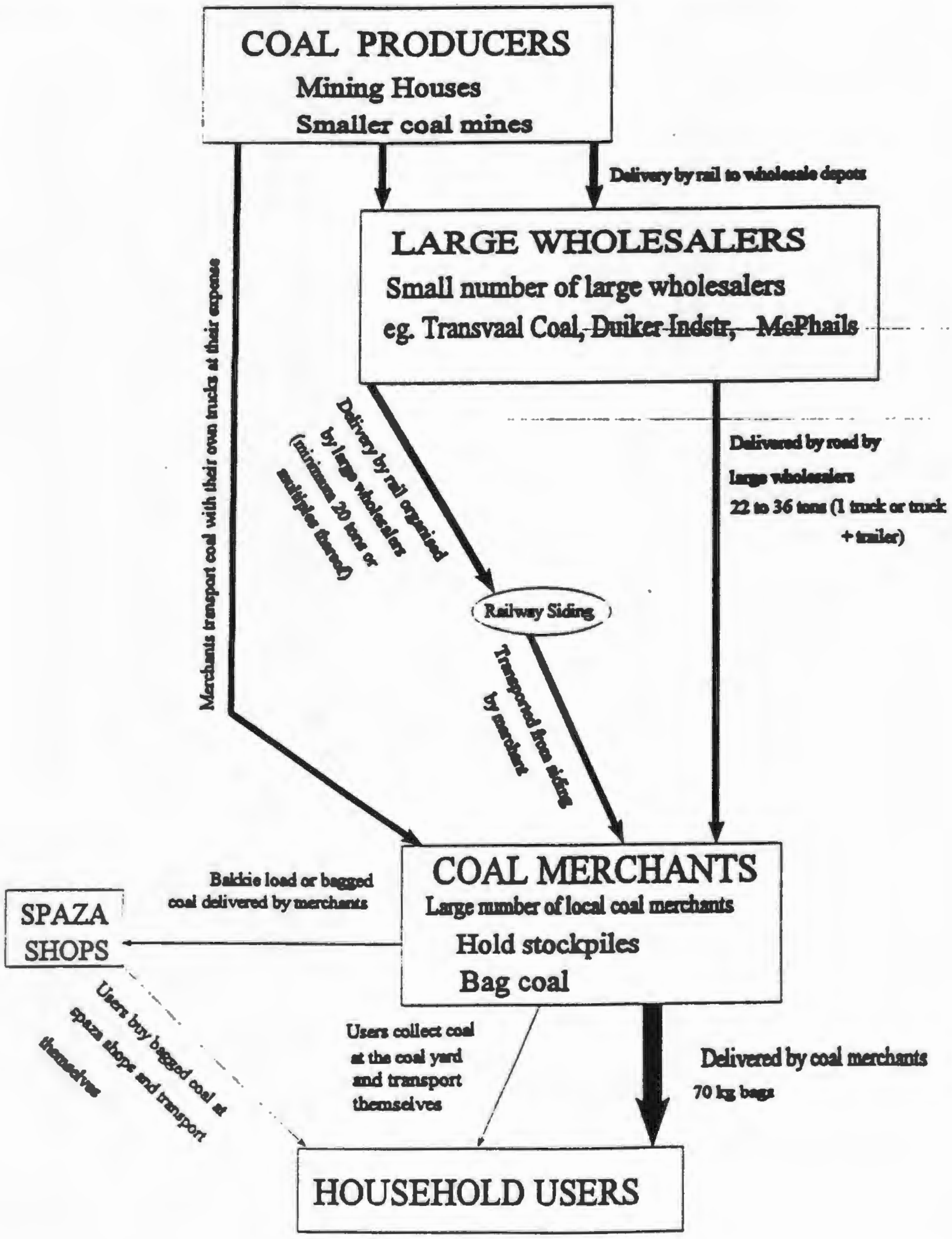
South Africa's coal reserves are located mainly in Eastern Transvaal (51% of recoverable reserves) and the Waterberg (28% of recoverable reserves) (Palmer Development Group 1995). Coal mined in the former Transvaal provides the bulk of the coal supplied to the household market, with the Free State mines serving mostly power stations and, the Natal mines being too distant to compete in the major household market in Gauteng (LHA, 1987a).

The source of household coal for Gauteng is the Eastern Transvaal coalfield at Witbank, while the Delmas mine just west of the Witbank coalfield is also an important supplier. The mines supplying the household markets are mostly owned by the major coal producers which include Tweefontein (Duiker), Witbank Cons (Duiker), Phoenix (Tavistock), Delmas (Ingwe) and New Clydesdale (Goldfields) (Palmer Development Group 1995:7). Coal mines sell their coal to wholesalers and directly to merchants coming to the mine with their own transport through cash offices at the pithead.

4.3 Household coal distribution system

There are four parties involved in the household coal industry; coal producers, large wholesalers, local coal merchants and end users. Figure 4.2 gives an overall description of the relationship between these various parties and shows coal distribution routes between producers and end users.

Figure 4.2: Household coal distribution system (after Palmer Development Group, 1993)



4.3.1 Wholesalers

The role of wholesalers is to purchase bulk coal from mines and to deliver to merchants' yards in the townships. If there is a railway siding close to the merchant's yard, the wholesalers will arrange for a railway truck load (or several loads) to be delivered to the closest siding. It is then the responsibility of the merchant to collect the coal from the siding and to transport it to its yard. If there is no siding in the vicinity, or if the merchant prefers, wholesalers deliver by road directly to coal yards. The large wholesalers entertain only large orders (20 tons minimum for railway transport and 22 tons for road transport), and in addition no deliveries will be executed without prepayment by coal merchants.

In Gauteng, the main coal wholesalers are M^c^Phails, Africoal, Coalbrite, Express Coal, L Pon, Vereeniging Coal and Goudryk Coal (Palmer Development Group 1995: 16). These wholesalers supply not only the household market but also industry. The main national wholesaler is M^c^Phails which has offices in most of the major cities and towns in South Africa. M^c^Phails has a number of subsidiary companies, with the most important being Africoal which is 51% owned by M^c^Phails with the remaining 49% being owned by coal merchants. At present (May 1995), this 49% share holding is owned by 42 coal merchants, although the number of share holding merchants continues to rise. The objective of the company is to build the capacity of township merchants by providing assistance with administration and access to lower coal prices, cheaper diesel and finance (for coal stocks, vehicles and other requirements).

4.3.2 Coal merchants

Virtually all coal used by Gauteng households reaches end users via local coal merchants that operate in every town in the region. For merchants the distribution process can be divided into two steps. The first involves obtaining a bulk supply, while the second step involves bagging and delivery to customers.

If one considers the first step, there are two basic options for obtaining a bulk supply:

- If a merchant owns trucks, it can purchase coal at the pithead and transport it to its yard using its own transport. In some cases merchants sub-contract cartage companies to transport their coal from the mine to their yards. The main cartage companies involved in the transport of coal are Coaltrans, Parsons, Ogies, Botha and Payloads (Palmer Development Group 1995: 26).
- If the merchant does not have suitable transport, coal can be ordered through one of the large wholesalers as described above.

There is a considerable range in the size and sophistication of coal merchants and the method used by them for acquiring their supplies is dependent on the distance of the merchant's yard from a railway siding, the distance from a coal mine, and whether the merchant owns a truck (or trucks) capable of hauling coal over relatively long distances. Another factor that influences the method of acquisition chosen by merchants is the availability of sufficient finance for the purchase of a full 20 or 22 ton load.

Once the merchant has the coal in its yard it is bagged and loaded onto vehicles for house to house delivery. Coal is bulky, dusty and requires large areas for handling. Generally bagging and loading is undertaken during the morning and delivery is undertaken in the afternoon and early evening when customers are more likely to be at home. Although most coal is sold in 70 kg bags from the back of delivery vehicles, many of the informal settlements do not have adequate roads for house to house delivery and, where this is the case, merchants establish a depot at the settlement. Customers then buy directly from the depot using their own containers. Containers that are used include 20 litre tins, wheel barrows and an assortment of others.

A large variety of vehicles, ranging from animal drawn carts, through bakkies to larger trucks, are utilised for household deliveries. In many cases these vehicles are old and in poor condition. Coal merchants tend to be 'specialists' as they do not operate other lines of business from their coal yard. They do, however, generally have mechanical skills and are able to maintain and keep their vehicles operational for in-township delivery to customers. Generally vehicle maintenance work is undertaken during the slacker summer months.

Some of the larger merchants also sell to small scale industrial and institutional users as well as to smaller merchants. Businesses such as laundries and dry cleaners and also institutions such homes for the aged, colleges and hospitals use coal. This is an important factor when considering the possible application of government price support for low-smoke fuels (see Section 6.4).

Although Figure 4.2 shows some coal being sold through spaza shops and people collecting their supplies from coal yards, the vast majority of coal is delivered by the merchants. In general coal is very easily accessible and people who are away from home during the day leave their order and money with neighbours and friends. The extent to which competition exists in the retailing of coal is not clear, however anecdotal evidence indicates that prices are 'agreed' within areas (Palmer 1994, Pondo 1995) and that merchants are concerned about the potential dangers of not keeping prices on a par with other merchants in their area (Palmer Development Group, 1993a).

4.4 Bituminous coal prices

As described in Section 4.3, there are three transport options for delivering bulk supplies from the pithead to merchants' yards: collecting at the pithead, road delivery by a wholesaler or rail delivery through a wholesaler. Wholesalers buy coal at the pithead at an average of R55/ton and sell to merchants at between R58 and R61/ton (Pondo 1995). If a merchant purchases coal directly from the pithead, the price paid could be slightly lower than that paid to wholesalers. However for the purposes of analysis in this report it will be assumed that all three methods result in coal reaching merchants' yards at a price of R60/ton plus the cost of transport which varies between R25 and R37/ton (an average of R31/ton), depending on the distance from the mine to the merchants' yards.

There is also a variation in the delivered retail price of coal. Palmer Development Group recorded a variation between R162 and R320/ton (1993 prices) while coal merchants are selling coal at R16/bag (R228/ton) in Gauteng in May 1995 (Pondo 1995). For the purposes of this report a delivered retail price of R228/ton will be assumed.

Thus Table 4.3 sets out the price of coal at the various points in the distribution system. This price structure will be assumed to be typical and will be used in comparisons with those estimated for low-smoke fuels.

Table 4.3: Bituminous coal prices

	[Rand/ton]
PRODUCTION	
Pithead sales price (incl VAT)	55.00
WHOLESALERS	
Purchase price at pithead (incl VAT)	55.00
Sales price to merchant (incl VAT)	60.00
Add cost of transport to merchant	31.00
Delivered price (incl VAT)	91.00
MERCHANTS	
Delivered purchase price (incl VAT)	91.00
Retail price (incl VAT)	228.00
Overall distribution cost (incl VAT)	**173.00**

The mark-ups applied by the wholesalers cover the cost of transport and their personnel and administrative costs while those applied by the coal merchants cover a range of expenses which include transporting the coal from the railway siding to their coal yard (when this is necessary), bagging the coal, delivering the coal to customers, and a range of other general overheads. In addition to covering these expenses the mark-up also includes the profit earned by coal merchants. Unfortunately it is unclear from existing information, what the breakdown between costs and profits is.

4.5 Retail price of low-smoke fuels

To estimate the retail price of the various low-smoke fuels it is assumed for present purposes that their cost of distribution will be equivalent to that of bituminous coal. For both the devolatilised coals (Wits/UCP and Coal Tar Products) this is a reasonable assumption as both products will be produced either at coal mines or in the same general area as the mines. With regard to the CSIR briquettes they could also be produced at a mine, or if they were to be produced closer to the market it would nevertheless be necessary to transport the fines and duff to a point of manufacture and hence transport costs would need to be taken into account. In the case of the Duffco and Ecofuel briquettes, they will not be produced at coal mines but closer to the market. However, for both these fuels, a retail price has been given by the producers. Table 3.10 provided a summary of production costs for the various fuels and these are used in Table 4.4 to estimate the retail prices of low-smoke fuels.

Table 4.4: Summary of the retail price of low-smoke fuels [1995 prices]

Fuel	*Price ex production (incl. VAT) [Rand/ton]*	*Distribution cost* [1] *(incl. VAT) [R/ton]*	*Retail price [R/ton]*	*CV [MJ/kg]*	*Energy price [c/MJ]*	*Energy Price Ratio [Low-smoke/ Bit. coal]*
Bituminous coal (C grade)	55	173	228	25	0.91	1
DEVOLATILISED COAL						
Wits/UCP	203	173	376	22	1.71	1.88
Coal Tar Products	171	173	344	22	1.56	1.72
BRIQUETTED FUELS						
CSIR	203	173	376	24	1.57	1.72
Ecofuel	[2]	[2]	500[3]	26	1.92	2.11
Duffco	860	[2]	2286[3]	25	9.14	10.03
ARO Firebrick	2000	173	2173	31	7.01	7.69

[1] *The distribution cost includes transport from the mine or point of production as well as door to door delivery by township coal merchants. The distribution cost for the various low-smoke fuels is assumed to be the same as that of bituminous coal .*

[2] *No data available*

[3] *Ecofuel and Duffco have indicated that their fuels will not be marketed through coal merchants and the retail prices shown are those given by the producers.*
In the case of Duffco the distribution cost also covers the cost of packaging, which includes plastic shrink-wrapping into five-briquette packs as well as cardboard cartons. The cost of this packaging alone amounts to 6c per briquette or R171/ton.

Table 4.4 has provided a summary of the retail prices of low-smoke fuels and compared these with the retail price of bituminous coal. However, it is important to recognise that these prices are not definitive by any means. Uncertainties revolve around the cost of discard coal and labour, as well as the cost of plant establishment and their output capacities. Also, current distribution costs vary considerably from area to area. Notwithstanding these difficulties with ascertaining actual costs, the data given in Table 4.4 will be used as the basis for the analysis of market interventions in Chapter Six.

Chapter Five

Legislative options to support the introduction of low-smoke fuels

5.1 *Introduction*

On its own, legislation is not an effective mechanism to ensure the penetration of low-smoke fuel into the low-income market. Nor is legislation a `market-based' intervention *per se* - the main focus of this report. However, it has the potential to be a very effective support mechanism, if implemented in conjunction with other policy options, such as pollution taxes on conventional coal and price support for low-smoke fuel other fuels, and for this reason, is included in the report. Potential legislative support for the market penetration of low-smoke fuels is found in existing legislation goveming the emission of air pollution from household sources in residential areas. This piece of support legislation is embodied in the Atmospheric Pollution Prevention Act (No 45 of 1965).

This chapter addresses the substance of the Atmospheric Pollution Prevention Act, the effectiveness of the Act in practice and the potential for the Act to be used as a piece of support legislation for the promotion of low-smoke fuels.

5.2 *Atmospheric Pollution Prevention Act (No 45 of 1965)*

The Atmospheric Pollution Prevention Act provides for the control of four different types of air pollution - noxious or offensive gases, smoke, dust and vehicle emissions. It is the control of smoke, govemed by Part III of the Act, that is relevant to the elimination of domestic use of coal and the adoption of low-smoke fuel altematives.

The ultimate objectives of the Department of National Health and Population Development, with regard to smoke control, are to reach a desired state where all local authorities exercise smoke control, all residential areas are declared as smoke control zones, all smoke from non-scheduled industries is limited and smoke levels in all residential areas are reduced to acceptable levels (South Africa: Department of National Health and Population Development 1991).

5.2.1 Authorities of control

In theory, the responsibility for the administration of the Act has recently been shifted from the Department of National Health and Population Development to the Department of Environmental Affairs and Tourism (Buys 1995). In practice, however, the Act is still being administered and financed by the Department of National Health and Population Development. Although changes in the structures for administering the Act can be anticipated, such changes are likely to be small as the staff administering the Act will be the same as present. Thus, for the puposes of this report, the Act will be examined in terms of how it is currently recorded in the book of statutes.

The Act empowers the Minister of National Health and Population Development[1], with the concurrence of the local authority concemed, to declare the provisions of Part III of the Act applicable to part or all of a local area (South African Govemment 1965). After the Minister has declared the area a smoke control zone, the responsibility for the control of smoke in the area rests with the

[1] In future, the Minister of Environmental Affairs and Tourism will hold this power.

relevant local authority and the powers to implement this Part of the Act are conferred to them. The chief air pollution control officer[2] may take over the exercise of these powers when the Minister deems that the Act is being inadequately enforced by a local authority or when a local authority requests that the powers be transferred to the chief officer. Where no local authority exists for an area declared applicable, the exercise of powers will be vested either in the chief officer or in the local authority of an adjoining area.

5.2.2 Regulations and Control

The local authority can exercise control of the Act at three different levels (Petrie et al 1992; Slabbert 1993). Level 1 empowers authorities to approve the siting of new equipment, to control the installation of fuel-burning appliances and to control smoke or other products of combustion causing a nuisance. This is the least stringent level of control and is usually applied in smaller country authorities, which are less developed industrially. Authorities implementing at the order of level 2 have control over smoke emanating from boilers and space heating appliances in flats, office buildings and light industries and over the burning of waste. Dwelling houses are excluded from control at this level. Adopting Part III of the Act at the order of level 3 is the ultimate level of smoke control provided for by the Act. This involves the declaration of a smoke control zone and applies mainly to residential areas.

Part III of the Act makes provisions for the restriction of coal use and smoke emissions on the one hand, while making provisions for the promotion and support of energy alternatives on the other.

The major provision for the restriction of coal use and smoke emissions is the empowerment of local authorities to declare, by order, the area within their jurisdiction or any part of that area to be a smoke control zone and, thereby prohibit the emanation or emission from any premises in that zone of smoke of a darker colour or greater density or content than is specified in the order (South African Government 1965).

In order to enforce these *smoke control zones*, a local authority may make regulations which prohibit the emission of dark smoke, prohibit the sale and use of solid fuel for a fuel-burning appliance which does not comply with the requirements specified in the regulations, provide for the inspection of fuel-burning appliances and generally provide for all effective control of the emission or emanation of smoke from any premises.

Section 21[3] of Part III of the Act is concerned with *contracts for the supply of fuel*. It makes provision for local authorities to actively support and promote the development and production of alternative energy technologies such as low-smoke fuel, by allowing the authorities to enter into

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[2] The chief air pollution control officer, hereafter referred to as the *chief officer*, is appointed by the Minister of National Health and Population Development and, under the directions of the Minister, exercises the powers and the functions assigned to him/her under the Act.

[3] 'A local authority may ... enter into a contract with any natural person or body corporate for the supply ... to users, of any fuel which will facilitate or render possible the application of or compliance with the regulations made by such local authority in terms of this Part, and may, subject to such consent, without prejudice to its general powers under this section, indemnify or guarantee any producer or supplier of fuel against any loss, or itself act as wholesale or retail dealer in such fuel or make a contribution towards the cost of producing such fuel or the cost of establishing an industry for the production of such fuel' (South African Government 1965).

contracts with suppliers of fuels to facilitate the adoption or implementation of a smoke control zone or to contribute to the capital and production costs of producing such fuels or to indemnify any producer or supplier of such fuel against any loss (South African Government 1965). It also allows for the local authority to act as a wholesale or retail dealer in such a fuel. This support can take the form of subsidies to producers, capital subsidies, the elimination of risk for producers or the entering into of agreements by the relevant parties.

5.2.3 Enforcement of the Act

The power to enforce Part III of the Act is placed in the hands of the local authorities who appoint qualified municipal inspection officers to police the Act by monitoring emissions and enforcing the regulations.

A local authority may authorize any person to enter any premises for the purpose of making any investigation in connection with the emission or emanation of smoke or in connection with any fuel burning appliance or for the purpose of taking action necessary for the implementation of the Act, provided that the person does not enter into any part of the building for residential purposes, without the consent of the owner/occupier (South African Government 1965). The clause omitting residential buildings aims to protect local residents, but this has not been an issue yet.

If the requirements of a *smoke control zone* or of the regulations set out to implement such a zone, are contravened, the local authority can, after consultation with the chief officer, serve a notice on the owner or occupier of the premises to bring about the cessation of smoke in a given period (Petrie et al 1992). If the individual fails to comply with the notice of abatement, it is considered an offence. The local authority or chief officer issuing the notice may then take the necessary actions to prevent pollution and recover the costs from the polluter (Petrie et al 1992).

The regulations made by the local authorities can provide for penalties for any contravention of or failure to comply with those regulations. In the case of a first offence, these penalties may not exceed a fine of two hundred rand or, in default of payment, imprisonment for a period of six months. In the case of a second or subsequent offence, the penalty may not exceed a fine of one thousand rand or, in default of payment, imprisonment for a period of one year (South African Government 1965).

5.3 The Act in practice[4]

By May 1995, 284 municipalities had enforced Part III of the Act in their jurisdictions (Lloyd 1995). The control of this Part of the Act has, however, been exercised, by the municipalities, at various levels on the basis either of the specific needs of the local area or of the availability of staff who are qualified to implement the Act (Slabbert 1993). One hundred and thirty-eight local authorities had control in terms of level one of this Part of the Act, 80 had control in terms of level two and 66 in terms of level three (Lloyd 1995).

To-date, this Part of the Act has been implemented in historically white residential areas only. This can be attributed to the fact that the enforcement of *smoke control zones* is easier, both politically and economically, in those areas where the dependence on and use of coal is less and for those people

[4] Much of the information in this section is drawn from information from discussions with Lloyd (1995) and Miller (1995).

who can afford cleaner alternatives. Therefore, while it has been easy to implement smoke control legislation in historically white local areas, which have enjoyed the almost exclusive use of electricity, it would have been futile to apply the Act to coal-using townships, because the residents would be unable to comply with its regulations owing to their dependence on coal-based appliances and to their lack of access to alternative affordable energy sources.

Even with the amalgamation of historically racially-defined local authorities, resource constraints persist in poorer areas, making the enforcement of the Act difficult. The Department of National Health and Population Development does subsidise the salaries of smoke control officers, which could help to even the playing fields, but the cost of monitoring equipment comes out of the budget of the local authority (Lloyd 1995, Miller 1995). This can disadvantage poorer local authorities in terms of control of smoke.

In practice, air pollution control is administered by the chief officer or local authority and the municipal smoke control officers who are appointed by the local authority. The smoke control officers, who police the area, must be suitably qualified as health inspectors with further training in the field of air pollution control. Such a qualification in air pollution control can be obtained at most Technikons.

The smaller local authorities with smoke pollution problems have appointed at least one smoke control officer on a part-time basis. Lloyd (1995) states that this situation is satisfactory and that the smoke control zone can be effectively enforced under these circumstances, while Petrie et al (1992) argue that adequate policing of smoke control zones is already restricted by staff shortages. This suggests that it will be even more difficult to police areas where there are strong economic incentives to keep using coal.

To-date, only a limited number of abatement notices have been issued (Petrie et al 1992). In most cases, problems are resolved by the approach based on the principle of 'best practicable means[5]' where the local authority enters into a process of negotiation to obtain the co-operation of the residents. In this way, smoke reduction is achieved without the serving of abatement notices. As it stands in the Act, the principle of 'best practicable means' does not apply to smoke emissions from domestic sources, but Lloyd (1995) states that this is the method which is currently used to ensure abatement.

Although the Act does make provision for the prosecution of individuals who do not comply with the regulations of a smoke control zone, the local authorities tend to play the role of educator rather than that of prosecutor with regard to the control of domestic smoke. The provisions for the prosecution of individuals who contravene the regulations of the Act tend to be applied to industry only, while domestic transgressions are dealt with by providing advice and education on how to reduce smoke emissions.

[5] The principle of *best practicable means* is based on the following run of ideas: although a safe and healthy environment is essential, air pollution control is very expensive and capital costs rise exponentially if very high levels of control are required. Such stringent requirements can harm the country's economy and, therefore, in a developing country like South Africa, one must maintain a delicate balance between what is essential for a safe and healthy environment and that which can be afforded (South Africa: Department of National Health and Population Development 1991).

Smoke levels have dropped significantly in most areas enforcing smoke control (Lloyd 1995). The success of the Act seems to be based on the types of areas in which it has been implemented (that is, areas where domestic use of coal is limited to winter space heating and where residents are flexible with regard to their use of coal and can afford to incur the costs of more expensive alternatives) and on the change in end-user preferences as they have switched from coal-fires to electric heating.

Financial constraints, together with staffing shortages, make it impossible to patrol the smoke control zones and to monitor and measure specific sources of domestic emissions and, therefore, policing of Part III of the Act tends to involve a combination of responding to complaints and visual observation from vantage points. These observations are made by inspectors during the winter period only. When inspectors detect smoke emanating from domestic sources, a message is relayed to inspectors on the ground, who then follow this up in an advisory capacity. One of the main problems with this type of observation, is that it takes place during the day and most burning of coal for domestic use takes place during the evening or night-time.

5.4 Implications if the Act were to be enforced in urban townships

The Department of National Health and Population Development has prioritised certain areas and certain aspects of air pollution control, because of the variable levels of air pollution between areas and between economic sectors. *Residential areas without electricity* have been targeted as one group which is considered to be a high priority for air pollution control (South African Government: Department of National Health and Population Development 1991). The Department sees the problem of smoke pollution in residential areas without electricity as being socio-economic in nature and sees the final solution as full electrification. In the interim, they seek solutions in educating residents to use mini-smoke stoves and to make fires in such a way as to produce the minimum amount of smoke. This prioritisation of residential areas without electricity is an essential step toward the realisation of Departmental objectives with regard to smoke control. Although low-smoke fuels are not considered as an option for reducing smoke emissions, the Atmospheric Pollution Prevention Act together with the Departments' commitment to controlling smoke, provides a means for promoting low-smoke fuels in these areas.

The Act in itself is incapable of ensuring that people switch from bituminous coal to low-smoke fuels, but it can provide the necessary support for policy interventions, if other measures are met prior or simultaneous to its implementation. There are a number of pre-requisites for the successful implementation of Part III of the Act in urban townships, which are described below.

5.4.1 Availability of adequate alternatives to bituminous coal

It is pointless to enforce the Act in coal-burning townships until the residents have access to alternatives to bituminous coal. Owing to the cost of electricity and the lag that exists between acquiring access to electricity and employing electricity for all household use, such alternatives should include not only electricity, but also low-smoke fuel alternatives. These low-smoke alternatives must meet certain criteria if they are to successfully replace coal in the household. Firstly, they should be comparable to coal in terms of both their technical performance and their affordability. Secondly, the supply of these low-smoke fuels should be consistent and reliable and the distribution must be convenient and transparent.

5.4.2 Timing of implementation

The Act should be introduced and enforced in the local area only after adequate and affordable low-smoke fuels have been made available. If the Act is made applicable to a local area and these conditions have not yet been met, then it would be impossible for the local area residents to obey and respect the regulations of the Act. This, in turn, would undermine the credibility of both the legislation and the agencies of enforcement.

5.4.3 Public awareness

General public awareness is of vital importance to the successful implementation of this Part of the Act in coal-using townships. In order to successfully implement the Act, the support of both the town council and the affected residents is required and, therefore, a publicity campaign to promote the use of low-smoke fuels is essential (Lloyd 1995). There are different aspects which need to be explored in a public awareness campaign:

- The publicity campaign must educate people on the benefits of low-smoke fuel, such as environmental and, particularly, health benefits.
- The campaign must educate people on the disadvantages of using coal in the household (for example, smoke induced respiratory problems).
- The campaign must ensure that the residents are aware of the low-smoke alternatives to coal. This must include what the different alternatives are, why they are better than coal and how they are distributed.
- The public must be made aware of the application of the Act in their area and the implications for them resulting from its application. As it stands, the Act requires that its application be advertised in three consecutive issues of an Afrikaans newspaper and three consecutive issues of an English newspaper which circulate in the area. This notice must state the general effect of the order, the area to which the order applies and the fact that objections to the order must be made, in writing, to the Minister and the town clerk within one month of its first appearance. This is inadequate as it potentially excludes a large proportion of the local population by omitting African languages and assuming a literate population. A campaign, involving local civics and conducting public forums to discuss the Act and its application is required to ensure that the residents are aware of what the Act entails, what the effects of its application are for the local community and what the penalties are for contravening the regulations of the Act.

5.4.4 Cost implications

In order for the implementation of the Act to be successful, it is essential that the local authorities have sufficient funds to enforce its application. Funds are required for the salaries of pollution control officers and inspectors, for the purchase of monitoring equipment and for the design and implementation of promotional campaigns. The salaries of the pollution control officers are subsidised by the Department, but the monitoring equipment and the publicity campaigns must be financed out of the local authority coffers. This may require cross-subsidisation from richer to poorer local authorities, particularly owing to the fact that the costs of implementation and enforcement of the Act are likely to be higher in coal-burning townships, where the need for higher levels of policing and closer monitoring of smoke emissions must be met by an increased staff complement.

Chapter Six

Analysis and policy recommendations

6.1 *Important points of departure*

In considering policy recommendations there are a number of assumptions that have been made relating to costs of production and distribution as well as technical characteristics of fuels. These are set out below:

- Throughout this report it has been assumed that the technical performance of low-smoke fuels meets the requisite standards, in terms of pollution emissions, ability to ignite, length of burning, friability and so on. Any products which do not meet these standards will not be eligible for the kinds of policy support proposed here.
- Unless indicated otherwise, it has been assumed for the purposes of this report that the present distribution system will be used for low-smoke fuel marketing and sales and that the cost of distribution of low-smoke fuels is equivalent to that of distributing bituminous coal. It is not inconceivable, however, that this might change and that low-smoke fuels could be distributed either through different channels, or through a re-organised sector. Two low-smoke fuel producers, Ecofuel and Duffco, intend marketing their products through other channels and hence distribution costs for these two fuels are taken as those provided by their producers.
- It has also been assumed that household consumers would be unable or unwilling to pay any significant price premium for low-smoke fuels as compared to bituminous coal. In the longer term, conditions may change so as to invalidate this assumption, for example, if household income levels rise due to improved employment opportunities, or if households decide to reallocate limited disposable income from other items of expenditure towards low-smoke fuels. Should such circumstances materialise, the implications for government's commitment in terms of price support would clearly be favourable.
- Fuel price comparisons are made on the basis of energy and hence are sensitive to the calorific values given or estimated by the various prototype producers. The calorific value of bituminous coal is assumed to be 25 MJ/kg although this will vary depending on which grade of bituminous coal is used.
- The retail prices of low-smoke fuels are, in many cases, based on estimates of production costs provided by manufacturers. Given that in many cases organisations have not carried out accurate production cost estimates, the figures used are subject to change. However, in general, estimates probably err on the conservative side.

6.2. *Policy analysis*

The previous chapters of the report have outlined a number of policy options as well as the cost structures of the low-smoke fuel prototypes which are in existence. Here, five interventions are presented which, it is suggested, could constitute a comprehensive and multi-faceted policy package which is mutually supporting and, therefore, more likely to be successful.

6.2.1 Introduce a pollution tax on bituminous coal

The imposition of a pollution tax or levy on bituminous coal is potentially one of the most important interventions which government could make in the household coal market. Issues surrounding this option were described in detail in Chapter Two, but for present purposes, several salient features are described:

- The motivation for a pollution tax would *not* be to raise general revenues for the fiscus, but to *internalise* or account for the *external costs* of producing and consuming coal in the household sector.
- A pollution tax could be most effectively levied at the *producer stage* as opposed to end-user or intermediary stages in the supply chain, because of the smaller number of producers and the relatively formal nature of this portion of the market.
- The *amount* of the tax should be determined with reference to the external costs which are currently incurred in the use of conventional bituminous coal. Illustrative scenarios are described below.
- In determining the *scope* of the tax, it seems most logical and practicable to impose the tax on the sale of coal destined for the *household* market and not on export sales or coal used for industrial purposes.
- The *timing* of the introduction of such a tax is important: it should not be imposed until consumers have easy access to an *alternative* source of energy which is affordable and does not cause any loss in welfare. In more specific terms, this means that a pollution tax should not be imposed in any given area until consumers are able to purchase low-smoke fuels at competitive prices.
- The *administration costs* for such a system of taxation need not be significant due to the relatively small number of coal producers involved and the fact that their accounting systems are relatively sound. The cost to government of employing one or two people to administer the tax would be minimal in relation to the revenue generated by the tax.

If such a tax is introduced on household coal, it will have the inherent effect of encouraging a shift away from bituminous coal towards cleaner alternatives (which will include not only low-smoke fuels but also electricity). Since low-smoke fuels will be more expensive than normal coal, such a tax will also have the effect of narrowing the price differential. Provided a tax is introduced together with other interventions (refer below), it will not have any negative distributional or equity effects.

It was noted earlier that inadequate data exists on which to base sound estimates of the external costs of household coal use, but if an annual amount of R100 million is assumed for present purposes, and this is spread equally over the annual household consumption of 3.3 million tons, then the suggested pollution tax should be in the region of R30 per ton. The effect of introducing such a tax on the price of bituminous coal is shown in Table 6.1.

Table 6.1: Comparison of bituminous coal price structure with and without a pollution tax of R30/ton

Fuel	Production price [R/ton]	Pollution tax [R/ton]	Net production price [R/ton]	VAT (14%) [R/ton]	Distribution costs [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy price [c/MJ]	Delivered price ratio
No tax	48.25	0	48.25	6.76	173.00	228.01	25	0.91	1.00
With tax	48.25	30	78.25	10.96	173.00	262.21	25	1.05	1.15

It is evident that the introduction of a pollution tax at the producer stage has an increased effect on retail prices due to the knock-on effect of Value Added Tax. If the price structure with the pollution tax is compared with the possible retail price of low-smoke fuels, it is evident that a pollution tax will bring about some narrowing of the price gap. This is shown in Table 6.2.

Table 6.2: Comparison of various fuel price structures with and without a pollution tax of R30 / ton

Fuel	Retail price [R/ton]	CV [MJ/kg]	Energy price [c/MJ]	Energy price ratio with no tax	Energy price ratio with a tax
Bitum coal - no tax	228.01	25	0.91	1.00	-
Bitum coal - R30 tax	262.21	25	1.05	-	1.00
Wits/UCP	376.32	22	1.71	1.88	1.63
Coal Tar Products	344.29	22	1.56	1.72	1.49
CSIR	375.92	24	1.57	1.72	1.50
Ecofuel	500.00	26	1.92	2.11	1.83
Duffco	2286.00	25	9.14	10.03	8.70
ARO	2173.00	31	7.01	7.69	6.68

It is evident from Table 6.2 that the price premium of the various low-smoke fuel prototypes over bituminous coal is reduced when a pollution tax is imposed. Thus, for example, the price excess for the Wits/UCP product would reduce from R148.31 to R114.11 per ton, or on an energy cost basis, from a premium of 88% to 63%. This impact is clearly not large enough, by itself, to make a major difference to the competitiveness of low-smoke fuels, but when combined with other measures, this intervention could be important.

In considering whether a pollution tax might be introduced, it should also be noted that several *precedents* exist for the introduction of levies or taxes in the energy sector: from the fuel levy which comprises over a third of the petrol or diesel pump prices, to the levy on electricity sales which finances the National Electricity Regulator, to the tariff protection granted to synthetic fuels. The case for a tax or levy on coal as part of a national low-smoke fuel programme is, if anything, stronger than in the existing cases, both on economic and environmental grounds.

6.2.2 Price support for low-smoke fuels

In considering price support for low-smoke fuels, Chapter Two has set out several guiding principles:

- Price support should not favour any one product or producer. Given this principle, the level of price support be should be determined so as to allow the lowest cost low-smoke fuel to be competitive with bituminous coal.
- The amount of price support should be sufficient to reduce the risk facing producers considering entering the low-smoke fuel market.
- The amount should be determined such that producers will have a strong incentive to innovate and improve their products and service.

Chapter Two also identified three possible points for the practical implementation of price support;

firstly rebate coupons to end users, secondly rebates to distributors and thirdly rebates to producers. Of these three options, the first two can be rejected due to practical difficulties with implementation and associated high administration costs (see Section 2.4 for further discussion). Producers, on the other hand, offer a relatively uncomplicated point at which financial support can be injected into the supply chain. Table 6.3 quantifies the rebate that would have to be paid to each of the producers to allow their products to be retailed at an *energy price* equivalent to bituminous coal (assuming no other intervention). Clearly this rebate will vary if the aim is to achieve parity in retail prices measured by Rands per ton.

Table 6.3: Producer rebates necessary for low-smoke fuels to retail at prices equal to bituminous coal

Fuel	Price ex-production (excl VAT) [R/ton]	Rebate [R/ton]	Nett Price [R/ton]	VAT [R/ton]	Price Ex-production (incl VAT) [R/ton]	Distrib-ution cost [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy Price [c/MJ]	Retail energy price ratio
Bit. Coal	48.25	0.00	48.25	6.76	55.01	173.00	228.01	25.00	0.91	1.00
Wits/UCP	178.00	154.14	23.86	3.34	27.20	173.00	200.20	22.00	0.91	1.00
CTP	150.25	126.39	23.86	3.34	27.20	173.00	200.20	22.00	0.91	1.00
CSIR	178.00	138.18	39.82	5.58	45.40	173.00	218.40	24.00	0.91	1.00
Ecofuel	[1]									
Duffco [2]	754.39	754.39	0.00	-	0.00	1426.00	1426.00	25.00	5.71	6.27
ARO	1754.39	1658.69	95.70	13.40	109.10	173.00	282.10	31.00	0.91	1.00

[1]*Information on the production cost of Ecofuel is not available.*
[2]*Distribution costs for Duffco are provided by the producer and are extremely high. Even if the production cost was fully subsidised, the distribution costs are more than six times the retail price of bituminous coal.*

Table 6.3 shows that three low-smoke fuels (Wits/UCP, Coal Tar Products, CSIR) have reasonably similar production costs and require rebates ranging between R 126 and R 154/ton. If all fuels received equivalent price support at the lowest level of R126/ton, these three fuels would be price competitive with bituminous coal (see Table 6.4). Such a rebate would in fact bring Coal Tar Products' fuel onto the market at a lower 'per ton' price than bituminous coal (although the energy cost would be equal). The other three low-smoke fuels (Ecofuel, Duffco & ARO) will still not be competitive although the rebate will assist expansion of their markets.

Table 6.4: Retail price of low-smoke fuels assuming a standard rebate of R126/ton for all fuels

Fuel	Price ex-production (excl VAT) [R/ton]	Rebate [R/ton]	Nett Price [R/ton]	VAT [R/ton]	Price ex-production (incl VAT) [R/ton]	Distribution cost [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy Price [c/MJ]	Retail energy price ratio
Bit. Coal	48.25	0.00	48.25	6.76	55.01	173.00	228.01	25	0.91	1.00
Wits/UCP	178.00	126.39	51.61	7.23	58.84	173.00	231.84	22	1.05	1.16
CTP	150.25	126.39	23.86	3.34	27.20	173.00	200.20	22	0.91	1.00
CSIR	178.00	126.39	51.61	7.23	58.84	173.00	231.84	24	0.97	1.06
Ecofuel		126.39				*	356.00	26	1.37	1.50
Duffco	754.39	126.39	628.00	87.92	715.92	*	2142.00	25	8.57	9.42
ARO	1754.39	126.39	1628.00	227.92	1855.92	173.00	2028.92	31	6.54	7.18

* *Ecofuel and Duffco have provided a retail price for their fuels and thus the retail price is not based on the distribution cost of bituminous coal.*

It will be important to ensure that rebates are paid only to low-smoke producers which are supplying the low-income household market, otherwise the rebate could simply contribute to profits from other market sectors.

6.2.3 Taxation incentives

Tax incentives such as accelerated depreciation write-offs and direct taxation allowances or rebates are not recommended on the grounds that they carry large transaction costs (in terms of administration and collection) and that their effectiveness in terms of influencing the investment decisions of producers is questionable. Instead, the possibility of introducing *incentives in indirect taxation*, and specifically Value Added Tax (VAT) warrants consideration. Although, in theory, VAT is payable at each of the links in the coal distribution chain, in practice this is the case only at the more formal upstream ends of the supply chain. Consequently, changes to VAT legislation would be effective only if they were introduced at producer stage.

Several categories of zero-rated products exist already, most of which can be described as commodities which meet basic needs, and this category could easily be extended to include low-smoke fuels. If low-smoke fuels were zero-rated at the point of production, then this would introduce another structural price advantage in their favour. The effect of this on the retail prices of the various fuels is shown in Table 6.5. For present purposes, it is assumed that VAT is not collected beyond the producer stage in the household coal supply chain.

Table 6.5: Comparison of various fuel price structures with and without zero-rating of low-smoke fuels at producer stage

		VAT included			VAT zero-rated		
Fuel	Production price [R/ton]	Retail price: with VAT	Energy price [c/MJ]	Retail price ratio	Retail price: zero-rated	Energy price [c/M]	Retail price ratio
Bitum. coal	48.25	228.01	0.91	1.00	-	0.91	1.00
Wits/UCP	178.00	376.32	1.71	1.88	351.00	1.60	1.76
Coal Tar Product	150.00	344.29	1.56	1.72	327.00	1.49	1.64
CSIR	178.00	375.92	1.57	1.73	351.00	1.46	1.60
Ecofuel	na	500.00	1.92	2.11	na	na	na
Duffco	754.39	2286.00	9.14	10.04	2180.39	8.72	9.58
ARO	1754.39	2173.00	7.01	7.70	1927.39	6.22	6.84

na - information not available.

It is evident from the table that the effect of zero-rating is relatively small, reducing the price premium in the case of (for example) the Wits/UCP fuel from R148.31 to R122.99 per ton. Expressed on the basis of delivered energy price (c/MJ), the price difference is reduced, for the same fuel, from 88% to 76%. Once again, this is not significant on its own, but when combined with the other interventions discussed in this chapter, could contribute towards a more supportive environment for low-smoke fuels. As mentioned in Chapter Two, the opportunity cost of such a tax, in terms of revenue which is foregone, would not be highly significant: a maximum loss of about R20 million per annum. To this loss would be added the `transaction cost' of administering a more complex VAT system, and although this is difficult to quantify, it is unlikely to be very significant.

6.2.4 Access to finance

The various low-smoke fuel production techniques vary considerably with regard to capital requirement for the establishment of production facilities. While some potential producers are part of large industrial groups, and could therefore secure finance at prevailing market rates, the same will not be true of small producers who may wish to enter the market. These smaller producers may face constraints in securing any finance at all, or if they do, it may carry a high premium due to their relative institutional weakness. Notwithstanding these potential discrepancies in access to finance, Table 6.6 gives estimates of capital requirements by the various producers, the associated production capacity, as well as indicative loan repayments on plant establishment costs.

Table 6.6 shows that both the lump coal devolatilisation process proposed by United Carbon Producers and Coal Tar Products, and the briquetting approach taken by Duffco (and Ecofuel - from discussions with the owner) require considerable initial capital, while the CSIR's labour intensive briquetting approach requires minimal capital expenditure. When related to output capacity, the cost of capital is higher for the briquetted fuels than for the devolatilised coals. From Table 6.6 it is also evident that if producers had access to capital at say 10% rather than 15%, the cost savings would be relatively small and amount to R1.19/ton for UCP fuels, R4.41 for Coal Tar Products and R9.17 for Duffco. There would be virtually no benefit for producers using the CSIR approach to production.

Table 6.6: Impact of variable interest rates on production costs of low-smoke fuels

Organisation	Capital cost of plant [R]	Plant production capacity [Tons/annum]	Loan repayments [R/ton] [1]		
			10 % interest	15% interest	20% interest
United Carbon Producers	11 000 000	324 000	5.38	6.57	7.87
Coal Tar Products	15 000 000	120 000	19.80	24.20	29.00
Using CSIR approach	3000	960	1.24	1.30	1.38
Ecofuel	No information available				
Duffco	2 500 000	9 550	41.51	50.68	60.71
ARO	No information available				

[1] *It is assumed that loans will be repayable over 10 years, except in the case of the CSIR production method where the repayment period is assumed to be 3 years.*

Thus, in general, the impact on the retail price of low-smoke fuels as a result of having access to preferential finance is small. However, similar to the other interventions, it reduces the price differential between low-smoke fuels and bituminous coal and, therefore, can be a useful component of an intervention strategy. In some cases, like the CSIR process, the impact of this intervention would not be aimed at reducing the price of the product, but more fundamentally to facilitate the market entry of small scale producers.

6.2.5 Legislative options

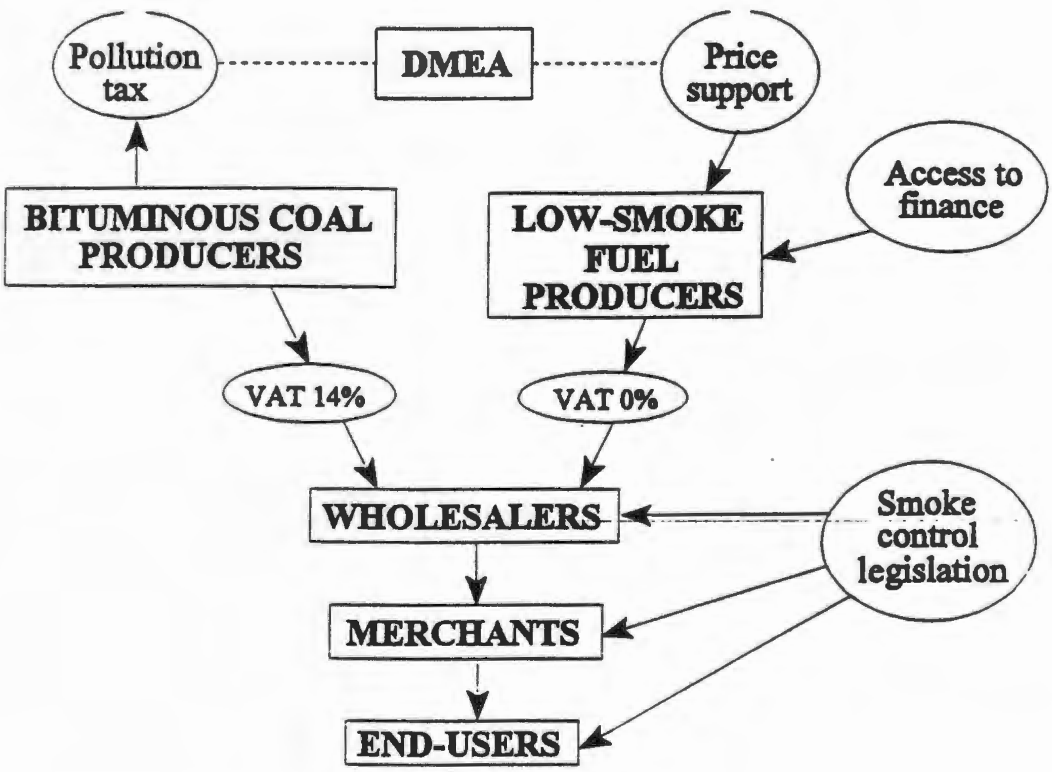
Legislation has the potential to be an effective instrument of support for the introduction of low-smoke fuels to the low-income market, complementing other interventions which are more directly market-based. Part III of the Atmospheric Pollution Prevention Act (No 45 of 1965) is an existing piece of legislation which makes provision for both the restriction of coal use and smoke emissions (through the creation of smoke control zones) and the promotion and support of energy alternatives. The Act is enforced at local government level and is policed by municipal inspection officers. While compliance with the Act tends to be encouraged through education and compromise, the Act does make provisions for the prosecution of offenders.

The implementation of the Act has enjoyed a high rate of success in historically white residential areas, but to-date there has been no attempt to apply it in coal-burning townships. Its potential to be successfully applied in residential areas without electricity is dependent on meeting a number of conditions prior to its application. These conditions include the availability of adequate alternatives to bituminous coal, a publicity campaign to heighten the public's awareness of both the contents of the Act and its implications, and adequate funds to finance promotional campaigns, emission monitoring and policing of the Act.

6.2.6 Summary of interventions

Figure 6.1 depicts the five intervention options that have been considered and indicates how they could interact with the bituminous coal and anticipated low-smoke fuel supply chain.

Figure 6.1: Intervention options for the support of low-smoke fuels



6.2.7 Recommendations for an intervention policy

Having examined each option on its own, consideration can be given to how these could be combined into a comprehensive policy package. The aim of the intervention policy should be to bring low-smoke fuels on to the market at an energy price equivalent to bituminous coal. Assuming this as a basic objective, the recommended components of a policy package are set out below.

1. Of the four feasible market based options discussed in this chapter, concessionary finance has the smallest impact on the price of low-smoke fuels. Nonetheless, this intervention is a practical and achievable option and hence it is recommended that government assists potential producers in obtaining access to concessionary finance through parastatal financing agencies such as the Small Business Development Corporation and the Industrial Development Corporation.

2. Zero-rating VAT on low-smoke fuels has a somewhat higher impact on the price of low-smoke fuels than concessionary finance (see Table 6.5) and hence can reduce the price differential

between the two types of fuel. Thus it is recommended that the DMEA motivates for zero-rating on low-smoke fuels. There may, however, be difficulties in persuading fiscal agencies to grant a concession, especially seeing that current reforms in the revenue collection system is moving towards fewer exceptions and special cases.

3. A third recommendation is that a pollution tax should be levied on the sale of bituminous coal . The value of the tax should ideally be set at a level which takes the external costs associated with the use of household bituminous coal into account. Present estimates show that this could be about R30 per ton.

4. It will be necessary to use the fourth feasible market based option, price support for low-smoke fuels, to make up the remaining price differential between bituminous coal and low-smoke fuels after the effect of the above three options has been quantified. This rebate should be valued so as to bring the price of the lowest cost low-smoke fuel down to a point where it equals the energy cost of bituminous coal.

5. With regard to the utilisation of legislation, timing is very important. It is generally accepted that the Air Pollution Prevention Act will be impossible to enforce unless the penetration of the bituminous coal market by low-smoke fuels is well advanced. This implies that the above market-based interventions will have to lead the way, with legislation playing a supportive role at a later stage.

In attempting to quantify the combined impact of these recommended four market-based interventions, there are many permutations that could be considered given the uncertainty in the figures presented in this report. However, using the figures that have been presented, Table 6.7 shows the rebate that would be required for each of the low-smoke fuels to achieve price parity. The figures are based on the following assumptions:

- concessionary finance will be available at about 5% below market rates ,
- VAT on low-smoke fuels is zero-rated, and
- a pollution tax of R30/ton is levied on bituminous coal sales.

Table 6.7: Rebate required to allow each low-smoke fuel to be priced equal (in energy terms) to bituminous coal

Fuel	Price ex-production excl VAT [R/ton]	Savings finance charges [R/ton]	Tax/ (Rebate) [R/ton]	Nett Price[1] [R/ton]	Distribution cost [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy Price [c/MJ]	Delivered Retail price ratio
Bit. Coal	48.25	(0)	30.00	89.21	173	262.21	25	1.05	1.0
Wits/UCP	178.00	(1.19)	(119.07)	57.74	173	230.74	22	1.05	1.0
CTP	150.25	(4.41)	(88.11)	57.74	173	230.74	22	1.05	1.0
CSIR	178.00	(0.10)	(99.28)	78.72	173	251.72	24	1.05	1.0
Ecofuel		2			2	272.69	26	1.05	1.0
Duffco	754.39	(9.17)	(754.22)		1426	262.21	25	1.05	1.0
ARO	1754.39	2	(1602.26)	152.13	173	325.13	31	1.05	1.0

[1] *VAT is payable on bituminous coal (14% x R 78.75)*
[2] *No information available*

Thus, for example, Coal Tar Products would need to retail its fuel at R 230 per ton for it to have the same energy price as bituminous coal. Assuming distribution costs are equal to those for bituminous coal, the fuel would need to have an ex-production price of R 57.74. After accounting for savings in finance charges and the zero-rating of VAT, the required rebate will be R88.11.

Table 6.8 shows the effect of paying this rebate to all low-smoke fuel producers. It is evident that the resulting energy price of three of the low-smoke fuels (Wits/UCP, CSIR and Coal Tar Products) makes them competitive with bituminous coal. The 'per ton' price of Coal Tar Product's fuel will be more than 10% lower than that of bituminous coal while the Wits/UCP and CSIR fuels will have the same price per ton as bituminous coal.

Table 6.8: Recommended market intervention package for the support of low-smoke fuels

Fuel	Price ex-production excl VAT [R/ton]	Savings in finance charges [R/ton]	Tax/ (Rebate) [R/ton]	Nett Price[1] [R/ton]	Distribution cost [R/ton]	Retail price [R/ton]	CV [MJ/kg]	Energy Price [c/MJ]	Delivered Retail price ratio
Bit. Coal	48.25	(0)	30.00	89.21	173	262.21	25	1.05	1.00
Wits/UCP	178.00	(1.19)	(88.11)	88.70	173	261.70	22	1.19	1.13
CTP	150.25	(4.41)	(88.11)	57.74	173	230.74	22	1.05	1.00
CSIR	178.00	(0.10)	(88.11)	89.89	173	262.89	24	1.10	1.04
Ecofuel		2	(88.11)			399.55	26	1.54	1.47
Duffco	754.39	(9.17)	(88.11)	657.11	1426	2083.11	25	8.33	7.94
ARO	1754.39		(88.11)	1616.23	173	1839.28	31	5.93	5.66

[1] *VAT is payable on bituminous coal (14% x R 58.75)*
[2] *No information available*
[3] *No information available on cost of production plant. Although savings on finance charges have not been included there will in fact be some savings which will make a small difference to the nett price*

Given that coal is a basic commodity for large numbers of poor households, a R30 tax imposed at an early stage in an intervention strategy would have undesirable equity consequences. Thus the above recommendation is seen as a target to be met in the medium term. In the immediate short term, it is suggested that a lower pollution tax of about R10/ton is levied, with this increasing to R30/ton over a period of years. This will obviously mean that initially, a higher rebate per ton would be required for low-smoke fuel producers. The cost to the government, however will be countered by the fact that initially bituminous coal sales will be considerably higher than low-smoke fuel sales. In the longer term, once low-smoke fuels have established themselves and are being widely utilised, it would be desirable for government to taper its price support down to zero. The establishment of a nett cost to government for any combination of the above intervention options will require more accurate base data and also a detailed consideration of the likely shift in market proportion between low-smoke fuels and bituminous coal.

6.3 Related issues

Whilst the policy interventions which have been described above represent a comprehensive package of strategies which need to be implemented in co-ordination with each other, there are several other interventions which should take place at the same time. These are set out briefly below.

- A *publicity and education campaign* is required so that end-users and other participants in the household coal market (such as merchants and wholesalers) are aware of both the health problems caused by bituminous coal use, and the many issues surrounding the government's efforts to introduce low-smoke fuels.
- Government should *communicate* its intentions and plans clearly and openly, so that end-users and participants in the supply chain are informed and can plan accordingly. This will contribute further towards the objective of *reducing the risk and uncertainty,* as far as this is possible, for producers seeking to enter the low-smoke fuels market.
- It is vital to the successful implementation of the legislation that the application of a *smoke control zone* to an area is preceded by a suitable *publicity* campaign. The campaign must be targeted to ensure that coal users become aware of the stipulations of the Act, penalties for contravention as well as alternative fuel choices. It is also important that publicity associated with legislation is ongoing, particularly in the medium term. One of the problems identified when policing smoke control zones is that in those areas where the legislation was put into effect some time ago, many of the newer residents are not aware of the fact that the area is a smoke control zone.
- Whatever intervention options are exercised by government it will be important to establish an ongoing monitoring process to gauge the impact of the overall intervention strategy and to institute amendments should they be required.

6.4 Unresolved issues

Further work is required in certain areas addressed by this report:

- Quantification of the current external costs of coal use in the household sector should be undertaken to improve upon the rough estimates which currently exist. The importance of this lies in the fact that this estimate is the key factor which should determine the size of the pollution tax on bituminous coal.
- The coal distribution chain is still not well understood, especially in the informal segment which comprises numerous small merchants and traders. It will be imperative for these merchants, both small and large, to understand and support the introduction of low-smoke fuels. To date this sector has not been effectively drawn into planning for the introduction of low-smoke fuels.
- If the market-based interventions outlined in this report, such as a pollution tax on bituminous coal and price support for low-smoke fuels, are to be implemented, then clearly more detailed work needs to be done leading to the actual implementation of those strategies. As part of this work it will be necessary to more carefully consider the time-scales for the increase in pollution taxes as well as those for the tapering of rebates to low-smoke fuel producers.
- A possible problem with levying a pollution tax on household coal is that it can be difficult to distinguish between coal going to household market and small industry. Thus it may be necessary for coal distributors and merchants to have improved accounting systems as mentioned in Chapter Two. This is an area that requires further research and input from involved parties.

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